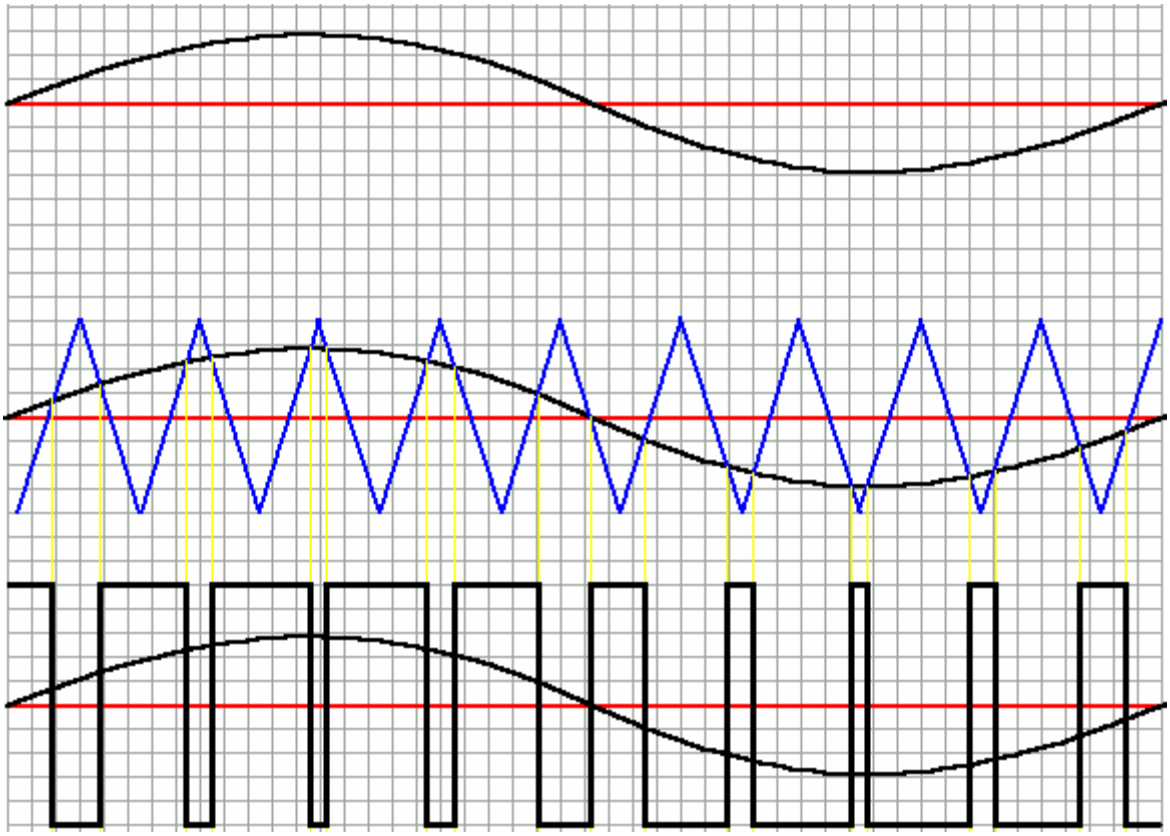
harman consumer group

SERVICE CENTER TRAINING GUIDE

Servicing Class D Amplifiers



And The Theory of Operation

Introduction to Class D Amplifiers

I. A Brief Description of Other Audio Amplifier Classes

Class A

• Class A amplifiers are biased. The signal operates in the linear region between cutoff and saturation.

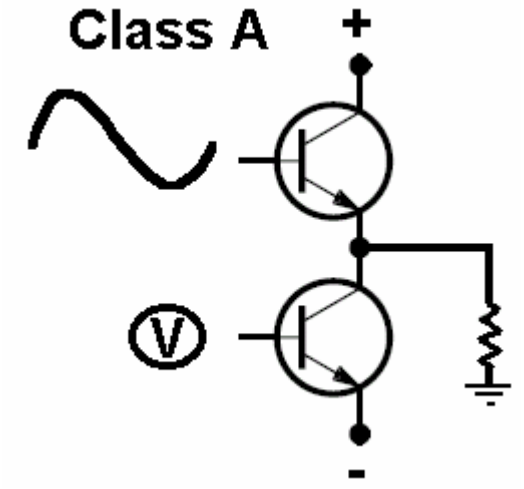
• The output devices conduct continuously, the bias current flows in the output devices at all times.

• In Class A operation, both devices are always on. There is never a time when one output or another is turned off.

• Class A is the most inefficient of all power amplifier designs.

• Class A amplifiers are large, very heavy and run very hot. All of this is due to the amplifier constantly operating at full power.

• Class A designs are the most linear, with the least amount of distortion.



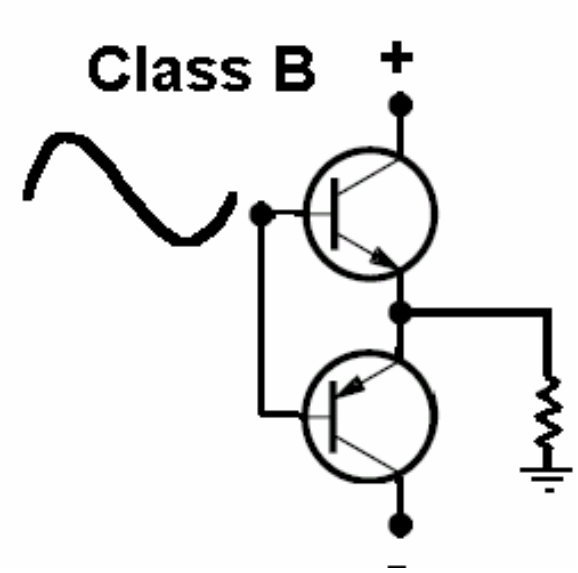
I. A Brief Description of Other Audio Amplifier Classes (cont'd.)

Class B

• Class B operation is the opposite of Class A. Both output devices are never allowed to be on at the same time.

• The output devices have no bias (.6 volts is needed to bias each device).

• Each output device is on for exactly one half of the time. Class B designs have high efficiency but poor linearity; this is due to extreme crossover distortion.



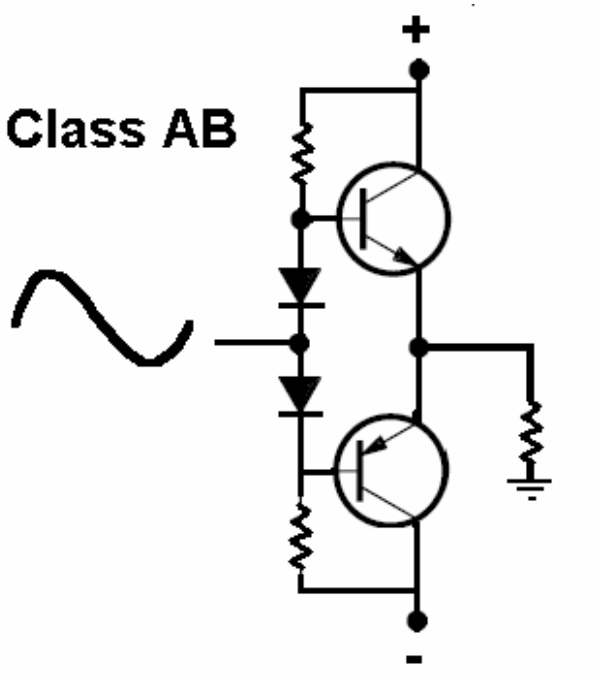
I. A Brief Description of Other Audio Amplifier Classes (cont'd.)

Class A/B

• Class A/B is a combination of Class A and Class B.

• Class A/B operation allows both devices to be on at the same time that the outputs have a bias voltage, so current flows to the output devices more than half of the time but less than the full time of the output wave form.

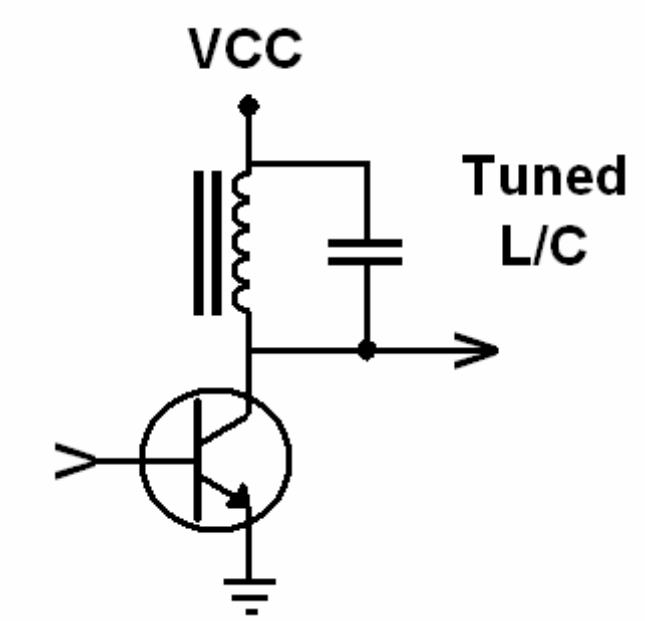
This is called bias, and bias eliminates extreme crossover distortion.



