"RIBBON" ALL-FET CLASS A POWER AMPLIFIER

Borbely Audio EB-700/343
Distributed by Audiokits.com USA

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Building Blocks

The EB-700/343 Driver Stage consists of four (4) building group:

1. EB-700/343 Driver w/regulator
2. EB-1199/114 Class-A Output Section
3. EB-1199/237 Power Supply
4. EB-1099/244 Dual Mains Transformer

Group 1 is detailed in this document. Group 2 and 3 are detailed in their own documents found elsewhere on this website. The mechanical design and layout of this kit is highly individualistic and personalized, so creativity can be shown as the amplifier takes shape. There are enclosures that are available on our website that facilitate the driver circuit, power supply and output section. To view the enclosures, please visit out website at www.audiokits.com. We recommend following excellent soldering habits and always work in an ESD safe environment.

Deliverables

The EB-700/343 kit is complete; meaning the etched and drilled PC board, heatsink (s), all electronic components and this document is included with your purchase. It is assumed the builder has the basic construction tools, soldering iron, solder, etc. This kit can be adjusted with a common voltmeter (i.e. DVM, DMM, VOM etc.) Other audio equipment is desirable to conduct other tests, but is not necessary. This project is a "module" that can be easily installed in a variety of enclosures, retrofitted into existing systems, or multiple units can be incorporated into a single enclosure.

Take the time to read the text. With the purchase of this kit, a parts list will be included that you will need to identify the components and their proper layout on the PC board. Please check the components for correct quantity and accuracy. When inserting components on the PC board(s) please check the schematic as well as the stuffing guide for proper placement. This will save time if a problem arises later. *If you find a discrepancy, please let us know immediately.*

General design information

The "Ribbon" driver is a high-speed driver circuit, intended for ribbon/electrostatic speakers and high-speed cone speakers. With a maximum supply voltage of +/- 40V (+/-45V unregulated), it can deliver up to 40W. If the power supply and the output stage/heatsink are chosen correctly, all of this can be delivered in pure Class A.

The circuit is a fully complementary design, using only FETs as active elements. The input stage is a complementary differential cascode JFET circuit, using dual monolithic JFETs as input devices. Each of these is working with 2mA drain current. The second stage consists of two JFETs in parallel and a MOSFET, connected in cascode. The JFETs are operated at 10mA each, providing a total of 20mA drive for the output stage.

The bias circuit is a Vgs multiplier, using a MOSFET. The MOSFET itself, a TO-220 device, is selected according to the MOSFETs used in the output stage and is mounted on the

output heatsink, if necessary. This ensures proper bias tracking with the different output MOSFETs. The output offset is tracked and controlled by Q7, which is a JFET-input opamp. Two shunt regulators provide +/- 10V supply voltage for the opamp.

There are three outputs marked “FB”, “OUT” and “REL OUT”. Under normal operation the feedback point “FB” is connected to the “FB” on the output stage and the “OUT” is the output to the speaker. However, there is a tiny DC – thump at turn-on and turn-off due to the slight differences between the second stage MOSFETs. This is not dangerous to the speakers, but can be avoided by using the “REL OUT”. Relay RY1 is operated from a timer on the power supply board, and switches the speaker on after the DC conditions have stabilized.

The L1‖R30 parallel combination prevents oscillation when the load is highly capacitive (Exotic cables, for example!) However, when the load is not capacitive, the L1‖R30 combination can be shorted out, increasing the damping factor of the amplifier.

The feedback network is a so-called T-network, especially developed for the ALL-FET line of power amplifiers. It allows both unbalanced and balanced operation, without changing the feedback network. The only switching necessary is at the input, which equalizes the gain in unbalanced and balanced mode, and ensures equal input impedance for the two inputs in balanced mode (2.2K both)

The driver circuit is supplied from the on-board ALL-FET discrete regulators, see fig 1.

