End Mass #1 Damping Electronics 1983 February to 1985 May 1

Society Note Book

The Coop

2739Q

END MASS #1
DAMPING ELECTRONICS

EM 1

the Coop

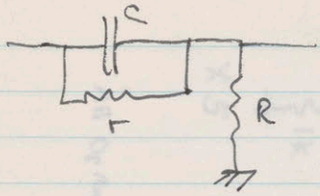
1882 — A Century of Service — 1982

Name _____

_____

$1.30

"This book is made with 20lb. paper"



$\frac{1}{rC}$

$\left(\frac{Rr}{R+r}\right)C$

$\boxed{\frac{\omega_2}{\omega_1} = 5}$

$\omega_0 = 8\text{Hz} \times 2\pi$

$\omega_c^2 = \omega_1\omega_2 = 5\omega_1^2$

$\omega_1 = \frac{1}{\sqrt{5}}\omega_0 = \frac{2\pi 8}{\sqrt{5}} = 22.5 = \frac{1}{rC}$

$f_1 = 3.56\text{Hz}$

$f_0 = 8\text{Hz}$

$f_2 = 17.89\text{Hz}$

$C = .1\mu\text{F}$

$r = \frac{1}{(22.5)(.1\times10^{-6})} = 444\,\text{k}$

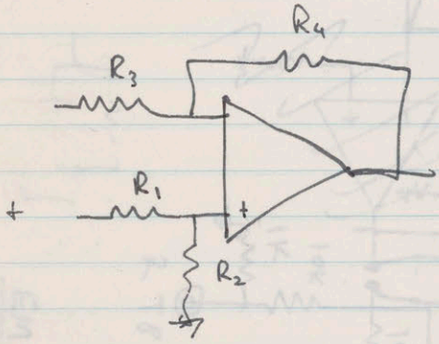
$R_{ef} = \frac{1}{(5)(22.5)(.1\times10^{-6})} = 89\,\text{k}$

$\frac{1}{R} = \frac{1}{89} - \frac{1}{444} = (111\,\text{k})^{-1}$

$\varphi_{max} = \tan^{-1}\left(\frac{\omega_2-\omega_1}{2\sqrt{\omega_1\omega_2}}\right) =$

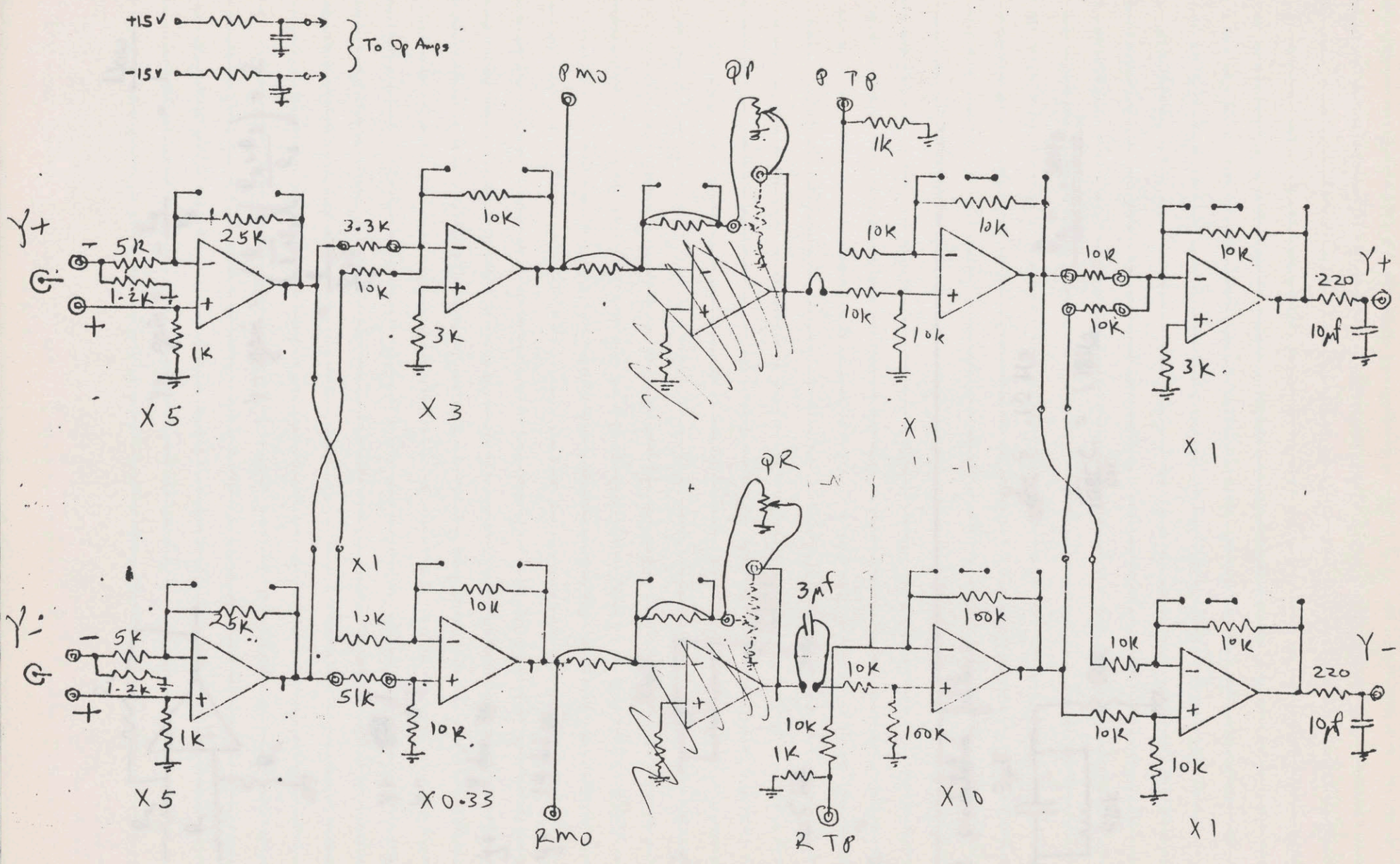
$= \tan^{-1}\left(\frac{\omega_2/\omega_1 - 1}{2\sqrt{\omega_2/\omega_1}}\right)$

$= 41.8°$



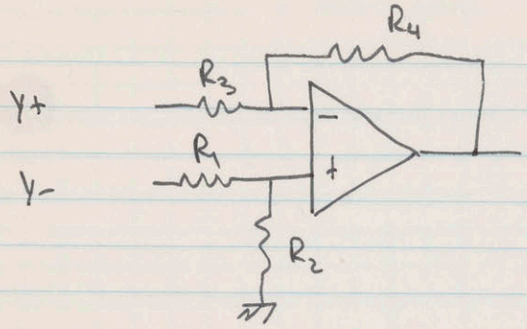
$g_+ = \left(\frac{R_2}{R_1+R_2}\right)\left(\frac{R_4+R_3}{R_3}\right)$

