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CAUTION: THE 1800-V PROFESSIONAL STEREO POWER AMPLIFIER SYSTEM CONTAINS NO USER-SERVICEABLE PARTS. TO PREVENT WARRANTY INFRACTIONS, REFER SERVICING TO WARRANTY SERVICE STATIONS OR FACTORY SERVICE.

SAFETY INFORMATION

1. Parts that have special safety characteristics are identified by the symbol on schematics or by special notes on the parts list. Use only replacement parts that have critical characteristics recommended by the manufacturer.

2. Make leakage current or resistance measurements to determine that exposed parts are acceptably insulated from the supply circuit before returning the unit to the customer. Use the following checks to perform these measurements:

A. Leakage Current Hot Check-With the unit completely reassembled, plug the AC line cord directly into a 120V AC outlet. (Do not use an isolation transformer during this test.) Use a leakage current tester or a metering system that complies with American National Standards Institute (ANSI) C101.1 "Leakage Current for Appliances" and Underwriters Laboratories (UL) 1492 (71). With the unit AC switch first in the ON position and then in OFF position, measure from a known earth ground (metal waterpipe, conduit, etc.) to all exposed metal parts of the unit (antennas, handle bracket, metal cabinet, screwheads, metallic overlays, control shafts, etc.), especially any exposed metal parts that offer an electrical return path to the chassis. Any current measured must not exceed 0.5 milliamp. Reverse the unit power cord plug in the outlet and repeat test. ANY MEASUREMENTS NOT WITHIN THE LIMITS SPECIFIED HEREIN INDICATE A POTENTIAL SHOCK HAZARD THAT MUST BE ELIMINATED BEFORE RETURNING THE UNIT TO THE CUSTOMER.

B. **Insulation Resistance Test Cold Check**-(1) Unplug the power supply and connect a jumper wire between the two prongs of the plug. (2) Turn on the power switch of the unit. (3) Measure the resistance with an ohmmeter between the jumpered AC plug and each exposed metallic cabinet part on the unit. When the exposed metallic part has a return path to the chassis, the reading should be between 1 and 5.2 Megohms. When there is no return path to the chassis, the reading must be "infinite". If it is not within the limits specified, there is the possibility of a shock hazard, and the unit must be repaired and rechecked before it is returned to the customer.

ELECTROSTATIC DISCHARGE SENSITIVE (ESDS) DEVICE HANDLING

This unit contains ESDS devices. We recommend the following precautions when repairing, replacing or transporting ESDS devices:

- Perform work at an electrically grounded work station.

- Wear wrist straps that connect to the station or heel straps that connect to conductive floor mats.

- Avoid touching the leads or contacts of ESDS devices or PC boards even if properly grounded. Handle boards by the edges only.

- Transport or store ESDS devices in ESD protective bags, bins, or totes. Do not insert unprotected devices into materials such as plastic, polystyrene foam, clear plastic bags, bubble wrap or plastic trays.

SPECIFICATIONS

Size:		3.5"H (2U) x 19" W x 13.25" D 89mm x 483mm x 337mm
Weight:		Net 30 lbs. (13.6 kgs) Shipping 36 lbs. (16.3 kgs)
Display:		7 LED indicators per channel 1 green READY, 5 yellow SIGNAL, 1 red CLIP/PROTECT
Operating Temperature:		0° to 50° C, up to 85% RH

Performance Specifications

Power Output

Continuous Average Output Power, both channels driven:		450 watts per channel into 8 ohms from 20 Hz to 20 kHz, with no more than 0.2% THD
		600 watts per channel into 4 ohms from 20 Hz to 20 kHz, with no more than 0.2% THD
Bridged-mono Operation:		1400 watts into 8 ohms from 20 Hz to 20 kHz, with no more than 0.2% THD
Voltage Output:		61.6V line voltage per channel into 8 ohms
Dynamic Headroom:		1.0 dB nominal
Power Bandwidth:		5 Hz to 40 kHz (+0, -3 dB)
Frequency Response:		20 Hz to 20 kHz (±0.75 dB)
Channel Separation:		> 65 dB @ 1 kHz > 55 dB @ 10 kHz
Damping Factor:		>170
Input Impedance:		25 kilohms unbalanced, each leg to ground 50 kilohms balanced
***Sensitivity:**	High	0.775V rms for rated power into 4 ohms @ 1 kHz 57mV rms for 1W into 4 ohms @ 1 kHz
	Low	1.5V rms for rated power into 4 ohms at 1 kHz 116mV rms for 1W into 4 ohms @ 1 kHz
***Gain:**	High	36.2 dB (± 0.5 dB)
	Low	30.2 dB (± 0.5 dB)
Input Overload:		+18 dBu

***The amplifier sensitivity is set to 0.775V rms for rated output. To reduce the sensitivity by 6 dB to 1.5V rms, remove JP100 (CH1) and JP200 (CH2), located on the main amplifier board.

IM Distortion:	< 0.1%
THD:	@ 0.775V Sensitivity < 0.2% @ 1.5V Sensitivity < 0.1%
Signal-To-Noise Ratio:	> 100 dB, A-weighted, ref. to rated power into 4 ohms (high gain) > 78 dBW, A-weighted, referenced to 1W into 4 ohms (high gain)
Slew Rate:	10V/µS (Bandwidth limited) 40V/µS (RFI filtering removed)
CMRR:	> 80 dB @ 1 kHz (without Bose® Input Module) > 60 dB from 20 Hz-20kHz (without Bose Input Module)
Power Consumption:	40W at idle 800W with musical program 1500W at full power into 8 ohms (continuous) 2400W at full power into 4 ohms (continuous)
Power Requirements:	120VAC/50-60 Hz 220-240VAC/50-60 Hz 100VAC/50-60 Hz
Fusing:	15 amp slo-blo (125V/60 Hz) 8 amp slo-blo (230V/50Hz)