I. A Brief Description of Other Audio Amplifier Classes (cont'd.)

Class C

Class C is used in single frequency RF applications. (Radio)



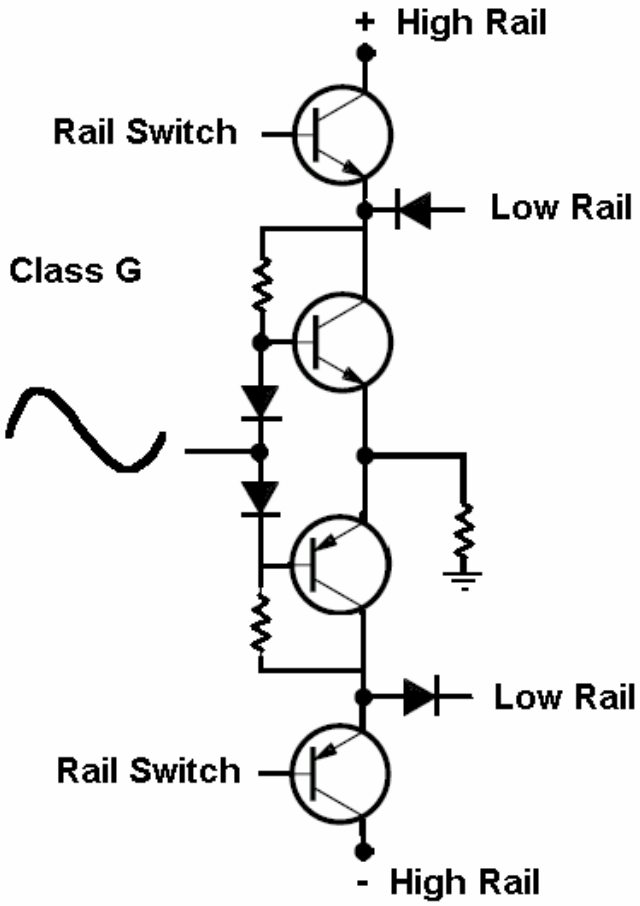
Class F

There are no existing products that use this class of amplifier. (You could be the first!)

I. A Brief Description of Other Audio Amplifier Classes (cont'd.)

Class G

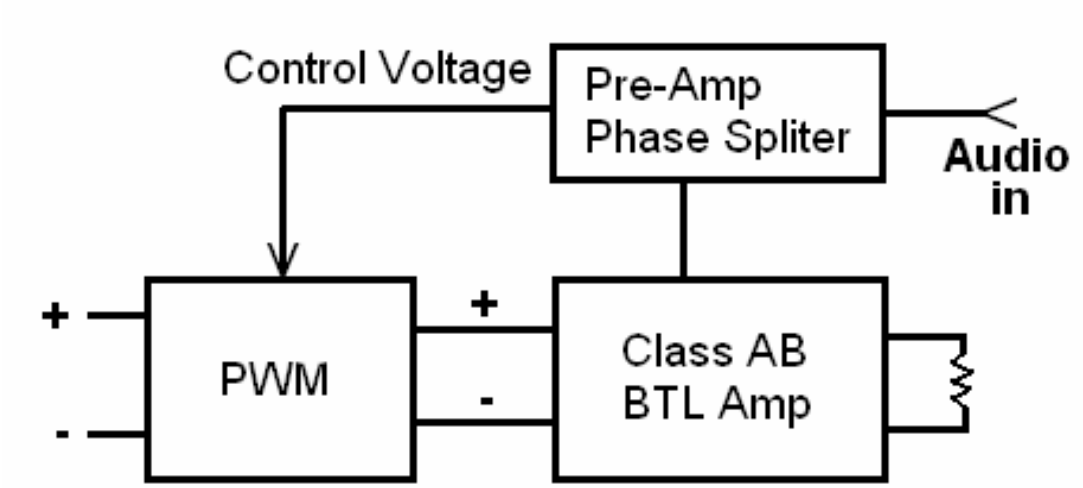
In Class G operation two power supplies' voltages are used. A Class A/B amp is connected to a low voltage rail and a diode transistor matrix. When the signal is greater than the lower voltage rail can supply, a transistor switch connects the output stage to a higher voltage rail. This involves changing the power supply voltage from a lower level to a higher level automatically when a larger output swing is required for large signal peaks.



I. A Brief Description of Other Audio Amplifier Classes (cont'd.)

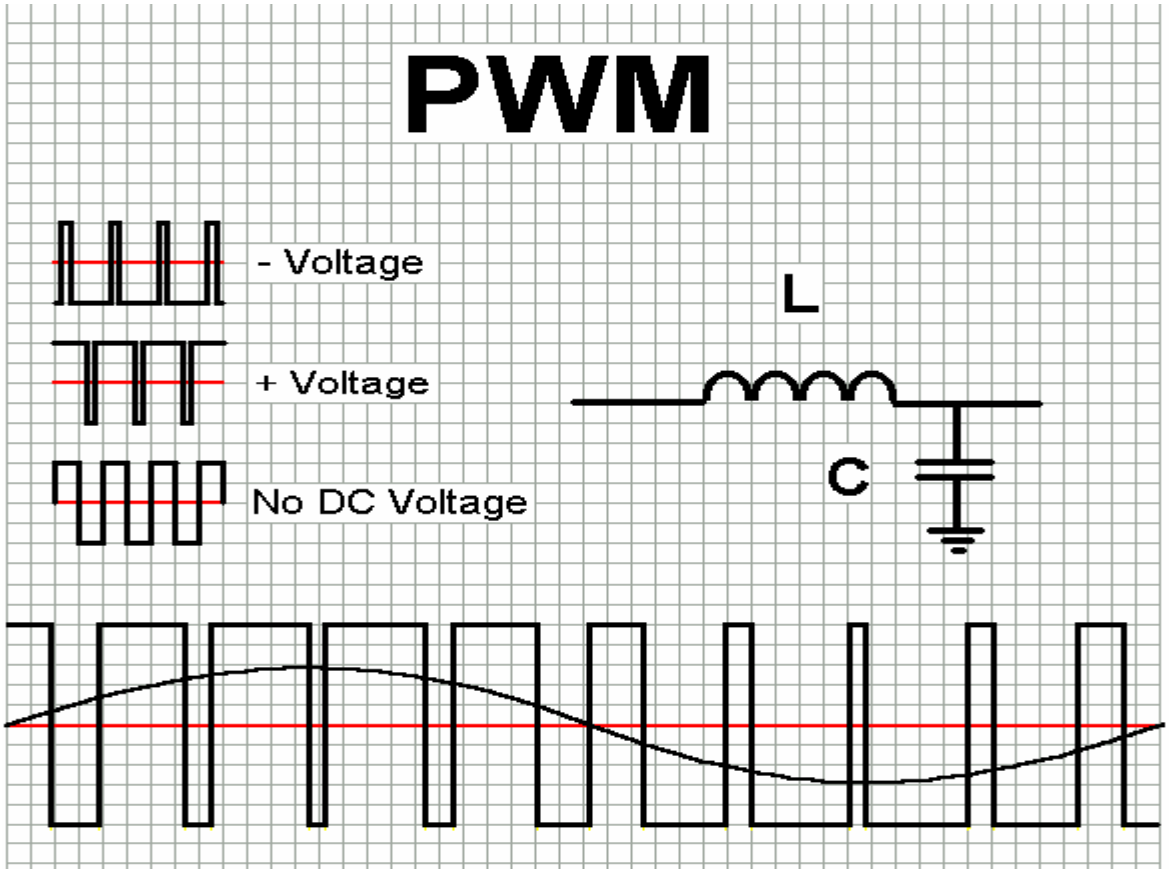
Class H

The Class H design is like the Class G, except that the power supply tracks the audio input signal. This is the same as in the Bash power amps that we use in our amplifiers.



II. What Is Class D Amplification?

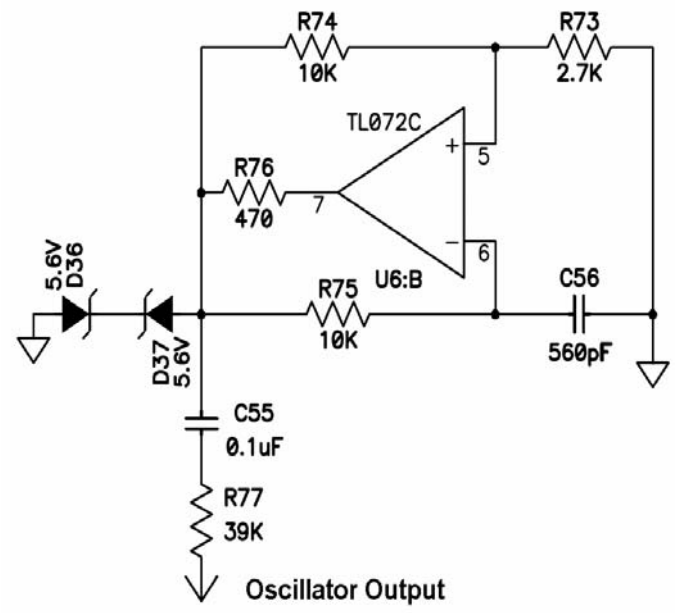
It's a switched mode amplifier using "Pulse Width Modulation," or, PWM.



The output signal is proportional to the ratio of positive and negative of the square wave. Then it is filtered by a low pass filter to remove the high frequency content of the square wave. If the duty cycle is 50% no output from the LC filter will be produced.

If the positive portion of the square is greater than 50% then the output will be a positive voltage from the LC network.
If you modulate the square wave the output will vary proportionally to the modulated signal.

II. What Is Class D Amplification? (cont'd.)



The output of the oscillator to the input of the opamp U6:A is a ramp waveform.

