27/9/66

RF. Tuner Performance

Source 50 ohms   Output across secondary of double tuned circuit

Low End

KC	Input mv	Output Volts	DB
1500	200	,02	
1600	200	.080	
1700	50	,055	
1800	20	.265	
1850	10	.820	
1860	5	.715	
1870	5	.870	
1887	5	.815	
1903	5	.855	
1915	5	,710	
1930	10	.670	
2000	20	.12	
2100	200	.12	
2200	200	,03	

Middle

KC	Input mv	Output Volts	DB
1700	200	.03	
1900	100	.095	
2000	50	.190	
2060	20	.375	
2100	10	.64	
2120	5	.72	
2130	5	.895	
2140	5	.965	
2148	5	.960	
2158	5	.970	
2170	5	.905	
2180	5	.660	
2200	10	.535	
2250	20	.24	
2300	100	.24	
2400	200	.12	
2500	200	.03	

High End

KC	Input mv	Output Volts	DB
1800	200	.03	
1900	200	.05	
2000	200	.09	
2100	100	.10	
2200	50	.135	
2300	20	.42	
2350	10	.78	
2370	5	.785	
2380	4	.82	
2400	4	.88	
2420	4	.745	
2430	5	.70	
2450	10	.605	
2500	20	.285	
2550	50	.165	
2600	100	.155	
2700	200	.100	
2800	200	.050	
2900	200	.02	

27/9/66

Input Circuit Performance

Source 50 ohms. Primary 5 turns wire over secondary

Secondary

Tertiary 3 turns litz over secondary.

No Current in Transistor

KC	Input mv	Output volts	DB
500	200	.03	
1000	200	.12	
1500	100	.12	
1700	50	.145	
1800	20	.135	
1865	20	.235	
1950	20	.12	
2100	50	.12	
2400	100	.11	
3000	200	.115	
5000	200	.04	

Transistor Current 2 ma Collector Grounded.

KC	Input mv	Output volts	DB
	200	.03	
	200	.125	
	100	.125	
	50	.12	
	20	.08	
	20	.10	
	20	.09	
	50	.11	
	100	.10	
	200	.115	
	200	.04	

Output Circuit operative

KC	Input mv	Output volts	DB
	200	.03	
	200	.125	
	100	.12	
	50	.115	
	20	.06	
1865	20	.135	
1895	20	.105	
1920	20	.135	
1950	20	.095	
2100	50	.105	
2400	100	.100	
3000	200	.115	
5000	200	.04	

Transistor input Circuit 26/9/66

Input 183 mv to primary. Output across tuned secondary.

		KC	Volts		
Unloaded.	3DB	1859	.28	9KC	19KC wide.
	Peak	1868	.40	10KC	
	3DB	1878	.28		
Current in transistor but Collector shorted	3DB	1850	.14	18KC	38KC wide
	Peak	1868	.20	20KC	
	3DB	1888	.14		
Collector in Circuit	3DB	1860	.27	8KC	17KC wide
	Peak	1868	.38	9KC	
	3DB	1877	.27		

Output across secondary of double tuned pair.
Input 17.8 mv.

Edge	1855	.54	12KC	
Peak	1867	1.00	25KC	43KC wide.
Dip	1892	.54	18KC	
Peak	1910	.98	5KC	
Edge.	1915	.54		

Emitter winding $1\frac{1}{4}$ turns over secondary.
Primary 7 turns 5/8" dia and 5/8" from bottom end secondary.

System obviously has feedback and needs to be neutralized.

Small mutual and still less top capacity 1.8 pf approx Range 511 KC

Peak	1856	.90	2066	.83	2360	.79
Dip	1888	.50	2100	.53	2399	.57
Peak	1921	.96	2139	.87	2430	.74
Width	65		73		70	
Av. Max		.93		.85		.77
DB Dip	5.4		4.1		2.6	

Decreased mutual & about 1.8 pf top Range. 514 KC

Peak	1861	.92	2077	.84	2368	.84
Dip	1882	.63	2100	.67	2396	.72
Peak	1912	1.00	2125	.91	2418	.78
Width	51		48		50	
av. Max		.96		.90		.81
DB Dip.	3.6		2.6		1.0	

10 mv input. Output 5 turn over sec to base of grounded emitter mixer.

Decided to leave in this condition.

