

DMC-2181S

DeltaMax™ Electronic Controller for DML-2181A Series Low-Frequency Sound-Reinforcement Speaker Systems

- Accepts stereo inputs
- Supplies a mono-summed signal for and electronically controls one or more DML-2181A series subwoofers
- Supplies a high-passed stereo signal to feed dual DMC-1122B or DMC-1152B controllers
- Active sensing broadband compressor circuit, with varying compression ratio, provides speaker thermal protection
- Active sensing speaker overexcursion protection and soft-clip limiting

TO BE USED WITH DML-2181A SERIES SPEAKERS ONLY.

SYSTEM SPECIFICATIONS:¹

Frequency Response, DMC-2181S with DML-2181A Series Speaker, One Watt Into Sub Mid Band (2.00 volts at 70 Hz) on Axis in Anechoic Environment (see Figure 1):
36-100 Hz

CONTROLLER SPECIFICATIONS:

General Functions:

Dual two-way crossovers; subwoofer output includes frequency and time-delay equalization, 12-dB-per-octave infrasonic filter, temperature, excursion and amplifier clipping protection

Channel Configuration:

Dual channel (stereo) two-way, one sense channel (subwoofer); high-frequency outputs unity gain above crossover frequency

Crossover Frequency:

100 Hz

Crossover Filter:

4th-order Linkwitz-Riley (24-dB-per-octave)

Gain:

+5 dB nominal, equalized sub output. Unity gain high output.

Signal-Path Equalization

(subwoofer section):

+3 dB at 37 Hz
-3 dB at 30.5 Hz

Signal Delay (subwoofer output):

4.0 ms at crossover frequency

Total Harmonic Distortion, 20-20,000 Hz:

0.03% typical, 0.1% maximum

Noise, Each Output, 20-20,000 Hz

Bandwidth, Typical:

-86 dBu¹

Signal Input,

Type:

Active differential

Maximum Level:

+18 dBu

Impedance:

20,000 ohms and .0015 μ f

Common-Mode Range:

± 24 V

CMRR, Typical:

-55 dB

Connectors:

Female 3-pin XLR-type

Signal Outputs,

Type:

Transformer floating differential

Maximum Level:

+18 dBu

Minimum Load Impedance

for Full Level:

600 ohms

Protection:

Safe for short circuit or ± 25 volts dc

Connectors:

Male 3-pin XLR-type

Sense Input (subwoofer only),

Type:

Active differential

Maximum Level:

145 volts rms

Impedance:

200,000 ohms differential

Connector:

Binding post/banana jacks, spaced 1.9 cm (0.75 in.)

Controls (all except power switch are screwdriver adjustable):

Output levels, amplifier limit calibration, amplifier clip/limit switch; power on-off switch

Indicators:

Dual three LED input level, right & left

(-20, 0, and +16 dBu)

Three LED gain reduction

(3, 6, and 12 dB)

Three LED LF output protection

(temperature, excursion, clipping)

One LED power on

Power Requirements:

100, 120, or 240 volts ac, 50-60 Hz, 13 watts

Chassis Construction:

Painted steel

Color:

Gray front panel and black chassis with white graphics

Mounting and Overall Dimensions

(see Figure 3):

EIA 19-inch (48.3-cm) rack mount, 4.45 cm (1.75 in.) high, 22.8 cm (8.97 in.) behind panel, including connections; supplied with front-panel security cover for controls

Net Weight:

3.6 kg (8 lb)

Shipping Weight:

4.2 kg (9 lb, 3 oz)

DESCRIPTION

The Electro-Voice DMC-2181S controller is part of the DeltaMax™ series of electronically controlled speaker systems intended for high-level sound reinforcement and permanent installation applications. The DMC-2181S controller is intended to be used only with the DML-2181A series low-frequency speaker systems. In addition to providing frequency division, time-offset correction, broadband equalization and high-pass filtering, the controller, when placed in the signal path before the amplifier, incorporates special speaker performance-modeling circuitry to electronically protect the transducers against overexcursion, voice-coil overheating and amplifier clipping.

1. See DML-2181A series engineering data sheets for detailed speaker system specifications.
2. 0 dBu is 0.775 volts rms sine wave.

FIGURE 1 — DML-2181A/DMC-2181S Series Frequency Response, on Axis in Anechoic Environment (1 watt/1 meter into LF midband)

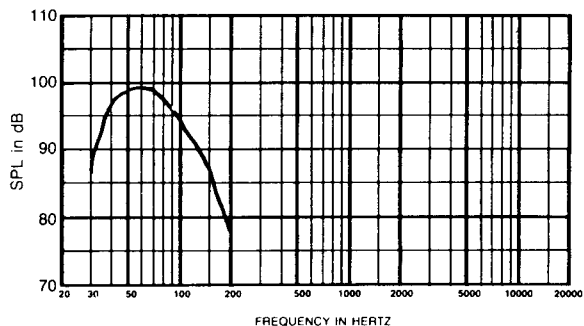


FIGURE 2 — DMC Frequency Response

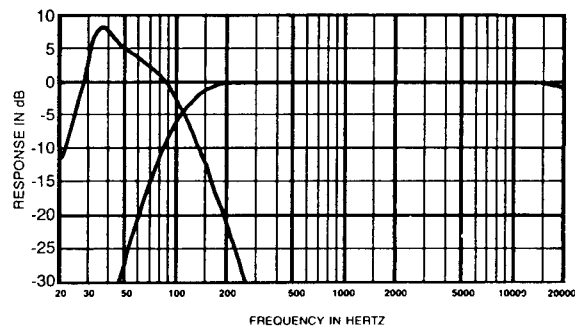
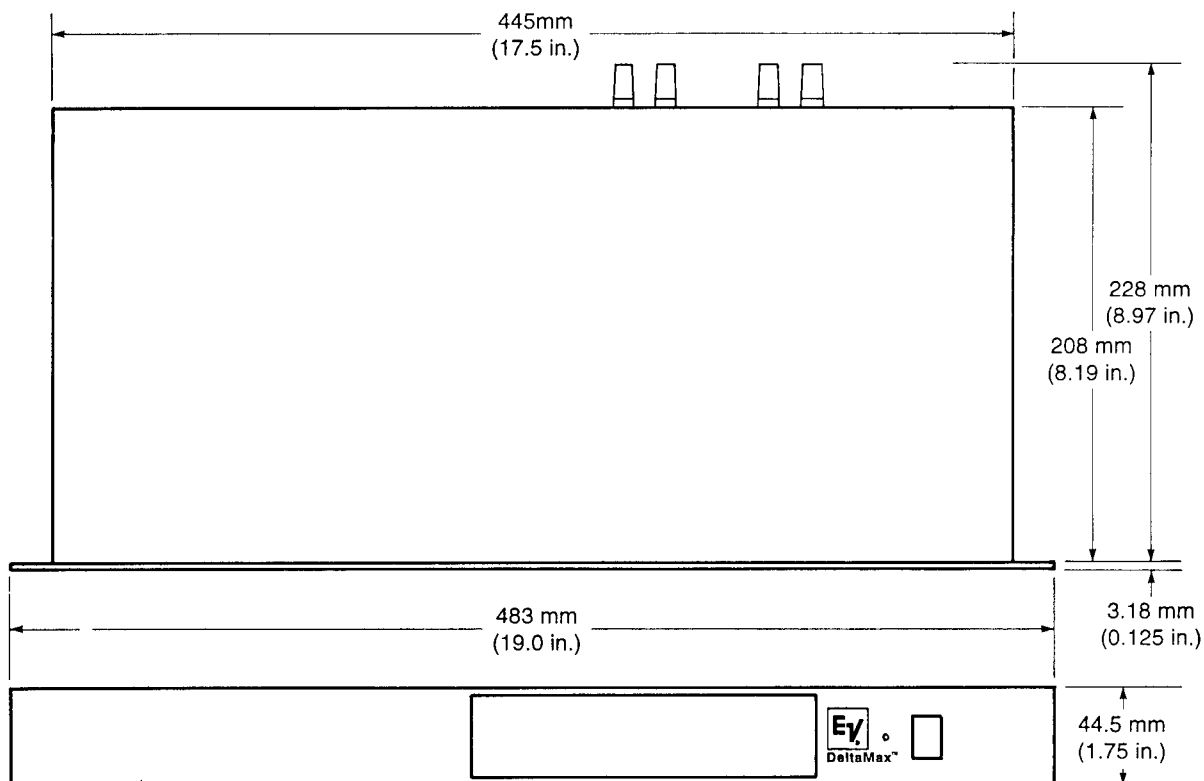


FIGURE 3 — DMC-2181S Dimensions



The result is maximum fidelity at extreme power outputs, without sacrificing reliability.

The companion DML-2181A series speaker systems utilize two DL18MT low-frequency reproducers, and incorporate Electro-Voice's Manifold Technology® enclosure design. This allows greater output over conventional vented boxes in a greatly reduced package size. Additionally, acoustic loading is improved, yielding increased low-frequency efficiency and reduced distortion over direct-radiating and horn-loaded cabinets.

The electronic circuitry in the DMC-2181S is designed to provide optimum audio performance, even when the audio drive level is increased beyond normally safe levels for maximum loudness. A high-quality, low-noise VCA is driven by speaker performance-modeling circuitry to provide long-term temperature protection and amplifier anticlip limiting. Excursion protection is accomplished via voltage-limiting circuitry which follows excursion/frequency modeling parameters to control amplitude peaks before damage is incurred.

Front panel indicator lights show input levels, gain reduction, and low-frequency output-limit thresholds for excursion, temperature and amplifier clipping. Operation of the protection functions is completely automatic. The user-adjustable clipping-threshold calibration will work with any professional amplifier operating within the power and gain range stated in the Amplifier Requirements section.

IMPORTANT CAUTION!

Optimum performance and maximum protection of the DML-2181A series speaker systems can only be attained in conjunction with the DMC-2181S electronic controller. **DO NOT DRIVE THESE SPEAKERS WITH OTHER ELECTRONIC CROSSEOVERS OR PROCESSORS. DO NOT USE THE DMC-2181S CONTROLLER ON OTHER SPEAKERS AS ALL PARAMETERS ARE SPECIFIC TO THE DML-2181A SERIES.**

PRINCIPLE OF OPERATION

Refer to block diagram in Figure 3.

The signal paths consist of right and left active differential input circuits driving two fourth-order Linkwitz-Riley crossover sections. This configuration provides high-frequency left, high-frequency right, and low-frequency adjustable outputs. The right and left high-frequency signals pass unaffected to their respective outputs. The right and left low-frequency signals are summed and drive a VCA (voltage controlled amplifier) section. The control voltage is derived from a single amplifier-linked sense input, modified by a dual-time-constant compressor control circuit. Following the VCA, the low-frequency signal enters a delay circuit (for proper time/phase alignment relative to other DeltaMax™ systems at crossover frequency) and a frequency-contouring equalizer to provide optimum flat response for the speaker system. Additionally, an underdamped second-order high-pass filter, combined with a variation of a first-order shelving low-boost function provides optimum low-frequency system roll-off. All three outputs are transformer isolated, with feedback for distortion reduction.

The primary dynamic action (gain reduction) of the compressor circuit is controlled by a dual-time-constant detection circuit driven by rectified audio sensed at the speaker terminals. The compression ratio above the threshold is determined by modeling circuits, which increases the compression ratio as required by detection of temperature, and/or amplifier-clipping limits being passed. In all modes, the compressor gain-transfer function has a gradually changing slope across its threshold. This soft-knee design reduces the audibility of the compression. The ratio above the threshold can vary from 1:1 (no effect) to approximately 20:1 (hard limiting) depending on the signal source and the type of protection called for.

A dynamic frequency-sensitive voltage limiter at the output of the low-frequency band protects the speakers from excursion damage. If the speakers approach their excursion limit, the peak of the output waveform is clamped at a level above which excursion damage would occur.

FREQUENCY RESPONSE

The frequency response of the DMC-2181S/DML-2181A combination shown in Figure 1 was measured on axis in the far field of an anechoic environment, using swept one-third-octave input and calculated to a one-meter equivalent distance using the inverse-square law. Drive level was set at one watt of power (2 volts rms at 70 Hz) delivered to the mid band of the low-frequency range.

INSTALLATION

Mounting/Location

The unit is one rack space high, 4.45 cm (1.75 in.), and fits a standard EIA 19-inch rack. Mount the DMC controller in a rack cabinet near the power amplifiers to simplify wiring. The controller is well shielded from magnetic and radio-frequency interference. It is possible to use the controller at a "house mix" location, removed from the amplifier mounting location and near the mixing board, in order to facilitate adjustment of the crossover levels and provide easy visual inspection of the LED metering. In this application, signal-return lines are needed to feed signal splits to the amplifiers. The low source impedance will adequately drive long cable lengths. A speaker sense line must be returned to each DMC-2181S controller from the amplifier location.

Grounding

A widely accepted grounding scheme for audio systems is the star-connection (single-point) ground technique. While the final configuration will be determined by the size of the system and the equipment used, the star-connection grounding scheme is recommended as a start.

