A HIFI Screen Modulated Broadcast Band Transmitter

(with a "complete" set of schematics)

During the Holidays I like to listen to my favorite music tracks whether inside or outside the house. However, I prefer to hear them over AM with high fidelity.

During the late '30's through the early '60's, many Home Broadcaster modules and kits were offered, many under the category of "Phono Oscillators," which could be fed a signal from a Phonograph. One could place a "45" or an LP on the turntable and listen to the signal anywhere in the house. One of the more recognized kits would have been the Allied-Knight broadcaster kit:
http://www.smecc.org/knight_kit_home_broadcasters_-_allied_electronics.htm .

One of the few tube based Broadcaster kits commercially offered today is the K-488 by AES: https://www.tubesandmore.com/products/K-488 , and is based on the original 1939 Zenith model S-7000 Wireless Record Player using a single 12SA7 mixer tube. While it is a fun first kit, it unforntunately does not come with a chassis (safety issue) and suffers from hum and buzz.

Presented here is a three-tube, crystal-controlled, screen modulated HIFI AM Broadcast tranmitter. With appropriate component changes, this transmitter can also be used as a Ham radio QRP transmitter. Note that each schematic has it own component numbering system.

The Speech Amplifier, V1A and V3A:

V1 is a 6U8 tube in which the V1A pentode section serves as the first gain stage. The audio is then passed on to audio gain control potentiometer R10 and then on to a 12AZ7 triode (or equivalent). An alternative schematic shows a 1st stage 6AU6-based speech amp.

V3A, a 12AZ7 (or equivalent), develops audio for the Modulator. Keeping R12 unby-passed keeps distortion very low.

J1 is a ¼" phone plug for microphones or audio equipment that have output impedances of 50k ohms or greater.

J2 is a 3.5 mm stereo jack that accepts audio from home entertainment equipment (for 10k loads), personal CD players, or MP3 players. R4 and R5 sum the two stereo channels. If CD or MP3 players are the audio sources, a switch is thrown to properly load those devices using R6 and R7. Audio levels are controlled by those devices and R10 for least distortion.

In testing with audio sourced directly from personal CD players, the audio response was 50 Hz to 15 kHz. Listening to this transmitter on a GE Super Radio III in the "Wide" mode shows the full range capability of AM. **Who says AM cannot produce the full range of audio?**

One can always place an audio limiter in the audio chain to level out the audio.

The Screen Modulator V3B:

V3B (a 12AZ7 or equivalent) modulator is a cathode follower designed for good waveform symmetry. A -8V voltage is applied as bias to the grid and cathode resistor in order to make sure the screen modulated voltage waveform is "pulled down" to near zero on negative excursions of the driving audio waveform. The effect is a symmetrical, 100% screen modulated waveform.

R1 allows limited control over power output. R1 and R2 can be replaced with a single 3.3M resistor if you do not want the adjustable power option. However, R1 helps to obtain a sweet spot between power output and optimum audio quality.

Using a scope probe at R4, one adjusts R1 and R10 (on Speech Amp schematic) for the most symmetrical waveform possible without flatopping or distortion.

The Modulated RF Amplifier V2 and Pi-L Network:

The familiar 6CX8 multi-section tube serves as the oscillator and the power amplifier. The triode section, V2A, serves as the crystal oscillator while the pentode section is the modulated final amplifier.

The crystal holder is a 9 Volt battery holder by ACME. The contact pins are hollow and have an inner diameter of exactly 0.093" and pin spacing of 0.5", which is perfect for FT-243 crystals. The capacitance between each pin and holder is a mere 5 pF so it has little effect on the crystal frequency.

The triode is configured as a Pierce crystal oscillator circuit. R5 provides oscillator-final isolation to prevent any "pulling" of the oscillator frequency. All resistors in the triode section and the final's grid resistor are carbon composition or carbon film type. Frequency stability was better than +, - 25Hz with the crystal used.

The pentode Final section operates in class A with an efficiency of approx. 20%. While class A is an inefficient amplification class for RF, it produces a very clean RF output waveform with very low harmonics. The RF output signal is tapped off at the V2B plate pin 9 and C12 for transfer to the Pi-L network.

