F5 Turbo V3 Assembly Instruction.

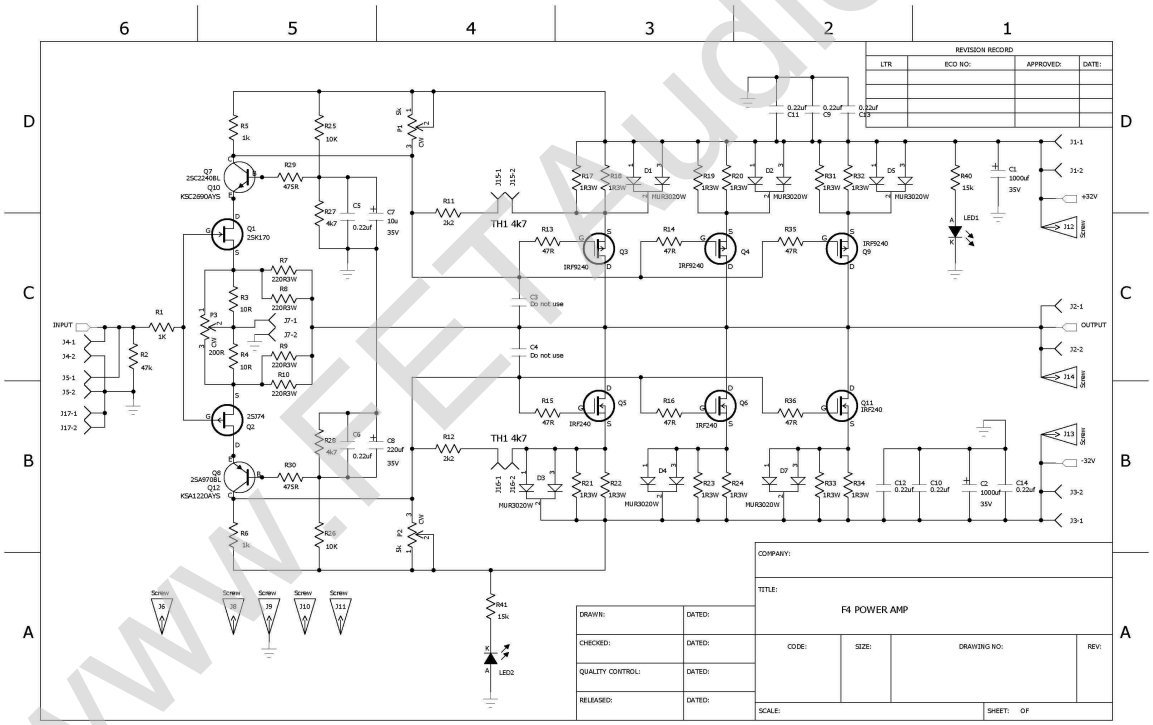
1. Introduction:

This PCB is designed base on the Nelson Pass F5T V3 circuit. Details please refer to the article posted by Nelson on First Watt website: http://www.firstwatt.com/pdf/art_f5_turbo.pdf .

The main difference between this version and Pass F5T V3 is that the PCB only use 3 pairs of power mosfet, not 4 pairs. The main reason is that this version PCB is 100% fit into the F4 PCB that I sold in 2007. Details: http://www.fetaudio.com/archives/33 . Thus this provide a fast upgrade from F4 into F5T without any modification of the heat sink.

2. Circuit Diagram:

Since the PCB is layout by FETAudio and here is the circuit diagram for reference.



Notes:

a. The Q7 and Q8 is in TO-92 package. I have also put TO-220 package pads in the PCB if the original transistors recommended by Nelson are used.

b. J7 is a pin header and it should be shorted to ground by a jumper for normal operation. The "X" point is for those who want to modify the power amp into F5X mode.

c. Since I use Toshiba 2SK1530 and 2SJ201 power Mosfets, I have changed some values of resistors and thus please refer to the update BOM (bill of material) for details.

3. Assembly Instruction:

a. Solder the ¼W resistors per BOM. Note that a gap about 1mm should be allowed between the body of resistor to the top of PCB. This is to prevent any arcing of high voltage from resistors to the ground plan.

b. Solder the 8 pcs film capacitors, 2 pcs LEDs, and 3 VRs. Note that the VRs P1 and P2 should have the same direction of the P3 as shown below.

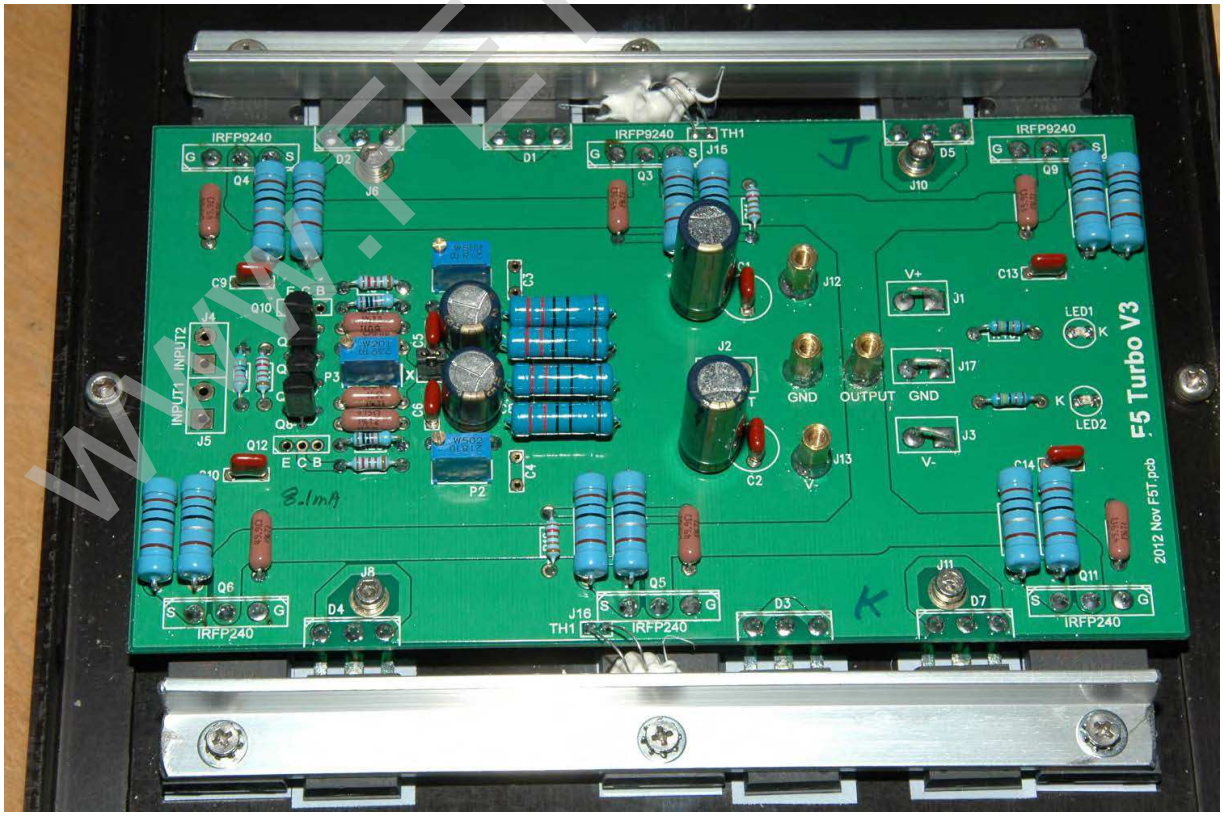
c. Solder the 3W resistors.

d. Solder the Jfets K170 and J74 (Q1 and Q2). Then solder the transistors Q7 and Q8.

e. Lastly solder the E-capacitors.

f. Note that J15 and J16 (TH1) are Thermistor 4k7 (black color). The leads should be insulated by the shrink wrap provided.

g. J6, J8, J10, & J11 are M3 holes mounting for the PCB. Use a M3 x 16mm with 10mm post (stud) on the bottom side to mount the PCB onto the heat sink.



h. Q3, Q4 and Q9 are marked IRF9240, solder 2SJ201 at these locations.

i. Q5, Q6, and Q11 are marked IRF240, solder 2SK1530 at these locations.

j. D1 – D5 and D7 are MUR3020W locations.

