FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	PAGE
	$\bar{p}$ Note #488	1

SUBJECT: DRF1 φ feedback

NAME: RJ Pasquinelli

DATE: 1/8/90

REVISION DATE:

The phase feedback for DRF1 must be different from ARF1 because the Q of the cavities are different. From the note written on 10/13/88. response to a 50° phase step took a max of 35 μsec to lock up. This amp had unity gain @ 10 KHz.

ARF1 Q ≈ 150 to 200

DRF1-1 Q ≈ 4182 DRF1-8 Q ≈ 3096
see attached graphs.

The narrow band of the cavity now is the controlling loop parameter. and will not allow for such a fast response as is obvious by oscillation of φ error voltage. see attached plot #1

It is therefore necessary to lower the Bandwidth for DRF1 φ loop yet maintain the fastest possible lockup time.

A new amp filter for the PLL will be tried. data is attached.
3dB BW of cavity is ≈ 15 KHz

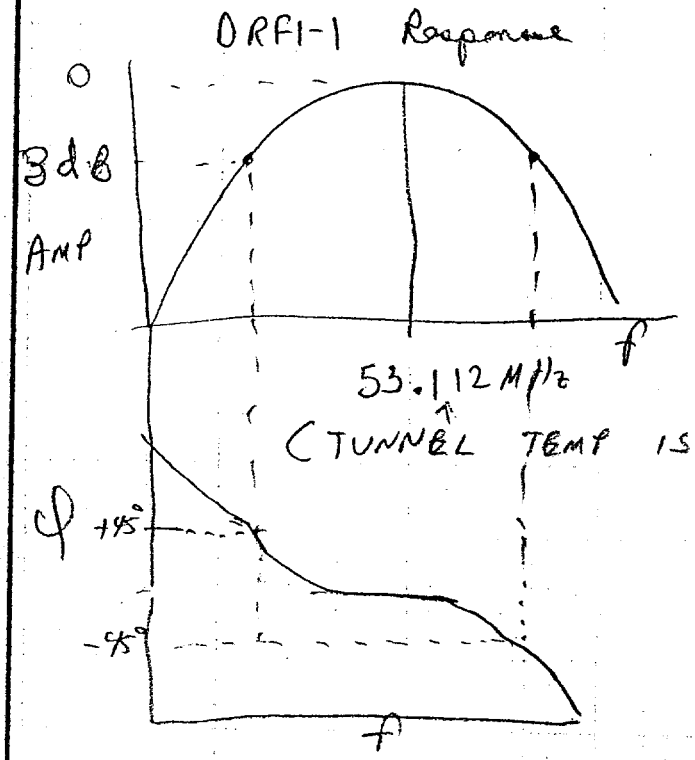
522703

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
			2

SUBJECT: DRF1 φ feedback

NAME: Ralph J. Pasquinelli
DATE: 1/8/09
REVISION DATE:



the phase modulation noted in the phase error plot shows a 13.3 KHz oscillation. This is due to the restriction of the cavity position. For a feedback circuit to work properly it will be necessary to have the controlling loop filter well within this bandwidth.

Again by observation of PLOT 1 the φ error voltage is oscillating 1.44 Vpp between +3 & +4 volts where the φ shifter gain is ≈ 39°/volt see attached sheet for PMES-4-53. This corresponds to sidebands in Plot 2 note these measurements were made off the resonant frequency. similar measurement made on fo show a smaller φ error with sidebands @ 30KHz see plots 3 & 4

522703

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
			3

SUBJECT: DRFI φ feedback

NAME: RJP

DATE: 1/11/90

REVISION DATE:

It was decided to try a filter with half the BW of the final. unity gain of this filter ≈ 5 KHz see attached plots. performance of φ feedback is now acceptable as shown in attached plots response to a step turn on in DRFI-1 dum yields lock up of ≈ 1.7 msec.

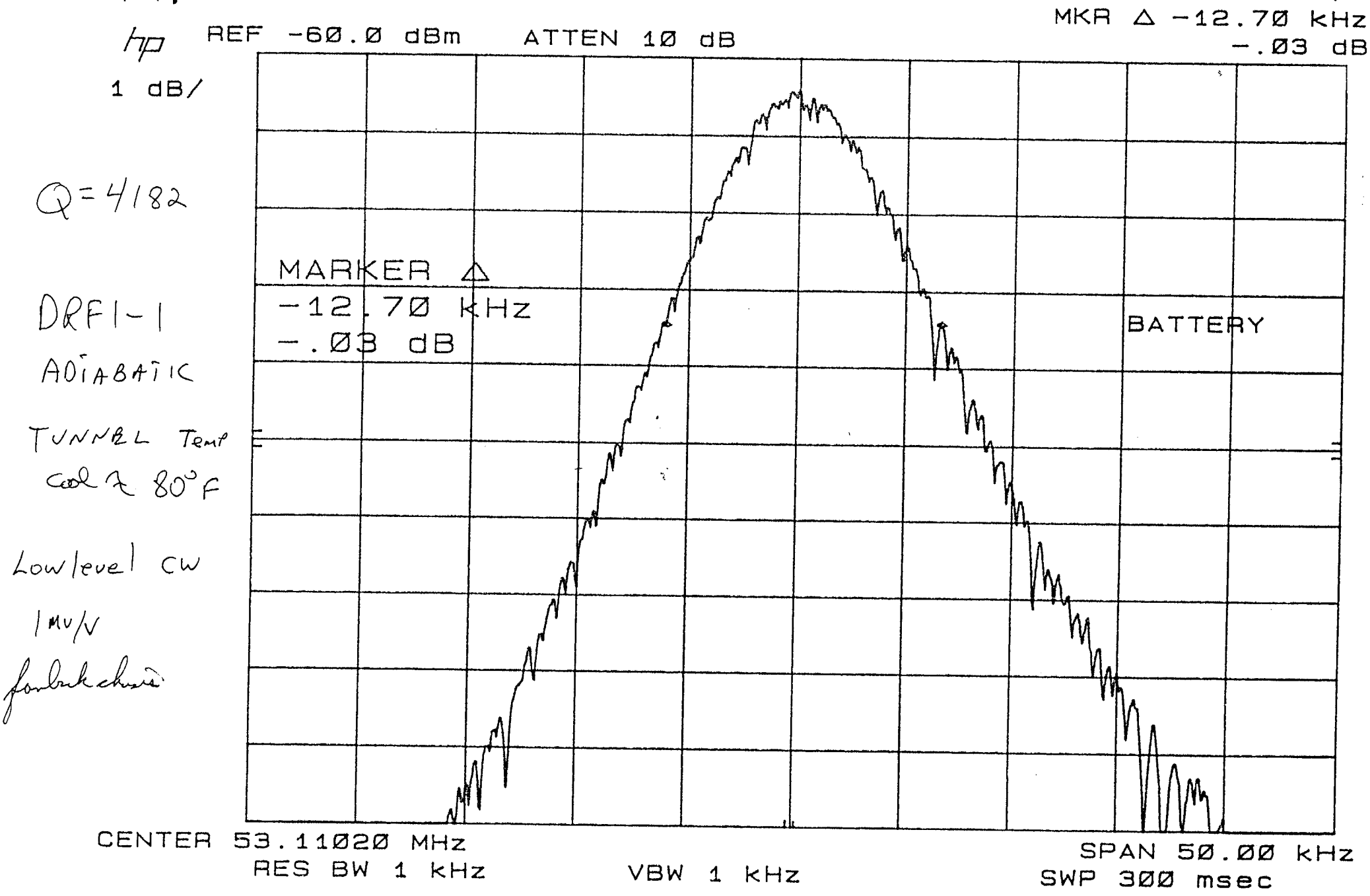
DRFI-8 locking faster due to fact that limiter in Low level is always picking up some stray 53 MHz component and keeping a bias on the φ detector.

Both systems were check for φ tracking throughout the 20 msec pulse of the arm drive.

This indicates that adiabatic cavities should be turned on ≈ 2 msec before the rotators.