The input signal is modulated with a much higher fixed frequency. The waveform of the fixed frequency is a saw-tooth signal formed from the 100khz ramp generator.

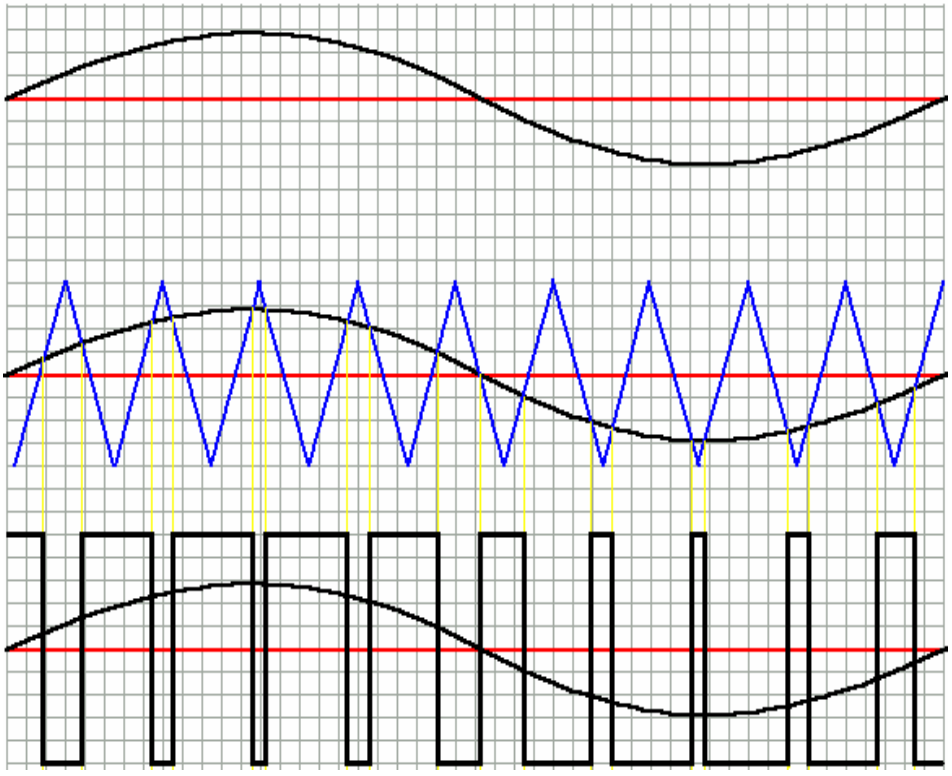


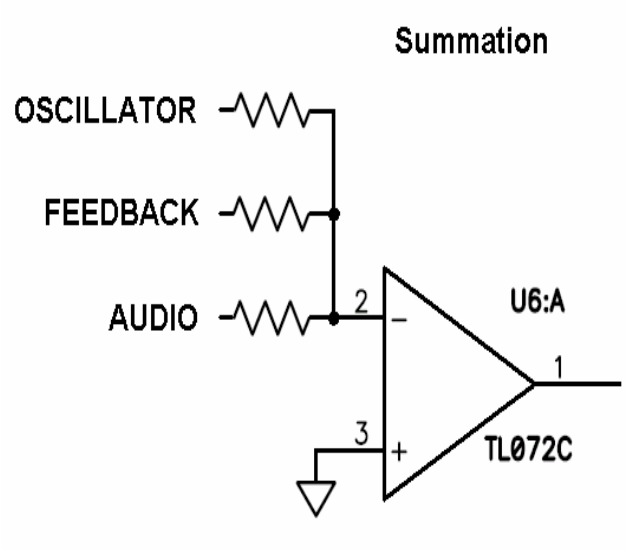
Fig. A

Fig. B

Fig. C

II. What Is Class D Amplification? (cont'd.)

Class D Modulation is obtained by using an opamp as a summer to achieve PWM.

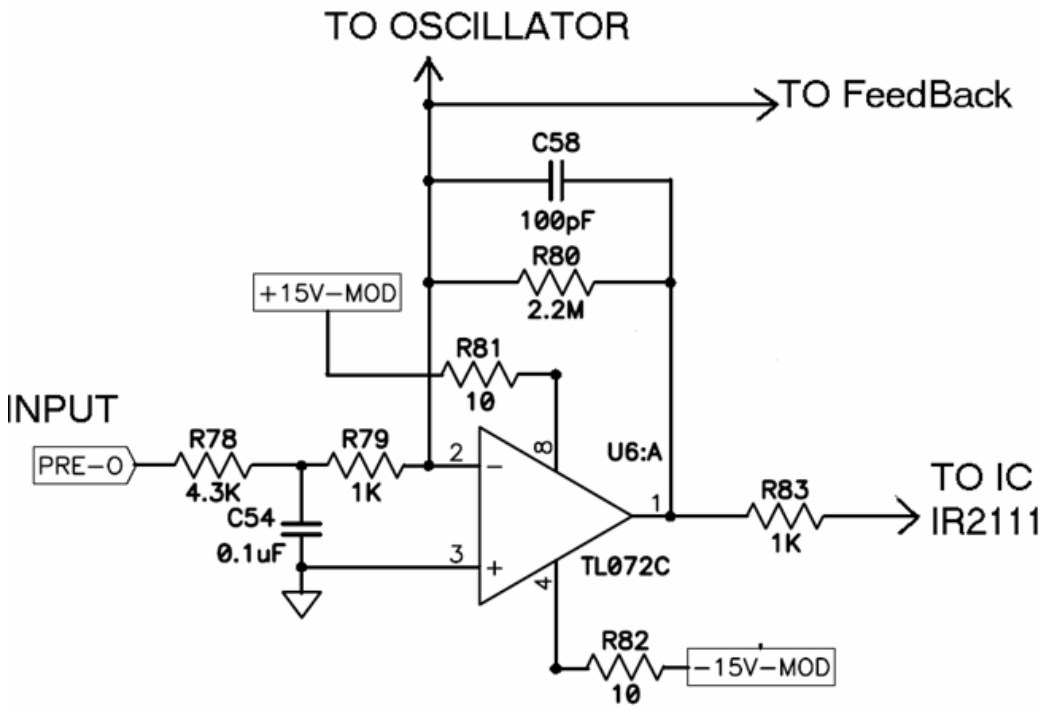


On our Class D Amps
the oscillator, feedback and audio all feed into one input of the opamp.

The result is a summation of all the signals at pin 2 of IC U6 with a result of a square wave out at pin 1 of U6.

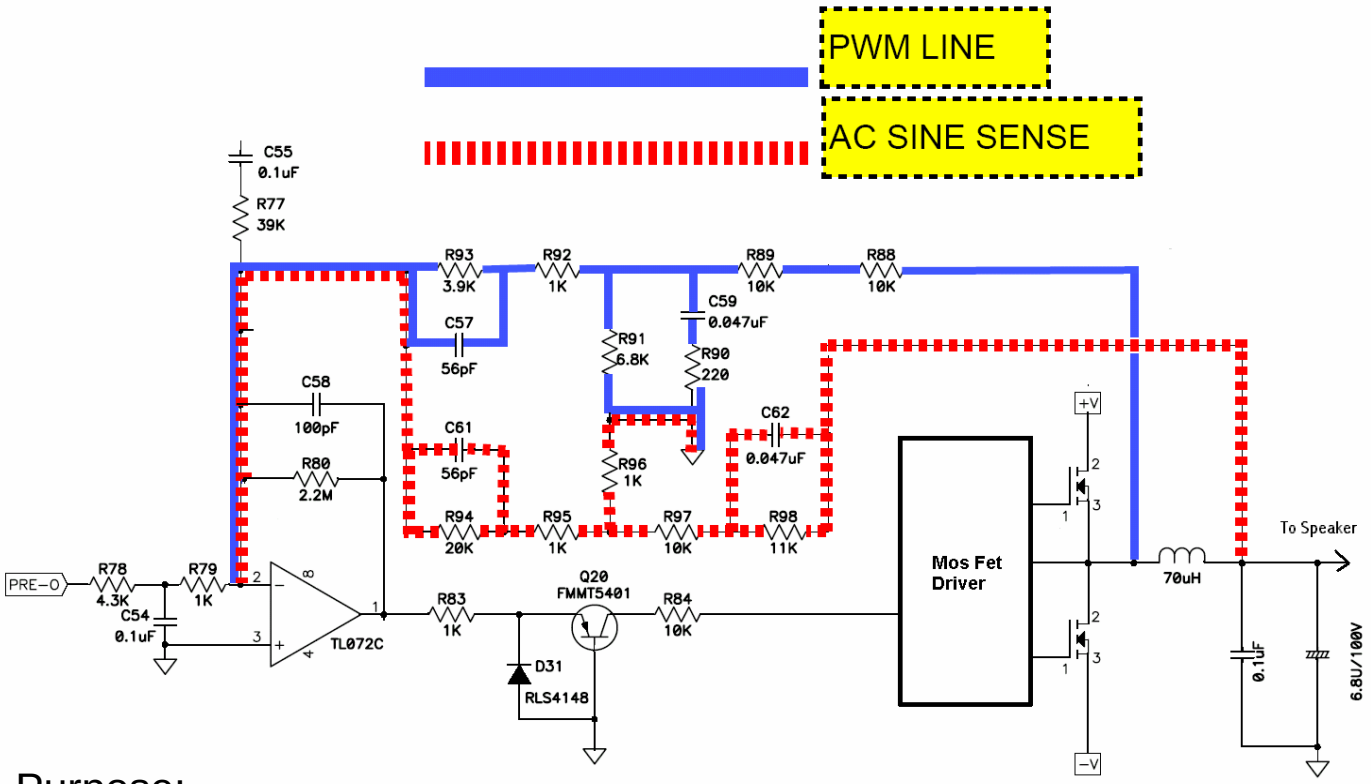
Note: The opamps gain is very high due to 2.2meg feedback resistor R50.