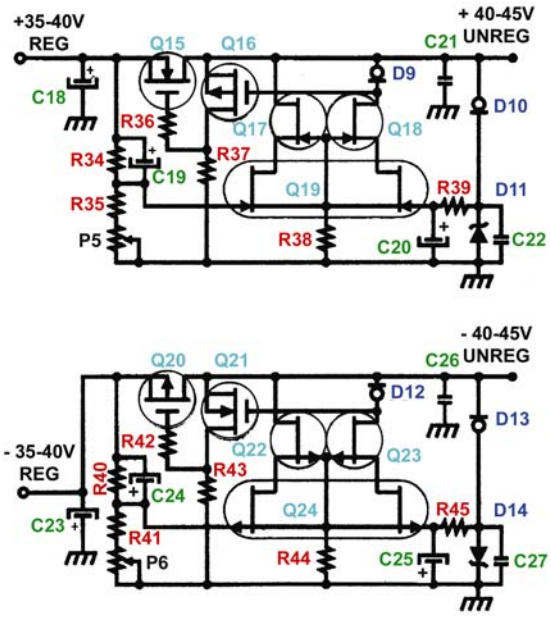


Figure 1.

Each regulator is one half of a complementary ALL-FET power amplifier. The regulators are made up of a differential cascode input stage, and a single MOSFET driver and output stage. The reference voltage is provided by 6.9V low-noise buried-zener reference diodes, which are fed from JFET constant current sources. Output voltage can be adjusted between 20 and 40V. Minimum input/output voltage difference is 4V, but, to make sure that the regulators are always operating correctly, we recommend a difference of 5V. Maximum input voltage is 45V.

The recommended power supply for a “Ribbon” power amplifier is the EB-1199/237. It contains independent PS for the output stage and the driver circuit. The main electrolytics for the output stage are not included on the board and are not included in the kit. Minimum recommended value for the capacitors is 47,000uF. The power supply board also contains two independent timers, one for the slow-turn-on circuit and one optional one for the output relays. The mains transformer should be rated at 400VA. To view the EB-1199/237 power supply and documents, please click here.

Testing and Alignment

It is recommended to start the assembly with the power supply, as this will serve as the supply for the testing of the other boards, and eventually the whole amplifier. If you are using one of the BORBELY AUDIO circuits, then follow the instructions/schematics of that circuit. If you are designing/assembling your own power supply, then make sure that you have the right voltage available for the driver circuit and the output stage.

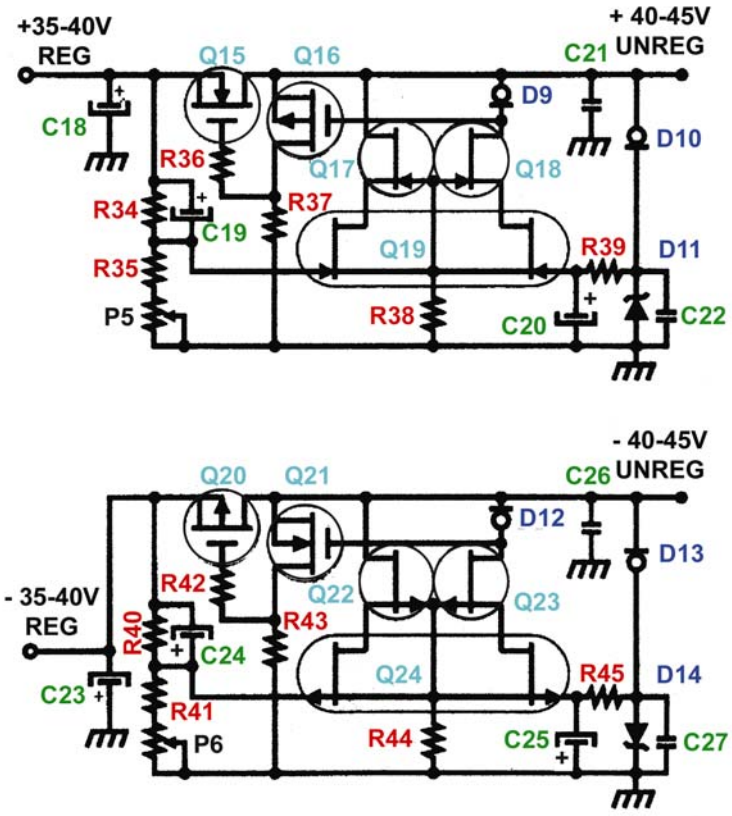
Start the assembly of the driver circuit with the two regulators. Since the PC board is silk-screened and the components are marked with the component number and packed in separate plastic bags, the assembly is easy. Nevertheless, we recommend that you follow the schematic of the circuit as well, which reduces assembly-related problems. When finished, connect a 500 Ohm/10W resistor and a DVM at the output of the regulator, apply the unregulated DC to the input and adjust the output voltage with trimpots P5 and P6 to 35-40V (20/40W amplifier).

