
L85 HF Linear Amplifier
DRAKE
TRANSMIT AGC
Ep KV
Ig mA
Ip mA
RELATIVE OUTPUT
STANDBY OPERATE
RELATIVE OUTPUT ADJUST
PLATE
BAND
LOAD
LOAD RANGE
20 - 30
10 - 20
POWER
ON
OFF
PLATE mA
PLATE KV
R. L. DRAKE CO.

L85

Maintain, Modernize, or Magnify? YOU can do all three!

Agenda

L4B Tune Up; it's not what you think.

TR-7 adjustable ALC/Power, for ALL modes.

C-Line is great, but what frequency am I on?

Self-Contained, 2 tube L4B: How did he do that?

Prize Drawings.

Q&A

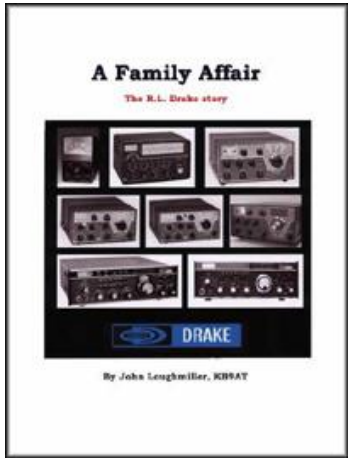
Resources

Drake Technical Net: Sunday, 7238 kc @ 4:00 PM Eastern

Drake & Antique Tube Gear Net: Tue. 3865 +/- kc @ 8 pm Eastern

Drake West Coast Net : Thur. 3895 +/- QRM @ 8pm Pacific Time

Drake Family Affair Book by John Loughmiller, KB9AT



Drake L4B Tune Up; It's not what you think.
Evan, K9SQG

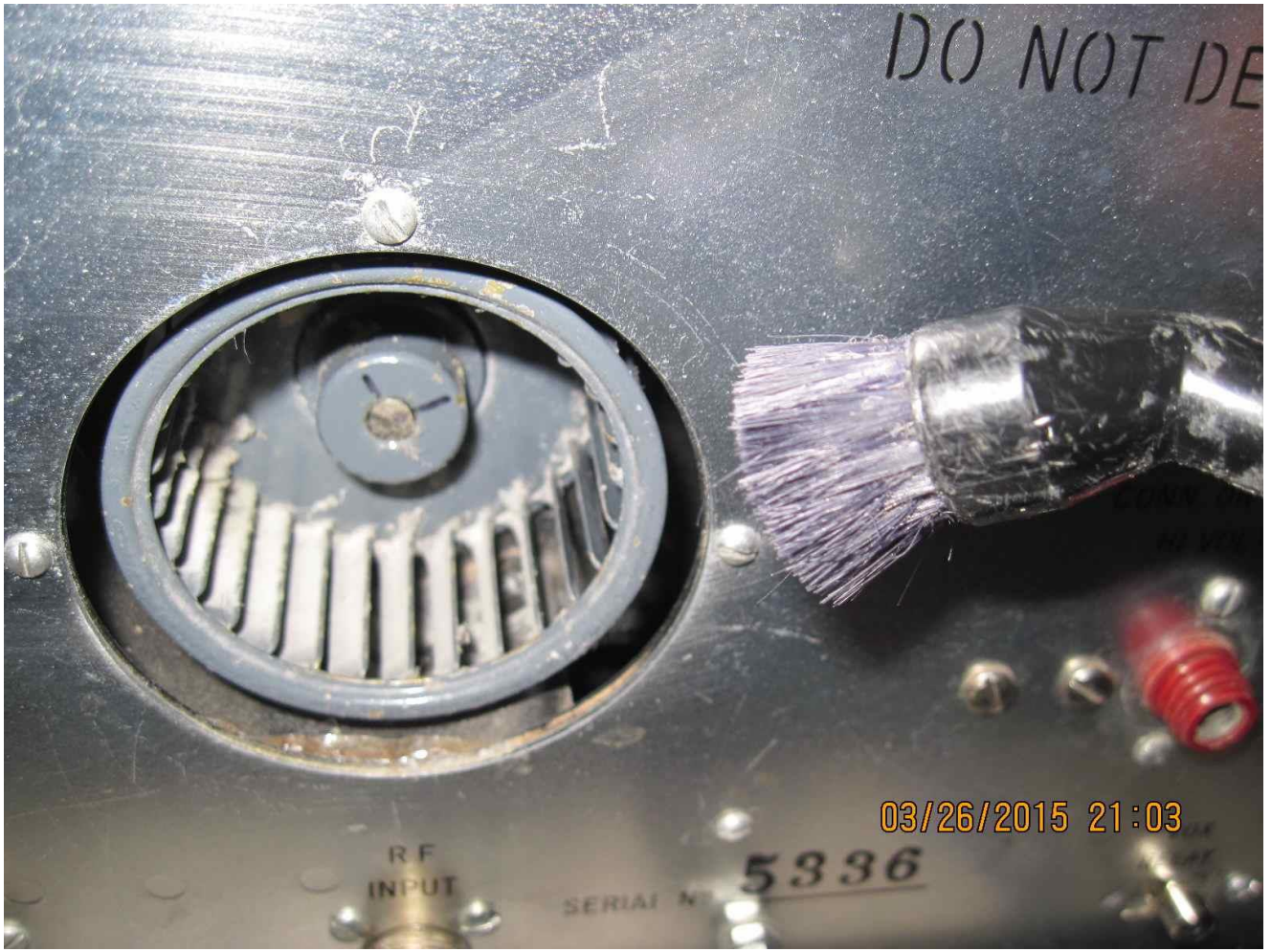
What are they used for?

First Phase: The External Tune-Up

Preventive Maintenance spoken here!

Dusting without Damage

One year's indoor dust accumulation.



Mated connectors are not immune.

How do you clean inside this connector?!

Second Phase: Dynamic checks before tune-up

Current status? Not the status of the current.

- HV caps vented in power supply?
- Meter bulbs ok?
- Input SWR and power between rig and amp, unchanged?
- Plate voltage:
  - SSB and CW
  - standby, operating w/o audio, with hard audio peaks
  - capacitor bleed down when turned off (10 second rule for "food")
- Tube color, standby, transmit without signal, with hard audio signal.

Third Phase: Internal Tune-Up

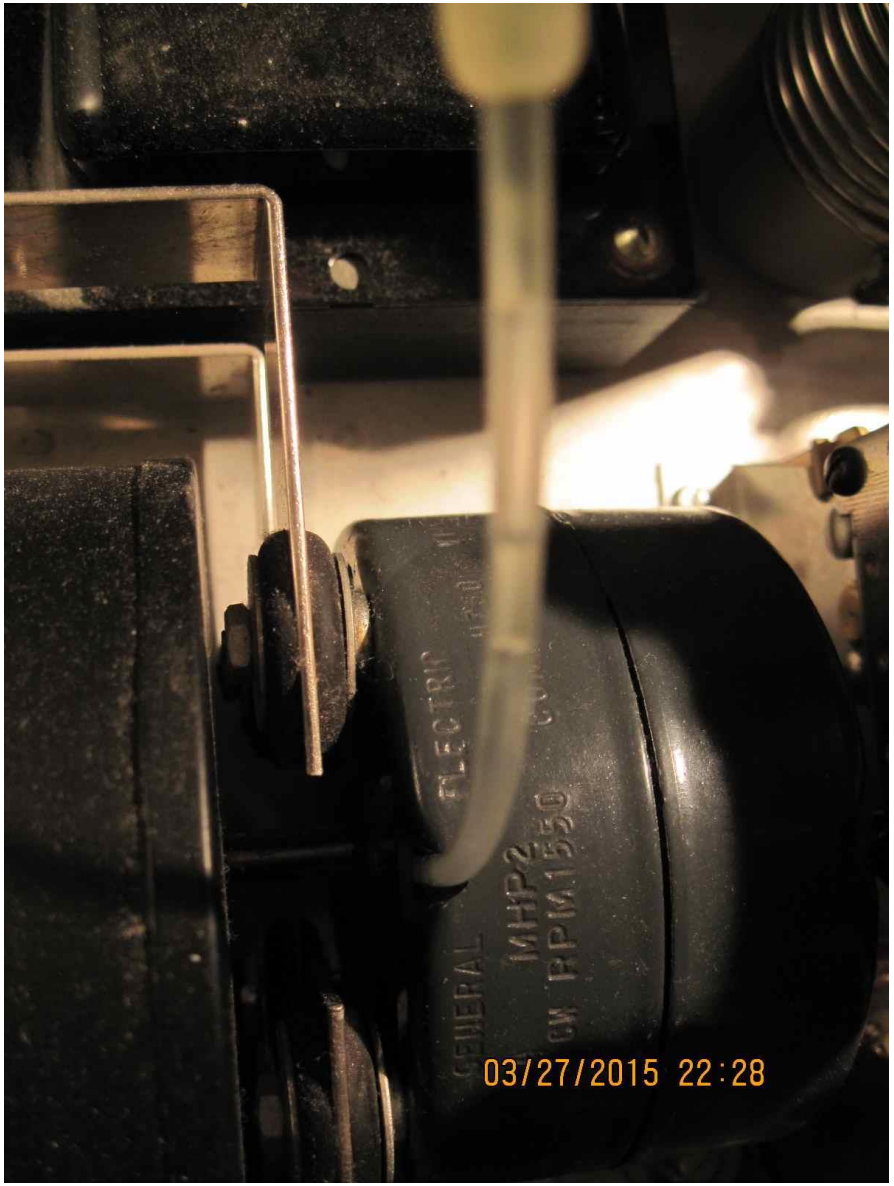
(Static tune up, or is it tune up for static?)

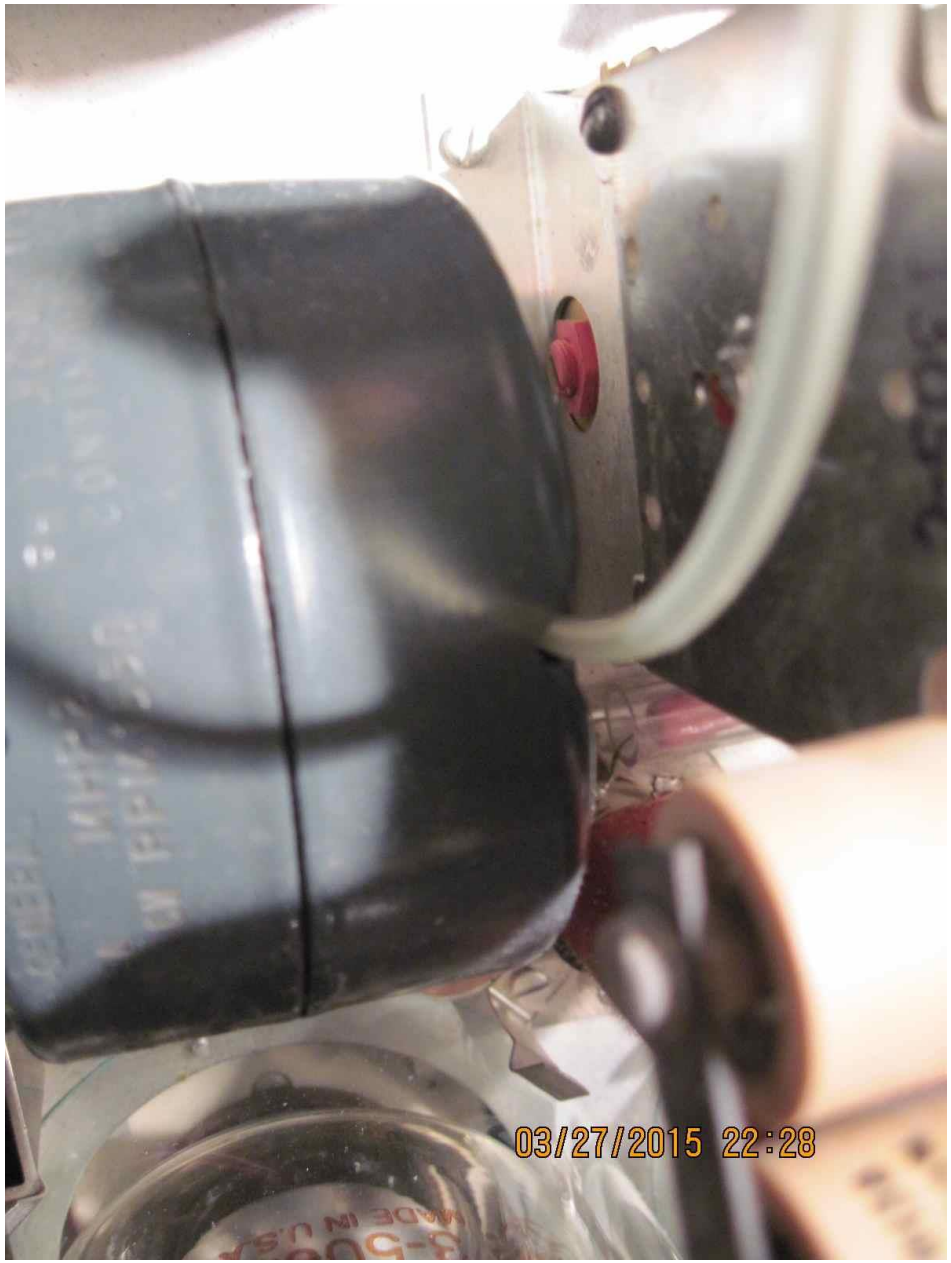
Overall visual inspection.

Mr. Dustin Damage is not your friend.

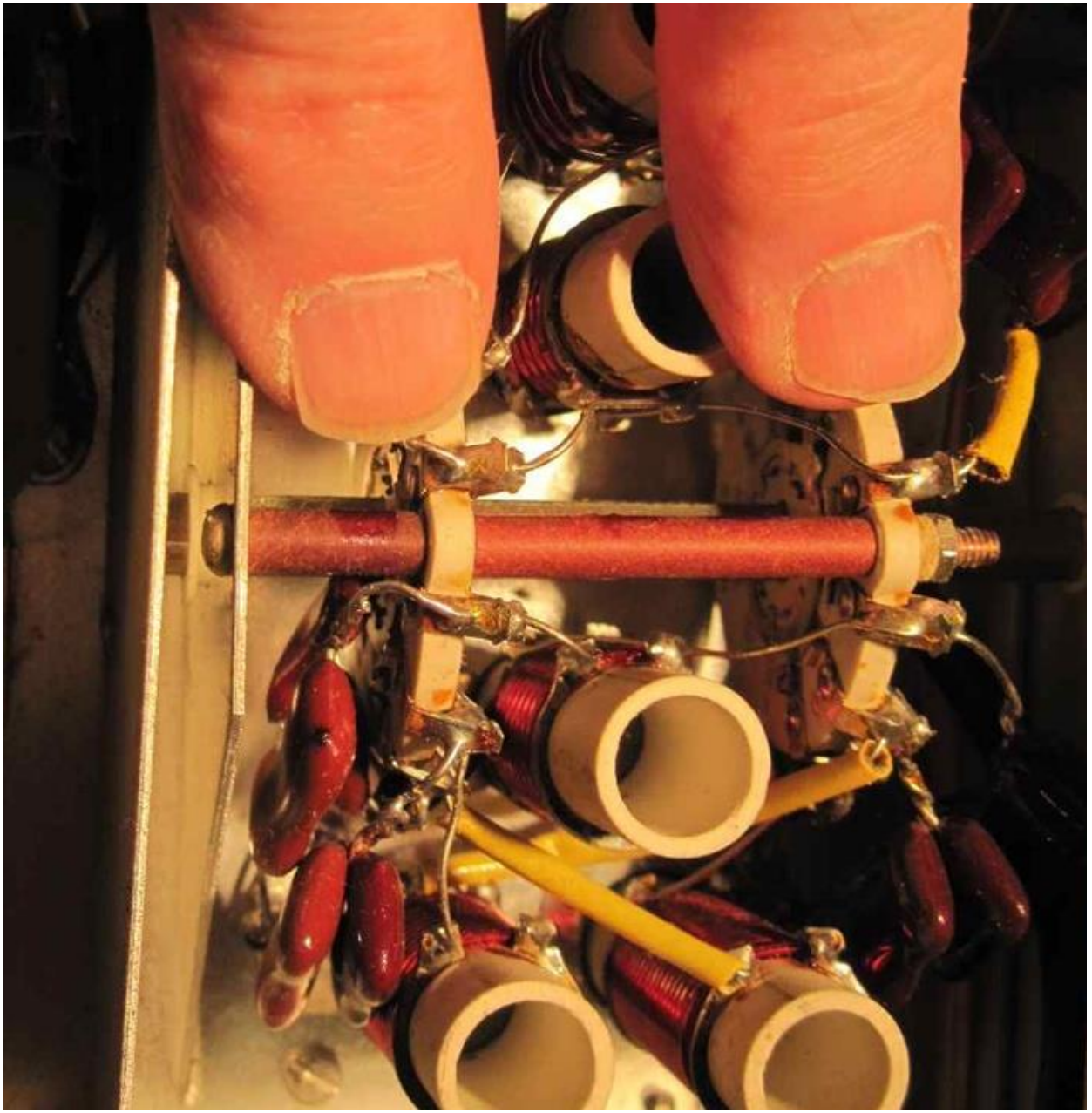

03/27/2015 22:33

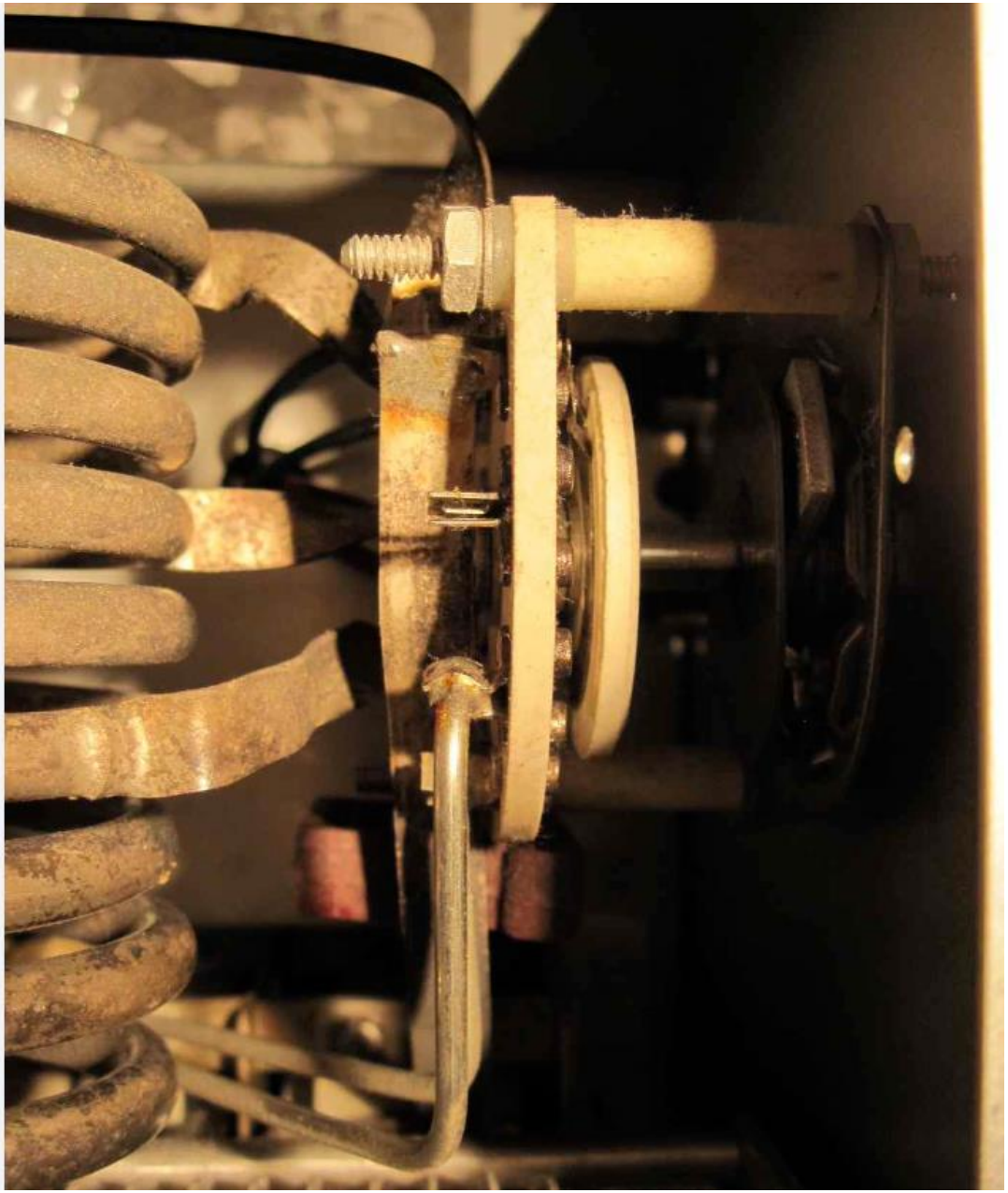
Oil change? Nah, just top it off...


GENERAL
MHP2
RPM1550
03/27/2015 22:28


03/27/2015 22:28

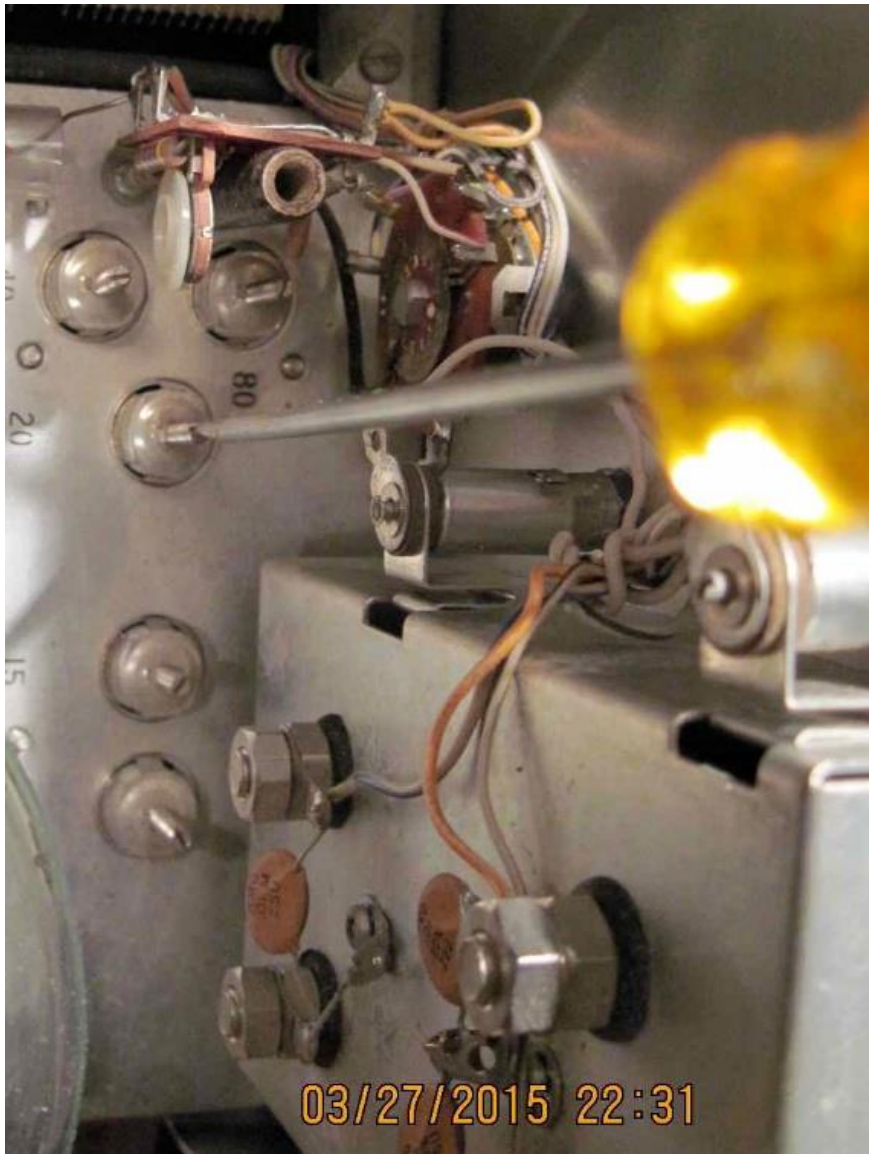
Ms. Dee Oxit: our previously shown friend not just for tube pins.



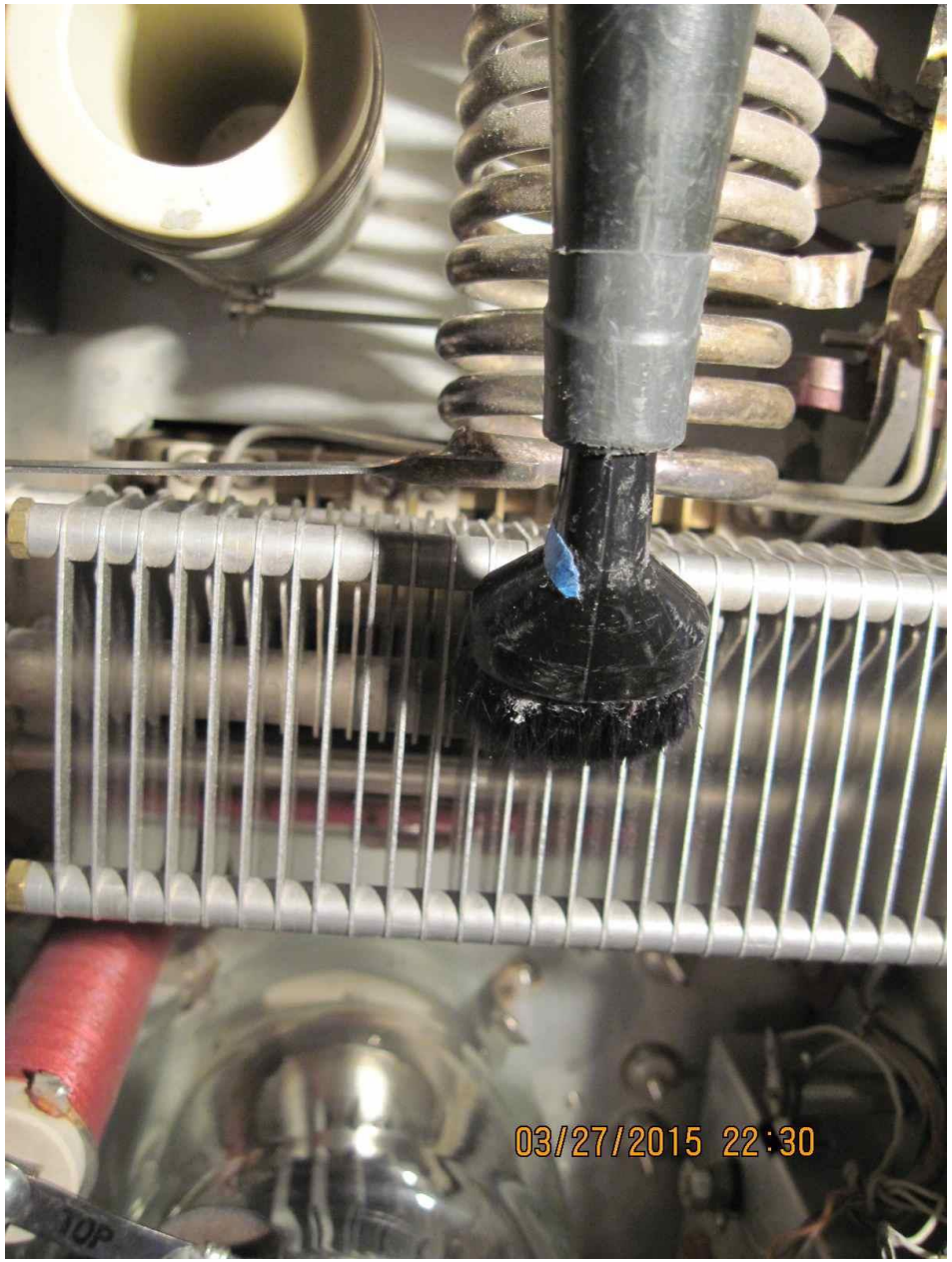


On the lighter side, for 50 cents worth of parts...
Or

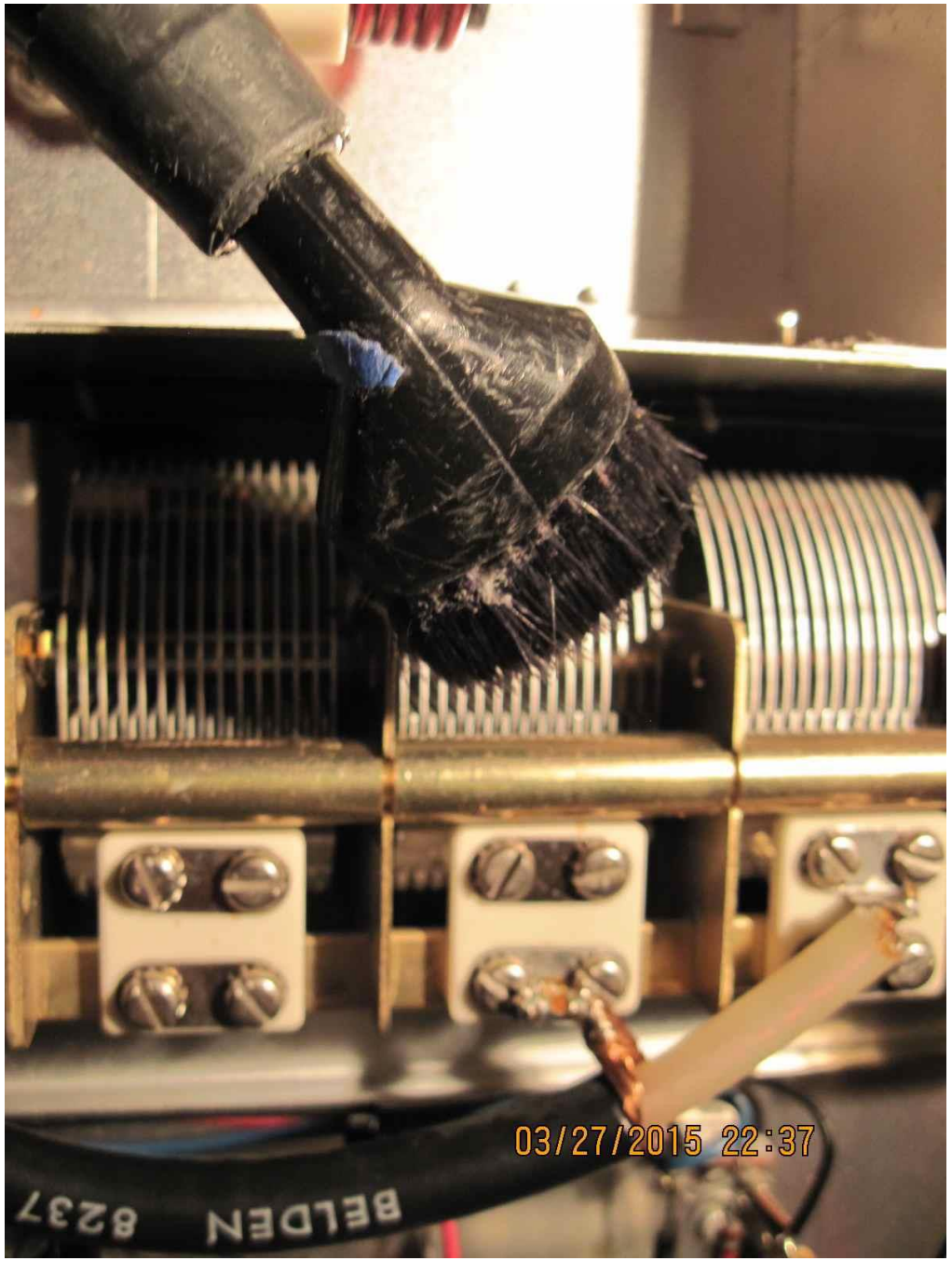
If you have the cabinet open anyway...