$$Vout = \frac{2.2meg}{1k} Vin$$



II. What Is Class D Amplification? (cont'd.)

Feedback



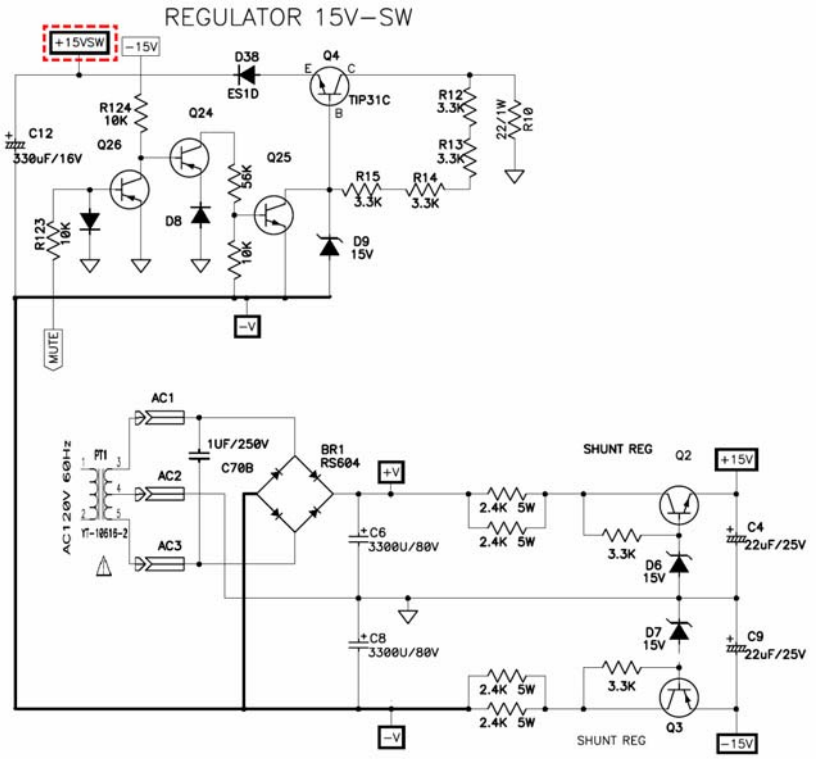
Purpose:

• To compensate for nonlinearities either in the amplifier stage or the load with the end purpose of reducing distortion.

• We use two feedback paths for our design; the main one is before the output inductor (L3 on most amps). It consists of a low pass filter to remove the carrier and reconstruct the modulated audio signal. This signal is fed to amplifier U6.

• The second feedback path we will call the AC sine sense, and it's taken after the low pass filter. This is a minor feedback and is used for additional stability.

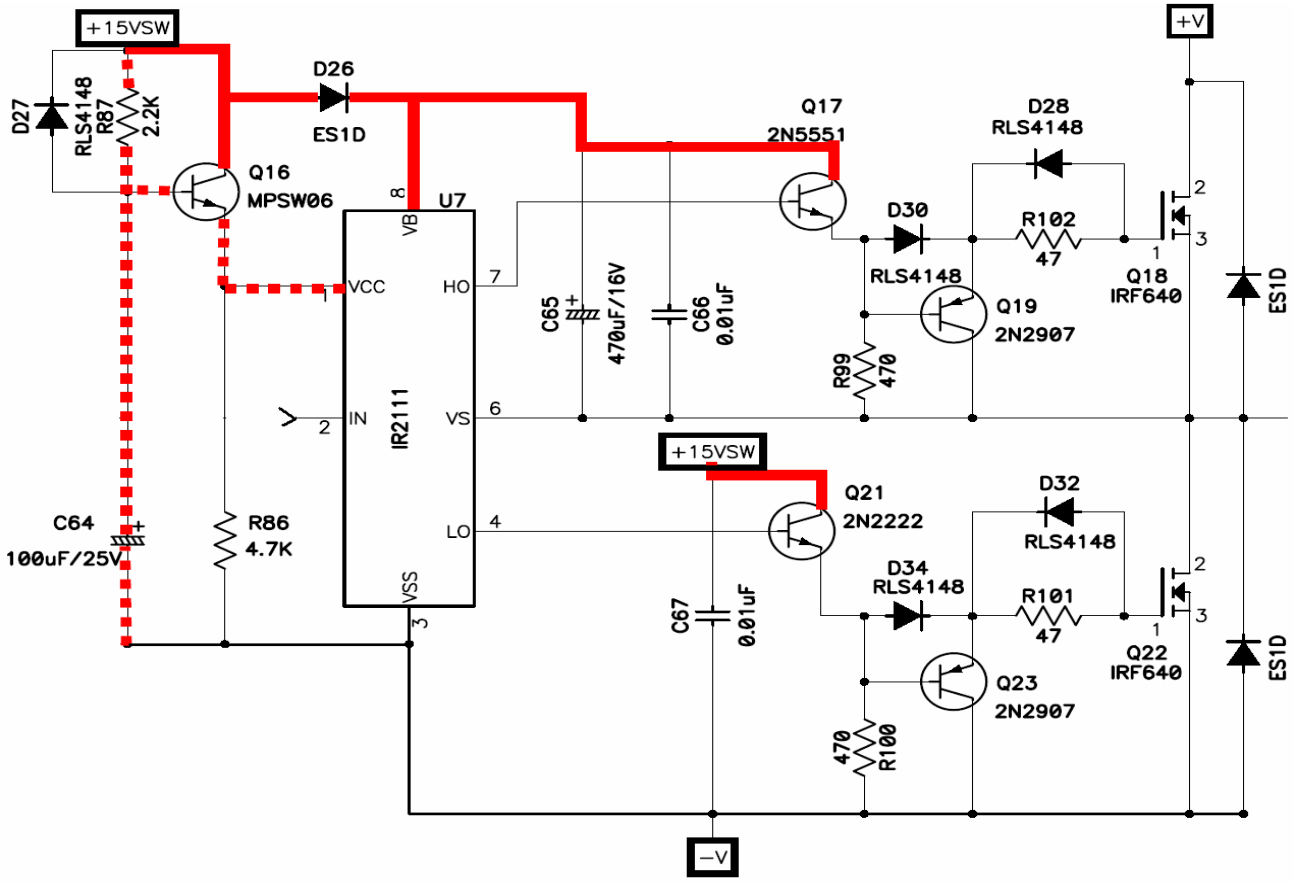
II. What Is Class D Amplification? (cont'd.)



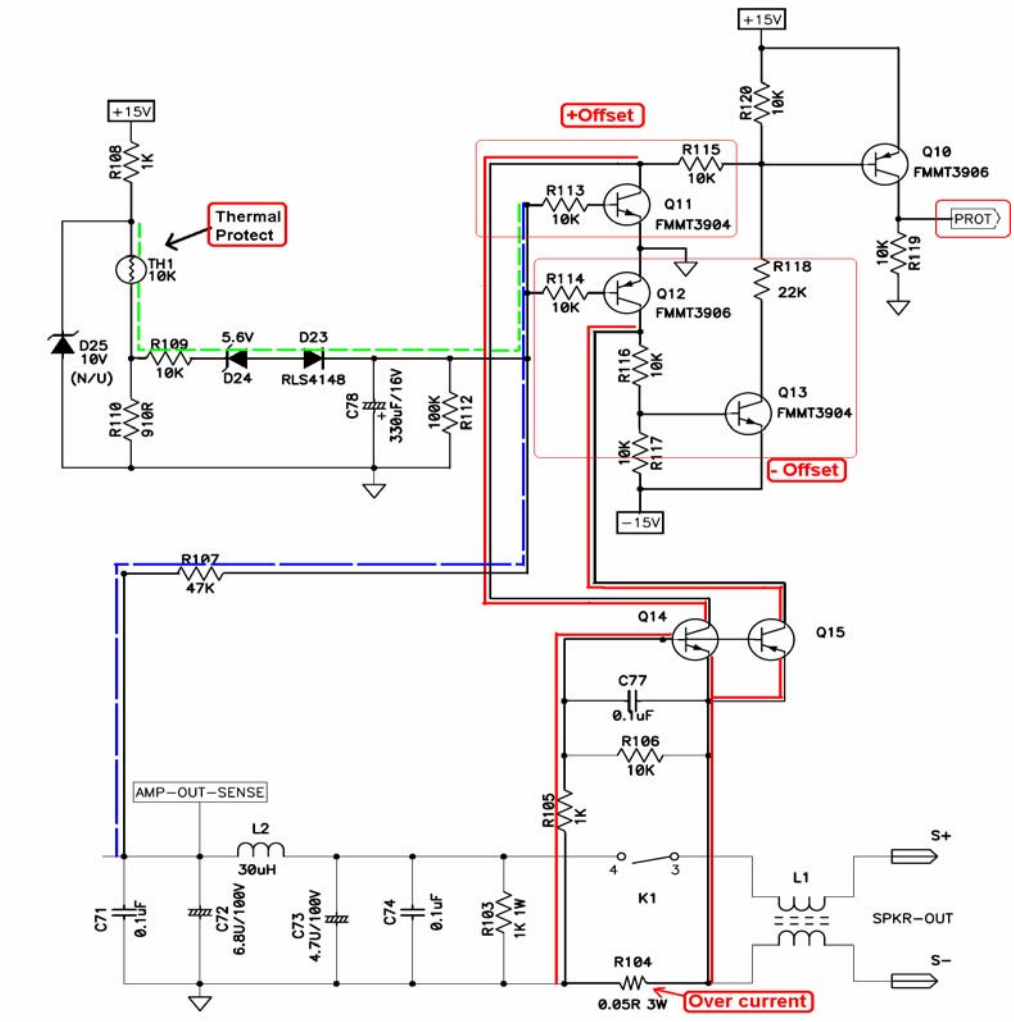
+15VSW is referenced from **–V**, **not ground**

Always check the +/-15 Volt supply. It is the supply for all of the opamps.