522703

1/9/90


hp
REF -60.0 dBm
ATTEN 10 dB
MKR Δ -12.70 kHz
-.03 dB
1 dB/
Q=4182
DRF1-1
ADIABATIC
TUNNEL Temp
cool ≈ 80°F
Low level CW
1 MV/V
MARKER Δ
-12.70 kHz
-.03 dB
BATTERY
CENTER 53.11020 MHz
RES BW 1 kHz
VBW 1 kHz
SPAN 50.00 kHz
SWP 300 msec

1/9/90

hp

REF −52.0 dBm ATTEN 10 dB

MKR Δ −17.15 kHz
.01 dB

1 dB/

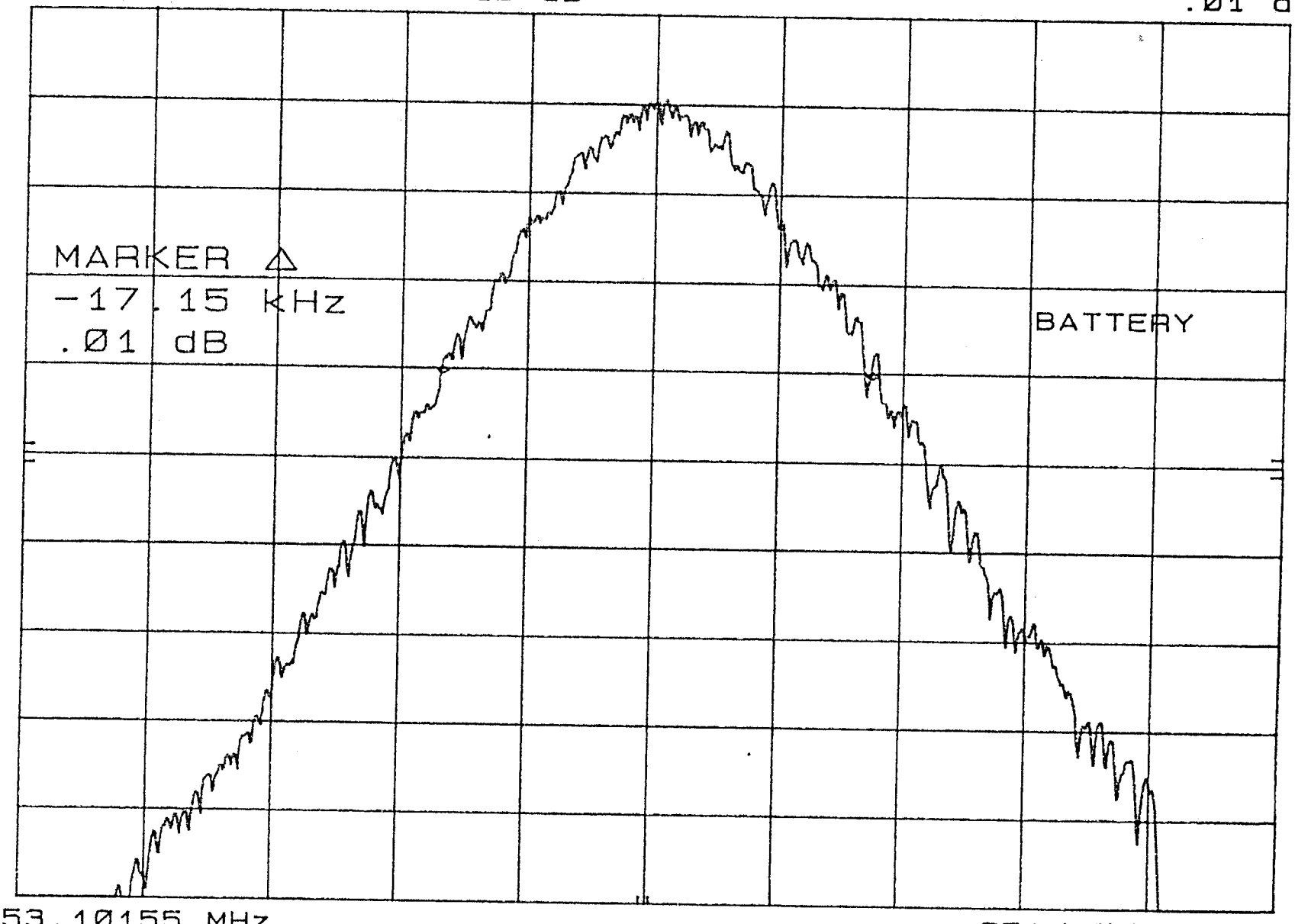
Q = 3096

DRF1-8

ADIABATIC

TUNNEL TEMP
cool ≈ 80°F

Low Level CW
1mV/V
fanback down



CENTER 53.10155 MHz
RES BW 1 kHz

VBW 1 kHz

SPAN 50.00 kHz
SWP 300 msec

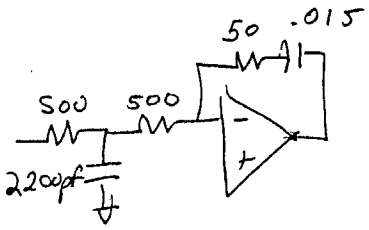
carly f_o = 53.1102MHz

f_o = 53.1035MHz

PLOT #1

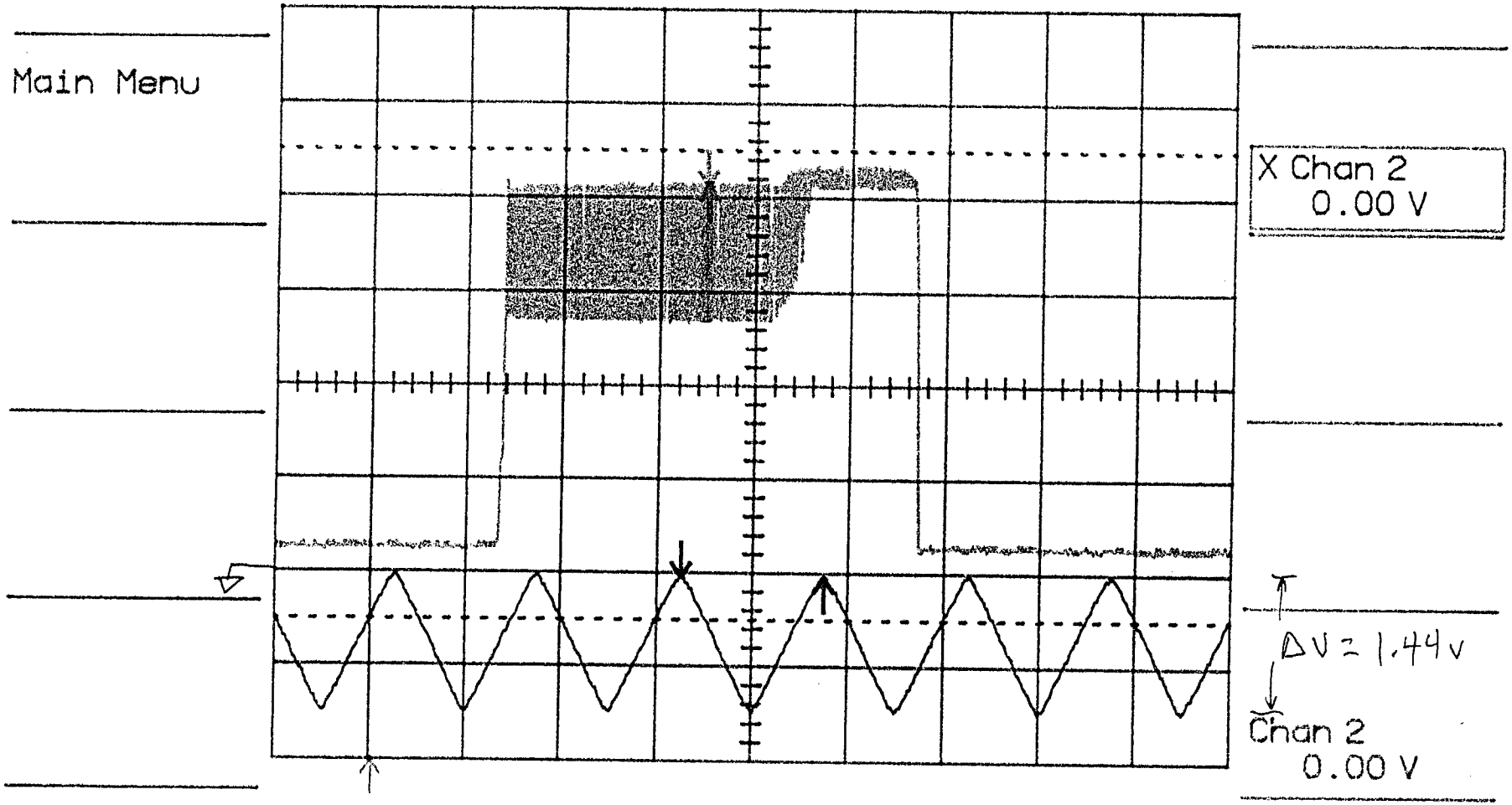
DEB DRF1-1 ADIABATIC

ϕ ERROR USING