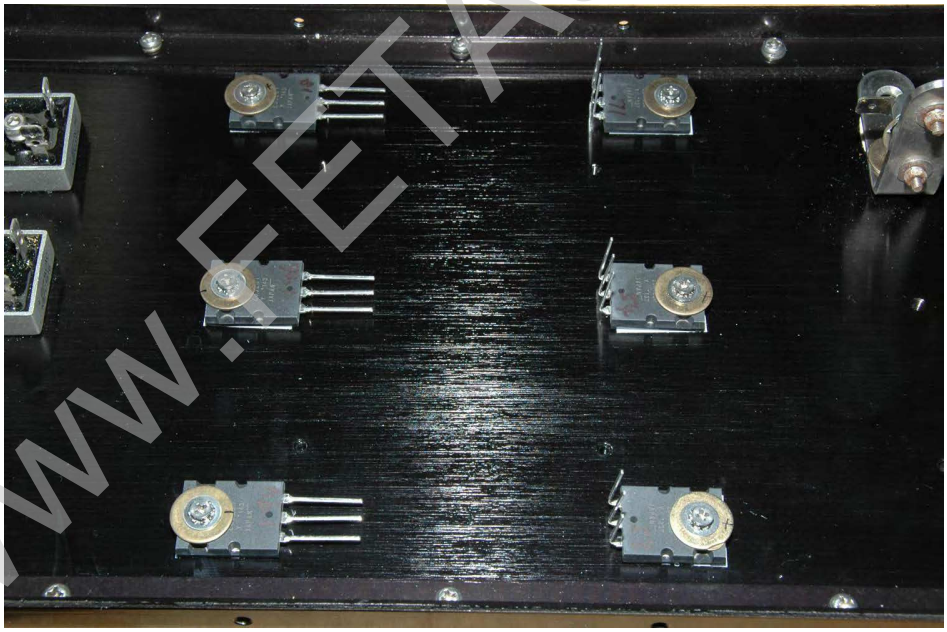
k. When mounting the mosfet and MUR3020W, make sure an insulation thermal sheet is used to isolate the body from the heat sink.

l. The drilling dimensions of the heat sink are provided at the end of this document. A heat sink size of 200mm x 400mm is used as an example.

m. Insert the PCB mounting screws (total 4) from top and screw in a 10mm spacer post at the bottom of the PCB.

n. When mounting the mosfet, fix them onto the heat sink as shown. Bends the leads about 90 deg upwards. Put the PCB on top and then insert all the leads (total 18) into the pad holes of the PCB. It will take a bit time to do so. Press down the PCB and then tighten the 4 PCB screws. Tighten the screws until they are in position.

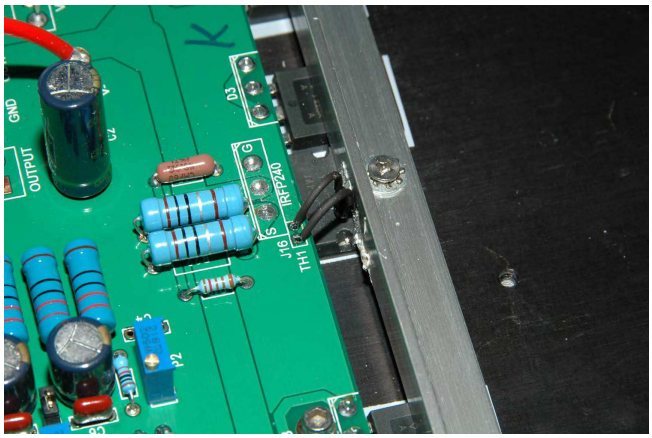
o. Loosen the mosfet mounting screws a bit so that they will release some of the force on the leads. Tighten all the screws of the mosfets again.



p. Note that the MUR3020W should have their leads bended 90 deg also and then inserted into the PCB holes from bottom of the PCB. Do not forget the insulation sheet for them. It should be quite easy to do so as the leads of MUR3020 is just long enough to protrude out the hole by about 1.5mm.

q. When all the PCB screws are in position and tighten, solder all the leads on top. Do not forget to solder the leads of MUR3020W.

r. Note that the thermistor should be mounted as below. The leads must not touch any ground as it carries the +ve or –ve high voltages! Use the shrink tube provided to insulate the leads.

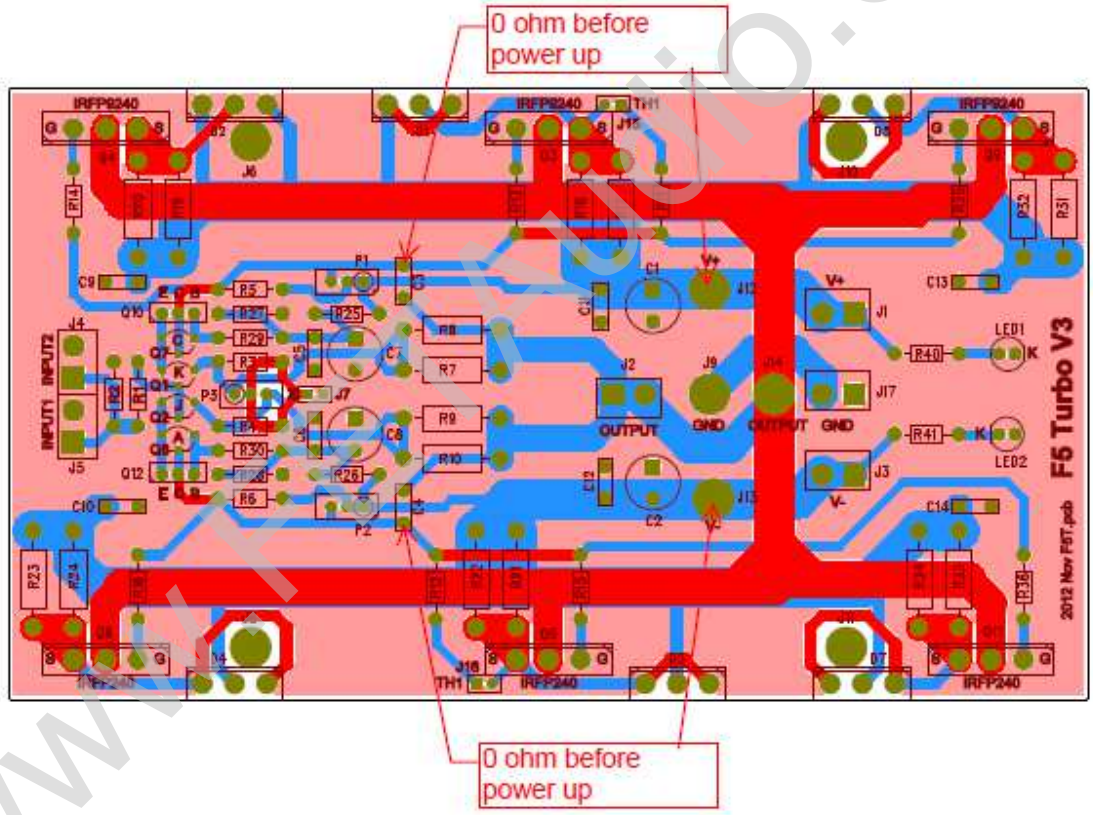


s. Check the +Ve and –Ve point for any short circuit to the ground with a multi-meter. **Note that a ground plan is used in the PCB design with a narrow gap. Thus extreme care must be taken care during soldering of any parts to prevent short circuit to the ground plane.** **Due to the narrow gap, the supply voltage of this PCB should not be more than +/-50V.**