VCC of U7 (IR2111) is delayed at turn on (mute release). U7 is the drive that insures that the mosfets never turn on at the same time.



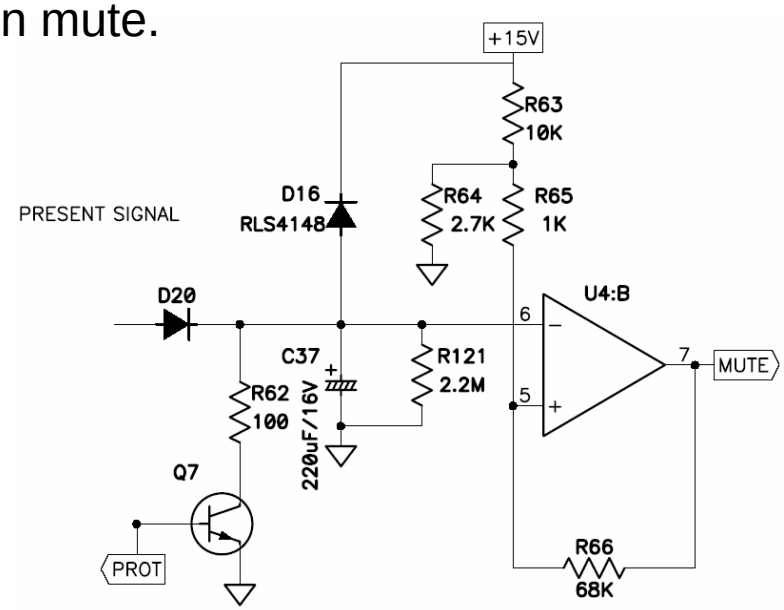
II. What Is Class D Amplification? (cont'd.)



Protect only
triggers mute

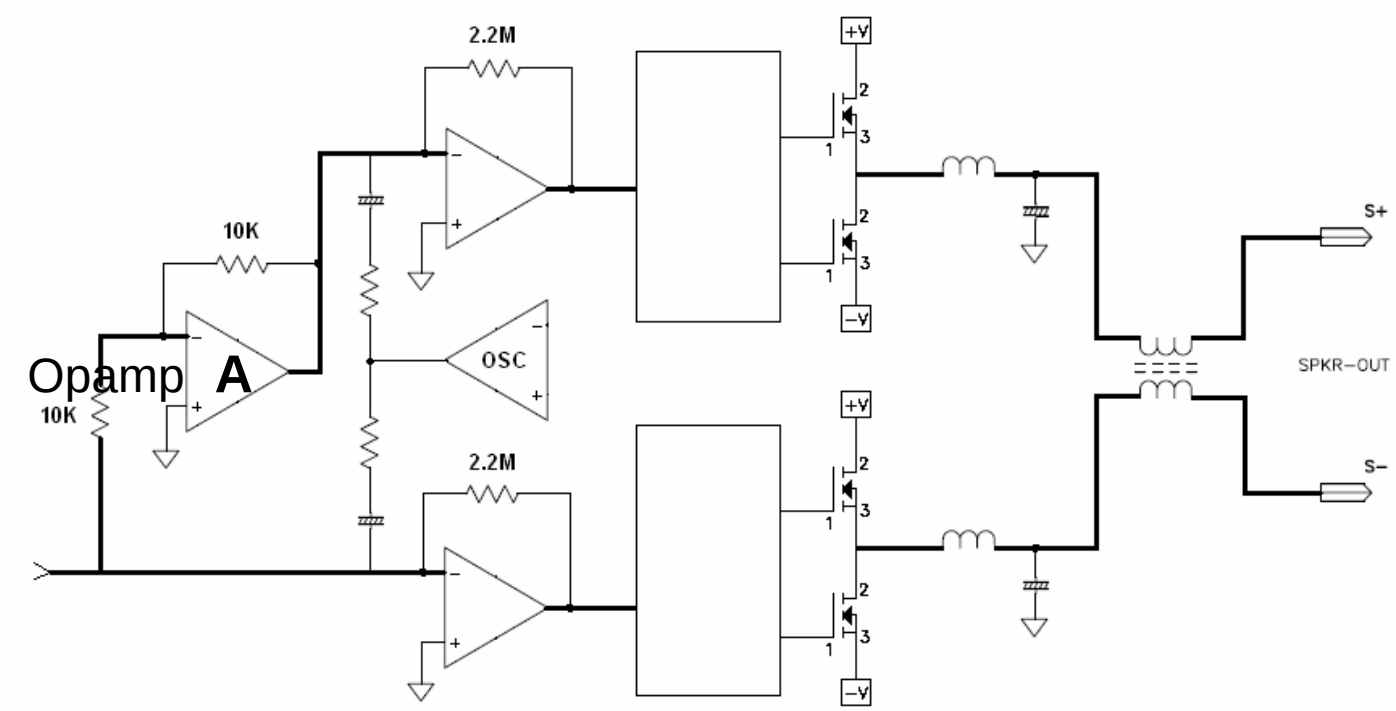
Base of Q10 goes low. Voltage at Q10 goes up, turning on Q7. This then puts the amp in mute.

Remember!
Protection is only
MUTE (standby mode).



II. What Is Class D Amplification? (cont'd.)

BTL Class D



Opamp **A**

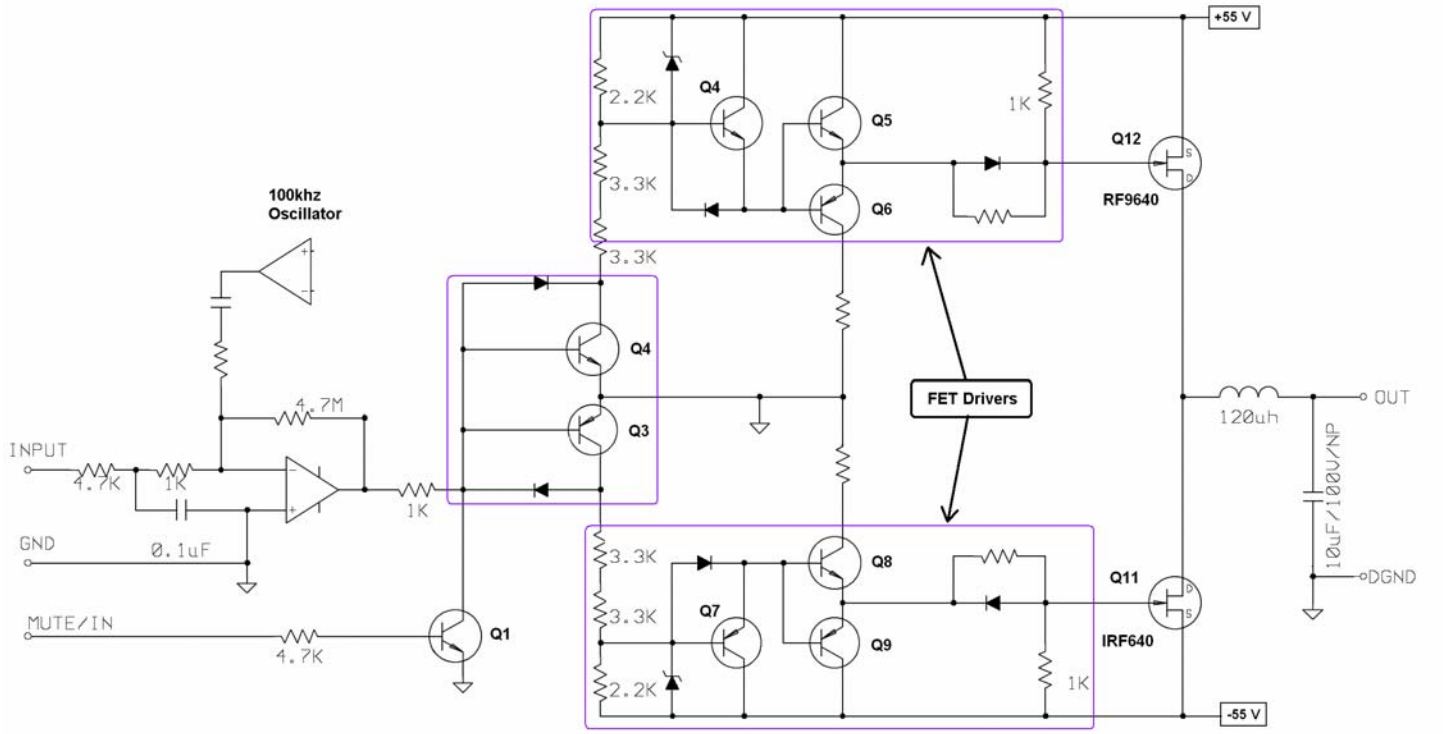
This is the output block of the JBL S120PII. All that was added to the amp was a second FET output stage and opamp A. Opamp A has no gain, and is used for phase inversion of the audio to the 2nd FET output stage.