Never lift the safety ground of the ac power cable, as it protects against chassis shock hazard.

Ventilation

In normal operation, the controller generates some heat. In order to keep all components in their operating range, it is recommended that the electronics be mounted with adequate flow-through ventilation front and back. Do not place amplifiers or controllers in a sealed

enclosure. Leaving a single empty rack space between adjacent amplifiers and the controller, preferably vented, will provide a margin of safety for all devices. Ambient temperature inside the enclosure should never exceed 60° C (140° F).

Security

A security cover and mounting screws are supplied for protecting the user-adjustable controls on the front panel of the controller.

CONNECTIONS

The DeltaMax controller has XLR-type connectors for signal input and outputs. Pin 1 is shield, pin 2 is high (+), and pin 3 is low (-). The input is active differential and the outputs are transformer-balanced differential. When used in an unbalanced configuration, pin 3 should be shorted to ground.

The SUB sense connection is a dual-binding-post/banana jack (five-way binding post). The sense input is active differential, enabling connection to the output of mono-bridged amplifiers, and are high impedance, allowing small gauge wire (e.g. #22 AWG) to be used for the sense connection. Although current flow in the sense lines is negligible, they must be capable of handling the high-output voltages of the amplifiers.

AMPLIFIER REQUIREMENTS

The DML-2181A cabinet contains two drivers. With a 4-pin Neutrik Speakon® NL4MP-R connector, each driver may be accessed separately. There are two ways these drivers may be wired:

1. Each driver may be connected to its own separate amplifier channel. Each amplifier channel should have a power rating of 400-600 watts into eight ohms. The amplifier channels must be identical, having the same voltage gain and power rating.
2. The two drivers may be paralleled to one amplifier channel. The speakers should be paralleled at the amplifier, not at the cabinet. The amplifier channel should have a power rating of 800-1200 watts into four ohms.

NOTE: DML-2181A cabinets may be paralleled (in either of the above configurations) with other DML-2181A's if the amplifier is capable of delivering adequate power at the lower impedance. The use of amplifiers with lower power ratings is acceptable; however, the DML-2181A will not realize its full power capabilities. The use of amplifiers with significantly higher power ratings is wasteful and may endanger the loudspeakers; it is not recommended. The user is instructed to consult the DeltaMax™ Owner's Manual for details. The manual is included with the DMC-2181S electronic controller.

ARCHITECTS' AND ENGINEERS' SPECIFICATIONS

The controller shall consist of two crossover circuits with fourth-order Linkwitz-Riley filters, a compression system with variable ratio and dual-time-constant detector, a voltage-clamping circuit for excursion protection, speaker-modeling circuits which control the compressor and clamp circuits to prevent destruction of the

drivers due to excessive drive level. Included in the signal path shall be special frequency equalization and signal delay to provide flat (± 3 dB) on-axis anechoic frequency response in the range of 36 Hz to 100 Hz.

The total harmonic distortion through the signal path shall be nominally 0.03% and no greater than 0.1% from 20 Hz to 20 kHz, within the unit's passband. The noise at the outputs measured with a 20-20,000-Hz equivalent-noise-bandwidth filter shall be typically -86 dBu.

The signal inputs shall be active differential with a level capability of +18 dBu, and female XLR-type connectors. The outputs shall be transformer isolated with a level capability of +18 dBu into 600 ohms, and male 3-pin connectors. There shall be an active differential sense input for speaker protection, with binding-post/banana-jack connectors.

Front panel controls shall include sub, left and right high-level controls, a sub amplifier calibration control, and a switch to control the amplifier limit function, all accessible with a screwdriver after removing the security cover. There shall be a power switch on the front panel. Front panel indicators shall include right input level, left input level, gain reduction, output limits (for amplifier, excursion, and temperature), and power on.

The chassis shall be made of painted steel with a gray front panel and white graphics. It shall be rack mountable in a 19-inch (48.3-cm) EIA rack and be 4.45 cm (1.75 in.) high and 22.8 cm (8.97 in.) deep overall, including connectors. The unit shall weigh 3.6 kg (8 lb). The unit shall be an Electro-Voice DMC-2181S.

WARRANTY (Limited)

Electro-Voice products are guaranteed against malfunction due to defects in materials or workmanship for a specified period, as noted in the

individual product-line statement(s) below, or in the individual product data sheet or owner's manual, beginning with the date of original purchase. If such malfunction occurs during the specified period, the product will be repaired or replaced (at our option) without charge. The product will be returned to the customer prepaid.

Exclusions and Limitations: The limited warranty does not apply to: (a) exterior finish or appearance; (b) certain specific items described in the individual product-line statement(s) below, or in the individual product data sheet or owner's manual; (c) malfunction resulting from use or operation of the product other than as specified in the product data sheet or owner's manual; (d) malfunction resulting from misuse or abuse of the product; or (e) malfunction occurring at any time after repairs have been made to the product by anyone other than Electro-Voice or any of its authorized service representatives.

Obtaining Warranty Service: To obtain warranty service, a customer must deliver the product, prepaid, to Electro-Voice or any of its authorized service representatives together with proof of purchase of the product in the form of a bill of sale or receipted invoice. A list of authorized service representatives is available from Electro-Voice at 600 Cecil Street, Buchanan, MI 49107 (616) 695-6831 and/or Electro-Voice West at 8234 Doe Avenue, Visalia, CA 93291 (209) 651-7777.

Incidental and Consequential Damages Excluded: Product repair or replacement and return to the customer are only remedies provided to the customer. Electro-Voice shall not be liable for any incidental or consequential damages including, without limitation, injury to persons or property or loss of use. Some states do not allow the exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you. **Other Rights:** This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Electro-Voice Electronics are guaranteed against malfunction due to defects in materials or workmanship for a period of three (3) years from the date of original purchase. Additional details are included in the Uniform Limited Warranty statement.

Electro-Voice Speakers and Speaker Systems are guaranteed against malfunction due to defects in materials and workmanship for a period of five (5) years from the date of original purchase. The Limited Warranty does not apply to burned voice coils or malfunctions such as cone and/or coil damage resulting from an enclosure design inappropriate for the program material. Electro-Voice flying hardware (including enclosure-mounted hardware and rigging accessories) is guaranteed for one (1) year from the date of original purchase. Electro-Voice active electronics associated with the speaker systems are guaranteed for three (3) years from the date of original purchase. Additional details are included in the Uniform Limited Warranty statement.

Electro-Voice Flying Hardware (including enclosure-mounted hardware and rigging accessories) is guaranteed against malfunction due to defects in materials or workmanship for a period of one (1) year from the date of original purchase. Additional details are included in the Uniform Limited Warranty statement.

Electro-Voice Accessories are guaranteed against malfunction due to defects in materials or workmanship for a period of one (1) year from the date of original purchase. Additional details are included in the Uniform Limited Warranty statement.

Service and repair address for this product: Electro-Voice, Inc., 600 Cecil Street, Buchanan, MI 49107.

Specifications subject to change without notice.



ELECTRO-VOICE a MARK IV company **600 Cecil Street, Buchanan, Michigan 49107**
MANUFACTURING PLANTS AT ■ BUCHANAN, MI ■ NEWPORT, TN ■ SEVIERVILLE, TN ■ OKLAHOMA CITY, OK ■ GANANOQUE, ONT.
© Electro-Voice, Inc. 1993 ■ Litho in U.S.A. Part Number 531934 — 9303 • 42-02-038186



Electro-Voice®
THE DELTAMAX™ SYSTEM

OWNER'S MANUAL



DMC-2181S CONTROLLER
DML-2181A LOUDSPEAKER

TABLE OF CONTENTS

DESCRIPTION and FEATURES	2
SPECIFICATIONS	3
BLOCK DIAGRAM	5
OPERATION	
Front Panel Indicators and Controls	6
Back Panel Connections	8
Typical System Operation	8
AMPLIFIER/CONTROLLER CALIBRATION	
Amplifier Calibration Procedure	10
Controller Calibration Procedure	10
INSTALLATION	
Amplifier Requirements	11
Connector and Cable Requirements	11
Controller Connections	11
Loudspeaker Connections	12
Multiple Loudspeaker Arrays	12
Speaker Installation	13
Controller Installation	13
Power Source	13
Mounting	16
Grounding	16
Ventilation	16
Security	16
Maintenance	16
ASSEMBLY VIEWS OF P.C. BOARDS	
Power Supply Board	17
Main Board	18
SCHEMATIC DIAGRAMS	19-23
SERVICE/WARRANTY INFORMATION	
Shipping Damage	16
Field Service	16
Controller Power Inspection	16
Driver Replacement	16
Warranty	24

**WARNING: "TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK,
DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOISTURE."**

DESCRIPTION**GENERAL**

The DeltaMax™ DMC/DML-2181 system consists of the DML-2181A high-performance Manifold Technology® subwoofer speaker system and the companion DMC-2181S electronic controller. The DMC/DML-2181 subwoofer system is intended for use with one of the full-range DeltaMax™ systems (such as the DMC/DML-1122 or DMC/DML-1152) for high-level sound reinforcement in touring-sound and permanent-installation applications. The unique circuitry of the DMC-2181S controller provides accurate protection for the subwoofers without the use of shifting highpass or lowpass filters, shifting crossover frequencies, or independent bandpass compression; and the electronic protection is invoked only when catastrophic conditions are present for the subwoofers. The left and right highpass output signals (above 100 Hz) are unprotected and are intended to be sent to a pair of full-range DMC-controller/DML-loudspeaker systems. The result is that accurate frequency response is maintained from the lowest sound pressure levels to the very highest sound pressure levels available from the loudspeakers. The compact DML-2181A enclosure allows tight-cluster designs, enabling maximum mutual coupling and single-point-source arrays. There are two models in the DML-2181A series: the DML-2181AP (painted finish) and the DML-2181APF (painted finish with flying hardware).

The DML-2181A is a vented-box design comprised of two DL18MT 18-inch woofers, each facing into a manifold chamber at the center of the cabinet. Manifold Technology® (U.S. Patent No. 4,733,749) results in increased acoustic loading, yielding increased low-frequency efficiency and reduced distortion over conventional direct-radiating designs.

The DML-2181APF flying version includes three steel-reinforced, aircraft-type pan fittings on the top and bottom of the enclosure. These fittings ease the hanging of multi-cabinet arrays. Each DeltaMax™ flying system is packed with a separate owner's manual which provides specific hanging instructions.

The DMC-2181S circuits are designed to provide optimum audio performance, even when the audio drive level is increased for maximum loudness. Unusually accurate speaker modeling circuits control a high-performance compressor and voltage limiter which provide speaker excursion protection, voice-coil temperature protection and amplifier maximum-power limiting.

Optimum performance of the DML-2181AP and DML-2181APF will occur only when used with the DMC-2181S. **Do not use with other electronic crossovers and/or processors.**

FEATURE SUMMARY

- Fourth-order Linkwitz-Riley crossover filters provide smooth, accurate response through the crossover region.
- Special equalization circuits allow flat, wideband system response.
- Sensing circuits for the drivers control the compressor and voltage limiter to prevent voice-coil overheating, overexcursion and amplifier clipping without affecting spectral balance or program dynamics.

Dual-time constant compressor circuit with variable compression ratio reduces peak and average levels for loud-speaker thermal protection and amplifier clipping prevention, as necessary, while preserving relative program dynamics.
- Connection to the compressor control voltage is available through a jack on the back panel. This allows precise gain tracking when more than one unit is in use, or between the subwoofer controller and other DeltaMax™ controllers.
- Front panel display shows the drive signal level of each channel and resulting sub-channel compressor gain reduction. Sensing display shows amplifier limit, excursion limit and temperature limit. When its limit is approached, each LED lights yellow.
- Speaker system is compact for tight-cluster array designs. Flying versions feature integral, steel-reinforced fittings to ease hanging.
- The woofers utilize the latest technology for high power and accurate sound reproduction.
- Manifold Technology® employed for maximum low-frequency loudspeaker performance.

CONTROLLER SPECIFICATIONS

CHANNEL CONFIGURATIONS —

Stereo two-way; one sense channel

FILTER TYPE —

4th-order Linkwitz-Riley

CROSSOVER FREQUENCY —

100 Hz

GAIN —

6 dB nominal, equalized sub output. Unity gain high output

TOTAL HARMONIC DISTORTION, 20-20,000 Hz —

0.03% typical, 0.1% maximum

NOISE, EACH OUTPUT, 20-20,000 Hz NBW, TYPICAL —

-86 dBu

SIGNAL INPUTS —**Type:**

Electronically balanced differential

Maximum Level:

+18 dBu

Impedance:

20,000 ohms

CMRR, Typical:

-55 dB

Connectors:

Female 3-pin XLR-type

SENSE CHANNEL INPUT —**Type:**

Floating differential

Maximum Level:

145 V rms

Impedance:

100 kilo ohms each side to ground

Connectors:

Two five-way binding posts

OUTPUTS (Sub and High) —**Type:**

Transformer floating differential

Maximum Level:

+18 dBu

Minimum Load Impedance for Full Level:

600 ohms

Connectors:

Male 3-pin XLR-type

POWER REQUIREMENTS —

100, 120, 220, 240 V ac, 50-60 Hz, 13 W

CHASSIS CONSTRUCTION —

Painted steel

COLORS —

Gray front panel/black chassis with white graphics

MOUNTING —

EIA 19" rack mount, 1.75" high, 8.25" behind panel (excluding connectors);

Supplied with front-panel security cover for controls.