9-Jan-90
10:06:04

LeCroy



Δt 75.00 µs

1/Δt 13.333 kHz

EXT 1.69 V DC

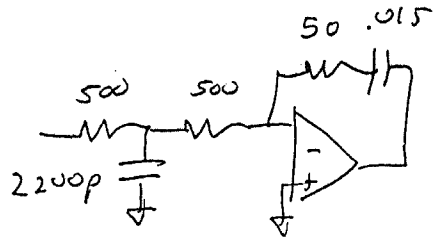
CH1 20 mV

CH2 1 V

T/div 5 ms

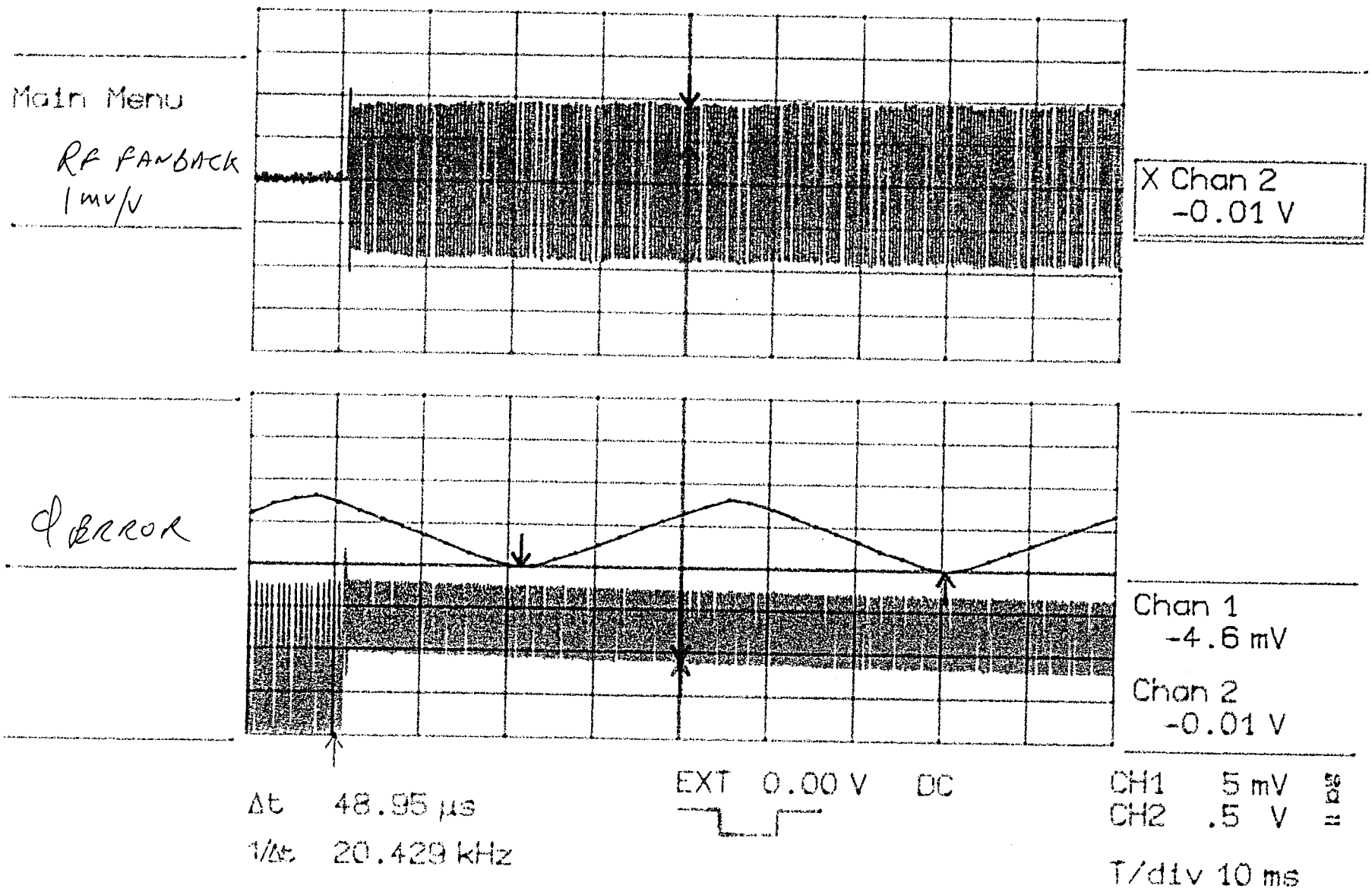
$f_0 = 53.1035\,MHz$ DRF1-1 ADIABATIC

f_0 CAVITY = 53.1105 MHz



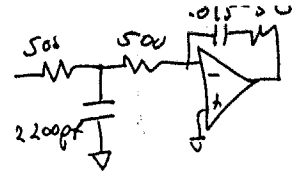
10-Jan-90
10:21:05

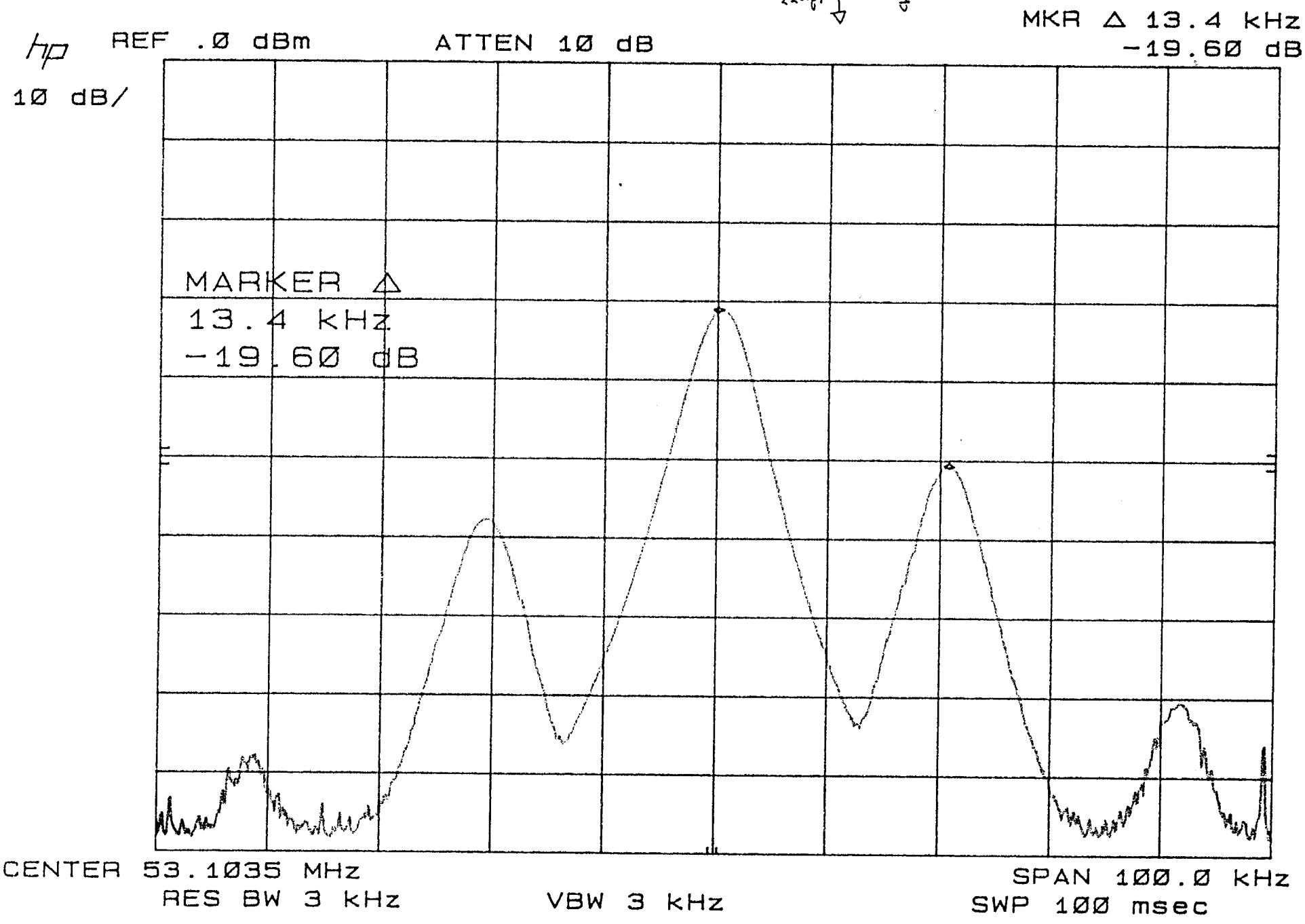
LeCroy



1/10/90

DRFI-1 ADIABATIC





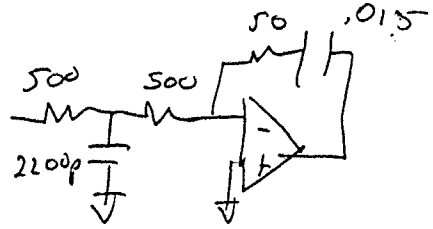
PLOT 2

f_o = 53.1105 MHz

f_{CAVITY} = 53.1105 MHz

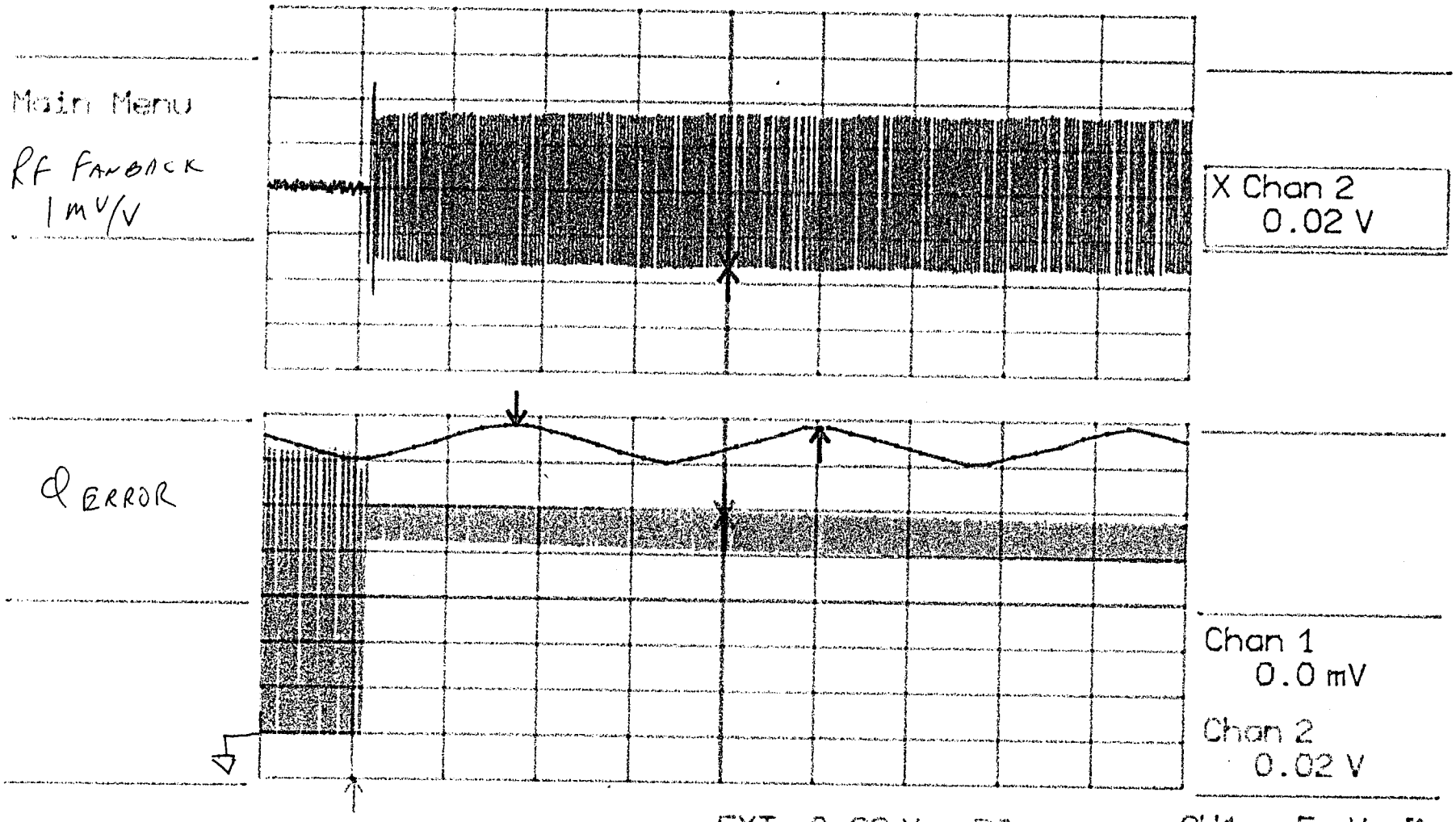
DRFI-1 ADIABATIC

PLOT 3



10-Jan-90
10:37:55

LeCroy



Δt 32.85 µs

1/Δt 30.441 kHz

EXT 0.26 V DC

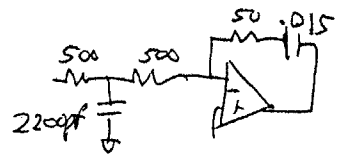
CH1 5 mV
CH2 .5 V