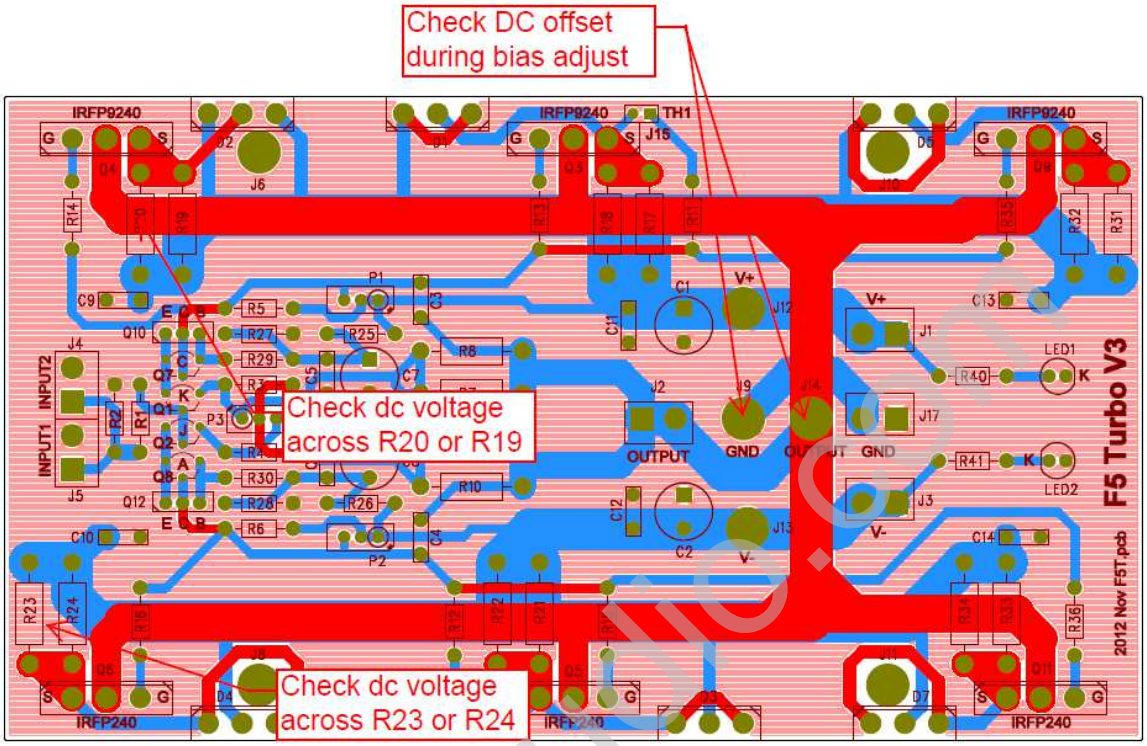
4. Tuning procedures:

a. Before power up, adjust P1 and P2 to fully anti-clockwise if P1 and P2 is same direction as P3 Pot. You will hear a "click" sound upon reaching the end of the tuning. This is a multi-turn pot and thus you will need to adjust many turns.

b. Check the resistance between the points show must be below 1 ohm if P1 and P2 are adjusted correctly.



c. Connect three DC meters at the locations shown.



d. Power up the amplifier, the output DC offset should be close to 0V. Voltage across R20 and R23 should also be 0V. If not, power off the amplifier immediately and trouble shoot.

e. If there is no error, then adjust P1 slowly in clockwise direction until you see the output DC voltage start to increase. Stop at about +100mV. Then adjust P2 in clockwise direction slowly. The DC offset at output will then drop and then stop adjust P2 when at 0V (+/-1mV). Note the voltage drop in R20 and R23. They should be have some readings but no more zero.

f. If you adjust the P2 more than required, the dc offset will go to negative voltage. In that case, turn the P2 anti-clockwise and the voltage will be back to around 0V.

g. Target bias of 1A (for the three pairs of mosfet in total or per channel), then the voltage across R20 and R23 should be 0.167V. If target bias is 2A, then the voltage across the R20 and R23 should be 0.333V. Note that the voltage across R20 and R23 will not be the same but should be close within 10% if the mosfet are well matched.

h. Then repeat the step “e” until the target bias current is reached. **When the voltage across the R20 is more than 0.15V, the output dc offset should only be adjusted to up 50mV to ensure the bias is not increased too fast. When the bias is up to 0.2V across R20, adjust the dc offset to about 10 to 20mV to slow down the bias increment.** In fact when you adjust, the heat sink is cold and thus the bias should only be 80% of the target value. The reason is that when the heat sink is hot, the bias will increase due to thermal drift. Let the

heat sink temperature stable, re-adjust down or up until the target bias is reached. This will take about 1 hrs to stable temperature.

i. Check through the voltage drop across all mosfet source resistors (1 ohm resistors) to see how good the match is. The voltage drop or bias should be within 10% across all the mosfets. This is to ensure that all the mosfet is matched within a reasonable limit and share an almost equal load on the total bias.

j. Note that the DC offset will drift from cold to hot and it is normal. The target is that when hot, the dc offset should be within +/-10mV relative to ground.