Next assemble the driver circuit. Start with the smaller resistors, trimpots, and capacitors and (don't forget the jumpers), transistors. Note that two of the leads of Q1 and Q2 have to be bent slightly to fit into the appropriate holes on the PC board. Next install the second stage MOSFETs on the heatsinks and finally the large resistors, the coil and the relay on the output side. Connect SGND to PGND at the output. Do not install Q7 yet. You can now adjust the driver circuit DC-wise, by shorting the +Drive, the –Drive together and connecting them to the FB point. (The driver is now set up as an independent discrete opamp DC-wise). Connect the +Input to SGND. Apply the supply voltage and adjust the voltage drop across R5 (or R12) with P2. It should be 3V. This will automatically set up the right current also in the second stage. Next, connect the DVM to the combined +D/-D/FB point and adjust the offset voltage with P3 to zero volts. Install Q7 and check the offset again, it should be less than a couple of mV. This is all the DC adjustment you can do at this stage, so remove the short from the +D/-D/FB points and proceed with the output stage.
After mounting both driver and output board on the heatsink and wiring them together, the amp is ready for the remaining adjustments. It is recommended to use a VARIAC for this. Leave the short circuit at the +Input and connect a 50W/8 Ohm load to the speaker output. Replace only one of the fuses on the output with an Amp-meter, set it to 1 Amp and turn on the VARIAC slowly. If the bias current is increasing beyond 0.5A, reduce it with P4. If it stays below a few hundred mA, then turn on the VARIAC fully and then adjust the bias current to the appropriate value with P4. Let the amp idle for 15-20 minutes, and then check the temperature on the heatsink. It should not be more than 55°C. If it is less, you can increase the bias until the temperature reaches 55°C.

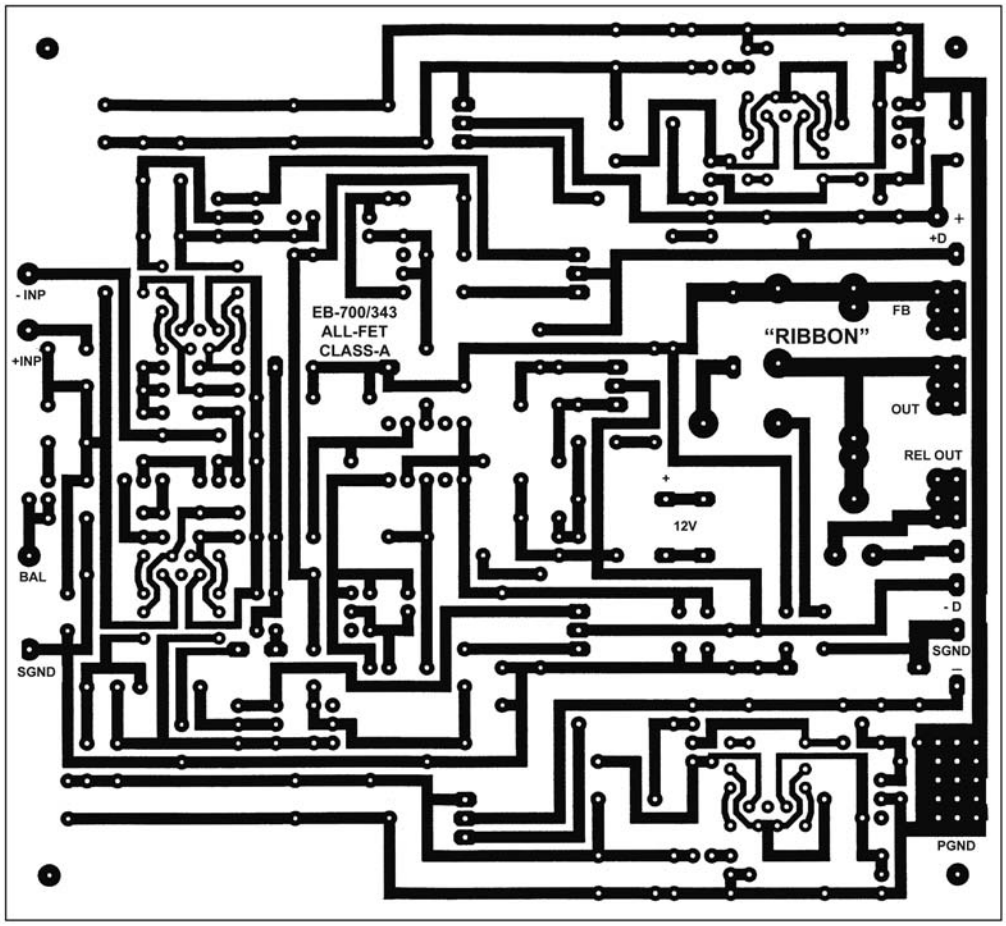
The final adjustment is the Common-Mode Rejection. For this you need an audio oscillator and an Audio mV meter. Connect the +Input and the –Input together and connect this to the output of the oscillator. Apply a 10kHz, 3VRMS signal to the input. By monitoring the output with the mV meter, adjust P1 for minimum output. The CMRR should be better or equal 50dB; i.e. the output should be 50dB below the oscillator level. The amp is now ready for use.