FREQUENCY CURVES

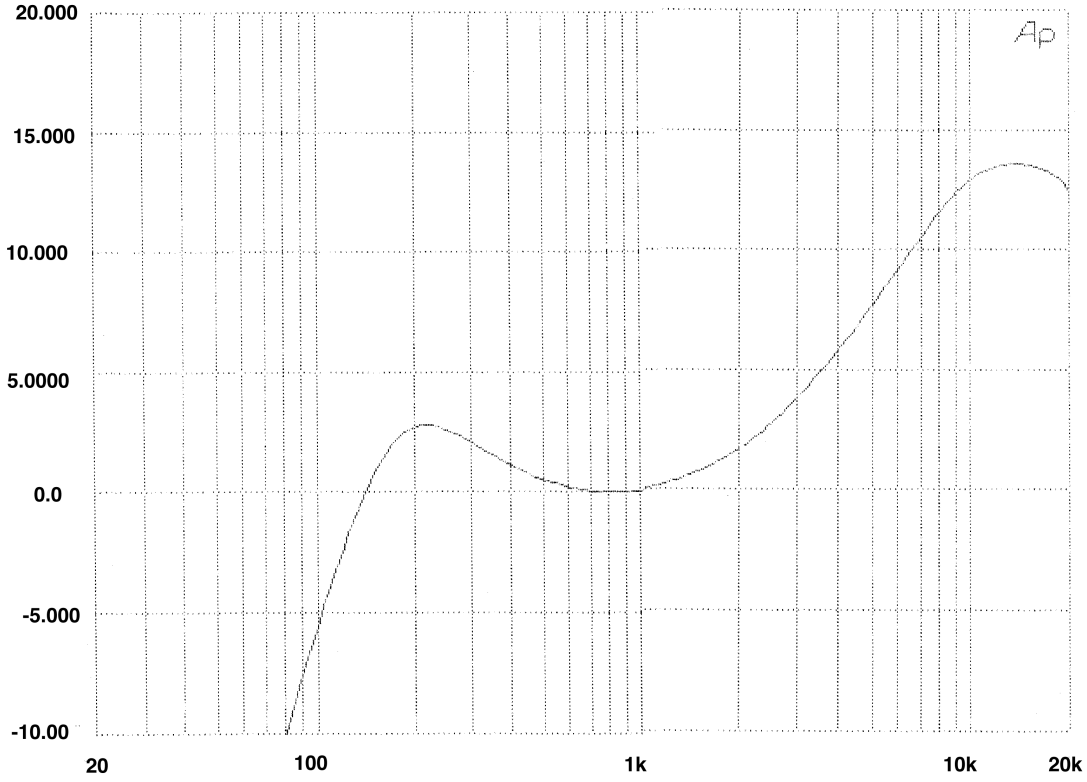


Figure 1. 402 EQ Card HF Only Response

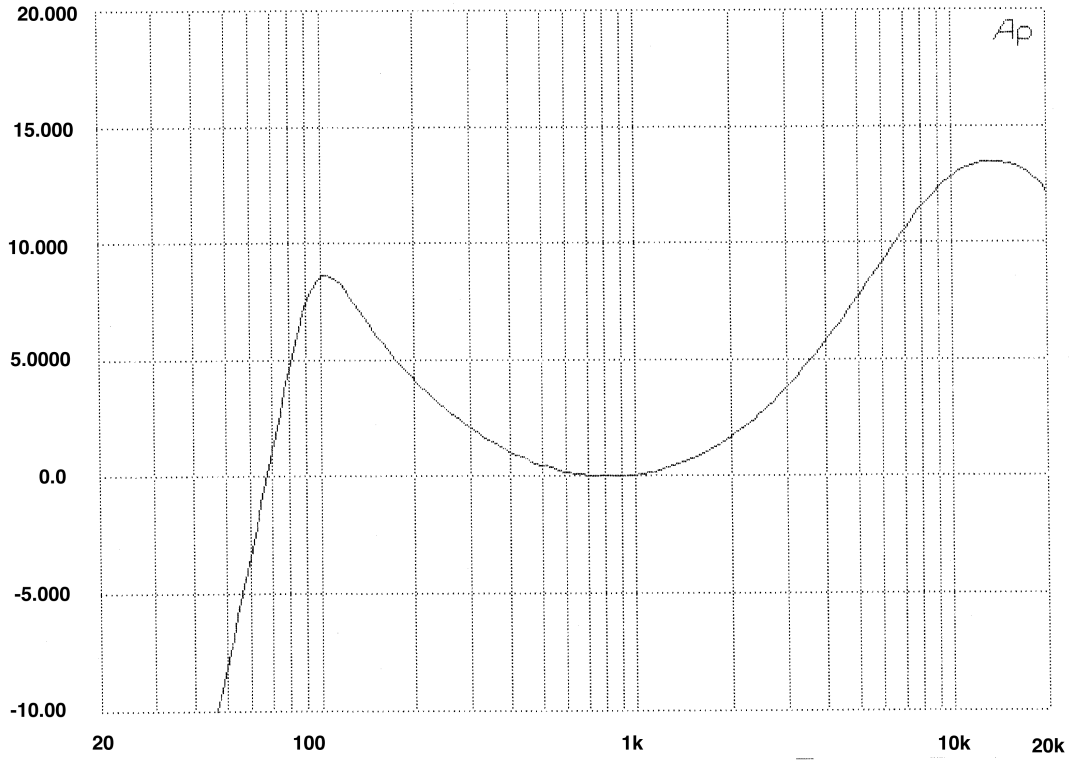


Figure 2. 402 EQ Card Full Range Response

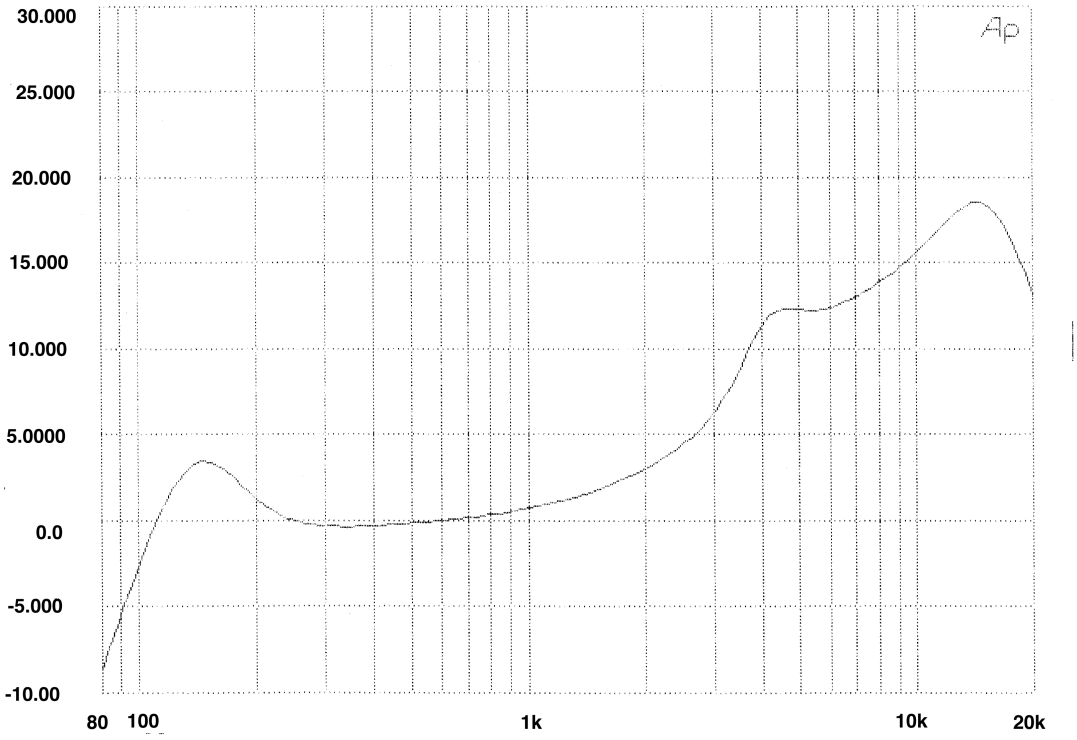


Figure 3. 502A EQ Card HF Only Response

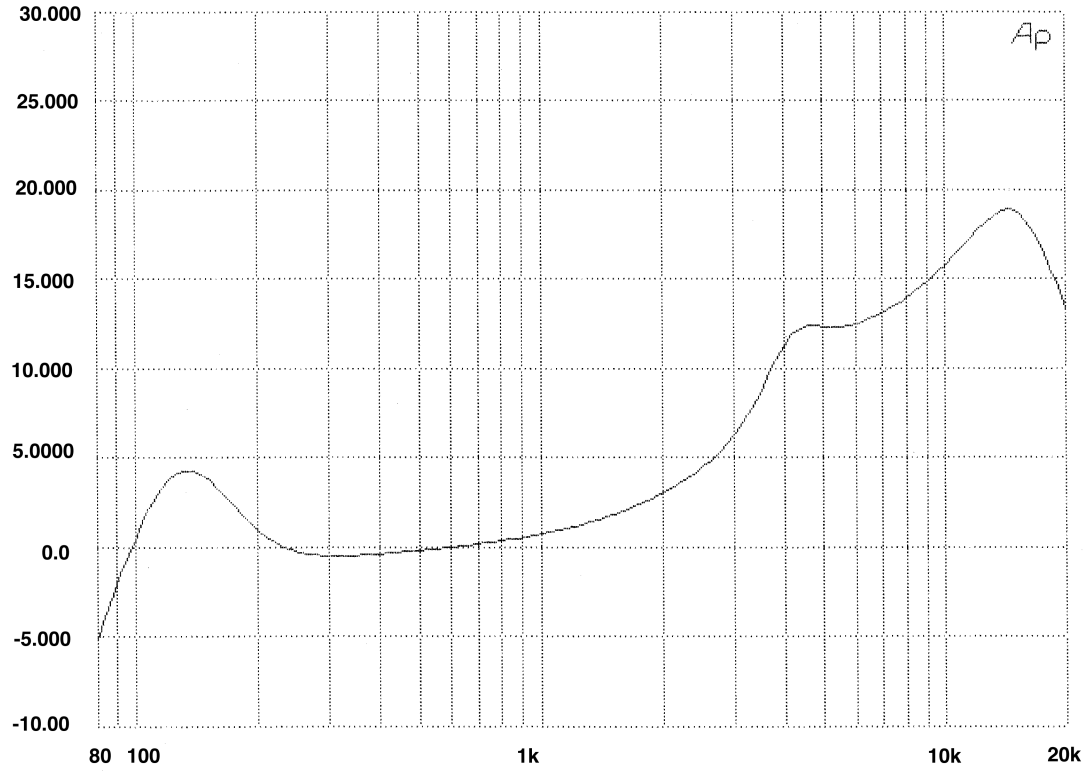


Figure 4. 502A EQ Card Full Frequency Response

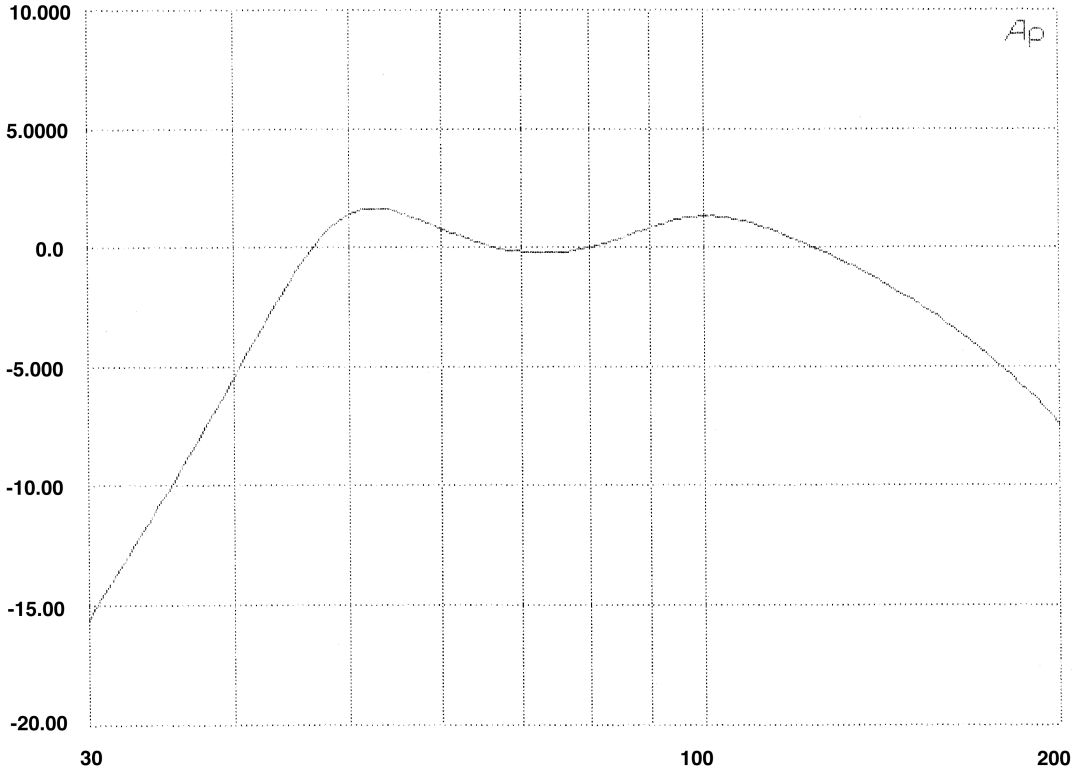


Figure 5. 502B EQ Card Response

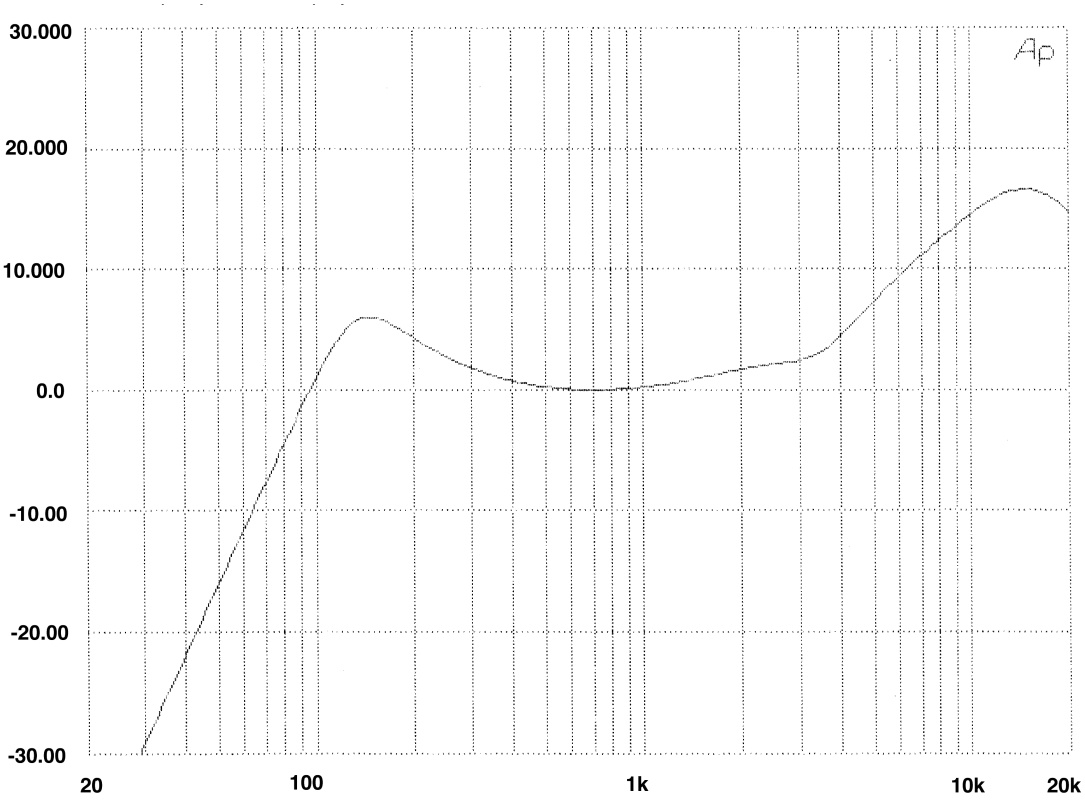


Figure 6. 802 EQ Card HF Only Response

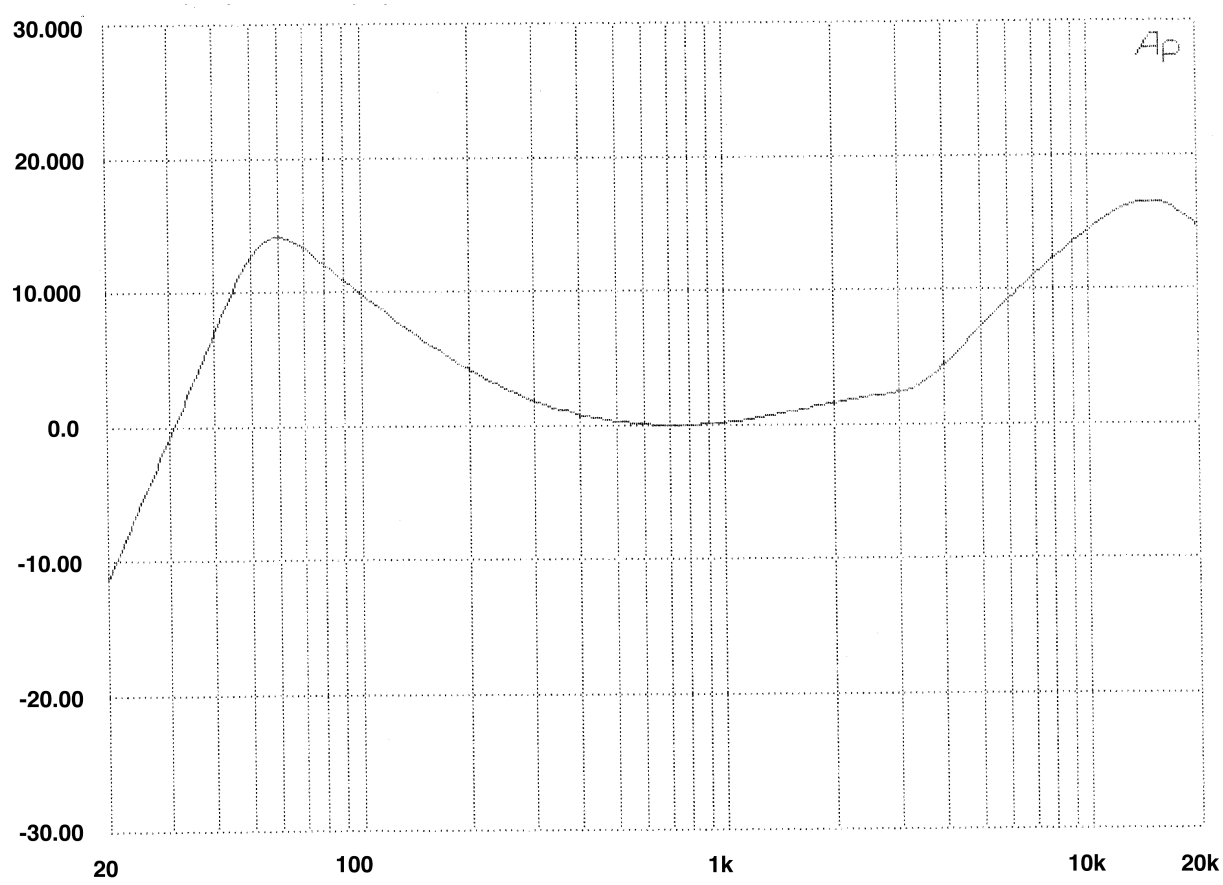


Figure 7. 802 EQ Card Full Range Response

BLOCK DIAGRAM

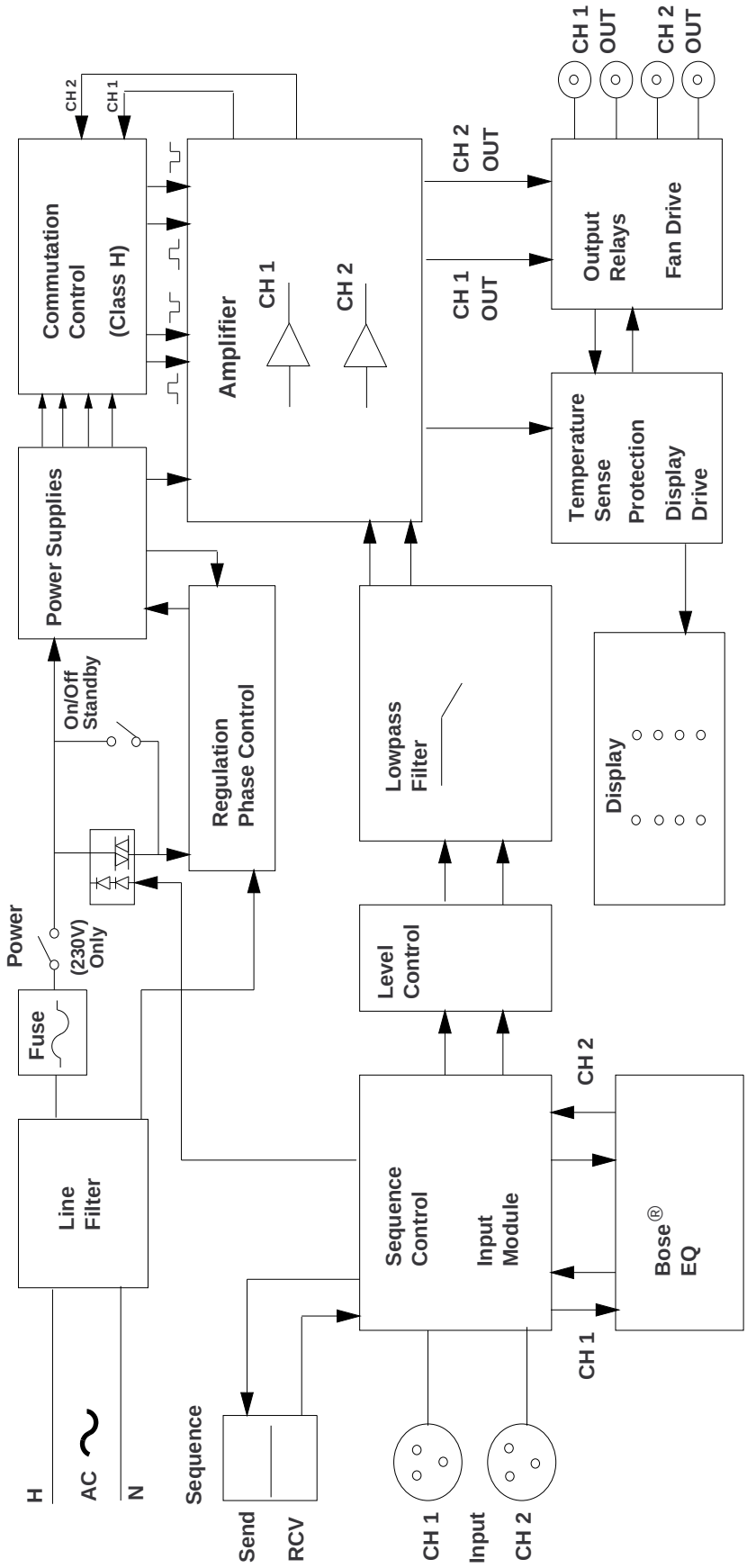


Figure 8. 1800-V Block Diagram

THEORY OF OPERATION

1. GENERAL

The Bose® Model 1800-V Professional Stereo Power Amplifier is an installed/portable amplifier made for professional sound applications. It is a two-channel amplifier rated at 600 watts into 4 ohms and 450 watts into 8 ohms. In the bridged-mono setting it can deliver 1400 watts.

The protection circuits designed into the amplifier will protect the system from unexpected faults, excessive temperature, continuous current limiting and shorted outputs.

The balanced inputs use high quality, high common-mode rejection differential amplifiers for exceptional hum and noise rejection.

Through the use of equalization cards the amplifier can provide active equalization for Bose 402™, 502®A, 502B and 802® professional loudspeakers. These cards fit into the J6, Channel 1 and J7, Channel 2 connectors located on the Input Module motherboard.

Additional Features are as follows:

- Two input connectors per channel allow 1/4" TRS, XLR, or quick connect terminal block connection
- Two input connectors for each channel are wired in parallel
- Accepts balanced or unbalanced lines
- Independent CH 1 and CH 2 Level Controls with 11 detented positions
- Level Control Defeat Switch
- Dual Mono Mode for combining the power of both channels into a single higher powered channel
- Sequencer connection for sequentially powering-up multiple amplifiers to limit instantaneous in-rush current
- Bi-Amp/Full Range configurable
- Internally configurable for Parallel Mono mode for single channel low impedance operation
- Internally configurable for 0.775V or 1.5V rms input sensitivity
- Internally configurable input polarity of XLR connectors
- Class H dual-rail power supply
- Additional protection circuitry includes Clipping Eliminator, AC Lines Fuse
- Power Connected/Standby Indicator
- 7 LED display per channel, including power ready and Clip/Protect indicators
- Two-speed fan cooled

2. CIRCUIT DESCRIPTIONS

This section discusses the theory of operation of the 1800-V Amplifier. For a better understanding of the circuitry involved, refer to the schematics included with this manual. Component pin designation is notated as follows: U1-7 means U1 at pin 7.

Unless otherwise noted, this discussion centers around the CH 1 circuitry. The CH 2 circuitry is essentially identical.

2.1 Input Module

The Input Module consists of signal input connections, mode switching, optional equalization, and power sequencing circuitry. The module operates from +15V and -15V, supplied by the host amplifier through J2-2 and J2-1 respectively.

The signal inputs are designed for balanced connection, though unbalanced inputs can be configured by proper input wiring. Channel 1 (CH1) line-level inputs are made via P4 and J4, Channel (CH2) input connections are made via P1 and J5. P4 and P1 allow for the insertion of either male XLR or phone plugs. The phone plug terminations are: tip positive (+), ring negative (-), and sleeve ground. The XLR connections pins 2 and 3 are user configurable. As shipped, jumper blocks JB2 and JB1 have jumpers between pins 2 to 3 and 5 to 6. This jumper configuration assigns XLR pin 2 to positive (+) and pin 3 to negative (-), pin 1 is ground in all configurations. If the jumpers are placed across JB1/JB2 pins 1 to 2 and 4 to 5 the XLR pin assignment becomes pin 2 negative (-), and pin 3 positive (+). The Euro-block terminal block connectors J4 and J5 assignments are: pin 1 positive (+), pin 2 negative (-), and pin 3 ground.

The CH1 input signal is applied to ICs U1, and the CH2 signal to U2. U1 and U2 are unity gain (0 dB) differential amplifiers (SSM2141). These inputs are protected against RFI (Radio Frequency Interference) and ESD (Electro-Static Discharge). The signals are then routed to the A inputs of op-amp/switch ICs (BA3128) U4 (CH1) and U3 (CH2) and to EQ card connectors J6-4 and J7-4 respectively. The switch's B inputs are driven by the output of the EQ cards via J6-5 and J7-5.

The input module detects the presence of EQ cards via J7-6 and J6-6. Without the card installed these pins are pulled high (+15V) which keeps both CH1 and CH2 sections of dual LED D23 extinguished. This logic high signal is also applied to the control pins of the switch ICs which selects the A (unequalized) input. When an EQ is plugged into J7 and/or J6 pin 6 the EQ is detected and pulls the control pin low (+7.5V), turning on the corresponding LED(s) and switching the IC to the B input which selects the output of the EQ card.

On some EQ cards the equalization can be modified for either full range "FULL BANDWIDTH" or bi-amplified "HF ONLY" operation. The equalization mode switch SW2 selects either FULL BANDWIDTH or HF ONLY modes of the EQ cards installed. These control signals are sent to the EQ cards via J6-7, 8 and J7-7, 8.

The selected signals from U4 and U3 are buffered by U7B and U7A which are wired to P2 and P3. These phone connectors provide balanced, buffered, equalized outputs (if an EQ card is installed) to drive additional amplifiers or other equipment. This allows external equipment to provide equalized signals without the need for additional equalization. The pin assignment for these connectors are the same as for the input phone connectors P1B and P4B. The output circuitry is also protected from RFI and EMI.

The amplifier can be operated in four different output modes: normal (two independent channels) dual mono (one input channel, two separate channels), bridged mono, or parallel mono. These modes are selected via SW1 and control the operation of op-amp/switching ICs U6 and U5. Parallel mono operation requires internal modifications to the amplifier, contact the local Bose® Pro Product dealer for information on parallel mono operation.

When SW1 is set to the NORMAL mode, CH1 and CH2 operate independently. In this mode a logic high is applied to the control pins of U6 and U5. This routes the outputs of U4 and U3 to their respective channels in the amplifier via J1-20 and J1-16.

In DUAL MONO mode both amplifier channels are driven by the signal applied to the CH2 input. U6-1 is driven high (+15V) and U5-1 is driven low (+7.5V), selecting CH2 to drive both channels of the amplifier.

In BRIDGED MONO operation the CH2 signal is routed directly from the equalizer switch U3 to the amplifier inputs. U5 control pin 1 is driven low (+7.5V) selecting the inverting input of the op-amp switching IC signal. This inverting signal is then sent to the B input of U6 whose control signal at pin 1 is driven low selecting the B input. This routes the inverted signal to the CH1 input of the amplifier.

For information on sequence operation see **Section 2.8, Sequence Send/Receive.**

2.2 Power Amplifier Circuitry

The 1800-V uses a conventional class AB push-pull power amplifier circuit, with a commutated two-stage (dual-rail, class H) power supply. U100A-1 is the input stage, providing differential inputs for input and feedback connections as well as most of the open-loop voltage gain of the circuit. Local and global negative feedback from the output stage via R109, R113, R111/ R112 and R129 sets the closed-loop gain at 36.7 dB. Removing jumper JP100 disconnects R111 from the circuit and sets the closed-loop gain at 30.7 dB. The factory default setting is 36.7 dB gain. The output of U100A-1 drives Q100 and Q101, operating as common emitters that level-shift the drive signal and couple it to the pre-driver amplifiers Q102 and Q103. Q102 and Q103 provide additional voltage gain, and when combined with the voltage gain of the input op-amp is sufficient to swing the input signal between the +106V power supply rails. Q104 and Q122 are connected as an NPN-PNP conjugate pair and used as a V_{BE} multiplier for bias control. Q104 is thermally connected to the output transistors and together with Q122 provides bias stabilization over a wide temperature range. R124 allows the bias current to be adjusted to its optimum value.

The predrivers (Q102 and Q103) provide the base current to the drivers Q108 and Q109. These drive the output transistors; Q110, Q112, Q114, Q116, Q118 and Q120 for the positive half-cycle, and Q111, Q113, Q115, Q117, Q119 and Q121 for the negative half-cycle.

Q105 operates as a V-I limiter, sensing the voltage drop across emitter resistor R148 (Q106 across R149 for the negative side), and reducing the drive signal to the output stage under overload conditions (see Section 3.1 Over-Current Protection further on).

From the Amplifier Board, the signal passes to the Output Board via E100. R100, L100, R110 and C100 comprise the output pole circuit for amplifier stabilization. Relay K100 is used to connect the output signal to the Speaker Output Binding Posts.

2.3 Magnetic Field Power Supply

The main power supply for the 1800-V is a dual-voltage design which provides no-load voltages of +/-106 and +/-53 volts DC. The triac drives the primary of the magnetic field power transformer by operating as a phase controlled switch; its gate signal depends on the signal supplied to opto-isolator U3 located on the regulator board. U4B provides steering for the photodiac in U3, allowing the triac to fire on both alternations of the power line.

U2 on the Regulator Board provides AC to DC conversion, with the AC line voltage providing the input to the converter through limit resistors R3/R4, and the 12.5VDC output determined by feedback resistor R6. This voltage provides the positive supply for U4, DC reference for comparators U4C and U4D, and the current through opto-isolator U1 which sets the voltage for the voltage-to-current converter U4A. Note that U4 (MC3405) is a dual op-amp and dual-voltage comparator in a singe package (U4A/U4B are op-amps and U4C/U4D are open collector comparators).

2.4 Start-up Sequence

When the power switch is OFF (S1 across E1 and E2) and the linecord is connected to an AC voltage, D1 illuminates (STANDBY LED). When the power switch is turned ON (S1 across E2 and E3), the LED goes off and AC H1 is supplied to the Regulator Board.

D2 and D3 on the Regulator Board provide overvoltage protection to U4. U4B-14 is a full-wave rectifier that outputs positive pulses to comparator U4C. The reference voltage is set at 0.7VDC by R10 at pin 3. Where pin 2 crosses the threshold, the output of U4C-1 goes open and C6 begins to charge through R21 and U4A-8.

U4A is a voltage-to-current converter (Howland current pump), whose output current is determined by the voltage at the junction of R12 and R13. As the voltage increases, the charging current to C6 increases.

The voltage on C6 is connected to comparator U4D-6. The reference voltage is set at 0.7VDC by R22 at pin 5. When pin 6 crosses the threshold, the output of U4D-7 goes open and base current is supplied to Q1 through R14. Q1 turns on, and current flows through the LED portion of U3, illuminating it and turning on the diac. This applies voltage to the gate of triac Q1 on the Power Supply Board which fires it and allows it to conduct current through the primary side of the power transformer.

When the output of U4B-14 drops below the threshold voltage of U4C-3, U4C-1 goes low and C6 discharges rapidly through it. When the voltage on C6 drops below the threshold voltage of U4D-5, U4D-7 goes low and Q1 and U3 turn off, removing the gate voltage to the triac momentarily interrupting the current through the primary side of the transformer.

The triac is switched on and off every half-cycle of the 60Hz AC line. Thus, the triac switches the AC line current off at a rate twice the line frequency, at the instant the line current crosses the zero axis. The triac will then remain off for a number of degrees of the sinusoid, before switching on again. The phase angle at which the triac switches on is the “firing angle” of the triac.

This produces enough voltage to the primary of the power transformer to allow the secondary regulator stage to begin to operate.

2.5 Power Supply Regulation

The firing angle of the triac controls the voltage on the primary of the transformer, and is determined by the conduction of the optocoupler U3 on the Regulator Board.

As the conduction of the optocoupler increases, so does the conduction angle of the triac. The photodiac conduction of the optocoupler is controlled by the current through the LED portion of the optocoupler, the amount of current through the LED is equal to the amount of current through transistor Q1. When the LED in U3 is fully ON, the triac conducts earliest in the AC cycle: the power supply is operating at maximum output. The LED current is supplied by voltage regulator U2 on the Regulator PCB. U5A differential amplifier senses the secondary supply voltages through R37 and R38. The output voltage at U5A-1 increases at the rate determined by R30 and C8 (slow start-up). The idle secondary voltages are set by R36 on the Regulator Board .

2.6 Load Regulation

When the amplifier is driven at high power into a load, the high DC supplies (rail voltages) will begin to "sag". Differential amplifier U5A-1 senses this and increases the LED current to optocoupler U1. This action increases the phototransistor conduction, which increases the output current of U4-8, increasing the charging rate on C6. This ultimately increases the triac conduction which increases the primary voltage, which increases the secondary voltages, thus providing steady, regulated DC supplies for the amplifier stage.

The -15VDC supplied to U5A-4 is backed up with a voltage divider off the -106VDC supply (R26/R27). Without this, if the -15VDC supply should fail for some reason, the output of U5A-1 would go high, drawing maximum current through the LED in U1 and latching the triac into full conduction. To prevent this, D8 will become forward biased and supply negative DC to U5A-4, keeping it operating normally. Note that if the +15VDC' supply should fail, the output of U5A-1 would go negative, turning off the triac.

2.7 Secondary Voltages

The secondary winding of the power transformer has two taps that supply the two pairs of DC supply voltages, ±106V and ±53V, each having its own bridge rectifier and filter capacitors.

The ±15VDC supply is tapped from the ±53VDC supply through R6 and R8, and regulated by Q2, Q3 and zener diodes D3 and D6. The +15VDC supply powers the op-amps and small-signal transistors.

2.8 Sequence Send/Receive

The amplifier can be powered up while the power switch is in the OFF position by applying a DC control voltage of +7V to +15V to the Sequence RCV terminal. Q3 on the Input Board will turn on and carry the control voltage through to the SND terminal, which is connected to the next amplifier in the sequential chain. Q1 also turns on which turns on Q2, providing enough current to pass through the LED portion of optocoupler U1 on the Power Supply Board to illuminate it and turn on the diac. This provides a gate voltage to fire triac Q1, which powers up the primary circuit. Once the secondary voltages are up, the +15VDC supply keeps the Receive circuit operating.

2.9 Commutators

Under idle or small-signal conditions the low-rail voltage is applied to the collectors of the output transistors through D13 and D19 on the Power Supply Board. The output of the amplifier is connected to the Power Supply Board via J1-10/J2-10. The signal is half-wave rectified by D7 and D14, sending the positive half of the signal to comparator U2A-1 and the negative half to comparator U2B-7. When the signal level exceeds the threshold of the comparator, Q4 (positive) or Q10 (negative) turns on. Current can now flow from ground through Q8 which acts as a current source for Q6. Q6 or Q11 turn on providing gate drive to the power FET Q9 (positive) or Q14 (negative). When the FETs turn on, the high-rail voltage is connected to the collectors of the output transistors. D13 and D19 become reversed biased and switch off the low-rail voltage from the circuit.

Zener diodes D11 and D18 provide gate protection to the FETs. Q7 and Q12 speed up the turn off time of the FETs.

This two-stage approach minimizes the voltage across each of the output devices which also minimizes the power dissipation required. Without this approach, the output transistors would be required to support the entire power supply voltage under small-signal conditions and the “unused” portion of the power supply voltage would be turned into heat.