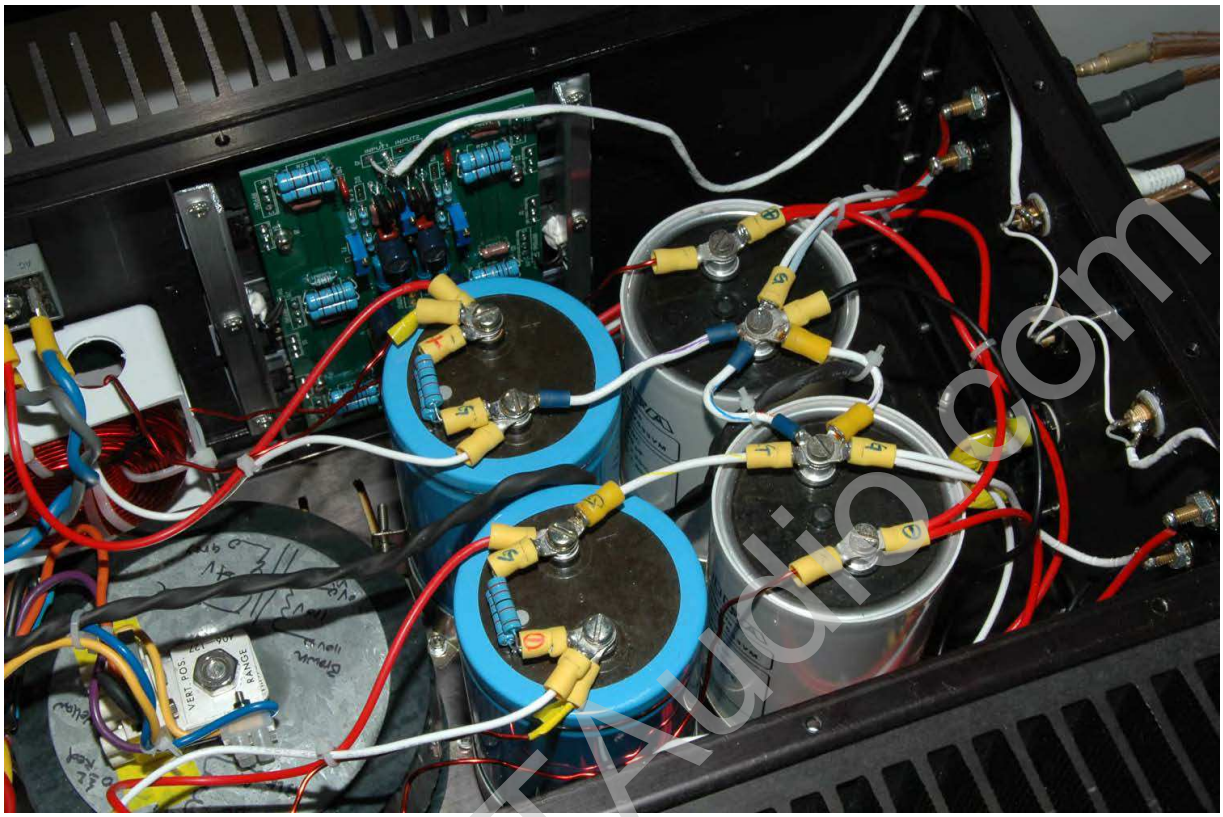
- The R5 and R6 are changed to 475R from 1k ohm. This is to improve the tuning of bias to be less sensitivity. In that case, the output dc offset can be set to below 1mV easily. Moreover, the change will also improve the DC offset drift from cold to warm conditions to be within +/-10mV.

k. Thus adjust the bias value according to the heat sink size used. Target temperature of the heat sink should be below 50 degC.

l. If you do not have 3 meters, then check the output DC offset and voltage across R20. I think two meters is a minimum.

m. For P3 pot adjustment, refer to Pass's article for details.

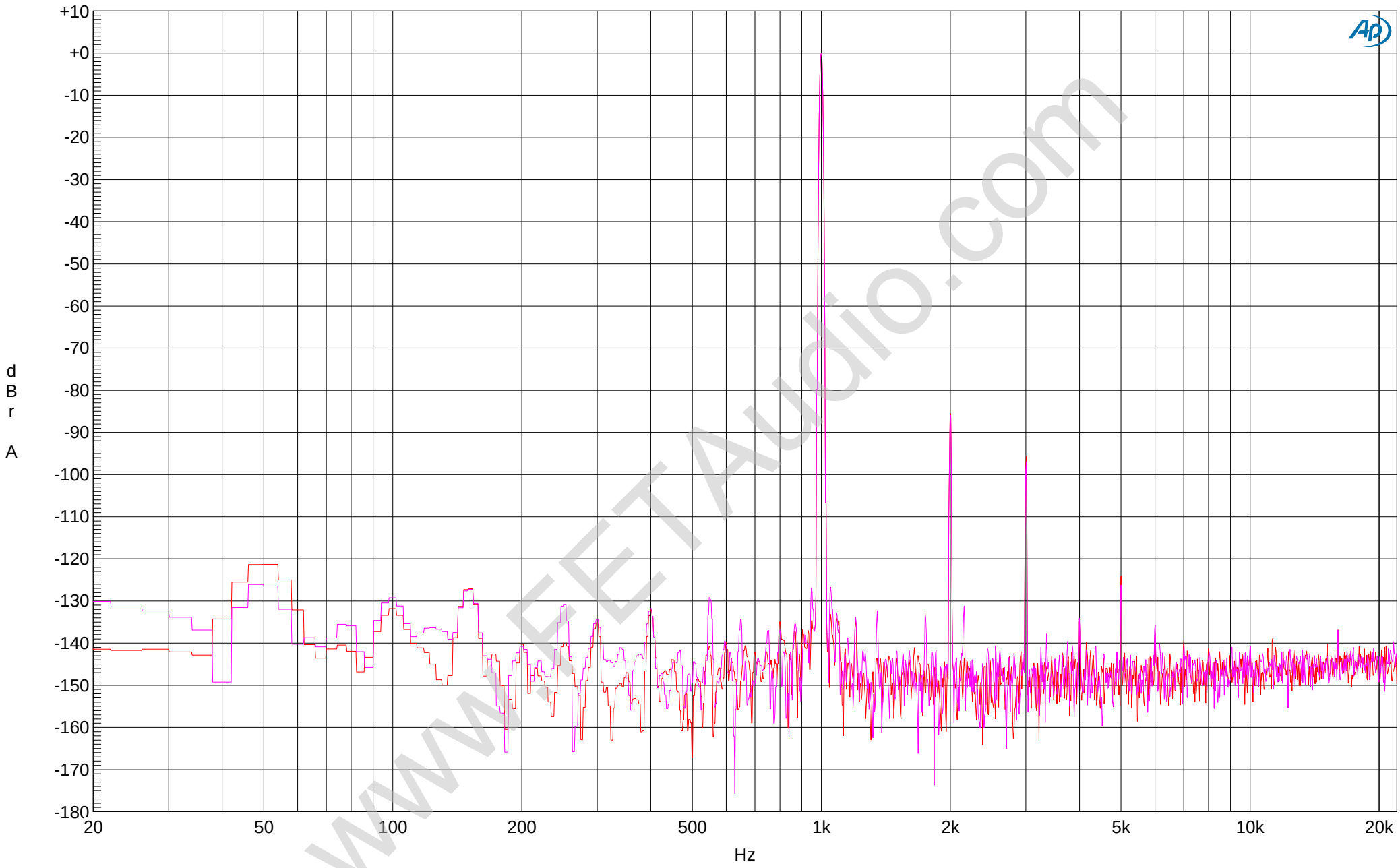
5. Picture of a complete set F5 Turbo:



This set use Airlink 625VA 25Vx2 transformer, Bridge rectifier, 70000uF 50V Mallory, 1mH solen coil, 30000uF 100V Rifa long life. The ripple at the Rifa cap is below 5mV. Bias is set to 1.7A to 1.8A per channel and heat sink temperature is 52 deg C, room temp is 20 deg C. The idle noise level is around 100uV which is very low in the AP measurement. FFT and Distortion vs Power charts are attached in this document for reference. Distortion at 1W 8.2 ohm load is 0.004%.