Cost and Ordering

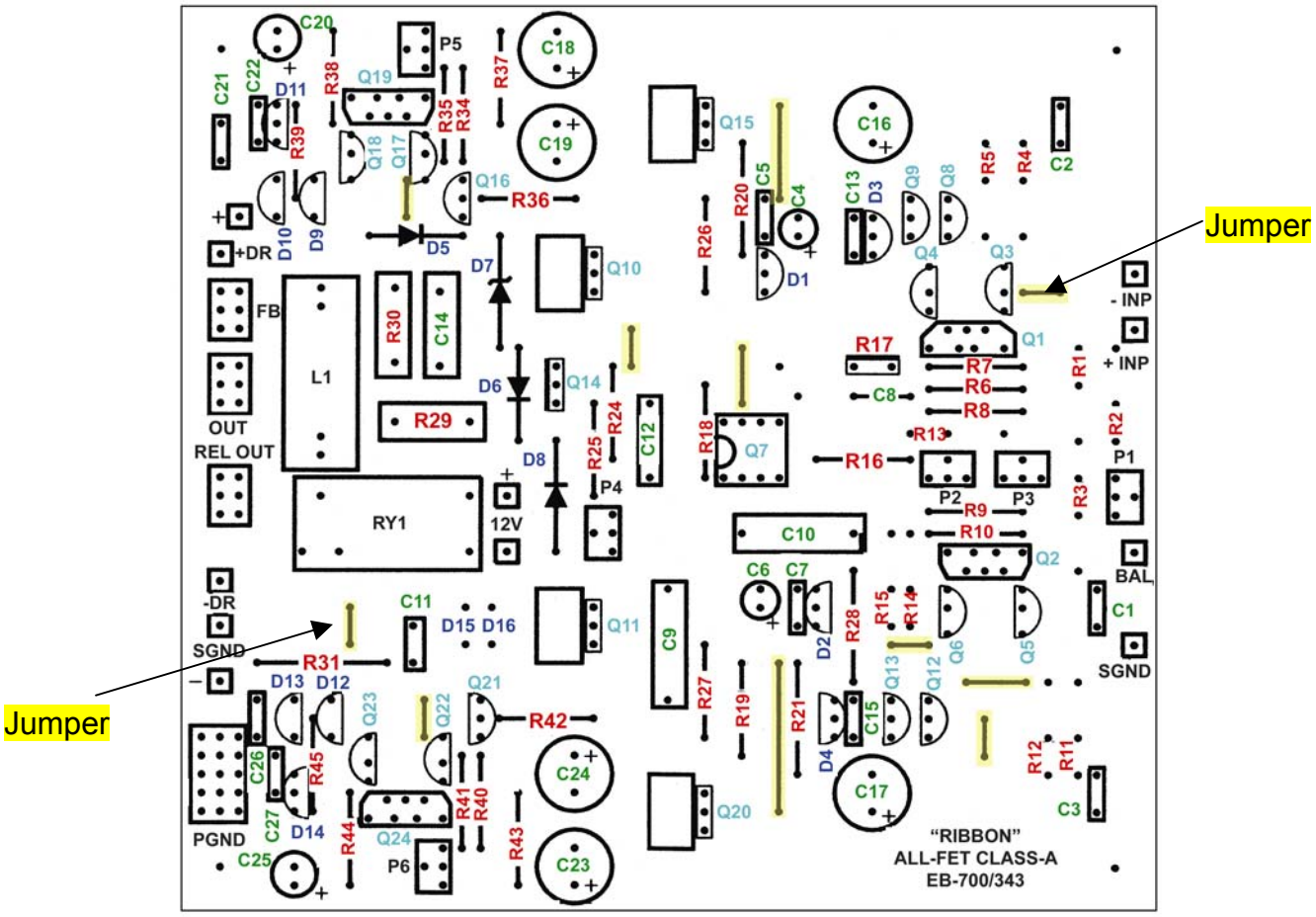
Pricing for the EB-700/343 is available on our website at www.audiokits.com. Please refer to our website for updated pricing and kit availability. For your convenience on-line shopping is available with secure purchasing and order fulfillment. You may even track your purchase from order placement to delivery.