Range should be reduced to 450 KC by removing turn from coils

Capacity ratio $= \left(\frac{2396}{1882}\right)^2 = 1.620$ to 1   Minimum $= \frac{1.000}{.620} \cdot 102 = 165$ pf.

145 shunts
11 gang
3 coils
6 transistor
165 total

$L = 1/(6.28 \cdot 1.882)^2(165+102) = 1/139.8 \cdot 267 = 10^{-6}/.0373$

$= 26.8$ uh effective in can at $21\frac{1}{2}$ turns.

Desired = 23.9 uh

Required turns $= \left(\frac{23.9}{26.8}\right)^{1/2} 21.5 = 20.3$ turns

Required to remove one turn from coils.

23/9/66

Spacing between bottom edges of coil supports $10\frac{1}{2}/32" = 21/64"$

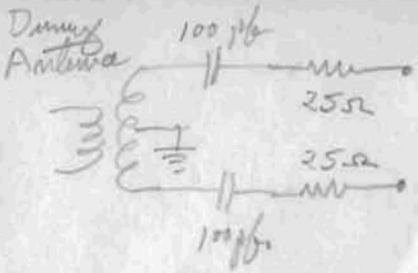
23/9/66

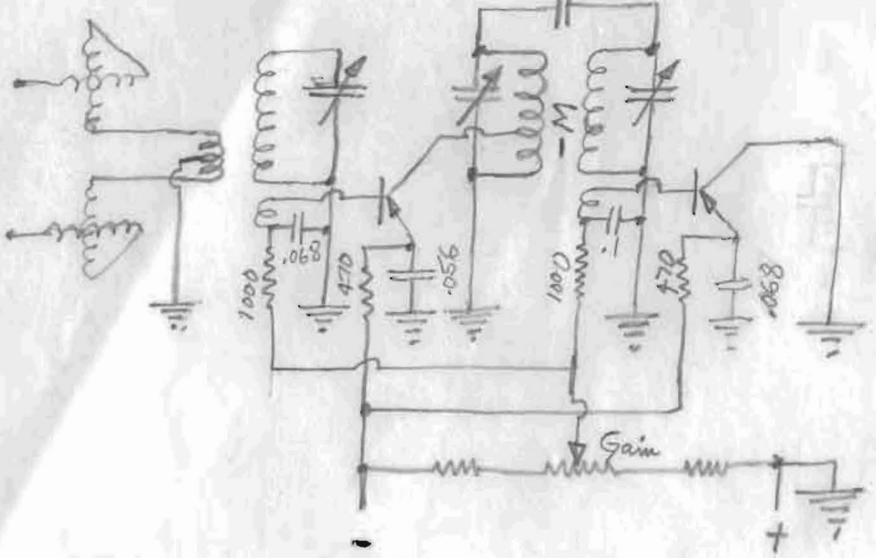
Double Tuned Circuit + Compound Coupling

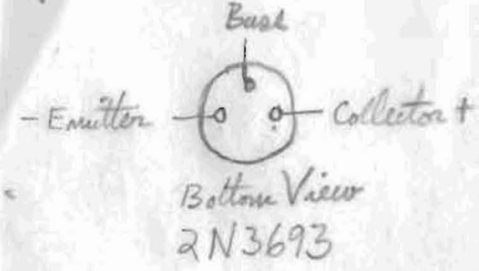
Coils $21\frac{1}{2}$ turns 75/#44 Litz. Input 10mv, Output = volts.
Transistor grounded base, Collector at top of primary.
Each transistor draws 2ma at 7 volts, 500Ω emitter resistor.

	Low Frequency KC	Output	Medium Frequency KC	Output	High Frequency KC	Output
Small mutual and top capacity					Range	480 KC
Peak	1851	.96	2083	.93	2340	3DB
Dip	1872	.69	2100	.82	2352	1.01 single peak.
Peak	1894	.96	2118	.89	2376	3DB
Width	43		35		36	
Av. Max		.96		.91		
DB dip	2.9		6.9			
Larger mutual and same top capacity					Range	486KC
Peak	1831	.92	2058	.85	2325	.82
Dip	1875	.43	2093	.49	2361	.56
Peak	1912	.94	2138	.86	2399	.73
Width	81		80		74	
Av. Max		.93		.855		.775
DB dip	6.7		4.8		2.8	
Small mutual and lesser top capacity.					Range	509 KC
Peak	1858	.88	2076	.80	2364	.78
Dip	1881	.56	2103	.60	2390	.69
Peak	1916	.99	2132	.91	2412	.80
Width	58		56		48	
Av. Max.		.94		.86		.79
DB dip.	4.5		3.1		1.2	