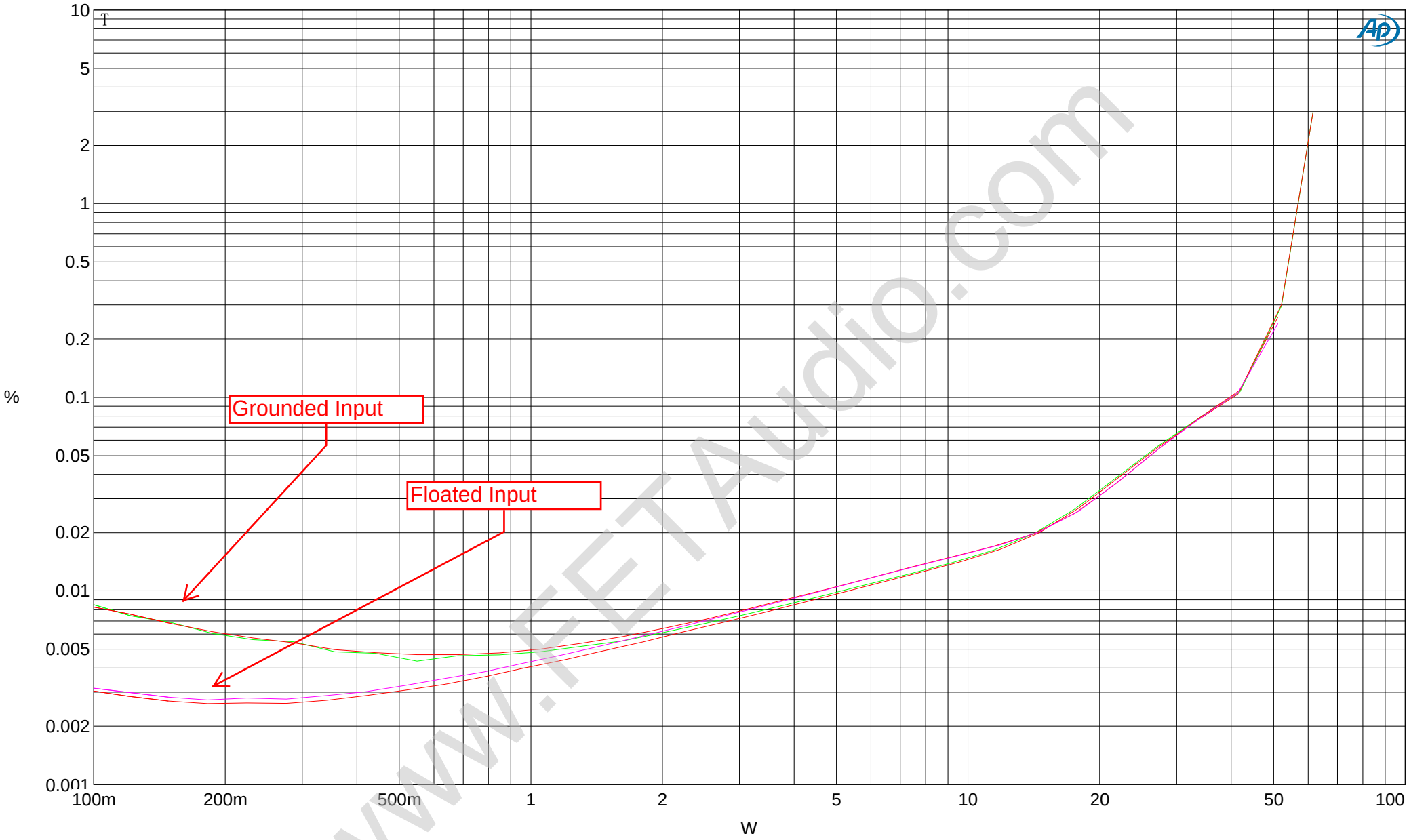
The use of an inductor 1mH air coil (AWG #14 solen) improves the ripple of the power supply by about 20 times. You can see the measurement in attachment page. For this set, the ripple is about 4.5mV peak to peak and the waveform is more rounded like a sine wave. In fact, not only the ripple is improved, the sound is even more relaxing and smooth! Thus this is highly recommended upgrade as the cost to add a 1mH inductor is cheaper than adding one more filter capacitor.

Attachment follows:-



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	1	Fft.Ch.1 Ampl	Left	Set 3 : 32V supply
1	2	Magenta	Solid	1	Fft.Ch.2 Ampl	Left	

F5T FFT2.at27



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	1	Anlr.THD+N Ratio	Left	Float input, lower noise
1	3	Magenta	Solid	1	Anlr.THD+N Ratio	Left	
2	1	Green	Solid	1	Anlr.THD+N Ratio	Left	Grounded input, higher noise
2	3	Red	Solid	1	Anlr.THD+N Ratio	Left	

REVISION RECORD			
LTR	ECO NO:	APPROVED:	DATE:

INPUT
J4-1
J4-2
J5-1
J5-2
J17-1
J17-2
R1 1K
R2 47k
P3 200R CW
R3 10R
R4 10R
R5 1k
R6 1k
R7 220R3W
R8 220R3W
R9 220R3W
R10 220R3W
J7-1
J7-2
R25 10K
P1 5k CW
R26 10K
P2 5k CW
R27 4k7
C5 0.22uf
R28 4k7
C6 0.22uf
C7 10u 35V
C8 220uf 35V
R29 475R
R30 475R
Q7 2SC2240BL
Q10 KSC2690AYS
Q8 2SA970BL
Q12 KSA1220AYS
Q1 2SK170
Q2 2SJ74
R11 2k2
R12 2k2
J15-1
J15-2
TH1 4k7
J16-1
J16-2
TH1 4k7
C3 Do not use
C4 Do not use
R13 47R
R14 47R
R15 47R
R16 47R
R35 47R
R36 47R
Q3 IRF9240
Q4 IRF9240
Q5 IRF240
Q6 IRF240
Q9 IRF9240
Q11 IRF240
R17 1R3W
R18 1R3W
R19 1R3W
R20 1R3W
R21 1R3W
R22 1R3W
R23 1R3W
R24 1R3W
R31 1R3W
R32 1R3W
R33 1R3W
R34 1R3W
D1 MUR3020W
D2 MUR3020W
D3 MUR3020W
D4 MUR3020W
D5 MUR3020W
D7 MUR3020W
0.22uf C11
0.22uf C9
0.22uf C13
C12 0.22uf
C10 0.22uf
C2 1000uf 35V
C14 0.22uf
C1 1000uf 35V
R40 15k
LED1
R41 15k
LED2
J1-1
J1-2
+32V
J12 Screw
J2-1
OUTPUT
J2-2
J14 Screw
J13 Screw
-32V
J3-2
J3-1
Screw J6
Screw J8
Screw J9
Screw J10
Screw J11

DRAWN:	DATED:
CHECKED:	DATED:
QUALITY CONTROL:	DATED:
RELEASED:	DATED:

COMPANY:

TITLE: F4 POWER AMP

CODE:	SIZE:	DRAWING NO:	REV:

SCALE: SHEET: OF

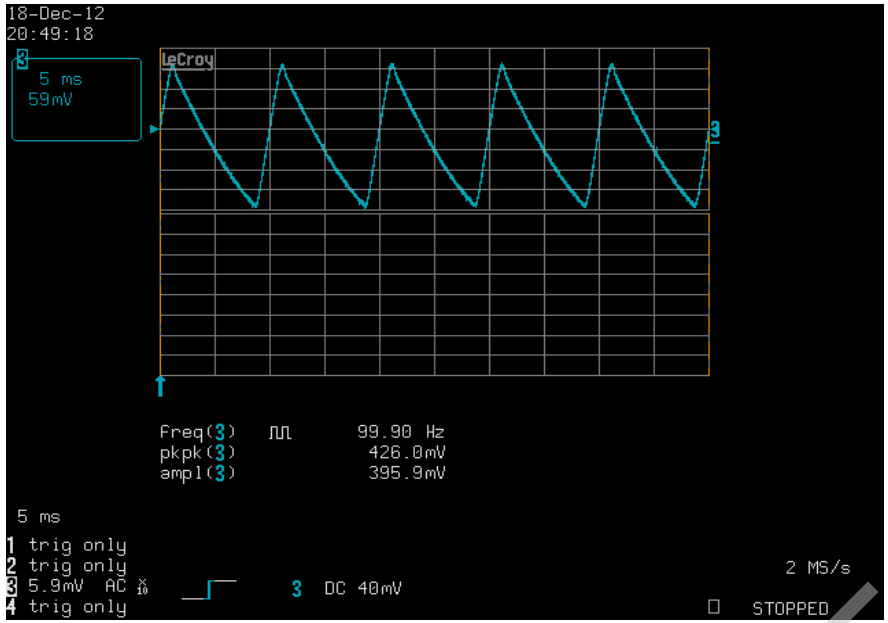
Item	Reference	Value	Manufacturer	Description	Qty	PCB DECAL
1	Q8	2SA1145Y	TOSHIBA	PNP Low Noise PNP Transistor	1	TO-92D
2	Q12	Do not use	Fairchild	PNP Driver Transistor	0	TO-2-8H1AB
3	Q7	2SC2705Y	TOSHIBA	NPN Low Noise NPN Transistor	1	TO-92D
4	Q10	Do not use	Fairchild	NPN Driver TRANSISTOR	0	TO-2-8H1AB
5	Q2	2SJ74BL match	TOSHIBA	P-CHANNEL,LOW NOISE JFET	1	TO-92D
6	Q1	2SK170BL match	Toshiba	N-CHANNEL, LOW NOISE JFET	1	TO-92D
7	C1-2	560uf 35V 5mm	Panasonic FC	ALUMINUM ELECTROLYTIC CAP.	2	ECAP-A-5MM
8	C7-8	220uf 35V 5mm	Panasonic FC	ALUMINUM ELECTROLYTIC CAP.	2	ECAP-A-5MM
9	C5-6 C9-14	0.047uf 50V 5mm	Panasonic ECQ-V	RADIAL FILM CAPACITOR, MKS	8	CK06
10	C3-4	Do not use	CDE	Mica 470pF 500V	0	CK06
11	J7	2x1 pin Header with jumper	China	GENERIC 2 PIN SIP HEADER .100 CENTERS	1	SIP-2P
12	J1-5 J17	Do not use	China	GENERIC 2 PIN SIP HEADER .200 CENTERS (5MM)	6	CONN-2P5MM
13	Q5-6 Q11	2SK1530	TOSHIBA	MOSFET N CHANN POWER 200V 1.8A	3	TO-247_F4AB
14	Q3-4 Q9	2SJ201	TOSHIBA	MOSFET P CHAN 200V 1.8A	3	TO-247_F4AB
15	LED1-2	LED TH	Green	LIGHT EMITTING DIODE	2	LED
16	D1-5 D7	MUR3020W	Vishay	Switch Mode Power Rectifier	6	TO-247_F4
17	J15 J16	4.7k TH1 with shrink tube	China	Varistor negative temp 4k7	2	SIP-2P
18	R25-26	10K	Xicon	RES BODY:060 CENTERS:400	2	RM10_1/4WR
19	R3-4	10R	Xicon	RES BODY:060 CENTERS:400	2	RM10_1/4WR
20	R40-41	15k	Xicon	RES BODY:060 CENTERS:400	2	RM10_1/4WR
21	R1	1K	Xicon	RES BODY:060 CENTERS:400	1	RM10_1/4WR
22	R17-24 R31-34	1R3W	China 1% MF	RES BODY:060 CENTERS:400	12	RM12_5_3WR
23	R5-6	1k to 475R	Xicon	RES BODY:060 CENTERS:400	2	RM10_1/4WR
24	R7-10	220R3W	China 1% MF	RES BODY:060 CENTERS:400	4	RM12_5_3WR
25	R11-12	2k2 to 1.21k	Xicon	RES BODY:060 CENTERS:400	2	RM10_1/4WR
26	R29-30	475R	Xicon	RES BODY:060 CENTERS:400	2	RM10_1/4WR
27	R13-16 R35-36	47R to 49.9R	Xicon	RES BODY:060 CENTERS:400	6	RM10_1/4WR
28	R2	47k	Xicon	RES BODY:060 CENTERS:400	1	RM10_1/4WR
29	R27-28	4k7 to 10k	Xicon	RES BODY:060 CENTERS:400	2	RM10_1/4WR
30	J6 J8-14	Do not use	China	M3 size	8	SCREWM3
31	P3	200R	Bourns 3296W-1	VARIABLE RESISTOR (TOP ADJUST TYPE)	1	VRES-TOP-ADJ
32	P1-2	5k	Bourns 3296W-1	VARIABLE RESISTOR (TOP ADJUST TYPE)	2	VRES-TOP-ADJ
33	PCB-F5T	PCB-F5T	China	PCB-F5T	1	PCB-F5T

Notes:

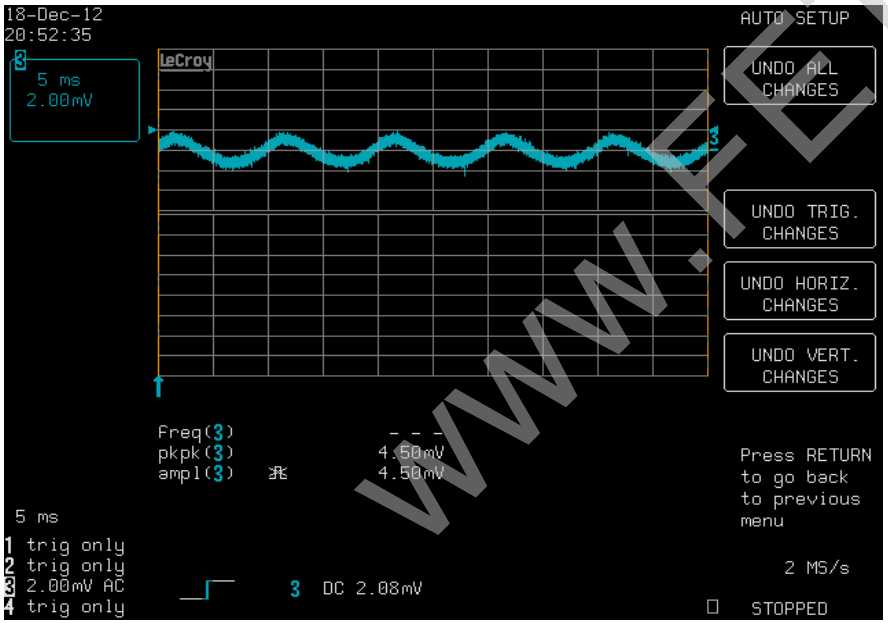
1. Use 1.2k for Toshiba power mosfet - low Vgs; improve thermal stability
2. 4k7 to 10k: 50% Vcc will be on input jfets, good for +/-22V supply
3. 47R to 49.9R; use 49.9R as alternative
4. R5-6 change to 475R, improve bias tuning