The screen is modulated by the V3B cathode follower. C11 shunts any RF to ground while R10 provides a constant load and a pulldown in case something opens up at the cathode follower circuit. The coax run from the modulator to the pentode's screen provides additional capacitance to shunt RF.

The matching network shown is a conventional Pi-L circuit to match a wide range of antenna impedance. A trap is provided to reduce any interference to other services. Recall that short verticals have very low resistances and can vary widely with respect to reactance, so your antenna system may have to be adjusted to compensate.

Power Supply:

The power supply is a full-wave type for supplying 360V and180V. The -8V supply is a half-wave type providing a well filtered and stiff voltage for modulator bias. You will notice that "last chance" filtering is applied at each stage to reduce hum and shunt RF. T1 is an EDCOR XWPR050-120 power transformer.

Operation:

After the circuit has been wired according to the schematic, power up and check voltages. At the RF output connect a 50 ohm dummy load and place scope probe #1 at the *RF sample point* on the PI-L Net circuit (junction of RPi1 and RPi2). Set the screen grid voltage of the final (V2B) to 45 volts with Modulator potentiometer R1. Set variable capacitor CPT to 50% mesh and CAT to 50% mesh. Throw OP switch and adjust CPT and CAT until 0.6 volts P-P of RF appears at the RF sample point.

Set speech Amp R10 to 80%. Place scope probe #2 on V3B pin 7. Apply audio. Adjust audio input device until no "flat topping" is present on V3B pin 7**.** Adjust audio until 95% Modulation is seen at the RF sample point. **If your modulated RF waveform at the RF sample point is not 100% symmetrical, you DO NOT have the transmitter tuned properly.**

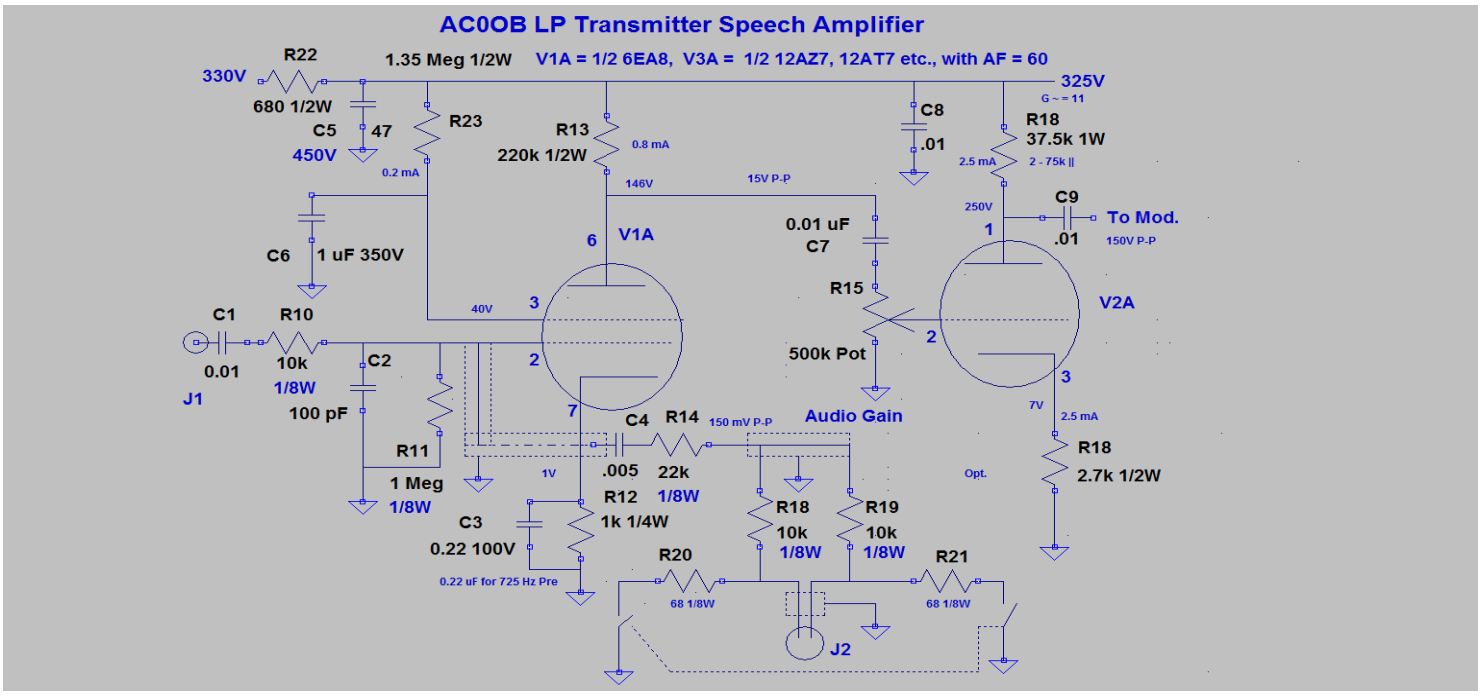
When using the whip antenna system, adjust CPT and CAT for max RF on a Field Strength Meter. A tripod mounted 108” mobile CB whip with 10 ground radials and the ATU can cover most lots quite well with Hi Fidelity AM sound.