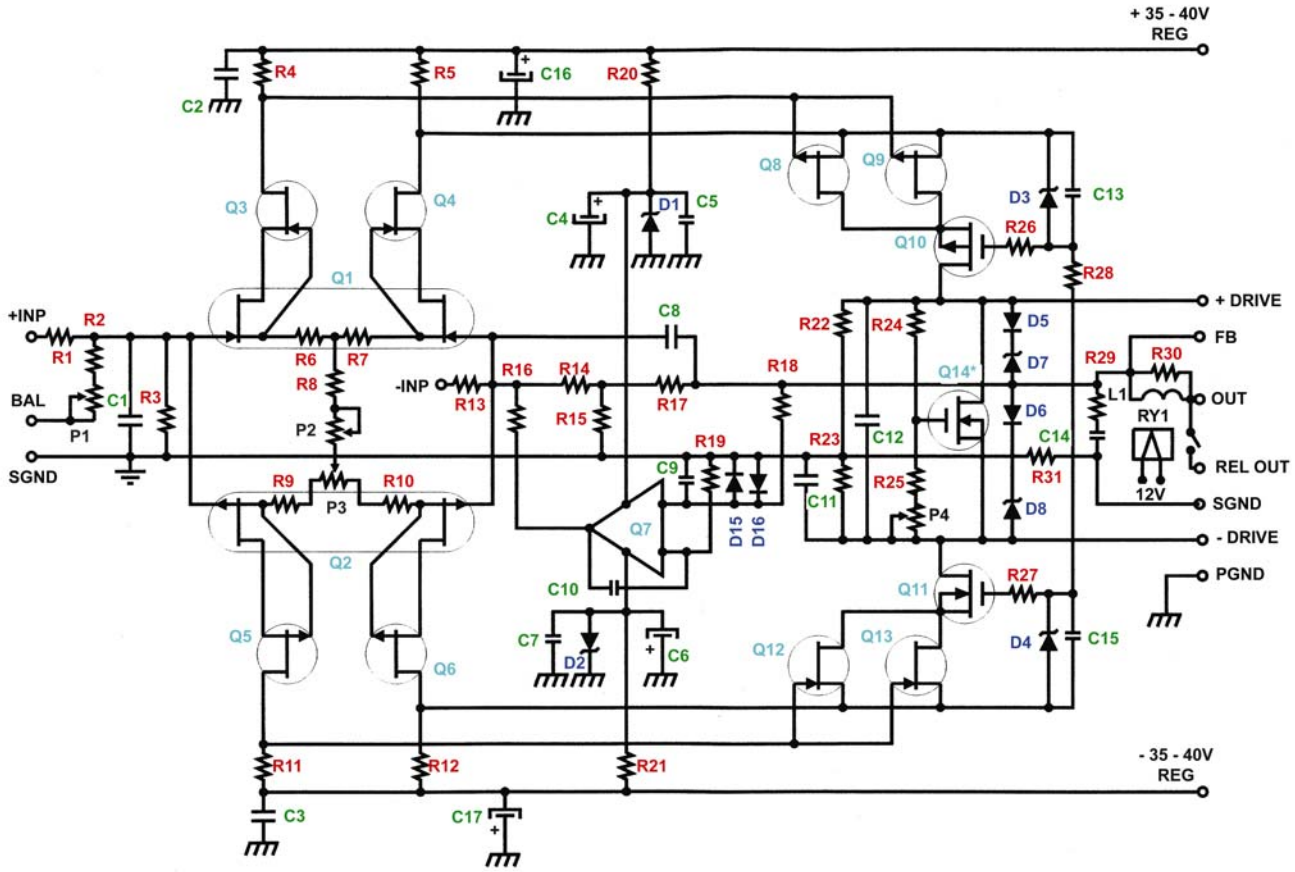
“Ribbon” All-FET Regulators
EB-700/343



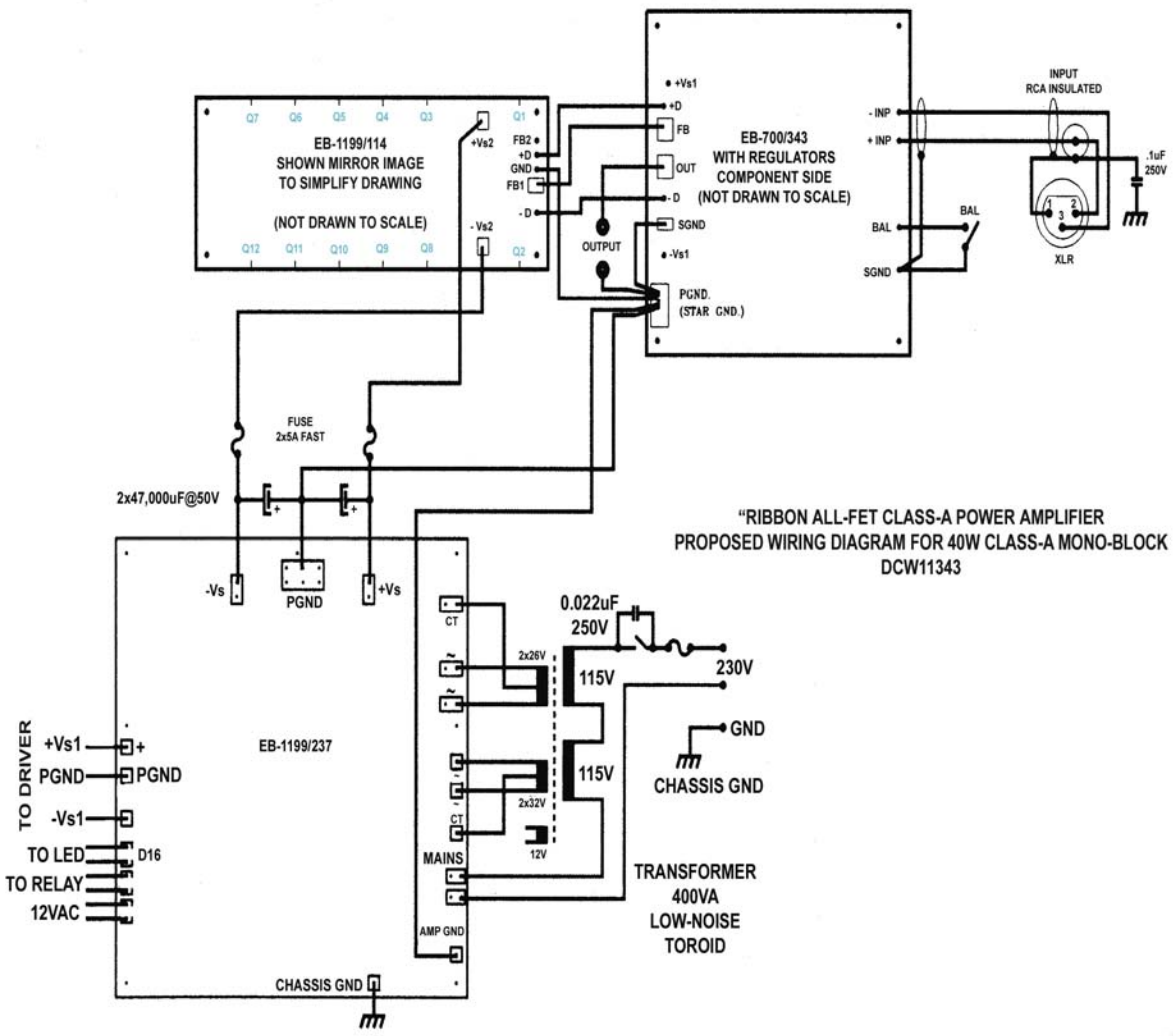
All–FET Class-A "Ribbon" Driver
EB-700/343 CLASSA23 (K170/J74)
Mod July 8, 2000



Stuffing Guide for "Ribbon" Driver
Component Side
DCSTF343



“Ribbon” All-FET Class-A Driver
EB-700/343



Proposed wiring diagram for the "RIBBON" Power Amplifier