Do I have the capacity to do this?



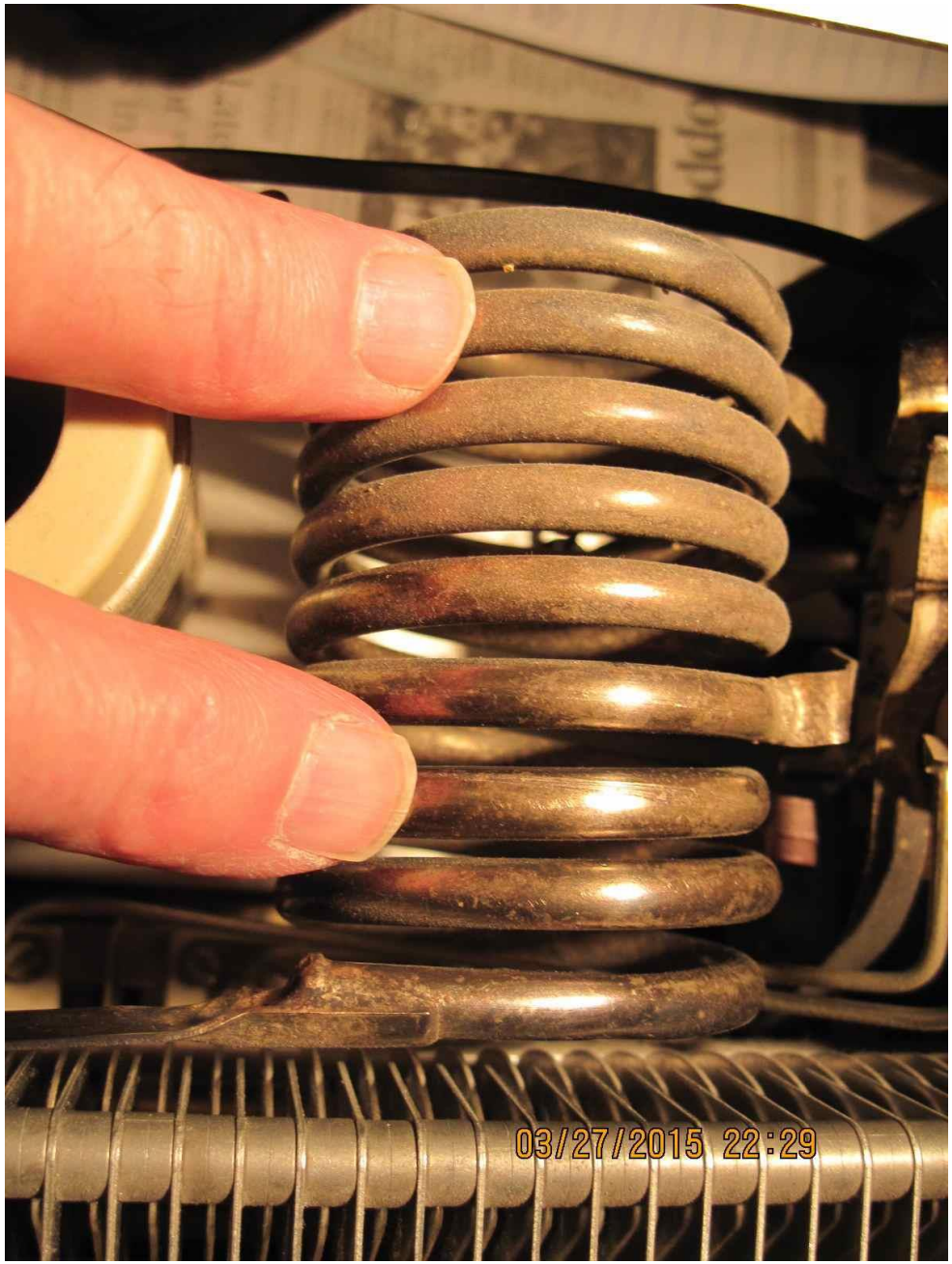
What a load...



"What difference does it make?"

or

Sometimes it doesn't matter.

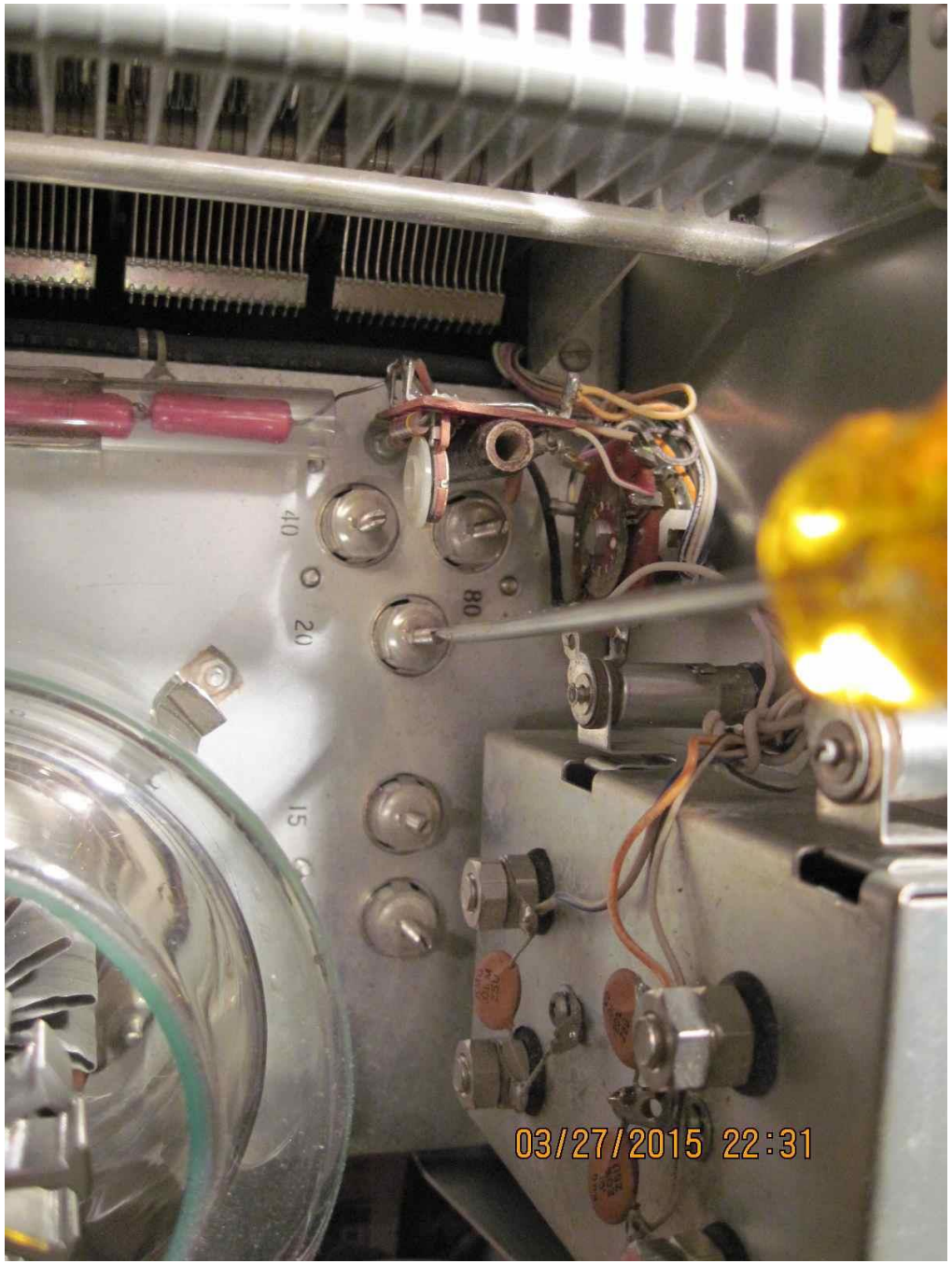


"There is a season, turn, turn..."

If the season has seen tube or rig changes:

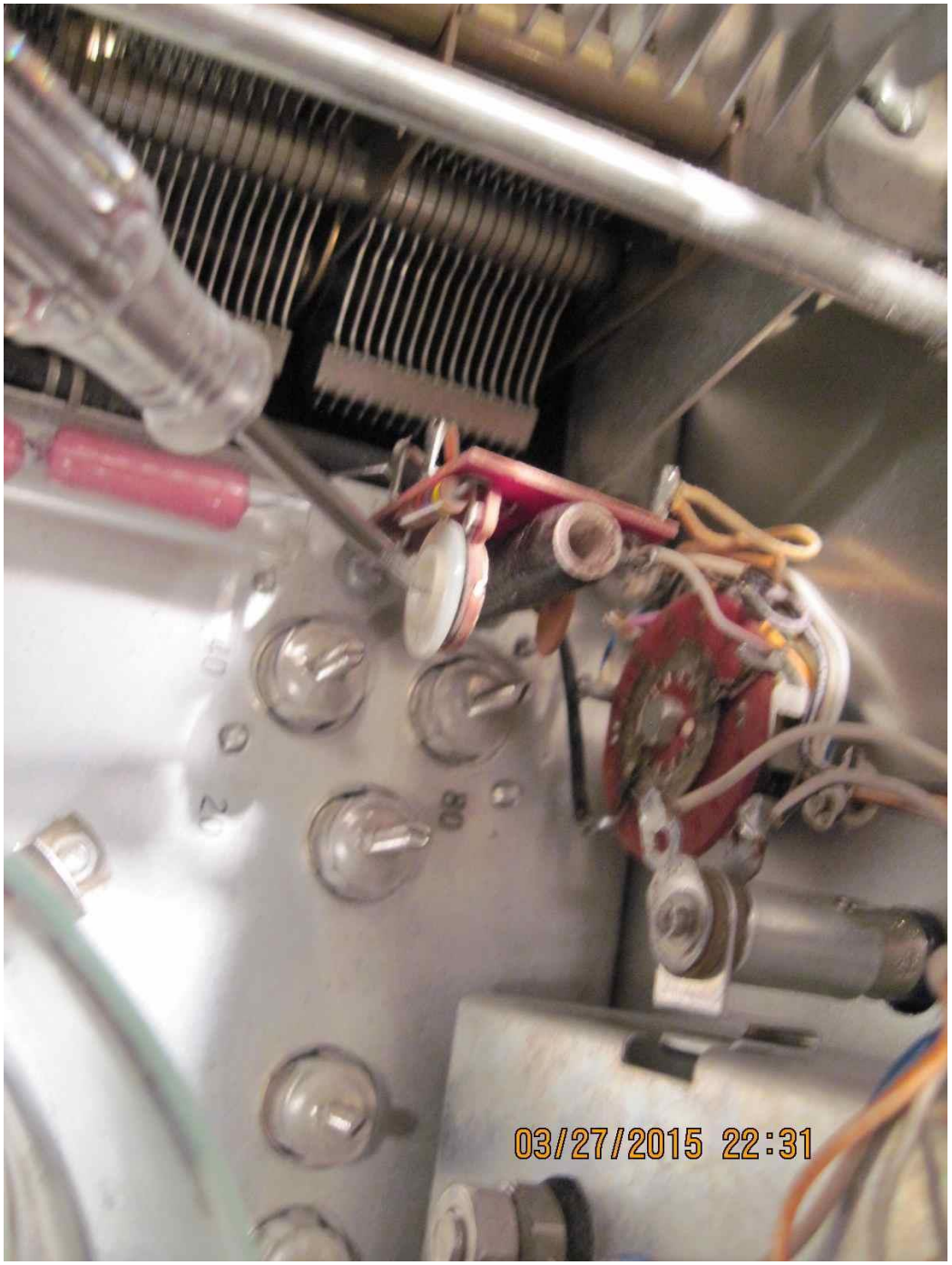
Check input SWR to see if input coil adjustment is needed.

Check grid current calibration.



Current Event, or non-Event?

Procedure in your owner's manual.



M.V.G. May 2015

Fourth Phase: How to tune up on the air, or with a dummy load

(Need we go there?)

Our Assumptions Here:

You are tuning up for SSB.

Plate voltmeter is calibrated (or inaccuracy is known).

Grid ammeter is calibrated (or inaccuracy is known).

Plate ammeter is calibrated (or inaccuracy is known).

External wattmeter(s) known to be reasonably accurate.

Keep the multimeter reading GRID current, < 220 ma!!!!! That's Drake and Eimac talking, Amperex says <250 ma for their tubes.

General Tune-Up Procedures

(1) Exciter with dummy load first. Vacuum tube style vs solid state, and set power level.

(2) Then antenna tuner with antenna on unused frequency, or preferably continue with dummy load.

(3) Chart knob settings, power levels, etc.

Examples of Two Tune-Up Procedures

1. Drake's instructions

2. CW pulser or keyer with dots (in SSB mode all the time)

1. Drake's instructions (simplified)

(I'm glad you asked.)

Goal: 565 ma of plate current with no more than 220 ma grid current.
First do "SSB AND AM TUNING" then "SSB OPERATION".

- Set PLATE VOLTAGE switch to CW-TUNE.
- Increase exciter output while not exceeding 400 ma of plate current, tune PLATE control for a dip. Keep grid current under 220 ma!
- Iteratively increase the exciter power, dip the PLATE, and increase LOAD controls striving to reach 565 ma of loaded plate current while keeping the grid current at or under 220 ma, at resonance.

- Insert a strong single audio tone into the microphone of the exciter and set it for maximum output. (Constant amplitude and frequency?)
- Put linear into transmit, and turn AGC control clockwise until the plate current reads 580 ma.
- Set PLATE VOLTAGE switch to SSB

2. CW pulser or keyer with dots

(I beg to differ, please let me differ...from Drake's instructions.)

- Set PLATE VOLTAGE SWITCH to SSB.
- Ensure exciter is set to approximately 40 watts output, level is RMS for a CW pulser, a keyer sending dots, or PEP for an SSB audio pulser.
- Set LOAD control to number "3", around 11 o'clock.
- Go into transmit and iteratively adjust PLATE and LOAD for maximum power out.
- Gradually increase driving power up to around 60 watts (MAX) and iteratively adjust PLATE and LOAD for maximum output power.
- Put exciter into CW key down condition, ensure grid current never exceeds 220 ma, and increase driving power, iteratively adjusting PLATE and LOAD for maximum output while plate current never exceeds 565 ma.

- Only if tubes are soft have I seen the need to go to 70-80 watts of driving power to achieve 220 ma of grid current.