$= \frac{1}{2}\left(\frac{R_4}{R_3}+1\right)$ pick $\frac{R_4}{R_3} = 7 \therefore R_4 = 70\text{k}$



All Op Amps are LF356

EMI Matrix Box : Y Pair-a-degrees



Now

$y+$ gain $= -\frac{R_4}{R_3} = 1$

$y-$ gain $= \left(\frac{R_2}{R_1+R_2}\right)\left(\frac{R_4+R_3}{R_3}\right) = 2$

$= \frac{1}{\frac{R_1}{R_2}+1}$

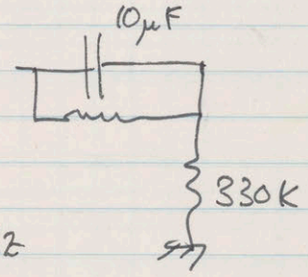
with 3.6k: $y+$ 1

$y-$ .53

10Hz $\Rightarrow$ $y+$ .8 div pp

$y-$ 1.4 div pp

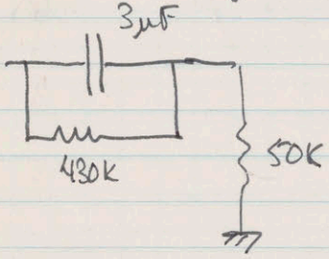
Also have:



$\frac{1}{2\pi rC} = .05$ Hz

$\frac{1}{2\pi \frac{rR}{r+R} C} =$

Canonical pendulation filter:



$\frac{1}{2\pi rC} = .12$ Hz

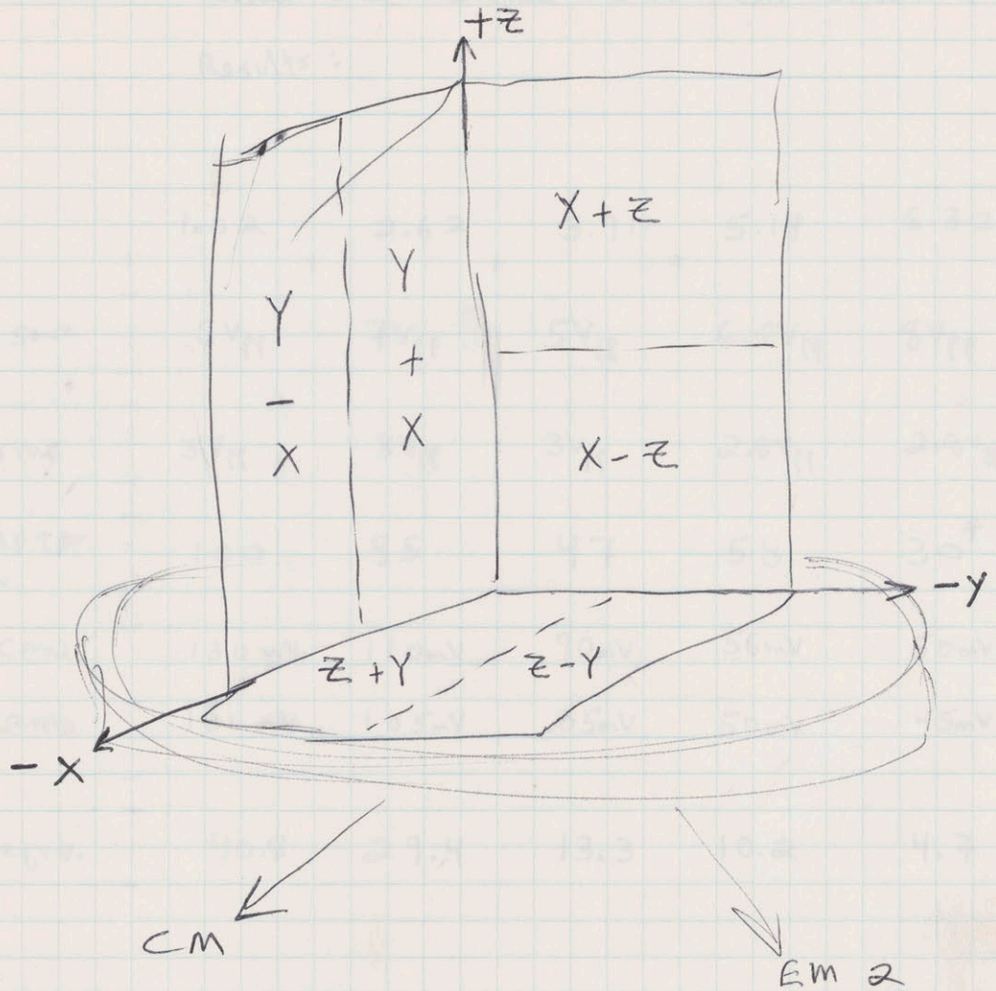
$\frac{1}{2\pi \frac{rr}{r+r} C} = 1.18$ Hz

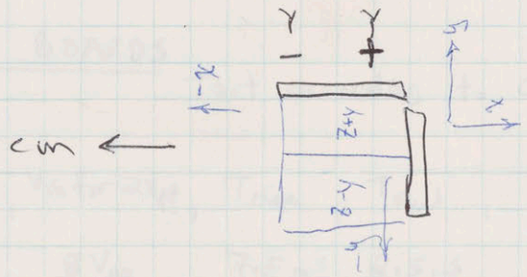
$f_0 = .38$ Hz

END MASS 1 NIM SLOT ASSIGNMENTS:

7.51	BRIDGE	Z+Y	7.51	DRIVE	
Z-Y	HV AMP	Z+Y	6.32	DRIVE	
6.32	BRIDGE	Z-Y	5.14	DRIVE	
5.14	BRIDGE	Y+X	MATRIX BOX		
Y-X	HV AMP	Y+X			
3.91	BRIDGE	Y-X			
2.62	BRIDGE	X+Z	3.91	DRIVE	
X-Z	HV AMP	X+Z	2.62	DRIVE	
1.02	BRIDGE	X-Z	1.02	DRIVE	

EM 1 Cage Plate Designations:





End Mass 1 Driver Boards

2/14/83

Tested and aligned as in CM notebook p4

Results:

	1.02	2.62	3.91	5.14	6.32	7.51
Drive into 50Ω	6 V_{pp}	7 V_{pp}	5 V_{pp}	6.5 V_{pp}	8 V_{pp}	7.5 V_{pp}
Mixer Drive	3 V_{pp}	3 V_{pp}	3 V_{pp}	2.8 V_{pp}	2.8 V_{pp}	2.5 V_{pp}
RFIN to RFTP GAIN	100	85	47	58	30‡	72*
1 V_{pp} @ RF TP — CMO	130 mV	110 mV	90 mV	56 mV	50 mV	42 mV
1 V_{pp} @ RF TP — 50Ω	130 mV	105 mV	85 mV	50 mV	45 mV	38 mV
a equiv.	40.8	29.4	13.3	10.2	4.7	9.5

‡ Has #42 inductors in filter

* 220Ω ~~—~~ after filter and 5539 gain is 10K/(47/2)

HV AMP BOARDS

2/15/83

Test according to C.M. p5:

Unit	V_{out} max	V_{in} for 2 V_{pp}	T_{rise}	T_{Fall}	Q Quiescent Current {500 VDC after NO AC
~~Z+Y~~ (A)	7.5 V	8 V_{pp}	7.5 mS	2.5 mS	7.2 mA
Z−Y (B)	6.9	8 V_{pp}	7 mS	5 mS	
Y+X (A)	6.9	9 V_{pp}	7 mS	4.5 mS	7.2 mA
Y−X (B)	8.0	8.5 V_{pp}	7.5 mS	4 mS	
X+Z (A)	7.6 V	8.5 V_{pp}	6 mS	6 mS	7.5 mA
X−Z (B)	7.9 V	8.5 V_{pp}	7 mS	2.5 mS	

Bridge Boards

2/15/83
2/16/83

Input Filter between Transformer and first U431 as given in CM p13.

Set Bias and Balance Pots so that $V_{2K} \approx -3.5V$

AA. on fake EM capacitor - Power bridge.
Measure dV_{pp}/V_{cmon} and output noise...

Freqy.	V_B pp	C_{det} (1mm)	$\frac{dC}{dx}$ pf/mm	$\frac{dV_{pp}}{dC_{mon}}$ * for a=1	$\frac{V_{pp}}{V}$ measured	Theory Gain into 00-2	Noise into 50-2	Noise Referred to Bridge
							(486)	(6.7)
1.02	58	139.0	44.44	39.3 mV/V	5.71	145	818 nV/√	15.2 nV/√
2.62	62	146.5	46.20	39.7	8.00	201	398 nV/√	3.9 nV/√
3.91	42	100.0	18.11	39.4	3.70	94	178 nV/√	3.8 nV/√
5.14	42	102.2	17.46	35.8	20.00	560	126 nV/√	4.5 nV/√
6.32	43	85.8	15.03	46.1	4.76	103	199 nV/√	3.9 nV/√
7.51	~~28~~	87.3	14.46	29.6	~~2.00~~	~~67~~	199 nV/√	5.9
					2.78	94	199 nV/√	4.2 nV/√

* $$\frac{dV_{pp}^{aFOUT}}{dC_{MON}} = \frac{V_B^{pp} \cdot \frac{dC_V}{dV_V}}{\left(1+\frac{C_{det}}{C_B}\right)(C_B+C_{det})\left(\frac{C_V}{C_S}+1\right)^2}$$

with $C_B = 120$ pf

$$\frac{\frac{dC_V}{dV_V}}{\left(\frac{C_V}{C_S}+1\right)^2} = \frac{1}{2.64} \text{ pf/V}$$

Modified Driver Boards à la p8 EM2 2/22/83

Bridge drives down by 1.3 to 1.6 probably.

2/24/83

Measure V_B^{pp}... now ...

Freqy	V_B^{pp}	$\frac{dV_{pp}}{dC_{mon}}$ for a=1	$\frac{dV^{pp}}{dC_{mon}}$	$\frac{dV_{pp}}{dC_{mon}}$ RF to RF	a bridge board with RF-RF	× a driver	÷ 800
1.02	42	28.5	(1.29) 4.44	2.42	84.9	3464	4.3
2.62	49	31.4	1.06 7.41	4.00	127.4	3746	4.7
3.91	32	30.0	1.04 3.57	2.25	75.6	997	1.2
5.14	27	23.0	1.35 14.81	11.43	497.0	5069	6.3
6.32	27	28.9	1.45 3.28	2.38	82.3	397	0.5
7.51	17	18.0	1.24 2.25	1.83	101.7	966	1.2

Capacities vs. Distance (including s.c.) from

DAVID SHOEMAKER
AVC '81 → SEPT '82
p40
5/19/82

+1.4pf

			1mm + s.c.
	X−Z S (156.81)	155.41 + 41.44/d	196.85
	X+Z D (180.14)	178.74 + 60.29/d	
	X−Z D (174.90)	173.50 + 58.22/d	
XTS:	X+Z S (159.69)	158.29 + 46.20/d	204.49
	Y−X S (141.24)	139.84 + 18.11/d	157.95
	Y+X D (159.13)	157.73 + 27.44/d	
	Y−X D (154.49)	153.09 + 30.90/d	
	Y+X S (144.12)	142.72 + 17.46/d	160.18
	Z−Y S (130.20)	128.80 + 15.03/d	143.83
	Z+Y D (134.36)	132.96 + 27.35/d	
	Z−Y D (133.49)	132.09 + 22.58/d	
	Z+Y S (132.25)	130.85 + 14.46/d	145.31

Reduce Bridge Board Gains to get a ≈ 800 ! 2/24/83

U431 stages

Unit	1st	2nd	dVpp/dVcmon desired	measured
1.02	÷1.8, −7.0	÷2.5, −8.0	0.56	0.51
2.62	÷2, −7.2	÷2.5, −7.6	0.85	0.83
3.91	÷1.1, −5.2	÷1.1, −7.0	1.88	1.90
5.14	÷2, −7.4	÷3, −7.5	1.81	~~2.04~~ 1.83
6.32	÷1.13, −6.3	÷1.13, −5.5	~~2.38~~	2.11
7.51	÷1.4, −7.4	÷1.4, −6.8	0.92	0.91

a = 400

Set b values of driver boards: 2/25/83

$$A_{CFB} = \frac{\pi b}{V_{BPP}} \left(1 + \frac{C_{det}}{C_B}\right)(C_{det} + C_B) \cdot 2.64\ V/pf$$

with $b = 0.05$
$C_B = 120\ pf$

	Unit	Cdet	VBPP	ACFB calc	Feedback R	ACFB measured	"Real b"
	1.02	139.0	42	5.52	12K	5.22	0.047
	2.62	146.5	49	5.01	11K	4.76	0.048
Y−X	3.91	100.0	32	5.23	12K	5.26	0.050
Y+X	5.14	102.2	27	6.32	15K	6.38	0.050
	6.32	85.8	27	5.42	12K	5.01	0.046
	7.51	87.3	17	8.74	20K	8.53	0.049

Put 1300 pf caps across these to filter (≈ 10 kHz) at MHz feedthrough.