When servicing this amp, please remember that the speaker out +/- is hot to ground.

Never ground the S-.

II. What Is Class D Amplification? (cont'd.)

Class D Power Amp Harman/Kardon HKTS 10/20



The HKTS10/20 is different from other Class D amps because it uses discrete components for the FET drivers and the output FETs themselves.

The drivers and outputs are Class B amps. They are used to insure that the mosfets never turn on at the same time.

The mosfets are IRF640 and IRF9640. They are built with Schottky diodes inside the FETs. The amps contain inductors (low pass filters) and drive loads with inductance. The diodes will clamp fly-back voltages and clamp waveforms that have overshoot.

Service Bulletin

Service Bulletin JBL2003-06 - April 2003

This is considered a Minor repair

To: All JBL Service Centers

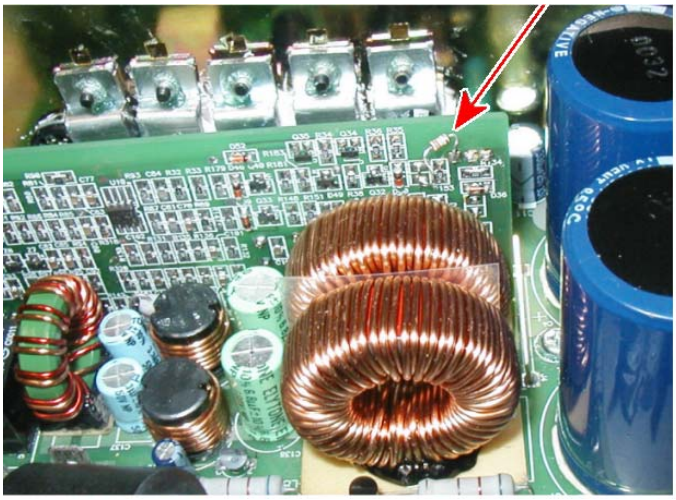
Model: S120PII

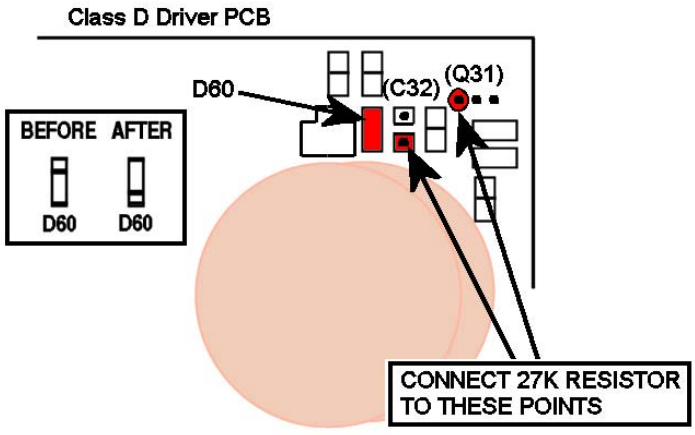
Subject: Distortion When Coming Out Of Standby

In the event you receive an S120PII subwoofer with the complaint "There is a brief chirping sound, or short oscillation that occurs when the unit is in the AUTO mode, in Standby, when it's triggered ON with a music signal", follow the procedure below to correct this condition:

Synopsis: Replace D60 (RLS4148 diode) with a 3.6V Zener Diode; add new Resistor.

1) Remove the amplifier assembly from the subwoofer cabinet (12 Phillips screws).
2) Remove the Plastic Amp Cover from the faceplate (4 Phillips screws).
3) The area of concern is on the Class D Driver PCB (Small Upright PCB on the MAIN AMP PCB). A long, thin, soldering iron tip is recommended. Care must be taken not to damage surrounding components, like large inductor pair L8.
4) Locate, remove D60 (RLS4148 diode); replace with a 3.6V zener diode, JBL Part# ZMM5227BCT-ND. When replacing D60 the polarity of the new (zener) diode should be reversed.
5) Add new 27KΩ resistor, JBL Part# 299-27K, to the indicated connections. (This component, electrically, will be in parallel with R37, reducing its value to <22KΩ). Assure the leads do not come into contact with any other connections; insulate the leads if necessary.
6) Replace amp cover and return amplifer assembly to cabinet.
7) Test the subwoofer to assure the distortion is no longer present.





Infinity

TECH TIPS

Troubleshooting tips and solutions to common service problems

For models: PS-10, PS-12, SUB750 **TIP# INFTT2003-04**

Subject: Replacing MOSFETS Q18, Q22

In the event you need to replace MOSFET transistors Q18 or Q22 as part of a repair, it is important to use ONLY the Infinity part# FE106401110 *or* only the brands: International Rectifier, or Fairchild.

Replace both Q18 and Q22 MOSFET's in the circuit, even if only one seems to be damaged.

Do NOT mix & match these components from different manufacturers, or batches. They should be identical.

DETAILED TROUBLESHOOTING

A. Power Amp Section

Resistance Check	Resistance from S+ (SPK O/P) to GND should be >1M Ω (NO LOAD)
	Resistance from V+ (C6 P+) to V- (C8 P-) gradually Fully CHARGED should read >10k Ω
	Resistance from V+ (C6 P+) to S+ (SPK O/P) should read >1MΩ
	Resistance from V- (C8 P-) to S+ (SPK O/P) should read >1M Ω

2. Power Up LED RED

With a 5mV signal to Low level input, LED should change to GREEN

-Voltage measurements (DVM)

	OP AMP	
LED	P-U4(1)	P-U4(7)
RED	0Vrms	11.84VDC
GREEN	7.13Vrms	-12.93VDC

3. D.C. Operation

-Voltage measurements (DVM) on CLASS D POWER AMP

Between	V+	Q4(E)	Q1(C)	Q10(C)	U7(1)	U7(2)	U7(4)	U7(6)	U7(7)	U7(8)
And This Point	GND	V-	GND	GND	GND	GND	GND	GND	GND	GND
Get this Reading	71.7V	0V	-71.7V	0V	-71.7V	-71.5V	-71.2V	0V	0V	4.65V

4. Check Switching Frequency

- Oscilloscope - **USE THE PROBE TIP TO U6(7) TO GND**
- Reading 100kHz +/-10%,24Vp-p

B. Pre Amp Section

Line Level Input Sensitivity

-Set up Turn level, X'OVER FREQ POT Fully CW and LFE switch off
Generator Set at 200mV@50Hz
Signal to Line level input

DETAILED TROUBLESHOOTING (CONT'D)

- Voltage measurements

OP AMP									SPEAKER
U2(1)	U2(14)	U2(8)	U3(7)	U3(1)	U3(14)	U3(8)	U5(7)	U5(1)	O/P
306.9mV	461mV	460mV	658mV	628mV	598mV	2.326V	2.02V	3.57V	23.33V

2. High Level Input Sensitivity

-Set up Turn level, X'OVER FREQ POT Fully CW and LFE switch off
Set Generator at 1.3V@50Hz
Signal to High level input

-Voltage measurements 15.3V at speaker output

3. Low-Pass

-Set up Set Generator at 200 mV@100Hz
Signal to Line level input
Measure voltage at S+ speaker output

-Voltage measurement

X'OVER FREQ. Setting	Output
CW	14.03V
CCW	4.8V

4. LFE

-Set up Set Generator at 200mV@200Hz
Signal to Line level input
Measure voltage at S+ speaker output

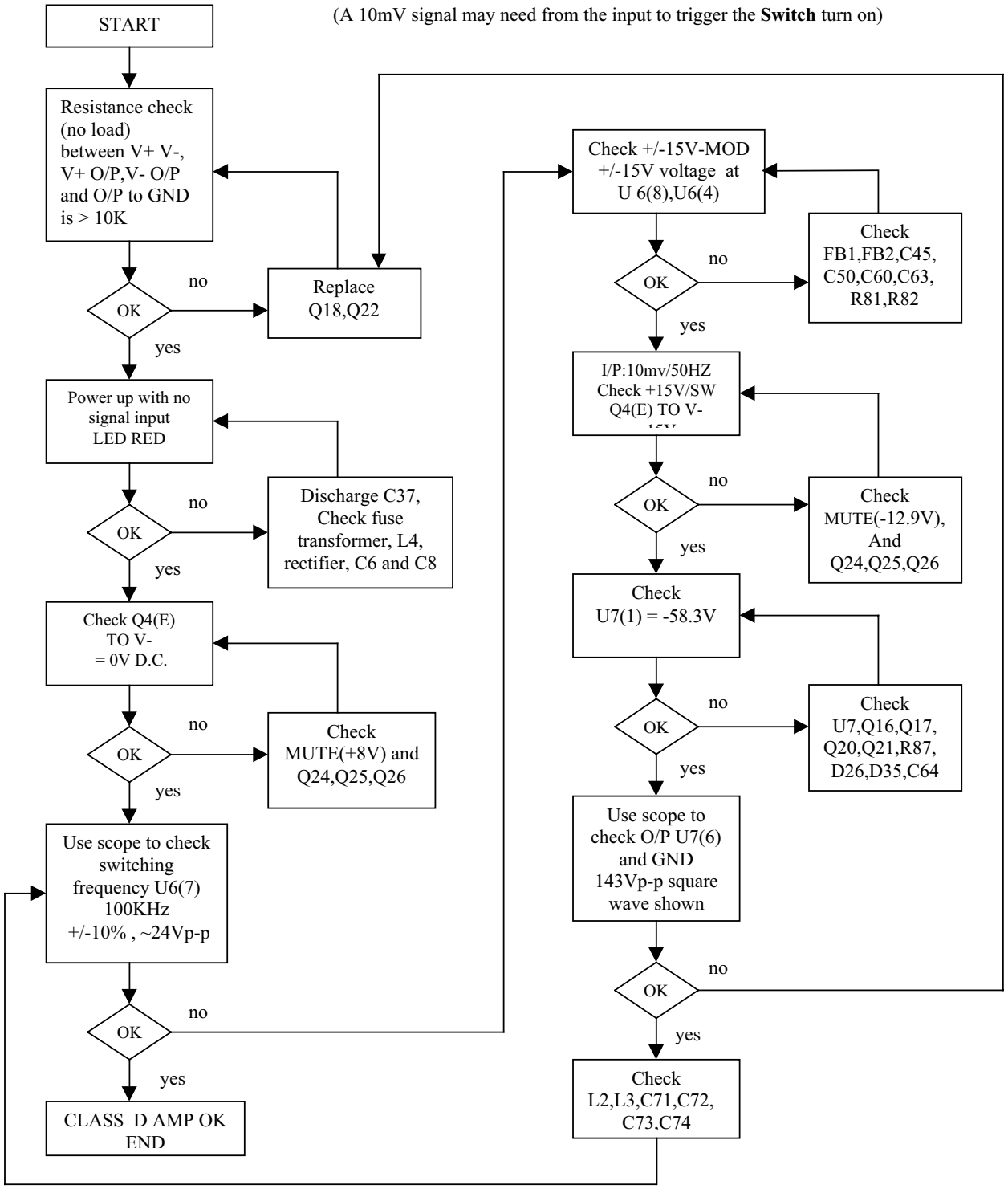
LFE switch Setting	Output
Normal	6V
LFE	18.32V