20/9/66



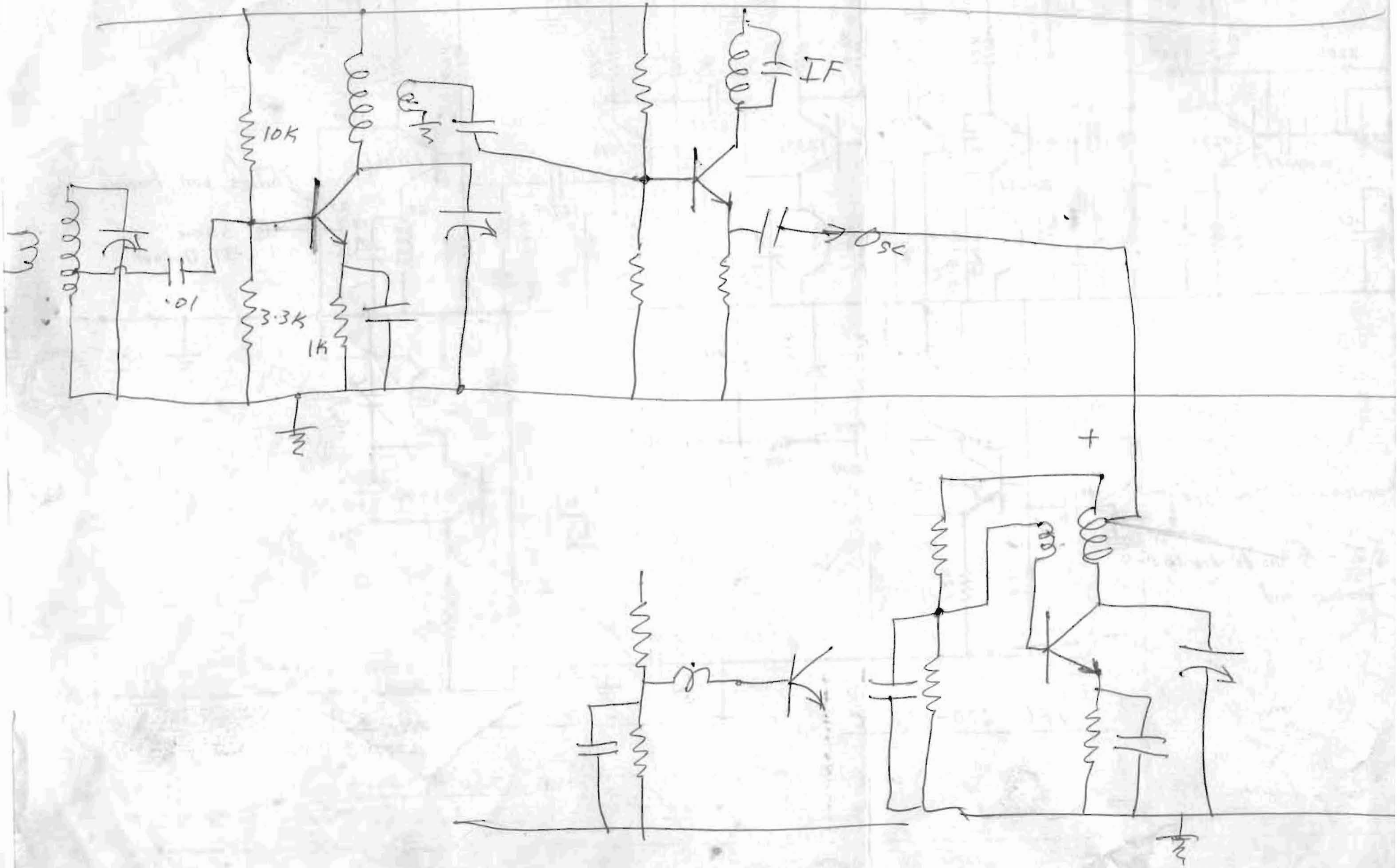




$24\,\mu h = \left(\frac{24}{32.7}\right)^{1/2} 25T = 21.4$ turns

Eddystone Radio Ltd
Birmingham 31, England

→ Eddystone model EC
sold by R. H. Cunni



MC	Q	R
1.5	387	278
2.1	198	269
3.0	95	235
4.2	47	188

2/9/66

42 T, 125/#44 L'itz close wound 0.85 mm dia
37.5 mm long, 29.6 mm dia
In Air
$C_0 = 2.7$ pf
L = 78.9 μh

Same wire as 47T 26.2 mm dia

5/9/66

1.5	356	419
2.1	182	370
3.0	87.5	296
4.2	44	228
1.5	390	371
2.1	200	340
3.0	95.5	282
4.2	47.5	221