SYSTEM SPECIFICATIONS — DML-2181A/DMC-2181S

Frequency Response, Measured in Farfield Calculated to One Meter on Axis, Swept One-Third-Octave Pink Noise, 1 Watt into LF Midband (2.00 V at 70 Hz), Anechoic Environment:

36-100 Hz

Low Frequency 3-dB Down Point:

36 Hz

Sound Pressure Level at One Meter, One Watt Input Power, Anechoic Environment, Band-Limited Pink -Noise Signal, 50-100 Hz:

98 dB

Typical Maximum Continuous Sound Pressure Levels at One Meter, Anechoic Environment:

127 dB

Typical Maximum Peak Sound Pressure Levels at One Meter, Anechoic Environment:

133 dB

Crossover Frequency:

100 Hz

Beamwidth Angle Included by 6-dB-Down Points on Polar Responses, Indicated One-Third-Octave Bands of Pink Noise, 63-100 Hz horizontal (see Figure 3):

285° (+75°, -52°)

63-100 Hz vertical (see Figure 3):

240° (+120°, -77°)

Directivity Factor R_0 (Q), 63-100 Hz median (see Figure 4):

1.84 (+0.36, -0.37)

Directivity Index D_i, 63-100 Hz median (see Figure 4):

2.66 dB (+0.77 dB, -0.99 dB)

Distortion, Indicated SPL at 1 Meter, Shaped Spectrum Second Harmonic, 120 dB SPL (see Figure 5),

50 Hz:

1.4 %

80 Hz:

1.2 %

Distortion, Indicated SPL at 1 Meter, Shaped Spectrum Third Harmonic, 120 dB SPL (see Figure 5),

50 Hz:

2.0 %

80 Hz:

2.5 %

SPEAKER SPECIFICATIONS — DML-2181A

Transducer Complement:

Two DL18MT 18-inch woofers

Efficiency:

5.0 %

Long-Term Average Power Handling Capacity Per EIA Standard RS-426A:

800 watts

Short-Term Power handling Capacity (10 ms.):

3200 watts

Maximum Long-Term Midband Acoustic Output:

40 watts

Nominal Impedance:

Two 8-ohm loads (each woofer accessed individually)

Minimum Impedance:

Two 8.6-ohm loads (each woofer accessed individually)

Dimensions,**Height:**

91.4 cm (36.0 in.)

Width:

57.2 cm (22.50 in.)

Depth:

75.9 cm (29.88 in.)

Net Weight:

74.5 kg (164 lb)

Shipping Weight:

79.5 kg (175 lb)

Enclosure Materials,**Structural:**

3/4-inch 14-ply birch plywood

Finish:

Black textured paint

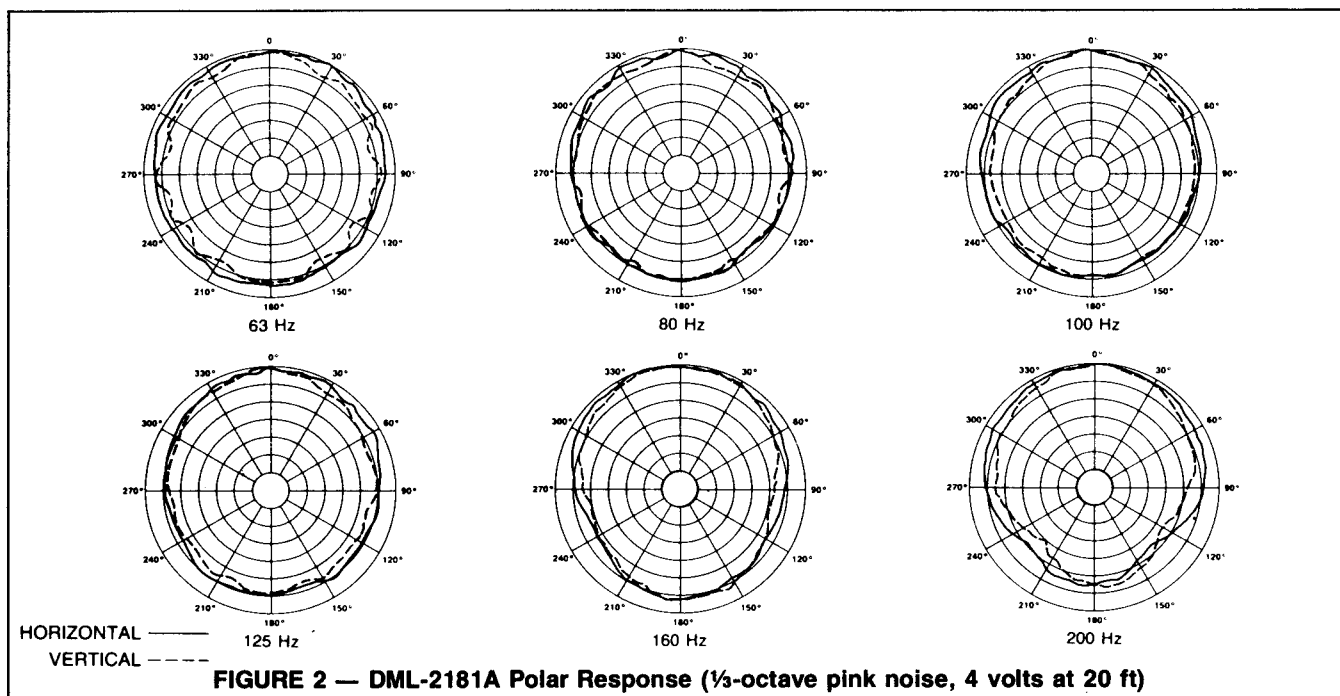
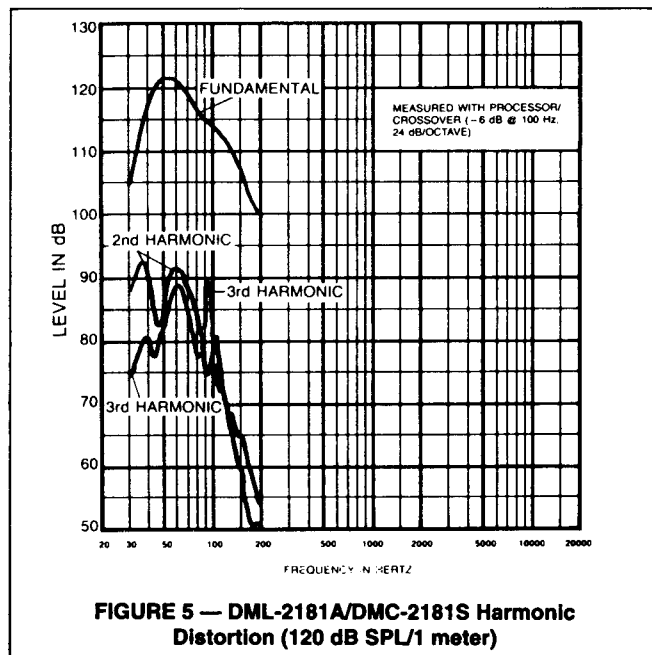
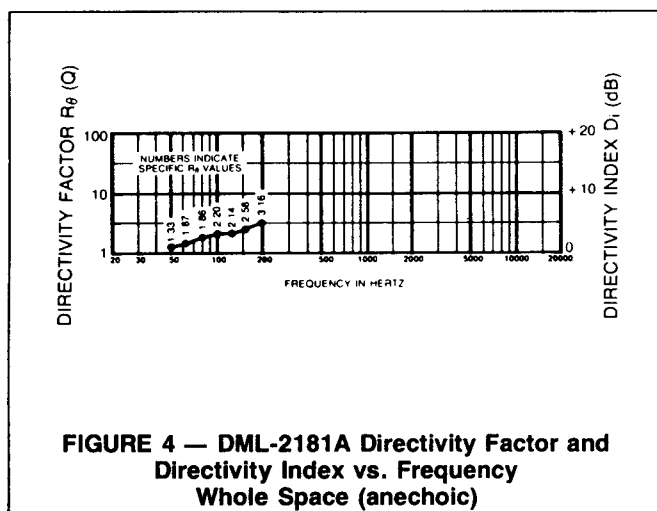
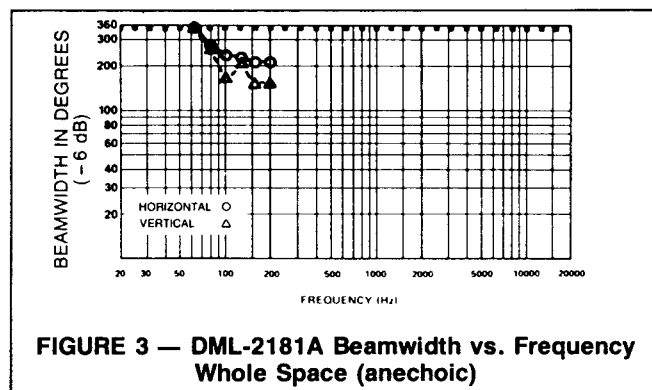
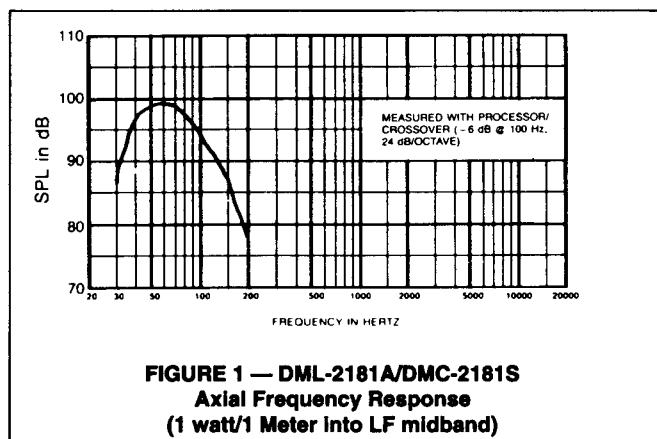
Grille:

Steel with charcoal gray foam

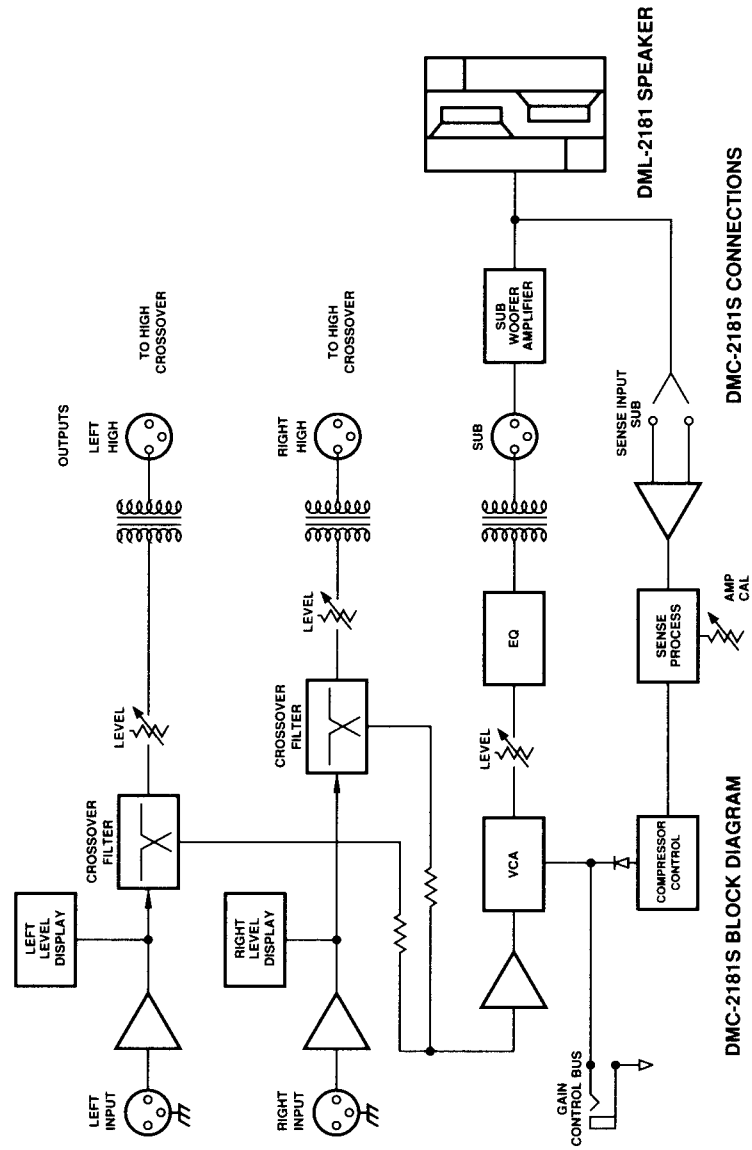
Hanging (DML-2181APF only):

3-point flying system

(accepts Kinedyne 32326 and 32343 fittings)



BLOCK DIAGRAM



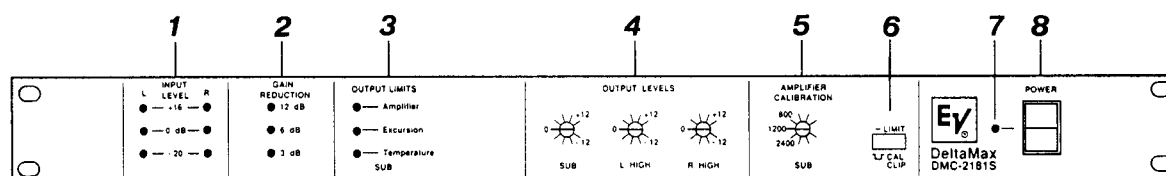


FIGURE 6 — DMC-2181S Front Panel

OPERATION

FRONT PANEL INDICATORS AND CONTROLS

1. **INPUT LEVEL INDICATORS:** Three LED's show the drive level input channel of the DMC-2181S. Levels are calibrated in dBu (-20, 0, +16).