DRAKE

Drake TR-7
"ALC"
Power Control
in All Modes

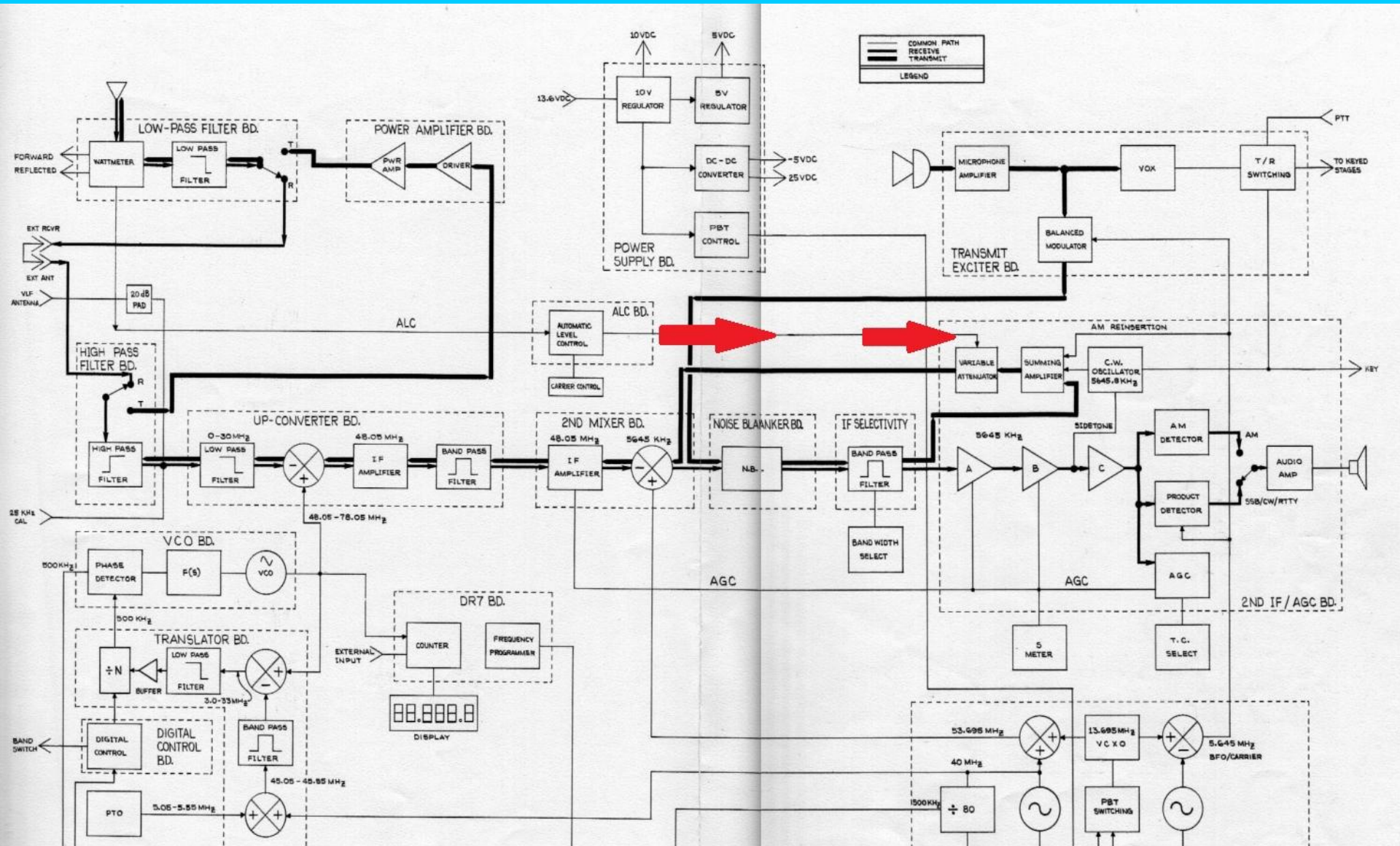
By: Jeff Covelli / WA8SAJ

TR-7 Carrier & Output Power Control

Stock

A.M. & C.W. Only

TR-7 "ALC" sending voltage to control drive in the 2nd I.F. audio board



DRAKE

2nd I.F. / Audio Board

Normal ALC

voltage in SSB mode

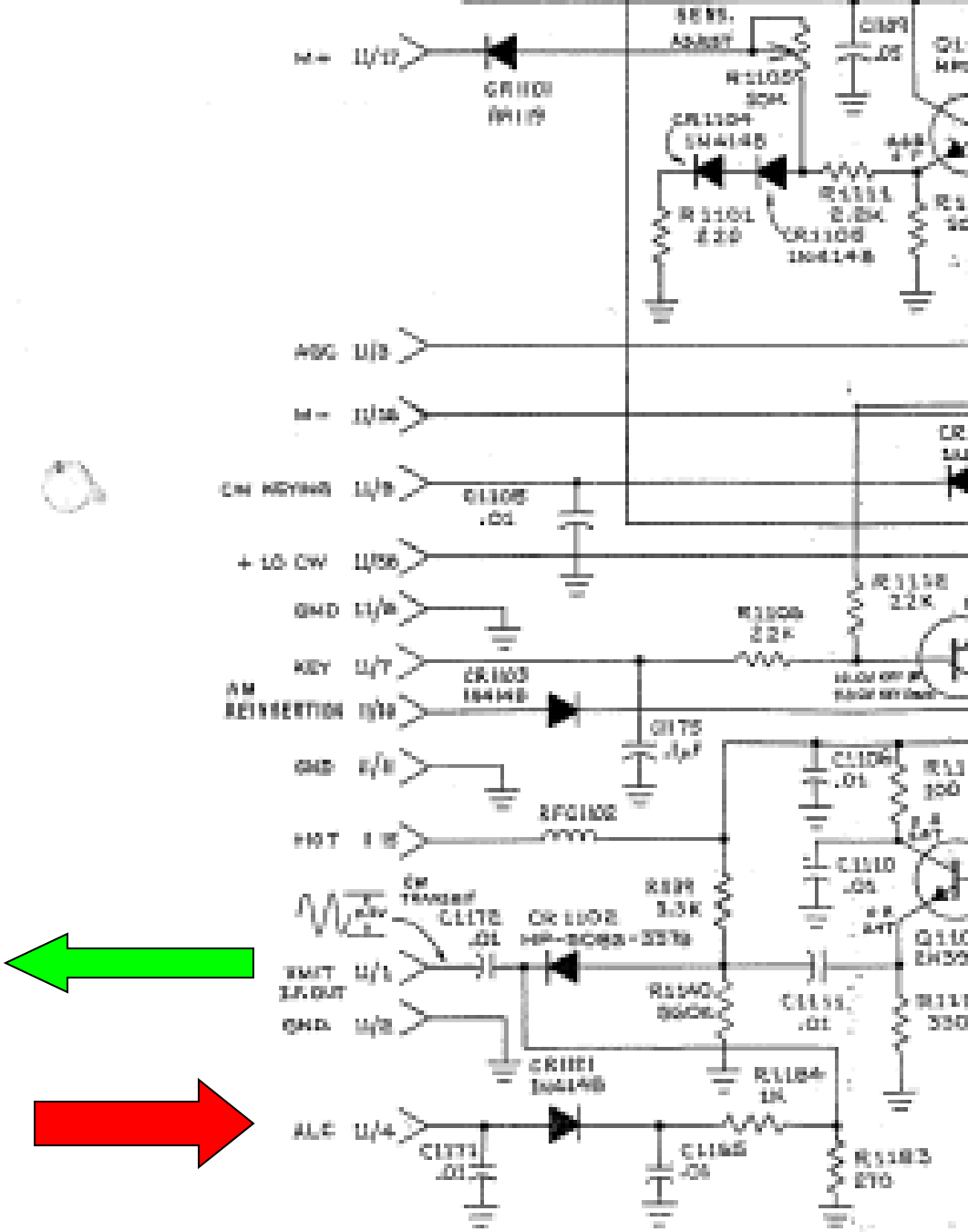
Varies 0 to 3 volts

Transmit

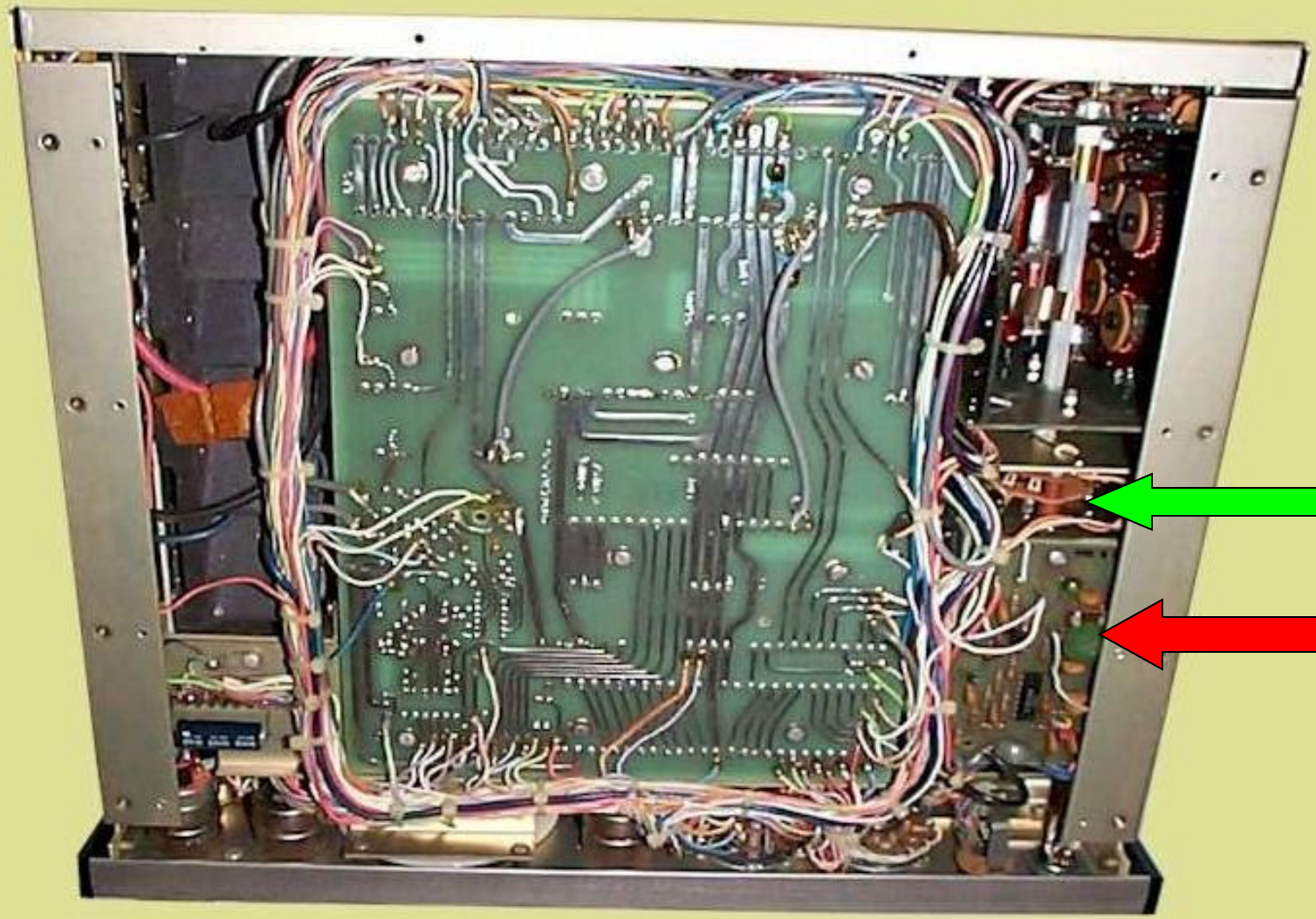
5645 kHz I.F. out

0 to 6 - D.C.Volts

total ALC voltage



TR-7 Bottom View



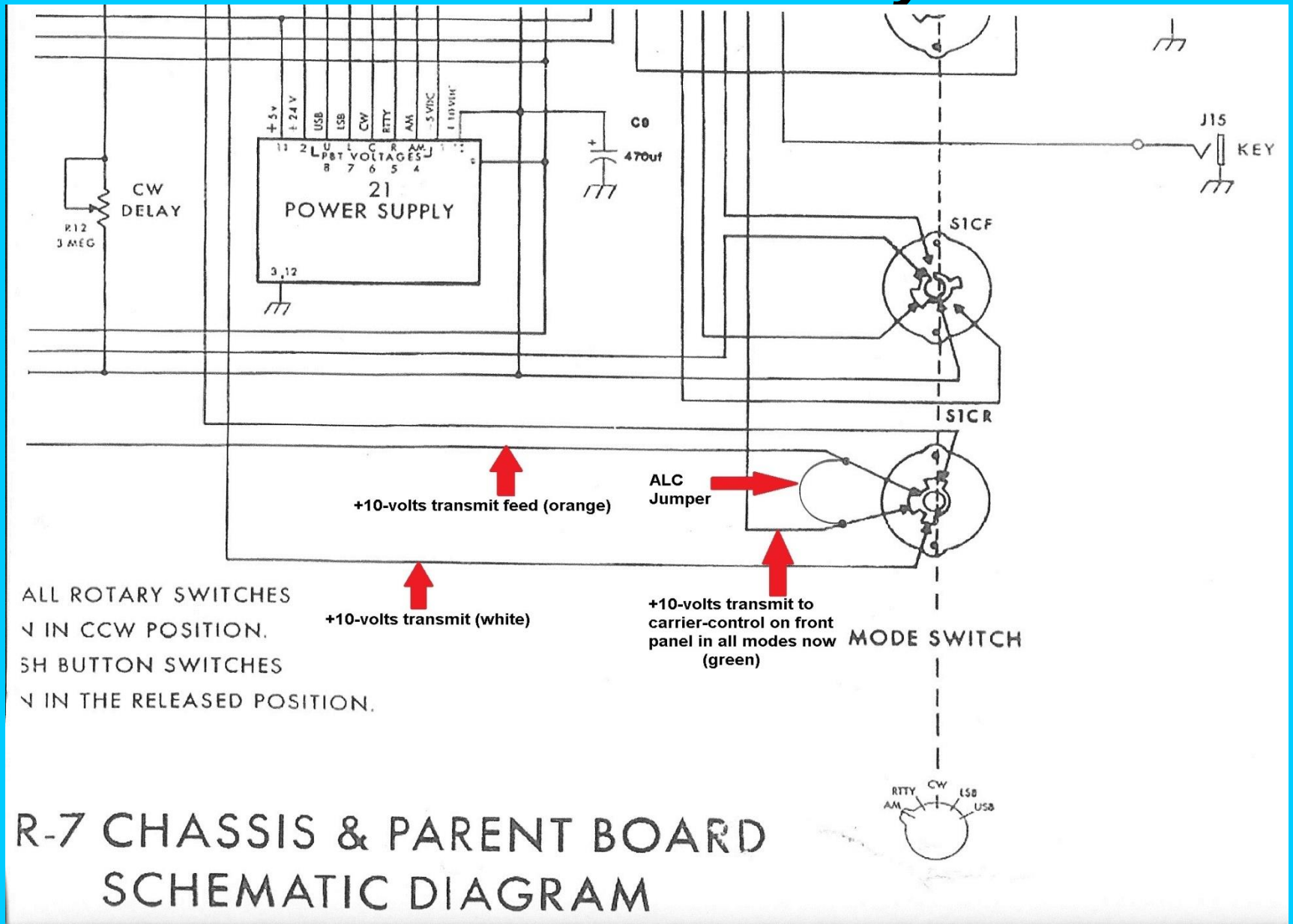
10 & 15 Wafer

<u>ALC</u> Pot R-1603

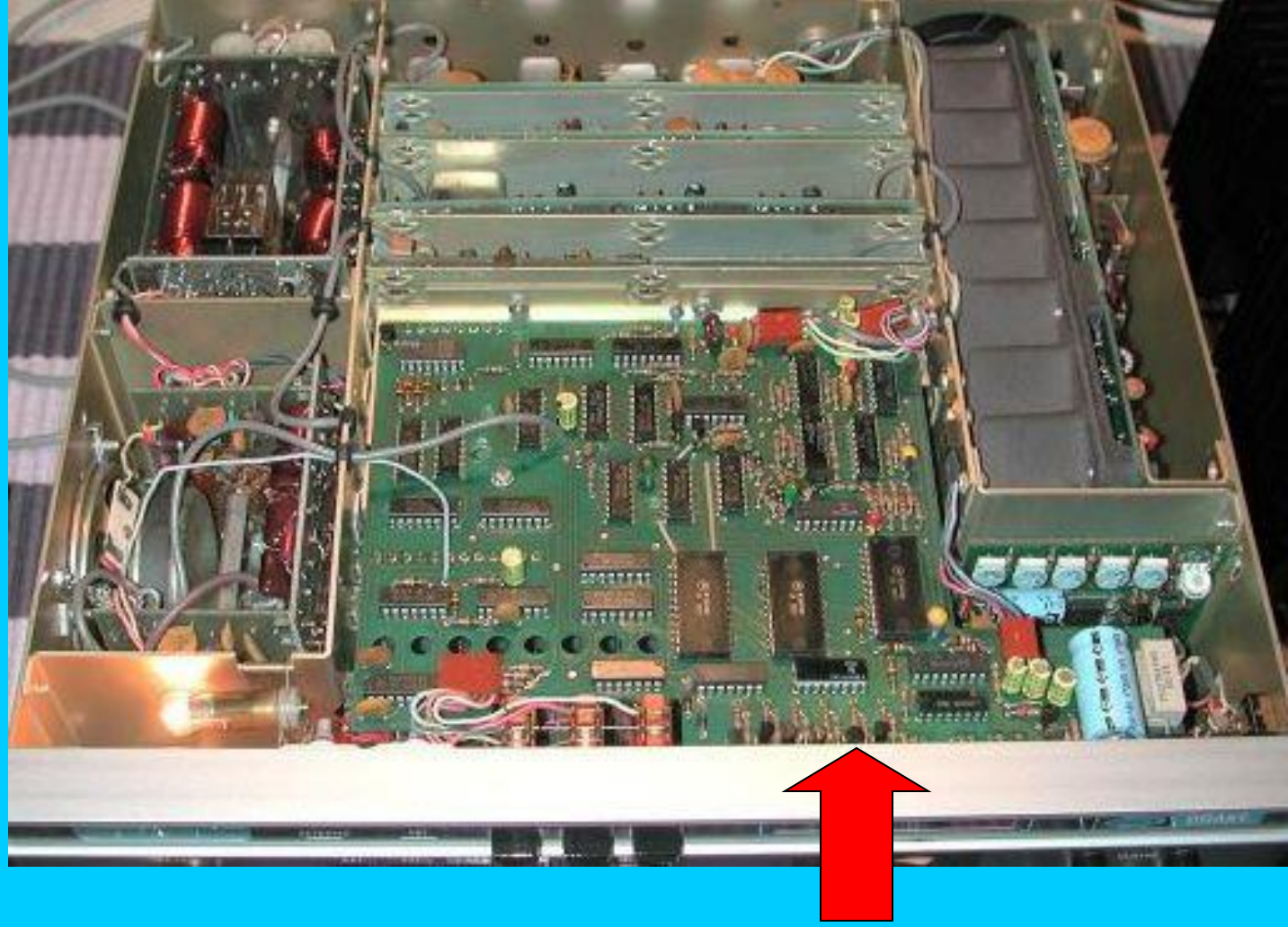
DRAKE

TR-7 Bottom View of ALC Board

TR-7 Mode Switch Layout



DRAKE



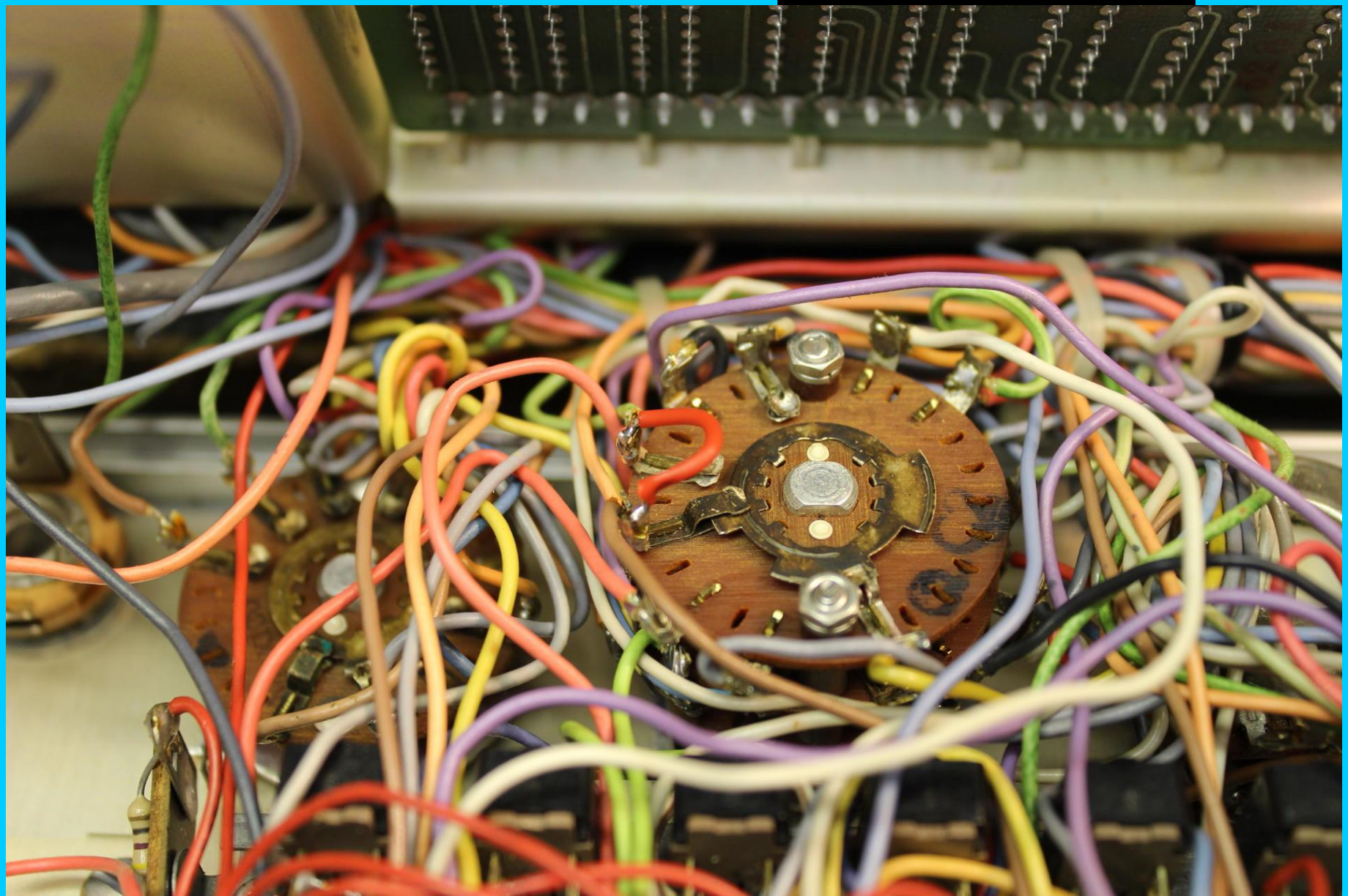
Before removing the DR-7 board

Use an ESD static wrist strap tied to ground !

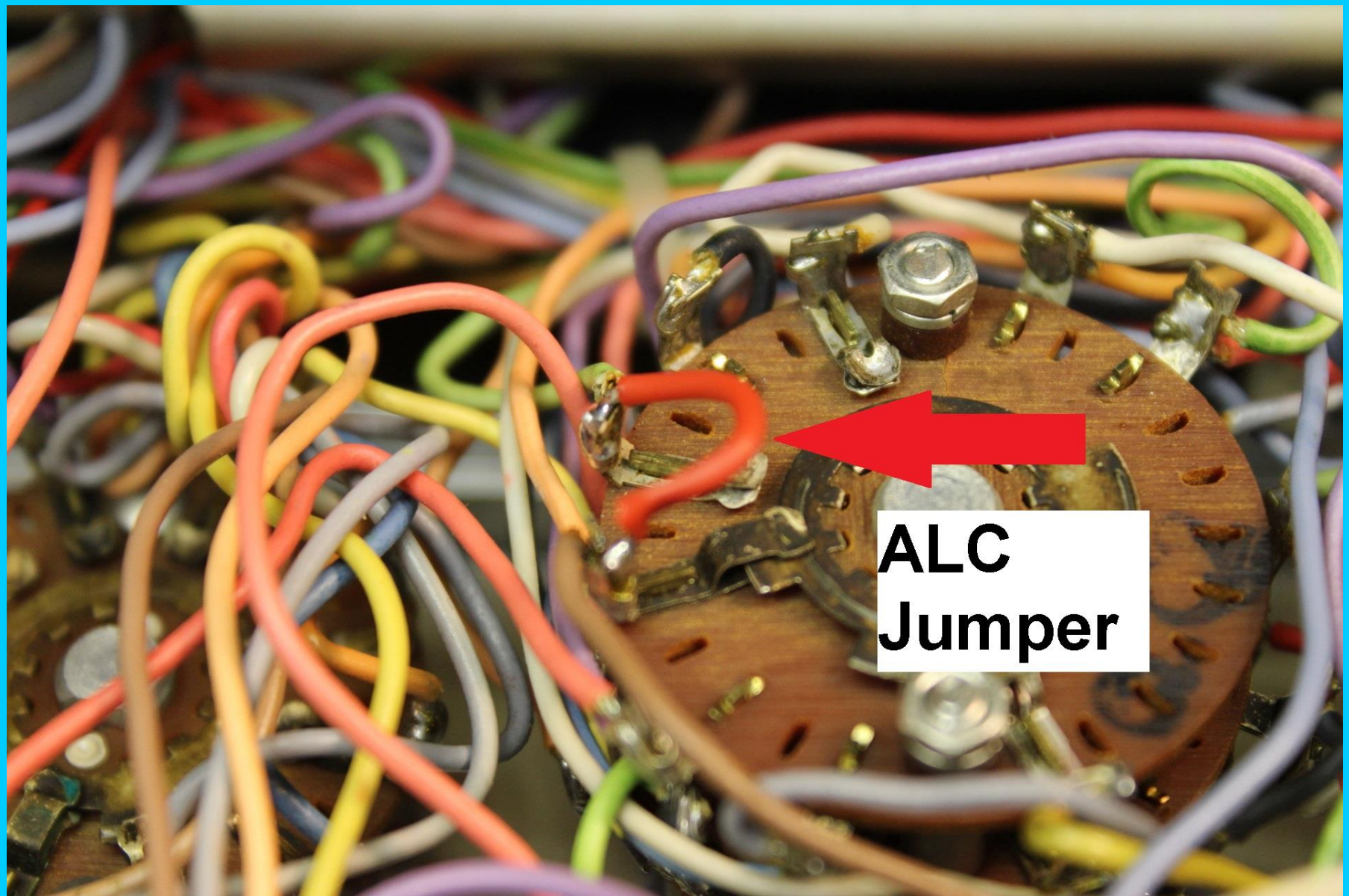
Along with the TR-7 tied to ground !

DRAKE

TR-7 Mode Switch "Back View"



TR-7 Install an ALC Jumper



TR-7 Carrier & Output Power Control

Now Full Power Control In All Modes

DRAKE

Normal ALC

Voltage in SSB mode

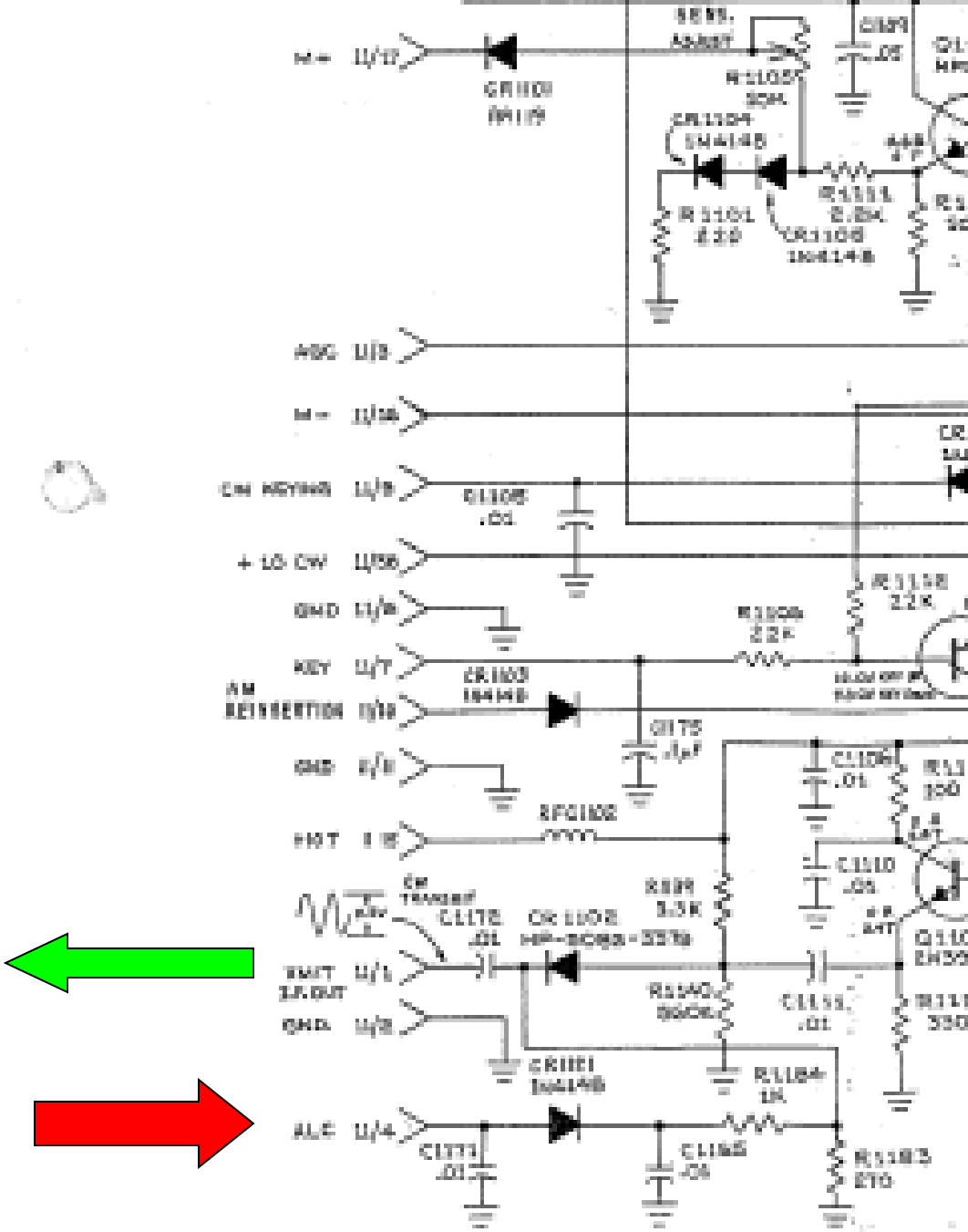
Varies 0 to 3 volts

Transmit

5645 kHz I.F. out

0 to 6 - D.C.Volts

total ALC voltage



The End

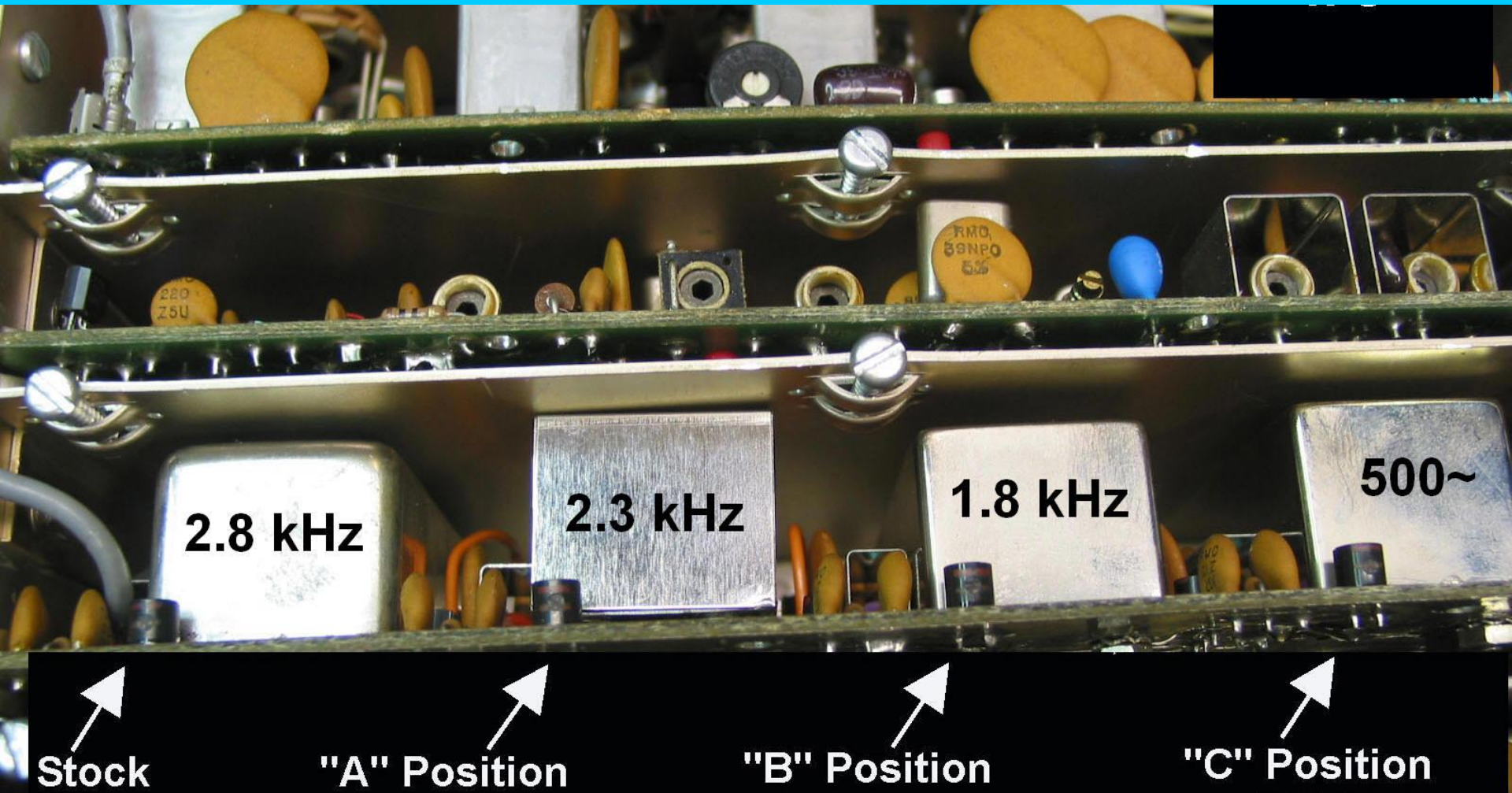
Drake TR-7
Stock 2.3 kHz Wide Filter

vs.

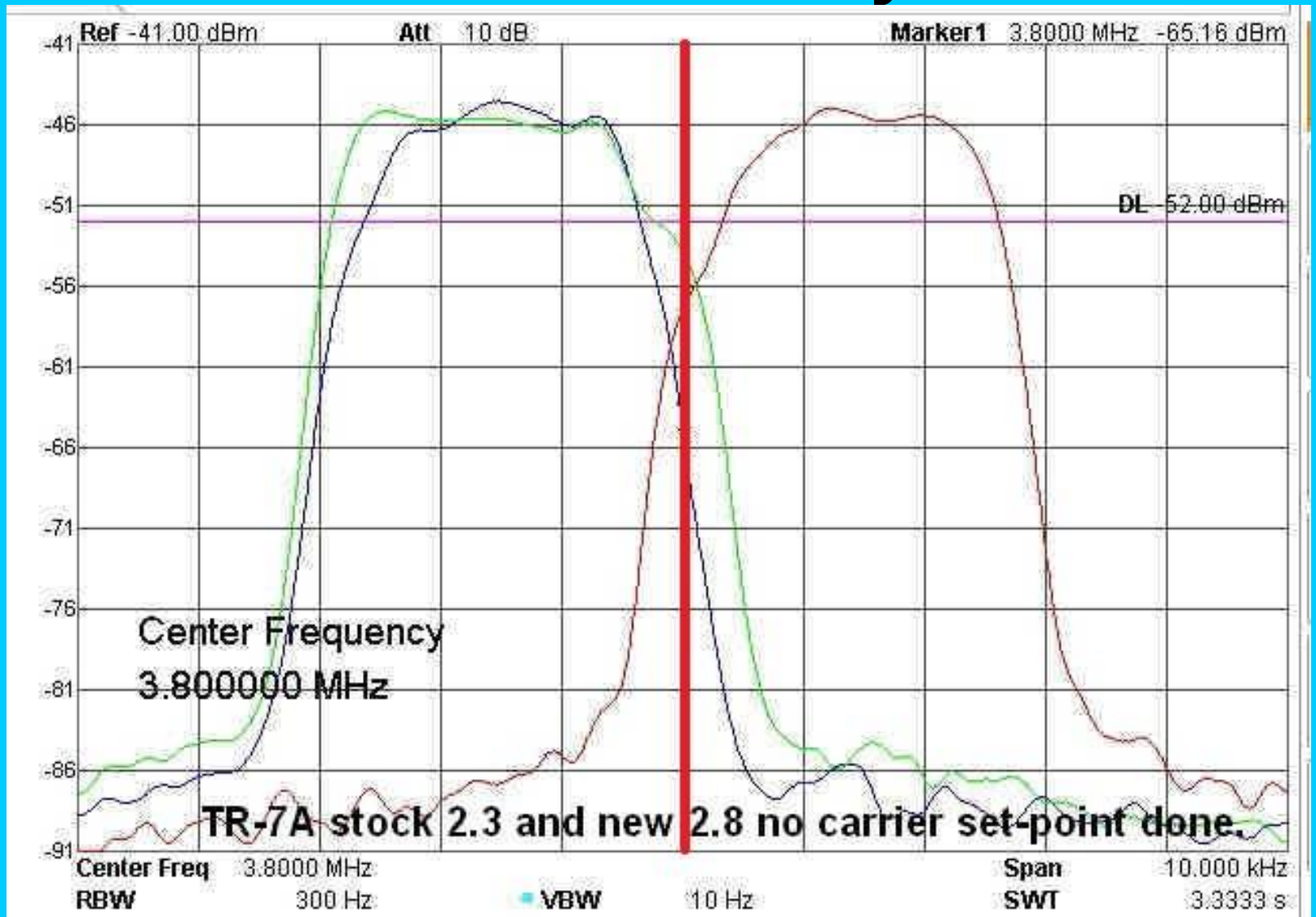
INRAD 2.8 kHz Wide Filter
Part Number - 1714.2

By: Jeff Covelli / WA8SAJ

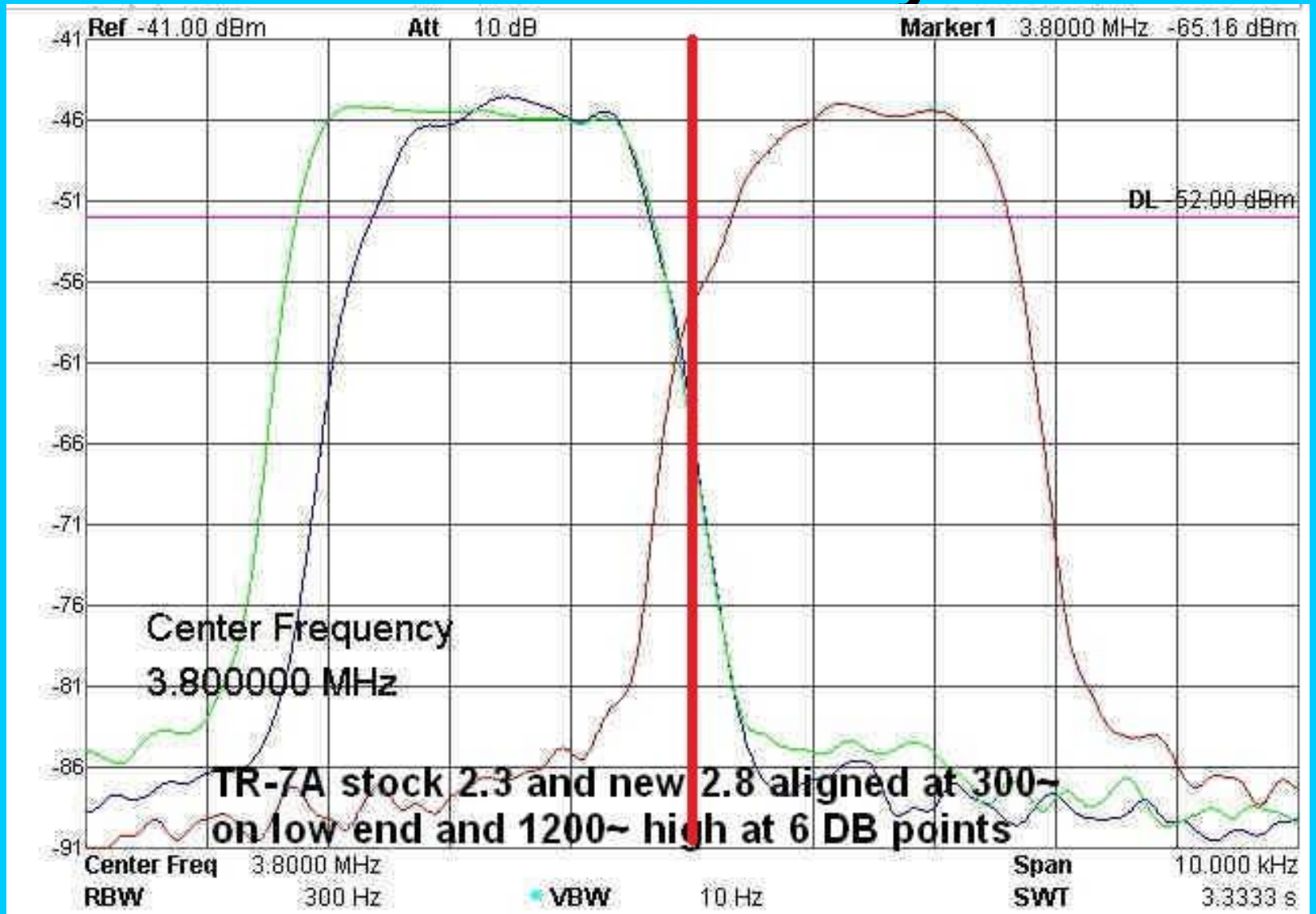
TR-7 New INRAD 2.8 kHz Filter Installed & the stock 2.3 kHz installed in the "A" slot now for receive



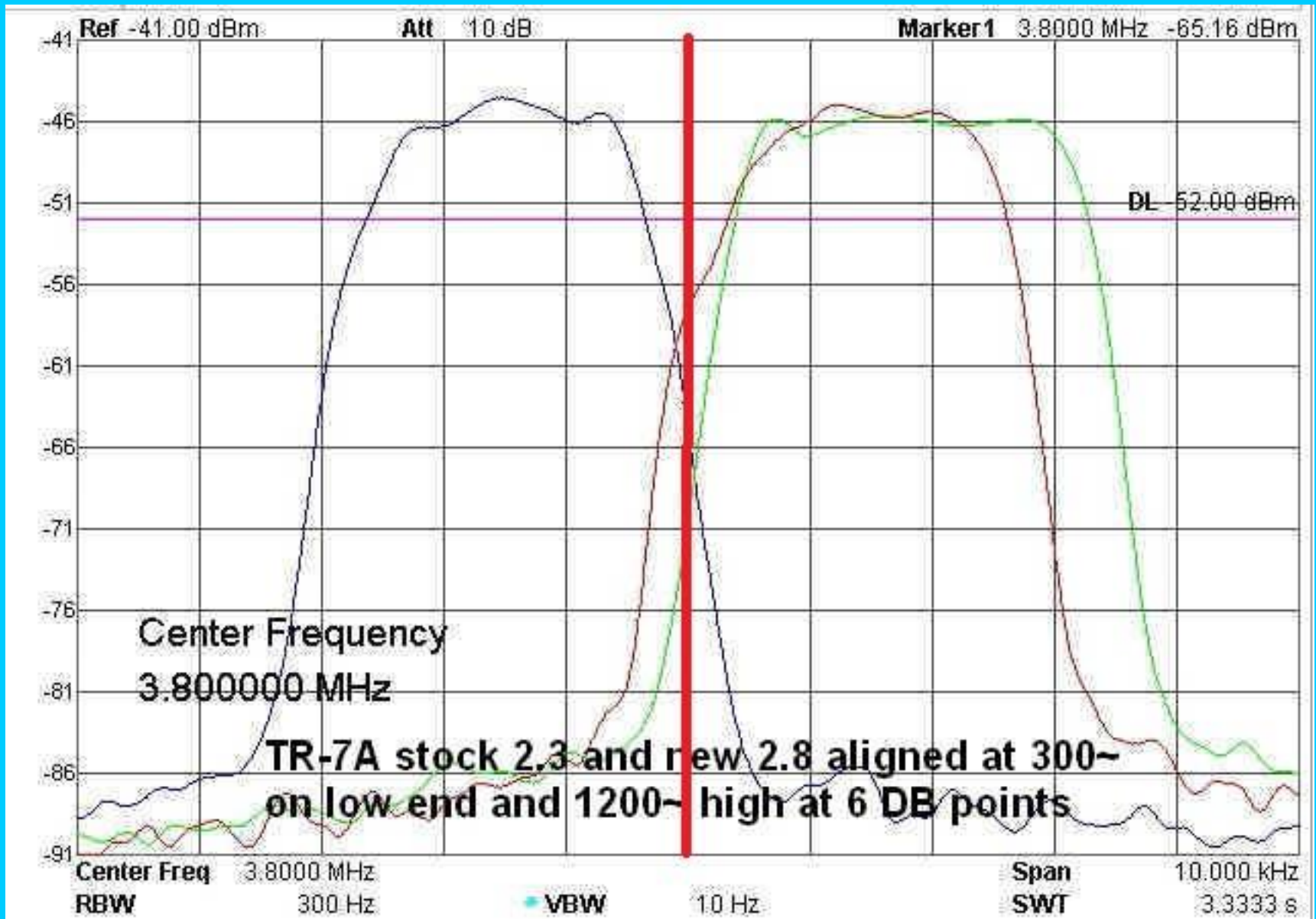
INRAD Compared to Stock LSB not set correctly ! !

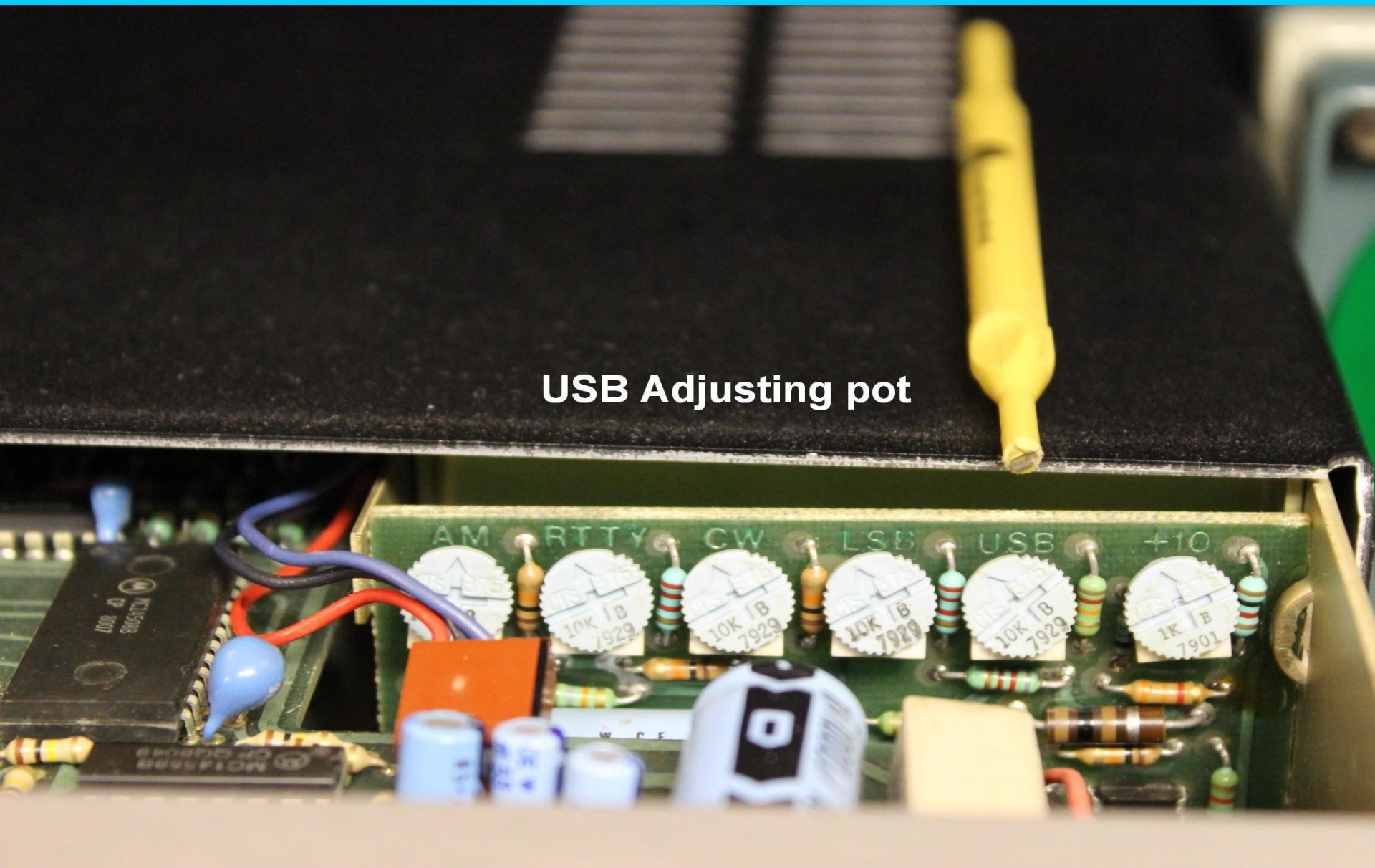


INRAD Compared to Stock LSB now set correctly ! !