25 T 125/#44 L'itz, closewound, 0.85 mm dia
21.2 mm long, 16.7 mm dia,
With core in air $C_0 = 2.0$ pf
½" dia x 1½"
L = 31.5 μh
R =

In copper can $C_0 = 3.0$ pf
2⅞" dia x 4" long
L = 28.7 μh = −8.9%
R =
Q at 2.1 mc − 8.0%

1.5	315	480
2.1	160	434
3.0	77	340
4.2	38.2	258
1.5	340	407
2.1	173	376
3.0	82	304
4.2	39.7	222

25 T, 75/#44 L'itz, closewound, .70 mm dia.
17.5 mm long, 16.4 mm dia
With core in air $C_0 = 2.3$ pf.
½" dia x 1½"
L = 35.6 μh.

In copper can
2⅞" dia x 4" long
R =
$C_0 = 4.3$ pf.
L = 32.7 μh = −8.2%
R =
Q at 2.1 mc −13.3%

Think this coil had some broken strands in the Litz when in the can

Coil tests in $2\frac{1}{2} \times 2\frac{1}{2} \times 3\frac{1}{2}$ Cans aluminum 2/9/66

all coils air core. PMG, Q machine

MC	pf	Q	R
1.5	442	74	
2.1	226	88	
3.0	109	104	
4.2	54	118	
1.5	437	77	
2.1	224	92	
3.0	108	110	
4.2	54	128	

57 T, .22 mm wire, 25.4 mm long, 16.1 mm dia.

In Can C_0 = 2.7 pf
L = 25.3 μh = -1.6%
R =
2.1 mc Q = -4.4%

In Air C_0 = 2.1 pf
L = 25.7 μh
R =

1.5	490	84	
2.1	250	99	
3.0	120	115	
4.2	60	128	
1.5	468	108	
2.1	240	128	
3.0	115	152	
4.2	58	175	

48 T, .39 mm wire, 37.3 mm long, 22.6 mm dia.

In Can C_0 = 3.3 pf
L = 22.8 μh = -4.6%
R =
2.1 mc Q = -22.6%

In Air C_0 = 2.7 pf.
L = 23.9 μh
R =

2/9/66

Mc	pf	Q	R
1.5	445	82	
2.1	227	95	
3.0	108	110	
4.2	53	120	
1.5	405	145	
2.1	205	170	
3.0	100	205	
4.2	50	231	

46T, .54 mm wire, 49.2 mm long, 29.7 mm dia

In Can C_0 = 4.7 pf

L = 25.1 μh = −9.3%

R =

2.1 mc Q = −44.1%

In Air C_0 = 1.7 pf

L = 27.7 μh

R =

41½T, Litz, close wound
29.0 mm long, 26 mm dia
Wire 0.78 mm dia

				Can ohms.
1.5	454	255	.909	.005
2.1	231	288	1.126	.014
3.0	110	294	1.576	.041
4.2	54	263	2.469	.100
1.5	415	279	.904	
2.1	212	316	1.140	
3.0	101	312	1.617	
4.2	49	275	2.569	

25 μh standard inductor.
Can 2½" dia, 3¼" long. copper.

In Can C_0 = 4.8 pf

L = 24.6 μh = −3.7%

R = 154.5 $\frac{Mc}{Q}$

Q = −7.2% at 2.1 mc.

In Air C_0 = 5.3 pf

L = 26.8 μh

R = 168.2 $\frac{Mc}{Q}$

Litz many very fine strands. Probably greater than 75 strands and finer than #44

MC	pf	Q	R
1.5			
2.1			
3.0			
4.2			
1.5		465	146
2.1		238	163
3.0		115	167
4.2		57	161

2/9/66

36T, 21-#41 B+S Litz, 32 mm long, 29 mm dia
0.47 mm O.D.