NOTE: Do not allow the 16-dB input-level indicator to stay on continuously. If the 16-dB indicator is allowed to stay on for long periods, the input circuit will clip. The input signal should be reduced until the 16-dB indicator lights only on loud, instantaneous peaks.

2. **GAIN REDUCTION INDICATORS:** Three LED's show how much gain reduction is occurring in the compressor at the input of the controller. The display is calibrated in relative dB (3, 6, 12). Gain reduction occurs only when the maximum temperature, excursion or amplifier capabilities are exceeded for the subwoofers. The Output Limits display indicates which limits are being exceeded when gain reduction occurs.

NOTE: Do not allow the 12-dB-gain-reduction indicator to stay on continuously. If the 12-dB indicator is allowed to stay on for long periods, the speakers may be damaged. The input signal should be reduced until the 12-dB indicator lights only on loud passages.

3. **OUTPUT LIMIT INDICATORS:**

- A. **TEMPERATURE LIMIT:** These LED's light when the temperature of the subwoofer voice coils approach their maximum allowable limit. Under this condition, gain reduction will occur at the input of the controller so that the maximum-temperature limits will not be exceeded for the subwoofers.
- B. **EXCURSION LIMIT:** These LED's light when the excursion of the subwoofer cones approach their maximum allowable limit. Under this condition, voltage clamping will occur at the output of the subwoofer section so that the maximum-excursion limits will not be exceeded for the subwoofers.
- C. **AMPLIFIER LIMIT:** These LED's will provide status information for the subwoofer power amplifiers if the

controller has been calibrated to the amplifiers—see the AMPLIFIER/CALIBRATION section. With the Cal/Clip Limit switch pressed in, the LED's will signal the occurrence of amplifier clipping. With the switch in the outward position, the LED's indicate that gain reduction in the form of hard limiting is occurring at the input of the controller to prevent the amplifiers from clipping.

4. **OUTPUT LEVEL CONTROLS:**

- A. **SUB:** This control adjusts the level of the subwoofer output signal (below 100 Hz). The control range is from -12 to +12 dB.
- B. **L HIGH and R HIGH:** These controls adjust the level of the highpass output signals (above 100 Hz) sent to the inputs of a pair of full-range DMC controllers. The control ranges are from -12 dB to +12 dB.

NOTE: The gain has been structured within the DMC-2181S controller so that when the DMC/DML-2181 combination is used with one of the full-range DeltaMax™ systems (like the DMC/DML-1122 or DMC/DML-1152), the entire combination will have a flat-frequency response in an anechoic environment with the output levels of the controllers set in the 0-dB-detent position and with the amplifier channels having identical gain.

5. **AMPLIFIER CALIBRATION CONTROLS:** These controls are used for calibrating the controller to the subwoofer amplifiers, so that the controller can monitor the clipping of the amplifier outputs and, if desired, act as a limiter to prevent amplifier clipping. See AMPLIFIER/CONTROLLER CALIBRATION section.

NOTE: The calibrated markings on the front panel correspond to the power level that an amplifier would deliver to an 8-ohm load. A crude, approximate calibration can be obtained by rotating the control until the slot of the trimpot points at a power level equivalent to the amplifier power rating for an 8-ohm load. (When the trimpot is in its mid position, it is pointing at 1200 watts.)

OPERATION (continued)

6. **CAL/CLIP LIMIT SWITCH:** This switch selects the mode that controller will monitor the amplifiers (assuming that the controller has been calibrated to the amplifiers — see **AMPLIFIER/CONTROLLER CALIBRATION** section). With the switch pushed in, the Amplifier Limit LED's will indicate when the amplifiers are clipping. With the switch in the outward position, the Amplifier Limit LED's will indicate that gain reduction is occurring to prevent the amplifiers from clipping.

NOTE: If the controller has not been calibrated to the subwoofer amplifiers, the Cal/Clip Limit switch should be pushed in. This will defeat the compressor/limiter from trying to prevent amplifier clipping. (The Amplifier Limit LED's will still flash when the amplifier exceeds the power levels that the Amplifier Calibration trimpots are set to.) Poor sound quality can result with incorrect calibration and the compressor/limiter engaged.

7. **POWER INDICATOR:** This LED lights when the controller is on.
8. **POWER SWITCH:** This switch turns the controller on and off.

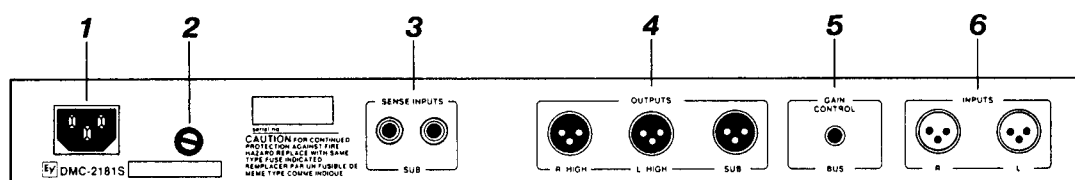


FIGURE 7 — DMC-2181S Back Panel

OPERATION

BACK PANEL CONNECTIONS

1. **AC POWER CORD RECEPTACLE:** This receptacle is for the provided ac power cord.
2. **FUSE RECEPTACLE:** This fuse receptacle requires either a 0.175A 250 V slow-blow fuse (for 100/120 V ac operation), or a 0.100A 250 V slow-blow fuse (for 220/240 V ac operation).
3. **SUB SENSE INPUT:** This input is for connection of the sense line to monitor the power delivered to the subwoofers and should be connected to the output of the subwoofer amplifier.

NOTE: The Sense Input is a floating differential with a 5-way binding post. See CONNECTOR AND CABLE REQUIREMENTS section for detailed wiring information.

4. **OUTPUTS:**
 - A. **SUB:** This connection is the subwoofer output (below 100 Hz) of the DMC crossover/controller and should be connected to the input of the subwoofer amplifier.
 - B. **R HIGH and L HIGH:** These connections are the highpass outputs (above 100 Hz) of the crossover/controller and should be connected to a pair of full-range DeltaMax controller systems for full-range stereo reproduction.

NOTE: The Sub and High outputs are transformer balanced XLR-type connectors having pin 1 as a ground reference, pin 2 high (+) and pin 3 (-). See CONNECTOR AND CABLE REQUIREMENTS section for detailed wiring information.

5. **GAIN CONTROL BUS:** This 1/4-inch jack is for slaving the gain-control buses of other DMC controllers to enable gain tracking in a multiple-controller system. See CONNECTOR AND CABLE REQUIREMENTS section for detailed wiring information.
6. **INPUT:** These connections are for the full-range right and left stereo signal inputs to the DMC controller. These

inputs are electronically balanced with female 3-pin XLR-type connectors with pin 1 as a ground reference, pin 2 high (+) and pin 3 low (-). See CONNECTOR AND CABLE REQUIREMENTS section for detailed wiring information.

TYPICAL SYSTEM OPERATION

The DML-2181 is a subwoofer loudspeaker system to be used with the DMC-2181S electronic controller. The DMC/DML-2181 subwoofer system is intended for use with one or two full-range DeltaMax™ electronically controlled loudspeaker systems (such as the DMC/DML-1122 or DMC/DML-1152). Besides conventional frequency division, the DMC-2181S controller has equalization and time delay to obtain optimum performance from the DML-2181A when used with a full-range DeltaMax™ system. A sense line to the controller monitors the voltage drive to the subwoofers and automatically activates the protection circuitry to prevent cone overexcursion, voice-coil overheating and amplifier clipping. The right and left high outputs are unprotected and are intended to be sent to the inputs of a pair of full-range DMC-controller/DML-loudspeaker systems. (Protection for the full-range speakers will take place in the full-range controllers.) Before operating a DeltaMax™ system, the user should read this manual thoroughly and make sure that the system has been set up as detailed in the INSTALLATION section and the amplifiers and controllers have been calibrated as detailed in the AMPLIFIER/CONTROLLER CALIBRATION section.

The gain and equalization structures in the DMC controllers have been set up so that the DML loudspeaker systems will have a flat frequency response (in an anechoic environment) when the Output Level trimpots on the controllers are set in the 0-dB-detent position and the amplifiers all have the same gain (i.e., the amplifiers are calibrated for 32 dB of gain as detailed in the AMPLIFIER/CONTROLLER CALIBRATION section). This gives the user a standard reference every time the system is set up. Adjustments to the drive levels of the low- and high-frequency sections are then only needed to compensate for room acoustics or array configurations. When adjustments are required, they should be made with the Output Level trimpots on the controllers. The level controls on

OPERATION (continued)

the amplifiers should be left in their calibrated positions. (See the MULTIPLE LOUDSPEAKER ARRAY section for circumstances when it is permissible to adjust the amplifier level controls.)

The input circuit of the DMC controllers clips with a +18 dBu (6.2 volts rms) input signal. The input-signal level display has three LED's calibrated to -20, 0 and +16 dBu. To avoid clipping, the input should be driven only to the point that the +16 dBu LED lights on instantaneous peaks. If more gain is desired from the controller, the Output Level trimpots may be turned up. Note that there are calibrated markings on the front panel of the controller (3 dB per division) to enable accurate gain adjustments.

Extensive modeling circuits allow the controller to monitor the status of the voice-coil temperature and the cone excursion of the subwoofer loudspeakers. If a loudspeaker approaches its maximum thermal limit, a multi-time-constant compressor circuit with a variable compression ratio will reduce the peak and average levels of the drive signal as necessary to protect the drivers, while preserving the spectral balance and the relative program dynamics. When gain reduction occurs, an Output Limit Temperature LED will light indicating that the subwoofers are reaching their thermal limit. If a subwoofer approaches its maximum excursion limit, a dynamic frequency-sensitive voltage-clamping circuit at the output of the subwoofer band will clamp the peak of the output waveform at a level above which excursion damage would occur to the loudspeaker; hence, preserving the overall spectral balance. When voltage clamping occurs, an Output Limit Excursion LED will light indicating that the subwoofers are reaching their excursion limit.

The DMC-2181S controller can also prevent long-term amplifier clipping. The controller must be calibrated as detailed in the AMPLIFIER/CONTROLLER CALIBRATION section and the Cal/Clip Limit switch must be in the Out position for this function to work properly. If the subwoofer amplifiers approach clipping, a multi-time-constant compressor-limiter circuit will reduce the peak and average levels of the drive signal as necessary to prevent long-term clipping, while preserving the overall spectral balance. When gain reduction occurs, an Output Limit Amplifier LED will light indicating that the subwoofer amplifiers are reaching their power limit. With the Cal/Clip Limit switch pushed in, gain reduction will not occur to prevent amplifier clipping and the Output Limit Amplifier LED's will simply indicate when the amplifiers are going into clipping.

The DeltaMax™ DMC controllers provide protection for the loudspeakers without affecting the overall spectral balance or dynamic range. The controllers have an LED display to inform the user when the protection circuitry is activated and what is causing the protection to take place. Each frequency band has three LED's to indicate loudspeaker thermal protection activation, loudspeaker excursion protection activation and amplifier clipping (or amplifier clipping prevention). In addition, there is an LED display to indicate the amount of long-term overall gain reduction occurring due to loudspeaker thermal protection and amplifier clipping prevention. (The instantaneous loudspeaker excursion voltage-clamping pro-

tection is not reflected in the overall gain-reduction display.)

In very high-powered applications, the detailed displays on the DMC controllers provide the user with information to make adjustments or changes to the system (if desired) to eliminate the protection and increase the acoustic output. For example:

- If an excessive amount of low-frequency protection is occurring, selective equalization can be used (1/3-octave-band equalizer, parametric equalizer, etc.) to reduce the frequency range that is causing the excessive excursion, allowing the overall level to be turned up. If the desired amount of high-level low-frequency response still cannot be obtained, subwoofers (or additional subwoofers) should be added to the system.
- If an excessive amount of loudspeaker thermal protection is occurring in any frequency band, more speaker systems are generally needed. If the program material has a lot of energy concentrated in a relatively small frequency range, selective equalization may serve as an effective compromise.
- If excessive amplifier clipping (or amplifier clipping prevention) is occurring without excessive loudspeaker thermal protection or excursion protection, larger power amplifiers should be used.
- If excessive loudspeaker thermal protection and excursion protection is occurring, more speakers should be used.
- If excessive overall gain reduction is occurring, more speakers should be added.
- If the 12-dB-gain-reduction LED is on for any significant portion of time, the level should be turned down. Levels driven beyond this point may exceed the protection capability of the protection circuitry.