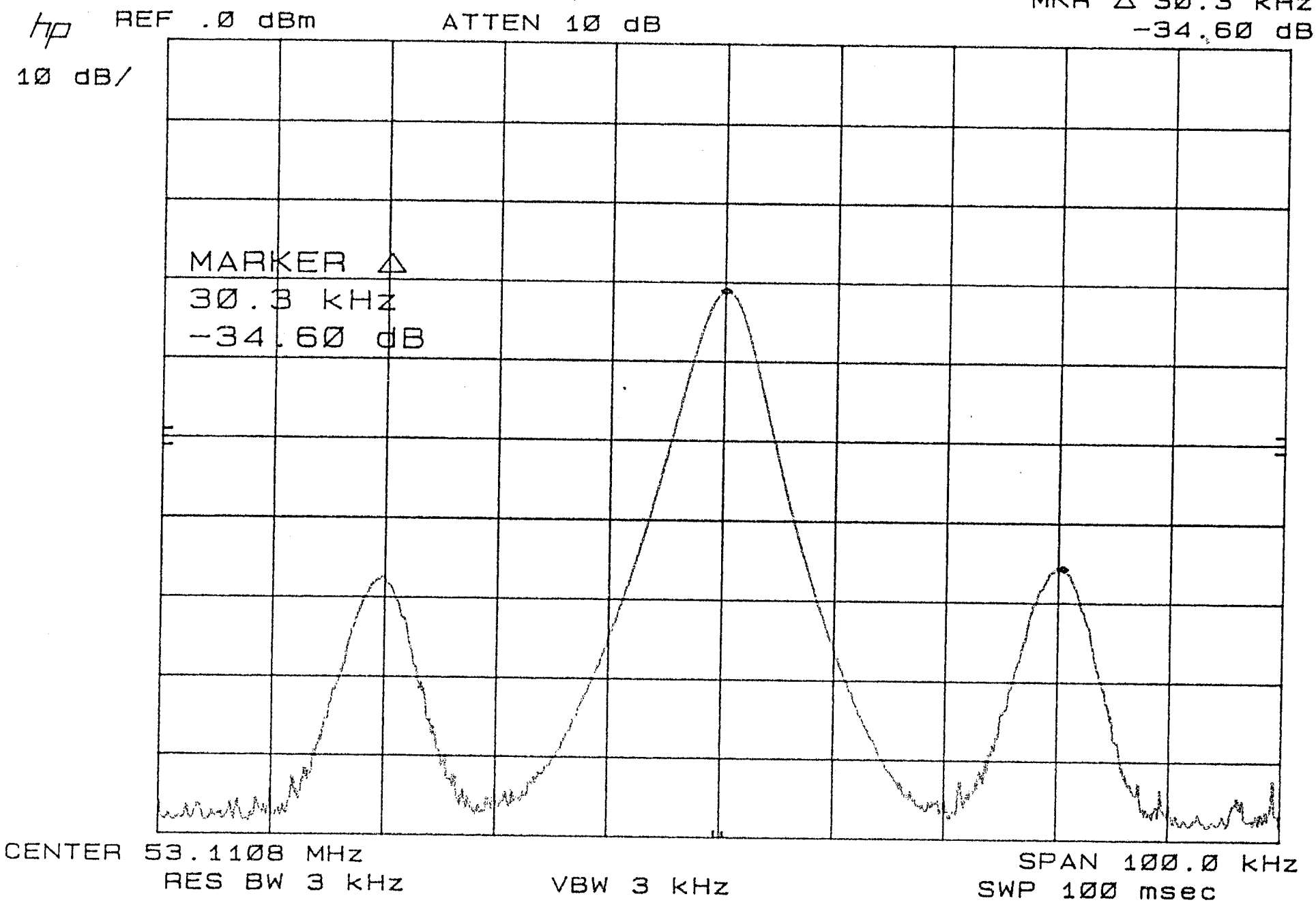
T/div 10 ms

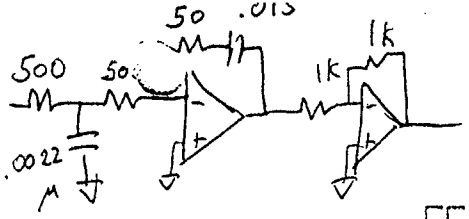
1/10/90

DRFI-1 ADIABATIC

PLOT 4



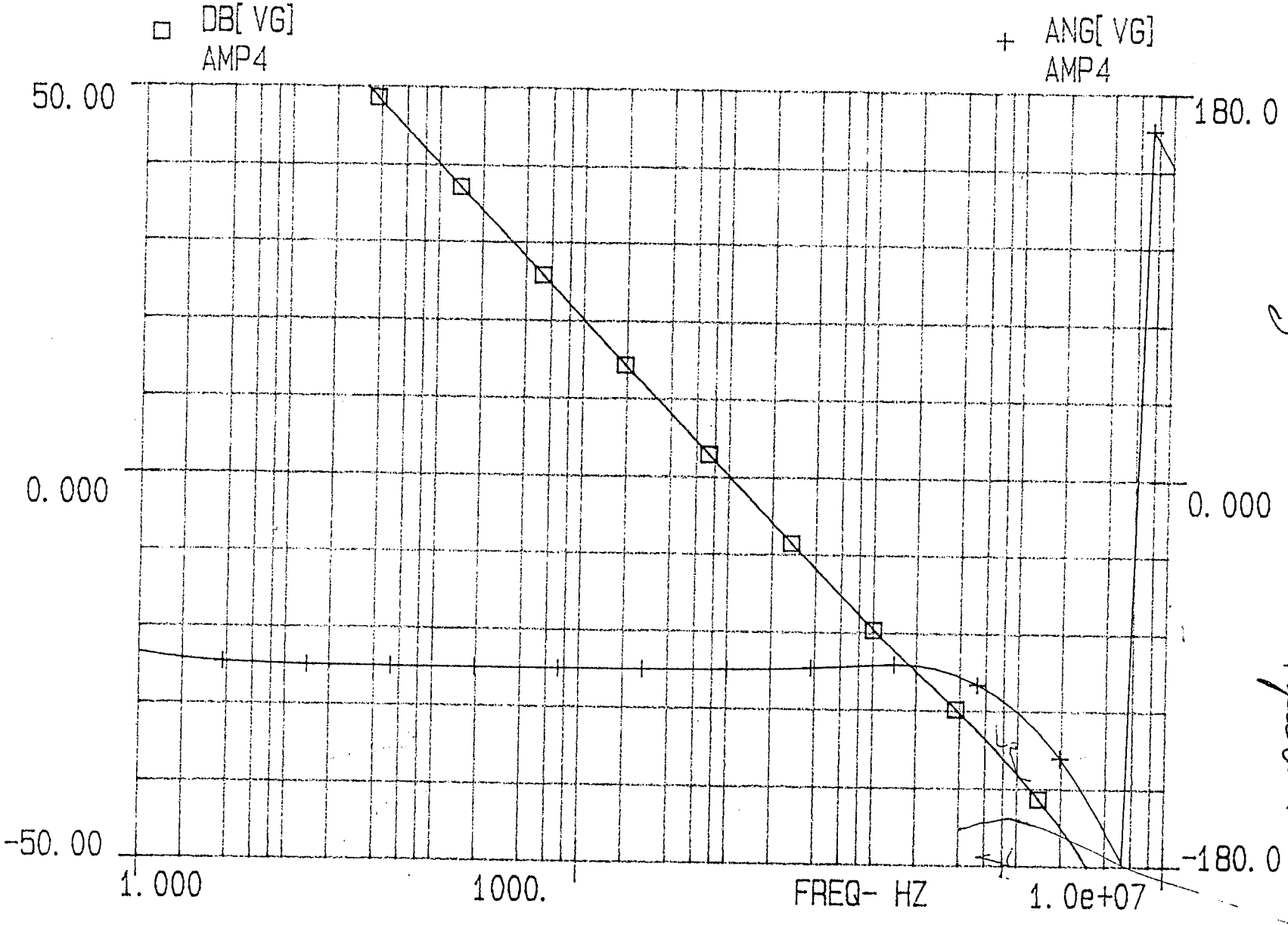




$F_T = 8\,MHz$

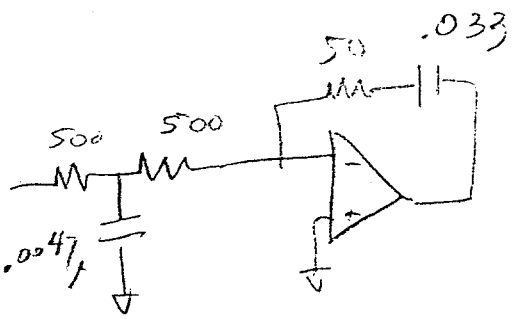
OP AMP

EEsof - Touchstone - Wed Oct 12 09:31:29 1988 - PLLFIL



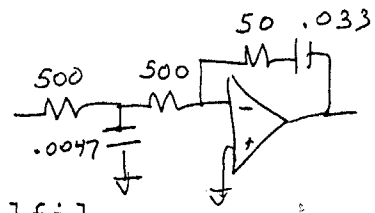
FILTER FOR ARFI & feedback
initially tested in ARFI & feedback

```
Touchstone (TM) - Configuration( 100 1700 101 16800 1684 1000 1 16582 )
                PLLFIL.CKT     Mon Jan 08 16:28:54 1990

!PLL OF   AMP FILTER

DIM
  FREQ  HZ
  RES KOH
  IND NH
  CAP UF
  LNG MIL
  TIME PS
  COND /OH
  ANG DEG


CKT
        OPAMP 1 0 2  0 0 M=1E5 A=0 R1=1E4 R2=1E4 R3=.001 R4=1E7  F=80 T=0
       RES 10 5  R=.5
       CAP 5 0 C=.0047
       RES 5 1 R=.5
       RES 1 20 R=.05
       CAP 20 2 C=.033
        DEF2P 10 2  AMP

        OPAMP 1 0 2  0 0 M=1E5 A=0 R1=1E4 R2=1E4 R3=.001 R4=1E4  F=80  T=0
       RES 10 1 R=1
       RES 1 2 R=1
         DEF2P 10 2 AMP2
!       OPAMP 1 0 2  0 0 M=1E5 A=0 R1=1E4 R2=1E4 R3=.001 R4=1E4  F=30  T=0
 !     RES 10 1 R=1
 !     RES 1 2 R= 1
!        DEF2P 10 2 AMP3
    AMP 1 2
    AMP2 2 3
!   AMP3 3 4
    DEF2P 1 3 AMP4

OUT

!       AMP  DB[VG] GR1
!       AMP  ANG[VG] GR1A
        AMP4 DB[VG] GR1
        AMP4 ANG[VG] GR1A
FREQ

 ESWEEP 1  1E7 50


GRID
    LRANGE  1 1E7
    GR1 50  -50  10
    GR1A -180 180

OPT
   RANGE 8 10 1
```