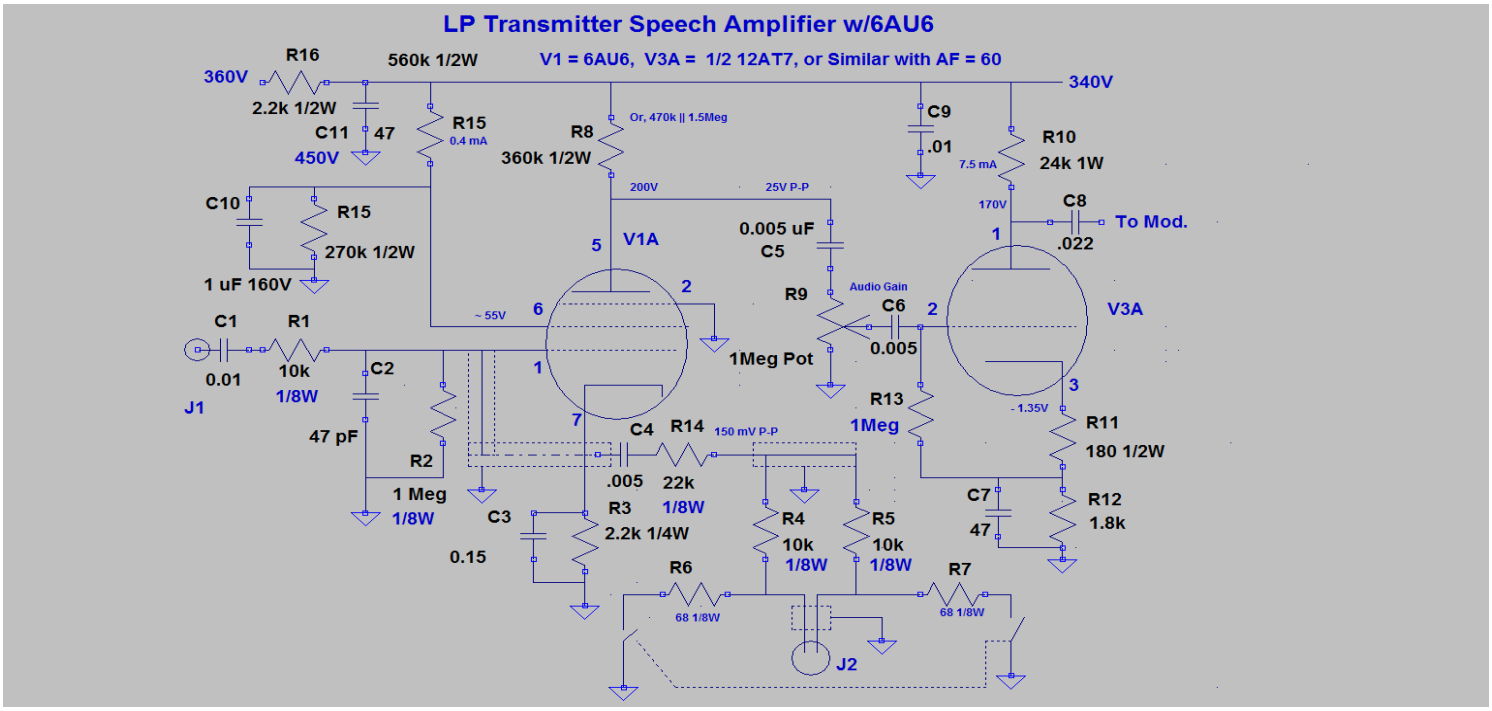
Construction Notes:

Components were mounted on a 10”X7” chassis as shown in the picture. All resistors are metal film type unless otherwise indicated. All capacitors are ceramic dielectric 500 volt units unless otherwise specified on the schematic.

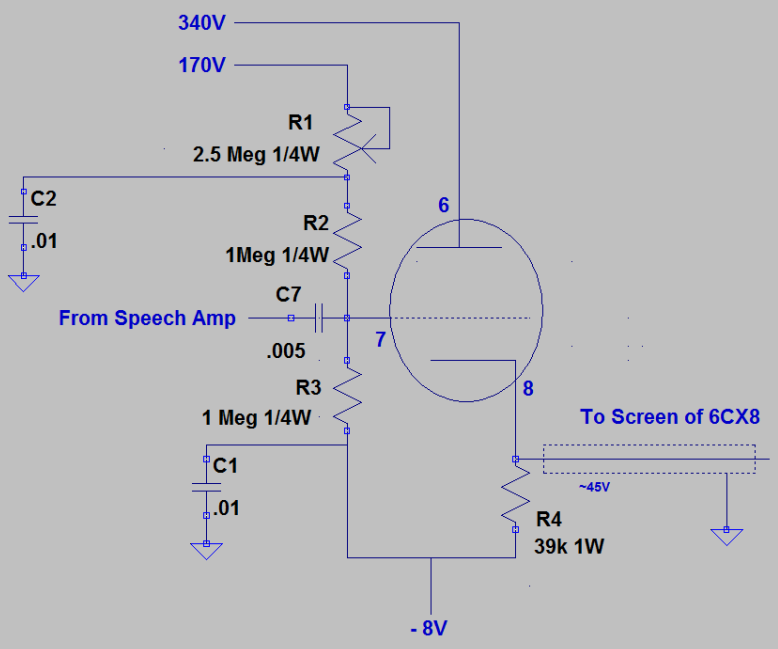
The Power-On Indicator DLED is a SuperBright $^{(TM)}$ 6.3V AC/DC LED with a Bayonet Base Holder.