When multiple DMC-2181S controllers are used, the control voltages should be slaved together as detailed in the INSTALLATION section. The gain of all of the controllers will then track whenever gain reduction occurs due to loudspeaker thermal protection or amplifier clipping prevention, regardless of which loudspeaker or amplifier was exceeding its limit. This will prevent acoustic image shifting at very high levels. When a DMC/DML-2181 subwoofer system is used with full-range DeltaMax™ systems (such as the DMC/DML-1122 or DMC/DML-1152), the control voltages should be slaved together to prevent spectral balance shifting at high levels when gain reduction occurs for loudspeaker thermal protection or amplifier clipping prevention. The voltage-clamping loudspeaker excursion protection will still operate independently in each frequency band in each controller when the control voltages are slaved.

AMPLIFIER/CONTROLLER CALIBRATION**AMPLIFIER CALIBRATION PROCEDURE**

Maximum performance of the DeltaMax™ controller protection circuitry occurs, under the most severely over-driven conditions, when the voltage gain of the amplifiers fall in the range of 27 to 35 dB (with 32 dB being optimum). This gain range is typical of most high-power amplifiers and can easily be adjusted by simply adjusting the level controls on the amplifier.

The procedure for calibrating an amplifier to have 32 dB of gain is as follows:

1. With the amplifier turned on and without speakers hooked on the amplifier output, apply 0.5-volt rms, 1,000-Hz sinewave signal to the input of the amplifier.
2. Adjust the level control until the output of the amplifier measures 20 volts rms.

NOTE: If the amplifier will be operated in the mono-bridged mode, it should be calibrated when wired in the mono-bridged configuration.

CONTROLLER CALIBRATION PROCEDURE

This procedure is for calibration of the DMC controller's internal amplifier limit circuits to the actual clip level of the subwoofer power amplifiers.

Before plugging in the ac power cord, be sure the controller is wired for the correct primary (mains) voltage.

Disconnect the speakers and remove the security cover from the controller by removing two screws on the front panel of the controller. Perform the following procedure:

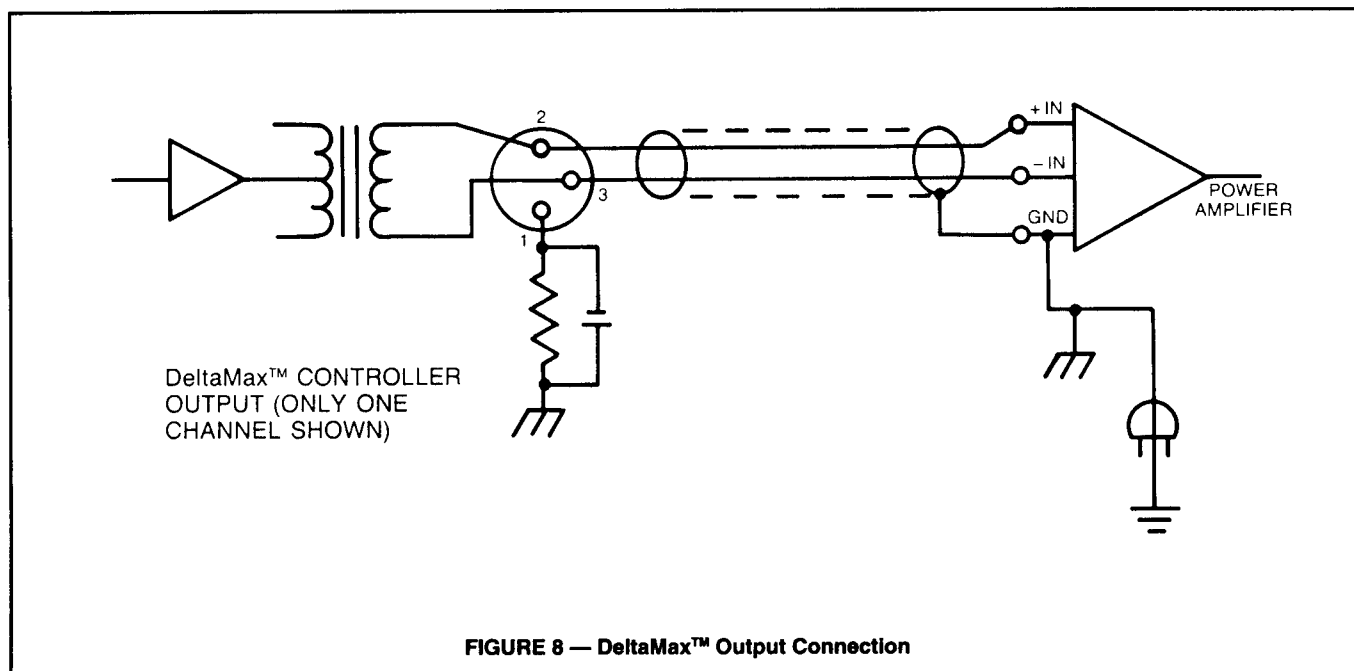
1. Connect the controller to the subwoofer power amplifier channels as detailed in the INSTALLATION section.
2. Be sure the controller Sub Sense Input is connected to the amplifier output and the **speakers are disconnected** from the amplifier.
3. Set the subwoofer amplifier gain controls for 32 dB voltage gain, or as close as possible to 32 dB (this is optimum, but it can be in the range of 27 to 35 dB). See the AMPLIFIER CALIBRATION PROCEDURE section.
4. Turn the Sub Amplifier Calibration trimpot on the controller to full counterclockwise. Press the Cal/Clip Limit switch to its recessed Cal/Clip position with a screwdriver or other suitable tool.
5. In order to prevent thermal limiting from occurring while calibrating the amplifier-limit levels, insert a shorted 1/4-inch phone plug (tip-sleeve) into the Gain Control Bus jack on the back of the controller. The thermal limit LED may still come on but no gain reduction should be indicated.
6. Send a 40-Hz sinewave test signal to the controller input.
7. Adjust the signal source level until the subwoofer amplifier begins to clip (you may turn up the Sub Output Level on the controller if necessary to get the amplifier to clip). Clipping is noted by the clip indicator on the power amplifier or by monitoring the output with an oscilloscope. Now, turn the level down until the clip light just goes out (or until the clipping disappears on the oscilloscope).

8. Turn the Sub Amplifier Calibration trimpot on the controller clockwise with a screwdriver until the Sub Amplifier Output Limit LED comes on. Note that the slot of the trimpot is pointed at the approximate power rating of the amplifier for an 8-ohm load as denoted by the calibrated marking on the front panel of the controller. Note that this is the maximum amount of power capable of being delivered to a single driver in this amplifier configuration.
9. **Remove the shorted 1/4-inch phone plug from the Gain Control Bus jack** and set the Cal/Clip Limit switch to the Limit position (out). Set the Sub Output Level control to its center-detent position (or as desired).
10. Turn the amplifier off and connect the speaker cables to the output of the amplifier. Be sure to observe polarity when making these speaker connections.

NOTES:

- A. The Amplifier Calibration trimpots may be adjusted during use with program material to set the desired amount of amplifier limiting. The limiter in the controller will allow some fast transient peaks through, allowing some amplifier clipping to occur. The limiter circuit will, however, prevent long-term amplifier clipping when adjusted properly.
- B. The Cal/Clip Limit switch may be left in the recessed Cal/Clip position if the power amplifier has an internal limiter, or if clip protection is not desired. When left in the Cal/Clip position, the Amplifier Output Limiter indicators on the front panel of the controller will indicate when the amplifier is self-limiting or clipping.
- C. If two or more speakers are connected in parallel to an amplifier output, most amplifiers will exhibit a drop in clipping voltage due to the lower load impedance. This will require that the Amplifier Calibration trimpot be set to a value slightly lower than the value obtained in the "no-load" calibration test.

Note that the result of this is that even when multiple speakers are paralleled on an amplifier channel, the Amplifier Calibration trimpot will always end up pointing at the maximum amount of power (on the calibrated marking on the front panel) that the amplifier is capable of delivering to each individual driver no matter how many drivers are connected in parallel.
- D. Do not change the amplifier gain, or recalibration will be necessary. Use the Output Level controls on the controller to change power amplifier drive levels.



INSTALLATION

AMPLIFIER REQUIREMENTS

The DML-2181A subwoofer system contains two 8-ohm drivers. Each system utilizes a 4-pin electrical connector that allows each driver to be accessed separately. There are two ways the system may be powered:

1. Each driver may be connected to its own separate amplifier channel. In this configuration, each amplifier channel should have a power rating of 400-600 watts into eight ohms. The amplifier channels must be identical, having the same voltage gain and power rating.
2. The two drivers may be paralleled to one amplifier channel. The speakers should be paralleled at the amplifier, not at the cabinet. In this configuration, the amplifier channel should have a power rating of 800-1,200 watts into four ohms.

DML-2181A systems may be paralleled (in either of the above configurations) with other DML-2181A systems if the amplifier is capable of delivering adequate power to each speaker at the lower impedance.

NOTE: For proper operation of the protection circuitry, the power amplifiers must be calibrated to have a voltage gain between 27 and 35 dB (32 dB is optimum). See the AMPLIFIER/CONTROLLER CALIBRATION section.

CONNECTOR AND CABLE REQUIREMENTS

Controller Connections

The DeltaMax™ controllers have 3-pin XLR-type connectors for signal input and output. The inputs are electronically balanced female connectors with pin 1 as a referenced ground, pin 2 high (+) and pin 3 low (-). The outputs are transformer balanced and have male connectors with pin assignments identical to the input. Figure 8 illustrates the preferred interconnection between the controller and the power amplifier. When driving unbalanced lines, pin 3 should be shorted to ground.

To hook up the DMC-2181S controller to the power amplifier, connect the Sub Output of the controller to the input of the subwoofer amplifier. If two amplifier channels are used, a Y-cord should be used to direct the signal into the input of both amplifier. The High Outputs of the controller are connected to the inputs of full-range DeltaMax™ controllers (like the DMC-1122B or DMC-1152B).

The outputs of the subwoofer amplifiers are then connected to the DML-2181A speaker system. For the configuration where each driver is driven by its own amplifier (see Figure 9): connect one driver in the DML-2181A to one amplifier making Pin 1- negative and Pin 1+ positive, and connect the other driver to the second amplifier making Pin 2- negative and Pin 2+ positive. For the configuration where the two drivers are paralleled on a single amplifier channel (see Figure 10): connect both drivers to the amplifier channel by making Pins 1- and 2- negative and Pins 1+ and 2+ positive. See the LOUDSPEAKER CONNECTIONS section for details of the loudspeaker wiring.

A Sense line must be connected to the DMC-2181S controller so that the power levels being delivered to the subwoofer drivers can be monitored. For the configuration where each driver is driven by its own amplifier: connect the output of one of the subwoofer amplifiers to the Sub Sense Input on the controller. (Do not connect another sense line to the output of the other amplifier—that would short the two amplifiers together.) Note that because the amplifiers are identical and both drivers are driven at the same level, both will be protected by the controller. For the configuration where the two drivers are paralleled on a single amplifier channel: connect the output of that subwoofer amplifier to the Sub Sense Input on the controller. The sense input connector is a 5-way binding post wired in a floating differential configuration. This configuration makes it possible to connect sense lines to a bridged amplifier without shorting out one of the legs of the amplifier. High-quality banana plugs may be used for these connections, but wires underneath the binding posts provide

INSTALLATION (continued)

greater security. Small gauge wire (e.g., 22 gauge) is acceptable for these connections because there is minute current flow, but be sure the connections are secure and safe enough for the high voltages from the amplifier output.

The gain control bus in the DMC controllers is accessible through a two-conductor 1/4-inch jack on the back of the controller. This feature is used when it is desired for the gain of two or more units to track. Using a standard 1/4-inch patch cable, connect the jacks together. For more than two units, use Y-connectors. For example:

1. When multiple DMC-2181S controllers and loudspeakers are used, the controller's Gain Control jacks should be connected together to maintain level balancing and imaging.
2. When the DMC-1122B/DML-1122A and DMC-1152B/DML-1152A full-range systems are used with the stereo DMC-2181S/DML-2181A subwoofer system, the controller's Gain Control jacks should be connected together between the three controllers to ensure flat-frequency response when the controllers are operating in the protection mode.

Loudspeaker Connections

The DML-2181A subwoofer speaker system is equipped with 4-pin Neutrik Speakon™ NL4MP-R connectors for electrical connection to the two subwoofer drivers. Each cabinet has two identical connectors with parallel wiring for connecting additional DML speaker systems. One mating Neutrik Speakon™ NL4FC cable-end connector is supplied with each system.