2.10 Output Relays

The CH1 and CH2 output relays located on the Output Board, are energized independently of each other. In CH1, immediately after the power switch is turned on +6V DC is applied to terminal 2 of D105 (READY LED) on the Display Board via the voltage divider formed by R112/R113. Terminal 1 of D105 is connected to pin 6 of K100 via J6-5 and J3-8 on the I/O Board. A small amount of current is drawn through R102 and the relay coil, which is enough to illuminate the red LED portion of D105 but not enough to activate the relay.

In the meantime, C13 begins to charge through R26 on the I/O Board which delays turning on Q2 and Q3 by a few seconds. When Q3 turns on, VLF+ is applied to pin 6 of K100 which activates the relay. VLF+ is also applied to terminal 1 of D105 which reverse biases the red LED and D107, and forward biases the green LED, drawing current from ground through R112.

2.11 Display Circuit

In addition to the READY LEDs just discussed, the Display Board contains five Signal LEDs and one CLIP/PROTECT LED per channel.

The clipping indicators are driven by transistors Q100 (CH1), and Q200 (CH2) located on the Display Board. The signal for the clipping indicators initially comes from U100A-1 and U100B-7 on the Amplifier Board. This is the same signal that operates the anti-clipping opto-isolator on the I/O Board. D30 on the I/O Board half-wave rectifies the positive-going portion of the signal and drives comparator U9B which is a switch. C9 and R62 establish the time constant of the clipping indicator. D23 rectifies the negative-going portion and also drives comparator U98. When clipping occurs, U9B-7 changes from positive to negative, which forward biases D100 on the Display Board and turns on Q100. Q100 supplies current for clipping LED D104, causing it to illuminate.

The output signal is sensed at the speaker output via the I/O Board (J2-3 Output Board to J6-3 I/O Board to J3-6 I/O Board to J1-6 Display Board). D22 half-wave rectifies the signal and provides a DC voltage proportional to the amplifier's output to drive the signal display circuit. C2 and R19 determine the response characteristics of the display.

The signal driver circuit comprised of U1-U4 is basically a ladder comparator driving LEDs, with a twist. Assume that the signal at U2A-3 is zero volts (ignore R24 and D23 for now). R13 and R14 are a voltage divider that establishes a reference voltage for the comparators (four per channel). The comparators compare this reference voltage against the voltages established by the tapped voltage divider made up of R22, R20, R15 and R25. The CH1 LEDs are in the following sequence (lowest to highest): D105 (red/green), D13 (amber), D15 (amber), D14 (amber), D12 (amber), D11 (amber), and D104 (red).

With the input at zero volts, all of the comparator outputs are at -12V, except for U2B-7 which is high. None of the signal LEDs have any voltage across them; all are extinguished. As the input signal rises, it crosses in sequence at the thresholds established at each of the four comparators. First U2A-1 fires; its output goes high and D13 illuminates. Next U1B-7 fires, its output goes high; D13 extinguishes (no net voltage across it) and D15 illuminates. Finally U1A-1 fires; D15 extinguishes, and (this is the twist) D23/R24 supply current to the bottom of the R15, R20, R22 and R25 voltage divider, which inverts the relationship of the comparators to each other.

When U1A-1 fires, the current through R24 reverses the sequence of the voltages that establish the thresholds for the three comparators. This allows the same comparators to perform double-duty. The new thresholds leave U1A-1 high, U2B-7 low, U2A-1 and U1B-7 low and D14 on. D11 and D12 are off. As the input signal rises further, U1B-7 fires, extinguishing D14 and illuminating D12. Next U2A-1 fires, extinguishing D12 and illuminating D11. Finally U2B-7 fires, extinguishing D11. The last LED is the clipping indicator, D104.

3. PROTECTION CIRCUITRY

Protection functions are provided that will deactivate the output relays. Protection is provided for the following fault conditions:

3.1 Over-Current Protection

The amplifiers are protected from short-term excess current through the output stage by electronic current limiters. When the current through the output transistors becomes excessive, the voltage drop across the emitter resistors R148 and R149 bias the current limiter transistors Q105 and Q106 on, which shunt the drive current via D106 and D107. R139, D102, R140 and D103 determine the V-I limits.

When the current-limiters turn on, the voltage at voltage divider R127/R128 becomes less positive, providing base current for Q1 on the I/O Board through R38. When Q1 turns on two things happen; current flows through U3 (LED/LDR module) via D31 which attenuates the input signal, removing the high current condition. Base current is also provided to Q5 through D1 which turns off Q2 and Q3, causing the relay to disengage. C13 provides a time delay to prevent the relay from disengaging during momentary program peaks. When the relay disengages, it causes the red LED in D105 (READY LED) to illuminate and also turns on Q100 and D104 (CLIP/PROTECT LED).

3.2 Clipping Eliminator Circuit

This circuit is controlled by the LED/LDR opto-isolator U3, located on the I/O Board. The LED portion of this component is driven from a bridge rectifier (D4) that gets its input signal from U100A-1 on the Amplifier Board. Under normal conditions (undistorted amplifier output) there is almost no signal at this point. If the amplifier is driven into clipping, the signal level at U100A-1 rises rapidly because the feedback signal no longer represents the input signal. Once this occurs, the LED in U3 illuminates, reducing the resistance of the LDR portion which in turn reduces the input signal. The clipping-eliminator circuit is activated by switch S2B on the I/O Board. When the switch is off, the signal driving the bridge rectifier is shorted to ground.

3.3 DC Offset

DC offset is sensed by the comparator amplifier U2A on the I/O Board. If a DC component should appear at the output, it is sensed through either D6 or D7, depending on its polarity. The output of U2A-1 will switch from -14VDC to +14VDC, which turns on Q5 via D8. This deactivates the relay, turns the READY LED red, and turns on the CLIP/PROTECT LED.

In addition, the output of U2A-1 is conveyed to the Regulator Board via D15, J100-12 to Regulator Board J1-12 and D9. The positive voltage on U5A-2 causes the output of U5A-1 to become less positive, shutting off the conduction current through optocoupler U1, which shuts off the triac and primary current.

3.4 Overheated Output Transistors

A thermistor (RT100) is positioned near each heatsink. As the negative coefficient thermistor heats up, the voltage on comparator U2B-6 drops. When it crosses the reference voltage set up by voltage divider R42/R43, U2B-7 goes positive. This forward biases D17, turning on Q5, which deactivates relay K100.

As the heatsink temperature cools, the thermistor will cool until the voltage at U2B-6 once again crosses the reference voltage at U2B-5, allowing the relay to reactivate.

3.5 Fan Speed Control

The fan operates at low speed when the amplifier is first turned on. The voltage at the thermistor is connected to the Fan Drive circuit on the Output Board via D16 (on the I/O Board) and J6-4/J2-4. As the heatsink temperature increases, the voltage at U1A-3 on the Output Board decreases until it crosses the threshold set by voltage divider R4 and R6. When this occurs, the output of U1A-1 toggles low, which turns on Q1. Q1 shorts across R1 and applies the full VF+ voltage to the fan, kicking it into high speed.

3.6 Major Faults

The slo-blo line fuse protects the unit from further damage when a major fault such as a shorted output transistor or a secondary power supply fault occurs.

If the unit is run at or near its rated power, the fuse will eventually blow. The rated line fuse allows the unit to be operated without interruption for all musical applications.

3.7 Bridged Mono/Dual Mono Switching

The Stereo/Mono Switch (S1) on the Input Board is a three-position switch used to select Normal Stereo, Bridged Mono or Dual Mono operation. In the Bridged Mono position, it connects CH 1 in parallel with the CH 2 input, but inverts the signal to CH 1. The CH 1 input connection becomes disabled. The speaker output signals are identical except CH 1 is 180 degrees out of phase. In this way, a single speaker can be connected between the two "+" speaker terminals and receive twice the voltage as a single channel. When connected in this way, each channel "sees" one-half the impedance of the speaker that is connected between them. If an 8 ohm speaker is used, each channel will see a 4 ohm load. Each channel can still be independently controlled with its own level control **so it is important that both level controls be set to the same position for a balanced output.** The result is twice the rated power (per channel) into twice the rated impedance.

When S1 is switched to the Dual Mono position, CH 1 is connected in parallel with the CH 2 input, but in phase. The CH 1 input connection becomes disabled. This allows both channels to be driven with the same signal without the use of special patch cords. Each channel can still be independently controlled with its own level control.

3.8 Parallel Mono

To operate in Parallel Mono mode, leave S1 in the Normal Stereo position. Removing jumpers JP201 and JP203 will disconnect the CH 2 predrivers from the output stage. Installing jumpers JP102, JP104, JP202 and JP204 will connect the CH 1 predrivers to the CH 2 output stage. In this way, both channels will operate at exactly the same level, and will be controlled by the CH 1 level control.

In addition, removing JP1 will prevent the CH 2 clip LED from activating, and installing a 16 ga. jumper wire between WL100 and WL200 on the Output Board will tie both amplifier outputs together before the relays.

When operating in parallel mono, either of the speaker output terminals (CH 1 or CH 2) can be used since they both have exactly the same signal present. When a speaker is connected to the output terminals it can be driven with twice the current capacity of a single channel. The result is twice the rated power (per channel) into half the rated impedance.

1800-V DISASSEMBLY/ASSEMBLY PROCEDURES

NOTE: Refer to the figures referenced in each procedure for an exploded view. Numbers in parentheses represent individual parts in the figures referenced.

IMPORTANT: It's advisable to mark or note wiring connectivity before any disassembly begins. For further assistance consult the **Wiring Diagrams on Pages 66 and 67.**

1. Cover Removal

1.1 Use a phillips-head screwdriver to remove nine screws **(3)** from the back and sides of the chassis cover **(1)**. Refer to **Figure 9. Do Not** remove the two screws at each top front side of the cover. These screws attach the nylon standoffs on the inside of the cover. Refer to **Figure 12.**

1.2 Lift the back of the cover up, while moving it forward (front panel) from the chassis **(2)**. The front lip of the cover is hinged on the two front angle pieces of the chassis. Refer to **Figure 12**.

2. Cover Replacement

2.1 Align the cover **(1)** so its front angle fits over the chassis's **(2)** two front angle hinges. Refer to **Figures 9 and 12**. The cover's nylon standoffs should be behind both of the chassis's angle hinges.

2.2 Secure the cover to the chassis by tightening nine screws **(3)** with a phillips-head screwdriver. Refer to **Figure 9**.

3. Display Board Removal

NOTE: Refer to **Figure 12** for this Procedure.

3.1 Remove the cover **(1)**, see **Procedure 1**.

3.2 Disconnect the connectors from transformer **(4)** terminals 6-11. This will give you access to the screw on the Display Board **(5)**, which is next to the transformer.

3.3 Remove two screws **(20)** on the solder side of the Display Board **(5)** with a phillips-head screwdriver.

3.4 Move the board back from the chassis's front panel and disconnect the wiring harness from the Display Board's J1 connector.

3.5 Lift the board out from the chassis.

4. Display Board Replacement.

NOTE: Refer to **Figure 12** for this procedure.

4.1 Connect the wiring harness from the I/O Board **(6)** to the Display Board's **(5)** J1 connector.

4.2 Secure the Display Board to the Chassis's standoffs by tightening two screws **(20)** with a phillips-head screwdriver.

4.3 Connect the Power Supply cables back to transformer **(4)** terminals 6-11.

4.4 Return the cover **(1)** to the chassis **(2)**, see **Procedure 2**.

5. Regulator Board Removal

NOTE: Refer to **Figures 11 and 12** for this procedure**.**

5.1 Remove the cover **(1)**, see **Procedure 1**.

5.2 To have better access to the Regulator Board **(8)** disconnect the following cables:

Disconnect the cables from the Power Supply Board **(7)** terminals, WL1-WL3 and WL5-WL7. These terminals are directly over the Regulator Board.

Disconnect the cables from the terminals of the Line Filter **(10)** that are next to the Regulator Board. See **Figure 12** for 100V/120V units and **Figure 11** for 240V units for their location.

(Procedure 5 Continued)

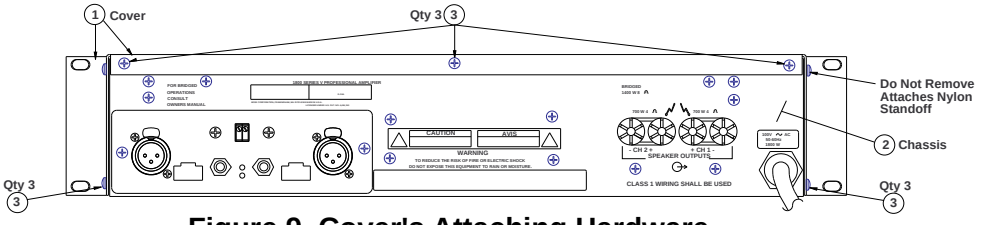


Figure 9. Cover's Attaching Hardware

5.3 Unsnap the Regulator Board from the nylon standoffs mounted on the Power Supply Board. This will also disengage the Regulator Board from the Power Supply's J1 connector.

6. Regulator Board Replacement

NOTE: Refer to **Figure 12** for this procedure.

6.1 Line up and insert the pins of the Regulator Board's **(5)** J1 connector (solder side) into the Power Supply's **(7)** J1 connector.

6.2 Carefully line up the holes of the Regulator Board **(8)** with the nylon standoffs mounted on the Power Supply Board. Snap three corners of the board onto each nylon standoff.

6.3 Connect the following cables:

NOTE: Refer to the Wiring Diagrams **(Figures 21 and 22)** for the proper connectivity.

Connect the cables from the Line Cord **(31)** (for 240V- Line cord and ground) to the Line Filters terminals **(10)**. Refer to **Figure 12** for 100V and 120V units and **Figure 11** for 240V units.

Connect the cables to Power Supply Board **(7)** terminals, WL1-WL3 and WL5-WL7. These terminals are directly over the Regulator Board.

6.4 Return the cover **(1)** to the chassis **(2)**, **See Procedure 2**.

7. Power or Sequence Switch Removal

NOTE: Refer to **Figure 12** for 100V and 120V units and **Figure 11** for 240V units.

7.1 Remove the cover **(1)**, **see Procedure 1**.

7.2 Unsolder the wires from the Power Switch Board's **(9)** E1-E3 terminals.

7.3 Unsolder the Power Switch Board from the switch.

7.4 Push the switch through the front of the chassis panel.

8. Power Switch Board Replacement

8.1 Push the switch into the chassis's **(2)** front panel. Refer to **Figures 11 and 12.**

8.2 Solder the Power Switch Board **(9)** to the switch's terminals. For 100V units, make sure the board's LED is lined up over the panel hole labeled "Standby" . For 240V units, make sure the board's LED is oriented underneath the "ON" position icon (⏍).

8.3 Solder the wires to the Power Switch Board's E1-E3 terminals. Refer to the Wiring Diagrams **(Figures 21 and 22)** for the correct wiring scheme.

8.4 Use **Procedure 2** to return the cover **(1)** to the chassis **(2)**.

9. Line Filter Removal

NOTE: Refer to **Figures 11-13.**

9.1 Remove the cover **(1)**, see **Procedure 1**.

9.2 Disconnect the cables attached to the line filter **(10)**.

9.3 Use a phillips-head screwdriver and a 5/16 wrench to remove the two screws **(11)** and locknuts **(12)** that attaches the line filter to the chassis **(2)**. The screws are driven from the bottom of the chassis.

9.4 Lift the Line Filter from the chassis.

10. Line Filter Replacement

NOTE: Refer to **Figures 11-13.**

10.1 Orient the Line Filter **(10)** into the chassis **(2)**. Refer to **Figure 12** for 100V/120V units and **Figure 11** for 240V units.

10.2 Secure the line filter to the chassis by tightening two screws **(11)** and locknuts **(12)** with a phillips-head screwdriver and 5/16" wrench. The screws are driven from the bottom of the chassis. Refer to **Figures 13 and 14**.

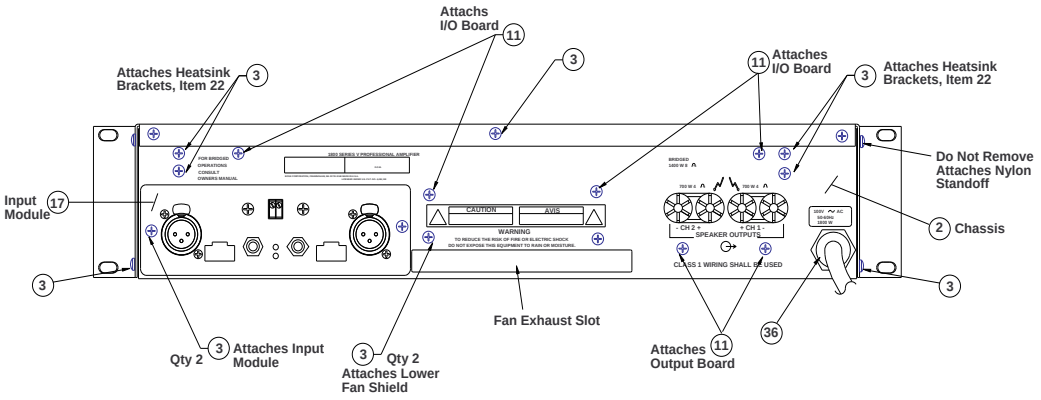
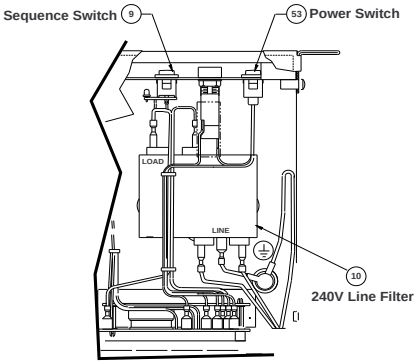


Figure 10. Rear View - Attaching Hardware

Figure 11. 240V Configuration



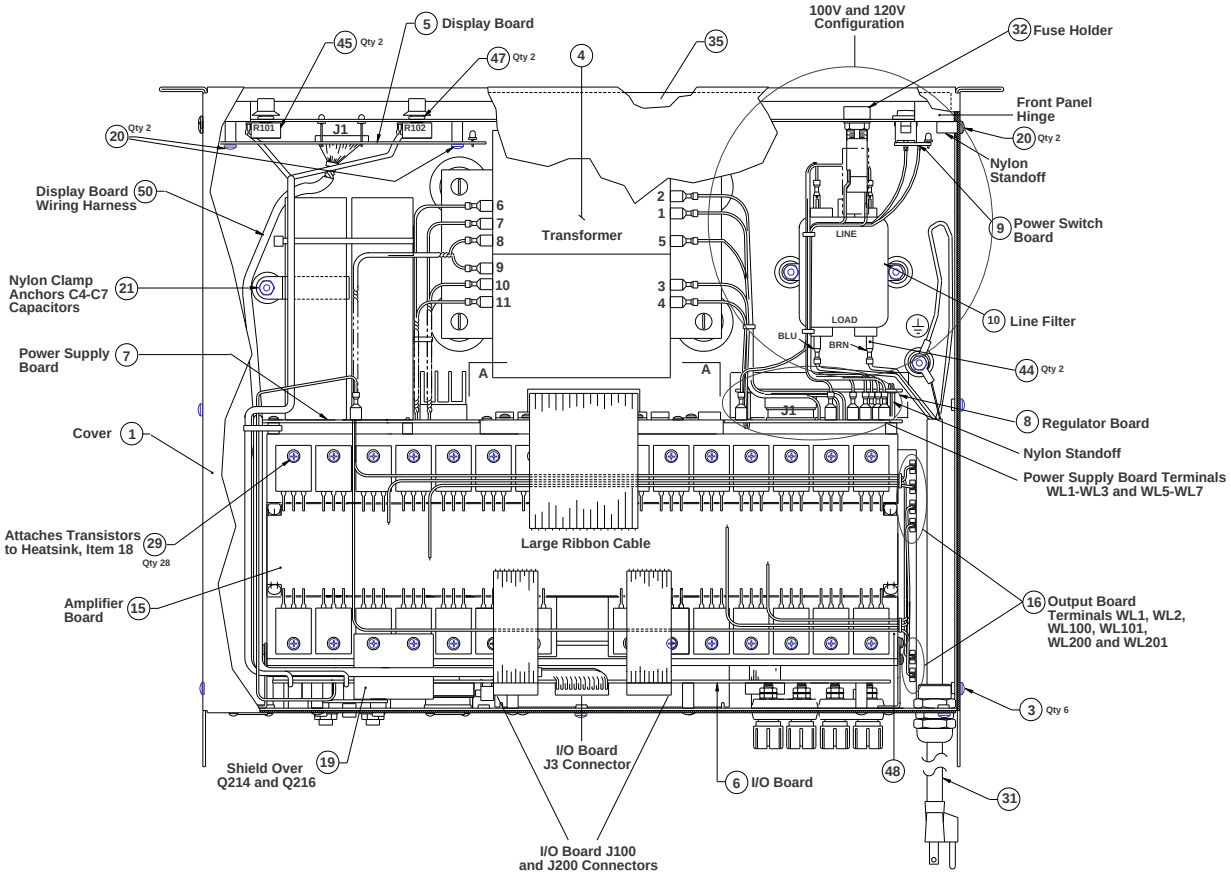


Figure 12. 1800-V Amplifier Assembly

10.3 Connect the cables from the Line Cord **(31)** and Power Supply to the terminals of the Line Filter. Refer to the Wiring Diagrams **(Figures 21 and 22)** if you are not sure of the wiring scheme.