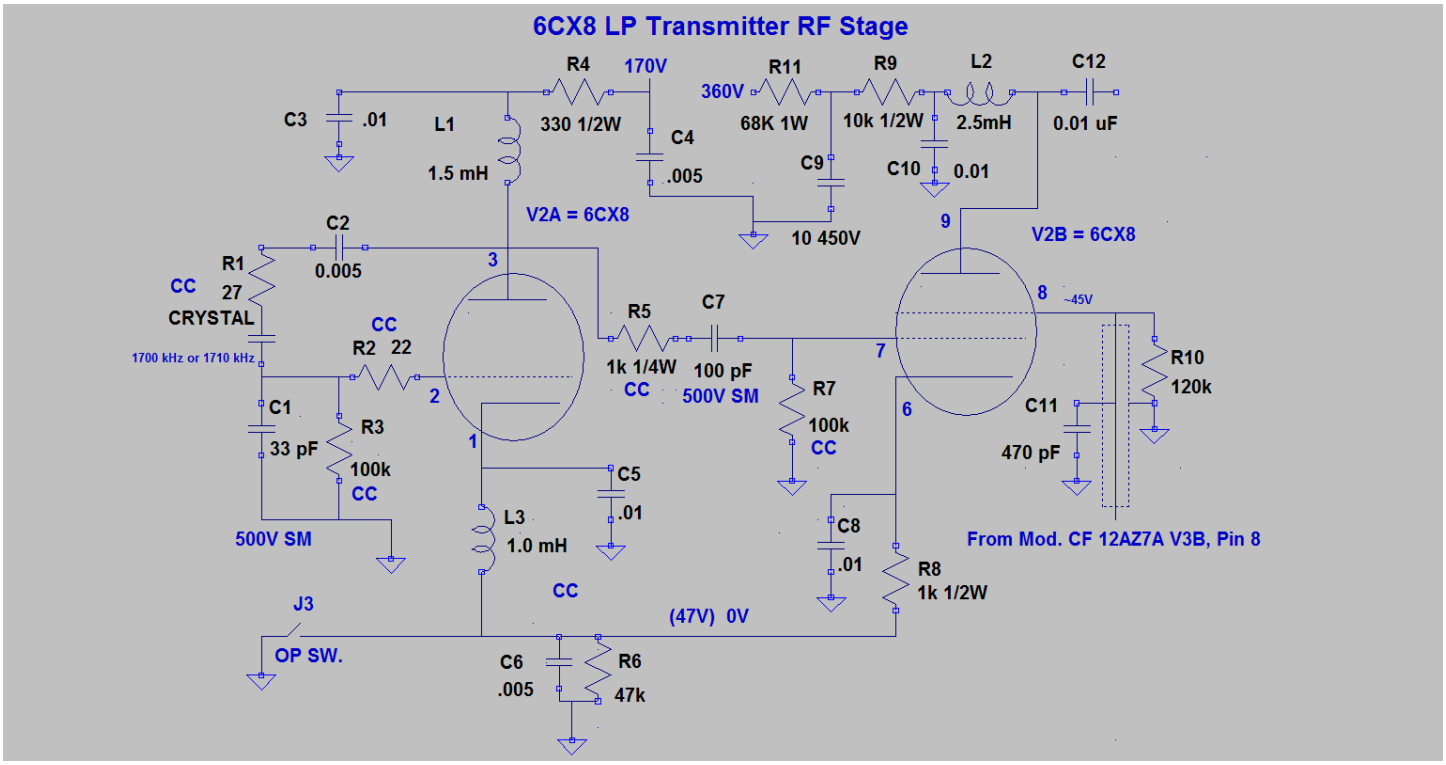
Disclaimer: This circuit is for educational purposes only. Emissions from this device is solely the responsibility of the constructor and operator, and neither the author nor this website takes any responsibility for the use of this circuit. If any questions exist as to Part 15 emission rules, consult: https://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet63/oet63rev.pdf