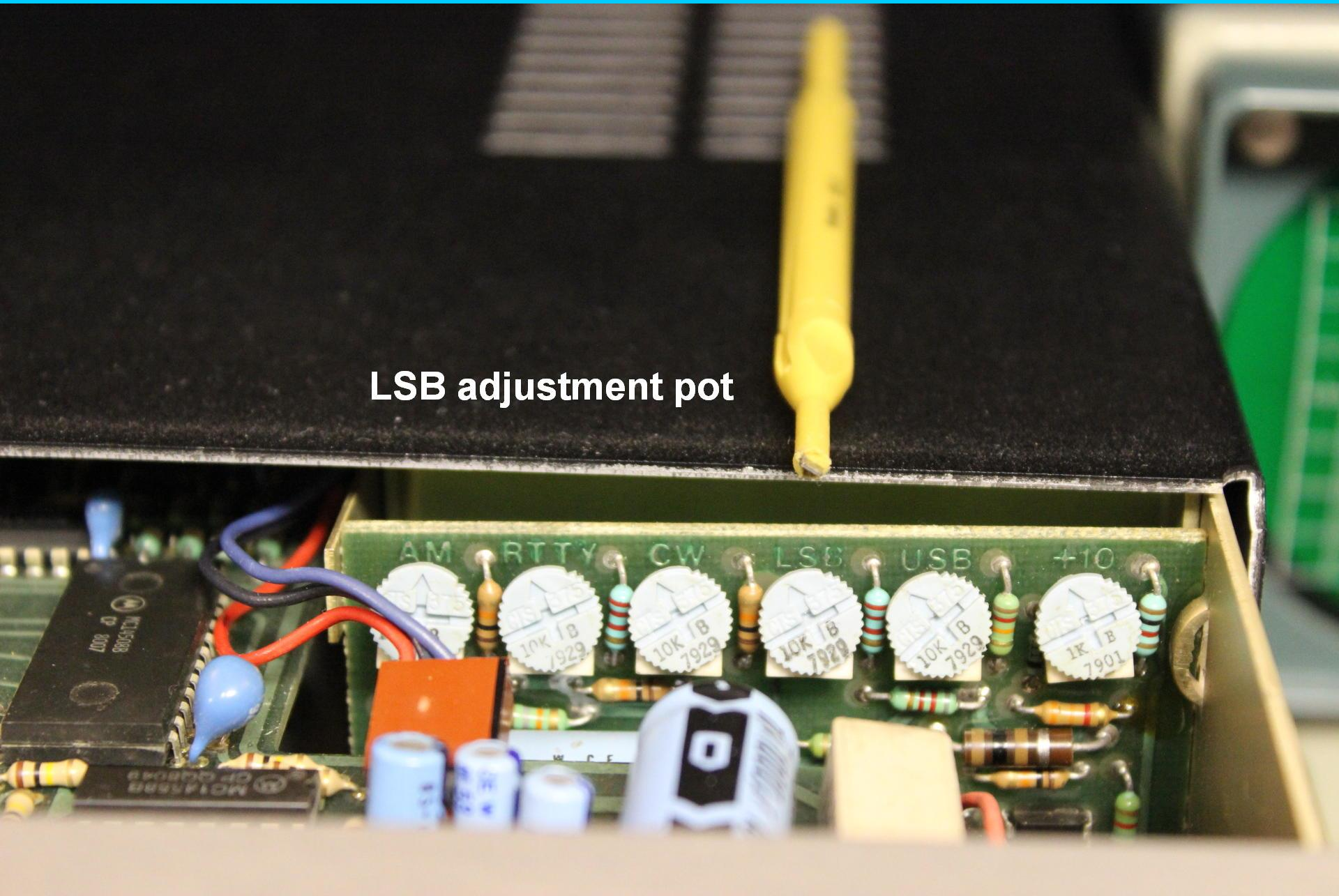


INRAD Compared to Stock USB

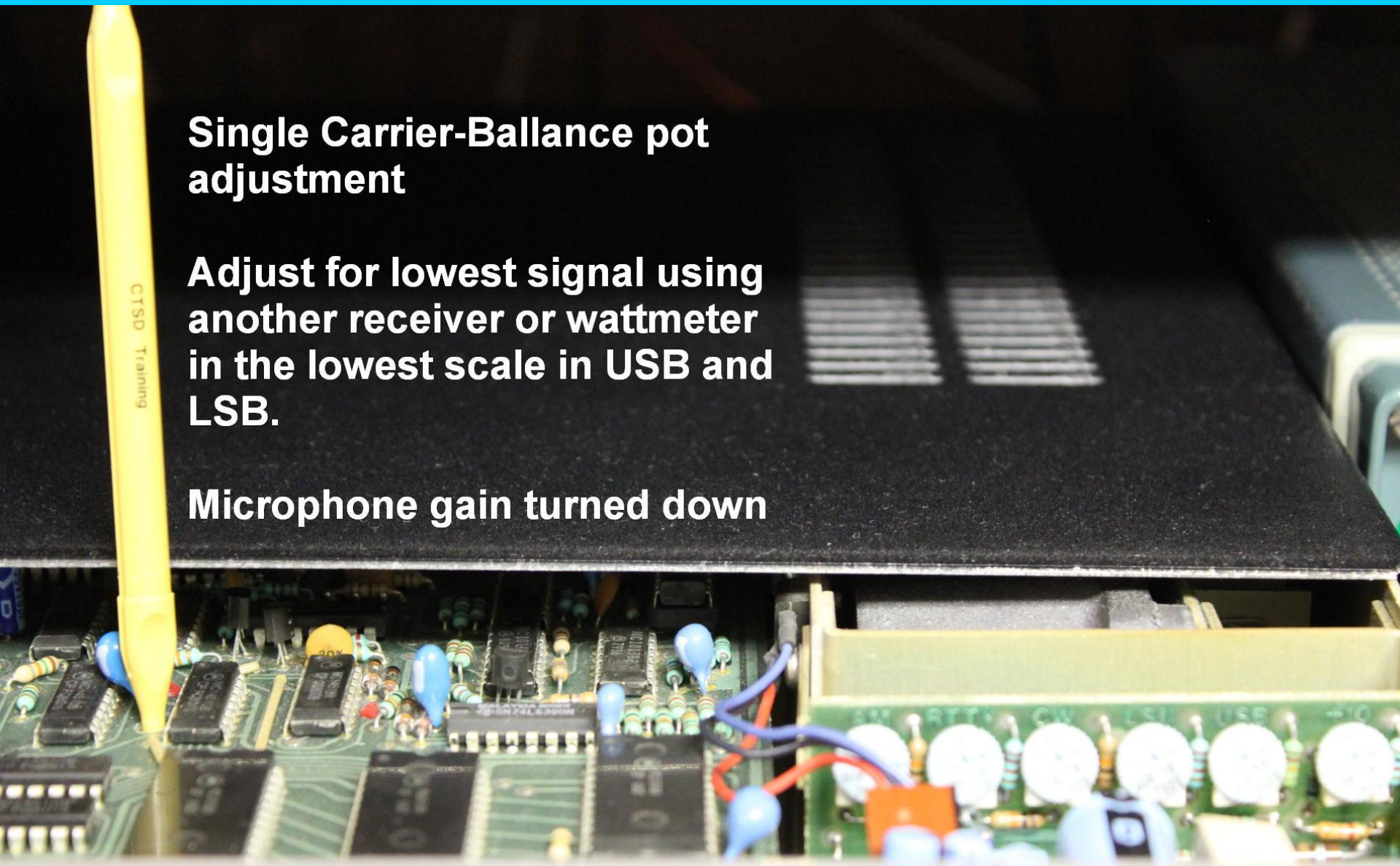



USB Adjusting pot
AM
RTTY
CW
LSB
USB
+10


DRAKE
UP
DOWN
NORMAL-OUT
FIXED
F
XMIT
RCV
PBT
S
VFO
BW
A
C
B
RCT
RIT
MODE
RTTY
CW
LSB
AM
USB
PBT
RIT
LSB
USB
Adjust "USB" pot for Zero-Beat on 13.693.3 MHz


LSB adjustment pot
AM
RTTY
CW
LSB
USB
+10


DRAKE
UP
DOWN
NORMAL-OUT
FIXED
F
XMIT
RCV
PBT
S
VFO
BW
A
C
B
RCT
RIT
MODE
RTTY
CW
LSB
AM
USB
PBT
RIT
LSB
USB
Adjust "LSB" pot for ZERO-BEAT on 13.696.7 MHz


Single Carrier-Ballance pot adjustment
Adjust for lowest signal using another receiver or wattmeter in the lowest scale in USB and LSB.
Microphone gain turned down

The End

A Crystal Range Solution for the Drake 4-Line Gear

Published in Electric-Radio
January 2015

By: Jeff Covelli / WA8SAJ

DRAKE

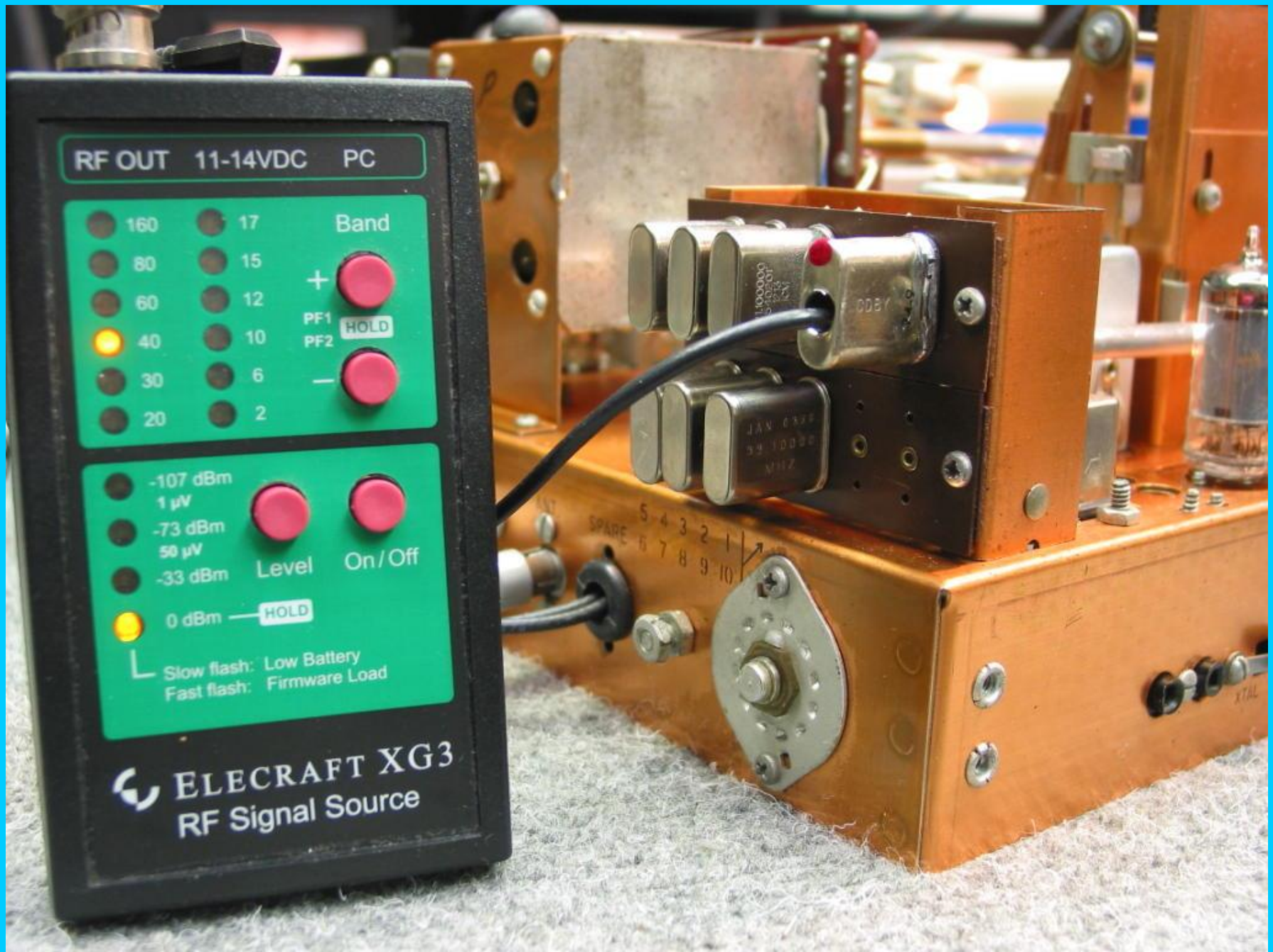

DRAKE
7295.0
DRAKE B-LINE
DIR
MEM
DigitalDial
Model A2
RAC
FUNCTION
ON
STBY
OFF
EXT. MUTE
NB
CAL
PASSBAND
L
U
4.8
2.4
1.2
.4
1 5 9 20 40 60
S – UNITS
DECIBELS
NORM
XTALS
PRESELECTOR
NOTCH
BAND
RF GAIN
SSB/CW
SLOW AVC
FAST AVC
AVC OFF
AM
AF GAIN
MODEL R-4B
RECEIVER
R. L. DRAKE CO., MIAMISBURG, OHIO
RF OUT 11-14VDC PC
Band
Level
On/Off
HOLD
Slow flash: Low Battery
Fast flash: Firmware Load
ELECRAFT XG3
RF Signal Source

DRAKE

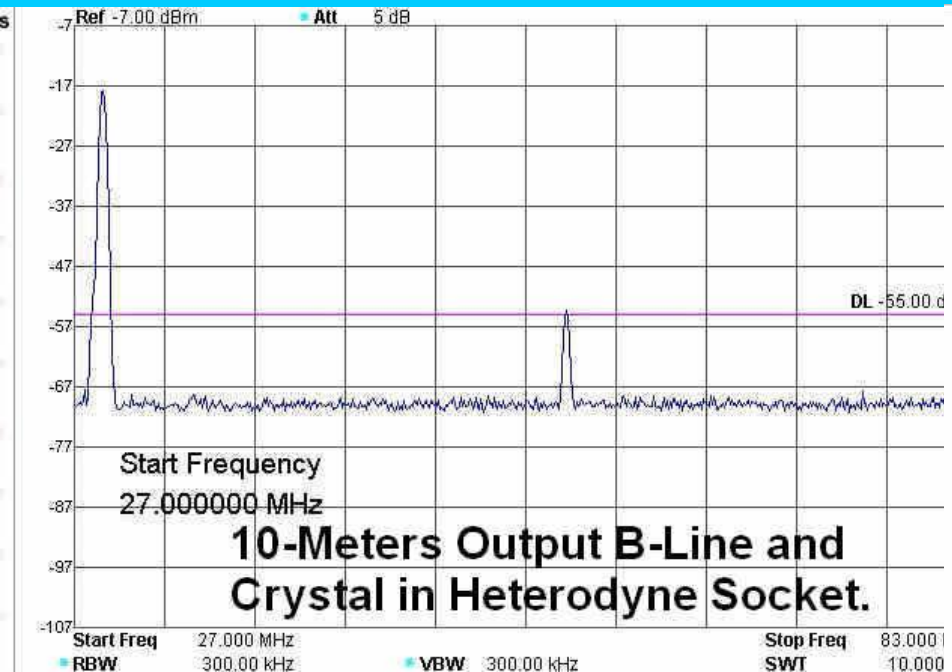

XG-3 With Cable Adapter
and Crystal Plug-In
RF OUT 11-14VDC PC
160
80
60
40
30
20
17
15
12
10
6
2
Band
+
PF1
PF2
HOLD
−
-107 dBm
1 µV
-73 dBm
50 µV
-33 dBm
0 dBm
HOLD
Level
On / Off
Slow flash: Low Battery
Fast flash: Firmware Load
ELECRAFT XG3
RF Signal Source

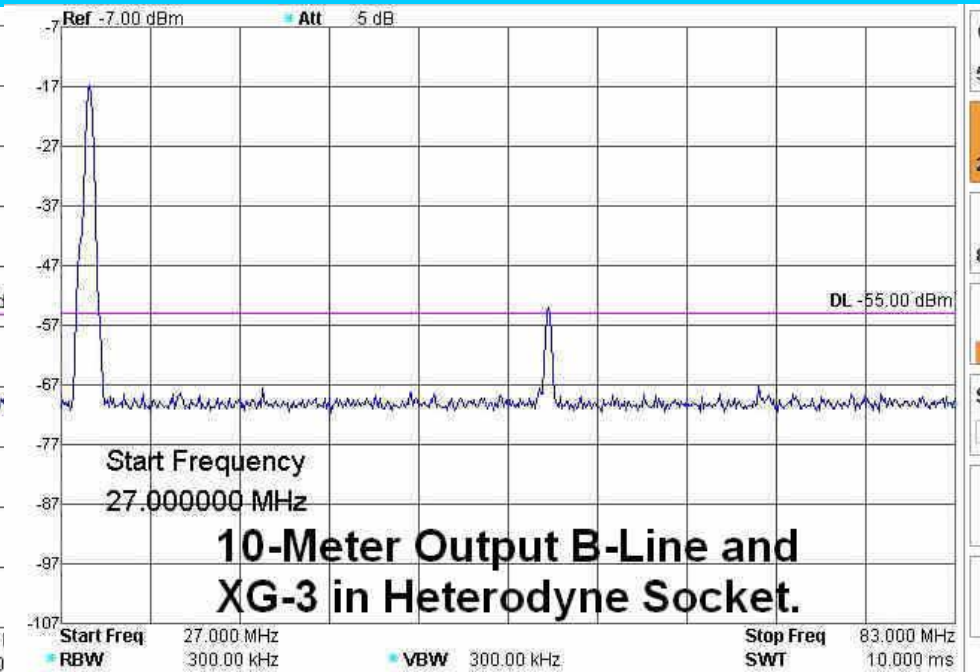
160	12.600000
80	14.600000
60	9.000000
40	18.100000
30	21.100000
20	25.100000
17	29.100000
15	32.100000
12	35.600000
10	38.100000
6	39.100000
2	39.600000

DRAKE


RF OUT 11-14VDC PC
160
80
60
40
30
20
17
15
12
10
6
2
Band
+
PF1
PF2
HOLD
—
-107 dBm
1 µV
-73 dBm
50 µV
-33 dBm
0 dBm
HOLD
Level
On / Off
Slow flash: Low Battery
Fast flash: Firmware Load
ELECRAFT XG3
RF Signal Source

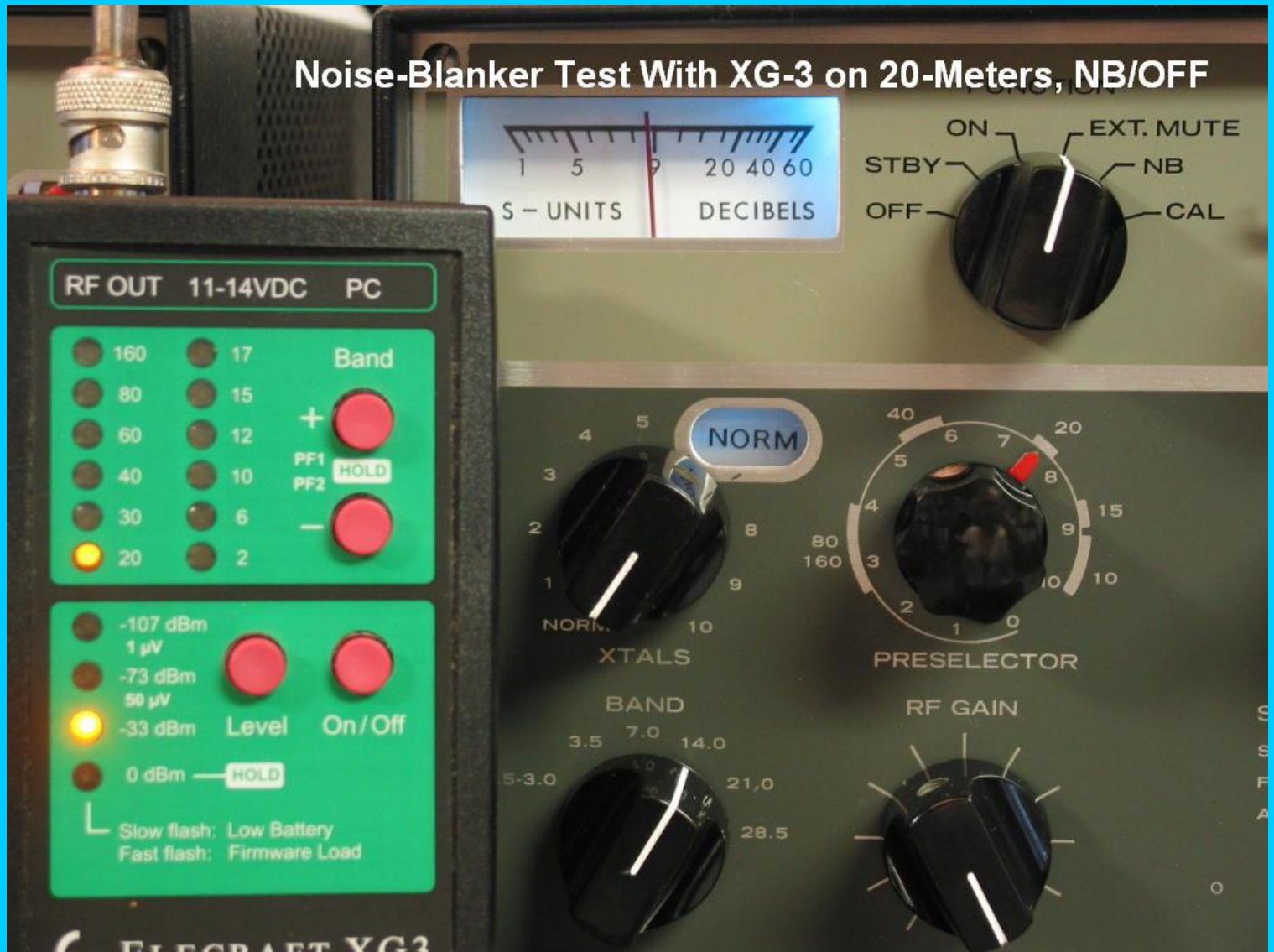
T-4XB Power Output on 10-Meters with Crystal in Het. Socket & Elecraft XG-3 Generator in Het Socket



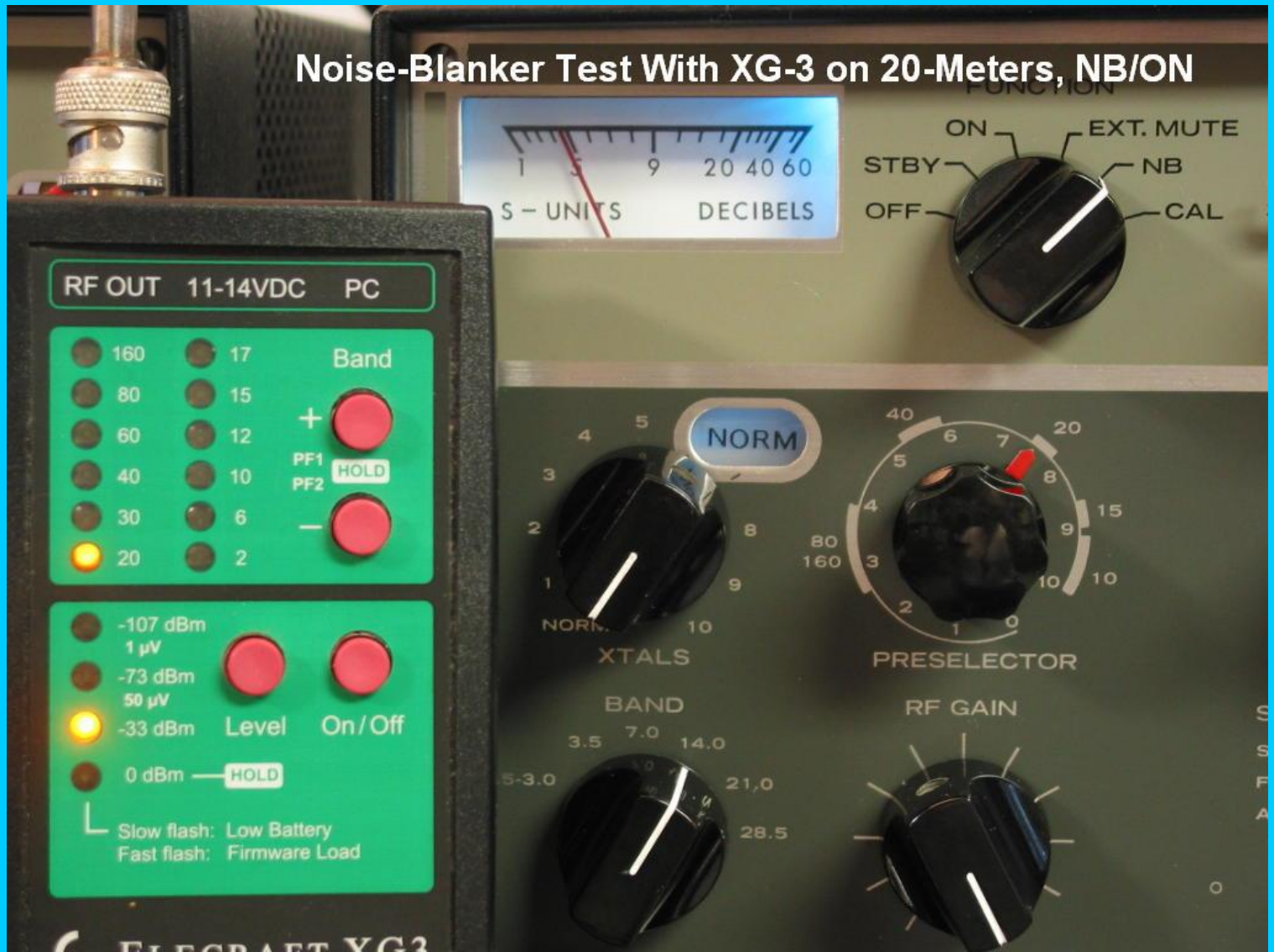


Other Uses For The XG-3 Generator

Noise-Blanker “Off”



Noise-Blanker “ON”



The End

The R.L. Drake Co.
Started in 1943 during WW II.

After the war was over <u>Bob Drake</u> needed help to grow the company and he hired a young engineer <u>Milt Sullivan</u> from the University of Cincinnati.

Milt Sullivan (K8YDO)
Drake's Chief Engineer
1946 to 1983 (37 Years Service)
Plus 4 Years Consulting for Drake

Milt's Job Application in 1946
Hired for 86 cents per Hour.

Date November 11, 1946

Applicant's Name Milton Arnold Sullivan, Jr.

Job Classification Title

Date to Begin Nov. 4, 1946

Hourly Rate .86

The above named applicant has been interviewed on the above date and hired in

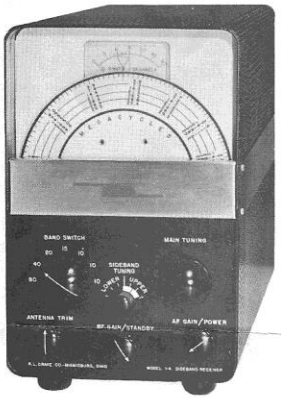
Engineering Department.

E L Drake

Supervisor

(1956)
Drake
1-A
Sideband Receiver

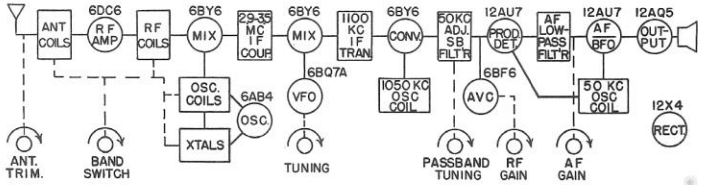
Milt's First
Receiver Design

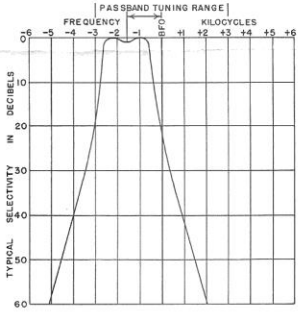


NEW

A SIDEBAND RECEIVER

Model 1-A
$259.00





FEATURES OF R. L. DRAKE COMPANY MODEL 1-A SIDEBAND RECEIVER

Crystal Controlled High Frequency Conferter -- Seven "ham" band tuning ranges 80, 40, 20, 15, 10, 10, 10

High Stability VFO -- New circuit does not need voltage regulator or filament ballast

Triple Conversion
Same tuning rate and stability on all bands -- each band 600 kc wide -- 10 meter band in tnree sections

Sideband Tuning -- 2.3 kc sideband filter tunes with front panel control through both sidebands

Sideband A.V.C. -- fast charge -- slow discharge -- full A.V.C. without pumping and clicking

Full tuning meter action on sideband

Muting and speaker connections arranged for best sideband and patch operation

Audio low pass filter built in for best signal to noise ratio

Product detector for distortion-free sideband reception

Inverse feedback audio for better low frequency response and minimum distortion

Built in the shape of a "scope" for portability and minimum desk space. Set it beside that old general purpose receiver.

Eleven tubes -- 6DC6 1st R.F. - 6BY6 1st mixer - 6BY6 2nd mixer
6BY6 3rd Converter - 12AU7 Product Detector
6BF6 A.V.C. amplifier and rectifier - 6AB4 crystal oscillator
6BQ7A V.F. oscillator - 12AU7 L.F. oscillator and 1st audio
12AQ5 output audio - 12X4 rectifier

Weight 17.5 pounds

Size 6-3/4 x 11 x 15"

Power consumption 45 watts at 115V A.C.