10.4 Return the cover **(1)** to the chassis **(2)**, see **Procedure 2**.

11. Transformer Removal

11.1 Remove the cover **(1)**, see **Procedure 1**.

11.2 Disconnect all connectors attached to the transformer's **(4)** terminals. Refer to **Figure 12**.

11.3 Place the chassis **(2)** on its side.

11.4 While holding the transformer with one hand, use a phillips-head screwdriver to remove four screws **(13)** and washers **(14)** from the bottom of the chassis. Refer to **Figure 13 and 14**.

11.5 Remove the transformer from the chassis.

12. Transformer Replacement

12.1 Place the chassis **(2)** on its side. Orient the transformer **(4)** in the chassis so the six terminal side of the transformer is next to the large capacitors of the Power Supply Board **(7)**. Refer to **Figure 12.**

12.2 While holding the transformer with one hand, use a phillips-head screwdriver to tighten four screws **(13)** and washers **(14)** from the bottom of the chassis. Refer to **Figures 13 and 14.**

12.3 Return the cables to their designated terminals on the transformer. Refer to the Wiring Diagrams **(Figures 21 and 22)** for proper connectivity.

12.4 Return the cover **(1)** to the chassis **(2)**, see **Procedure 2**.

13. Amplifier Board Removal

13.1 Remove the cover **(1)**, see **Procedure 1**.

13.2 Disconnect the following cables (Refer to **Figure 12**):

The two ribbon cables connected to the I/O Board **(6)** (J101, J201 from the Amplifier Board **(15)**).

The large ribbon cable (JP200) from the Power Supply Board **(7)**.

The cables connected to WL1, WL2, WL100, WL101, WL200, WL201 terminals on the Output Board **(16)**.

NOTE: Some cables are bundled together. Cut any wire wraps when necessary.

13.3 Use a phillips-head screwdriver to remove one screw **(29)** and washer from each of the twenty-eight transistors that attaches the Amplifier Board to the heatsink **(18)**. Refer to **Figure 12.**

13.4 Lift the Amplifier Board from the heatsink.

14. Amplifier Board Replacement

14.1 Place the Amplifier Board **(15)** onto the heatsink **(18)**. Orient the board so that the large ribbon cable is facing the Power Supply Board **(7)**. Refer to **Figure 12.**

14.2 Secure the Amplifier Board to the heatsink by tightening one screw **(29)** and washer to each of the twenty-eight transistors.

NOTE: Make sure the shield **(19)** is attached to Q214 and Q216 transistors. Refer to **Figure 12** for the shield's orientation.

14.3 Connect the following cables (Refer to **Figure 12**):

NOTE: Refer to the Wiring Diagrams **(Figures 21 and 22)** for the proper connectivity.

The two ribbon cables J101 and J201 to I/O Board **(6)** connectors, J100 and J200).

(Procedure 14 Continued)

The large ribbon cable (JP200) to the Power Supply Board **(7)** connector J2.

The Amplifier and Power Supply Board **(7)** cables to the Output Board's **(16)** WL1, WL2, WL100, WL101, WL200 and WL201 terminals.

14.4 Return the cover **(1)** to the chassis **(2)**, see **Procedure 2**.

15. Output Board Removal

15.1 Remove the cover **(1)**, see **Procedure 1**.

15.2 Disconnect the following cables (Refer to **Figure 12**):

NOTES: Some cables are bundled together. Cut wire wraps when necessary.

The Display Board's **(5)** wiring harness from the I/O Board's **(6)** J3 connector.

The Amplifier Board's **(15)** two ribbon cables from the I/O Board's J100 and J200 connectors.

The cables connected to the Output Board's **(16)** WL1, WL2, WL100, WL200 and WL201 terminals.

Unsolder the red and white wires from the I/O Board's E10 and E11 terminals. They are located near the Amplifier Board's transistor shield **(19).**

The cables from the Power Supply's WL1-WL8 terminals.

All the cables connected to the transformer.

15.3 Use a phillips-head screwdriver and 5/16 wrench to remove one screw **(20)** and locknut **(12)** from the nylon clamp **(21)** that fastens the Power Supply's **(7)** large, C4-C7 capacitors to the chassis **(2)**. Refer to **Figures 12 and 14.**

15.4 Use a phillips-head screwdriver to remove four screws **(29)** from the two brackets **(22)** that secures the heatsink **(18)** to the inside of the chassis's back panel. Refer to **Figure 14.**

15.5 To release the heatsink base from the bottom of the chassis, use a phillips-head screwdriver to remove four screws **(3)** from the chassis's bottom panel. Refer to **Figure 14.**

15.6 Move the entire heatsink away from the Output Board.

15.7 Disconnect the fan's **(23)** J1 connector from the Output Board's J3 connector. Refer to **Figure 13**.

15.8 Disconnect the I/O Board's ribbon cable from the Output Board's J2 connector. Refer to **Figure 13.**

15.9 Use a phillips-head screwdriver to remove two screws **(11)** that fasten the Output Board to the bottom of the chassis. Refer to **Figure 13.**

15.10 Use a phillips-head screwdriver to remove two screws **(11)** on the back panel that attach to two brackets on the Output Board. They are located underneath the red and black binding posts. Refer to **Figure 10.**

15.11 Use an 11/32 wrench and remove four nuts from the Binding Posts **(items 24 or 25)**. Refer to **Figure 13.** Release the wires from the posts.

15.12 Lift the Output Board out of the chassis.

16. Output Board Replacement

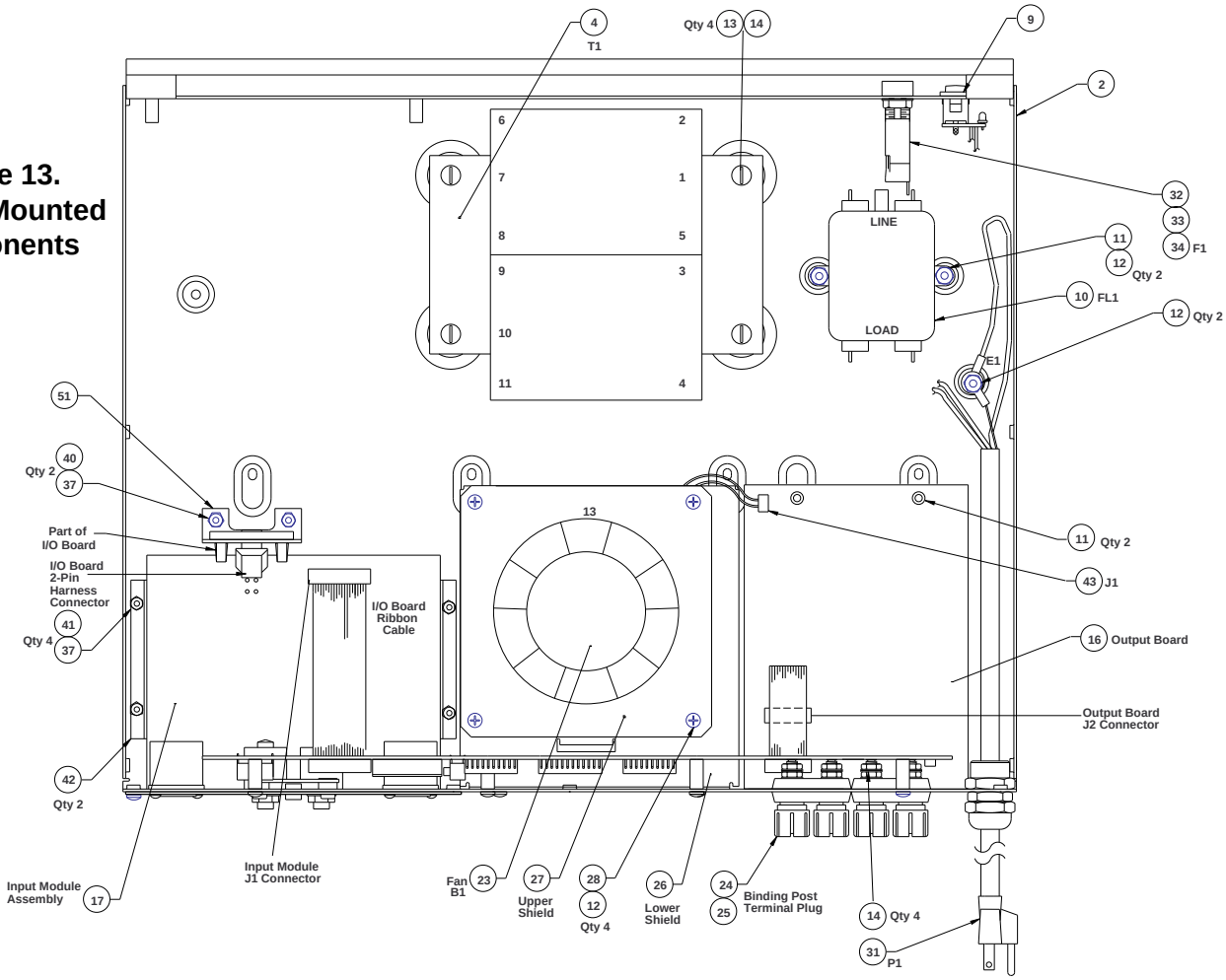
16.1 Place the Output Board **(16)** into the chassis **(2)**. Orient the board so the two brackets on the board face the back panel of the chassis.

16.2 Secure the Output Board to the bottom of the chassis by tightening two screws **(11)** with a phillips-head screwdriver. Refer to **Figure 13.**

16.3 Use a phillips-head screwdriver to tighten two screws **(11)** into the Output Board's two brackets. The screws are driven from the outside of the back panel. Refer to **Figure 10.**

(Procedure 16 Continued)

Figure 13. Bottom Mounted Components



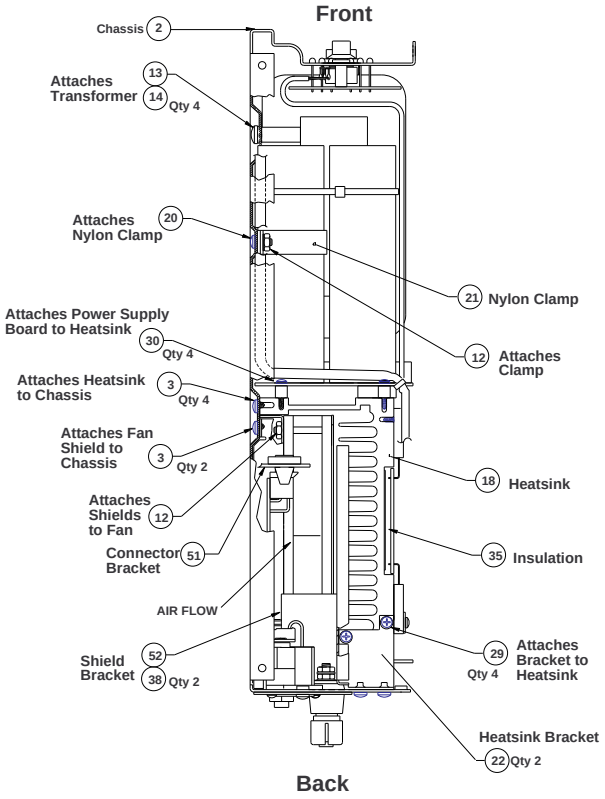


Figure 14. Side View - Bottom Mounted Components

16.4 Connect the Output Board's black wires to the binding posts **(items 24 or 25)** by tightening four nuts with an 11/32 wrench. Refer to **Figure 13** for their location. Refer to the wiring diagram for the proper wiring scheme.

16.5 Connect the I/O Board's **(6)** ribbon cable to the Output Board's J2 connector. Refer to **Figure 13.**

16.6 Connect the fan's **(23)** connector to the Output Board's J3 connector. Refer to **Figure 13.**

16.7 Place the heatsink **(18)** back into place. Use a phillips-head screwdriver to tighten four screws **(29)** to the two brackets **(22)** that fasten the heatsink to the chassis's back panel. Refer to **Figures 10 and 14.**

16.8 Secure the heatsink to the bottom of the chassis by tightening four screws **(3)** with a phillips-head screwdriver. The screws are driven from the bottom of the chassis. Refer to **Figure 14.**

16.9 Secure the Power Supply's **(7)** large capacitors to the inside of the chassis by tightening one screw **(20)** and locknut **(12)** into the nylon clamp that wraps around one of the capacitors. Use a phillips-head screwdriver and 5/16" wrench. Refer to **Figure 14.**

16.10 Connect the following cables (Refer to **Figure 12**):

NOTE: Refer to the wiring diagrams (**Figures 21 and 22**) for the proper connectivity.

Connect the cables from the Amplifier **(15)** and Power Supply Board to the Outputs Board's WL1, WL2, WL100, WL200 and WL201 terminals.

Connect the Amplifier Board's ribbon cables to the I/O Board's J100 and J200 connectors.

Connect the Display Board's **(5)** wiring harness to the I/O Board's J3 connector.

Solder the red and white wires from the 2-pin harness connector to the I/O Board's E10 and E11 terminals. They are located near the Amplifier Board's transistor shield **(19).**

Connect the cables from the line filter **(10)**, Power or Sequence Switch Board **(9)** and fuse holder **(32)** to the Power Supplies WL1-WL8 terminals.

All the cables connected to the transformer.

16.11 Return the cover **(1)** to the chassis **(2)**, use **Procedure 2**.

17. Power Supply Board Removal

17.1 Use **Procedure 1** to remove the cover **(1)** from the chassis **(2)**.

17.2 Disconnect the Amplifier Board's **(15)** ribbon cable from the Power Supply's **(7)** J2 connector. Refer to **Figure 12.**

17.3 Unsolder the wiring from Power Supply terminals E5-E17. Refer to **Figure 12.**

17.4 Disconnect the wiring from Power Supply terminals WL1-WL8 .

17.5 Use a phillips-head screwdriver and 5/16 wrench to remove one screw **(20)** and locknut **(12)** from the nylon clamp **(21)** that secures the Power Supply's large capacitors to the chassis. Refer to **Figures 12 and 14.**

17.6 Remove two screws **(30)** and washers from the heatsink bridge with a phillips-head screwdriver. **Refer to Figure 15.**

17.7 Disconnect the Regulator Board **(8)** from the Power Supply, use **Procedure 5**.

17.8 Remove four screws **(30)**, one from each corner of the Power Supply Board with a phillips-head screwdriver.

17.9 Lift the Power Supply Board from the chassis.

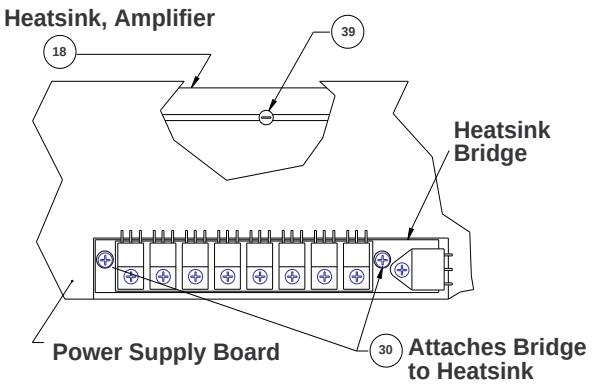


Figure 15. Heatsink Bridge

18. Power Supply Replacement

18.1 Attach the Power Supply Board **(7)** to the heatsink **(18)** by tightening four screws **(30)** into each corner of the board. Use a phillips-head screwdriver. Refer to **Figure 14.**

18.2 Seat the Regulator Board into the Power Supply Board, see **Procedure 6.**

18.3 Secure the Power Supply's heatsink bridge to the heatsink by tightening two screws **(30)** and washers with a phillips-head screwdriver. Refer to **Figure 15.**

18.4 Secure the Power Supply's large capacitors to the chassis by tightening one screw **(20)** and locknut **(12)** into the nylon clamp **(21).** Use a phillips-head screwdriver and 5/16 wrench. See **Figure 14.**

18.5 Connect the following (Refer to **Figure 12**):

NOTE: Refer to the Wiring Diagrams **(Figures 21 and 22)** for proper connectivity.

Connect all wiring back to the Power Supply's WL1-WL8 terminals.

Solder all wires designated to the Power Supply E5-E17 terminals .

Connect the Amplifier Board's ribbon cable to the Power Supply's J2 connector.

18.6 Return the cover **(1)** to the chassis **(2)**, use **Procedure 2**.

19. Fan Removal

Refer to **Figure 13** for the location of the fan and shields.

19.1 Remove the cover **(1)** from the chassis **(2)**, use **Procedure 1**.

19.2 Use **Procedure 15, Steps 15.2-15.6** to move the heatsink **(18)** (with the Amplifier, Power Supply and Regulator Boards attached) and to allow access to the fan **(23)**.

19.3 Release the fan and shield **(26)** from the chassis's back panel by removing two screws **(3)** with a phillips-head screwdriver. The screws are located over the fan's exhaust slot. Refer to **Figure 10.**

19.4 Release the lower shield from the bottom of the chassis by removing two screws **(3)** with a phillips-head screwdriver. Refer to **Figure 14.**

19.5 Disconnect the fan's cable (J1) from the Output Board's **(16)** J3 connector.

19.6 Lift out the fan and shield. To disassemble the fan from the shields, (upper **(27)** and lower **(26)**) use a phillips-head screwdriver and 5/16" wrench to remove four screws **(28)** and locknuts **(12)**. Refer to **Figure 13.**

20. Fan Replacement

20.1 Place the fan **(23)** label-side down onto the lower shield **(26)**. The fan is seated flush on one side of the lower shield and a 1/2" space on the other side. Orient the fan so the red and black wires are on the side of the shield with the 1/2" space. Refer to **Figure 13.**

20.2 Place the upper shield **(27)** on the back of the fan. Use a phillips-head screwdriver and 5/16" wrench to tighten four screws **(28)** and locknuts **(12)**.

20.3 Secure the fan and shield to the chassis's back panel by tightening two screws **(3)** with a phillips-head screwdriver. The screws are located over the fan's exhaust slot. Refer to **Figure 10.**

20.4 Secure the lower shield to the bottom of the chassis by tightening two screws **(3)** with a phillips-head screwdriver. Refer to **Figure 14.**

20.5 Connect the fan's cable into the Output Board's **(16)** J3 connector (Pin 1 is red, Pin 2 is black).

20.6 Use **Procedure 16, Steps 16.7-16.11** to install the heatsink **(18)** and cabling.

20.7 Return the cover **(1)** to the chassis **(2)**, use **Procedure 2**.

21. I/O Board Removal

21.1 Use **Procedure 15, Steps 15.1-15.5** to remove the chassis cover **(1)**, disconnect cabling, and to move the heatsink **(18)**, which will allow access to the I/O Board **(6)**.

21.2 Disconnect the I/O Board's ribbon cable from the Output Board's **(16)** J2 connector. Refer to **Figure 13.**

21.3 To release the I/O Board from the chassis's back panel, use a phillips-head screwdriver to remove four screws **(11)** from the board's standoffs. Refer to **Figure 10.**

21.4 Unsolder the cables from the I/O Board's E1-E9 terminals.

21.5 Lift the I/O Board from the chassis.

22. I/O Board Replacement

22.1 Place the I/O Board **(6)** into the chassis **(2)**, with the component side of the board facing the back panel.

22.2 Solder the cables from the Display **(5)** and Power Supply Board **(7)** to the I/O Board's E1-E9 terminals. Refer to wiring diagrams **(Figures 21 and 22)** for proper connectivity.

22.3 Connect the I/O Board's ribbon cable back into the Output Board's **(16)** J2 connector. Refer to **Figure 13.**

22.4 Attach the I/O Board to the chassis's back panel by tightening four screws **(11)** with the phillips-head screwdriver. The screws are driven from the outside of the back panel. Refer to **Figure 10.**

22.5 Use **Procedure 16, Steps 16.7-16.11** to install the heatsink **(18)** and cabling.

22.6 Return the cover **(1)** to the chassis, use **Procedure 2**.

23. Input Module Removal

23.1 Use a phillips-head screwdriver to remove two screws **(3)** from the Input Module's **(17)** connector panel. Refer to **Figure 10.**

23.2 Pull out the Input Module from the chassis **(2)**.

23.3 Disconnect the I/O Board's **(6)** ribbon cable from the Input Module's J1 connector. Refer to **Figure 13.**

23.4 Once the Input Module is out from the amplifier chassis the equalization cards can be accessed for removal.

24. Input Module Replacement

24.1 Put the Input Module **(17)** into its designated slot far enought so you can connect the I/O Board's **(6)** ribbon cable into the Input Module's J1 connector. Refer to **Figure 13.**

24.2 Slide the Input Module into the chassis slot until the Input Module's J2 connector is completely seated into the I/O Board's two-pin Harness connector. The Module should be flush with the chassis's back panel. Refer to **Figure 13.**

24.3 Secure the Input Module to the Amplifier's chassis by tightening two screws **(3)** with a phillips-head screwdriver. Refer to **Figure 10.**

TEST PROCEDURES

AMPLIFIER TEST PROCEDURES

1. Full Power Distortion

Use the following test conditions for measuring distortion in **Sections 1.1 and 1.2:**

- Connect the signal source to the **CH1** or **CH2** inputs
- Set the signal source to output **1.5 ± .1 Vrms @ 1 kHz Low Sensitivity, .775Vrms High Sensitivity**
- Set the **CH1** and **CH2** Level Controls to the full on position (full clockwise)
- The voltage at the amplifier's outputs shall be a least: **60 Vrms into 8Ω; 50 Vrms into 4Ω**
- Connect a **30 kHz** low-pass filter to the measurement equipment

1.1 Full Power Distortion: While following the test conditions outlined above, the total harmonic distortion should be ≤ **.5% @ 1 kHz** for all amplifier outputs.

1.2 Low Level Distortion: Set the **CH1** and **CH2** Level Controls to obtain **6.25 Vrms ± 1%** across **4Ω** at the speaker outputs. The total harmonic distortion for all outputs should be ≤ **0.1%**.