3/1/83

V_{HV}	$C_{pf\,drive}$	α	V_B pp	$\frac{dC}{dx}$ $\frac{pf}{cm}$	C_{det}	$\frac{dV}{dx}$ $\frac{V}{cm}$	G_{HV}	M_g	G_F^P	$1+\left(\frac{\omega}{h}\right)^2$	G_F^R	G_P Q=1	G_R Q=5 @5Hz	SYSTEM	
450	43.7	1.97	45	360	129	9.98	26.7	15000	112	2	42	1.2	10.5	CM	X
450	40.1	1.80	29	369	135	6.29	26.7	15000	64.5	2	24.2	2.1	18.1		Y
450	57.1	2.57	14.7	495	152	3.76	26.7	15000	55.0	2	20.6	(2.5)	21.4		Z
400	59.3	2.37	45.5	438	143	11.0	23.5	8000	245	1.12	164	0.55	2.7	EM1	X
450	29.1	1.31	29.5	178	101	4.1	22.8	8000	49	3.72	9.9	2.8	44		Y
500	25.0	1.25	22.0	148	86.5	2.92	25	8000	36.5	3.92	6.98	(3.7)	63		Z
400	51.4	2.05	46.7	430	167	9.31	29	8000	221	1.12	148	0.61	3.0	EM2	X
450	23.3	1.05	32.8	181	111	4.3	27	8000	48.8	3.72	9.8	2.8	45		Y
500	17.2	0.86	21.5	124	93	2.24	28.6	8000	22.0	3.92	4.22	(6.3)	104		Z

assumed: $C_B = 120$ pf
$a = 800$
$b = 0.05$
$RC = 1$ sec

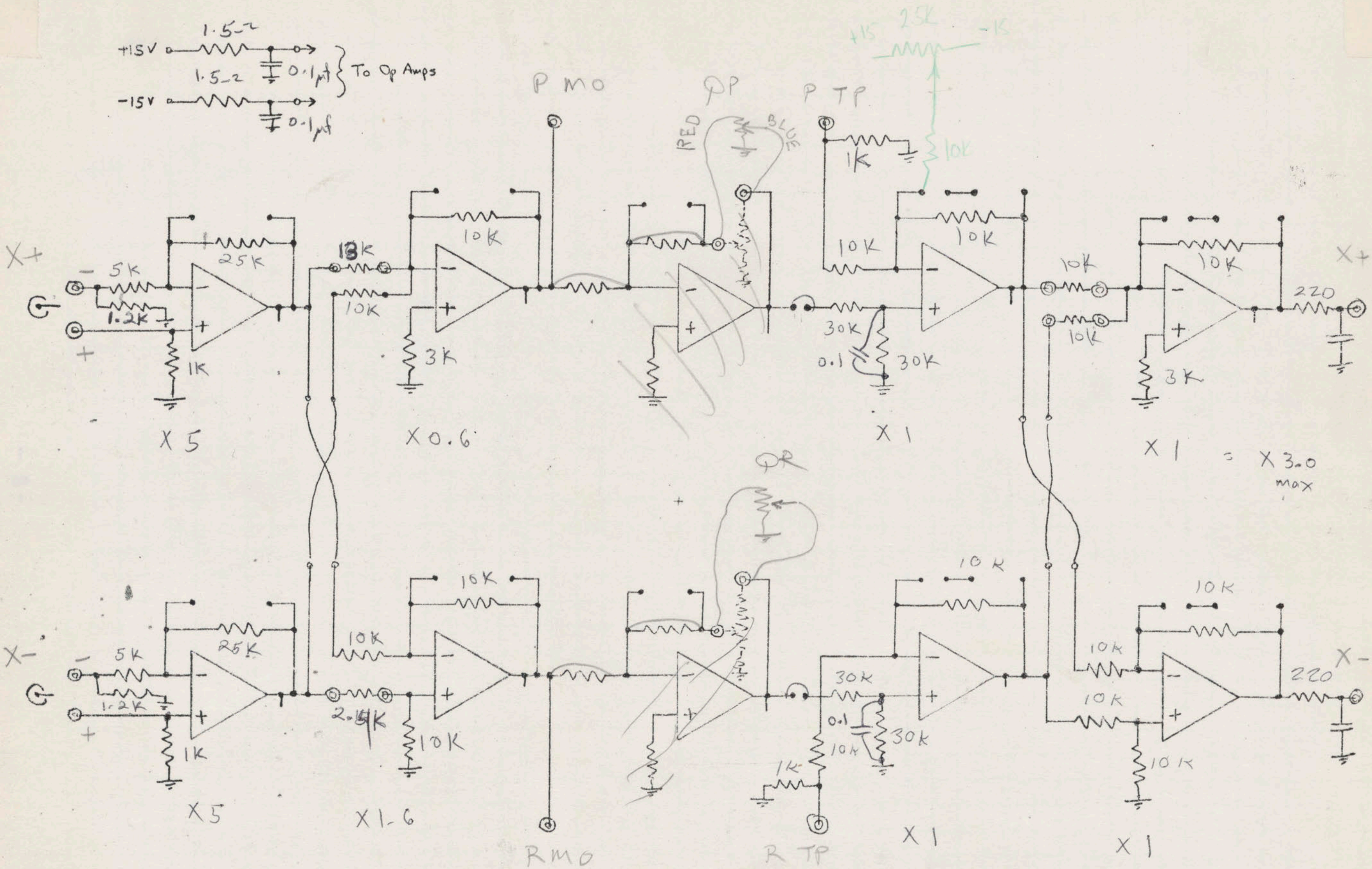
all parameters are averaged over both systems for a given axis.