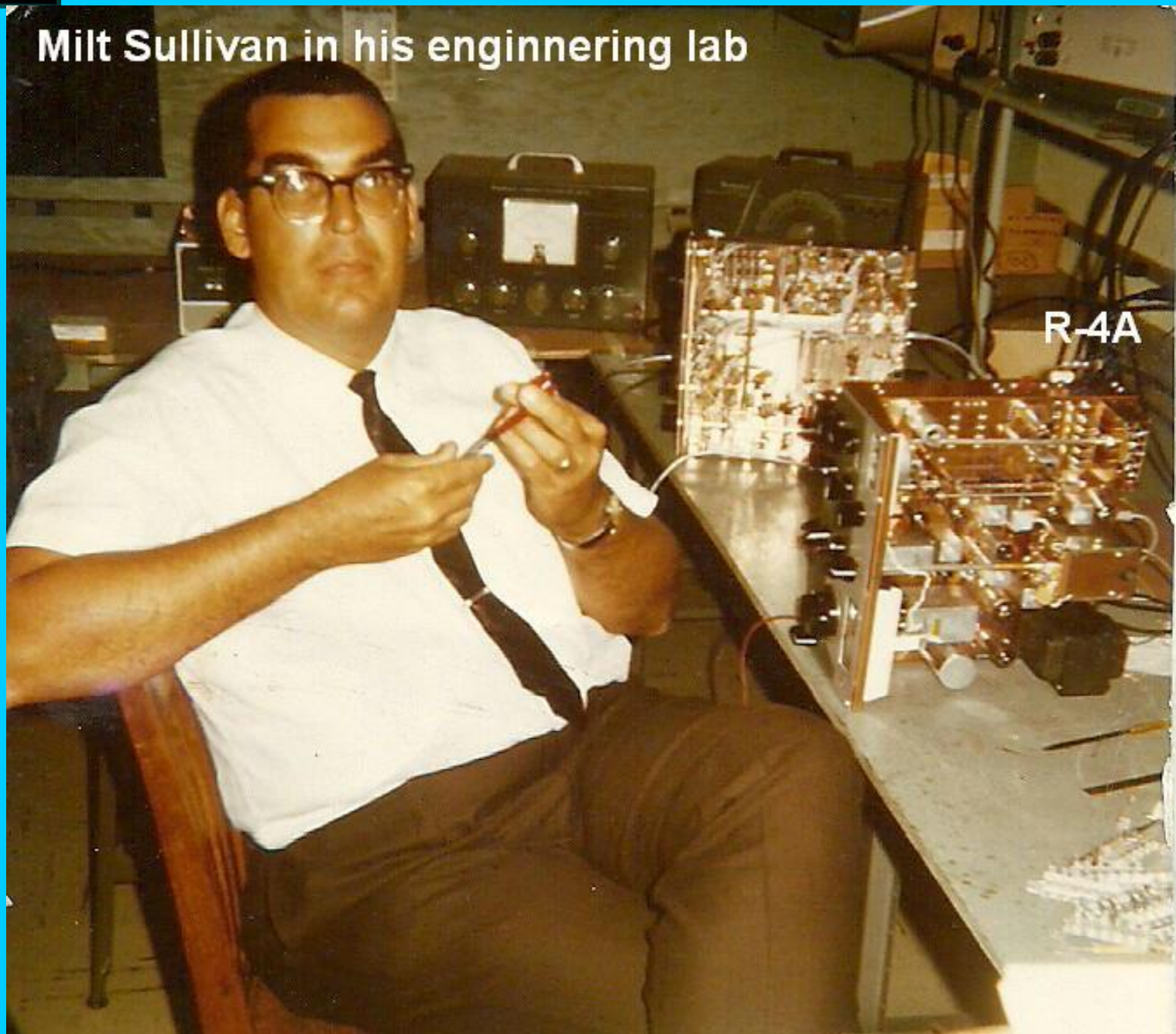
R. L. DRAKE COMPANY MIAMISBURG, OHIO

DRAKE

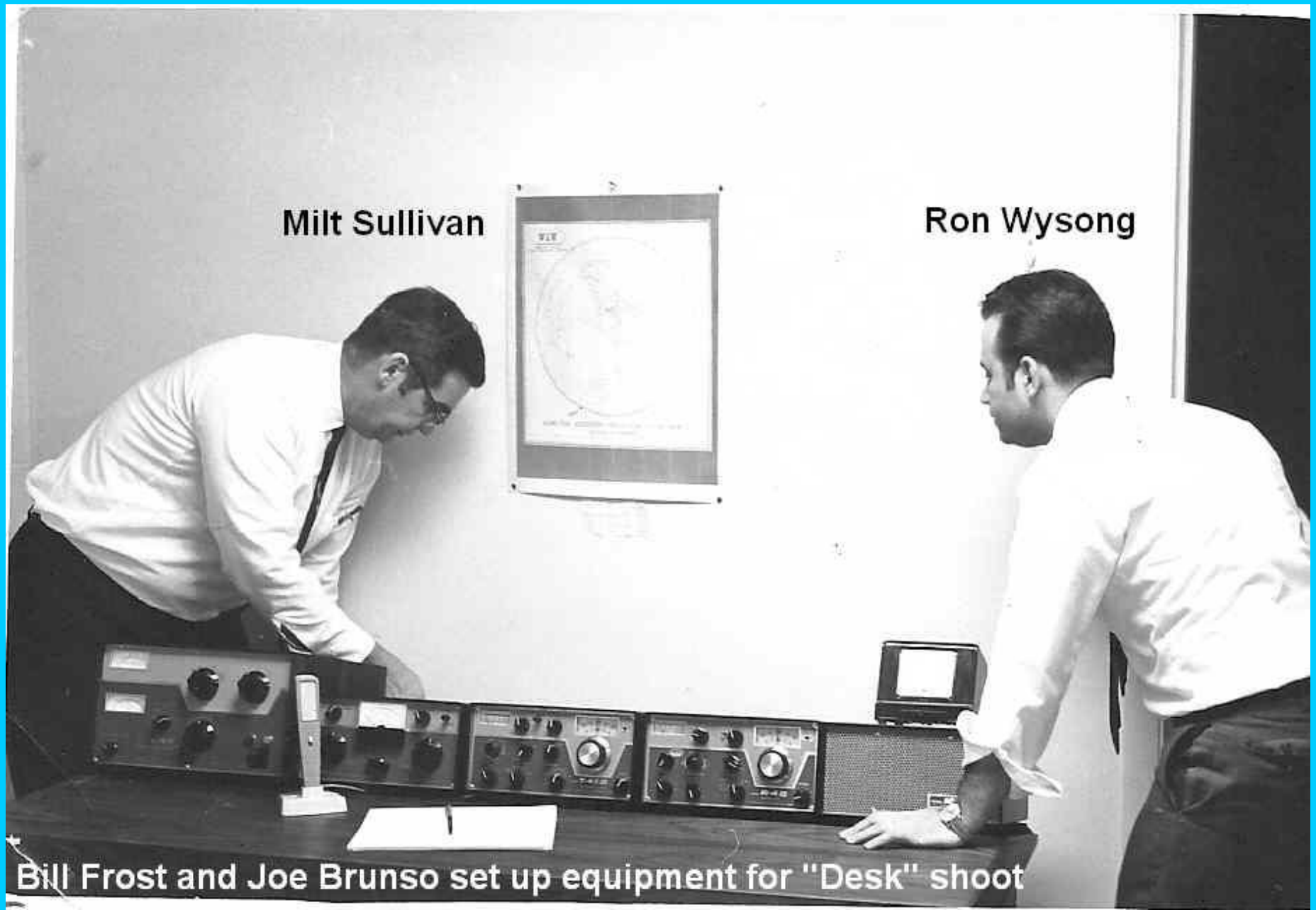
(1960's)

Drake

"A"
Line

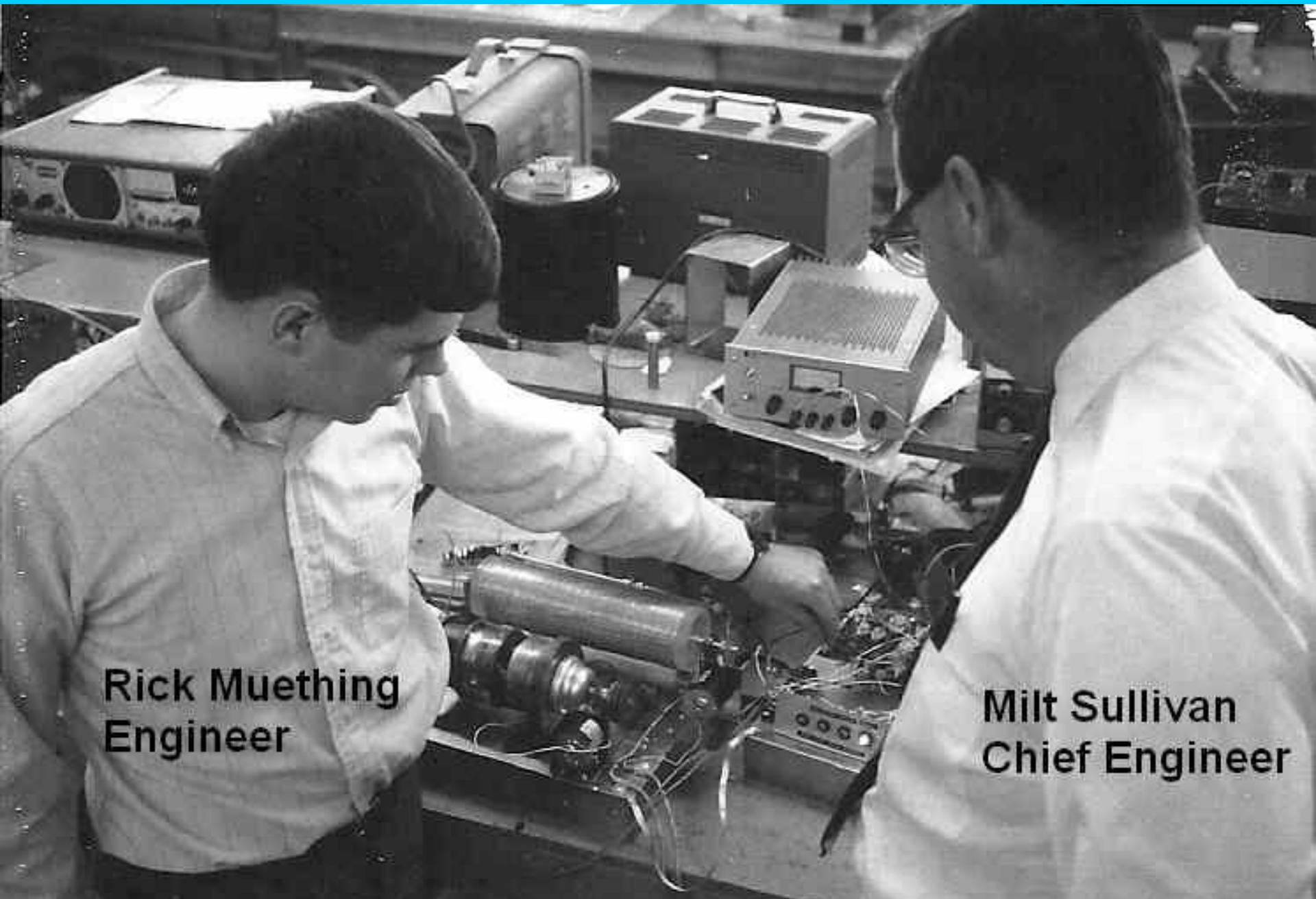


Drake B-Line (1968)



Bill Frost and Joe Brunso set up equipment for "Desk" shoot

DRAKE



DRAKE

Milt's Pride and Joy !

Milt's File Box
sent from Judy Sullivan

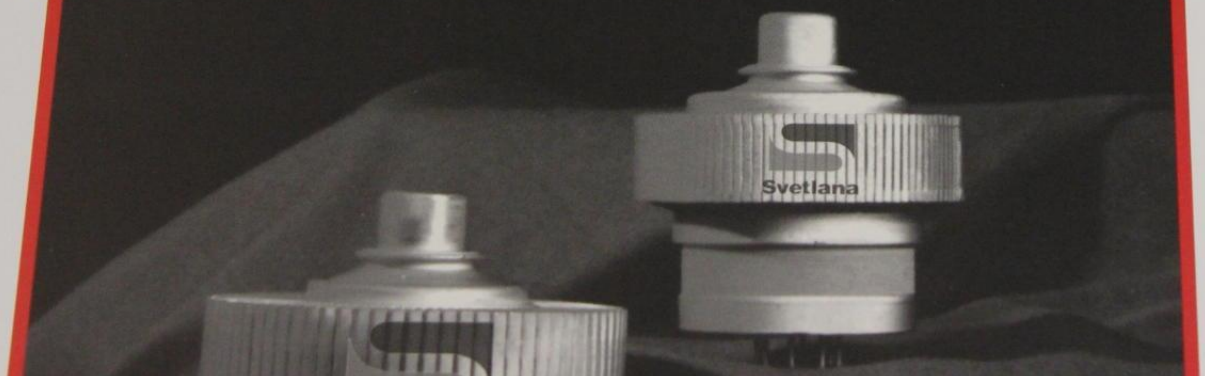
Thousands of Notes

QRP File (note the high power tube) !

onsior, *W6FR*
l Adobe Place
fornia 92635

QRP XMTR

Two New DX Winners



4CX250
Radial

DRAKE

Plenty of High Power notes !

Marv Gonsior, *W6FR*
418 El Adobe Place
Fullerton, California 92635

POWER ON A BUDGET

Using the Russian Svetlana 4CX1600B power tetrode in modern amplifier designs

Something new has been added for high-power linear amplifier designs. It's from Russia with love—a conservative legal limit, cost-effective power tetrode tube.

Background

There was a film some time ago titled, "The Russians are Coming." The introduction of a rather complete line of high quality RF amplifier tubes manufactured in St. Petersburg, Russia, which employ the modern external anode technology, makes this a reality. A very large company—Svetlana Electron Devices, Inc., privatized in 1992—now sells its products worldwide. Recent descriptions in *Communications Quarterly*[1] of two of their tubes, gave me the incentive to try one to revitalize my needy homebrewed Class AB1 amplifier. The application data and results are presented here.

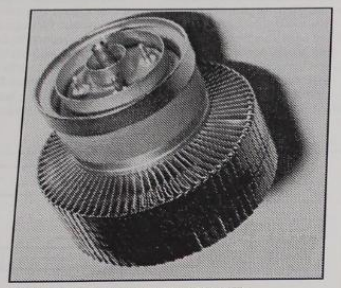


Photo A. Svetlana 4CX1600B. Photo by W6FR.

Svetlana 4CX1600B Characteristics

The tube, and its custom SK3A socket, are shown in **Photos A** and **B**. It's a ceramic-to-metal external anode tetrode whose original application was in a military transmitter, which has to its ruggedness and quality construction. (This tube was called the 4CX1600A, and a much smaller cooler.) Thanks to several design features, the 4CX1600B exhibits excellent performance when operated in class AB1 at relatively low anode voltage.

The anode was recently enlarged and is now essentially identical to the 8877 in size and configuration. Unfortunately, its matching chimney hasn't yet been modified to fit. To overcome this problem, I designed one of my own. I've been told that a compatible chimney will be available in the near future. For the general tube mounting outline, dimensions, and construction details of my homebrewed chimney, please refer to **Figure 1**.

Figure 2 shows the tube's specifications, along with my actual operating parameters, while running the tube as a grid driven amplifi-

QRP XMTR

4CX250BC/8 Radial Bear

The Svetlana 4CX250BC, compact metal/ceramic beam tetrode with a pl tion rating of 250 watts with for cooling. The 4CX250BC is inte Class AB SSB linear RF amplifi intended for stationary and m ment designs with power amp frequencies up to 500 MHz. T has an indirectly-heated oxide which operates at a low temp heater voltage for extended

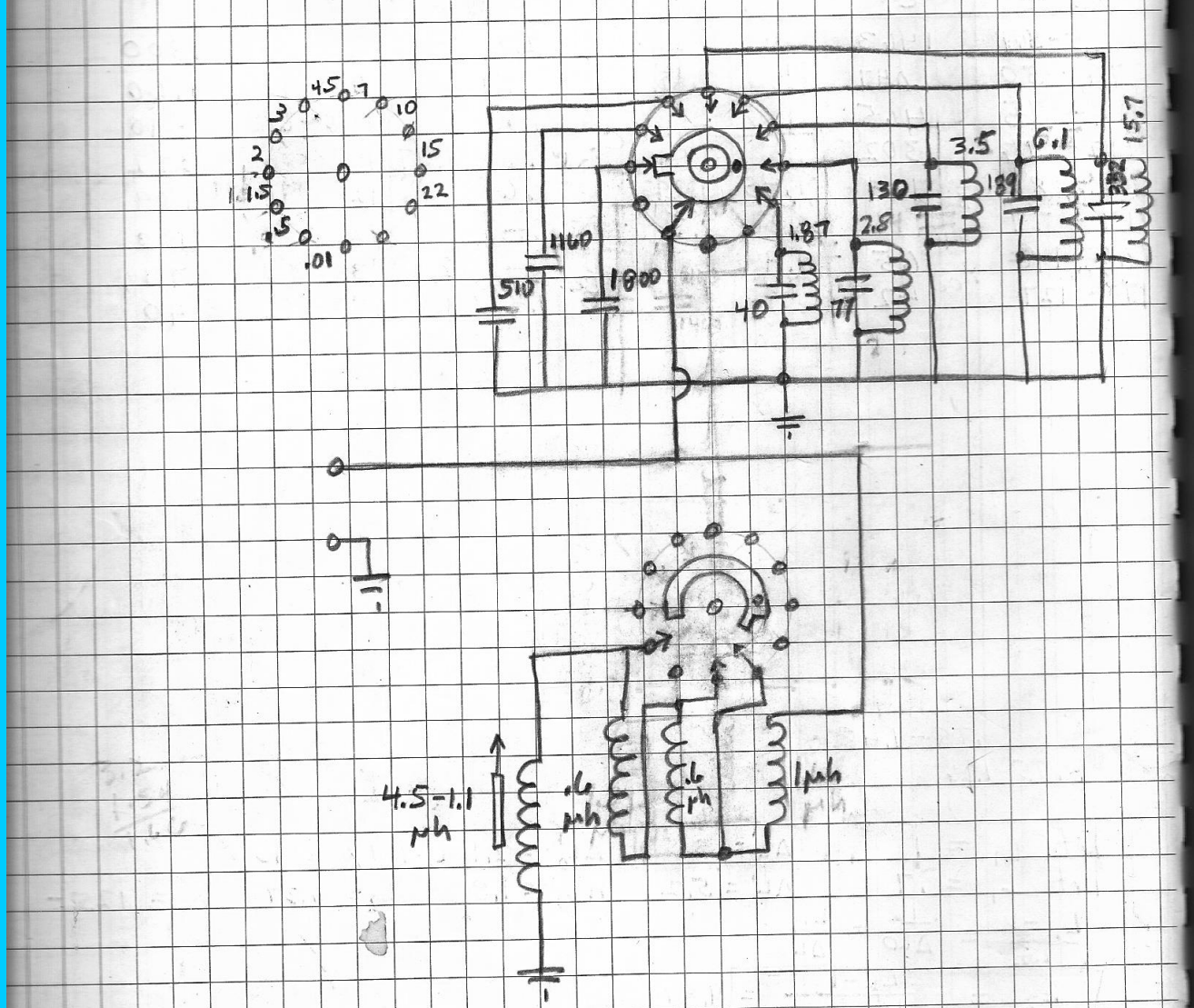
The Svetlana 4CX250BC is r the Svetlana factory in St. Pe Russia, and is designed to b replacement for the 4CX25 manufactured in the Unite

DRAKE

(1960's)

Drake TR-4 & T-4X

Inductance values on the Band-Switch



TR4 Inj plate choke ~16µh
T4X 160M Gr. multiplier ~ 6µh (-10T = 3.6µh)(-13T=2.7µh)
" pwr " ~ ~~2.5µh~~ 1.8µh
T4X Crystal Gr 20 Turn ~ 1. µh
1µh = 13 T 15/41 on QC Form
.6µh = 9 T 15/41 on QC Form

DRAKE

(1970's)

Drake R-4C

Pre-Selector Band-Pass Response

2.6 / 5.2

Project No. Notes: Std R4C ANT Coils
Book No. std Ant winding

TITLE Preselector Response

freq MHz	Insert Loss db	XMTR f	db	40db -f	40db +f	60db -f	60db +f
2	25	1.7	45	-.25	+.3	-.5	+1.0
2	25	2.3	40				
1.6	18 db	1.9	42	-.2	+.3	-.5	+1.0
2	10	1.7	48	-.18	+.22	-.5	+1.0
2	10	2.3	45				
3	20	2.7	41	-.28	+.35	-.64	+1.3
3	20	3.3	38				
3	7	2.7	40	-.3	+.42	-.84	+1.7
3	7	3.3	35				
4.4	17	4.1 (-.3)	35	-.4	+.5	-1.0	+1.7
6.5	12	6.2 (-.3)	30	-.6	+.7	-1.5	+2.4
8.8	10	8.3 (-.5)	35	-.8	+1.8	-2.2	+3.5
13.15	10	12.4 (-.75)	30	-2.0	+3.5	-3.0	+6.0
17.3	6	16.55 (-.75)	24	-2.2	+3.5	-6.0	+15
22.7	8	22.08 (+.625)	15	-3.2	+5.0	-7.5	+17.5

Note:
Tried Adding turns to Ant Link
Total turns 4 {2T at Top (slug end) 1T going up + 1T going down}

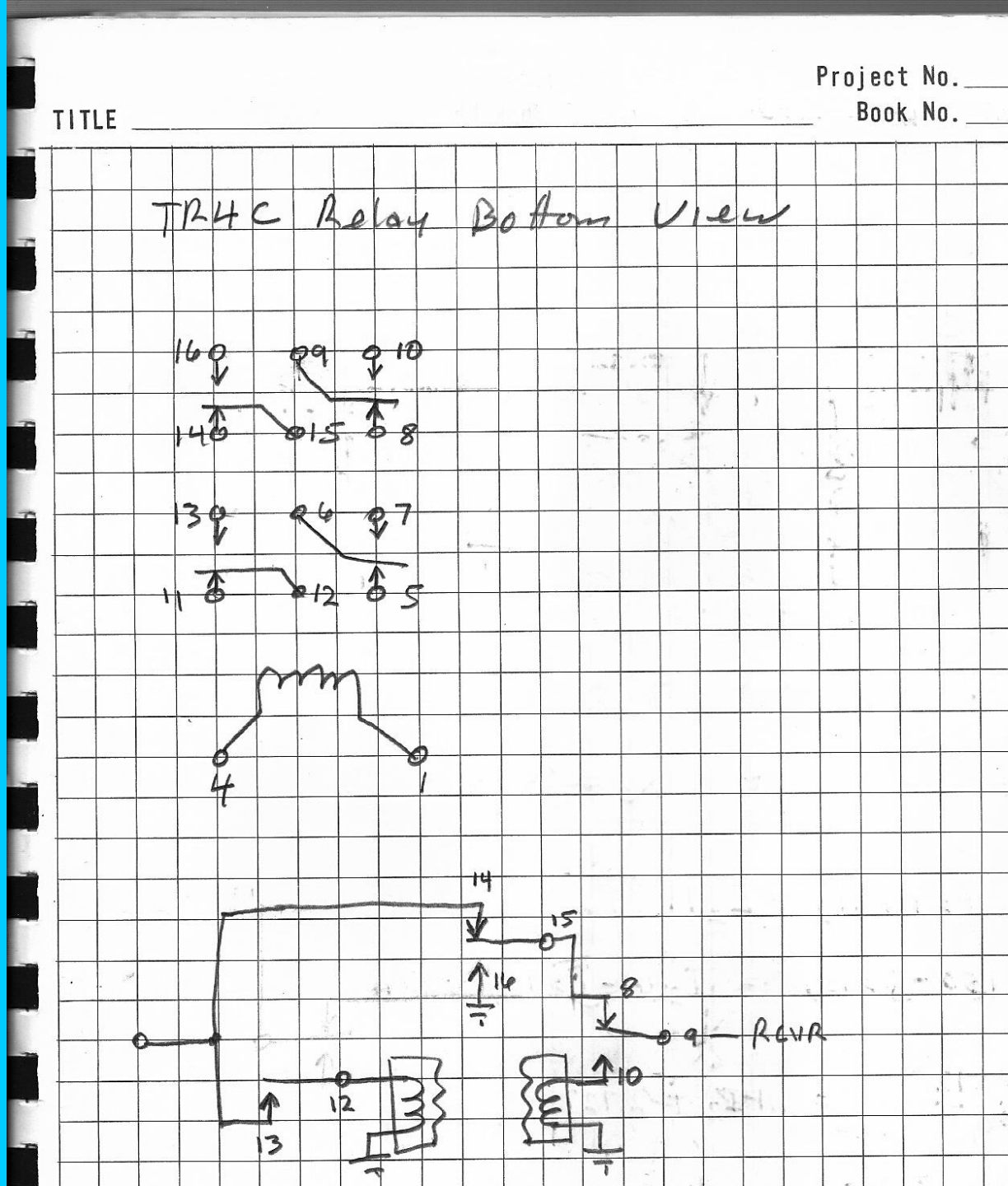
Better at 1.5 MHz 8 db insert loss
worse at 7-15 MHz 12 db
30 MHz 10 db

DRAKE

(1970's)

Drake TR-4C

Main Relay Bottom View



MN-7 & MN-2700

Band Switch RMS Voltage Breakdown

MN-7K / MN-2700

Project No. 11-14-77

Book No.

Switch Break down

REYNOLDS ALUMINUM Supply Company

PERFORMANCE AS PROMISED

ALUMINUM • STAINLESS STEEL • GALVANIZED STEEL

COMMERCIAL BUILDING PRODUCTS

Cent. Type 231

	Break Down Volts RMS
MN 2000 sw: Band sw rotor to frame (shaft)	2600
open contact to bladed contact	3200
open contact to open contact	3200
Ant sw: Oak Type HC, Cent. Type 300	
Ring blade to open contact	1750
blade to shaft	2200
contact to adj contact with blade in	1900
Blade front to blade rear	1100
Blade front: contact to Contact (No blade)	2750
contact to cont. with non shorting blade in	2500
blade to strut	2850

REYNOLDS ALUMINUM SUPPLY COMPANY
891 Redna Terrace, Cincinnati, Ohio 45215 • (513) 771-8940
Enterprise 8940 for Dayton & Columbus • 800-582-1637 Ohio

$L = 4.5 \times 10^{-6}$ H

$X_L = 100\ \Omega$ @ 3.5

$= 113$ @ 4.0

$I = 18 = \frac{V}{X_L}$

(3.5) $V = 1800$ Volts

$W = 3240$ watts

(4.0) $W = 2068$ watts

$R = 1000\ \Omega$ 3.5 MHz

$= 2000\ \Omega$ 4.0 MHz

$W = \frac{V^2}{R} = 6250$ watts

3225 watts

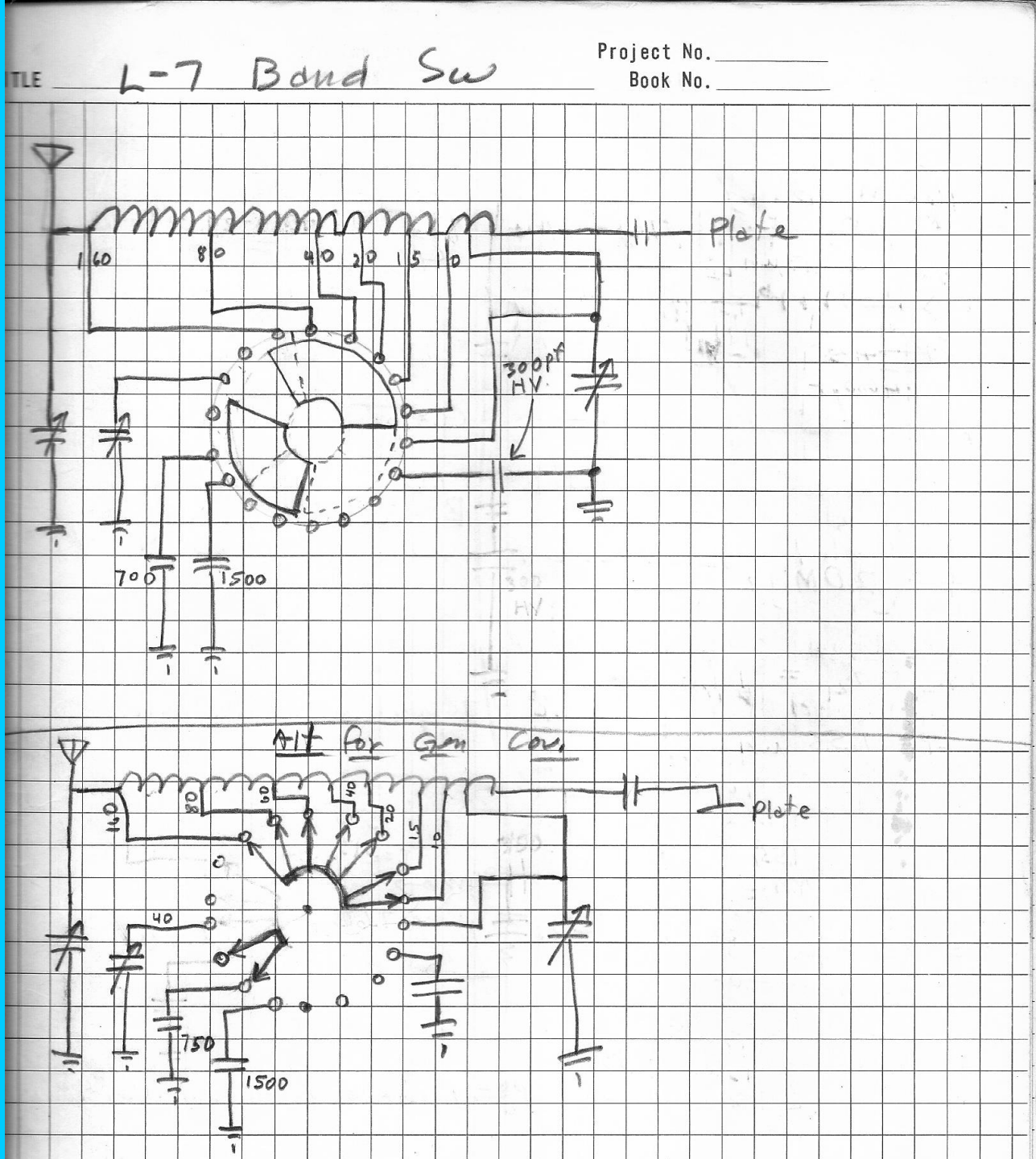
Type HO or 300 ok for 3000 watts output

DRAKE

(1977)

L-7 Amplifier

Tank Circuit Specs



DRAKE

(1977)

Drake

L-7 Amplifier

Plate Tank Circuit "Q"

TITLE L7 Plate Tank Q

Project No. _____

Book No. _____

3.800 MHz
f_1 = 3930 (−450)
f_2 = 3645 (+450)
Δf = 285
$Q = \frac{3800}{285} = 13.3$

1.900 MHz
f_1 = 1955
f_2 = 1820
Δf = 135
$Q = 1900/135 = 14.1$

7.200 MHz
f_1 = 7480
f_2 = 6770
Δf = 710
$Q = 7200/710 = 10.14$

Moved top ↓
7400
7000
400 Q = 18

14.200 MHz
f_1 = 14700
f_2 = 13600
Δf = 1100
$Q = 14200/1100 = 12.9$

21.25 MHz
f_1 = 22000
f_2 = 20350
Δf = 1650
$Q = 21.25/1650 = 12.9$

28.500 MHz
f_1 = 29450
f_2 = 27550
Δf = 1900
$Q = 28500/1900 = 15$

28.000 MHz
f_1 = 28900
f_2 = 26700
Δf = 2200
$Q = 28000/2200 = 12.7$

21.000 MHz
f_1 = 21700
f_2 = 20200
Δf = 1500
$Q = 21000/1500 = 14$

21.500 MHz
f_1 = 22250
f_2 = 21550
Δf = 1700
$Q = 21.500/1700 = 12.6$

14.5 MHz
f_1 = 15000
f_2 = 13800
Δf = 1200
$Q = 14.5/1.2 = 12.1$

14.000 MHz
f_1 = 14500
f_2 = 13400
Δf = 1100
$Q = 14/1.1 = 12.7$

30.000 MHz
f_1 = 31100
f_2 = 28750
Δf = 2350
$Q = 30000/2350 = 12.8$

Explained to & Understood by me. | Date | Entered by | Date

(1977)

Drake L-7 Amplifier

Plate Transformer

Specs.