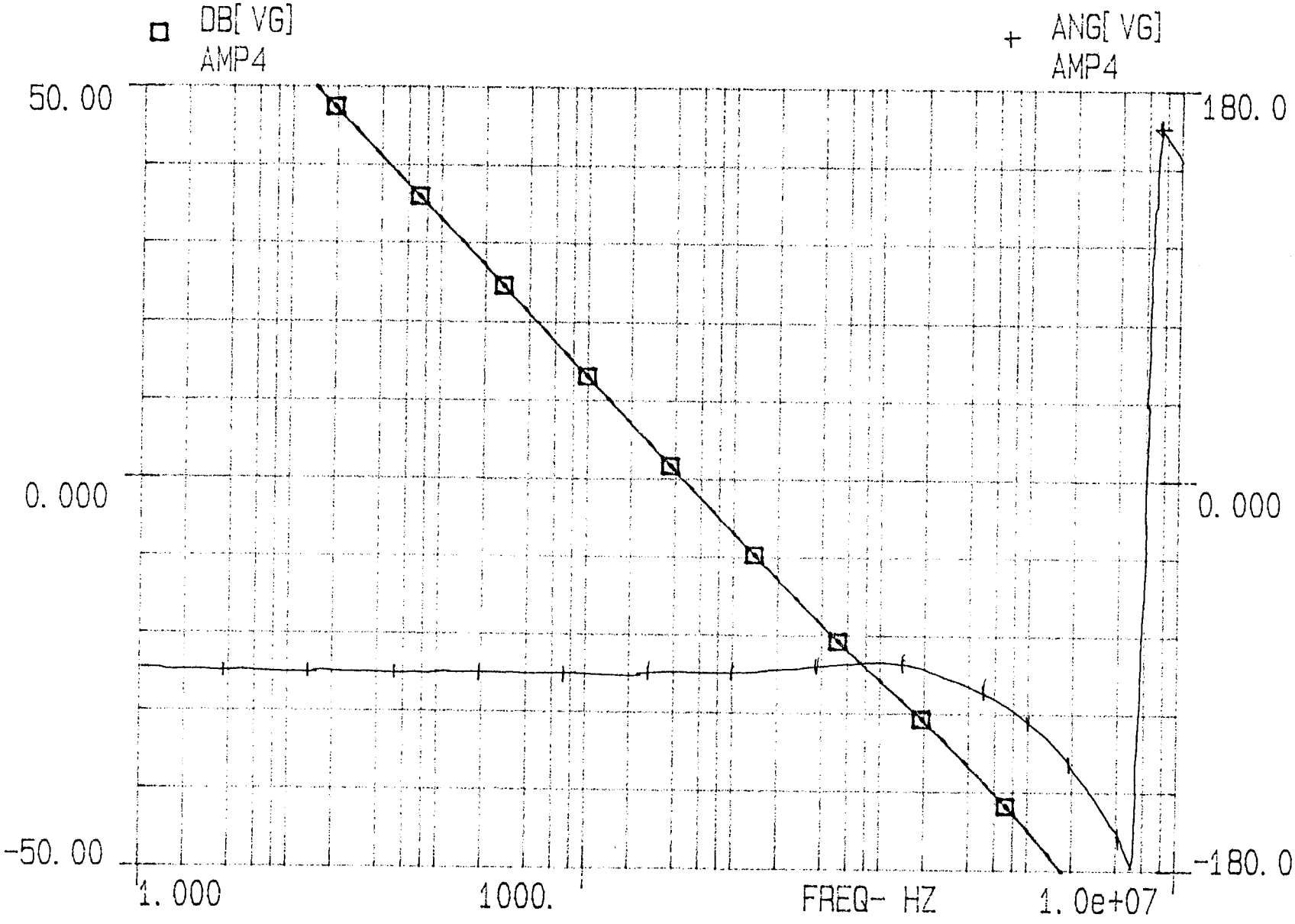


Touchstone (TM) - Configuration(100 1700 101 16500 1684 1000 1 15582)
PILFIL.OUT Mon Jan 08 16:28:26 1990

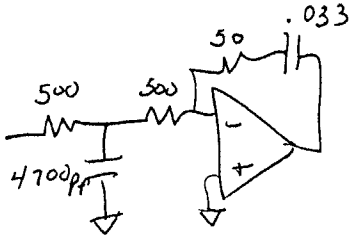
FREQ-MHZ	DB[VG] AMP4	ANG[VG] AMP4
1.00000	73.229	-87.369
1.38950	70.375	-88.106
1.93070	67.520	-88.636
2.68270	64.664	-89.018
3.72759	61.808	-89.293
5.17947	58.951	-89.491
7.19686	56.094	-89.633
10.0000	53.237	-89.735
13.8950	50.380	-89.809
19.3070	47.523	-89.861
26.8270	44.666	-89.898
37.2759	41.808	-89.925
51.7947	38.951	-89.943
71.9686	36.094	-89.954
100.000	33.237	-89.961
138.950	30.380	-89.963
193.070	27.523	-89.962
268.270	24.666	-89.956
372.759	21.809	-89.945
517.947	18.951	-89.928
719.686	16.094	-89.904
1000.00	13.237	-89.869
1389.50	10.380	-89.820
1930.70	7.524	-89.751
2682.70	4.667	-89.655
3727.59	1.811	-89.521
5179.47	-1.043	-89.336
7196.86	-3.895	-89.080
10000.0	-6.743	-88.728
13895.0	-9.581	-88.248
19307.0	-12.402	-87.607
26827.0	-15.194	-86.781
37275.9	-17.934	-85.790
51794.7	-20.595	-84.760
71968.6	-23.157	-83.993
100000.	-25.631	-83.939
138950.	-28.088	-84.965
193070.	-30.584	-87.099
268270.	-33.191	-90.109
372759.	-35.905	-93.801
517947.	-38.712	-98.217
719686.	-41.604	-103.623
1.0e+06	-44.602	-110.451
1.4e+06	-47.758	-119.224
1.9e+06	-51.178	-130.443
2.7e+06	-55.015	-144.382
3.7e+06	-59.460	-160.805
5.2e+06	-64.677	-178.811
7.2e+06	-70.737	162.999
1.0e+07	-77.590	146.065