3/1/83

Start working on matrix boxes.
Calculate approx. Damping gains needed (D. Denney p. 44-45)

Modified HV Amps for lower Noise 4/26/83

Amp	Gain @ 512 Hz	$\phi = 45°$ Freq'y.	Output Noise 512Hz	Output Noise 25kHz
X+Z	24.7	29 kHz	-110.8	-116.0
X-Z	25.9	27 kHz	-104.2	-115.2
Y+X	25.2	22 kHz	-101.0	-112.8
Y-X	27.7	25 kHz	-109.4	-113.6
Z+Y	26.1	29 kHz	-107.9	-112.4
Z-Y	24.7	29 kHz	-107.5	-117.0

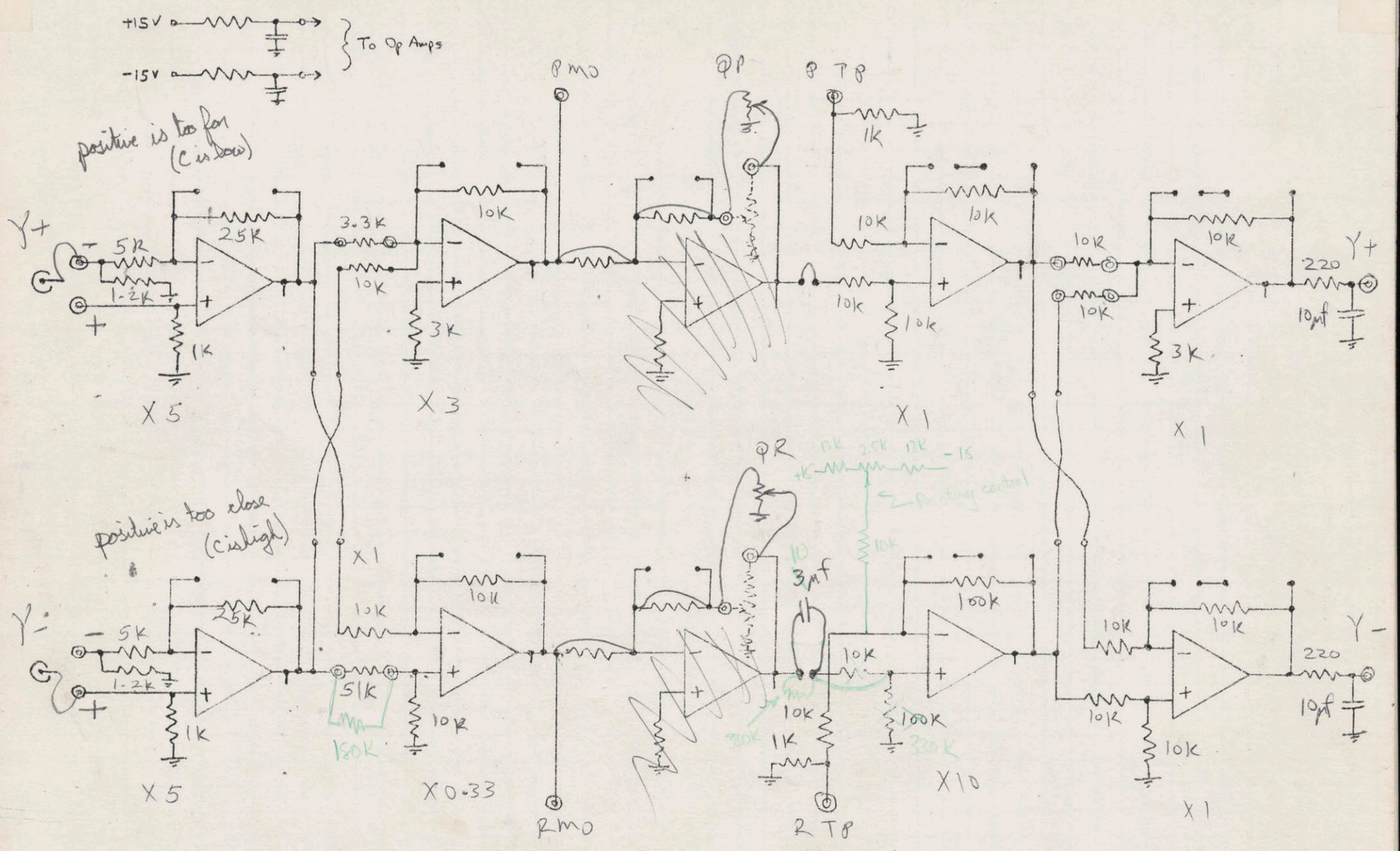


All Op Amps are LF356

EMI Matrix Box : X Pair-a-degrees

Nominal G_p : 0.5

G_R : 2.7

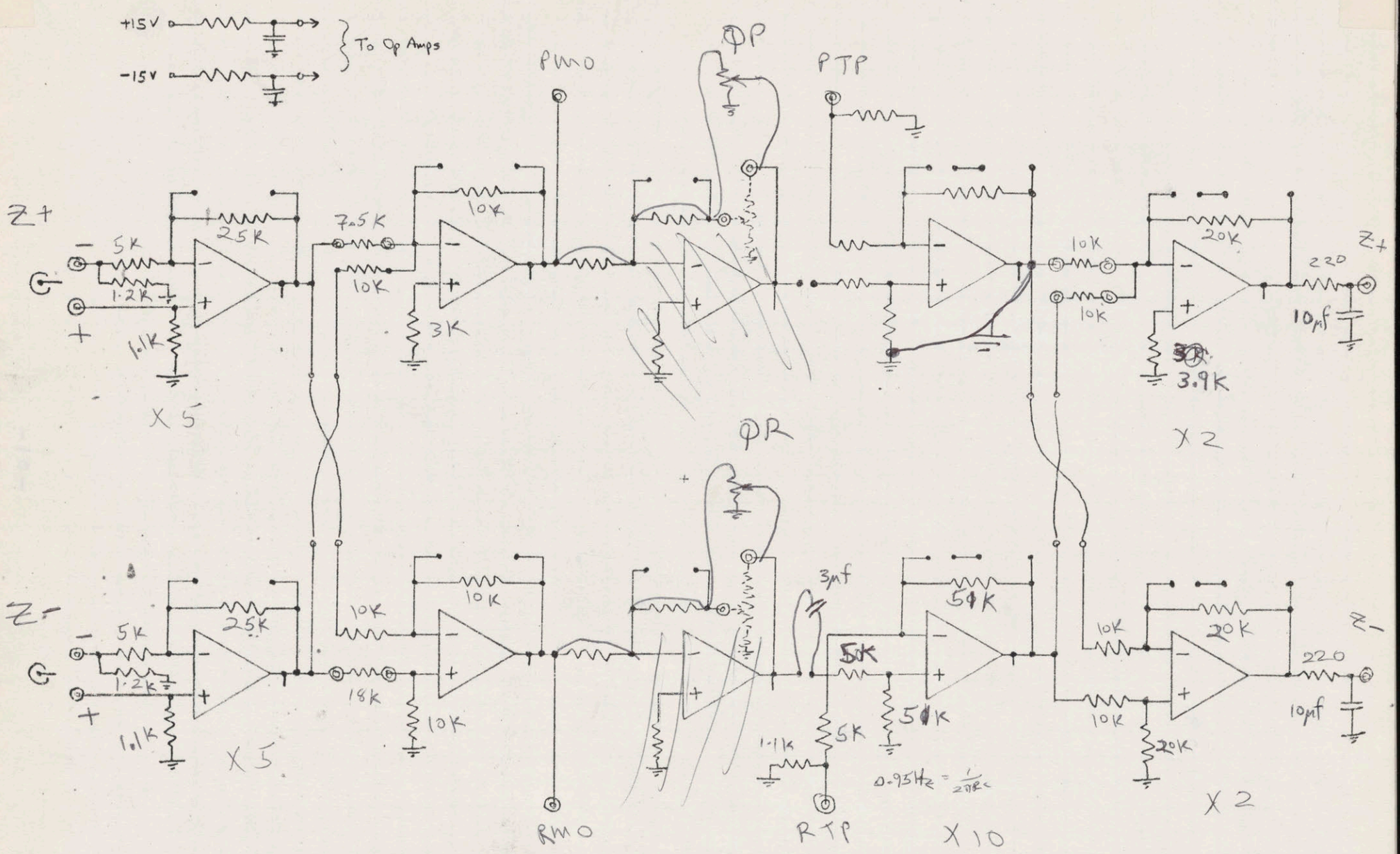


All Op Amps are LF356

EMI Matrix Box : Y Pair-a-degrees

Nominal $G_P = 2.8$

$G_R = 44$



All Op Amps are LF356

EM I Matrix Box : Z Pair-a-degrees

Nominal G_P = —

G_R = 63

6-June-83

Measure Capacities (with Standard Cable) (~6 58 pf)

Mass is grounded with a clip lead from tapped hole at top shoulder to case of hardline wiring attached to turn table. X, Y Nominally at 1mm Z is on bumpers

	C (pf)	d (mm)
Z+yD	172.5	0.69
Z+yS	158.9	0.52
Z-yD	166.0	0.67
Z-yS	156.7	0.54
y+xD	191.1	0.82
y+xS	165.5	0.77
y-xD	192.1	0.79
y-xS	171.3	0.58
(xTD) x+zD	246	0.90
(xTs) x+zS	216	0.80
x-zD	231.7	1.00
x-zS	200.1	0.93

25-OCT-83

Measure capacities over again, with a slightly different standard cable (new quick disconnect SMA connector) and Data Precision 938 capacitance meter. Ground through rod + Σ.

NEW STANDARD CABLE CAPACITANCE = 59.4 pf, 200 pf scale
.059, 2 nf. scale.

		C (pf)	d (mm)
Z+yD	(10)	173	.7078
Z+yS	(12)	159	.54
Z-yD	(11)	167	.67
Z-yS	(9)	157	.56
y+xD	(6)	185	1.06
y+xS	(8)	161	1.03
y-xD	(7)	185	1.01
y-xS	(5)	165	.78
x+zD	(2)	248	.89
x+zS	(4)	216	.82
x-zD	(3)	230	1.05
x-zS	(1)	199	.98

Program EMIXOC gives the d given C for this cable + more.

```
      PROGRAM EM1XOC
C
C     THIS PROGRAM COMPUTES THE DISTANCE OF PLATE MASS SEPERATION
C     OF THE END MASS GIVEN CAPACITANCE WITH S.C.
C
      DIMENSION OFF(12)
      DIMENSION DCDX(12)
      OFF(1)=156.81                !X-ZS
      OFF(2)=180.14                !X+ZD
      OFF(3)=174.90                !X-ZD
      OFF(4)=159.69                !X+ZS
      OFF(5)=141.74                !Y-XS
      OFF(6)=159.13                !Y+XD
      OFF(7)=154.49                !Y-XD