2. Frequency Response

2.1 Apply a **1 kHz** signal to **CH1** and **CH2**, and adjust the output to **6Vrms**.

2.2 Reference a dB meter to the **CH1** or **CH2** output.

2.3 Measure the response according to the following table:

Frequency	Output
20 Hz	± .75 dB
20 kHz	± .75 dB

3. DC Offset

Take this measurement without applying a source signal.

3.1 Connect a DC meter to the amplifier's output.

3.2 There should be ≤ **50 mVDC** at the amplifier output.

EQ CARD TEST PROCEDURES

1. 402 Equalizer Curve

Use the following test set-up parameters when measuring Full Range or High Frequency response outputs:

A. Apply a signal of **850 Hz at 1 Vrms** and adjust the amplifier's output to **6 Vrms**.
B. Reference a dB meter to the output.
C. Measure the response according to the charts in **Sections 1.1 and 1.2**

1.1 402 Full Range Frequency Response

IMPORTANT: Set the Input Module's **S2** switch to the Full Bandwidth (Full Range) position before beginning this test.

FREQUENCY	OUTPUT SPECIFICATION (dbr)
60	-3.7±1.5 dB
105	+8.5±1.5 dB
220	+3.5±1.5 dB
850	0.0
4000	+5.8±1.5 dB
14500	+13.3±1.5 dB

1.2 402 High Frequency Response

IMPORTANT: Set the Input Module's **S2** switch to the HF Only (High Frequency) position before beginning this test.

FREQUENCY	OUTPUT SPECIFICATION (dbr)
60	-16.4±1.5 dB
105	-4.8±1.5 dB
220	+2.8±1.5 dB
850	0.0
4000	+5.8±1.5 dB
14500	+13.3±1.5 dB

2. 502A Equalizer Curve

Use the following test set-up parameters when measuring Full Range or High Frequency response outputs:

A. Apply a signal of **600 Hz** at **1 Vrms** and adjust the amplifier's output to **6 Vrms.**
B. Reference a dB meter to the output.
C. Measure the response according to the charts in **Sections 2.1 and 2.2.**

2.1 502A Full Range Frequency Response

IMPORTANT: Set the Input Module's **S2** switch to the Full Bandwidth (Full Range) position before beginning this test.

FREQUENCY	OUTPUT SPECIFICATION (dbr)
40	-24.5±2.0 dB
140	+4.3±1.5 dB
600	0.0
2200	+3.5±1.5 dB
5000	+12.5±1.5 dB
15000	+19.0±1.5 dB

2.2 502A High Frequency Response

IMPORTANT: Set the Input Module's **S2** switch to the HF Only (High Frequency) position before beginning this test.

FREQUENCY	OUTPUT SPECIFICATION (dbr)
40	-28.5 ± 2.0 dB
140	+3.7 ± 1.5 dB
600	0.0
2200	+3.5 ± 1.5 dB
5000	+12.5 ± 1.5 dB
15000	+19.0 ± 1.5 dB

3. 502B Equalizer Curve

Use the following test set-up parameters when measuring the 502B card's response outputs:

A. Apply a signal of **80 Hz** at **1 Vrms** and adjust the amplifier's output to **6 Vrms**.
B. Reference a dB meter to the output.
C. Measure the response according to the following chart.

FREQUENCY	OUTPUT SPECIFICATION (dbr)
40	-6.2 ± 2.0 dB
80	0.0
100	+1.3 ± 1.0 dB
300	-17.5 ± 2.0 dB

4. 802 Equalizer Curve

Use the following test set-up parameters when measuring Full Range or High Frequency response outputs:

A. Apply a signal of **700 Hz** at **1 Vrms** and adjust the amplifier's output to **6 Vrms.**
B. Reference a dB meter to the output.
C. Measure the response according to the charts in **Sections 4.1 and 4.2.**

4.1 802 Full Range Frequency Response

IMPORTANT: Set the Input Module's **S2** switch to the Full Bandwidth (Full Range) position before beginning this test.

FREQUENCY	OUTPUT SPECIFICATION (dbr)
40	+8.0±1.5 dB
55	+13.5±1.5 dB
140	+6.6±1.5 dB
700	0.0 dB
2500	+2.1±1.5 dB
6000	+9.6±1.5 dB
14500	+16.7±1.5 dB

4.2 802 High Frequency Response

IMPORTANT: Set the Input Module's **S2** switch to the HF Only (High Frequency) position before beginning this test.

FREQUENCY	OUTPUT SPECIFICATION (dbr)
40	-21.0±1.5 dB
60	-11.5±1.5 dB
700	0.0
2500	+2.1±1.5dB
6000	+9.6±1.5dB
14500	+16.7±1.5dB

PART LISTS AND EXPLODED VIEWS

The following section contains part lists and exploded views for the 1800-V Amplifier. The part lists are broken down as follows:

- Main Assembly and Exploded Views
- Packaging Part List and Exploded View

Electrical and Mechanical Part Lists:

- Display PCB Assembly
- Input/Output (I/O) PCB Assembly
- Power Supply PCB Assembly
- Regulator PCB Assembly
- Power Switch PCB Assembly
- Amplifier PCB Assembly
- Output PCB Assembly
- Input Module Assembly (includes: Input PCB, Barrier PCB and Dual Input Panel Assembly)
- 402 Equalizer PCB Assembly
- 502A Equalizer PCB Assembly
- 502B Equalizer PCB Assembly
- 802 Equalizer PCB Assembly

PCB layouts and schematics are located in the back of the service manual.

1800-V MAIN ASSEMBLY PART LIST

Item Number	Decription	Part Number	Qty Per Assy	See Note
1	Cover, Top	182740	1	
2	Chassis, Gray	182739	1	
3	Screw, SM PP Serr. BLK 6x1/4 B	182721	23	
⚠4	Transformer, UI,1250W,MAG UI,IEC,**230V**	182765	1	1
	Transformer, UI,1250W,MAG UI,**120V**	182766	1	1
	Transformer, UI,1250W,MAG UI,**100V**	182767	1	1
5	CCA, Display	182762	1	2
6	CCA, I/O 1800 Series V	182758	1	2
⚠7	CCA, Power Supply	182757	1	1,2
8	CCA, Regulator	182760	1	2
⚠9	CCA, Power Switch	182761	1	1,2
⚠10	Line Filter, 16A/20A **120V & 100V**	182763	1	1
	Line Filter, W/Tabs, 8A 250V **230V**	182764	1	1
11	Screw, SEMS PP BLKOX WX 6-32x1/4	182723	10	
12	Nut, Lock 6-32 X 5/16, Zinc	182728	9	
13	Screw, Mach. PP BLK, 10-32x3/8	182719	4	
14	Washer, Int Lock #10 CAD PLTD	182730	8	
15	CCA, Amplifier,	182756	1	2
16	CCA, Output, PM	182759	1	2
17	Input Module Assembly	182755	1	2
18	Heatsink, Amplifier	182745	1	
19	Shield, Noise (Q214, Q216)	182749	1	

NOTES:

1. ⚠ This part is critical for safety purposes. Failure to use a substitute replacement with the same safety characteristics as the recommended replacement part might create shock, fire and/or other hazards.
2. This part is not normally available from Customer Service. Approval from the Field Service Manager is required before ordering.

1800-V MAIN ASSEMBLY PART LIST

Item Number	Decription	Part Number	Qty Per Assy	See Note
20	Screw,SEMS PP BLKOX WX 6-32x3/8	182724	6	
21	Clamp, Cable, Nylon 1.38"	182732	1	
22	Bracket, Heatsink	182741	2	
23	Fan, 24 VDC High Flow, B1	182710	1	
24	Post, BDG, Dual Short Red/BLK **120V & 100V**	182711	2	
	Post, BDG, Dual Short RT Entry **230V**	182712	1	
	Post, BDG, Dual Short LT Entry **230V**	182713	1	
25	Plug, Terminal Blanking, Red **230V**	182714	2	
	Plug, Terminal Blanking, Blk **230V**	182715	2	
26	Shield, Fan, Lower	182751	1	
27	Shield, Fan, Upper	182748	1	
28	Screw, BLK, FH 100DEG 6-32x1-1/4	182718	4	
29	Screw, Pan HD #4 SLFTPG W/WSHR 1/2"	182722	32	
30	Screw SHT MTL PP BLK 4x9/16	182720	6	
⚠ 31	Line Cord Europe, 16A, 7' **230V**	182737	1	1
	Line Cord, 14/3 SJT SHLD 15A Dom. 7, P1 **120V & 100V**	182738	1	1
32	Fuse Holder Panel MNT 120-230V	182706	1	
33	Fuse Carrier **120V & 100V**	182707	1	
	Fuse Carrier **230V Europe**	182708	1	
⚠ 34	Fuse,15 Amp,250V, F1, **for100V & 120V**	182736	1	1
	Fuse, 8 Amp, Time Lag, **for 240V**	183551	1	1
35	Insulation,Film	182709		
36	Strain Relief, Threaded	182716	1	

NOTE:

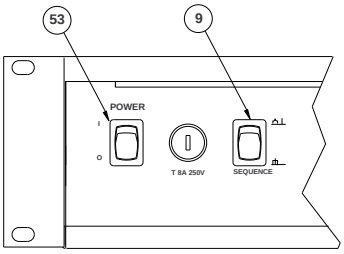
1. ⚠ This part is critical for safety purposes. Failure to use a substitute replacement with the same safety characteristics as the recommended replacement part might create shock, fire and/or other hazards.

1800-V MAIN ASSEMBLY PART LIST

Item Number	Decription	Part Number	Qty Per Assy	See Note
37	Screw, BLK FH 100 DEG 4-40X1/2,Card Slide	182717	6	
38	Screw SM #4 FHP 100DG 1/4"	182725	2	
39	Screw 4-40 Slot PNH NYL 6/6 3/8	182726	1	
40	KEPNUT, 4-40 ZC	182727	2	
41	Nut, 4-40 Mini	182729	4	
42	Slide, Card	182731	2	
43	Connector .100 Ctr 2-pin	182733	1	
44	Fast NYL 16-14Awg. BLU .250	182734	2	
45	Potentiometer,1KB 11 Detent R101,R102	182735	2	
46	Knob, Soft Touch - 13mm	182744	2	
47	Nut,Metric Dress 7mm	182746	2	
48	Insulator, Sil-Pad, K-6, 7-Pos	182747	4	
49	Shield, Pot Noise	182750	1	
50	Narness Conn, 13 Pin 22 Awg. 23"	182754	1	
51	Bracket, Connector	182742	1	
52	Bracket, Shield	182743	1	
⚠53	Switch, Rocker, SPST, QICDIS, 15A, **for 240V**	183550	1	1
54	402 Equalizer Card	177333	1	2
55	502A Equalizer Card	177342	1	2
56	502B Equalizer Card	177349	1	2
57	802 Equalizer Card	177356	1	2

NOTES:

1. ⚠ This part is critical for safety purposes. Failure to use a substitute replacement with the same safety characteristics as the recommended replacement part might create shock, fire and/or other hazards.
2. This part is not normally available from Customer Service. Approval from the Field Service Manager is required before ordering.



240V Variation

Figure 16. Front Panel Views

100V and 120V Variation

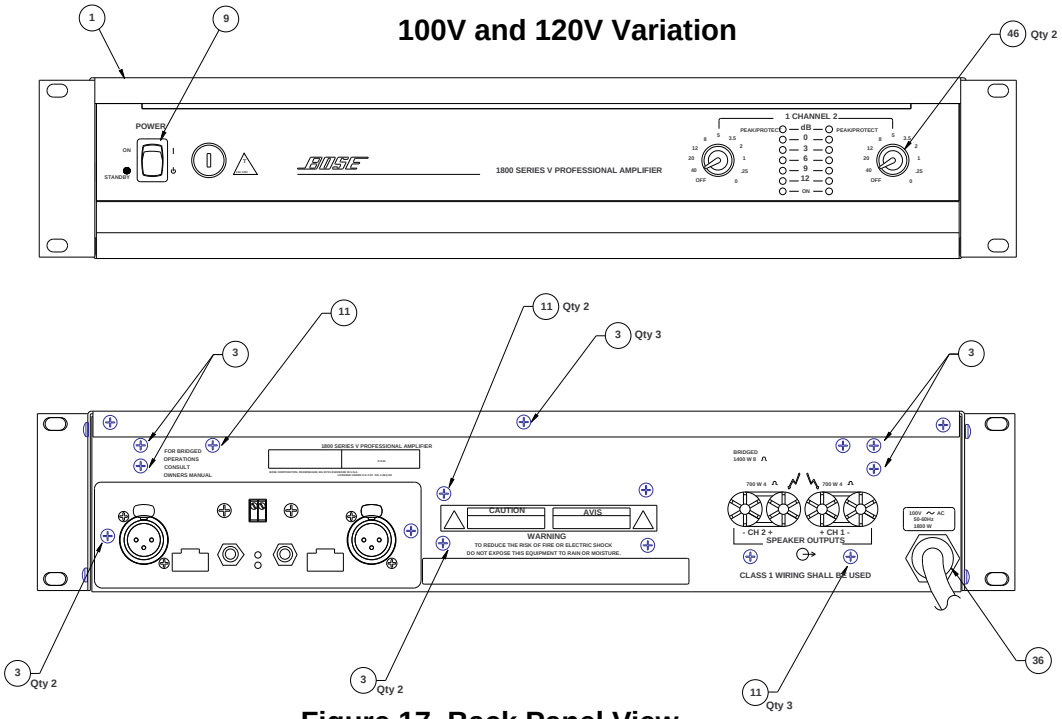


Figure 17. Back Panel View

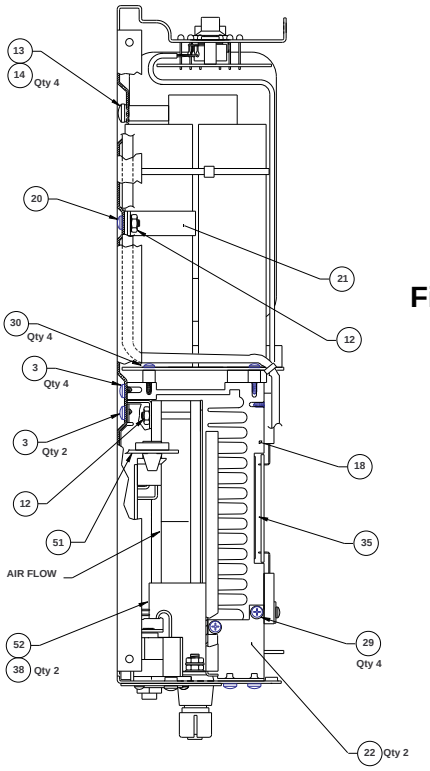


Figure 18. Cross Section View

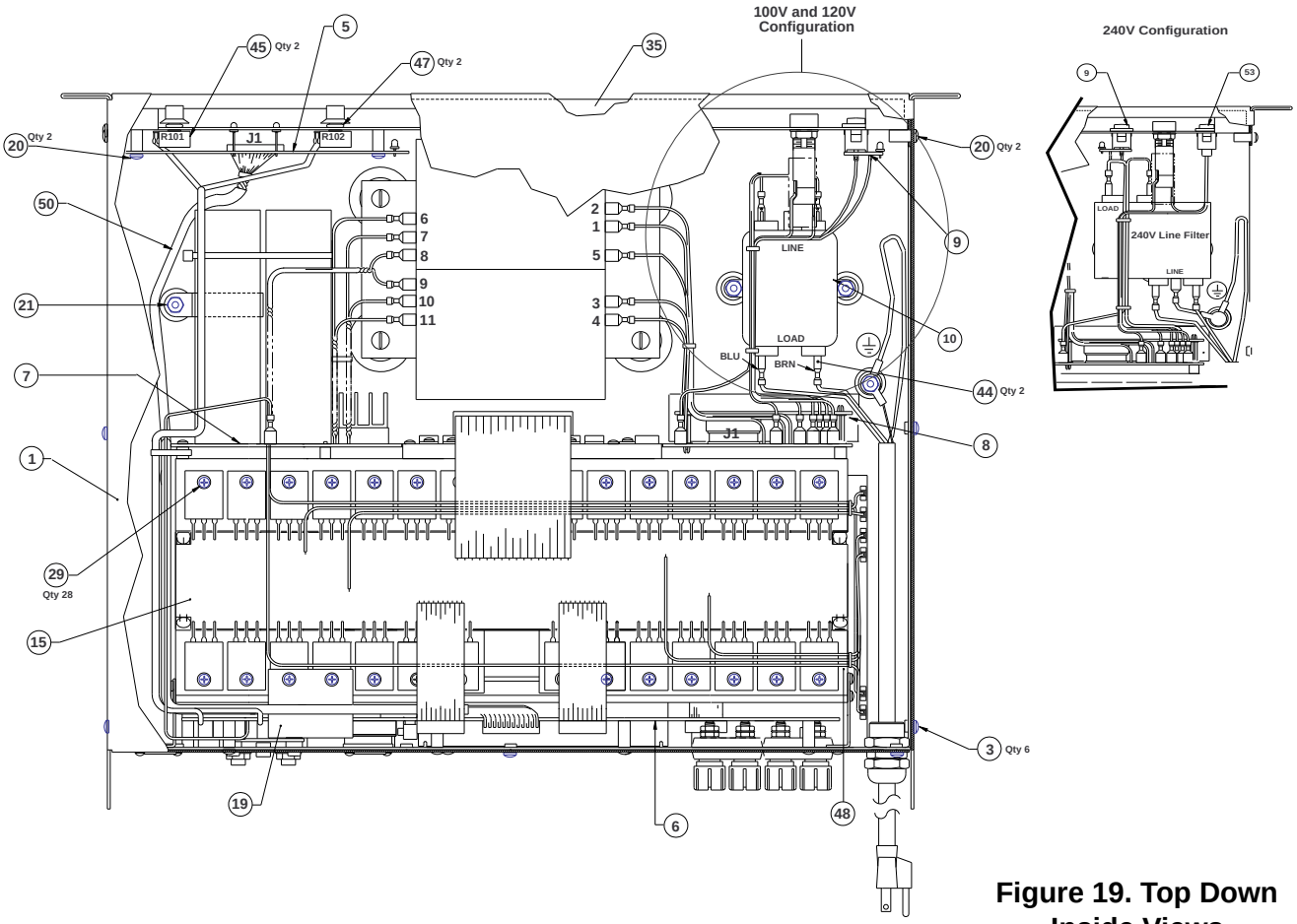
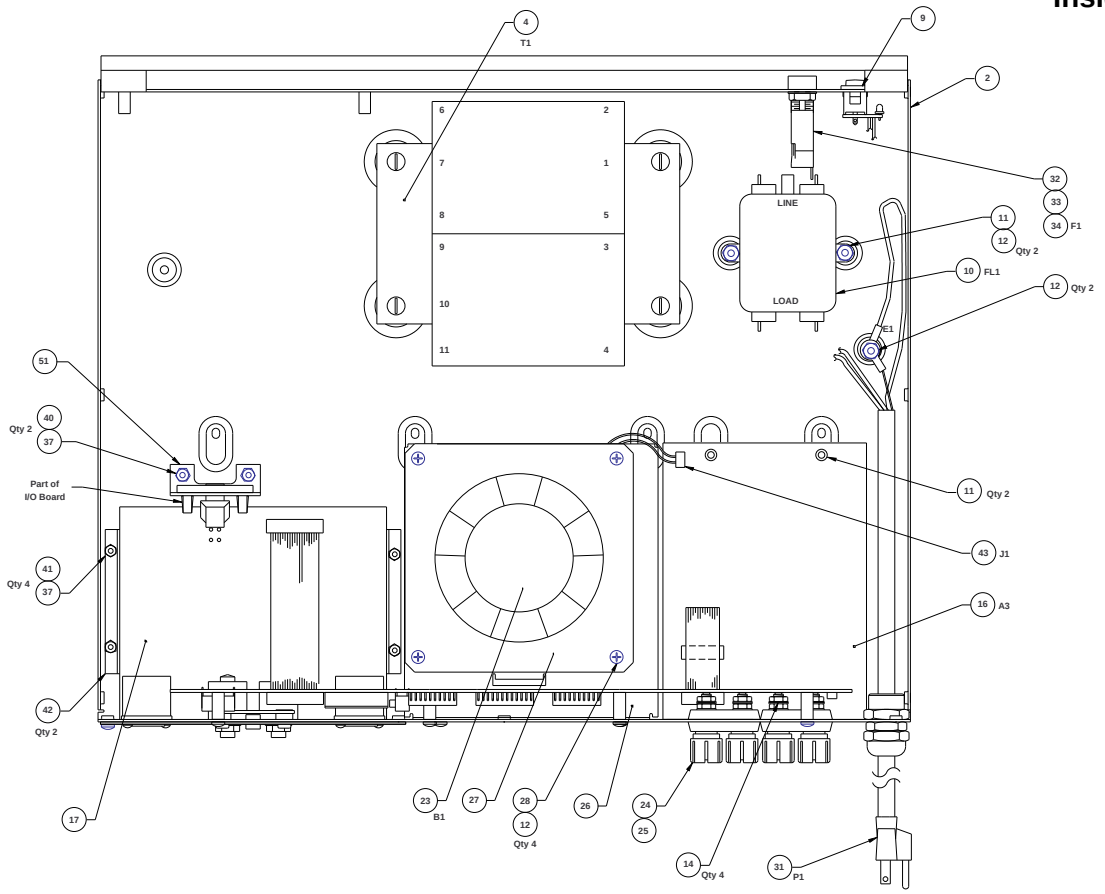


Figure 19. Top Down Inside Views



1800-V PACKAGING PART LIST

Item Number	Decription	Part Number	Qty Per Assy	See Note
1	Box Shipping, Amplifier	177326	1	
2	Packing Insert, Amplifier	182752	1	
3	Packaging Foam	182753	4	
4	Manual, User	179353-1	1	
5	Polybag, Amplifier	182768	1	
6	Literature Kit, EQ Cards	178857	1	
7	Bag, Antistatic, EQ Cards	177761	1	
8	Envelope, Corrugated	180135	1	
9	Connector Assembly, 502B Card Only (Summing Wire)	180137	1	
10	Feet (Not Illustrated)	142839	4	