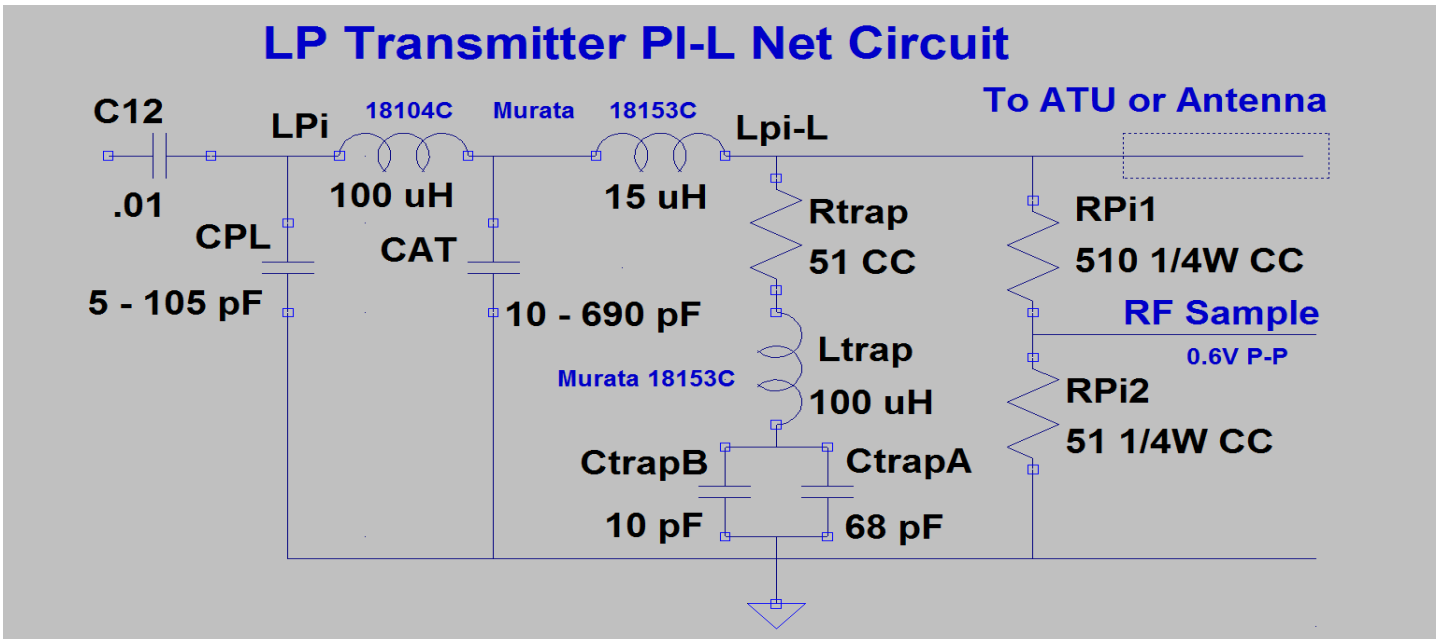

AC0OB LP Transmitter Speech Amplifier
R22
330V
680 1/2W
C5
47
450V
1.35 Meg 1/2W
V1A = 1/2 6EA8, V3A = 1/2 12AZ7, 12AT7 etc., with AF = 60
325V
G ~ = 11
R23
0.2 mA
R13
220k 1/2W
0.8 mA
146V
15V P-P
C8
.01
R18
37.5k 1W
2.5 mA
2 - 75k ||
250V
C9
.01
To Mod.
150V P-P
C6
1 uF 350V
6
V1A
0.01 uF
C7
R15
500k Pot
1
V2A
C1
0.01
J1
R10
10k
1/8W
40V
3
2
C2
100 pF
R11
1 Meg
1/8W
7
C4
.005
R14
150 mV P-P
22k
1/8W
Audio Gain
1V
R12
1k 1/4W
C3
0.22 100V
0.22 uF for 725 Hz Pre
R18
10k
1/8W
R19
10k
1/8W
R20
68 1/8W
R21
68 1/8W
J2
7V
2.5 mA
R18
2.7k 1/2W
Opt.