      OFF(8)=144.12                !Y+XS
      OFF(9)=130.20                !Z-YS
      OFF(10)=134.36               !Z+YD
      OFF(11)=133.49               !Z-YD
      OFF(12)=132.25               !Z+YS
      DCDX(1)=41.44
      DCDX(2)=60.29
      DCDX(3)=58.22
      DCDX(4)=46.20
      DCDX(5)=18.11
      DCDX(6)=27.44
      DCDX(7)=30.80
      DCDX(8)=17.46
      DCDX(9)=15.03
      DCDX(10)=27.35
      DCDX(11)=22.58
      DCDX(12)=14.46
10    CONTINUE
      TYPE *,'ENTER PLATE NUMBER, CAPACTANCE (pF) :'
      ACCEPT *,NPLATE,C
      IF(NPLATE.LT.0) STOP
      X=DCDX(NPLATE)/(C-OFF(NPLATE))
      TYPE 50,C,X
50    FORMAT(3X,'X(',F6.2,') = ',F7.4,' mm')
      GOTO 10
      END
```

Raisin mass
(82mm Hg & N_2)

10/26/83

Micrometers on top were left : X 5.00
Y 6.00
Z 6.09 }
6.12 }

Today
Z from 6.17 to 5.~~67~~ (½ mm vp)

Measure Z caps:

		c	d mm	d mm	c
(9)	Z+YS	148	0.84	0.95	146
(10)	Z+YD	164	0.92	1.03	161
(11)	Z-YD	155	1.05	1.16	153
(12)	Z+YS	153	0.70	0.81	150

Z micrometer to: 5.57 (0.6mm total)

OK Z!

		c	d mm
(1)	X-ZS	170	3.14
(2)	X+ZD	200	3.04
(3)	X-ZD	194	3.05
(4)	X+ZS	174	3.23
(5)	Y-XS	181	0.46
(6)	Y+XD	178.5	1.42
(7)	Y-XD	193	0.80
(8)	Y+XS	156	1.47

Move X axis from 5.00 to 1.1mm
No change in 3mm X values.
Try to move Y-XD to something reasonable.
Couldn't.

Shim X direction

		c	d			c	x
(1)	X-ZS	188	1.33			191	1.21
(2)	X+ZD	236	1.08			242	1.97
(3)	X-ZD	221	1.26			223	1.21
(4)	X+ZS	198	1.21			205	1.02
(5)	Y-XS	185	0.42	168	0.69	163	.83
(6)	Y+XD	183	1.15	178	0.45	178	1.45
(7)	Y-XD	196	0.74	184	1.04	181	1.16
(8)	Y+XS	158	1.26	155	1.60	156	1.47
(9)	Z-YS	151	0.72	146		147	.89
(10)	Z+YD	168	0.81	161		160.5	1.05
(11)	Z-YD	159	0.89	153		154	1.18
(12)	Z+YS	156	0.61	150		149	.86

Z micrometer to 5.37

CANONICAL #'s FOR 1.0 AND 1.1 mm:

From p11 bottom

PLATE #		1mm	1.1mm	New Cap pf	Distance mm
1	X-ZS	198.3	194.5	199.1	0.98
2	X+ZD	240.4	234.9	247.9	0.89
3	X-ZD	233.1	227.8	230.3	1.05
4	X+ZS	205.9	201.7	216.0	0.82
5	Y-XS	159.9	158.2	165.0	0.78
6	Y+XD	186.6	184.1	185.0	1.06
7	Y-XD	185.3	182.5	185.0	1.01
8	Y+XS	161.6	160.0	161.1	1.03
9	Z-YS	145.2	143.9	146	0.95
10	Z+YD	161.7	159.2	159	1.11
11	Z-YD	156.1	154.0	153	1.16
12	Z+YS	146.7	145.4	148	0.92