In Can C_0=

L=

R=

In Air C_0= 2.5 pf

L= 24.1 μh

R=

50T, 200-#44 Litz 42 mm long,
1.05 mm dia, 30 mm dia
14 turns, 2 banks at center.
In Can

1.5		284	263
2.1		145	210
3.0		68	156
4.2			116

In Air C_0= 4.0 pf

L= 39.1 μh

Need 42T for 27.5 μh.

2/9/66

MC	pf	Q	R
1.5	390	292	
2.1	200	261	
3.0	96	226	
4.2	48	181	
1.5			
2.1	223	235	
3.0			
4.2			

47 T, 125/#44 litz close wound .85 mm dia
40.5 mm long, 26.2 mm dia.

In air $C_0 = 2.3$ pf
$L = 28.7$ μh.

In $2\frac{1}{2}$ dia × $3\frac{1}{4}$" copper can
$C_0 =$
$L = -10.2\%$
$Q = -10.0\%$ at 2.1 mc

MC	pf	Q
1.5	375	272
2.1	191	274
3.0	92	249
4.2	46	210
2.1	213	248

43 T, 75/#44 Litz, close wound .70 mm dia
29.7 mm long, 26.1 mm dia.
In air $C_0 = 2.3$ pf.
$L = 29.9$ μh

In $2\frac{1}{2}$ dia × $3\frac{1}{4}$" copper can
$L = -10.2\%$
$Q = -9.4\%$ at 2.1 mc

This Litz not quite as good as in standard inductor

PMG machine

28 turns, .46 mm wire spaced wound. 5/8" dia × 1" long 1/9/66

MC	pf	Q	R	Shield ohms
1.5	341	95	2.25	.54
2.1	173	109	3.97	1.86
3.0	83	121	5.10	2.34
4.2	41	128	6.76	2.97
1.5	–?	70	.84	.03
2.1	920	84	.98	.08
3.0	449	102	1.16	.05
4.2	229	121	1.36	.05

In can $2\frac{1}{2} \times 2\frac{1}{2} \times 3\frac{1}{2}$ al.

With core

$C_0 = 3.0$

$L = 32.8\,\mu h$, $= -10.4\%$ $\mu = 5.24$

$R = 20.6 \frac{MC}{Q}$

Less core

$C_0 = 1.3\,pf$

$L = 6.26\,\mu h$ -1.8%

$R = 39.3 \frac{MC}{Q}$

				Core ohms
1.5	305	202	1.71	.90
2.1	154	229	2.11	1.13
3.0	74	250	2.76	1.65
4.2	37	255	3.79	2.48

			wire ohms
1.5	–?	74	.81
2.1	904	86	.98
3.0	440	108	1.11
4.2	225	129	1.31

In air

With core

26.3 μh = 23.6 T

$C_0 = 3.0$

$L = 36.6\,\mu h$, $\mu = 5.74$

$R = 230 \frac{MC}{Q}$

Less Core

$C_0 = 1.3\,pf$.

$L = 6.38\,\mu h$

$R = 40.1 \frac{MC}{Q}$

730 190 33
174 230 14
904 420 47

PMG machine

1/9/66

26T, .98mm wire close wound. 5/8" dia x 1" long

Incan

MC	pf	Q	R	shield ohms.	
1.5	415	53	4.8	.7	With Core.
2.1	213	59	6.0	.9	C_0 = 3.7pf
3.0	101	65	7.8	1.2	L = 26.9μh −10.6% μ = 5.07
					R = 169 MC/Q
1.5	2140	69	.72	.05	Less Core
2.1	1090	81	.86	.05	C_0 = 2.0pf
3.0	529	95	1.05	.08	L = 5.30μh −1.4%
4.2	271	111	1.26		R = 33.3 MC/Q

Core in Air

26.3μh = 24.3T

			core ohms.	wire ohms.	
1.5	371	69	4.1	3.3	with core
2.1	190	78	5.1	4.3	C_0 = 2.7pf.
3.0	91	86	6.6	5.6	L = 30.1μh μ = 5.60
					R = 189 MC/Q
1.5	2110	65	.77		Less core
2.1	1077	87	.81		C_0 = .3pf.
3.0	524	104	.97		L = 5.37μh
4.2	269	122			R = 33.7 MC/Q