TITLE L-7 Plate Transformer

Project No. _____

Book No. _____

Drake Construction

Lamination E1-212 5 5/16 x 6 3/8 x 2 1/8 center leg

Stack 3 1/8"

gage = .018"

Weight of core = $.92 \times 15.35 \times \frac{3.125}{2.125} = 20.77$ lbs

No core pcs .018 ga = 160

Total weight of Transformer meas = 30.125 lb

weight of copper = 9.357 lb

Cost of copper @ 1.30/lb = 12.16

cost of Core @ 91.50/mpcs = 14.64

$ 26.80

Cintran price $31.55

PS-7 Transformer

Lamination E1-212

Stack 1 1/2

gage = 018

Weight of Core = $.92 \times 15.35 \times \frac{1.5}{2.125} = 9.97$ lb

No core pcs = 70 pcs

Meas wt of Trans = 17.25 lb

weigh of copper = 7.28 lb

Cost of copper @ 1.30/lb 9.46

Cost of core @ 91.50/M 6.41

$ 15.87

Cintran price $ 21.50

DRAKE

(1977)

Drake L-7Amplifer

Plate Choke Specs

TITLE Plate Choke L-7

Project No.

Book No.

77 T #24 Spaced Ferrite Core

f	Z	Θ	R_s	X_s	I	P_d	
31.6	1250	-62 V	587	1104	1.6	1502 W	
31.0	1070 V	-71	348	1012	1.87	1217	
30.0	1140	-81	178	1126	1.75	549	10M
28	1360	-86	95	1357	1.47	205	
21.3	2100	-86	146	2095	.95	133	15M
18.4	2970 ∩	-71	967	2808	.67	438	
18.0	2400	-59 V	1236	2057	.83	858	
17.5	1900 V	-71	619	1796	1.05	685	
14.3	3000	-88	105	2998	.67	46.5	20M
7.3	8500	-88	297	8495	.24	16.4	40M
7.5	9300	-88	325	9294	.22	15	
4.6	100,000 ∩	-80	17345	98480	.02	7	
4.23	100,000	+80	do	do	do	do	
4.0	43,500	+85	3791	43,334	.046	8	80M
3.5	19,000	+87	994	18,974	.105	11	
2.0	5200	+88	181	5197	.38	27	160M
1.8	4500	+88	157	4497	.44	31	
1.6	3800	+88	133	3798	.53	37	

Zeros 19.2 31.4 48.0

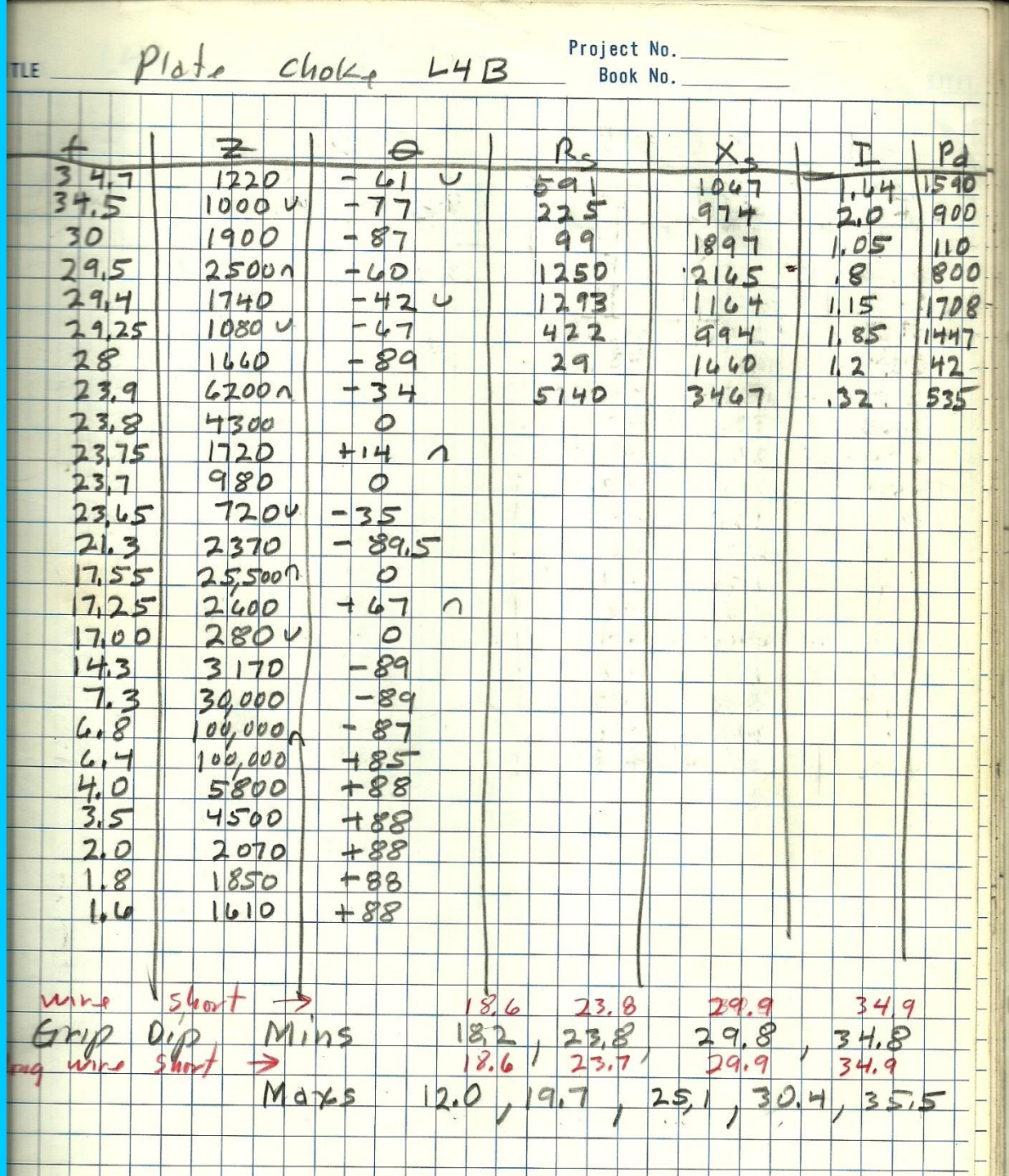
Poles 7.6 20.5 33.5

DRAKE

(1970's)

Drake L-4B Amplifier

Plate Choke Specs



TLE Plate Choke L4B Project No. ____ Book No. ____

f	Z	Θ	R_s	X_s	I	Pd
34.7	1220	-61 ∪	591	1047	1.44	1590
34.5	1000 ∪	-77	225	974	2.0	900
30	1900	-87	99	1897	1.05	110
29.5	2500 ∩	-60	1250	2165	.8	800
29.4	1740	-42 ∪	1293	1164	1.15	1708
29.25	1080 ∪	-67	422	994	1.85	1447
28	1660	-89	29	1660	1.2	42
23.9	6200 ∩	-34	5140	3467	.32	535
23.8	4300	0				
23.75	1720	+14 ∩				
23.7	980	0				
23.65	720 ∪	-35				
21.3	2370	-89.5				
17.55	25,500 ∩	0				
17.25	2600	+67 ∩				
17.00	280 ∪	0				
14.3	3170	-89				
7.3	30,000	-89				
6.8	100,000 ∩	-87				
6.4	100,000	+85				
4.0	5800	+88				
3.5	4500	+88				
2.0	2070	+88				
1.8	1850	+88				
1.6	1610	+88				

wire short → 18.6 23.8 29.9 34.9

Grip Dip Mins 18.2 , 23.8 , 29.8 , 34.8

ag wire short → 18.6 , 23.7 , 29.9 , 34.9

Maxs 12.0 , 19.7 , 25.1 , 30.4 , 35.5

DRAKE

(1970's)

Drake L-4B Amplifier

Out of Band Specs

TITLE L4B linear out of Band

Project No. _____

Book No. _____

Band pos	f	Input VSWR	Pin	"cw" Pout
80M	4000	1.85	130	920
	3750	1.2	130	920
	3500	1.7	125	900
	3352	2.0	108	800
	4500	3.4	65	520
	5000	7	30	150
40M	5000	3.9	38	260
	5500	5.6	25	240
	6000	2.2	74	500
	6500	1.75	115	820
	7000	1.3	125	930
	7.2	1.15	125	950
	7.5	1.45	125	950
	8.0	2.3	110	800
	8.5	3.3	55	450
	9.0	5.3	33	215
20M	14.2	1.25	115	900
	9.765	3.4	48	300
	10.0	3.6	46	310
	11.0	3.5	48	370
	12.0	2.7	70	600
	13.0	1.9	118	900
	14.0	1.3	115	900
	14.5	1.4	112	900
	15.0	1.85	110	820
	16.0	3.3	45	350
	17.0	6.5	25	180
15M	16.0	2.3	80	600
	17.0	2.1	92	720
	18.0	1.95	100	800
	19.0	1.80	90	780
	20.0	1.4	92	700
	21.0	1.4	92	800
	21.5	1.4	90	780
	22.0	1.5	90	780

Explained to & Understood by me, | Date | Entered by | Date

(1977)

Drake TR-7

PA Load Effect On Power

Project No. _____

TLE TR-7 PA Load Effect on Pwr Book No. _____

Limits of Max output (Point where Pwr just starts to drop)

f	Z	Θ	SWR (upper)	R	X
3.8	34	+26	1.75	30.5	15
	58	-37	2.6	46	-35
	40	+30	1.75	34.6	20
	46	-37	2.4	37	-28
	92	+5	1.9	92	8
	26	-10	1.9	25.6	-4.5
	79	+26	1.7	66.5	37
	40	+35	1.7	32.8	23
	40	-32	2.45	34	-21.2
1.8	26	+23	2.0	24	10.2
	68	-29	2.25	59.5	-33
	31	+29	1.9	27	15
	57	-33	2.25	48	-31
	49	-34	2.4	40.6	-27.4
	83	-20	2.4	78	-26.4
	85	0	2.0	85	0
	68	+16	1.5	65.4	18.7
	36	+31	1.75	31	18.5
	60	+23	1.4	55	23.4
	22	+2	2.3	22	.8
	35	-30	2.3	30.3	17.5
7.2	46	+34	1.7	38.1	25.7
	38	-30	2.4	33	-19
	55	-35	2.5	45	-31.5
	74	+25	1.75	67	31.3
	91	+12	1.8	89	19
	95	+14	2.4	92	23
	96	0	2.0	96	0
	27	0	2.0	27	0

DRAKE

(1970's)

Drake

Cooling Fan

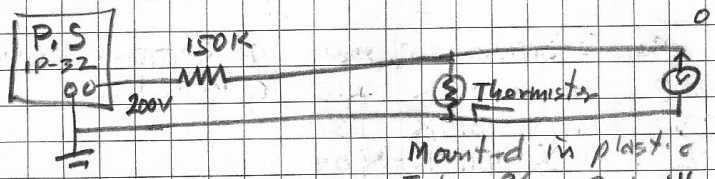
Specs

TITLE Cooling Fans

Project No. _____

Book No. _____

Note → Voltage is function of Air flow thru Tube



Mounted in plastic Tube 9/32 ID x 1 1/4 lg.

Fan Type	Voltage fan off	Voltage fan on	ΔV	HUM 1→10	Noise 1→10
IMC WS2107FL9	11.72	12.65			
IMC WS2107FL2	11.73	12.80			
Rotron WR2A1	11.72	12.88			
PAMOTOR 4500C	12.50	14.90		8	10
IMC WS2107-FL		14.83		5	8
TORIN TA450S		14.54		6	6
IMC WS2107-FL2		14.30		2	3
ROTRON WR2A1		14.27		4	4
IMC WS2107-FL9		14.07		1	1
ETRI 133-LY-21-82	12.13	14.23		3	2
ETRI	12.71	14.76			
FL-9	12.71	14.57			
FL-9	12.60	14.44			
Rotron WR2A1	12.30	14.33			
FL-9		14.12			
FL-2		14.16			
Rotron		14.20			
FL-2		14.16			
FL-9		14.02			
Rotron		14.09			
FL-2		14.09			
FL-2	12.06	14.07			
ETRI		14.02			
FL-9		13.86			

DRAKE

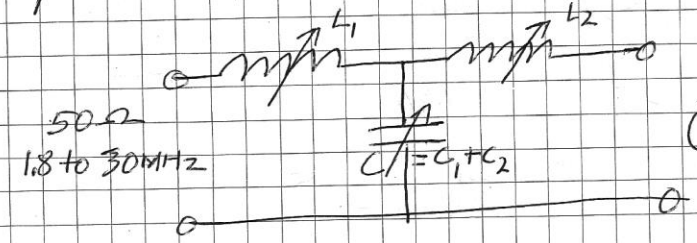
(1981)

Drake "NEW"

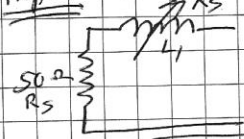
MN-7500 Antenna Tuner

TLE Antenna Coupler MN-7500 Project No. Book No.

Proposed Circuit!



Input



Let $R_p = 2500\Omega$ $W = 1000$ V = 1581 RMS = 2213 Peak

$$R_p = \frac{R_s^2 + X_s^2}{R_s} \qquad X_p = \frac{R_s^2 + X_s^2}{X_s}$$

$X_s^2 = (R_p - R_s) R_s = (2500 - 50)\,50$

$X_s = 350\ \Omega$

$X_p = \frac{50^2 + 350^2}{350} = 357\Omega$

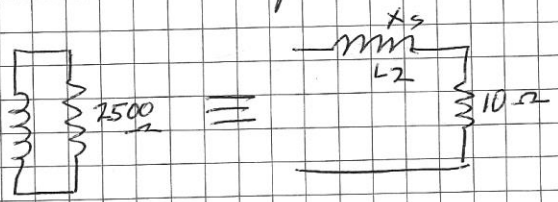
at 1.8 MHz

$L_1 = \frac{X_s}{2\pi f} = 30.9\ \mu h$ ←

$C_1 = \frac{1}{2\pi f X_p} = 248\ pf$

Output

$R_p = 2500$ $R_s = 10$ to $250\ \Omega$



Over

Explained to & Understood by me,	Date	Entered by	Date
		mas	9-14-81

DRAKE

(1981)

Drake MN-7500 Tuner

Knob Settings Specs.

C = 0-830pf Max RMS V = 1750

TITLE MN7500 Knob Settings Project No. _____ Book No. _____

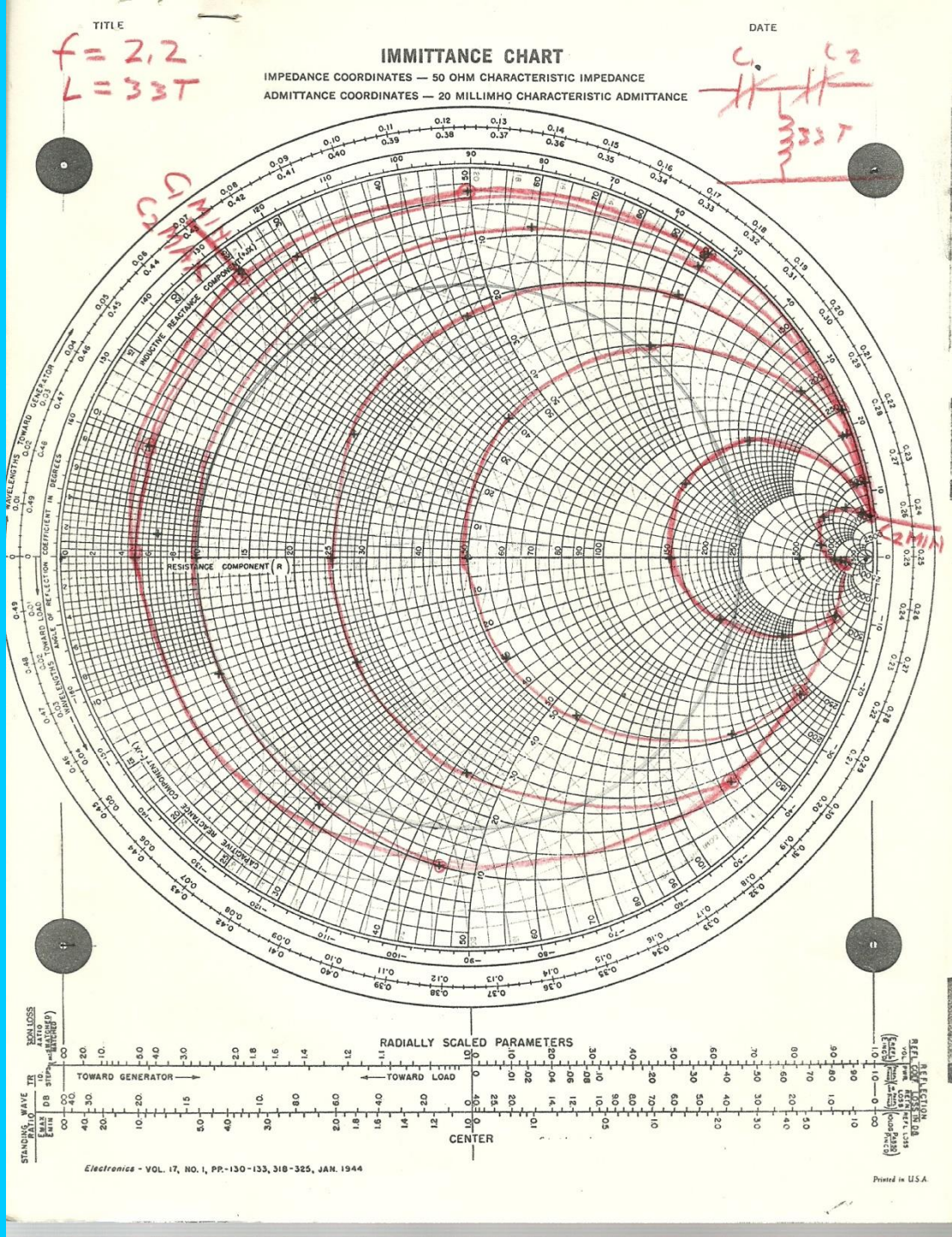
Freq	Ant Z	L_1 µh	T_1	C pf	0-10	L_2 µh	T_2	Rp	Max Pwr
1.8	10	30.95	42	805.7	.3	13.95	21	2500	1225W
	10	30.0		830	0	13.54		2355	
	50	30.45	42	495.1	4.2	30.95	42	2500	1225
	250	25.4	35	424	5.1	53.24	(64)	1700	1800
2.0	10	27.85	39	725.1	1.3	12.56	19	2500	1225W
	50	27.85	39	445.6	4.8	27.85	38	"	"
	250	27.85	39	318.3	6.4	(59.7)		2500	1225
	250	25	35	351.7	6.0	53	(64)	2025	1512
3.5	10	15.92	24	414.3	5.2	7.175	12.2	2500	1225
	50	"	"	254.6	7.2	15.92	24	"	"
	250	"		181.9	8.1	34.1	45	"	"
4.0	10	13.93	21.5	362.6	5.8	6.3	11	"	"
	50	↓	↓	222.8	7.6	13.93	21.5	"	"
	250	↓	↓	159.2	8.4	29.84	41	"	"
7.0	10	7.96	13.5	207.2	7.8	3.6	6.8	"	"
	50	↓	↓	127.3	8.8	7.96	13.8	↓	↓
	250	↓	↓	91	9.3	17.1	25	↓	↓
7.5	10	7.43	12.5	193.4	8	3.35	6.5	↓	↓
	50	↓	↓	118.8	9	7.43	12.5	↓	↓
	250	↓	↓	84.9	9.3	15.9	24	↓	↓
14.0	10	3.98	7.5	103.6	9.1	1.8	4	↓	↓
	50	↓	↓	63.66	9.6	3.98	7.5	↓	↓
	250	↓	↓	45.47	9.8	8.5	14	↓	↓
14.5	10	3.84	7.3	100	9.1	1.73	3.9	↓	↓
	50	↓	↓	61.47	9.6	3.84	7.3	↓	↓
	250	↓	↓	43.9	9.8	8.23	13.8	↓	↓
21	10	2.65	5.5	69.1	9.5	1.2	3	↓	↓
	10	2.4	5.0	77.1	9.4	1.07	2.5	2000	1,531
	50	↓	↓	47.3	9.8	2.4	5.0	↓	↓
	250	↓	↓	33.7	9.95	5.0	8.1	↓	↓
30	10	1.5	3.5	58.5	9.6	.07	0	1700	1,800
	10	1.86	4.1	48.3	9.8	.8		2500	1225 W
	50	1.5	3.5	35.8	9.93	1.5	3.5	1700	1800
	250	"	"	(25.4	>10)	3.2	6.3	"	"
	250	1.2	2.5	31	10	2.4		1100	2784

DRAKE

(1981)

Drake MN-7500 Tuner

Smith Chart Calculations



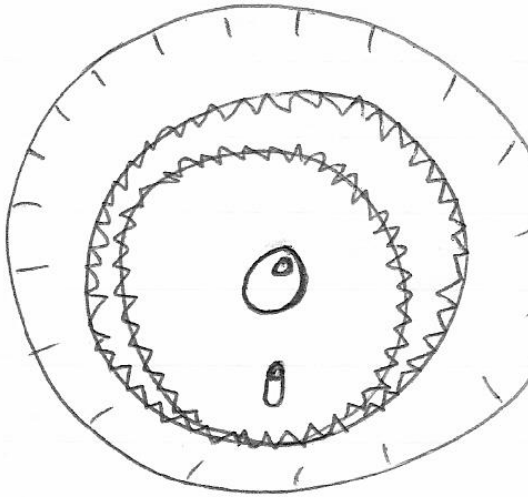
(1981)

Drake MN-7500 Tuner

Counter Dial Gear Calculations

Stock Drive Prod Cat.

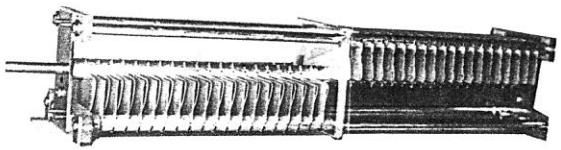
Pages	EXT (48 pitch)	INT	ratio
31,21	46	48	24:1
22	71	72	72:1
21,	70	~~68~~ 72	36:1
21,24,	80	~~96~~ 84	21:1
22	95	~~120~~ 96	96:1
		120	

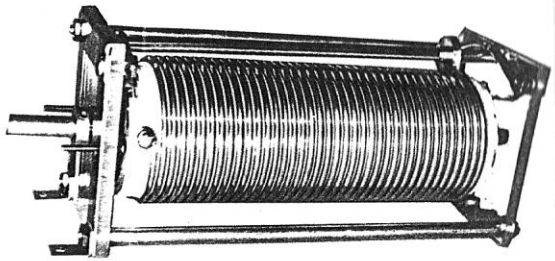


(1981)
Drake MN-7500 Tuner Roller Inductor From Murch Electronics

MURCH ELECTRONICS, INC. - COMPONENTS LIS

They are selling this outfit
But won't effect our order





CAPACITORS - Aluminum plates .032" thick with rounded edges - brass shafts - heavy brass contact springs - large ¼" tie rods

INDUCTOR - Ceramic inductor, wound with #8 wire - 3/8" dia. aluminum shafts - brass shaft & idler wheel - brass springs

ALL COMPONENTS ARE OF THE SAME RUGGED QUALITY USED IN THE ULTIMATE TRANSMATCH

Base Price $80.00

100- $ 68.00 ea
250- 60.00 ea -25%
500- 52.00 ea -35%
1000- -45%
2000-

TYPE	PK. V.	DIMENSIONS	RETAIL PRICE
A-CAPACITOR	4500	8¼" x 3¼"x 3"	$48.00 & Shipping
A-(SPLIT CAPACITOR)	4500	10" x 2¾"x 3	$56.00 & Shipping
B (SHOWN)	4500	14¼" x 2¾" x 3"	$68.00 & Shipping
INDUCTOR (SHOWN)	4500	10½" x 3" x 4½"	$80.00 & Shipping
4:1 BALUN		2" dia. x 2" h	$21.95 & Shipping

Wayne Murch

Send for price quotes on quantity.

Order From: Murch Electronics Inc., PO Box 69, Franklin, ME 04634 207-565-3319

VISA master charge

DRAKE

Drake

MN-5
500 Watt
Antenna Tuner

Economy Model

No Wattmeter
Small
Roller Inductor

$ 170.00

MN 5 Economy Match Box

Small meter for tuning (No wattmeter) 500 w PEP

Material removed from MN7500

ITEM	Price
Smaller V. Cap. (22S/25R) ½ length	.94
Smaller Roller Coils 6" vs 10"/#16 vs #12 wire	2.74
Meter-diff 50¢	7.76
Ant Sw/Knob	4.54
2 SO 239	.578
Push Sw	2.85
~~Pot~~	
PC Assy	
Vinyl Mat ⅜	1.227
DB shaft	.629
coupler	.1491
6.8 Megs	.1320
Sub. Panel Hdwr	.3027
Extrusion ⅜ Mat	.4033
Chassis ⅜ Mat	1.0222
Bottom ⅜ Mat	.4457
Remove from MN7500	23.719
Cost Material for MN-5 =	31.15
Labor Shop .67hr@7.50=5.025	
Labor Assy 2.5@4.85=12.125	
Total DL	17.15
OH 2.17X	37.22
	85.51
G+A 17%	23.08
Prof 20%	27.15
min Dealer price	135.74
Am Net	171.00

ITEM	Price

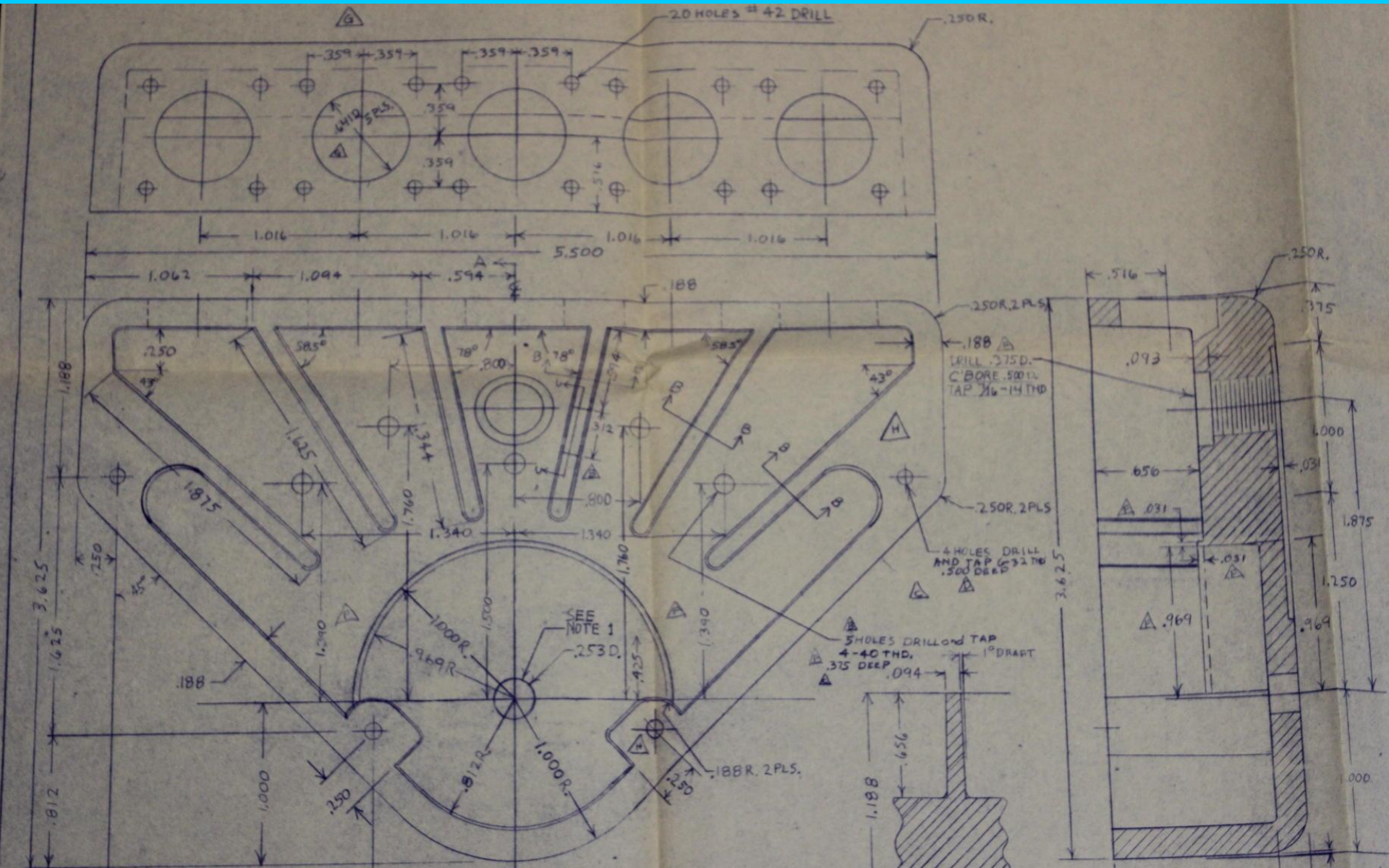
Milt retired from R.L. Drake in 1983 and stayed on for 4 years consulting for them