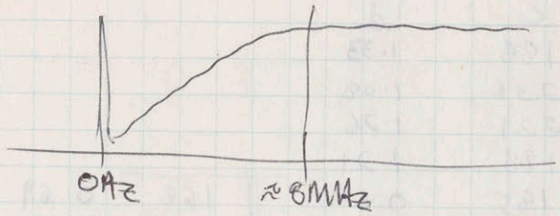
						10/26	10/27
1	X-ZS	192.5	1.16	202	0.92	202	202.5
2	X+ZD	231	1.19	247	0.90	247	247.5
3	X-ZD	221	1.26	233	1.00	234	234
4	X+ZS	201	1.12	215	0.84	215	216
5	Y-XS	169	0.66	171	0.62	164	164
6	Y+XD	188	0.95	189	0.92	184	184
7	Y-XD	189	0.89	191	0.84	184	184
8	Y+XS	164	0.88	165	0.84	161	161
9	Z-YS	146	0.95	146	0.95	146	146
10	Z+YD	159	1.11	159	1.11	159	159
11	Z-YD	153	1.16	153	1.16	153	153
12	Z+YS	148	0.92	148	0.92	148	148

$X_{bend} = 0.0185$
$Y_{bend} = -0.0115$

$X_{bend} = 0.017$
$Y_{bend} = -0.008$

Put 20mHz Noise in on XTD and look at XBS

See:



OK!

10/27/83

Checked capacities – look good! (p 12B2)
Using GR Bridge can see both X and Y pendulate.

Got 1.02 and 2.62 MHz units working!

Rough procedure:

Adjust C and Ω for no RF ie

Look at Ω MIX OUT and adjust phase for no mass motion feed through.

check C and Ω loop phases

10/28/83

X systems ok! Micrometers:

Read at 0 line of vernier

X = 5.03 mm
Y = 5.91 mm
Z = 5.37 mm

Microns/volt varactor for the channels

Channel	pf/mm	M/Volt
X-ZS	41.4	9.38
X+ZS	46.2	8.40
Y-XS	18.1	21.45
Y+XS	17.5	22.18
Z-YS	15.0	25.9
Z+YS	14.5	26.8

From p 16 of CM book we have:

$$\frac{\text{Mm}}{\text{varac volt}} = \frac{23.8\ \text{pf/v}}{61.31} \cdot \frac{10^3}{C_{\text{pf/mm}}}$$

	G_β	G_R
X	0.55	2.7
Y	2.8	44
Z	-	63

mixer ouput : $\frac{dV}{dx} \times 800 \rightarrow \approx$ 0.32 V/µm

$\pm 3\mu \rightarrow \pm 1V$

→ $\pm 1V$ with $\geq 1\mu V/\sqrt{}$

Input stage : $\pm X5$ ok

12/1/83

1/10 atm. nominal Driver caps :
with 159.4 pf S.C.

			Xm
(3)	X-	325	1.16
(2)	X+	336.5	1.07
(7)	Y-	285	1.01
(6)	Y+	285	1.06
(11)	Z-	253	1.16
(10)	Z+	259	1.11

Micrometer settings : (read correctly)

X = 5.255
Y = 5.78
Z = 5.325

Damping Signs :

X-	−
X+	−
Y-	+
Y+	−
Z-	+
Z+	−

Window lamp - Turn up HV's.

Measure relative X gains : X- is 0.6 times X+ at both resonance f's.

Y gains : Y- is 9.7dB larger than Y+ (×3.05) at 0.441Hz and 2.4Hz

Z gains : Z+ is -2.7dB times Z- @ 4.72Hz
Z ×0.73

2/7/84

1 6.600 = X_0 EM1
2 6.25
3 6.5

165 NO CABLE

297 X+Z S
-300

164 } 133 pf
297 }

X_{mic} = 6.035

Values for this cap have been : 311 pf
- 164
147
+ 56
205 pf → 0.99 mm

12/83:

NOTE: X HV amps modified for higher slew rate:
0.1μf 2KV cap. replaced by 0.01μf 2KV cap.
Gain of 10 in slew rate!

2/7/84 Low contrast. Move Cm1 ½ mm towards Cm.

X+Z S with long cable = 297pf
↳ = 164pf
133pf
+ S.C. 58pf
191pf with S.C.
∴ X_{mm} = 1.41 mm ← NOW

Micrometer setting went from 5.50 → 6.03 mm.

Jeff's measurement of X+Z S after doing knobs had been giving a value ≈ 311pf (+ long cable)
- 164
147 No cable
+ 58 S.C.
205pf → 1.00 mm ← was

May 7 '84

Em1 Y+X HV Amp shows ≈ -180V output independent of input V or offset adj. Suspect VPTB550's?

Yes: Lower VPTB550 gone.

IL-15 gone as well

Back to Atmospheric Pressure:

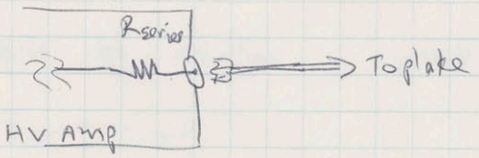
			x_{mm}	
Em1:	X-ZS	294	1.37	Gravity II p128
	X+ZD	330	1.41	5/8/84
	X-ZD	322	1.45	
	X+ZS	301	1.35	
	Y-XS	271	0.81	← "Error" of 0.2mm shows up in past - calibration error?
	Y+XD	291	1.10	
	Y-XD	291	1.04	
	Y+XS	268	1.03	
	Z-YS	252	1.02	
	Z+YD	265	1.16	
	Z-YD	259	1.22	
	Z+YS	254	0.98	

Replaced Z±Y HV Amps & VPTB550's 5/8/84
outputs went 100 → 200V
400V and clipped...

OK after replacement.