331 360 375
731 730 210
1050 1090
210

2/9/66

Tuning rate = 5KC per division = 500 cps per 0.1 division.
allow 50KC contraction at ends of range.
Net range 450KC = 1900 - 2350KC
Tuning range = $\frac{2350}{1900}$ = 1.237
Capacity range = 1.237^2 = 1.530
Capacity variation = 102 pf.
Minimum capacity = $\frac{102}{.530}$ = 192.5 pf.
$L = 1/(6.28 \cdot 1.9)^2 \, 294.5 = 1/142.2 \cdot 294.5 = 10^{-6}/.0419$ = 23.9 μh
allow 10% for reduction in can : 26.3 μh in air

30/8/66

4 gang Condenser, Front to Back

Gang	Max	Min	Range
1	111.0	8.0	103 pf
2	111.0	8.0	103 pf
3	110.0	8.0	102 pf
4	113.0	11.0	102 pf

PMG machine 1/9/66

Variometer

MC	pf	Q	R
.75	245	94	8.5
1.05	114	82	13.7
1.5	46	56	28.6
.75	-?	31	2.9
1.05	1190	37	3.4
1.5	575	44	4.0
2.1	285	48	5.2
3.0	127	48	7.4
4.2	53	39	12.8

Max inductance

C_0 = 20.3 pf

L = 170 μh

R = 1067 MC/Q

Min inductance

C_0 = 23.3 pf

L = 18.8 μh

R = 118 MC/Q

RAYTHEON COMPANY
SEMICONDUCTOR OPERATION
350 ELLIS STREET
MOUNTAIN VIEW, CALIFORNIA
AREA CODE 415
PHONE 968-9211
TWX 969-9190

July 19, 1965

Mr. Grote Reber
Tasmanian Regional
Laboratory, CSIRO
"Stowell", Stowell Avenue
Hobart, Tasmania
Australia

Dear Mr. Reber:

Reference is made to your inquiry of July 15, 1965. The specification sheets for the FN1024 and FN1034 Field Effect Transistors are indeed similar. The devices are selected to different specifications, however.

You will find the drain characteristics chart on page 3, top center of FN1024 quite accurate. This is a representation of typical characteristics and should be evaluated with this fact in mind.

The Raytheon FET has an insulated gate and the input resistance (R_g) does not change noticeably with a change in electrical parameters within the maximum ratings of the device. (This input resistance is the dielectric resistance of silicon dioxide). It is in excess of $10^{12}\Omega$ if the glass between the gate lead and all other leads is kept clean.

Very truly yours,

D. W. Hollenbeck

D. W. Hollenbeck

/dm

cc: E. Ziegler

15th July, 1965.

Raytheon Company,
Semiconductor Operation,
350 Ellis Street,
Mountain View,
CALIFORNIA...U.S.A.

Dear Sirs,

Recently I have secured product specification sheets issued 2-65 on your types FN1024 and FN1034 field effect transistors from your Mr. E. Ziegler of your New York office. The small charts showing drain current versus drain voltage for typical V_{GSB} at +25°C and +125°C are identical for both transistors. These charts are quite similar at -200°C. Unfortunately the large chart covering page 4 of sheet for FN1024 is markedly different from small chart at top centre of page 3. Which one is correct?

On page 3 near bottom under Typical Values for FN1024, item 1 lists $R_G = 10^{15}$ ohms. The specified conditions of $V_{DSB} = -10$ volts and $I_D = -1.0$ ma are quite far from centre of dynamic working range. I suspect R_G decreases rapidly as V_{GSB} becomes more negative and I_D becomes larger. Please send to me curves of R_G versus V_{GSB} for typical values of V_{DS}. This information in some other form such as tables of values will be quite satisfactory.

Yours faithfully,

Grote Reber.

GR:JEG

RAYTHEON COMPANY
REGIONAL COMMERCIAL SALES

210 SYLVAN AVENUE
ENGLEWOOD CLIFFS, NEW JERSEY 07632
AREA CODE 201 - DIAL: 567-4911
MANHATTAN TELEPHONE:
AREA CODE 212 - WISCONSIN 7-6400

June 30, 1965

Mr. Grote Reber
Research Corporation
405 Lexington Avenue
New York, N. Y. 10017

Dear Mr. Reber:

In accordance with your request, we are pleased to enclose data sheets FN1034 and FN1024 on our Field Effect Transistors.

Thank you for your interest in Raytheon products and, if we can be of further assistance, please feel free to contact the writer.

Yours very truly,

RAYTHEON COMPANY

E. Ziegler

E. Ziegler
District Sales Engineer
Components Division

Enclosures