He also consulted for Lytton Industries & taught engineering for Wright State

Consulted & Designed for Alpha-Delta

Milt Sullivan's Consulting & Designing for Alpha-Delta

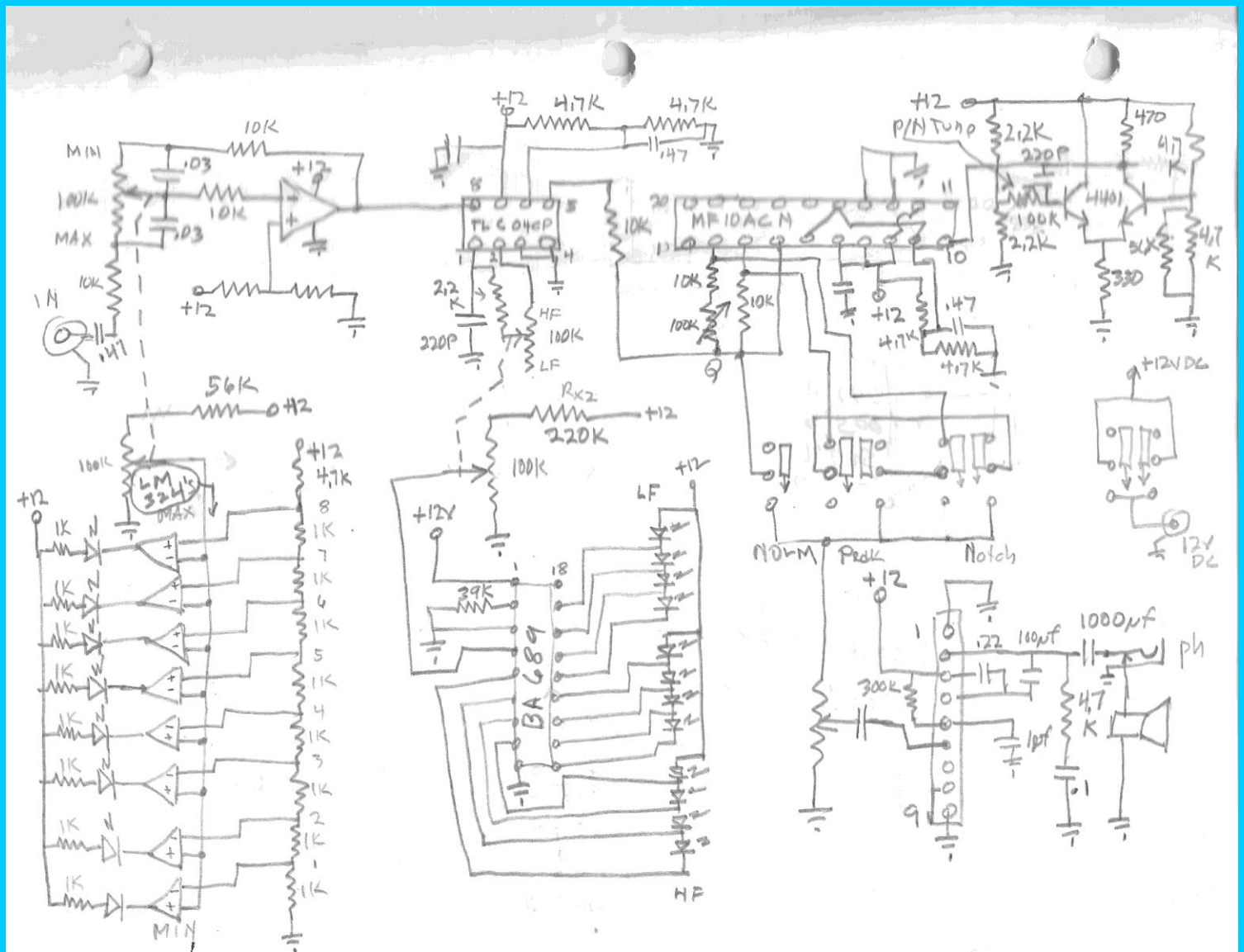
4-Position Coax Switch



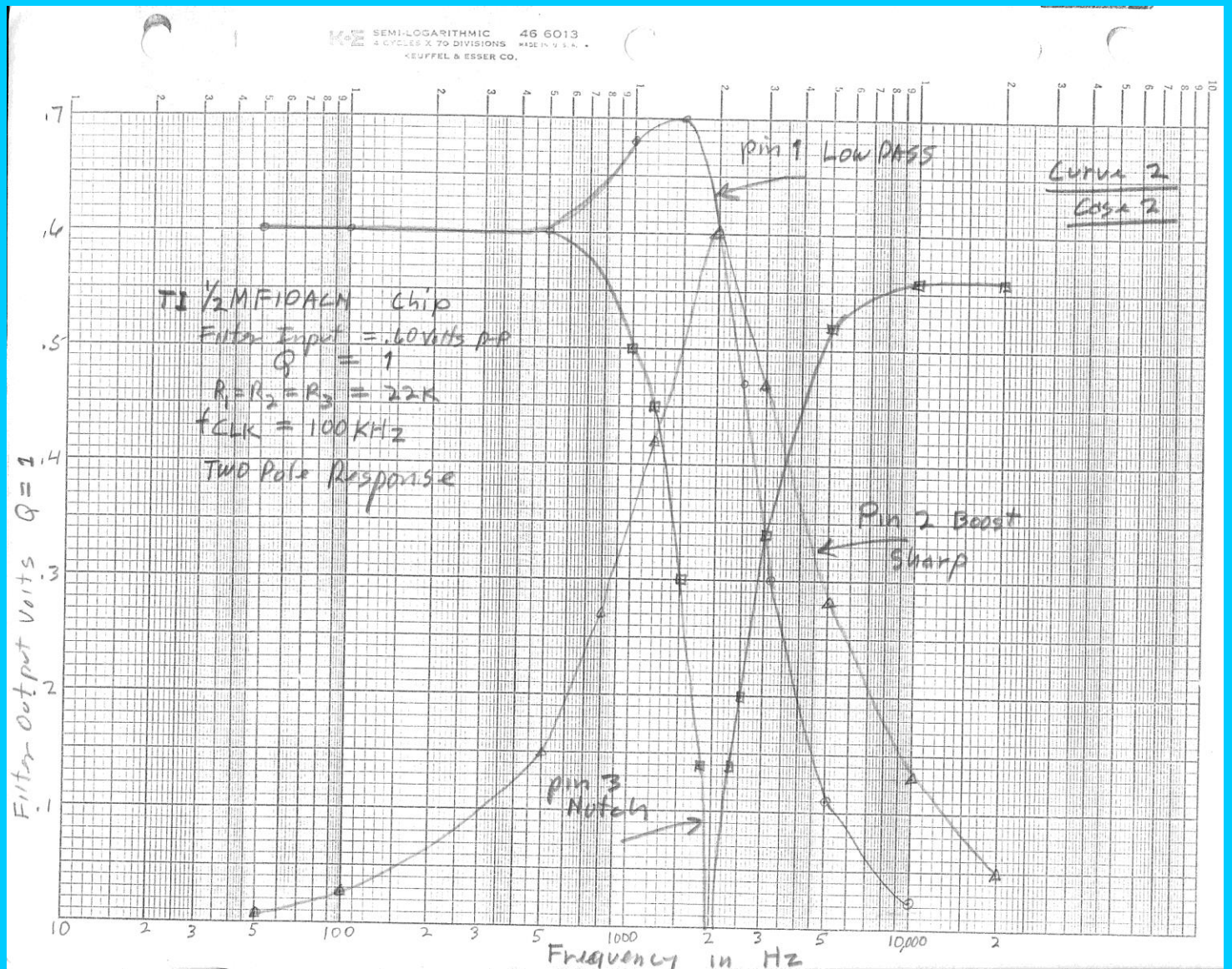
Milt's Notes for Alpha-Delta coax switch

Alpha-Delta VRC
Variable Response Console
Note the similar look to the
<u>Drake 2-BQ speaker</u> ! !

VRC Hand Drawn Schematic



VRC High & Low Pass Filters



Alpha-Delta VRC Speaker 4-1/2 Inches

10" Square Frame Woofer

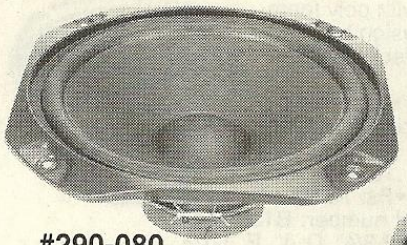
woofer with a paper cone and treated cloth surround. Black stamped frame and black cone. Perfect replacement for many name brand speaker systems that require square frame woofers. •Power handling: 40 watts RMS/70 watts max. •Voice coil diameter: 1-1/2 inches •Impedance: 8 ohms •Frequency response: 29-5000 •Magnet weight: 12 ozs. •Fs: 29 Hz •SPL: 92 dB 1W/1m •Vas: 5.37 •Qts: .33 •Qes: .38 •Qms: 2.37 •Xmax: .129 •Net weight: 3-1/2 lbs. •Manufacturer model number: E25FC92-54F •Dimensions: A: 10-1/4", B: 9-1/8", C: 4-1/2", D: 3-1/2", E: 1-3/8".

#290-080 .... $27.50 (1-3) .. $24.95 (4-UP)

12" Square Frame Woofer

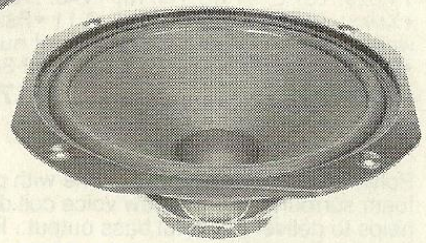
12" woofer with a paper cone and treated cloth surround. Black stamped frame and black cone. Perfect replacement for many name brand speaker systems that require square frame woofers. •Power handling: 50 watts RMS/80 watts max. •Voice coil diameter: 1-1/2 inches •Impedance: 8 ohms •Frequency response: 34-4000 Hz •Magnet weight: 14 ozs. •Fs: 34 Hz •SPL: 94 dB 1W/1m •Vas: 7.39 •Qts: .42 •Qes: .51 •Qms: 2.38 •Xmax: .129 •Net weight: 5 lbs. •Manufacturer model number: L30FC14-51F •Dimensions: A: 12", B: 10-3/4", C: 5", D: 4", E: 1-3/8".

#290-130 .... $35.80 (1-3) .. $32.80 (4-UP)



PIONEER

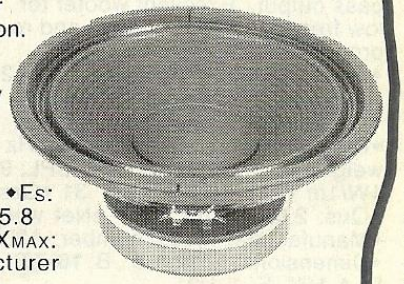
#290-080



#290-130

10" Musical Instrument Speaker

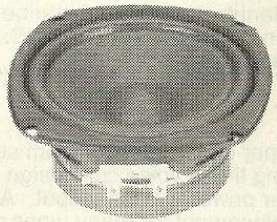
Ribbed paper cone with treated cloth accordion surround. Vented pole piece for heat dissipation and reduced distortion. Perfect replacement for many P.A. and musical type speakers. •Power handling: 100 watts RMS/200 watts max. •Voice coil diameter: 2 inches •Impedance: 8 ohms •Frequency response: 30-3000 Hz •Magnet weight: 40 ozs. •Fs: 30 Hz •SPL: 96 dB 1W/1m •Vas: 5.8 •Qts: .15 •Qes: .18 •Qms: 1.08 •Xmax: .129 •Net weight: 8 lbs. •Manufacturer model number: A25GC40-51F-Q •Dimensions: A: 10-1/8", B: 9-1/4", C: 5", D: 5-1/2", E: 1-3/8".



0-094 ..... $41.50 (1-3) $38.50 (4-UP)

4-1/2" Full Range

Paper cone with treated cloth surround. Open back and stamped basket. Perfect for bookshelf type speakers and car stereo installations. •Power handling: 20 watts RMS/30 watts max. •Voice coil diameter: 1 inch •Impedance: 8 ohms •Frequency response: 70-15000 Hz •Magnet weight: 9.3 ozs. •Fs: 70 Hz •SPL: 90 dB 1W/1m •Vas: .31 •Qts: .35 •Qes: .47 •Qms: 1.4 •Xmax: .043 •Net weight: 2 lbs. •Manufacturer model number: A11EC80-02F •Dimensions: A: 4-1/2", B: 4-1/8", C: 2-3/8", D: 3-1/8", E: 1".



#290-010 ..... $10.50 (1-3) $9.80 (4-UP)

8" Full Range

Paper cone with blue poly foam

Specs for 4-1/2 Inch Speaker DB Level VS Frequency

Not Just Guessing at How it Reacts ! !

Pioneer 4½ in ported 8×8×6 Cabinet

f	dB
54	55
60	60
75	55
79	60
88	66
94	70
118	73
137	74
142	76
160	76
165	80
177	90
185	90
207	86
235	84
255	88
265	80
270	76
277	80
290	83
300	80
310	74
315	80
325	84
360	85
375	78
390	85
410	76
432	89
452	85
490	85
520	93
545	85
610	87
650	83
680	90
720	95
730	91
800	94

f	dB
820	85
840	90
870	85
940	94
960	96
980	92
1030	94
1100	90
1180	86
1250	80
1250	70
1260	68
1300	76
1320	70
1360	74
1390	74
1420	82
1450	74
1460	84
1500	78
1580	82
1650	90
1760	80
1750	86
1860	92
1900	80
2000	84
2110	76
2160	84
2200	88
2260	70
2270	80
2290	86
2350	84
2390	80
2210	86
2460	86
2520	72
2550	82
2700	86
2850	92

f	dB
2950	70
3010	80
3020	87
3180	84
3420	86
4180	86
4440	88
5550	88
6500	90
7000	93
7900	88
8500	88
9300	85
10200	88
12000	87
12800	80
13900	70
14300	70
~~20,000~~	~~68~~
16100	60
17500	55

Some More of Milt's Great Work

(1998)

VSWR

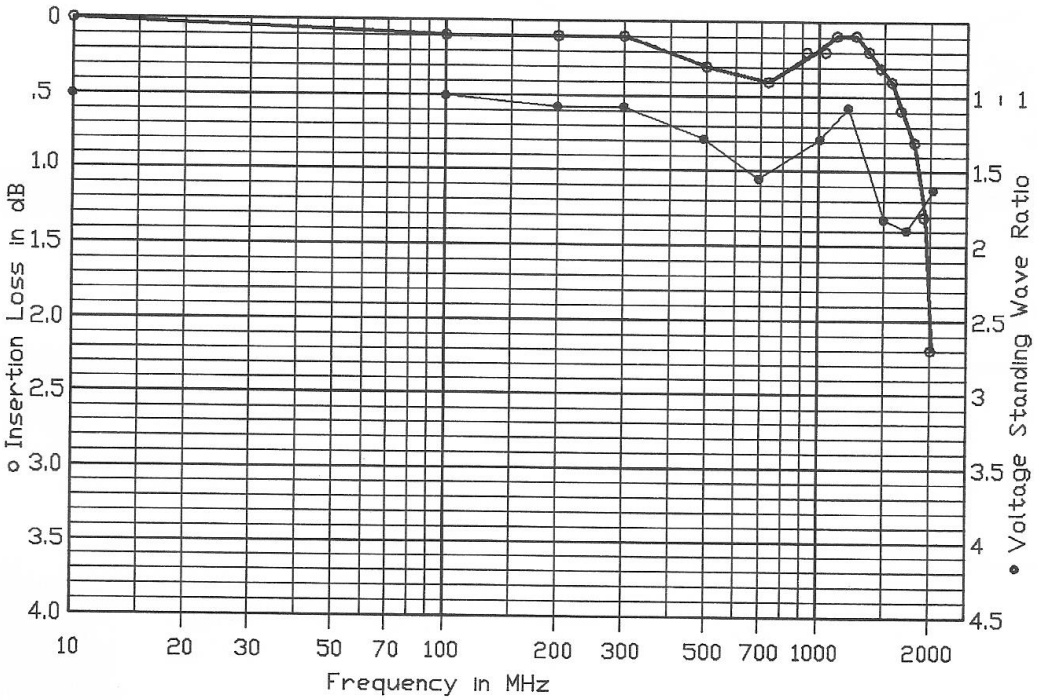
Measurements For The Trans-Trap

INSERTION LOSS/VSWR MEASUREMENTS

Corrected

ALPHA DELTA TRANSI-TRAP 2-17-98

MODEL #__RT/N-W/M___



Measurements made and certified by:

MILT SULLIVAN EE-Engineering Consultant
1303 Pilsdon Crest -- Mt. Pleasant,SC, 29464
Phone 803-884-1441 -- Fax 803-884-3254

Signed Milton A. Sullivan Date 2-17-98

On October 28, 2010
Milt Sullivan
died peacefully
at the age of 85

Thank You For Watching

DRAKE


WA8SAJ
LIFE MEMBER
THE AMERICAN RADIO RELAY LEAGUE
Certificate of Recognition
RADIO RELAY LEAGUE
Gulfstream G650
DRAKE
WA8SAJ
LOGBOOK

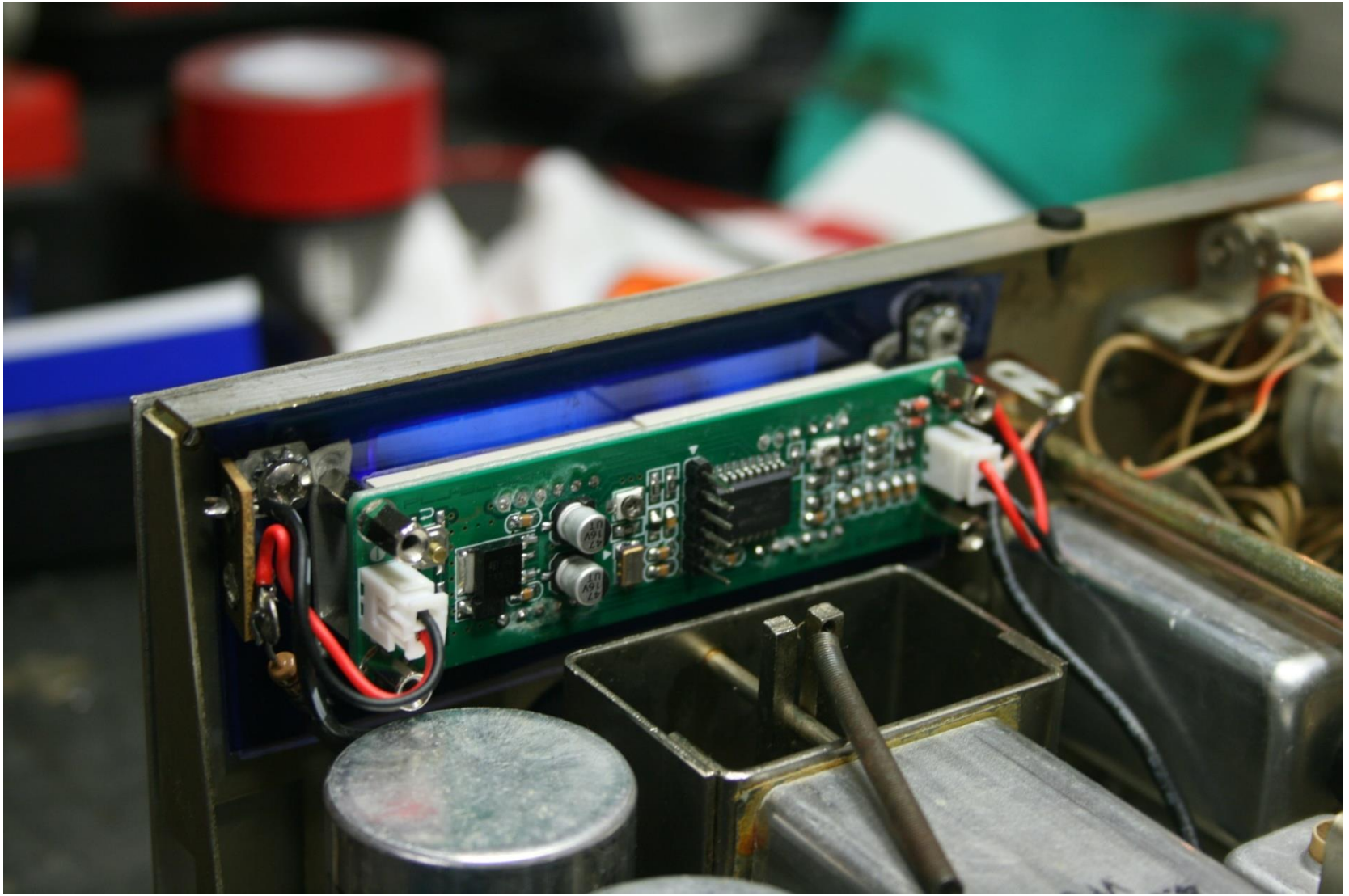
The End

By: Mark Gilger, WB0IQK

R4/T4 Internal Frequency Display

DRAKE

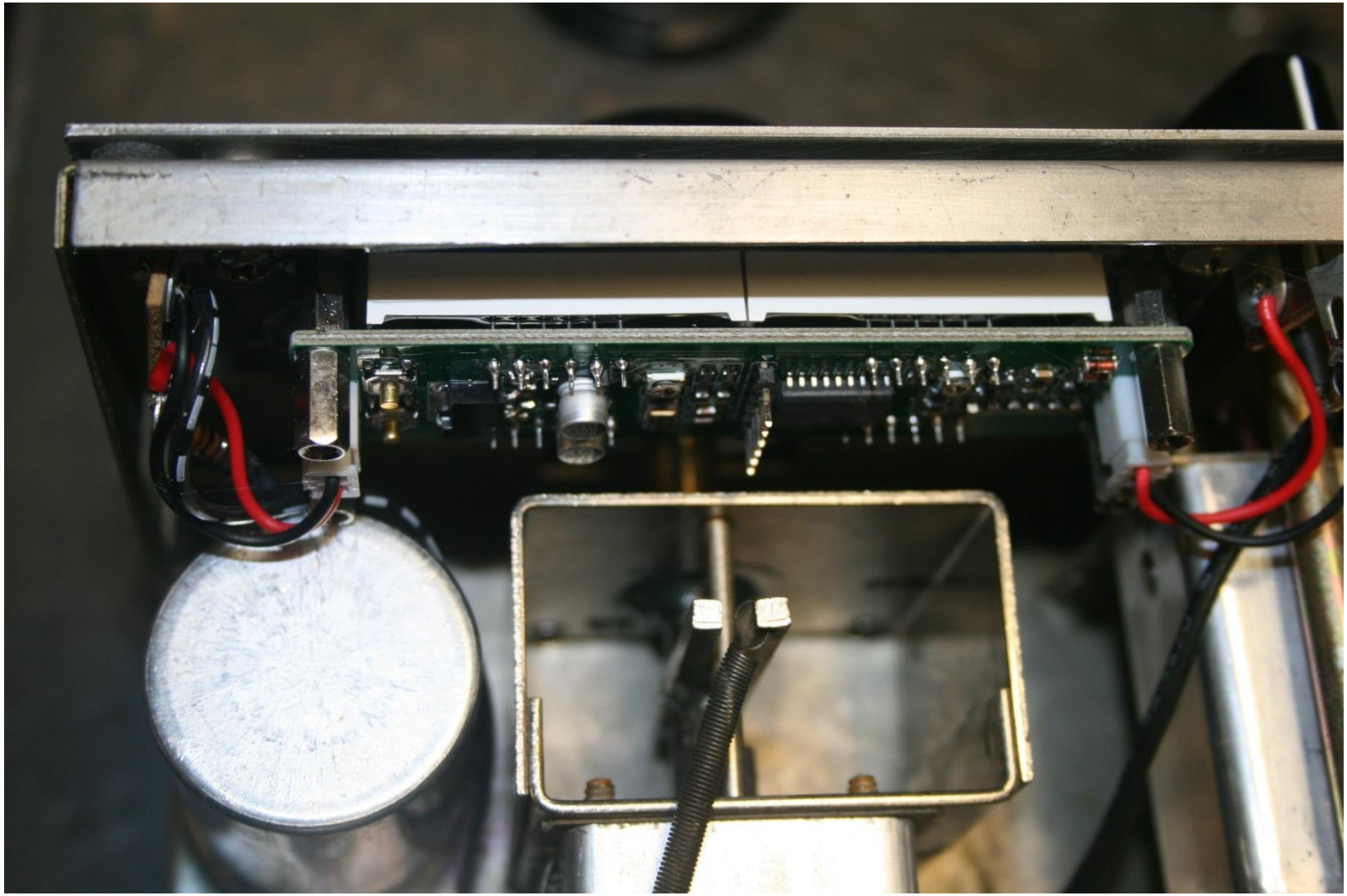
Full article located : www.wb4hfn.com



M.V.G. May 2015

DRAKE

Full article located : www.wb4hfn.com



- Cost of counters : < $12 on eBay.

- Counters are distributed by an eBay seller “elecbuy”.

http://stores.ebay.com/elecbuy?_trksid=p2047675.l2563

Specifications:

- Working voltage: DC 8V-15V
- Working current: 90mA(max)
- Input impedance: high resistance
- Measuring range: 0.1 MHz to 65 MHz
- Accuracy: 10 Hz
- Sensitivity: better than 60mVPP
- Display digits: Six common anode LED display , the highest display six digits.
- Dimensions: Length × width × height : 91 mm × 28 mm × 20 mm

- These counters are easy to install in about 2 hours.
- I’ve installed this in my T-4XC and R-4C with the same results. This upgrade will also work in the older lines of the T4 and R4 series.
- It has a provision for one positive or negative IF offset, in this case the 5645kc.
- It has the capability to read down to 100 or 10 hz resolution.
- Intensity can be adjusted in 1-8 steps.

DRAKE

Full article located :
www.wb4hfn.com

Drake R-4 and T-4 Series Internal Frequency Display and VFO Supply Regulation

By Mark Gilger, WBØIQK
11827 Fraze Street
Doylestown, OH 44230
wb0iqk@arrl.net

Introduction

I've been collecting and using Drake equipment for about 40 years. Recently I became curious if an internal frequency display could be mounted inside of my R-4C and T-4XC. I came across a mini 1-50 MHz frequency counter on eBay, and ordered a couple of them to experiment with. I was immediate impressed, and I started the task of testing it on both the R-4C, and T-4XC. The test proved that the counter was compatible with both R-4 series receivers, and T-4 series transmitters. I assumed it would be difficult to figure out the mounting, however, it turned out to be pretty simple.

There is one thing that is worth nothing before we start the upgrade process:

I installed the counter in 2 different R-4Cs, with similar drift characteristics. Both drifted close to 1 kHz over about a 3 hour period. Different results were obtained in both, as far as frequency stability. Both receivers also received better PTO voltage supply regulation; per the procedure at the end of this article.

My first installation was a 16K serial number model. It had plastic gears. The second R-4C was a 29K serial number, and it had metal gears. I chose to remove the plastic gears on the 16K receiver; making it have almost zero drag characteristics. I kept the metal gears in

Figure 1: This classic Drake R-4C receiver has been upgraded with a modern digital display.

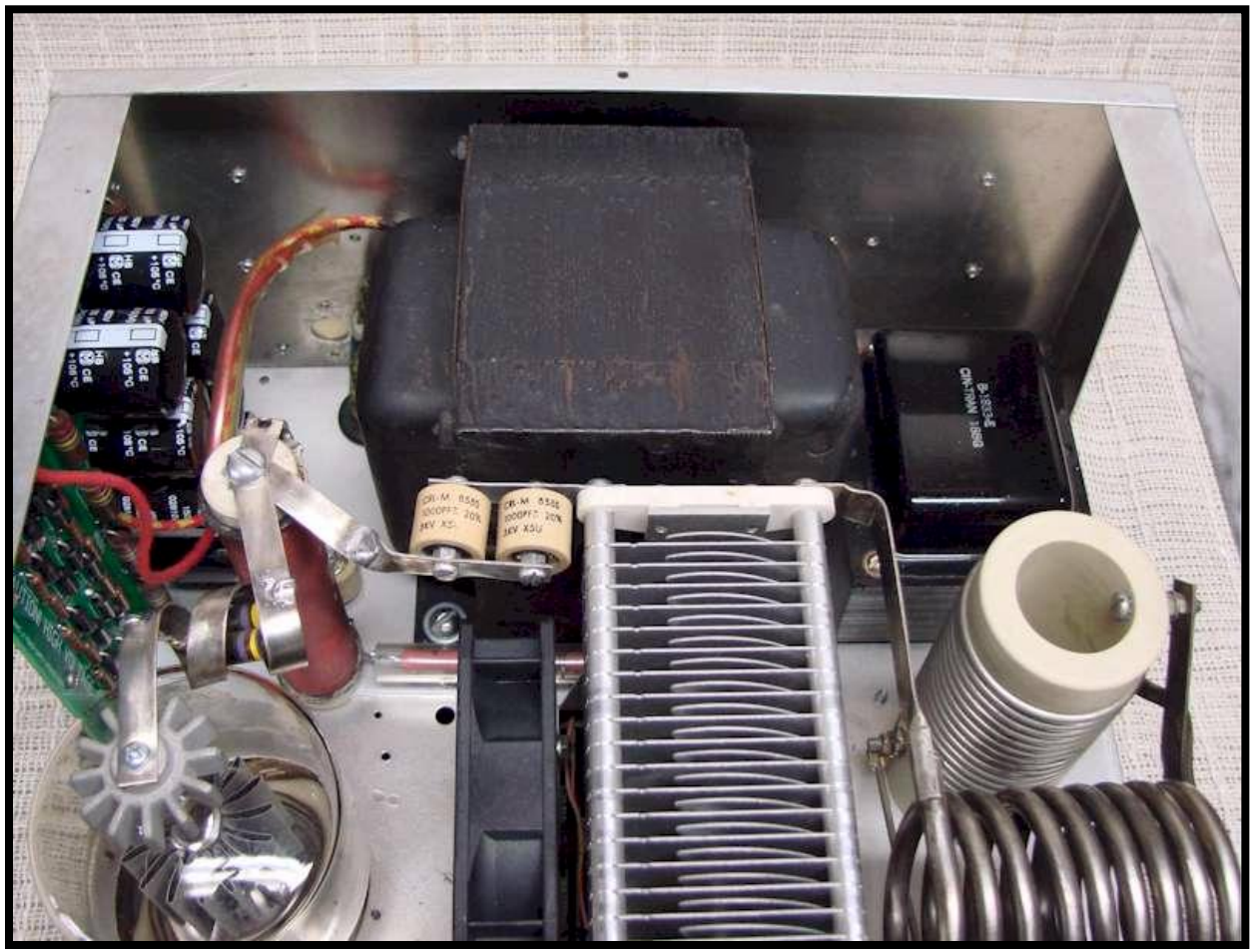
M.V.G. May 2015


WB4
HFN
Drake Vintage Radio
Repair And Restoration
Email: wb4hfn@wb4hfn.com
Website: www.wb4hfn.com

The L4B All In One Revisited

In 2012 the redesigned L4B with single tube and with built-in high voltage power supply.

The L4B All In One Revisited

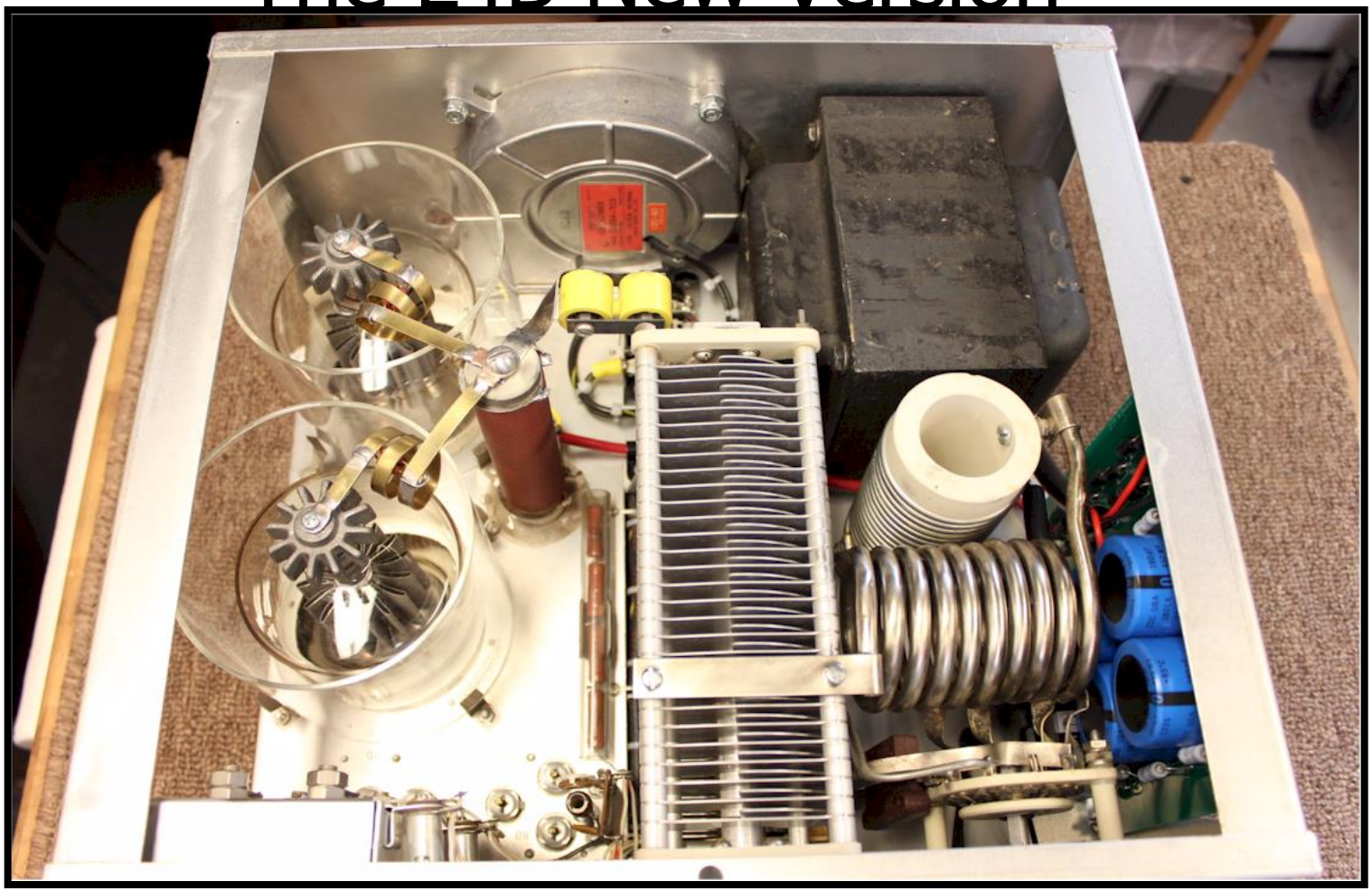


In 2012 the redesigned L4B with single tube and with built-in high voltage power supply.