~~JVAR~~
Aug. 1 '84

Add protective series r's at HV outputs:



Choose Rseries = 100 K-Ω for X plates
1M-Ω for Y, Z plates

$C_{Hardline\ \&\ driver} \approx 100 - 200$ pf

For 200pf 100K → 8 KHz pole

1M → 800 Hz pole

Final Capacities: EMI

2/May/85 Note - these capacities are suspect JCL

30-October

Gravity III, p. 113

EMI still hanging:

		C(pF)	d(mm)
(1)	X-ZS	308	1.15
(3)	X-ZD	335	1.29
(2)	X+ZD	344	1.23
(4)	X+ZS	315	1.15
(5)	Y-XS	285	.64
(7)	Y-XD	305	.87
(6)	Y+XD	305	.89
(8)	Y+XS	282	.76
(9)	Z-XS	266	.72
(11)	Z-XD	273	.92
(10)	Z+XD	280	.89
(12)	Z+XS	269	.66

"knobs"

X	1.537
Y	8.528
Z	2.423

standard cable = 173 pF

	EMI +	loops −
X	+12.05	-21.3
Y	+5.3	+9.3
Z	+3.2	+3.0

Reinstall XYZD mover, get mass back to old capacities:

	C(pF)
X-ZD	334
X+ZD	343
Y-XD	304
Y+XD	304
Z-XD	273
Z+XD	279

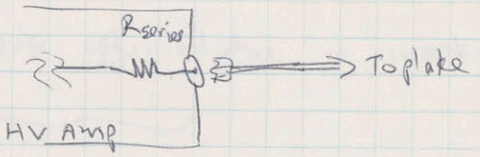
6-Nov-84 p. 122

angle

15-Jan-85 resoldered y+XD smc connector

~~JVR~~ Aug. 1 '84

Add protective series R's at HV outputs:



Choose Rseries = 100 KΩ for X plates
1 MΩ for Y, Z plates

$C_{Hardline\ \&\ driver} \approx 100 - 200$ pf

For 200pf 100K → 8 KHz pole

1M → 800 Hz pole

Final Capacities: EMI 3/May/85 Note - these capacities are suspect JCR 30-October

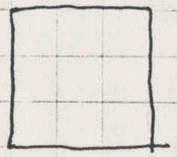
EMI still hanging: Gravity III, p. 113

	C (pf)	d (mm)		"knobs"
(1) x-2S	308	1.15		
(3) x-2D	335	1.29	x	1.537
(2) x+2D	344	1.23	y	8.528
(4) x+2S	315	1.15	z	2.423
(5) y-xS	285	.64		
(7) y-xD	305	.87		
(6) y+xD	305	.89		

standard cable = 173 pF

	EMI +	loops −
x	+12.05	-21.3
y	+5.3	+9.3
z	+3.2	+3.0

Looks good



angle

15-Jan-85 resoldered y+xD smc connector

X HV amp is crapping: March 25 85
+ output saturates at ± 450V
− " " " ± 425V
Yeah!
It's our feedback!

Replace All VETBs and Both opto-isolators — works.

6-April-1985
resoldered y+x D sma connector

1 May 85
resoldered y+x sma connector

EM 1 Driver Boards

2/14/83

1.02

6 V_{pp} 50-2 load

3 V_{pp} mixers

DPIN → RF TP = 100

1 V_{pp} RF TP → 130 mV_{pp} C mo

" -2

C: 11.5V ÷ $\frac{200K}{2.2K}$ = 127mV ok

-2: $\frac{1M-2}{2.2K}$

2.62 7 V_{pp} 50-2 load

3 V_{pp} mixers

RF PIN → RF TP = 85

1 V_{pp} @ RF TP: C mo 105mV (10V)(200K)

-2 mo 105mV

3.91 5 V_{pp}

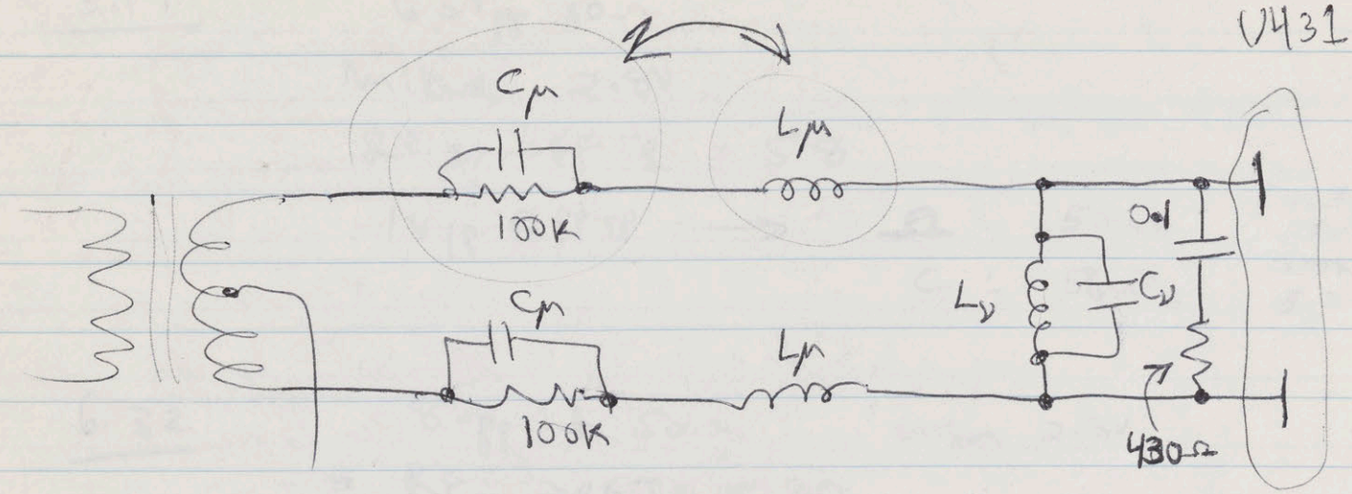
mixers 3 V_{pp}

RF PIN → RF TP ≈ 47

1 V_{pp} @ RF TP → Ω mo 85 mV_{pp}

C mo 90 mV_{pp} (6.3V, 170K)

V431



Filter Components (from EM 1)

Freqy	C_M	L_M	L_M	C_M
7.51	2000pf	0.23 (#5)	#39	10.0pf
6.32	2000pf	0.32 (#7)	#38	18pf
5.14	2000pf (3)	0.48 (#9)	#42	18pf
3.91	2000pf	0.83 (#12)	#42	39pf
2.62	2200pf		#42	82pf
1.02	4800pf		#42	510pf

EM1 Driver Boards ...

2/14/83

5.14

6.5 V_{pp} 50Ω

Mixers: 2.8V

RF In → RF TP = 5 dB

1 V_{pp} @ RF TP →

Ω: 50mV (1m-2 13V)

C: 56mV 200K 5.3V

6.32

8 V_{pp} into 50Ω Mixers 2.8V

→ RF in → RF TP = 30

Has #42 L's

Ω: 45mV

C: 50mV (390K 9.5V)

7.51

7.5 V_{pp} in 50Ω 2.5V

RF in → RF TP ~~72~~ (220Ω ahead of filter)

add 5539 gain is

(10K / 47/2 ↑)

1 V_{pp} → C: 42mV (6V 390K)

Ω: 38mV 1m