Cables, connectors and wiring accessories are available for the DML speaker systems from Pro Co Sound, Inc., and Whirlwind Music Distributors, Inc. To find your local Pro Co, Whirlwind or Neutrik dealer, contact:

Pro Co Sound, Inc.
135 E. Kalamazoo Ave.
Kalamazoo, MI 49007

Whirlwind Music Distributors, Inc.
P.O. Box 1075
Rochester, NY 14603

Neutrik USA, Inc.
195-S3 Lehigh Ave.
Lakewood, NJ 08701

The pin connections are as follows:

Pin 1- = LF 1 (-)
Pin 1+ = LF 1 (+)
Pin 2- = LF 2 (-)
Pin 2+ = LF 2 (+)

Both low-frequency inputs present a nominal eight-ohm load to the amplifier.

Multiple Loudspeaker Arrays

Arrays consisting of multiple of identical DeltaMax™ loudspeaker systems can be implemented in a variety of ways. There does not need to be one controller for every speaker cabinet. Generally, there only needs to be as many controllers

as there are different program sources. For example: a monaural program source requires one sub controller and one full-range controller, a stereo program source with mono bass requires one sub controller and two full-range controllers, a stereo program source with stereo bass requires two sub controllers and two full-range controllers, etc. For the sake of simplicity, the following discussion will be confined to the various possible connection schemes for arrays of identical loudspeakers with only one program source. (A stereo or multiple-source array can be broken down and analyzed as separate arrays, each having a separate program source.) Amplifier inputs, outputs and sense lines will be addressed in the discussion.

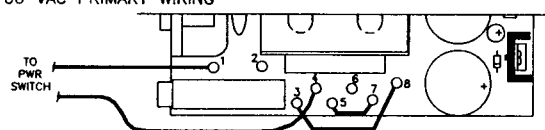
The outputs (Sub Out, LF Out, HF Out, etc.) of the DMC controllers are connected to the inputs of multiple amplifier channels through the use of Y-cords (or multiple Y-cords). The number of amplifier channels that can be driven by a single output of a controller is limited only by the total combined input impedance of the paralleled amplifiers. The DeltaMax™ controller outputs can drive a combined impedance of 600 ohms or greater. (For example, sixteen amplifiers, each having an input impedance of 10 K ohms, can be paralleled off of one DMC output.) If it is necessary to parallel additional amplifiers, line-level distribution amplifiers will have to be employed to drive the amplifier inputs. (Alternatively, multiple DMC controllers with paralleled inputs could be used to distribute the amplifier load.)

For the case where all of the DeltaMax™ loudspeakers are paralleled on the output of a single amplifier channel and only one controller is used, the sense line to that controller is connected to the output of the amplifier. In this case, all of the loudspeakers are driven at the same level and the controller monitors the voltage drive to each speaker. Make sure that the amplifier is calibrated for 32 dB of gain and that the controller is calibrated to the amplifier (see AMPLIFIER/CONTROLLER CALIBRATION section.)

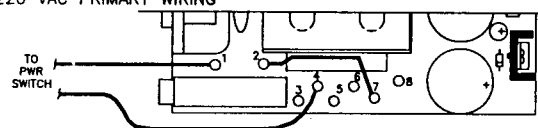
For the case where the DeltaMax™ loudspeakers are powered by multiple amplifiers, all driven at the same level and only one controller is used, the sense line to that controller is connected to any one of the amplifier outputs. Note that this requires the use of identical amplifiers, each calibrated for 32 dB of gain, and that the controller is calibrated to the amplifiers (see AMPLIFIER/CONTROLLER CALIBRATION section). Although the controller is only actually sensing one amplifier and one set of loudspeakers, they all are being protected equally as long as all of the amplifiers are performing identically.

For the case where the DeltaMax™ loudspeakers are powered by multiple amplifiers, each driven at different levels and only one controller is used, the sense line to that controller is connected to the output of the amplifier that is delivering the highest power levels to the loudspeakers. This is a fairly common occurrence; where the levels of individual loudspeakers in an array are adjusted to provide even room coverage. In this case, the amplifier being sensed must be calibrated for 32 dB of gain and the controller is calibrated to that amplifier. (See AMPLIFIER/CONTROLLER CALIBRATION section.) The other amplifiers must be identical to the one being sensed, with the exception that their levels are turned down as necessary to obtain even room coverage. Although

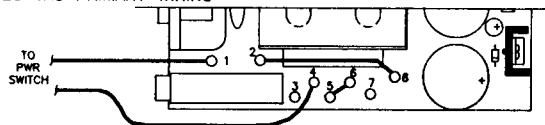
100 VAC PRIMARY WIRING



220 VAC PRIMARY WIRING



120 VAC PRIMARY WIRING



240 VAC PRIMARY WIRING

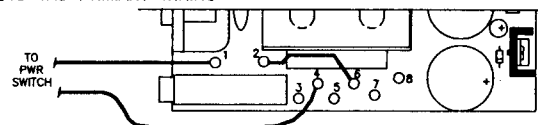


TABLE I — Primary Power Conversion Chart for 100-, 120-, 220-, and 240-V, 50/60-Hz Operation

INSTALLATION (continued)

the controller is actually sensing only one amplifier and one set of loudspeakers, they are all being protected because the one being driven the hardest is triggering the protection.

Note in the last two examples where multiple amplifiers are used to power multiple loudspeakers in an array, the level setting and calibration of the amplifiers are critical to ensure that all of the loudspeakers are protected with only one sense line. If, in the normal course of operation, the level settings of the amplifiers are likely to be tampered with, the system should be set up with one controller per amplifier, allowing each set of speakers to be monitored. In this case, each amplifier would be calibrated for 32 dB of gain and any level adjustment of loudspeakers would be done with the Output Level trimpots on the controllers.

SPEAKER INSTALLATION

The DML-2181APF is the flying version of the DML-2181AP. Each cabinet has a total of six steel-reinforced aircraft-type pan fittings (three on the top and three on the bottom). This three-point flying system makes maximum use of the compact cabinets, permitting a wide range of angle adjustment and offering maximum flexibility in array design and implementation for both the touring sound company and the sound contractor. The pan fittings mate with the Kinedyne 32343 and 32326 twelve-jaw fittings. Electro-Voice offers the DMS series of rigging hardware; a complete line of flying accessories to be used with the DML speaker systems.

*** CAUTION ***

The DML-2181APF speaker systems should be suspended overhead only in accordance with the procedures and limitation specified in the DML-2181AF Flying Manual which is packed with each flying speaker system.

CONTROLLER INSTALLATION

Power Source

The DMC-2181S comes prewired from the factory for operation at 120 volts. To operate at a different voltage, the primary wiring of the power transformer must be altered.

*** CAUTION ***

Hazardous voltages and currents may be encountered within the chassis. The service information contained within this document is for use by Electro-Voice authorized warranty stations and qualified service personnel only.

To change the transformer primary wiring configuration, use the following procedure:

1. Unplug the DMC-2181S power cord from the ac power source.
2. Remove the seven screws securing the top cover. There are two screws on each side, two screws on the rear, and one screw in the front panel (center, top).
3. Locate the eight voltage select solder cups near the power transformer. Referring to Table I, reconnect the leads corresponding to the desired primary voltage.
4. Install the correct line fuse. See values in Table II.
5. Install the top cover with the seven screws.

Line Voltage	Line Fuse, Slow-Blow
100 V ac	0.175 A/250 V
120 V ac	0.175 A/250 V
220 V ac	0.100 A/250 V
240 V ac	0.100 A/250 V
TABLE II Main Fuse Selection Guide	