CLC filtering

Ripple after rectifier = 426mVpp

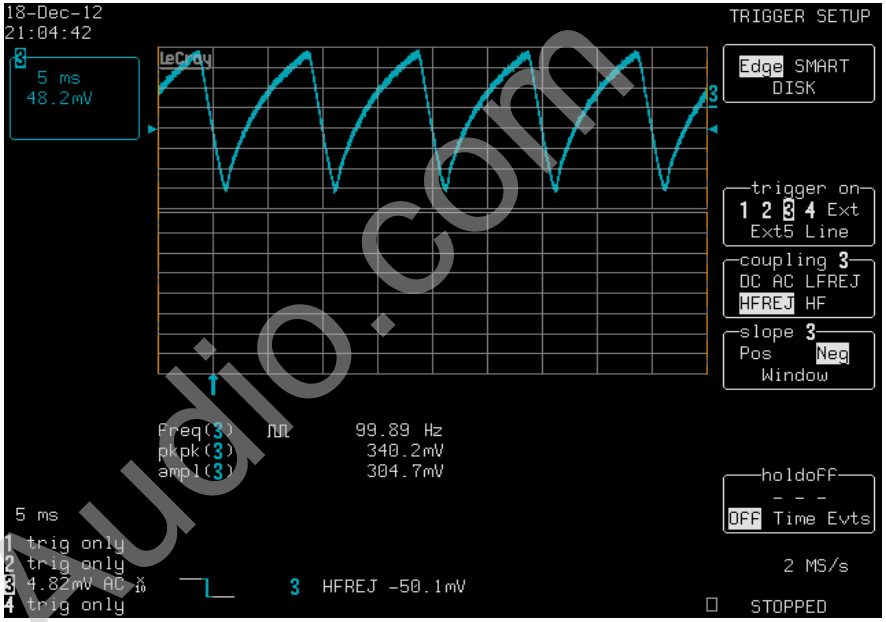


Ripple after 0.47mH coil = 4.5mVpp

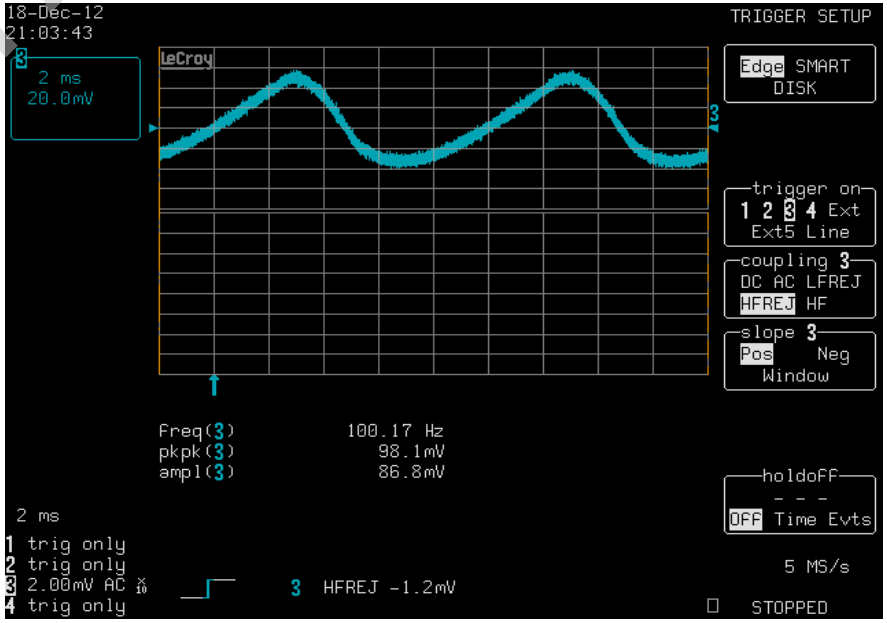


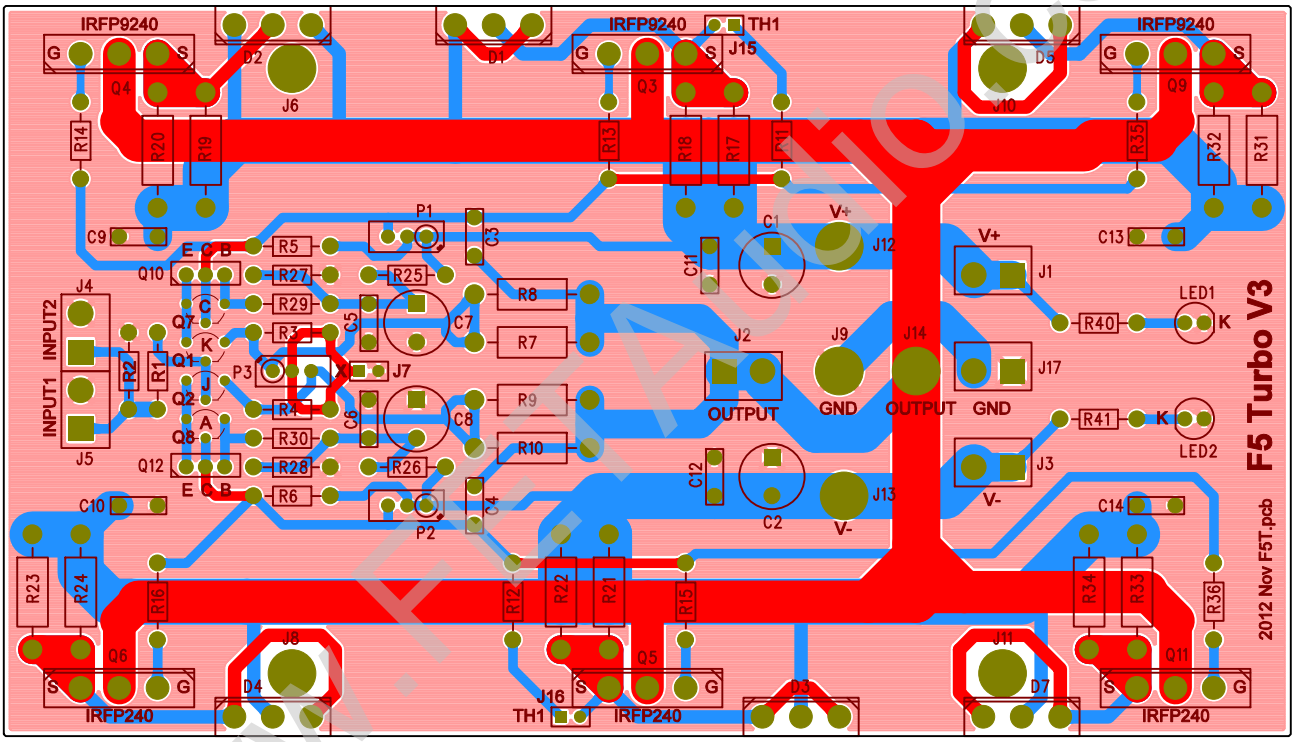
CRC filtering

Ripple after rectifier = 340mVpp

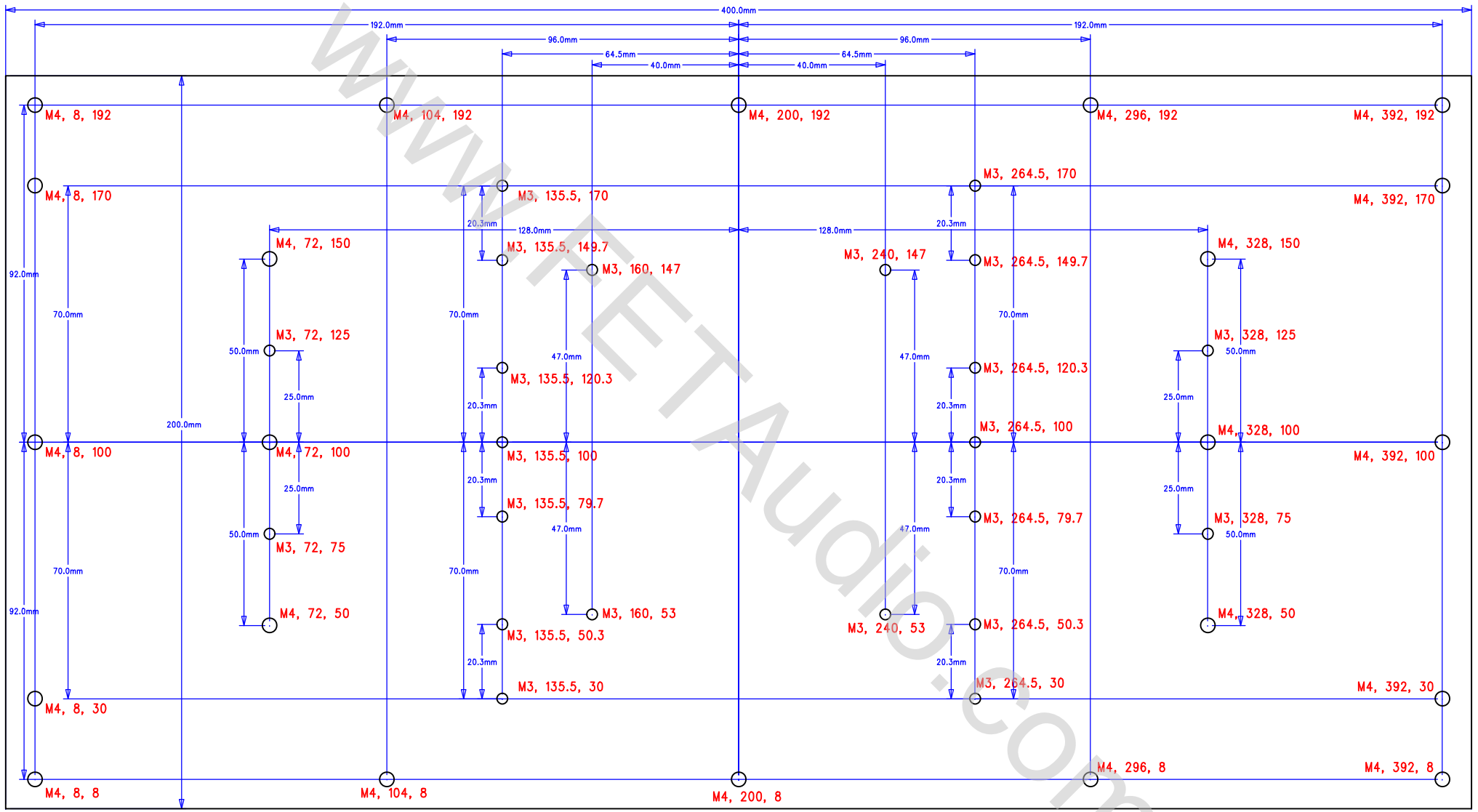