EEsof - Touchstone - Mon Jan 8 16:13:59 1990 - pllfil



$f_o = 53.1102\,MHz$

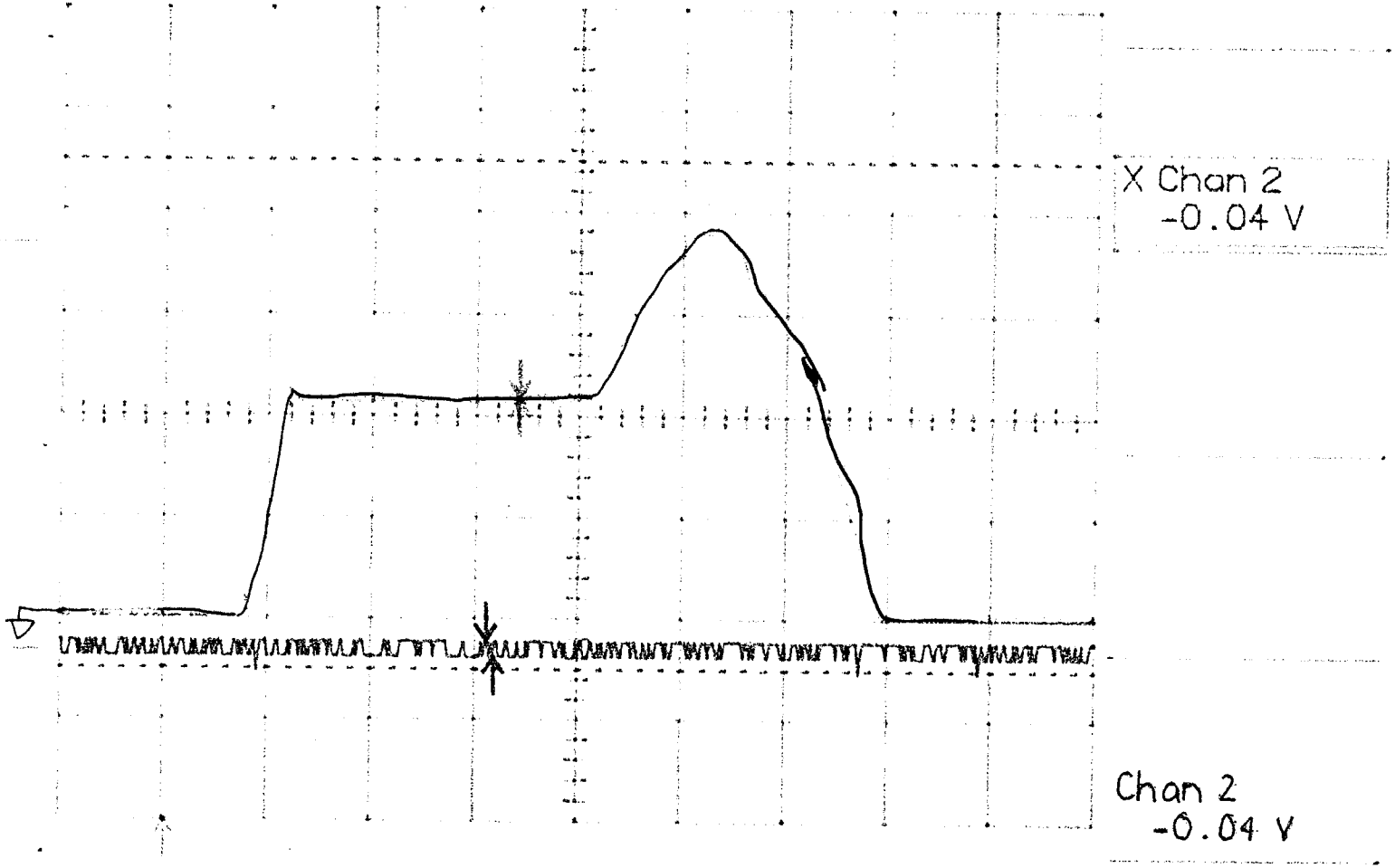


DEB DRFI-1 ADIABATIC

ϕ ERROR using

LeCroy

CURVE DRIVE



ϕ ERROR

EXT 1.69 V DC

CH1 20 mV
CH2 1 V

Δt 3.75 μs

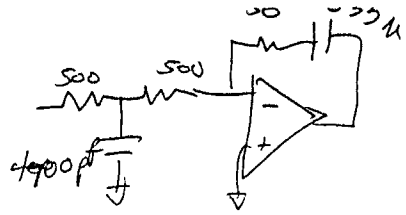
$1/\Delta t$ 266.7 kHz

I/div 5 ms

$f_0 = 53.1102$ MHz

DEB ORFI-1 ADIABATIC

ϕ ERROR STEP Response



9-Jan-90
11:09:47

LeCroy

Main Menu

FANBACK
1MV/V

Dual Zoom
OFF

ϕ ERROR

X Chan 1
- -

X Chan 2
2.16 V

Chan 1
-24.0 mV

Chan 2
2.16 V

At 1.7180 ms

1/At 582.751 Hz

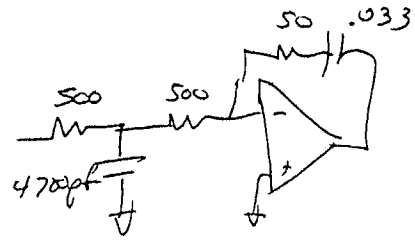
EXT 1.69 V DC

CH1 10 mV
CH2 1 V

T/div 5 ms

$f_o = 53.1102$ MHz DEB DRF1-1 ADIABATIC

φ ERROR CURVE DRIVE

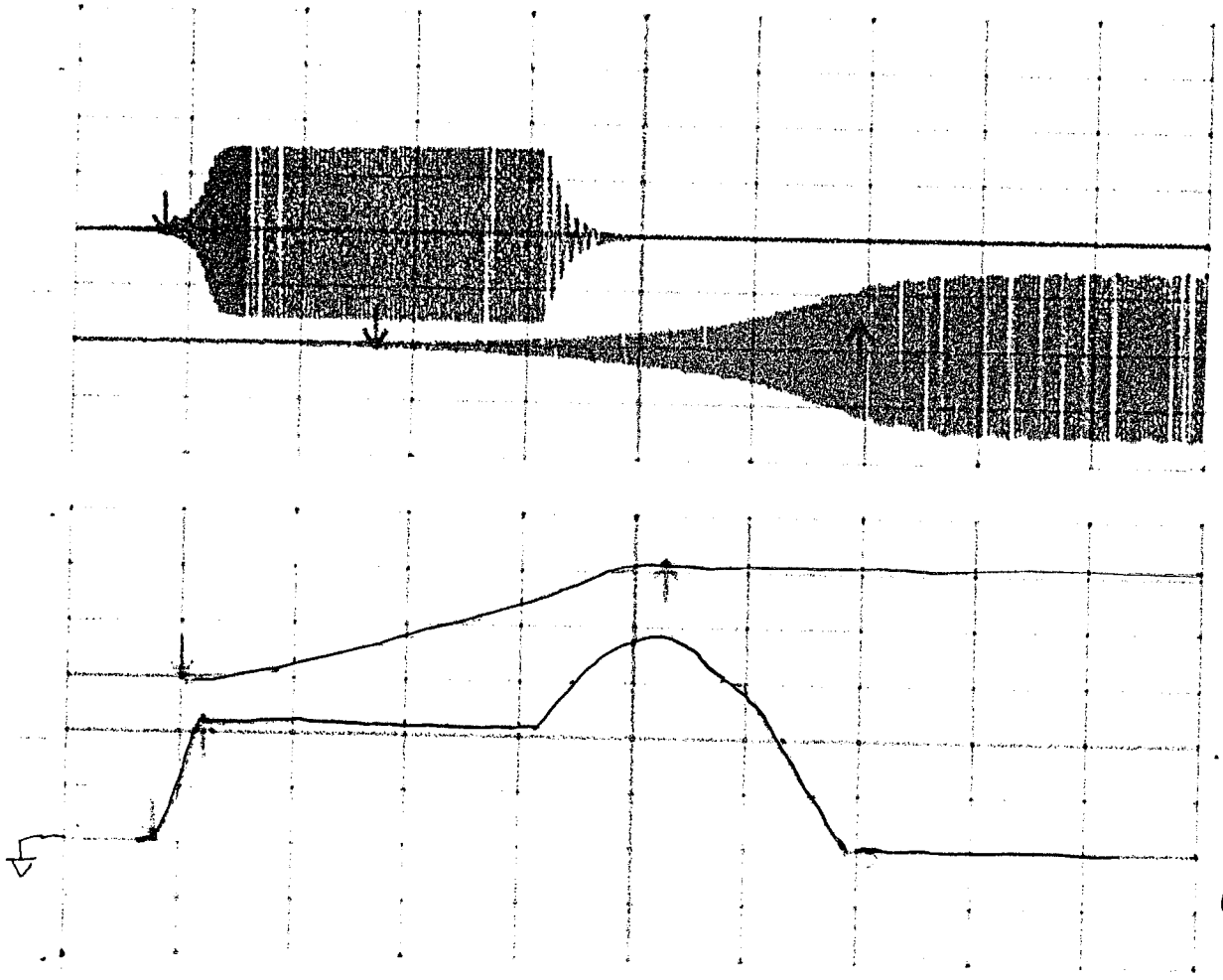


Main Menu

FANBACK
1mV/V

Dual Zoom
OFF

φ ERROR



At 2.1325 ms

1/Δt 458.933

EXT 1.69 V DC

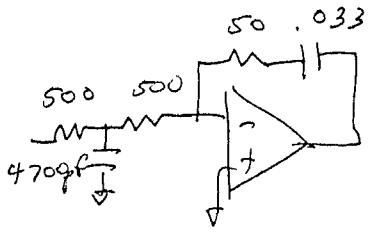
CH1 20 mV
CH2 1 V

5 ms

CAVITY F f_0 = 53.1015

f_0 = 53.1015

DRFI-8 ADIABATIC



curve drive is 10 V_{pp}

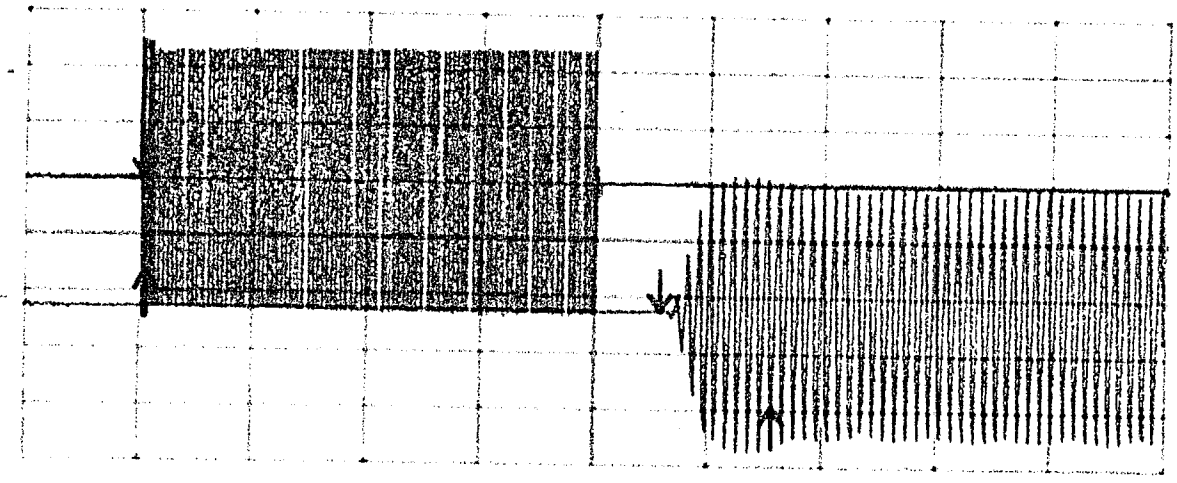
LeCroy

Main Menu

RF FANBACK

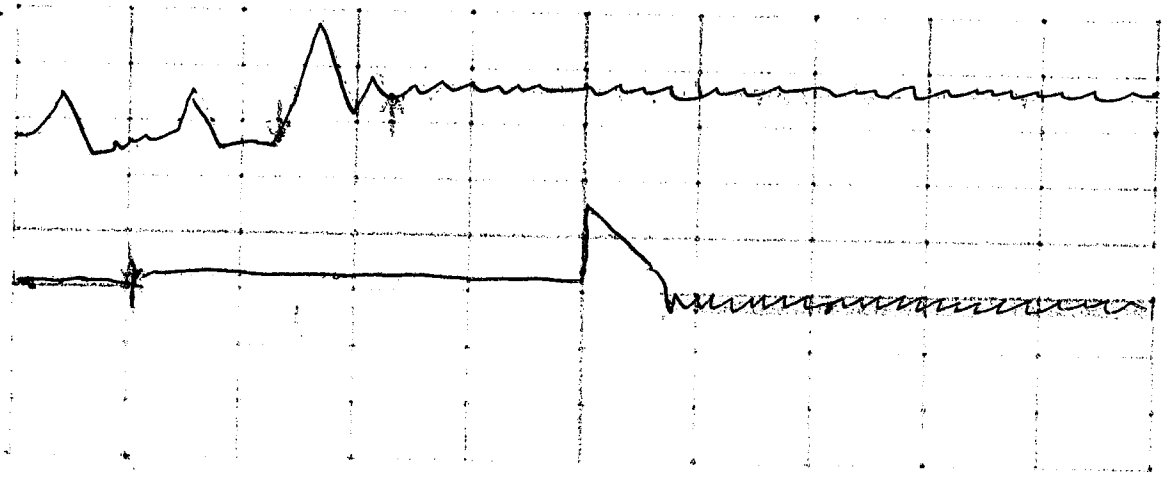
1mV/V

Dual Zoom OFF



X Chan 1
-33.6 mV

X Chan 2
0.18 V



Chan 1
-33.6 mV

Chan 2
0.18 V

Δt 98.0 μs

1/Δt 10.20 kHz

EXT 0.00 V DC

CH1 20 mV

CH2 1 V

T/div 5 ms

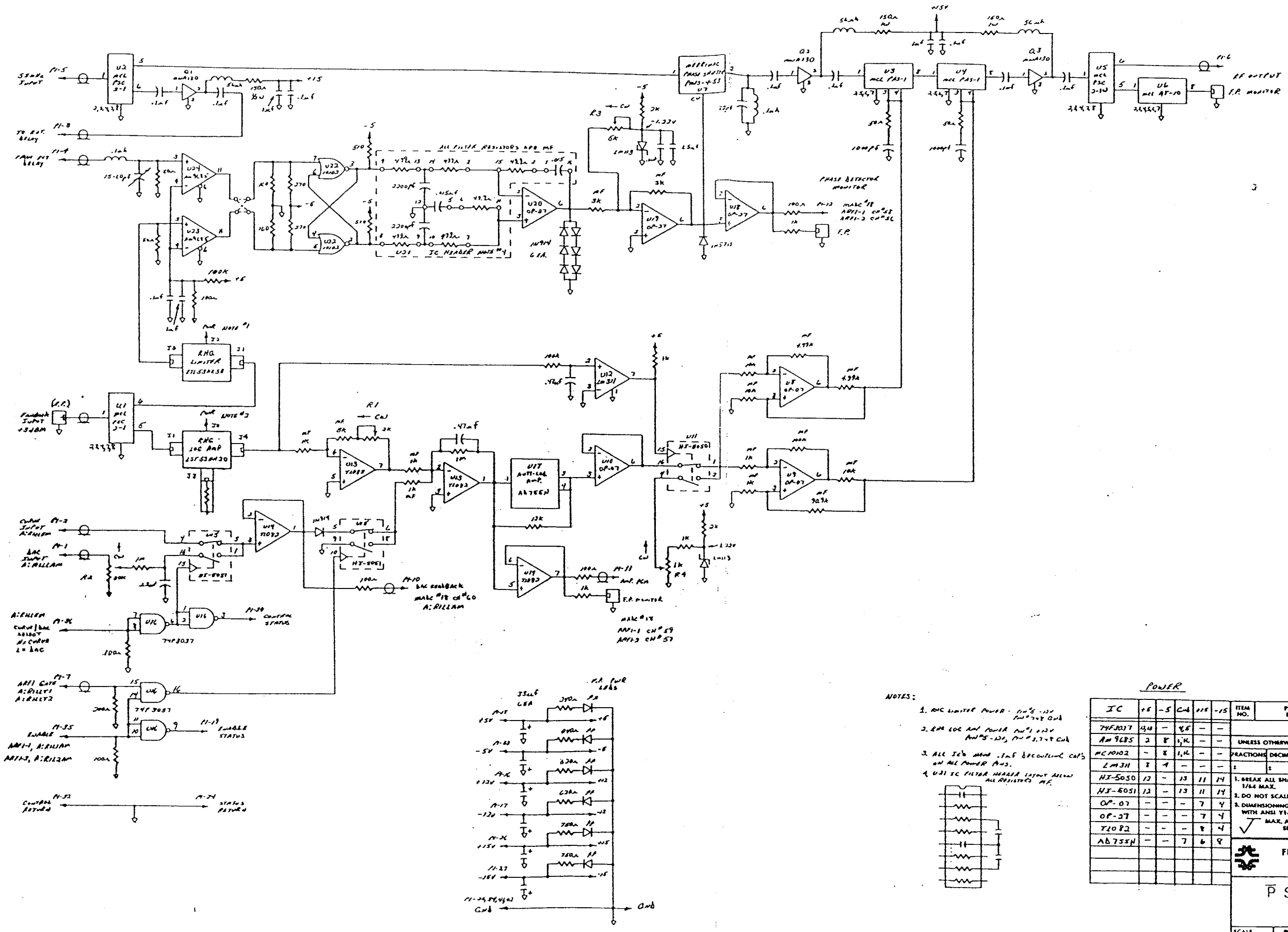
53 MHZ

MERRIMAC

PMES-4-53/57540

VOLTS	S/N 22 Ø SHIFT/VOLT	S/N 22 TOTAL Ø SHIFT	S/N 26 Ø SHIFT/VOLT	S/N 26 TOTAL Ø SHIFT
0-1V	54.077	54.077	55.15	55.15
1V-2V	46.591	100.67	46.82	101.97
2-3	42.14	142.81	42.52	144.49
3-4	38.99	181.80	38.931	154.417