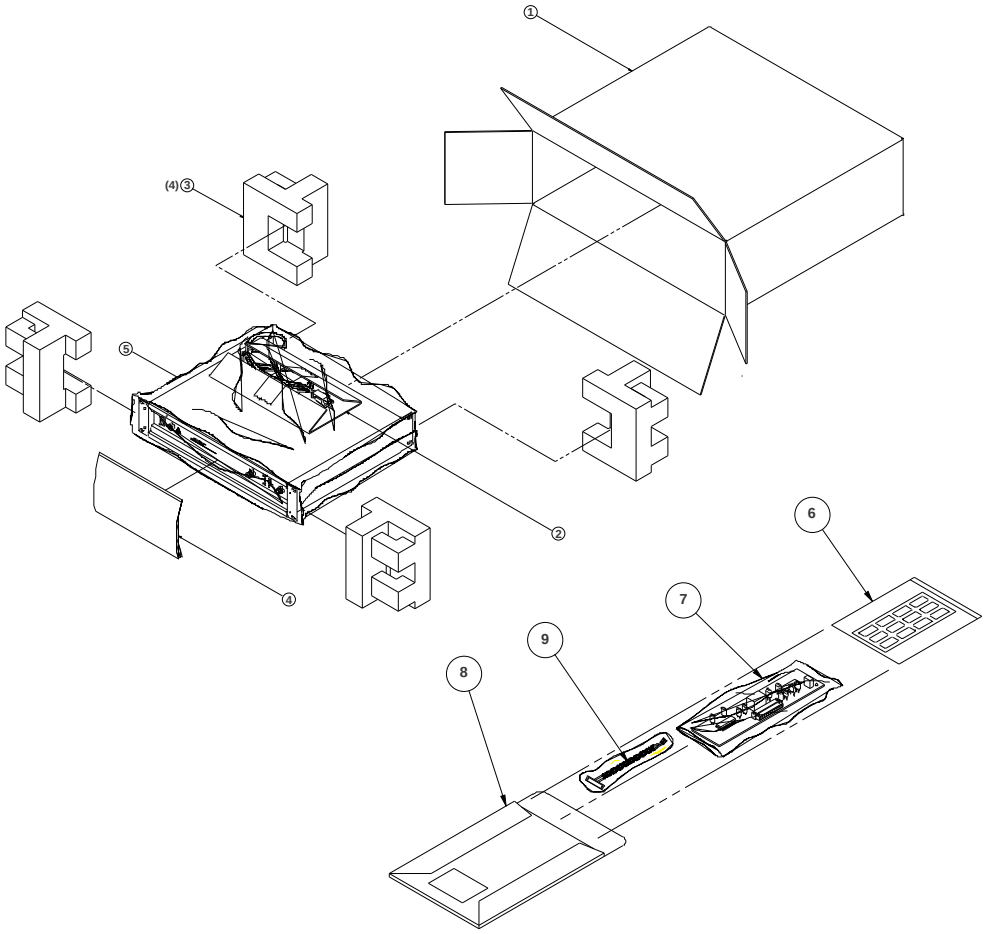


Figure 20. 1800-V Amplifier and EQ Card Packaging Illustration

1800-V ELECTRICAL AND MECHANICAL PART LISTS

Display PCB Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R9,10,13,17,24,35	10KΩ,1% 1/4W,MF	182800	
R11,18	2.21KΩ,1%,1/4W, MF	182908	
R12,19	150KΩ,5%,1/4W,CF	182974	
R14,36	2.74KΩ,1%,1/4W, MF	182976	
R15,20,22,25,26,28, 31,34	30.1KΩ,1%,1/4W, MF	182977	
R16,21,23,27,29,32	7.5KΩ,1%,1/4W,MF	182978	
R103,149,164,203	10KΩ,5%,1/4W,CF	182789	
R104,204	3.3KΩ,5%,1/4W, FLMPRF	182979	
R112,212	7.5KΩ,5%,1/2W,CF	182975	
R113,142,202,213	2.2KΩ,5%,1/4W,CF	182793	

Capacitors

Reference Designator	Description	Part Number	Reference
C1,2	1μF,50V,LYTIC, Axial	182973	
C3-6	.01μF,100V,Cer. MULTILYR RD	182780	

Diodes

Reference Designator	Description	Part Number	Reference
D1,105,205	LED, Red/Green 3MM	182982	
D10,21-25,100,101, 107,200,201,207	1N4148,75V	182868	
D11-20	LED, Yellow	182981	
D104,204	LED, Red	182980	

Transistors

Reference Designator	Description	Part Number	Reference
Q100,200	TO92,PNP,SM,SG 2N4125	182815	

Integrated

Reference Designator	Description	Part Number	Reference
U1-4	Dual Op-Amp 4558,8 PIN SIP	182914	

Connectors

Reference Designator	Description	Part Number	Reference
J1	Header, 13 Pin, .1 Lock RTANG	182972	

I/O PCB Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R1,3	62KΩ,5%,1/4W,CF	182906	
R5,15,67	2.2KΩ,5%,1/4W,CF	182793	
R6	4.7Ω,5%,1/4W, FLMPRF	182808	
R7,18	100KΩ,5%,1/4W,CF	182790	
R8,12,20,27,28,53, 96,97,99,100	10KΩ,1%,1/4W,MF	182800	
R9,11,56,92	1KΩ,5%,1/4W,CF	182788	
R10,26,63,76	200KΩ,5%,1/4W,CF	182901	
R13,16,30,38,44,59, 60,R62,66,78,81,95	10KΩ,5%,1/4W,CF	182789	
R14,65	3.6KΩ,5%,1/4W,CF	182794	
R17,91	2.7KΩ,5%,1/4W,CF	182902	
R19,70	30KΩ,5%,1/4W,CF	182852	
R21,22,71,72	27KΩ,5%,1/4W,CF	182903	
R23,73	510KΩ,5%,1/4W,CF	182798	
R24,74	330KΩ,5%,1/4W,CF	182904	
R29,77	910Ω,5%,1/4W, FLMPRF	182810	
R31,79	4.7KΩ,5%,1/4W,CF	182796	
R40,83	29.4KΩ,1%,1/4W, MF	182909	
R41,84	2.21KΩ,1%,1/4W, MF	182908	
R42,85	11.5KΩ,1%,1/4W, MF	182907	
R43,86	825Ω,1%,1/4W,MF	182910	
R61,93	1MΩ,5%1/4W,CF	182900	
R69,94	3.9KΩ,5%,1/4W,CF	182905	

Capacitors

Reference Designator	Description	Part Number	Reference
C1,24	100µF,20%,25V, LYTIC RAD	182897	
C2,23	1µF,100V,20%, LYTIC RAD	182898	
C3,29	.18µF,5%,50V, MTL FLM	182893	
C4,5	270pF,5%,100V, Cer.,ML NPO	182891	
C6,7,17-22	.01µF,100V, Cer. MULTILYR. RD	182780	

Capacitors

Reference Designator	Description	Part Number	Reference
C8,30	680pF,5%,100V, Cer.,ML NPO	182892	
C9,25,33,34	4.7µF,20%,100V, LYTIC RD	182894	
C10,12,15,31	470pF,10%,1000V, Cer. Disc	182890	
C11,26	22µF,25V,20%, LYTIC RAD	182841	
C13,27	220µF,20%,10V, LYTIC	182899	
C14,28	47µF,20%,25V, LYTIC RAD	182896	
C16,32	10µF,20%,50V, LYTIC RAD	182895	

Diodes

Reference Designator	Description	Part Number	Reference
D1,2,6-9,12-18, 20-24,27,29,30-34, 36	1N4148 75V	182868	
D3,4	Bridge Rectifier, 50V,1.0 AMP, DF005	182912	
D5,19	175 WIV High Speed	182812	
D10,26	1N4004,400V,PREP	182811	
D35,37	Zener 1N4744A 15V	182869	

Transistors

Reference Designator	Description	Part Number	Reference
Q1,3,6,10	TO92 PNP SM SG MPSA93	182873	
Q2,7	TO92 NPN SM SG MPSA06	182874	
Q5,13	TO92 NPN SM SG 2N4123	182913	

Integrated Circuits

Reference Designator	Description	Part Number	Reference
U1	Op-Amp, Dual, JFET 9-PIN SIP	182915	
U2,7,9	Dual Op-Amp 4558,8 PIN, SIP	182914	
U3,8	Optoisolator, VTL5C4	199766	

Connectors

Reference Designator	Description	Part Number	Reference
J1	Harn, Conn, 20 Pin, 28 Awg, 6"	182919	
J100,200	Header 10-Pin Rt. Angle Square	182888	
J3	Header, 13-Pin .1 Rt Ang Flat	182889	
J6	Harn, Conn, 14 Pin, #28, 6" Blind Mate Qty 1	182918	

Miscellaneous

S1,2	Switch Slide,Right Angle DPDT	182911	
	Harn, 2-pin 22awg	182920	

Power Supply PCB Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R1	270Ω,5%,1/4W,CF	182850	
R2	8.2Ω,5%,1/2W,CF	182857	
R3,12,21,32,41,52, 63	1KΩ, CF 5% 1/4W	182788	
R4	18Ω,5%,1/2W,CF	182849	
R5,9	6.2KΩ,5%,1/2W,CF	182856	
R6-8	1Ω,5%,1/4W, FLMPRF	182861	
R10,13,15,27,29,31, 42,44,46,59,60,62	10KΩ,1%,1/4W,MF	182800	
R11,30,43,61	511Ω,1/4W,1%,MF	182858	
R14,28,45,58	681Ω,1%,1/4W,MF	182859	
R16,47	3KΩ,5%,1/4W,CF	182851	
R17,23,39,48,54,71	10KΩ,5%,1/4W,CF	182789	
R18,49	5.1KΩ,5%,1/4W,CF	182855	
R19,50	30KΩ,1/4W,5%,CF	182852	
R20,35,51,66	910Ω,5%,1/4W, FLMPRF	182810	
R22,38,53,70	220Ω,5%,1/4W, FLMPRF	182863	
R24,40,55,69	100Ω,5%,1/4W, FLMPRF	182806	
R25,36,56,67	200Ω,5%,1/4W, FLMPRF	182862	
R26,37,57,68	15KΩ,5%,1/4W,CF	182848	
R33,64	220Ω,5%,1/4W,CF	182792	
R34,65	4.7KΩ,5%,1/2W,CF	182854	
R72	62KΩ,5%,1W,MO FP .8 AX LG	182860	
R73,75	470Ω,5%,1/4W,CF	182853	
R74,76	150Ω,5%,1/4W,CF	182847	

Capacitors

Reference Designator	Description	Part Number	Reference
C1,2	.1µF,250VAC, MTPOLY,UL/CSA	182846	
C3,9	22µF,20%,25V, LYTIC,RAD .	182841	
C4-7	22000µF,63V, LYTIC, SCRW MNT	182844	
C8	470µF,20%,63V, LYTIC,AX 1.7	182842	
C10,19,26,33	.1µF,100V,CER Multilayer RAD A	182838	
C11,27	.001µF,10%,100V PLYFLM, RD A	182839	
C12,18,21,28,32,35, 42,43	.0018µF,10%,100V, MYLAR, RAD	182840	
C13,20,29,34	390 pF,10%,1000V, Cer. Disc	182835	
C14,22,30,36	100µF,20%,25V, LYTIC,AX .95 D	182843	
C15,23,31,37	.01µF,20%,500V Cer. Disc	182836	
C16,17,24,25	.047µF,200V, Cer. Multilayer, RD A	182837	
C38-41	.01µF,100V,CER Multilayer,RD A	182780	
C44,45	10µF,100V, LYTIC, NP RAD .2 A	182845	

Diodes

Reference Designator	Description	Part Number	Reference
D1,2	Bridge Rectifier, 400V 25A	182866	
D3,6	ZENER,1N4745C 16V 1W 2%	182870	
D4,5,7,14,20,26,31	1N4004 400V PREP	182811	
D8-10,15,17,21-23, 27,28	1N4148 75V .4	182868	
D11,12,16,18,24,25, 29,30	ZENER 1N4744A, 15V .	182869	
D13	RECT HW Common Anode 16A 200V	182865	
D19	Rect. HW Com Cathode 16A 200V	182864	

Transistors

Reference Designator	Description	Part Number	Reference
Q1	Triac,Q6040K7,40A 600V,TO218AC	182867	
Q2	T0220 NPN 2N6488	182876	
Q3	T0220 PNP 2N6490	182877	
Q4,15	TO92 NPN SM SG MPSA43	182872	
Q5,7,12,16,18,23	TO92 PNP SM SG MPSA56	182875	
Q6,11,17,22	TO92 NPN SM SG MPSA06	182874	
Q8,13,19,24	152 NPN SM SG MPSW06	182871	
Q9,14,20,25	FET POWER IRFZ44	182878	
Q10,21	TO92 PNP SM SG MPSA93	182873	

Integrated Circuits

Reference Designator	Description	Part Number	Reference
U1	Opto-Triac Driver MOC3052	182880	
U2,3	Dual Volt Comparators, LM393	182879	

Connectors

Reference Designator	Description	Part Number	Reference
J1	Connector, 18 Pin Slg Row .100 Gold	182833	
J2	Hdr, Sq Pin .156 Ctr Tin 16pin A	182834	
JP3	Jumper,.2X.25 22AWG Insulated WHT	182881	
JP4	Jumper,Insulated, 18 AWG,	182882	
WL1-8	Connector,Qd Tab .250 Pcb	182825	

Miscellaneous

Description/ Location	Bose P/N	Quantity	Reference
Spacer, Push-In .250l	182826	2	
Spacer, Al .140 Id .250 Swg .25l	182827	4	
Standoff, Brs .25 Od 6-32 Swg .125 B	182828	2	
Heatsink Power Supply	182884	1	
Heatsink, Bridge	182885	1	
Insulator, Sil-Pad K-6, 8 Pos	182886	1	
Insulator, Sil-Pad K6 To 218	182887	1	
Screw, Mach Pp 6-32x3/4 Blk Wax	182829	2	
Washer Int Lock Cad Pltd #6	182831	2	
Screw Thd Rld Pp 4-40 Zc 1/4"	182830	9	
Washer, Shldr Nyl #4 .252x.093 A	182832	9	

Regulator PCB Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R1	150KΩ,5%,1W,CF	182947	
R3,4	MO FP,5%,390,2W 1.0 AX LG	182960	
R5,6,34	7.5KΩ,5%,1/4W,CF	182953	
R8	270Ω,5%,1/2W,CF	182949	
R9	47KΩ,5%,1/4W,CF	182927	
R10,22	1.05KΩ,1%,1/4W, MF	182956	
R11	510KΩ,5%,1/4W,CF	182798	
R12,18	100KΩ,1%,1/4W, MF	182801	
R13	3.32KΩ,1%,1/4W, MF	182958	
R14,17	10KΩ,5%,1/4W,CF	182789	
R15	1KΩ,5%,1/4W,CF	182788	
R16	15KΩ,5%,1/4W,CF	182848	
R19,21	10KΩ,1%,1/4W,MF	182800	
R20	30KΩ,5%,1/4W,CF	182852	
R23,24	20KΩ,1%,1/4W,MF	182957	
R25	390Ω, 5%,1/4W,CF	182951	
R26	3.3KΩ,5%,1/4W,CF	182950	
R27	22KΩ,5%,1W,MO FP .8 AX LG	182959	
R28-31	681Ω,1%,1/4W,MF	182859	
R32	18KΩ,5%,1/4W, CF	182948	
R33	5.1KΩ,5%,1/4W,CF	182855	
R35	910Ω,5%,1/4W,CF	182955	
R36	Potentiometer, 5KΩ Miniture PCB Mount	182786	
R37,38	82KΩ,5%,1/2W,CF	182954	
R41	5.6KΩ,5%,1/4W,CF	182952	

Capacitors

Reference Designator	Description	Part Number	Reference
C1	.1UF,250VAC, MTPOLY,UL/CSA	182846	
C2	330µF,20%,25V, LYTIC,RAD	182946	
C3,8	47µF,20%,25V,LYTIC RAD .2	182896	
C4,5	150 pF,10%,1000V, Cer. Disc	182944	
C6	.1µF,5%,100V, PLYFLM,RAD	182945	
C7	10µF,20%,50V, LYTIC,RAD	182895	
C9,10	.01µF,100V,Cer. MULTILYR,RD	182780	

Diodes

Reference Designator	Description	Part Number	Reference
D2,3	Zener,1N4736A, 6.8V	182961	
D4,5,7-9	1N4148,75V	182868	
D6	Zener,1N4735A 6.2V	182962	

Transistors

Reference Designator	Description	Part Number	Reference
Q1	TO92,NPN,SM SG, 2N4123	182913	

Integrated Circuits

Reference Designator	Description	Part Number	Reference
U1	Optoisolator, PXSTR,CNY17-2Z	182965	
U2	Power Supply, HV3-2405E-5	182963	
U3	Opto Triac Driver MOC3052	182880	
U4	Op-Amp/Comparator, MC3405P	182964	
U5	Dual Op-Amp 4558,8 Pin,SIP	182914	

Connectors

Reference Designator	Description	Part Number	Reference
J1	Header 18 Pin Sgl Row .100 Gld	182943	

Power Switch PCB Electrical Part List

Diodes

Reference Designator	Description	Part Number	Reference
D1	LED, Yellow	182970	

Switches

Reference Designator	Description	Part Number	Reference
S1	Switch, Rocker, SPDT, 15a	182969	

Amplifier PCB Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R100,200	1KΩ,1/4W,5%,CF	182788	
R101,115,201,215	10KΩ,1%,1/4W,MF	182800	
R102,107,114,116, 202,207,214,216	1.5KΩ,1%,1/4W,MF	182802	
R103,117,203,217	4.7KΩ,5%,1/4W,CF	182796	
R104,119,204,219	910Ω,5%,1/4W,Film PRF	182810	
R105,120,143,205, 220,243	100Ω,5%,1/4W, Film,PRF	182806	
R106,121,206,221	43Ω,5%,1/4W,Film, PRF	182807	
R108,118,208,218	750Ω,5%,1/4W,Film PRF	182809	
R109,209	45.3KΩ,1%,1/4W, MF	182803	
R110,210	2.2KΩ,5%,1/4W,CF	182793	
R111,112,211,212	909Ω,MF,1%,1/4W	182804	
R113,213	100KΩ,1%,1/4W, MF	182801	
R122,222	16KΩ,5%,1/4W,CF	182791	
R123,223	3.6KΩ,5%,1/4W,CF	182794	
R124 224	Potentiometer,5KΩ Miniture PCB Mount	182786	
R125,126,225,226	4.7Ω,5%,1/4W,Film, PRF	182808	
R127,128,134,227, 228,234	51KΩ,5%,1/4W,CF	182797	
R129,229	100KΩ,5%,1/4W,CF	182790	
R130,230	510KΩ,5%,1/4W,CF	182798	
R131,132,231,232	750Ω,1/4W,5%,CF	182799	
R133	10Ω,5%,1/4W,CF	182787	
R136,236	10KΩ,5%,1/4W,CF	182789	
R138,141,238,241	220Ω,5%,1/4W,CF	182792	
R139,140,239,240	4.3KΩ,5%,1/2WCF	182795	
R144-155,244-255	MO,FP,5%,.22,2W 1.0,AX LG	182805	
RT100,200	1000Ω,5%,1/2W, Thermistor,NTC	182785	

Capacitors

Reference Designator	Description	Part Number	Reference
C101,201	30pF,10%,1000V, CER DISC	182779	
C102,202	470µF,20%,6.3V, LYTIC,AX .95 B	182783	
C103,203	68pF,10%,1000V, Cer. Disc	182778	
C104,108,204,208	22µF,20%,35V, LYTIC AX .80 D	182782	
C105,107,205,207	50 pF,10%,1000V, Cer. Disc	182777	
C106,206	22 pF,10%,1000V, Cer. Disc	182776	
C109,209	4.7µF,20%,50V, LYTIC, AX .80 B	182784	
C110,111	.01µF,100V, Multilayer,CER RD	182780	
C112,113,210,211	.082µF,5%,50V, MTL Film	182781	

Diodes

Reference Designator	Description	Part Number	Reference
D100-103,106,107, 200-203,206,207	175,WIV,High, Speed,.4	182812	
D104,105,204,205	1N4004,400V,PREP	182811	

Transistors

Reference Designator	Description	Part Number	Reference
Q100,105,107,200, 205,207	TO92,NPN,SM,SG MPSA42	182817	
Q101,106,201,206	TO92,PNP,SM,SG MPSA92,A,200 P	182818	
Q102,202	TO126,PNP, 2SA1381E	182820	
Q103,203	TO126,NPN, 2SC3503E	182819	
Q104,204	TO92,NPN, MPSA18,UNPREP	182816	
Q108,110,112,114, 116,118,120,208, 210,212,214,216, 218,220	XSTR,TO3P(L) NPN,PWR, 2SC3281-0	182813	
Q109,111,113,115, 117,119,121,209, 211,213,215,217, 219,221	TO3P(L),PNP,PWR, 2SA1302-0 B	182814	
Q122,222	TO92,PNP,SM, SG,2N4125	182815	

Integrated Circuits

Reference Designator	Description	Part Number	Reference
U100	Dual Op-amp BIFET (TL072)	182821	

Connectors

Reference Designator	Description	Part Number	Reference
J1	Harness Conn, 16-Pin #18 6"	182824	
J101,201	Harness Conn, 10-Pin #22 4"	182823	