Ripple after Resistor = 98mVpp





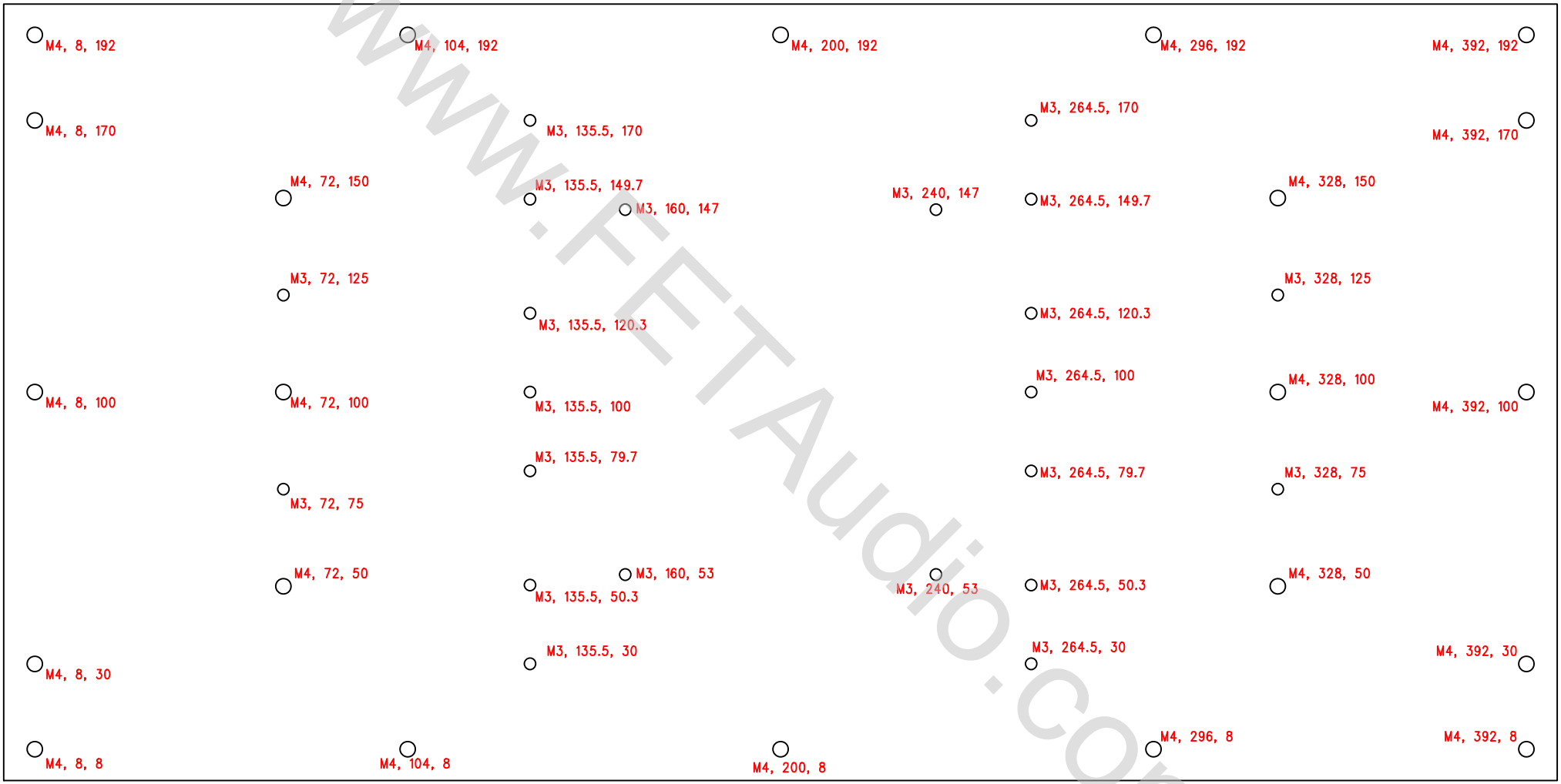
F4b HS400_200_50A-F51.p - Tue Dec 11 11:58:35 2012



Heatsink: **M3 = 6mm depth; M4 = 8mm depth**

Position X,Y=(0,0)

F4b HS400_200_50A-F51.p - Tue Dec 11 12:00:39 2012



Heatsink: **M3 = 6mm depth; M4 = 8mm depth**