4-5	35.935	217.735	36.935	221.354
5-6	31.875	249.65	32.785	254.139
6-7	27.385	277.015	27.731	281.87
7-8	23.045	300.06	23.17	305.04
8-9	19.12	319.18	19.24	324.28
9-10	16.15	335.33	16.28	340.56
10-11	13.58	348.91	13.67	354.23
11-12	11.507	360.417	11.58	365.81
12-13	10.051	370.47	10.07	375.88
13-14	8.6	379.07	8.71	384.59
14-15	7.565	386.635	7.615	392.205
15-16	6.685	393.32	6.69	398.895
16-17	5.97	399.29	5.91	404.89
17-18	5.295	404.585	5.21	410.1
18-19	4.78	409.365	4.775	414.875
19-20	4.25	413.615	4.245	419.12

REV.	DESCRIPTION	DRAWN	DATE
		APPD.	DATE



NOTES:

1. RHQ LIMITER POWER - PIN #5 -12V PIN #7 +8 GND
2. RHQ LOC AMP POWER PIN #1 +12V PIN #5 -12V, PIN #3, 7 +8 GND
3. ALL IC'S HAVE .1uf DECOUPLING CAP'S ON ALL POWER PINS.
4. U21 IC FILTER HEADER LAYOUT BELOW ALL RESISTORS MF.

POWER

IC	+5	-5	Gnd	+15	-15
74F3037	13,14	–	4,5	–	–
AM 9685	2	8	1,16	–	–
MC10102	–	8	1,16	–	–
LM311	8	4	–	–	–
HI-5050	12	–	13	11	14
HI-5051	12	–	13	11	14
OP-07	–	–	–	7	4
OP-27	–	–	–	7	4
TL082	–	–	–	8	4
AD755N	–	–	7	6	8

ITEM NO.	PART NO.	DESCRIPTION OR SIZE	QTY. REQ.
		PARTS LIST	

UNLESS OTHERWISE SPECIFIED

FRACTIONS	DECIMALS	ANGLES
±	±	±

1. BREAK ALL SHARP EDGES 1/64 MAX.
2. DO NOT SCALE DWG.
3. DIMENSIONING IN ACCORD WITH ANSI Y14.5 STD's.

√ MAX. ALL MACHINED SURFACES

ORIGINATOR	R.J.PASQUINELLI	
DRAWN	PETER SEIFRID	13OCT88
CHECKED		
APPROVED	Peter C. Seifrid	18 JAN 89

USED ON

MATERIAL-

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

$\overline{P}$ SOURCE LLRF ARFI/DRFI AMPLITUDE CONTROL MODULE

SCALE	FILMED	DRAWING NUMBER	REV.
		8000-ED-266058	