Output PCB Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R1	MO FP 5% 130 3W .9 AX SM	182932	
R2	910Ω,5%,1/4W, FLMPRF	182810	
R3	27KΩ,5%,1/4W,CF	182903	
R4	20KΩ,5%,1/4W,CF	183021	
R5	10KΩ,5%,1/4W,CF	182789	
R6	6.2KΩ,5%,1/4W,CF	182930	
R7	47KΩ,5%,1/4W,CF	182928	
R8	WW 5% 91 7W 1.3 AX	182936	
R11	56KΩ,5%,1/4W,CF	182929	
R100,200	6.8Ω,5%,5W,MO 1.2 AX SM	182934	
R102,202	MO FP 5% 470 2W 1.0 AX LG	182933	
R103,203	WW LRES 5% .02 5W 1.2 AX	182935	
R110,210	1Ω,5%,5W,1.2,MO, AX SM	182931	
R111,211	1Ω,5%,1/4W, FLMPRF	182861	
R112,113,212,213	10Ω,5%,1/4W, FLMPRF	182937	
R114,214	1.1KΩ,5%,1/4W,CF	182926	

Capacitors

Reference Designator	Description	Part Number	Reference
C1,2,101,201	.01μF,20%,500V, Cer. Disc	182836	
C3	4.7μF LYTIC,20%, 35V,LL RD	182925	
C4	4.7μF, LYTIC 63V 20% RAD .2	182924	
C100,200	.33μF,10%,400V, METPOLY RD	182923	

Diodes

Reference Designator	Description	Part Number	Reference
D100,101,200,201	1N4004 400V PREP	182811	

Transistors

Reference Designator	Description	Part Number	Reference
Q1	152 PNP SM SG MPS6729	182938	

Integrated Circuits

Reference Designator	Description	Part Number	Reference
U1	Dual Voltage Comparator LM393 B	182879	

Connectors

Reference Designator	Description	Part Number	
J2	Header, 14 Pin Dual Row .1 Gld A	182922	
J3	Header 2 Pin .1 Lock St Post	182921	

Miscellaneous

Reference Designator	Description	Part Number	Reference
K100,200	Relay, SPDT, 24V, 20A	182942	
L100,200	Choke, 5uH #14 Wire	182941	
WL1,2,100,101,200, 201	Connector,Qd Tab .250 PCB	182825	

Mechanical

Description/ Location	Part Number	Qty Per Assy	Reference
Bracket RTANG 6-32 .42 X .343	182940	2	

Input Module PCB Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R52-55,60,62	332KΩ,1%,1/4W, MF	183000	
R56	120Ω,5%,1/4W,CF	182995	
R57,58,61,64,69,70, 76,77	10KΩ,5%,1/4W,CF	182789	
R59	120KΩ,5%,1/4W,CF	182996	
R63	330Ω,5%,1/4W,CF	182998	
R65	30KΩ,5%,1/4W,CF	182852	
R66	51Ω,5%,1/4W,CF	182999	
R72,79	100KΩ,5%,1/4W,CF	182790	
R73-75,78,80-83	47KΩ,5%,1/4W,CF	182927	
R84,87	300Ω,5%,1/4W,CF	182997	
R85,88	100Ω,5%,1/4W,CF	182994	
R86,89	390Ω,5%,1/4W,CF	182951	

Capacitors

Reference Designator	Description	Part Number	Reference
C37-40	330pF,5%,100V, Cer. Disc,GP	182992	
C41,42	3,300pF,10%,100V, Ceramic Disc	183883	
C43	220µF,20%,16V, LYTIC,RAD	182993	
C44-47,57,58,60,61	.01µF,100V,Cer., MULTILYR RD	182780	
C59,62	.001µF PLYFLM 100V 10% RD	182839	

Diodes

Reference Designator	Description	Part Number	Reference
D1,4,5,22	1N4004,400V,PREP	182811	
D15,18	Zener,1N4746A, 18V,1W	183003	
D2,3,6-17,20,21, 24-31	1N4148 75V	182868	
D23	LED, Bi-Level GRN/GRN	183020	

Transistors

Reference Designator	Description	Part Number	Reference
Q1	TO92,NPN,SM SG, MPSA06	182874	
Q2,3	TO92,PNP,SM SG, MPSA56	182875	

Integrated Circuits

Reference Designator	Description	Part Number	Reference
U1,2	DIFF LINE RCVR SSM-2141P	183005	
U3-6	Op-Amp with Switch	183004	
U7	IC DUAL OP AMP BIFET (TL072)	182821	

Connectors

Reference Designator	Description	Part Number	Reference
J1	Header, 20 Pin Dual Rw .1 Post .3	182988	
J2	Hdr, Rt Angle Blind Mate 4 Pin A	182991	
J3	Header 2 Pin, .1 Lock St Post	182921	
J4,5	Header, 90 Deg Clsd End 3 Pin	182990	
J6,7	Header 12 Pin, .098 Ctr Shroud	182987	
JB1,2	Header, 6 Pin Dual Row .1 Gld	182989	
P1,4	Jack, XLR/TRS Right Angle	182984	
P2,3	Phone Jack 1/4" PC MNT	182985	
	Connector, Mini Link .10 Qty 4	182986	

Switches

Reference Designator	Description	Part Number	Reference
S2	Switch Slide,DPDT	183001	
SW1	SW Slide Right Angle,DPTT	183002	

Barrier/Input Module

Reference Designator	Description	Part Number	Reference
J2	Term. Block 2 P .15 Ctr Angled (Barrier)	182967	

Barrier/Input Module

Reference Designator	Description	Part Number	Reference
	PC Board - Barrier	182968	

Input Panel/Input Module

Description/Location	Part Number	Qty. Per Assy	Reference
Plug,RT Angle Terminal Block, 3-pin, J4, J5	182769	2	
Screw Metric MA/PP BLK M3X8MM	182770	4	
Screw SEMS PP BLKOX WX 6-32x1/4	182771	2	
Washer, Int Lock BLK #4	182772	4	
Panel, Rear,TRS, 1800-V	182773	1	

402 Equalizer PCB Assembly Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R1,2	10.0KΩ,1%,Chip	124894-1002	
R3,4,14	3.92KΩ,1%,Chip	124894-3921	
R5	8.25KΩ,1%,Chip	124894-8251	
R6,7	1.82KΩ,1%,Chip	124894-1821	
R11	100KΩ,1%,Chip	124894-1003	
R13,19-21,27,34-36	Jumper,CHIP	124896	
R17	5.11KΩ,1%,Chip	124894-5111	
R30	86.6KΩ,1%,Chip	124894-8662	
R31	21.5KΩ,1%,Chip	124894-2152	
R33	6.49KΩ,1%,Chip	124894-6491	
R32	78.7KΩ,1%,Chip	124894-7872	
R37,38	47KΩ,5%,Chip	124895-4735	

Capacitors

Reference Designator	Description	Part Number	Reference
C2	.1uF,5%, BOX FILM	137127-104	
C3	.27uF,5%,BOX FILM	137127-274	
C4	.0047uF,5%,BOX, FILM	137127-472	
C5	680pF,10%,CER	137269-681	
C6	.0022uF,5%,BOX, FILM	137127-222	
C7,8	.047uF,5%,BOX, FILM	137127-473	
C17,19	.068uF,5%,BOX, FILM	137127-683	
C20,22	.022uF,5%,BOX, FILM	137127-223	
C24,26,48-51	10000pF,+80/-20%, CHIP	124959-103	

Diodes

Reference Designator	Description	Part Number	Reference
D1,2,3,5	Axial,1N4148,26MM	121501	
D4,6	Zener,5%, 18V,1W	116995-4746A	

Integrated Circuits

Reference Designator	Description	Part Number	Reference
U1,2	OP-Amp	123458	
U1,2	OP-Amp	123458	
U3	Switch,Active, SIP-8,BA3128N	177292	

Connectors

Reference Designator	Description	Part Number	Reference
J1	Connector,Header, RTANG,12 POS	149538	

502A Equalizer PCB Assembly Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R1	3.65KΩ,1%,Chip	124894-3651	
R2,13,29	2.00KΩ,1%,Chip	124894-2001	
R3,4	4.02KΩ,1%,Chip	124894-4021	
R5,20	Jumper,Chip	124896	
R8	30.1KΩ,1%,Chip	124894-3012	
R11	49.9KΩ,1%,Chip	124894-4992	
R12	2.32KΩ,1%,Chip	124894-2321	
R14	13KΩ,1%,Chip	124894-1302	
R15	20.0KΩ,1%,Chip	124894-2002	
R16	1.33KΩ,1%,Chip	124894-1331	
R17	100KΩ,1%,Chip	124894-1003	
R18	3.16KΩ,1%,Chip	124894-3161	
R19	511,Ω1%,Chip	124894-5110	
R21	18.2KΩ,1%,Chip	124894-1822	
R22,25	274Ω,1%,Chip	124894-2740	
R23	8.66KΩ,1%,Chip	124894-8661	
R24	6.34KΩ,1%,Chip	124894-6341	
R26	1.91KΩ,1%,Chip	124894-1911	
R27	2.21KΩ,1%,Chip	124894-2211	
R28	2.43KΩ,1%,Chip	124894-2431	
R30	43.2KΩ,1%,Chip	124894-4322	
R31	3.01KΩ,1%,Chip	124894-3011	
R32	41.2KΩ,1%,Chip	124894-4122	
R33	3.92KΩ,1%,Chip	124894-3921	
R37,38	47KΩ,5%,Chip	124895-4735	

Capacitors

Reference Designator	Description	Part Number	Reference
C2,16	100pF,10%,50V, DISC,SL	137269-101	
C3,11,12,23	.01uF,5%,100V, BOX,85	137127-103	
C5	680pF,10%,50V, DISC,SL	137269-681	
C8,10	.0047uF,5%,100V, BOX,85	137127-472	
C14,15,18,19,21,22	.1uF,5%,50V,BOX, 85	137127-104	
C17,20	.47uF,5%,50V,BOX, 85	137127-474	
C24,26,48-51	10000pF, +80/-20%,CHIP	124959-103	
C25	.047uF,5%,63V, BOX,85	137127-473	

Diodes

Reference Designator	Description	Part Number	Reference
D1-3,5	Axial,1N4148,26MM	121501	
D4,6	Zener,5%,18V,1W	116995-4746A	

Integrated Circuits

Reference Designator	Description	Part Number	Reference
U1,2	Op-Amp,quad,dip-14,RC4156DB	123458	
U3	Switch,Active, SIP-8,BA3128N	177292	

Connectors

Reference Designator	Description	Part Number	Reference
J1	Connector,Header, 12 Pin	149538	

502B Equalizer PCB Assembly Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R35,52	6.81KΩ,1%,Chip	124894-6811	
R36,38	4.75KΩ,1%,Chip	124894-4751	
R37,39	15.4KΩ,1%,Chip	124894-1542	
R40	5.11KΩ,1%,Chip	124894-5111	
R41,44	221KΩ,1%,Chip	124894-2213	
R42	1.10KΩ,1%,Chip	124894-1101	
R43	49.9KΩ,1%,Chip	124894-4992	
R45	68.1KΩ,1%,Chip	124894-6812	
R46	6.98KΩ,1%,Chip	124894-6981	
R47	1.00KΩ,1%,Chip	124894-1001	
R48	4.32KΩ,1%,Chip	124894-4321	
R49	5.49KΩ,1%,Chip	124894-5491	
R50,51	14.0KΩ,1%,Chip	124894-1402	

Capacitors

Reference Designator	Description	Part Number	Reference
C26,27	100pF,50V,10%, CER	137269-101	
C28	CAP,BOX FILM,5%,.47uF	137127-474	
C29,30,34	.22uF,5%,Box,Film	137127-224	
C31,32	.1uF,5%,Box,Film	137127-104	
C35	.022uF,5%,Box,Film	137127-223	
C36	.18uF,5%,Box,Film	137127-184	
C52-55	10000pF, +80/-20%,Chip	124959-103	

Diodes

Reference Designator	Description	Part Number	Reference
D1-3,5,7,8	Axial,1N4148,26MM	121501	
D4,6	Zener,5%,18V,1W	116995-4746A	

Integrated Circuits

Reference Designator	Description	Part Number	Reference
U1,2	Op-Amp,Quad,DIP-14,RC4156DB	123458	

Connectors

Reference Designator	Description	Part Number	Reference
J1	Connector,Header, 12 Pin	149538	
J2	Connector,Header, 2 POS,Male	134739-02	

802 Equalizer PCB Assembly Electrical Part List

Resistors

Reference Designator	Description	Part Number	Reference
R1	13KΩ,1%,Chip	124894-1302	
R2	1.00KΩ,1%,Chip	124894-1001	
R3,4	18KΩ,5%,Chip	124895-1835	
R5,13,14,19,20	Jumper,Chip	124896	
R8	20.0KΩ,1%,Chip	124894-2002	
R9	2.74KΩ,1%,Chip	124894-2741	
R10	23.7KΩ,1%,Chip	124894-2372	
R21	22KΩ,5%,Chip	124895-2235	
R22,26,31	2.00KΩ,1%,Chip	124894-2001	
R23	27.4KΩ,1%,Chip	124894-2742	
R24	130KΩ,1%,Chip	124894-1303	
R25	470Ω,5%,Chip	124895-4715	
R27	8.2KΩ,5%,1/8W, 1206	124895-8225	
R28	10.0KΩ,1%,Chip	124894-1002	
R29	1.74KΩ,1%,Chip	124894-1741	
R30	160KΩ,5%,Chip	124895-1645	
R32	34.8KΩ,1%,Chip	124894-3482	
R33	6.81KΩ,1%,Chip	124894-6811	
R37,38	47KΩ,5%,Chip	124895-4735	

Capacitors

Reference Designator	Description	Part Number	Reference
C2,16	100pF,10%,50V, CER,	137269-101	
C3,8,10	.0068uF,5%,Box, Film	137127-682	
C5	270pF,10%,CER	137269-271	
C14,15	.033uF,5%, Box, Film	137127-333	
C17	.33uF,5%,Box,Film	137127-334	
C18,19	.1uF,5%,Box Film	137127-104	
C20	.47uF,5%,Box,Film	137127-474	
C21,22	.15uF,5%,Box, Film	137127-154	
C23	.0012uF,5%,Box, Film	137127-122	
C24,26,48-51	10000pF, +80/-20%,CHIP	124959-103	
C25	.068uF,5%,Box, Film	137127-683	

Diodes

Reference Designator	Description	Part Number	Reference
D1,2,3,5	Axial,1N4148,26MM	121501	
D4,6	Zener,5%,18V,1W	116995-4746A	

Integrated Circuits

Reference Designator	Description	Part Number	Reference
U1,2	Op-Amp,Quad,DIP-14,RC4156DB	123458	
U3	Switch,Active, SIP-8,BA3128N	177292	

Connectors

Reference Designator	Description	Part Number	Reference
J1	Connector,Header, 12 PIN	149538	