The L4B New Version

In 2015 the redesigned L4B with both tubes and with built-in high voltage power supply.

The L4B New Version



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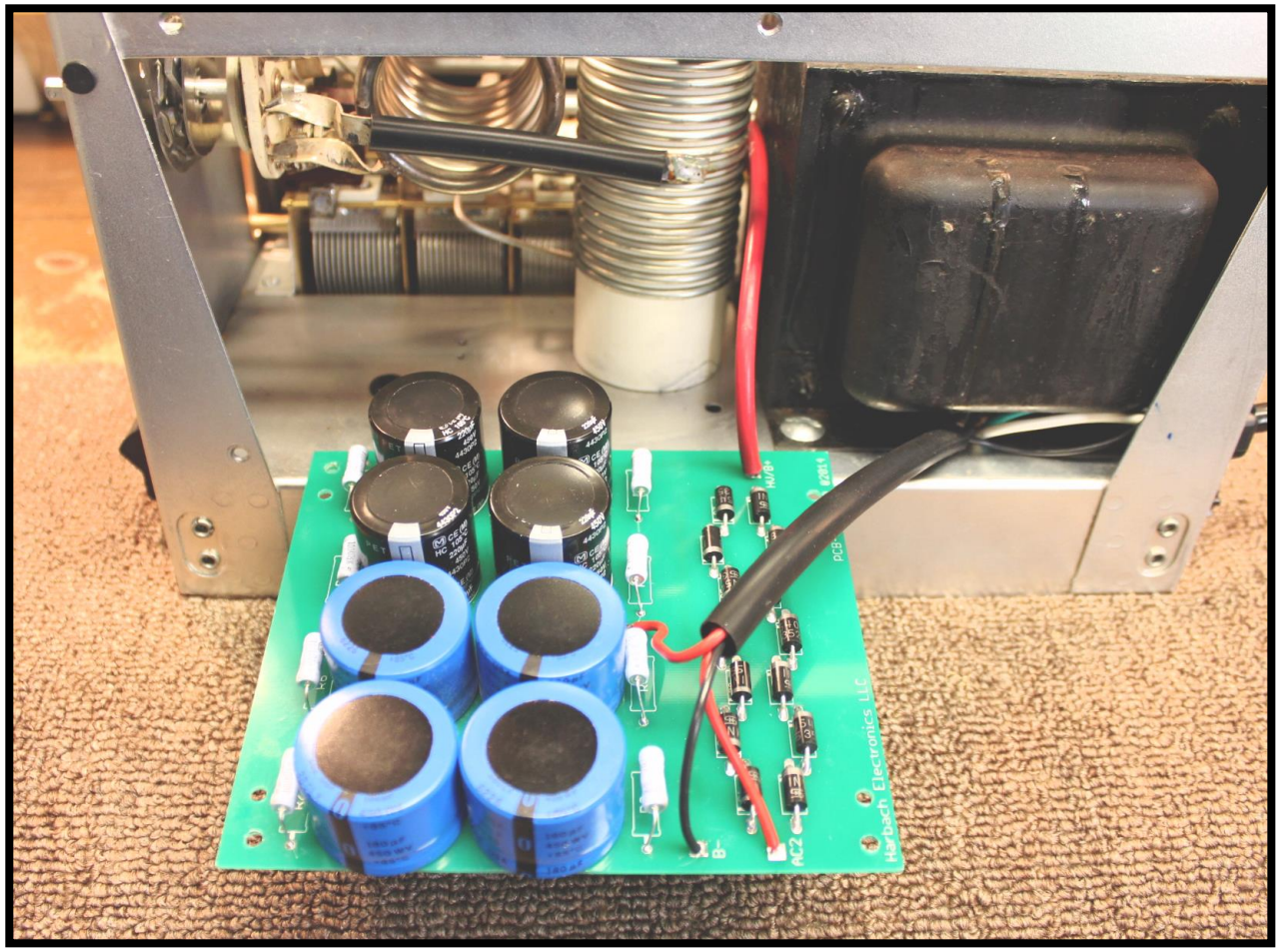
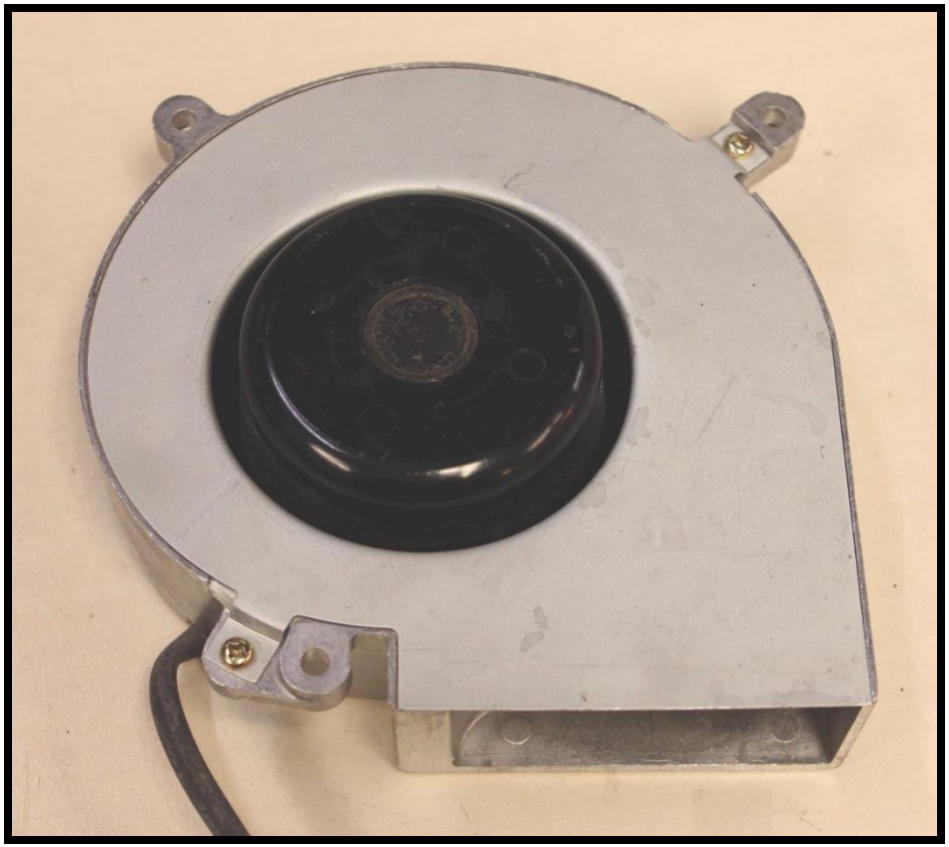
The L4B New Version



In 2015 the redesigned L4B with both tubes and with built-in high voltage power supply.

The L4B New Version



In 2015 the redesigned L4B with both tubes and with built-in high voltage power supply.

The L4B New Version

In 2015 the redesigned L4B with both tubes and with built-in high voltage power supply.

The L4B Two Tube "All In One"

In 2015 the redesigned L4B with both tubes and with built-in high voltage power supply.

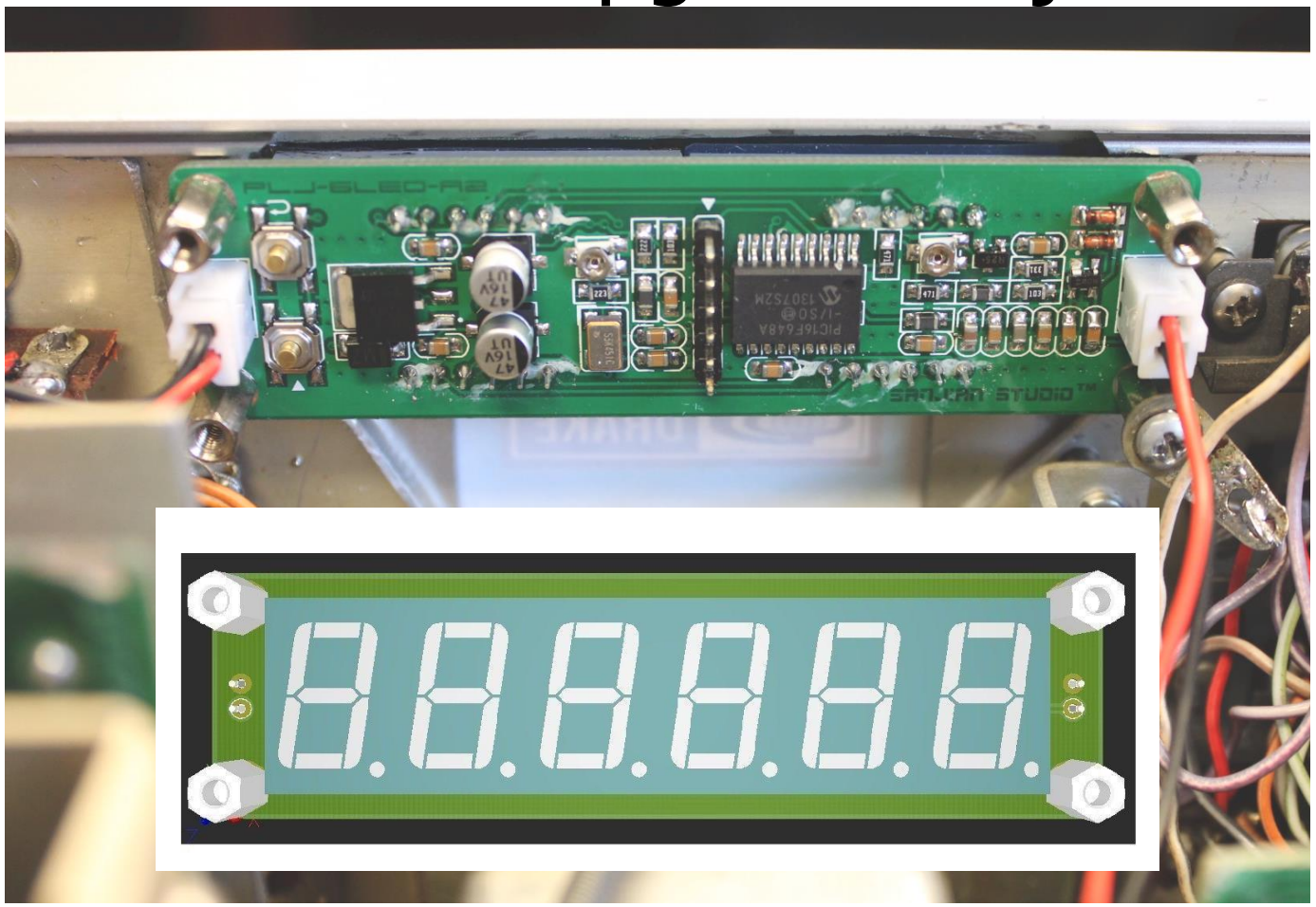
The TR7 Upgrade Project

This is my never-ending TR7 project that I am constantly thinking of ways to improve the performance.

The TR7 Upgrade Project

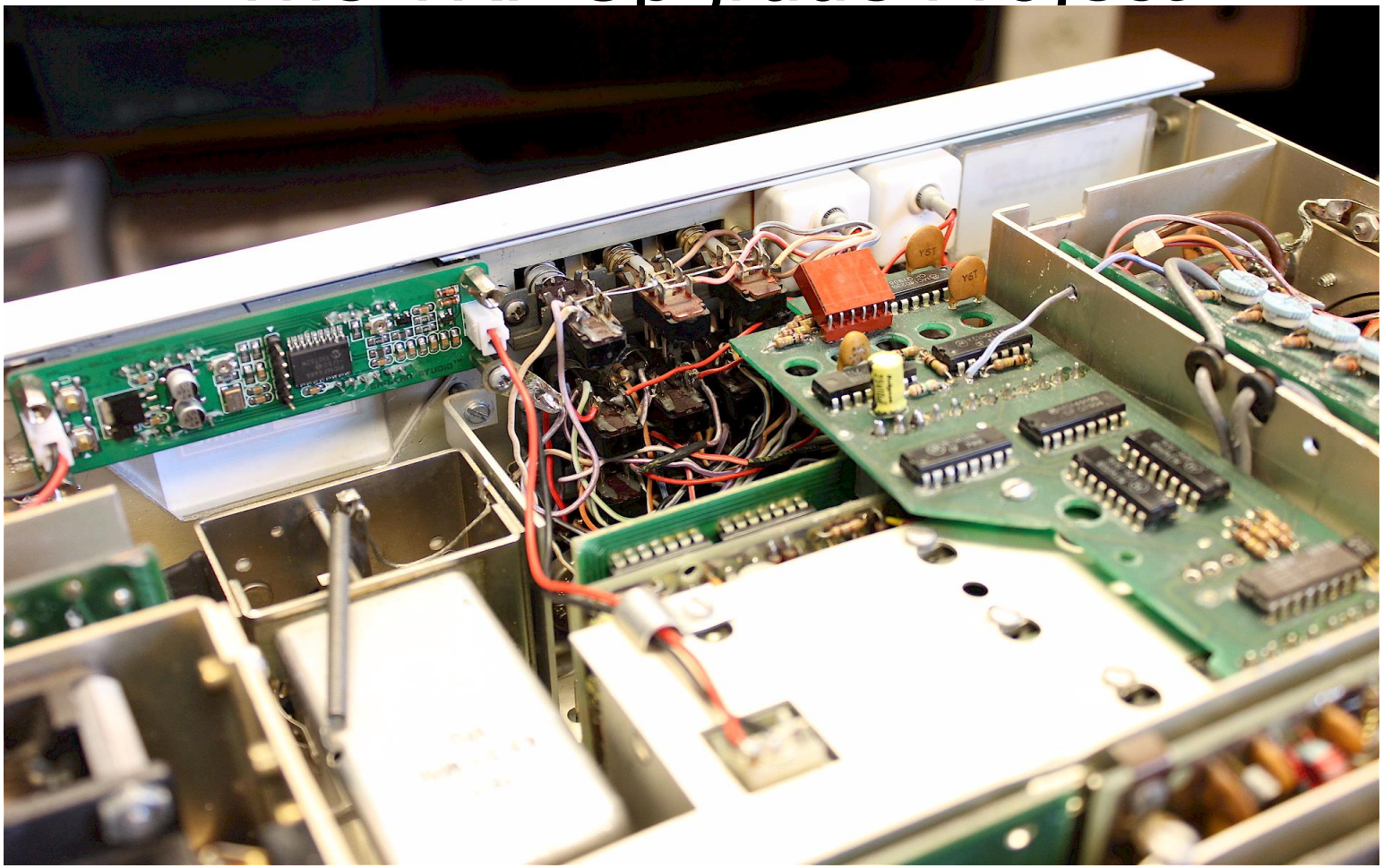
The new much larger digital display is the most significant upgrade.

The TR7 Upgrade Project



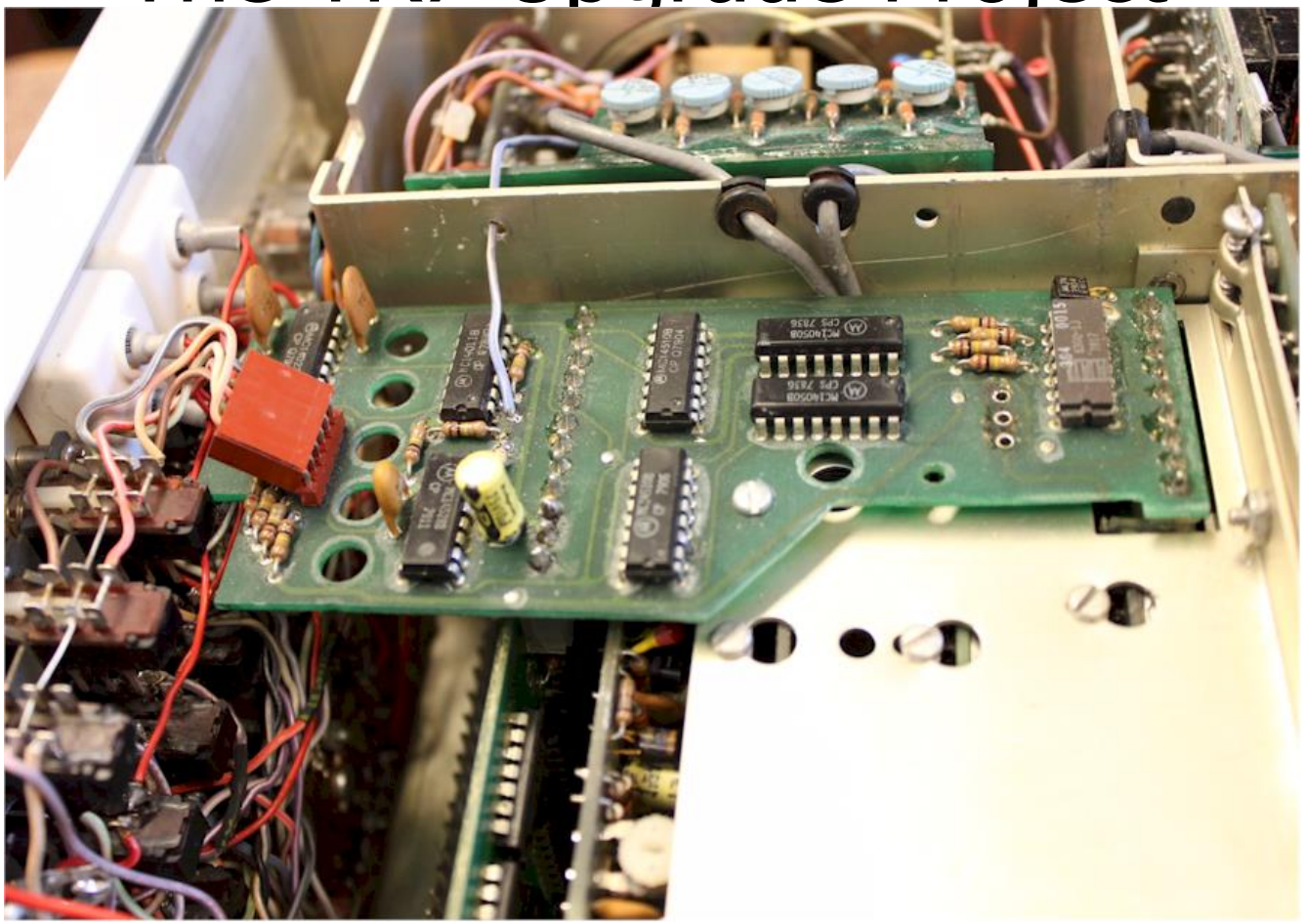
The digital display is a 65Mhz frequency counter with a programmable offset which is measuring the VCO frequency, with the 45.05Mhz IF frequency as the offset.

The TR7 Upgrade Project



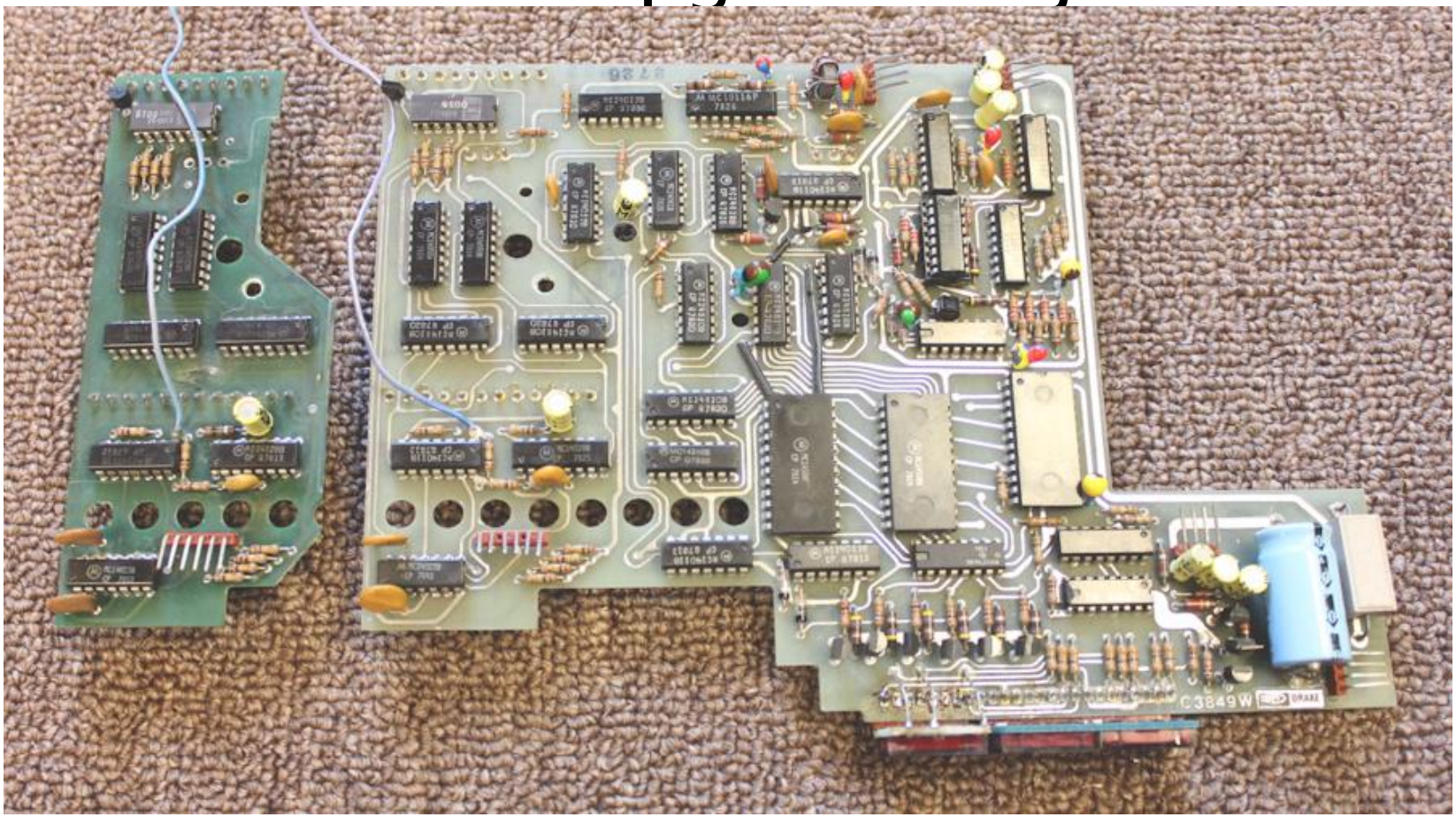
Wide angle view of the inside top area of the TR7 showing the new digital display and the cut away section of old DR7 board.

The TR7 Upgrade Project



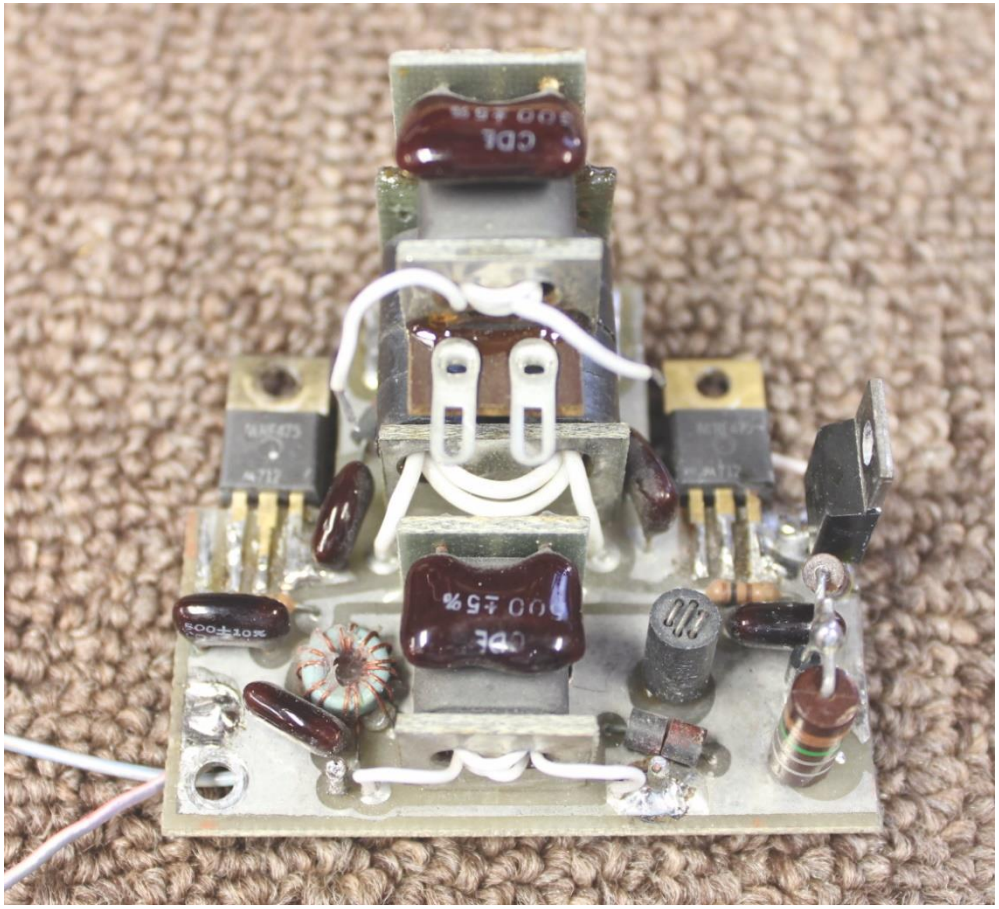
The DR7 board has two distinct sections, the frequency controller, and the frequency display section. Shown here is only the frequency control section of the board

The TR7 Upgrade Project



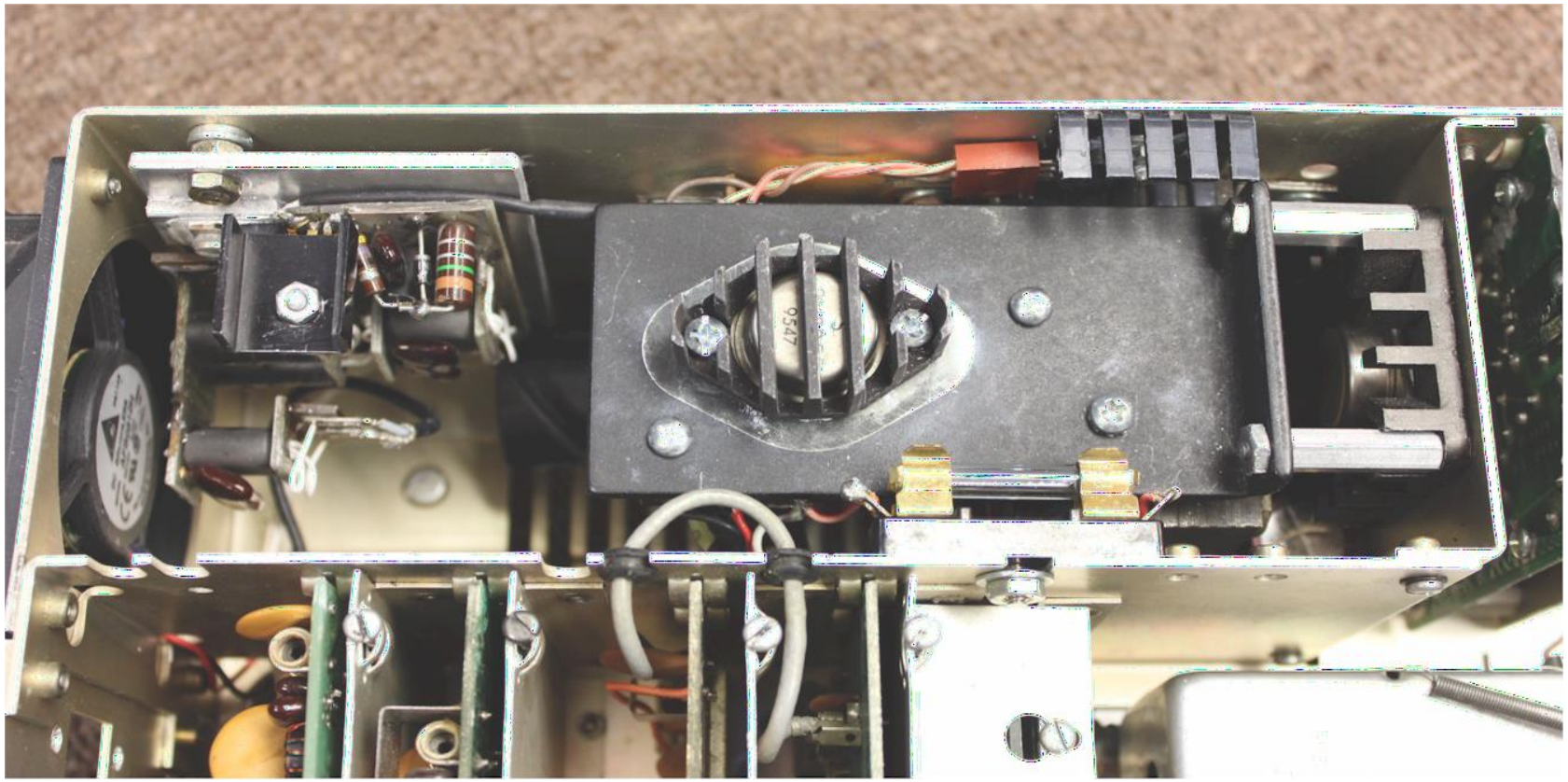
Here is a side by side view of the DR7 digital display board, shown on the left is the frequency control section cut away from the rest of the board.

The TR7 Upgrade Project



The TR7 power amplifier section is a cut away section of the original PA amplifier, the driver stage which drives the two final transistors. This section puts out about 15 watts.

The TR7 Upgrade Project



Shown here in the area originally for the PA amplifier, now contains the AC power supply on the right and the new PA amplifier stage on the left.

The TR7 Upgrade Project

So far the list of changes include:

- Built-in AC Power Supply
- 15 watt output Power Amplifier
- Large Blue LED display
- Digital Display board cut away modification
- Relocation of the Mode Switch frequency adjustments
- Removal of the entire analog frequency display section.
- New LED background lighting.
- Transmit predriver section of the PA amplifier relocated to the plugin slot of the old power supply board.
- New low noise balanced mixer stage in the receiver front end.
- Replaced the mixer diodes with new low noise tunnel diodes.

The TR7 Upgrade Project

So What Are The future Upgrades:

- Adding the Digital DDS PTO and eliminating the analog PTO.
- The AUX programming switch will become the IF bandwidth selector with up to 8 digitally programmable IF filters.
- The "A-B-C" IF filter selector will become the "A & B" digital VFO selector with the "C" position for operating split frequency.
- Anything I have not yet thought about adding to the radio.

QUESTIONS

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PRIZE DRAWING

Goal was to make time for presentations.

Tickets were pre-drawn in the presence of honest witnesses.
Stubs handed out randomly as you entered.

Only 1 prize per person.

Please claim your prizes in the hall after we dismiss.

The winning ticket numbers are.....

Questions & Answers

Ron, WB4HFN
Mark, WB0IQK
Gary, W8PU
Jeff, WA8SAJ
Evan, K9SQG

The Path Ahead…