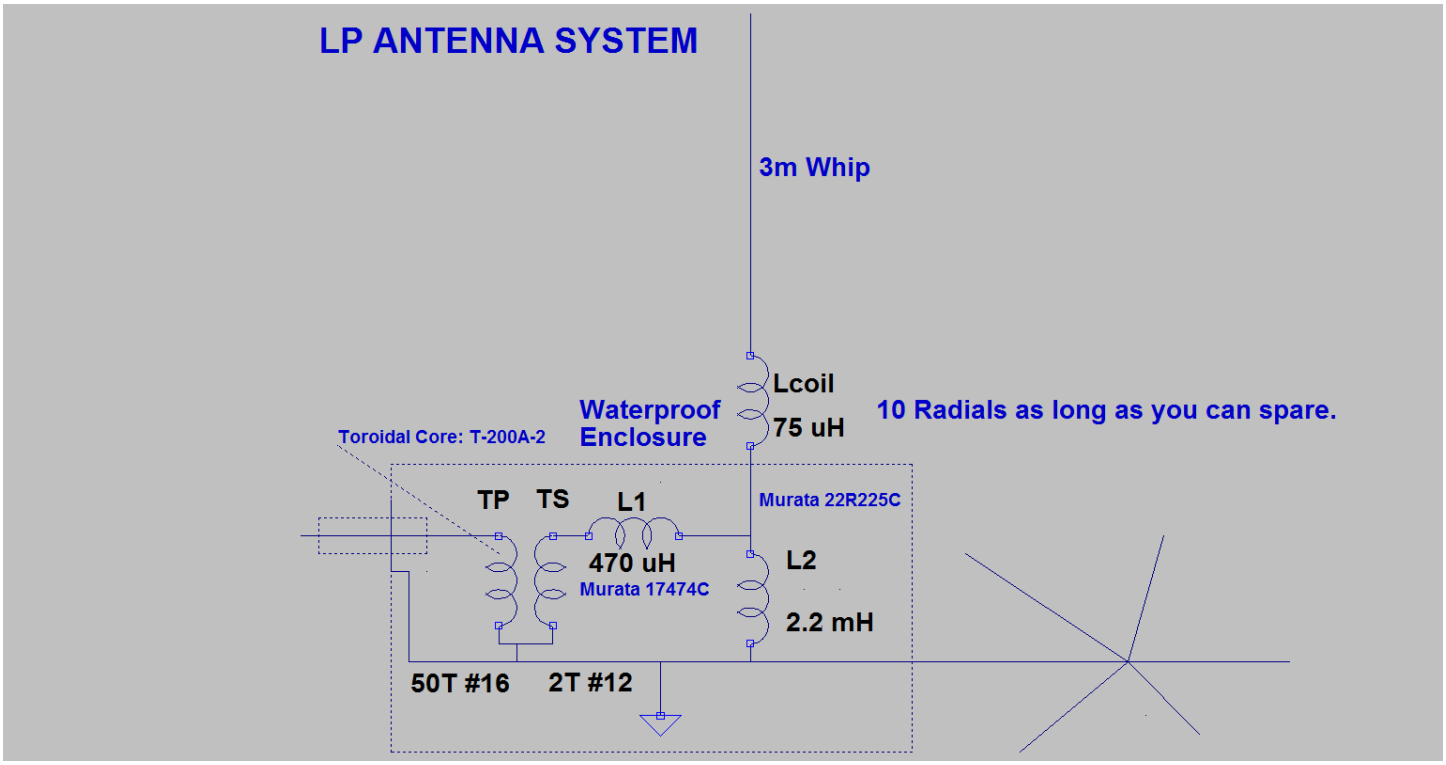

LP Transmitter Speech Amplifier w/6AU6
V1 = 6AU6, V3A = 1/2 12AT7, or Similar with AF = 60
R16
360V
2.2k 1/2W
C11
47
450V
560k 1/2W
R15
0.4 mA
R8
360k 1/2W
Or, 470k || 1.5Meg
340V
C9
.01
R10
24k 1W
7.5 mA
170V
C8
.022
To Mod.
C10
1 uF 160V
R15
270k 1/2W
200V
25V P-P
0.005 uF
C5
5
V1A
1
V3A
R9
1Meg Pot
Audio Gain
C6
0.005
2
6
~ 55V
C1
0.01
J1
R1
10k
1/8W
C2
47 pF
R2
1 Meg
1/8W
C3
0.15
1
7
C4
.005
R14
22k
150 mV P-P
R3
2.2k 1/4W
R13
1Meg
- 1.35V
3
R11
180 1/2W
C7
47
R12
1.8k
R4
10k
1/8W
R5
10k
1/8W
R6
68 1/8W
R7
68 1/8W
J2