WIRING DIAGRAMS

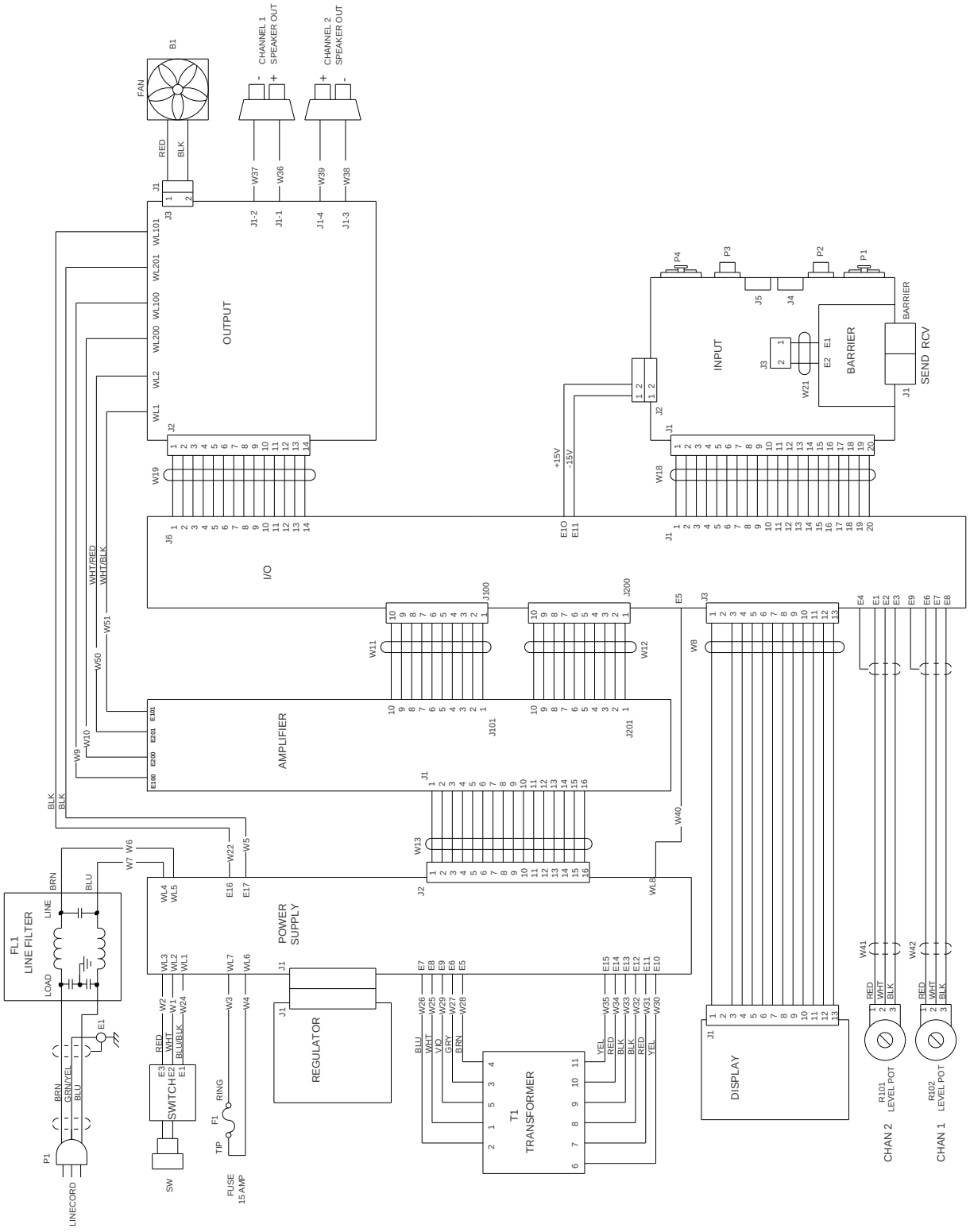


Figure 21. 1800-V Wiring Diagram

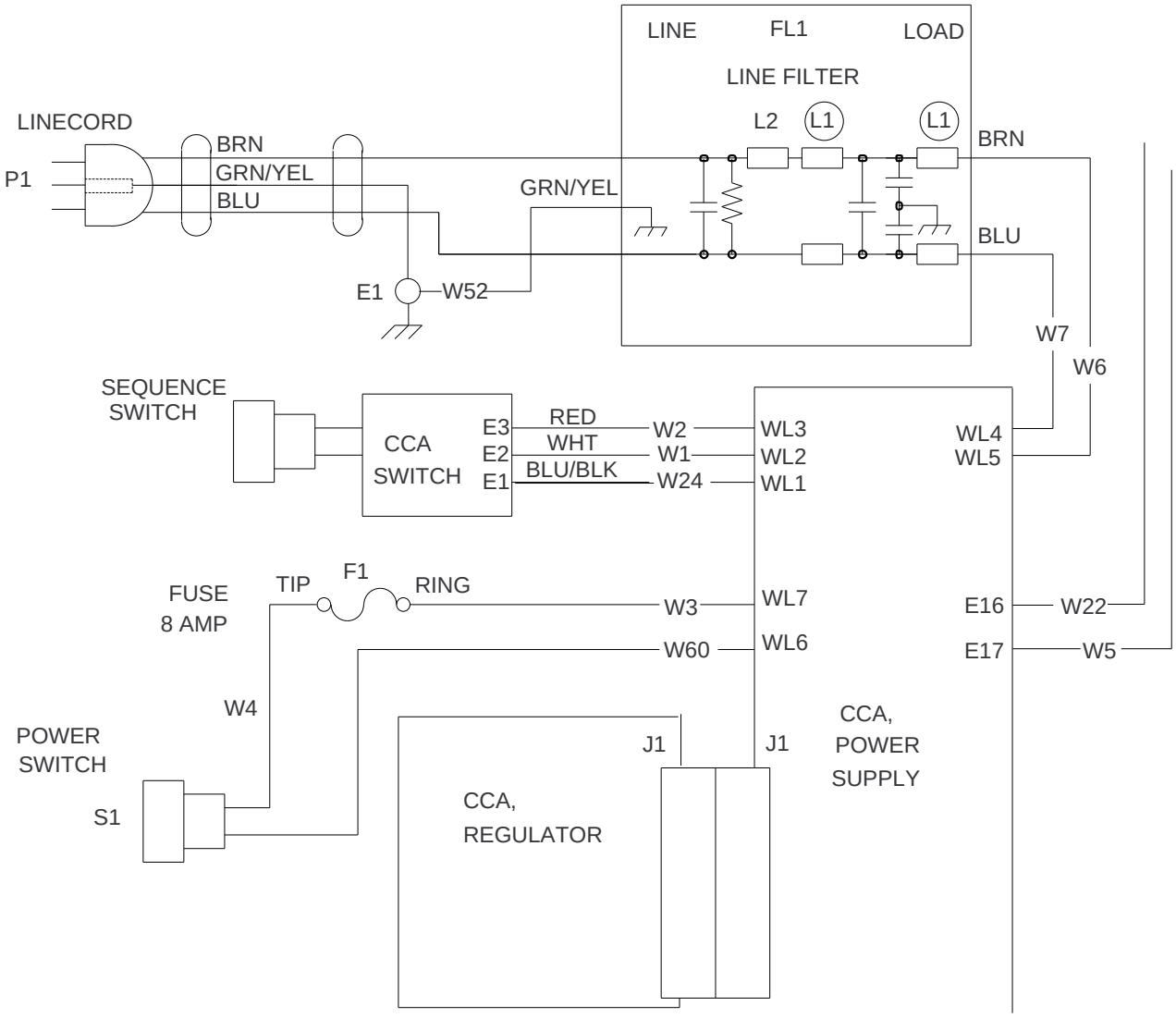


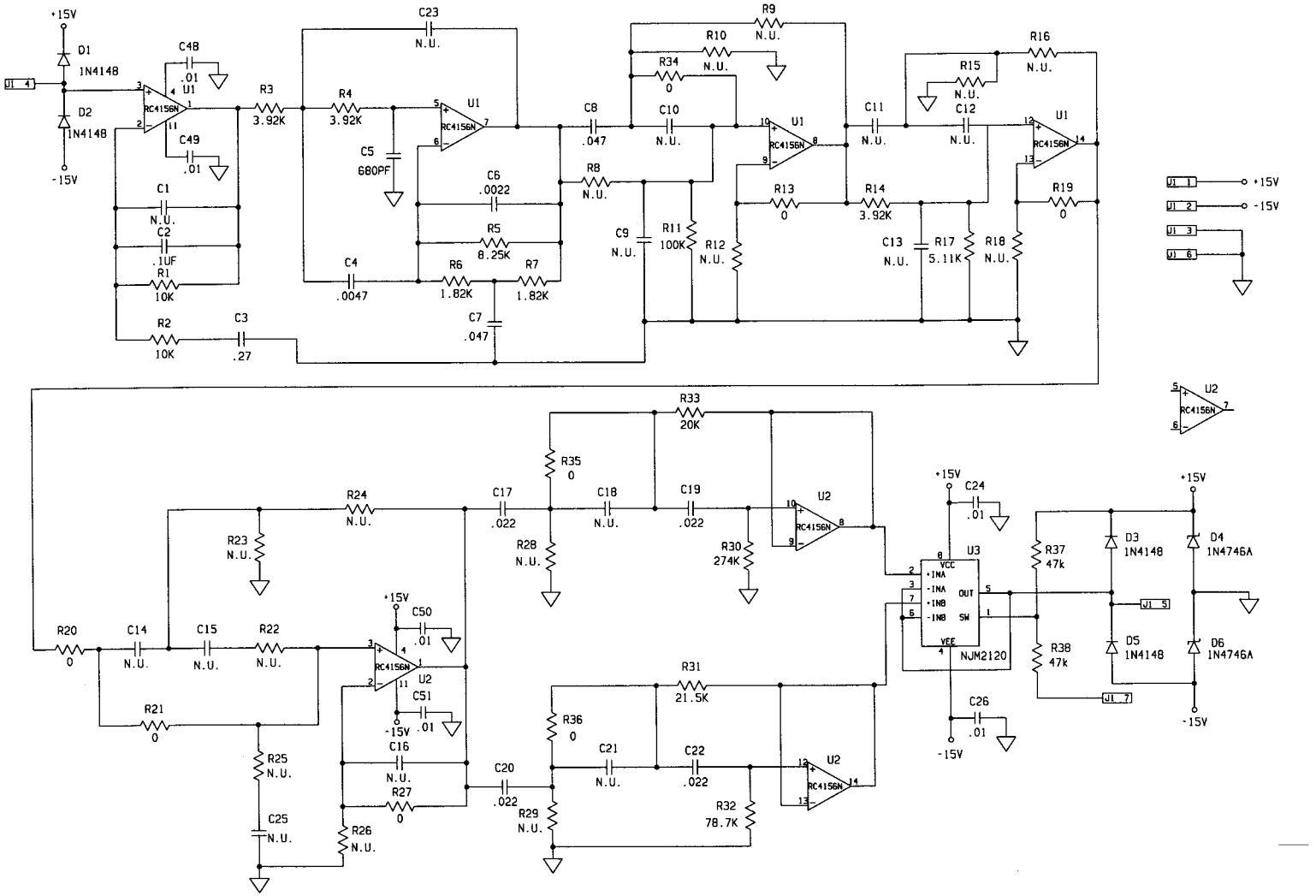
Figure 22. 1800-V 240V Wiring Diagram Variation Difference

SCHEMATICS AND PCB LAYOUTS

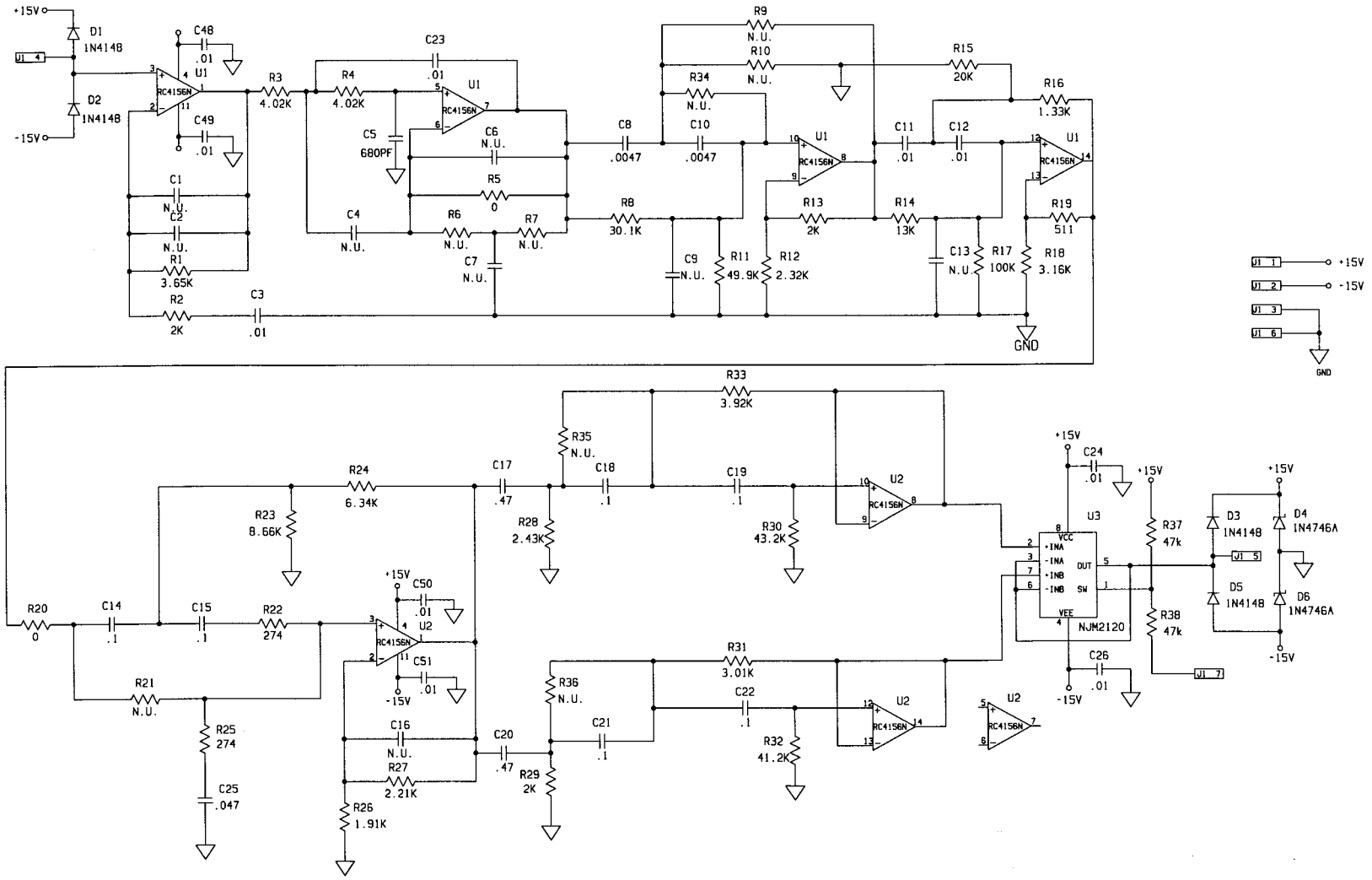
The schematics and layout views for the Equalizer Cards are located on Pages 69-74.

There are separate schematic and layout foldout sheets for the following PCB assemblies:

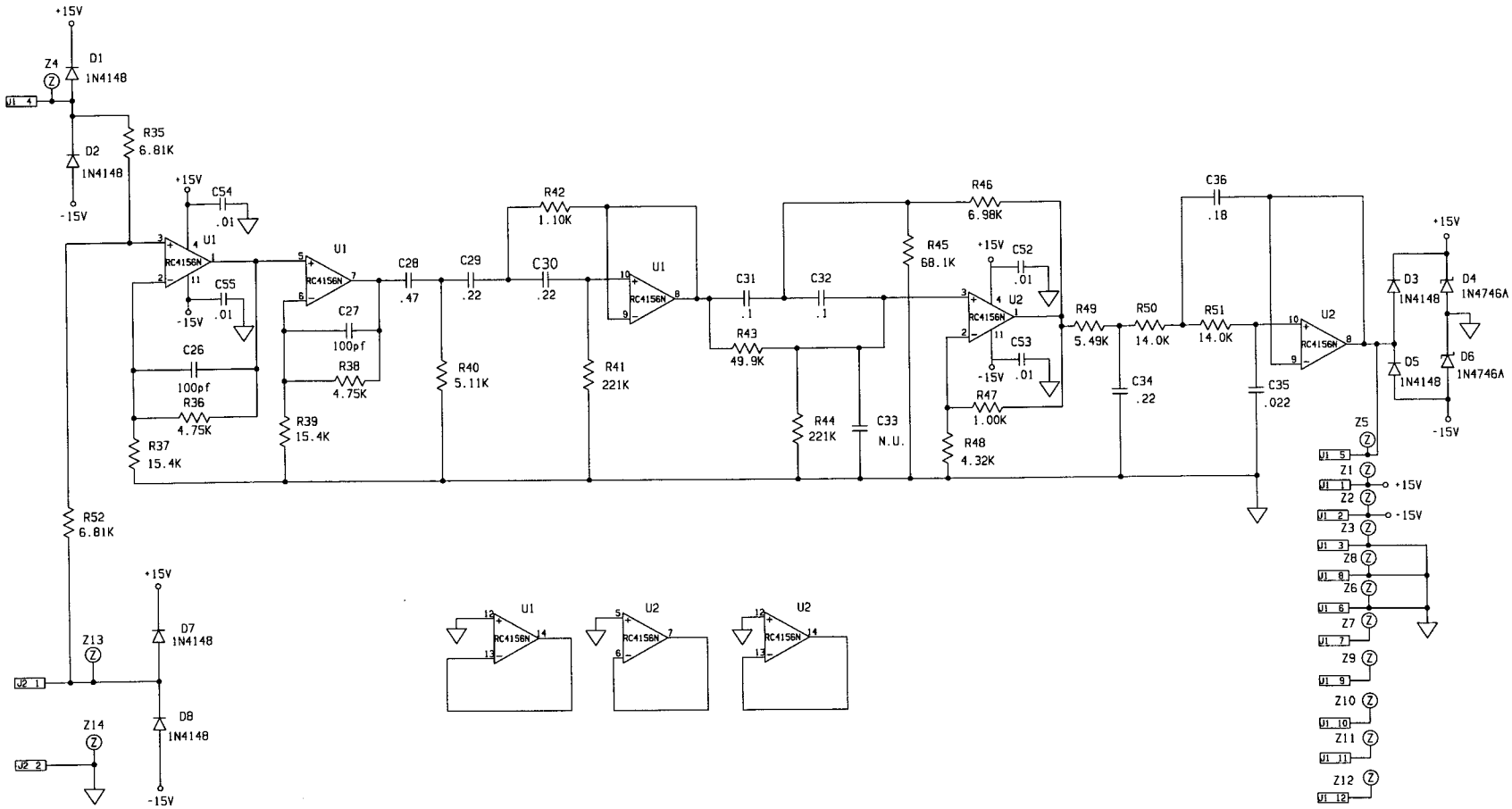
- Display PCB Assembly
- Input/Output (I/O) PCB Assembly
- Power Supply PCB Assembly
- Regulator PCB Assembly
- Amplifier PCB Assembly
- Output PCB Assembly
- Input Module Assembly



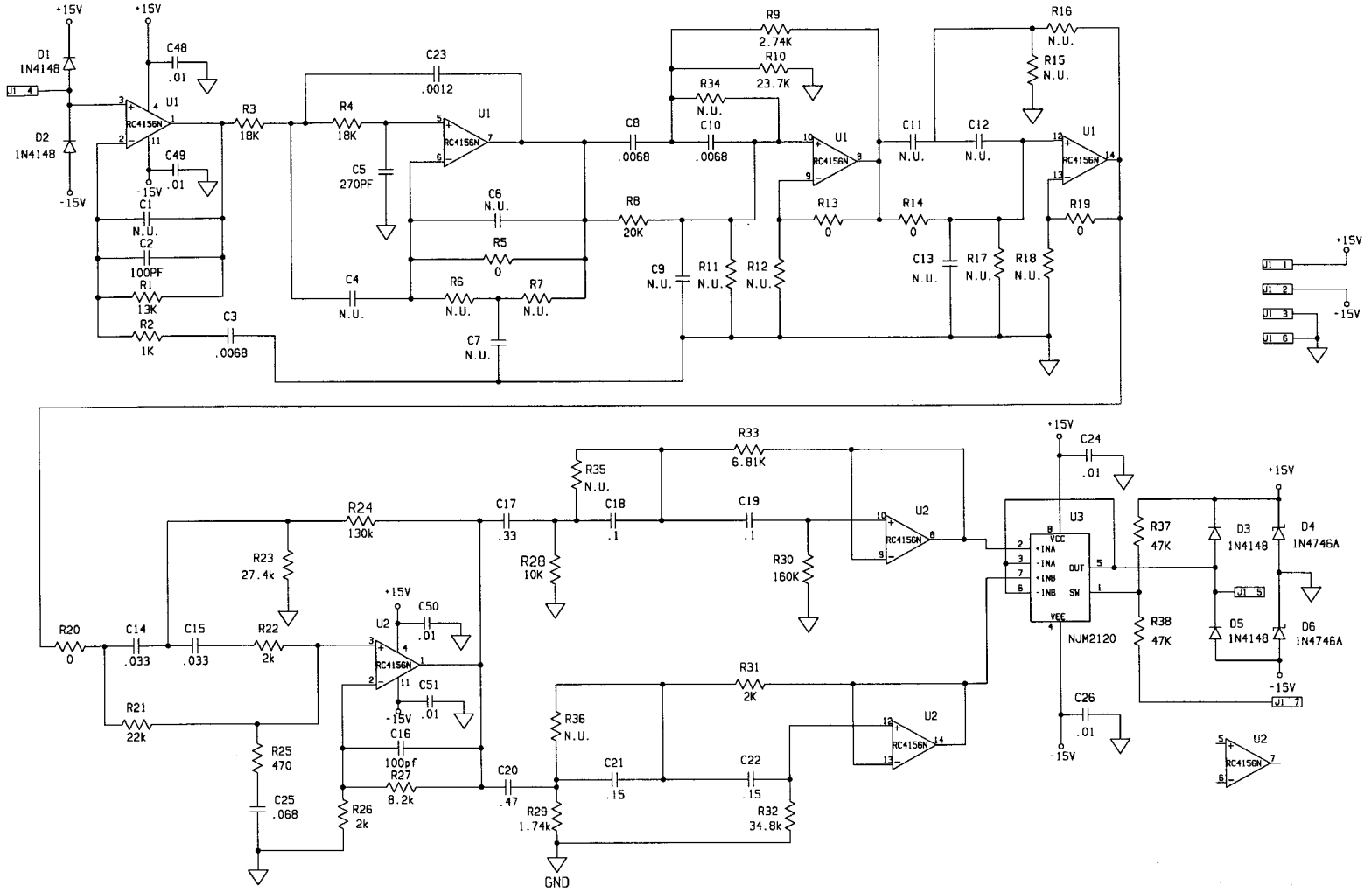
402 Equalizer Card Schematic



502A Equalizer Card Schematic

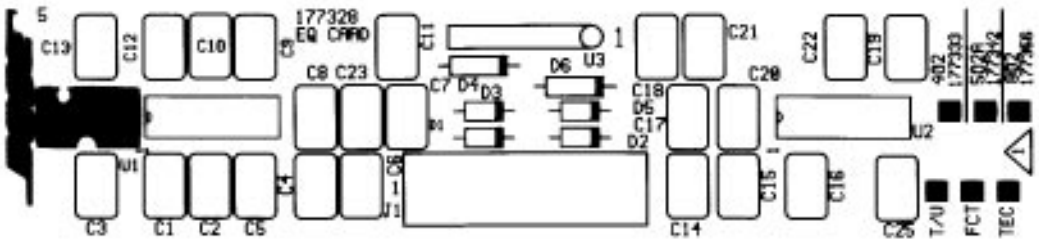


502B Equalizer Card Schematic

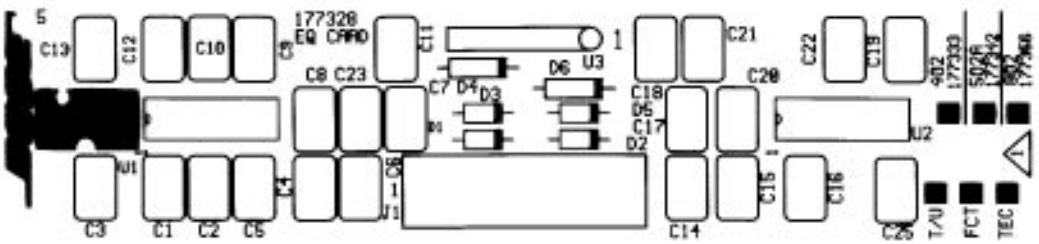


802 Equalizer Card Schematic

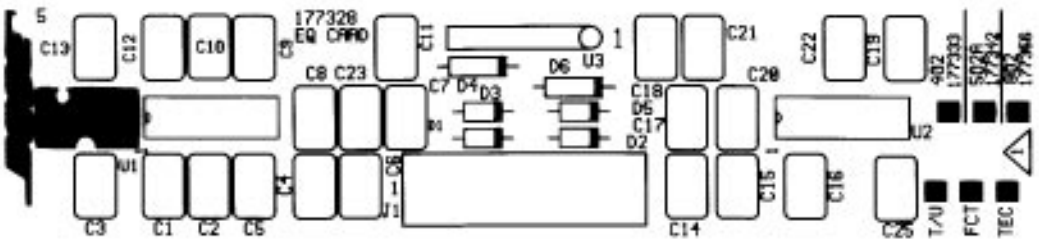
402, 502A AND 802 Equalizer Card
PC Board Layouts
PC Board Number 177328, Revision 01



Top Components
Top Etch Layer

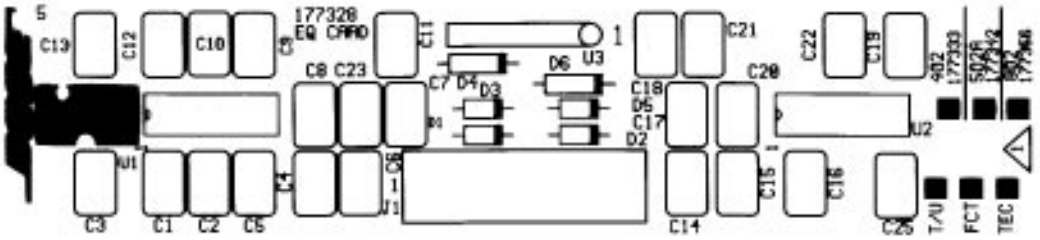


Top Components
Bottom Etch Layer

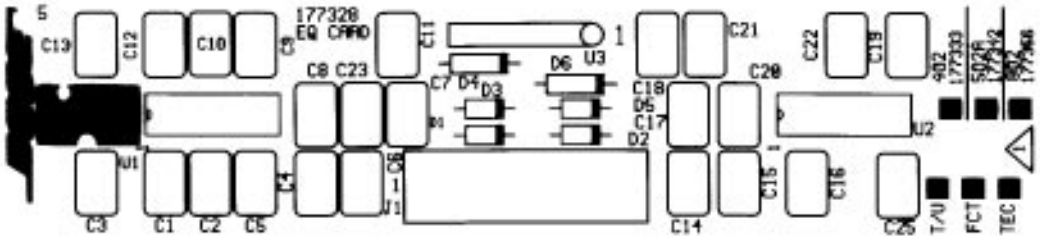


SMD Components
Bottom Etch Layer

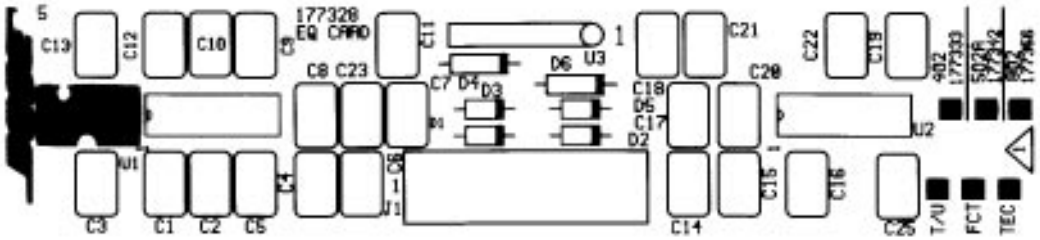
502B Equalizer Card
PC Board Layouts
PC Board Number 178860, Revision 0



Top Components
Top Etch Layer



Top Components
Bottom Etch Layer



SMD Components
Bottom Etch Layer

SPECIFICATIONS AND FEATURES SUBJECT TO CHANGE WITHOUT NOTICE

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