See flow chart next page for diagnostics.

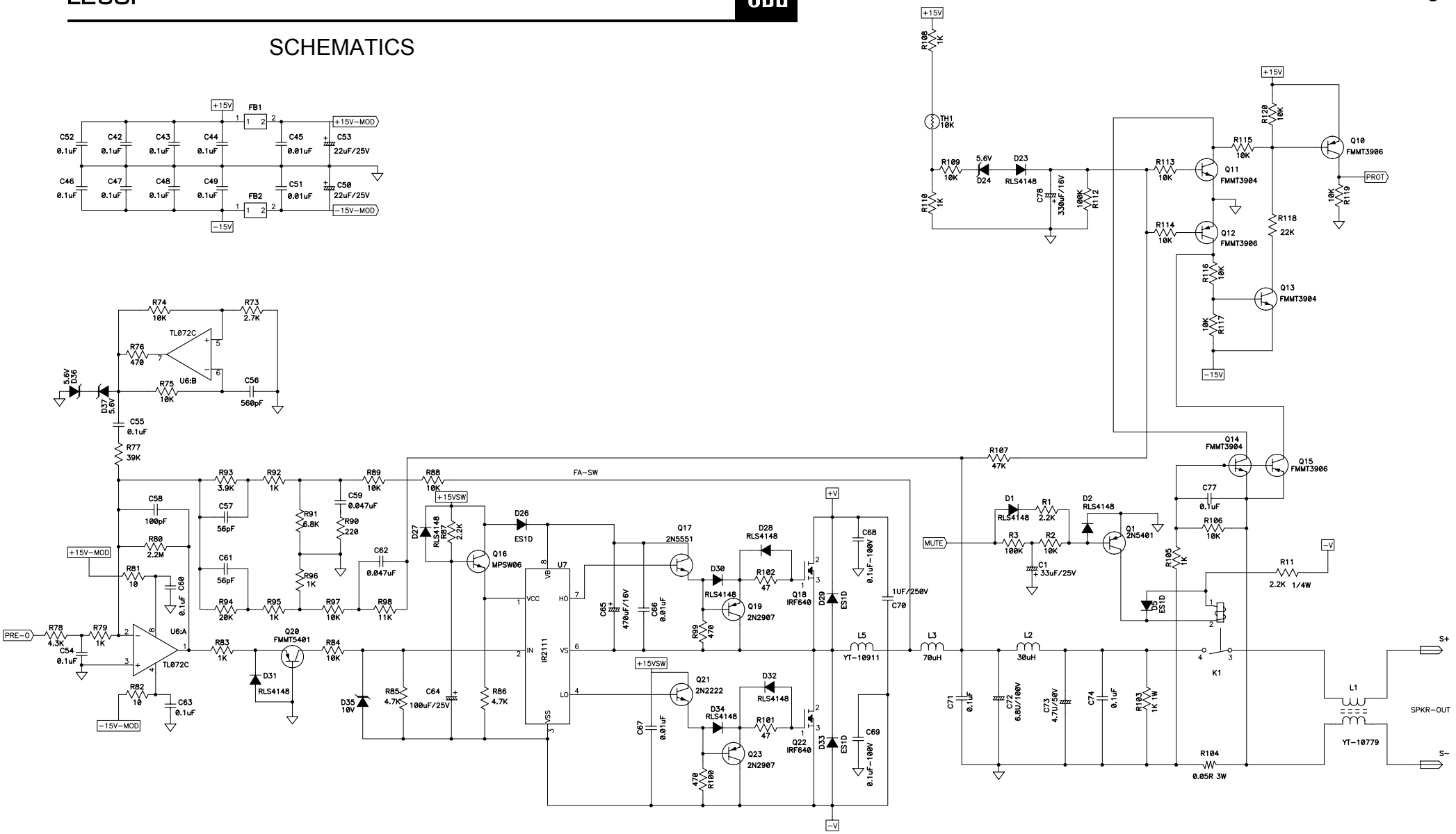
DETAILED TROUBLESHOOTING (CONT'D)

FLOW CHART

CAUTION : SPEAKER OUTPUT IS FLOATING AND IS ***NOT*** PROTECTED AGAINST A SHORT TO GROUND. ALL TEST INSTRUMENTS CONNECTED TO THE OUTPUT ***MUST*** BE FLOATING. ATTACH THE SCOPE PROBE TIP TO S - and REFERENCE LEAD TO S+.

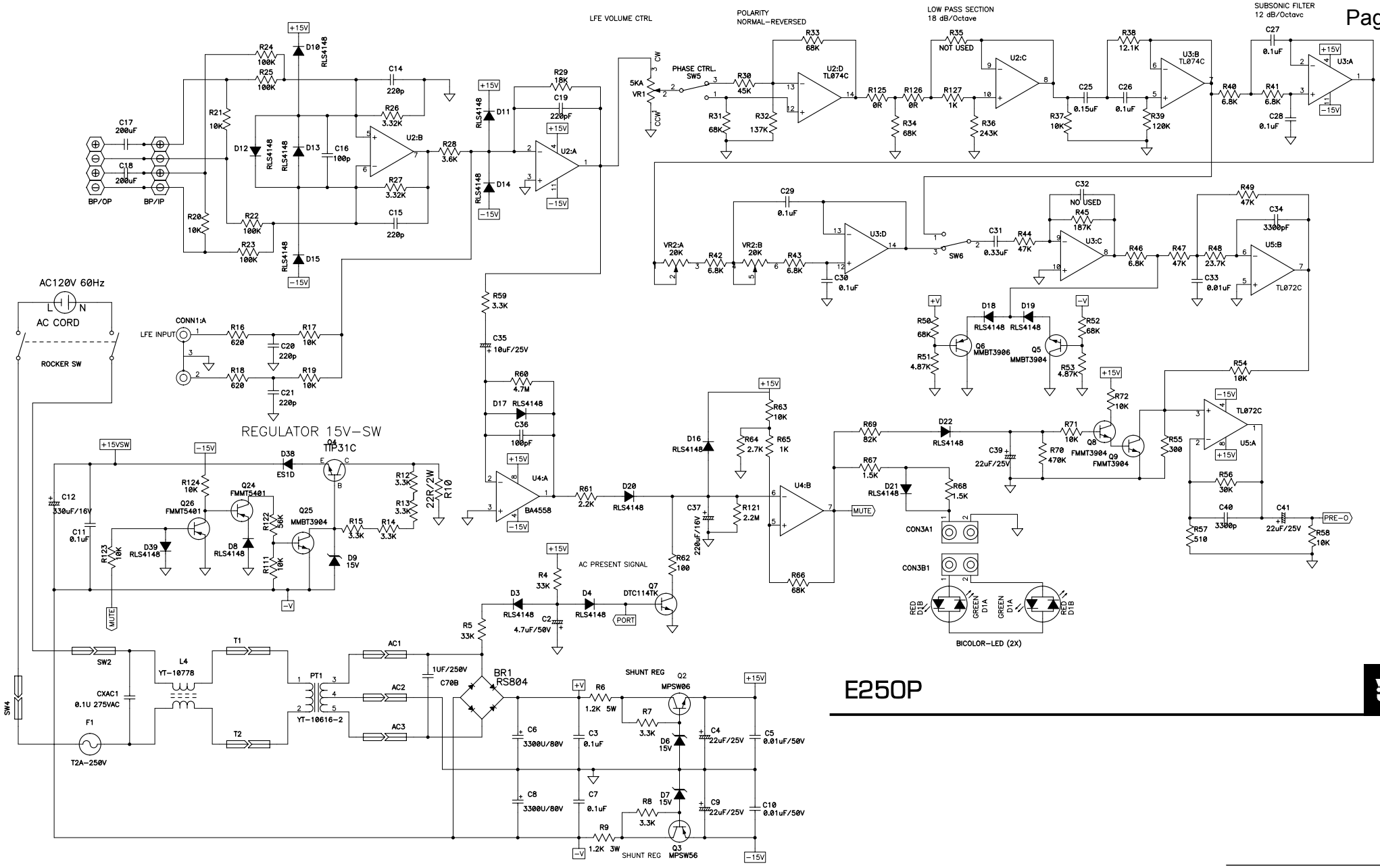


SCHEMATICS



Harman Consumer Group 250 Crossways Park Dr. Woodbury, New York 11797
Email techsupport@harman.com Web www.harmanservice.com