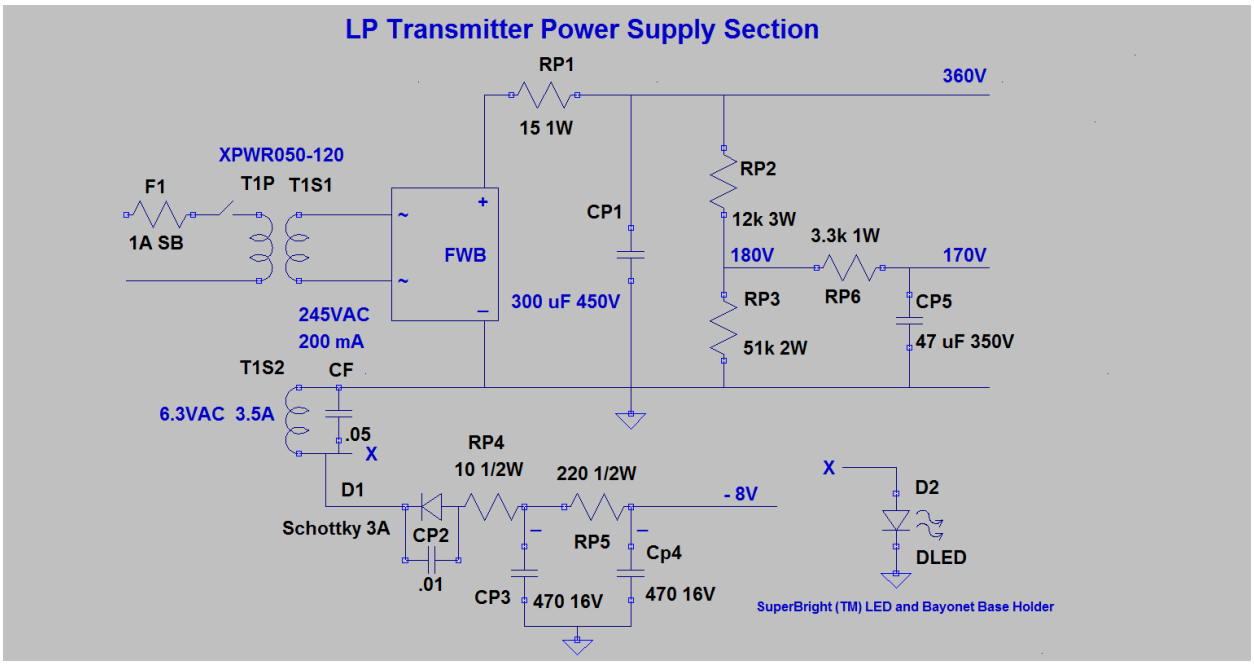
Modulator V3B, 1/2 12AZ7A or Eqv.




6CX8 LP Transmitter RF Stage
R4
170V
R11
R9
L2
C12
360V
C3
.01
L1
330 1/2W
68K 1W
10k 1/2W
2.5mH
0.01 uF
C4
1.5 mH
.005
C9
C10
0.01
V2A = 6CX8
10 450V
9
V2B = 6CX8
C2
0.005
3
R1
27
CC
CRYSTAL
8
~45V
R5
C7
CC
R2 22
1700 kHz or 1710 kHz
1k 1/4W
100 pF
500V SM
R7
R10
120k
7
2
CC
100k
CC
6
C1
C11
33 pF
R3
1
470 pF
100k
CC
C5
.01
500V SM
L3
1.0 mH
C8
.01
From Mod. CF 12AZ7A V3B, Pin 8
R8
1k 1/2W
CC
J3
(47V) 0V
OP SW.
C6
.005
R6
47k


LP Transmitter PI-L Net Circuit
C12
.01
LPi
18104C
Murata
18153C
Lpi-L
To ATU or Antenna
100 uH
15 uH
CPL
5 - 105 pF
CAT
10 - 690 pF
Rtrap
51 CC
RPi1
510 1/4W CC
RF Sample
0.6V P-P
Murata 18153C
Ltrap
100 uH
RPi2
51 1/4W CC
CtrapB
10 pF
CtrapA
68 pF


LP ANTENNA SYSTEM
3m Whip
Lcoil
75 uH
Waterproof
Enclosure
10 Radials as long as you can spare.
Toroidal Core: T-200A-2
TP
TS
L1
Murata 22R225C
470 uH
Murata 17474C
L2
2.2 mH
50T #16
2T #12


LP Transmitter Power Supply Section
RP1
360V
15 1W
XPWR050-120
F1
T1P
T1S1
1A SB
FWB
CP1
RP2
12k 3W
3.3k 1W
180V
170V
300 uF 450V
RP3
RP6
CP5
245VAC
200 mA
51k 2W
47 uF 350V
T1S2
CF
6.3VAC 3.5A
.05
X
RP4
10 1/2W
220 1/2W
- 8V
D1
Schottky 3A
CP2
.01
RP5
Cp4
CP3
470 16V
470 16V
X
D2
DLED
SuperBright (TM) LED and Bayonet Base Holder

Audio Stages on Left, Power Supply in Center, RF section on Right