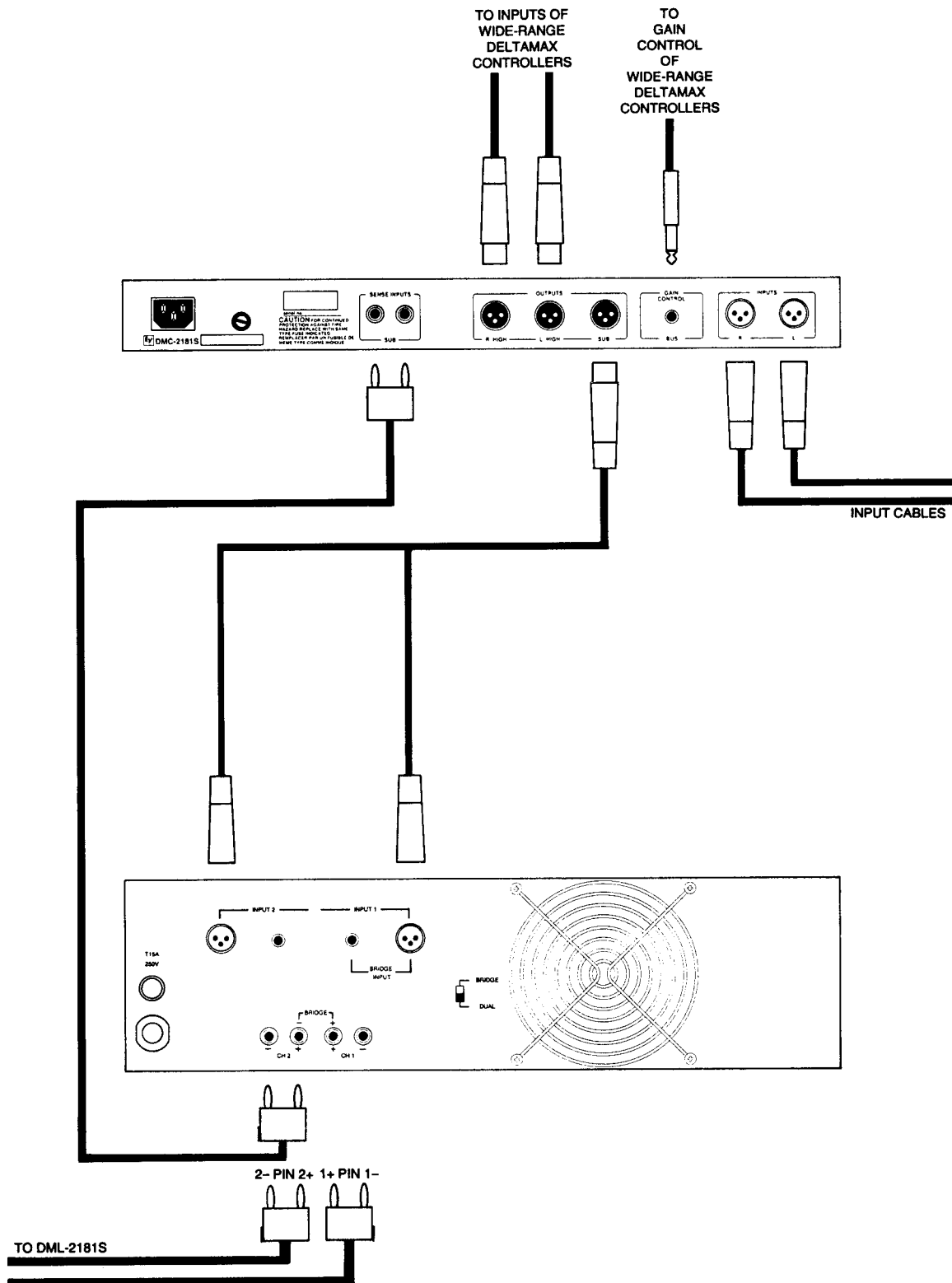


FIGURE 9 — Drivers Connected to Two Separate Amplifier Channels

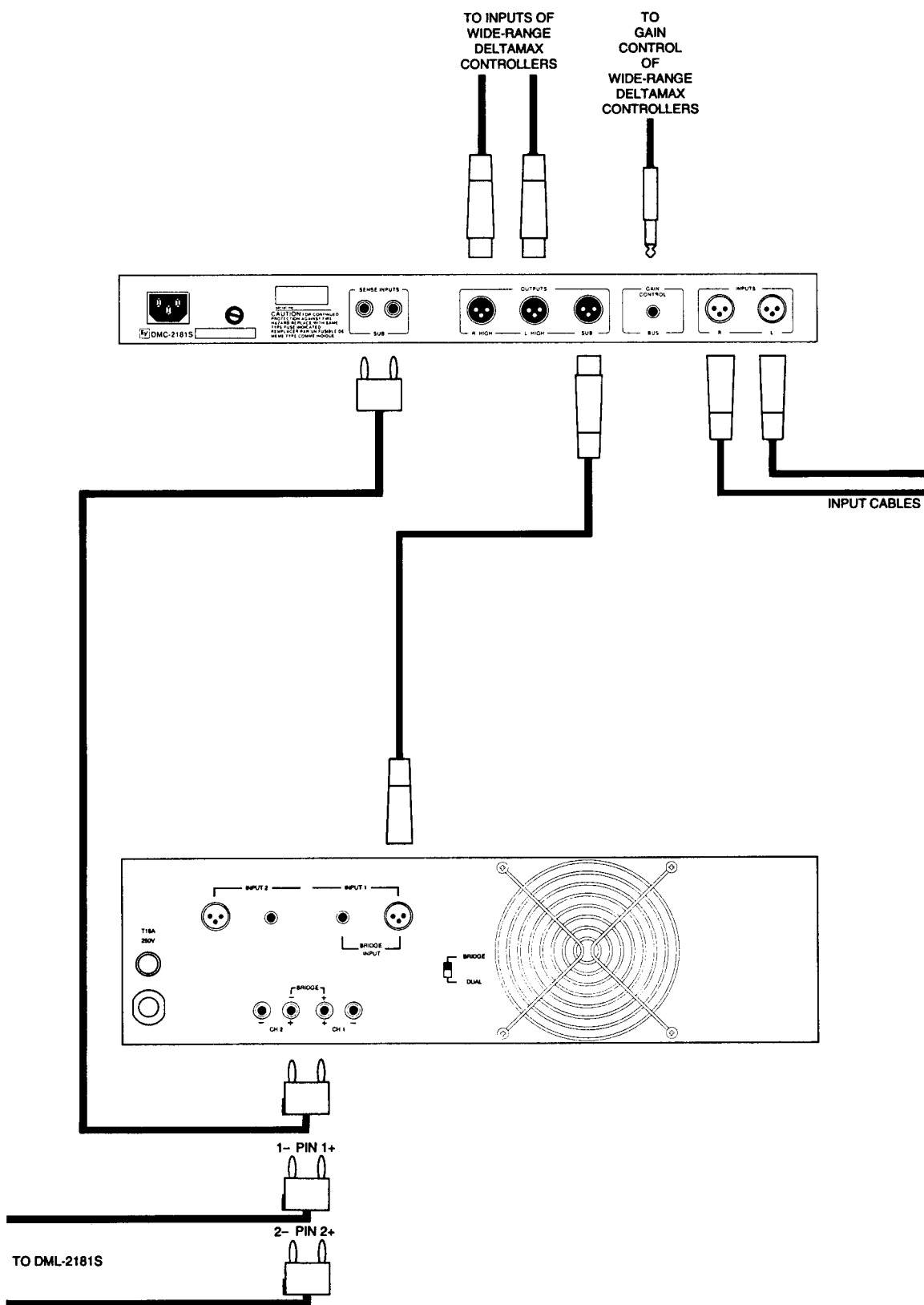


FIGURE 10 — Drivers Paralleled to One Amplifier Channel

INSTALLATION (CONTINUED)**Mounting**

The DMC-2181S is one rack-space high (1 $\frac{3}{4}$ in.) and fits in a standard EIA 19-inch rack. To make wiring easier, mount the controller in a rack cabinet near the power amplifier(s).

Grounding

A widely accepted ground technique for audio systems is the single-point ground. The final configuration will be determined by the size of the system and by the type of equipment used in the system. However, the single-point grounding system is recommended as a starting point.

The interconnecting cables of line-level equipment, such as the DMC-2181S, should have the shields connected at one point only. This point is usually the receiving end of the signal transmission. See Figure 8.

Never lift the third wire safety ground of the ac power cord. It protects against possible shock hazard.

When deciding how to ground the DMC-2181S in a particular system, note the controllers's input and output. XLR-type connectors have pin 1 referenced through medium impedance to chassis ground. The connector handle chassis is grounded. Circuit ground ties to the chassis ground internally at one point. The input to the controller is active-differential, and the outputs are transformer-isolated.

Ventilation

Provide adequate ventilation in the rack to maintain a reasonable operating temperature. The ambient temperature inside the rack cabinet should not exceed 60° C (140° F) under any conditions.

Security

The system contains a security cover and two screws to protect the control setting against uninvited adjustments.

Maintenance

Use a soft damp cloth to clean the unit. No other maintenance is required.

Item	EV Part No.
Complete Woofer	818-0882
Logo Namplate Assy.	81680
Foam Grille	72717
Steel Grille Assy.	81704
Input Panel Sub-Assy.	81867
Input Connector	17305
Cable Connector	17306

SERVICE INFORMATION**SHIPPING DAMAGE**

Inspect the shipping carton for possible damage. If the system arrives damaged, notify the transportation company immediately. Save the carton as evidence for the carrier to inspect. If damage occurs during shipping, it is the responsibility of the consignee to file a claim with the carrier. If the carton is in good condition but the unit is damaged, call Electro-Voice.

Included in the box with the DMC-2181S is a power cord, warranty card, two operating voltage labels, a 1/10 amp fuse for 220-240 V ac, and this manual.

FIELD SERVICE

WARNING: No user servicable parts inside. Extremely hazardous voltages and currents may be encountered within the chassis. The servicing information contained within this document is only for use by Electro-Voice authorized warranty repair stations and qualified service personnel. To avoid electric shock, DO NOT perform any servicing other than that contained in the Operating Instructions unless you are qualified to do so. Otherwise, refer all servicing to qualified service personnel.

NOTICE: Modifications to Electro-Voice products are not recommended. Such modifications shall be at the sole expense of the person(s) or company responsible, and any damage resulting therefrom shall not be covered under warranty or otherwise.

Controller Power Inspection

If the power indicator does not light:

1. Check the power switch.
2. Check the power cord.
3. Check the fuse.
4. Check the primary (mains) voltage and DeltaMax™ controller operating voltage configuration.

Driver Replacement

To access the drivers, first remove the foam grille. The grille may be removed by simply grabbing a corner and gently peeling it off. Next, remove the screws securing the metal grille screen. The screws can be easily removed with a #2 Phillips screwdriver; the screen can then be lifted off. Remove the eight 1/4-20 hex head bolts which secure each woofer. Use a 3/8-inch nutdriver or a ratchet with a 3/8-inch socket. The woofers then slide straight out of the enclosure.

Ordering Replacement Parts

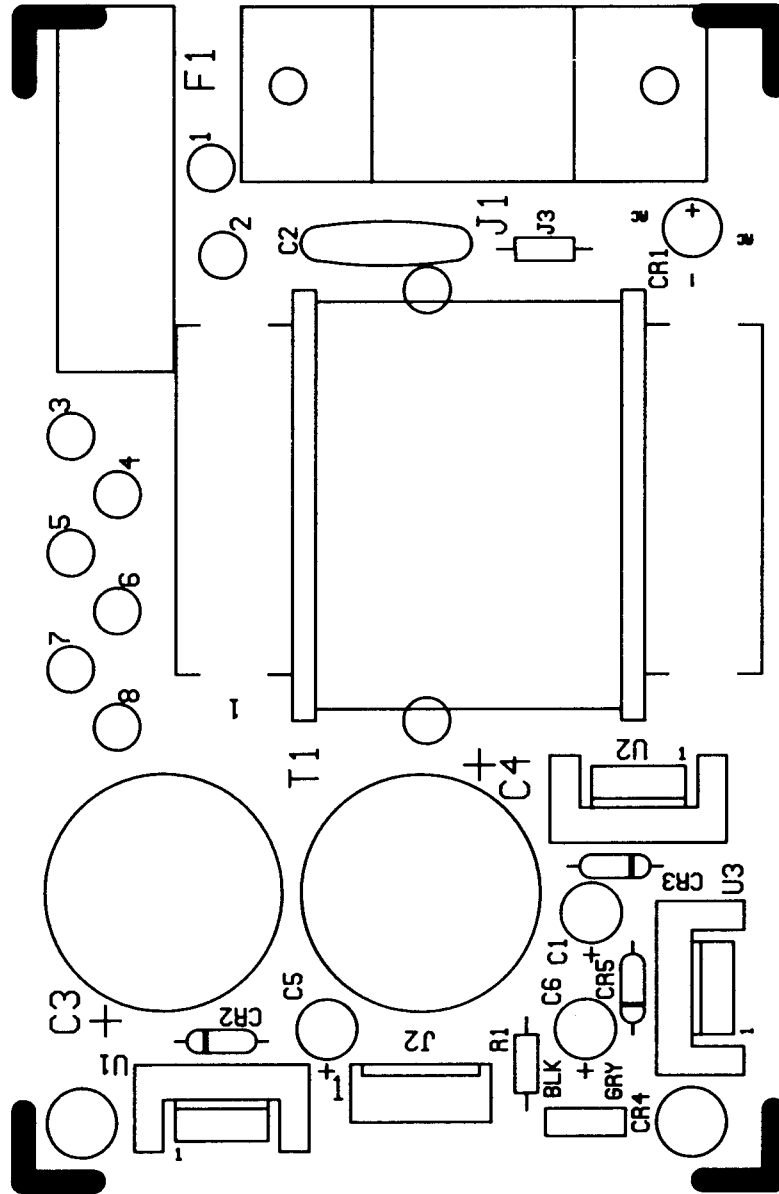
To order replacement parts, look up the order number from the component parts listing and call E.S.T. (616) 695-6831, FAX (800) 544-2153, for P.S.T. call (209) 651-7777, or write:

Electro-Voice Service
600 Cecil Street
Buchanan, MI 49107 U.S.A.

Technical Assistance

For applications assistance or other technical information, contact the Technical Services Manager. You can call (616) 695-6831, FAX (616) 695-1304, or write: Electro-Voice, Technical Services Manager, 600 Cecil Street, Buchanan, MI 49107 U.S.A.