JBL	
:	
Model no:	E250P 120V
Sch name	POWER AMP PCB
Issue no:	
Date:	2003/02/25
Sheet:	Rev: P1A
	Author: VITA



E250P

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	JBL
:	
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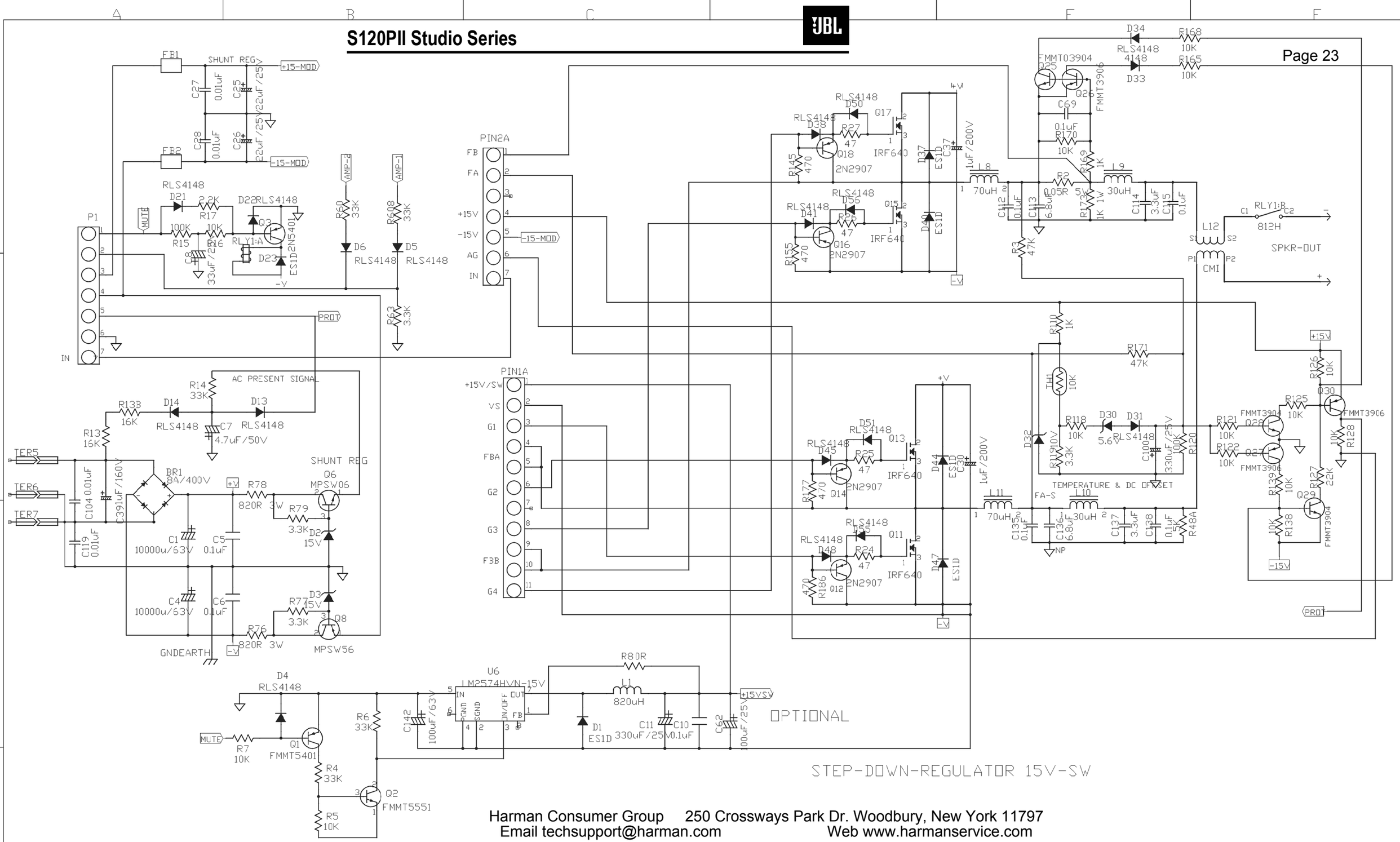
Sch name	PRE AMP PCB
Issue no:	
Date:	2003/02/25
Sheet: 16	Rev: P1A
	Author: VITA



STEP-DOWN-REGULATOR 15V-SW

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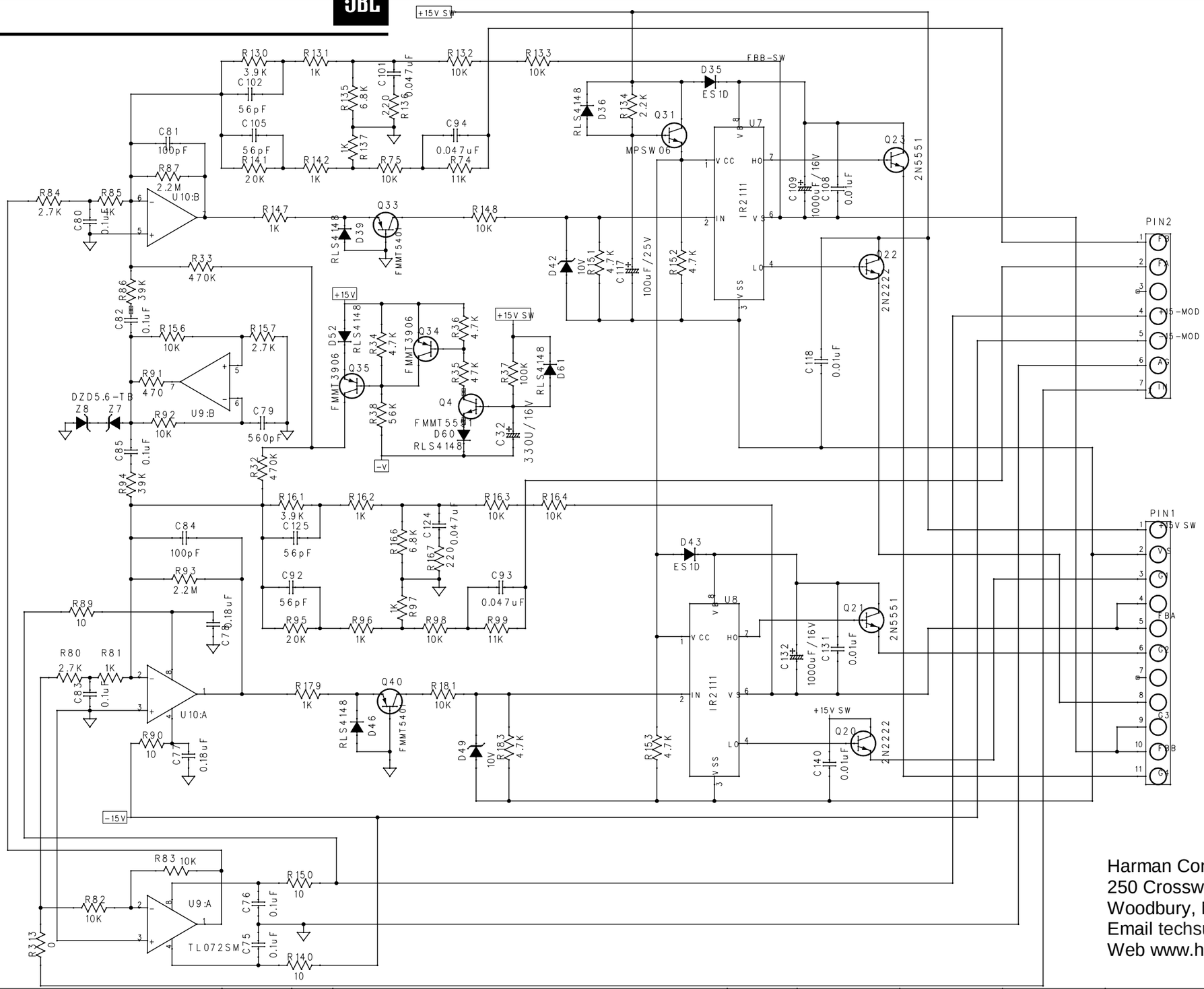
Rev:	Notes:	Date:	Rev:	Notes:	Date:	Draw by	Designed by	Checked by	Approved by

Customer:	HARMAN
P/N:	422-016:001-000
Model no:	S12P
Sch name:	CLASS D AMP PCB
Issue no:	ET-01-21-SCH-



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Rev:	Notes:	Date:	Rev:	Notes:	Date:	Draw by	Designed by	Checked by	Approved by	Customer: HARMAN
	REV. 11/07/2001									P/N: 422-0161001-000
										Model no: S120P-!!
										Sch name: CLASS D DRIVER PCB
										Issue no: ET-01-21-SCH-3618