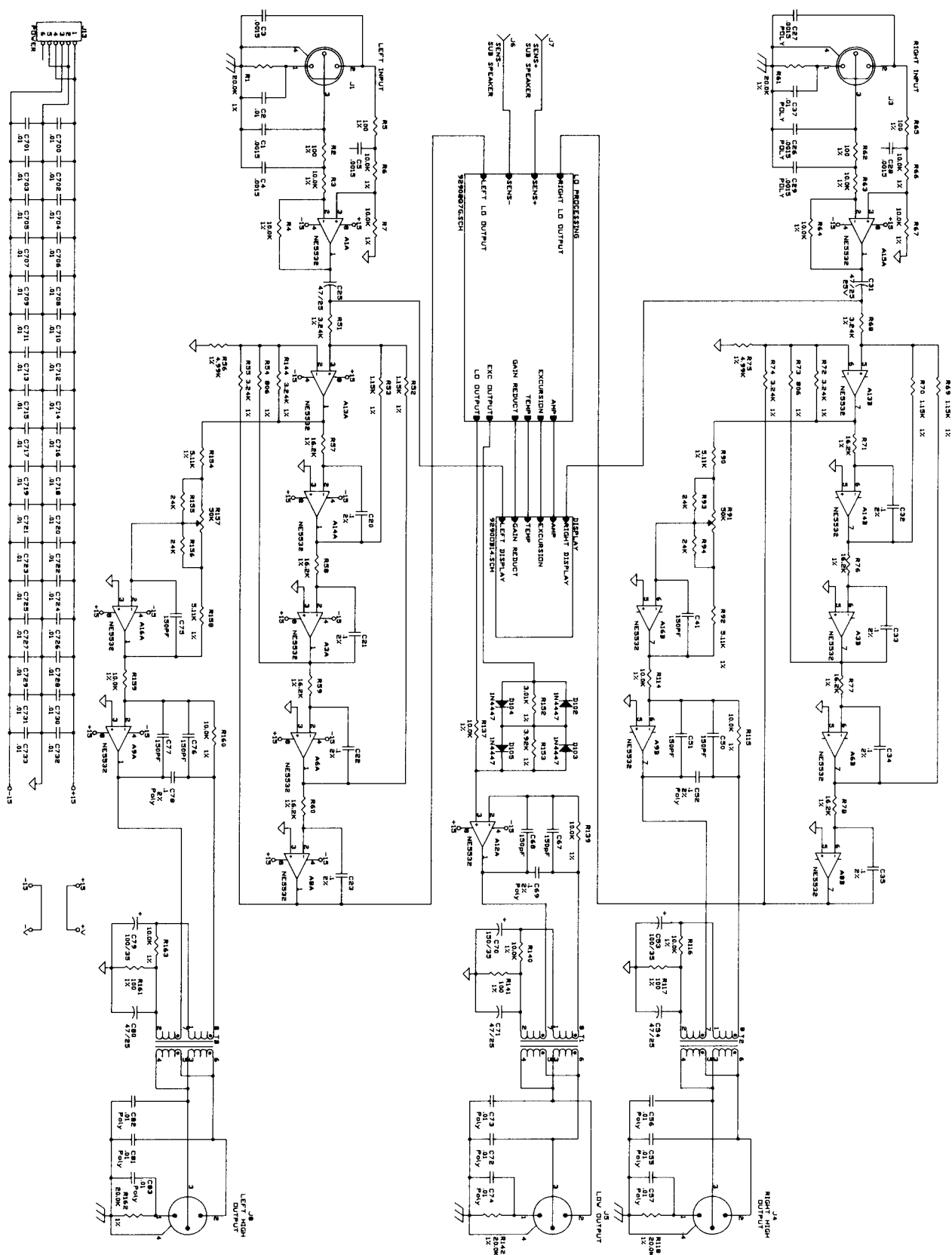
POWER SUPPLY BOARD

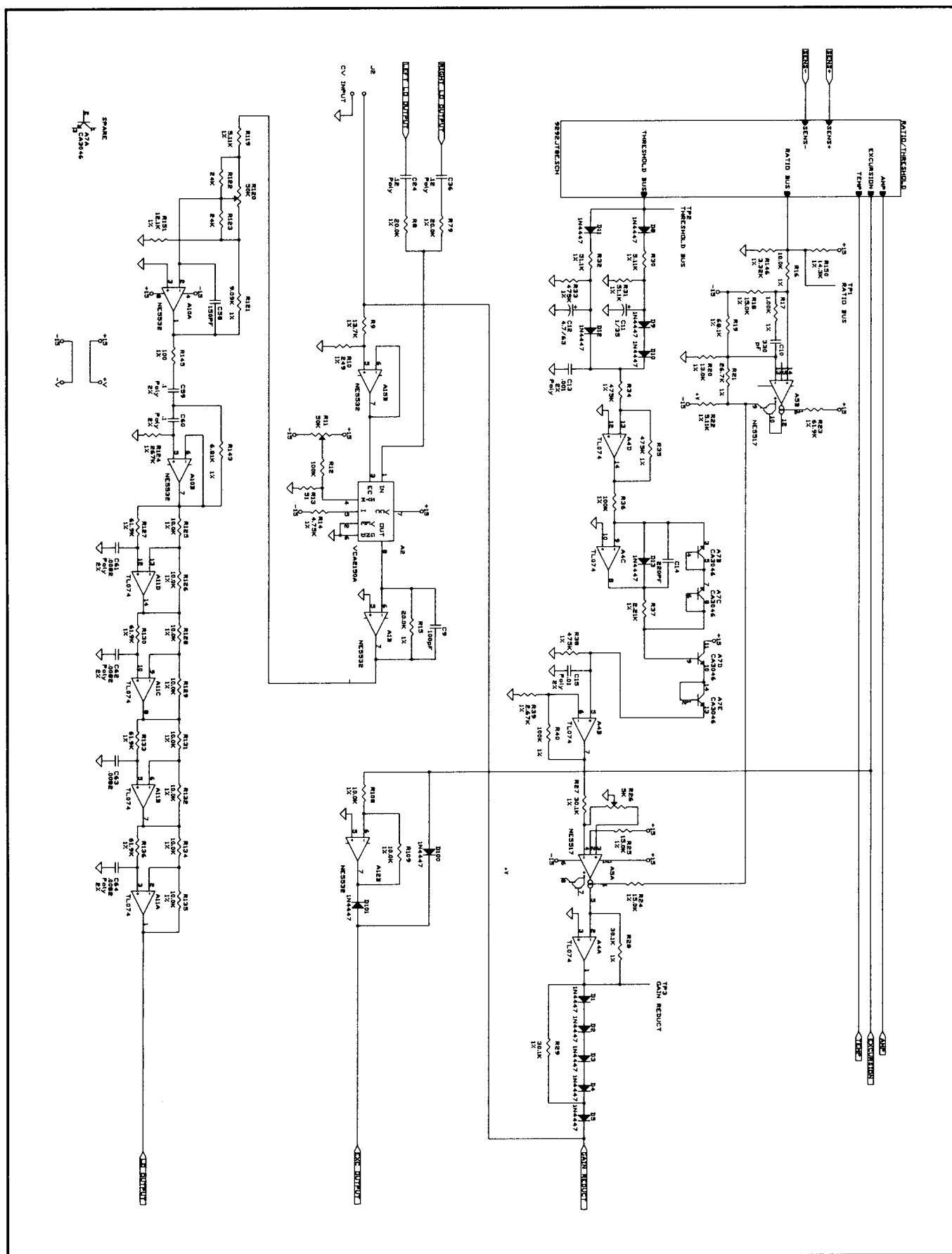


SENS+ SENS- +
 D211 D210
 R219 R218 R217 R216 R215 R214 R213 R212 R211 R210
 C206
 R204
 R203
 R202
 R201
 R200
 R199
 R198
 R197
 R196
 R195
 R194
 R193
 R192
 R191
 R190
 R189
 R188
 R187
 R186
 R185
 R184
 R183
 R182
 R181
 R180
 R179
 R178
 R177
 R176
 R175
 R174
 R173
 R172
 R171
 R170
 R169
 R168
 R167
 R166
 R165
 R164
 R163
 R162
 R161
 R160
 R159
 R158
 R157
 R156
 R155
 R154
 R153
 R152
 R151
 R150
 R149
 R148
 R147
 R146
 R145
 R144
 R143
 R142
 R141
 R140
 R139
 R138
 R137
 R136
 R135
 R134
 R133
 R132
 R131
 R130
 R129
 R128
 R127
 R126
 R125
 R124
 R123
 R122
 R121
 R120
 R119
 R118
 R117
 R116
 R115
 R114
 R113
 R112
 R111
 R110
 R109
 R108
 R107
 R106
 R105
 R104
 R103
 R102
 R101
 R100
 R99
 R98
 R97
 R96
 R95
 R94
 R93
 R92
 R91
 R90
 R89
 R88
 R87
 R86
 R85
 R84
 R83
 R82
 R81
 R80
 R79
 R78
 R77
 R76
 R75
 R74
 R73
 R72
 R71
 R70
 R69
 R68
 R67
 R66
 R65
 R64
 R63
 R62
 R61
 R60
 R59
 R58
 R57
 R56
 R55
 R54
 R53
 R52
 R51
 R50
 R49
 R48
 R47
 R46
 R45
 R44
 R43
 R42
 R41
 R40
 R39
 R38
 R37
 R36
 R35
 R34
 R33
 R32
 R31
 R30
 R29
 R28
 R27
 R26
 R25
 R24
 R23
 R22
 R21
 R20
 R19
 R18
 R17
 R16
 R15
 R14
 R13
 R12
 R11
 R10
 R9
 R8
 R7
 R6
 R5
 R4
 R3
 R2
 R1
 R0
 R-1
 R-2
 R-3
 R-4
 R-5
 R-6
 R-7
 R-8
 R-9
 R-10
 R-11
 R-12
 R-13
 R-14
 R-15
 R-16
 R-17
 R-18
 R-19
 R-20
 R-21
 R-22
 R-23
 R-24
 R-25
 R-26
 R-27
 R-28
 R-29
 R-30
 R-31
 R-32
 R-33
 R-34
 R-35
 R-36
 R-37
 R-38
 R-39
 R-40
 R-41
 R-42
 R-43
 R-44
 R-45
 R-46
 R-47
 R-48
 R-49
 R-50
 R-51
 R-52
 R-53
 R-54
 R-55
 R-56
 R-57
 R-58
 R-59
 R-60
 R-61
 R-62
 R-63
 R-64
 R-65
 R-66
 R-67
 R-68
 R-69
 R-70
 R-71
 R-72
 R-73
 R-74
 R-75
 R-76
 R-77
 R-78
 R-79
 R-80
 R-81
 R-82
 R-83
 R-84
 R-85
 R-86
 R-87
 R-88
 R-89
 R-90
 R-91
 R-92
 R-93
 R-94
 R-95
 R-96
 R-97
 R-98
 R-99
 R-100
 R-101
 R-102
 R-103
 R-104
 R-105
 R-106
 R-107
 R-108
 R-109
 R-110
 R-111
 R-112
 R-113
 R-114
 R-115
 R-116
 R-117
 R-118
 R-119
 R-120
 R-121
 R-122
 R-123
 R-124
 R-125
 R-126
 R-127
 R-128
 R-129
 R-130
 R-131
 R-132
 R-133
 R-134
 R-135
 R-136
 R-137
 R-138
 R-139
 R-140
 R-141
 R-142
 R-143
 R-144
 R-145
 R-146
 R-147
 R-148
 R-149
 R-150
 R-151
 R-152
 R-153
 R-154
 R-155
 R-156
 R-157
 R-158
 R-159
 R-160
 R-161
 R-162
 R-163
 R-164
 R-165
 R-166
 R-167
 R-168
 R-169
 R-170
 R-171
 R-172
 R-173
 R-174
 R-175
 R-176
 R-177
 R-178
 R-179
 R-180
 R-181
 R-182
 R-183
 R-184
 R-185
 R-186
 R-187
 R-188
 R-189
 R-190
 R-191
 R-192
 R-193
 R-194
 R-195
 R-196
 R-197
 R-198
 R-199
 R-200
 R-201
 R-202
 R-203
 R-204
 R-205
 R-206
 R-207
 R-208
 R-209
 R-210
 R-211
 R-212
 R-213
 R-214
 R-215
 R-216
 R-217
 R-218
 R-219
 R-220
 R-221
 R-222
 R-223
 R-224
 R-225
 R-226
 R-227
 R-228
 R-229
 R-230
 R-231
 R-232
 R-233
 R-234
 R-235
 R-236
 R-237
 R-238
 R-239
 R-240
 R-241
 R-242
 R-243
 R-244
 R-245
 R-246
 R-247
 R-248
 R-249
 R-250
 R-251
 R-252
 R-253
 R-254
 R-255
 R-256
 R-257
 R-258
 R-259
 R-260
 R-261
 R-262
 R-263
 R-264
 R-265
 R-266
 R-267
 R-268
 R-269
 R-270
 R-271
 R-272
 R-273
 R-274
 R-275
 R-276
 R-277
 R-278
 R-279
 R-280
 R-281
 R-282
 R-283
 R-284
 R-285
 R-286
 R-287
 R-288
 R-

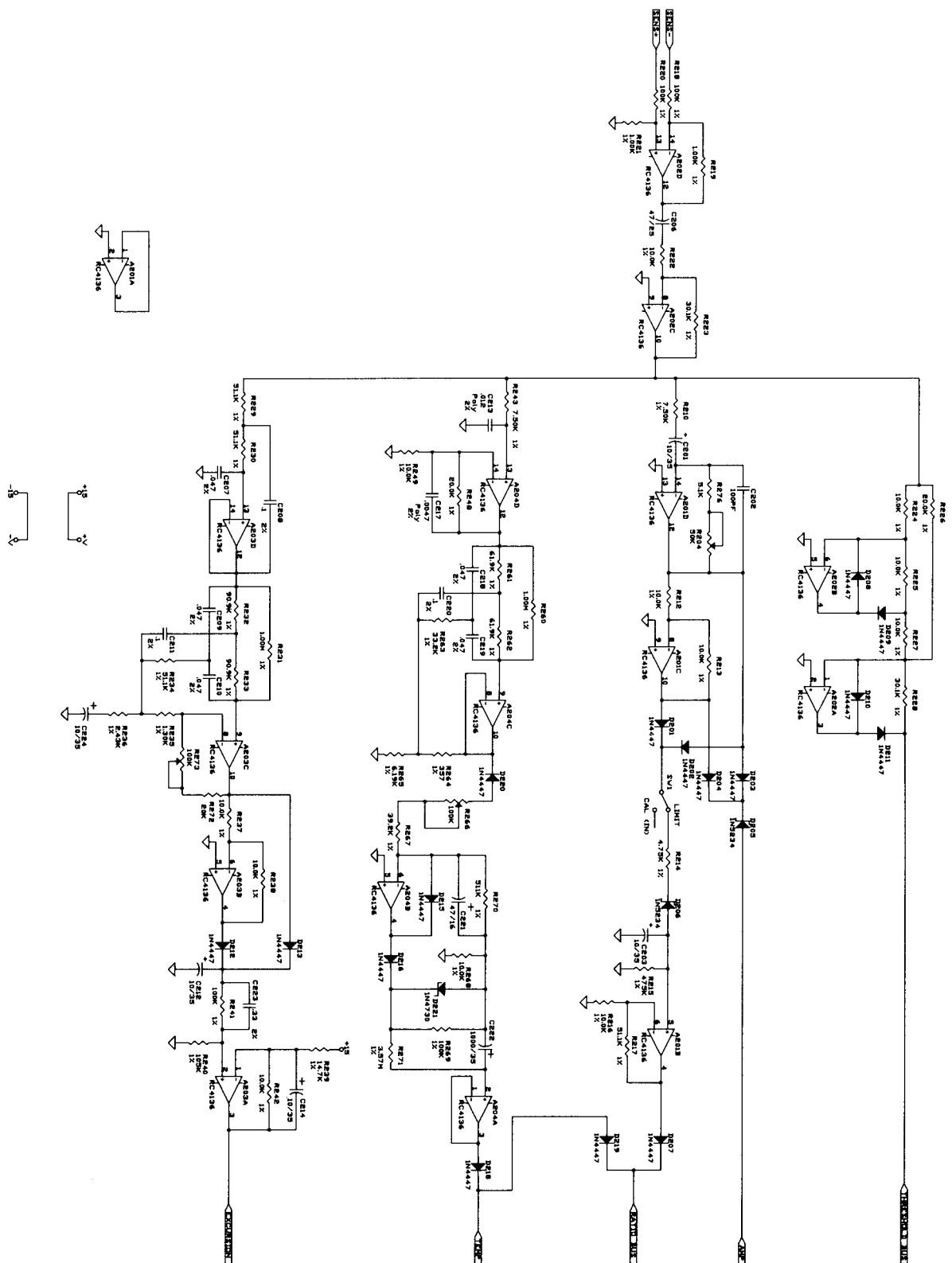
27-01-036051-01 Rev. A

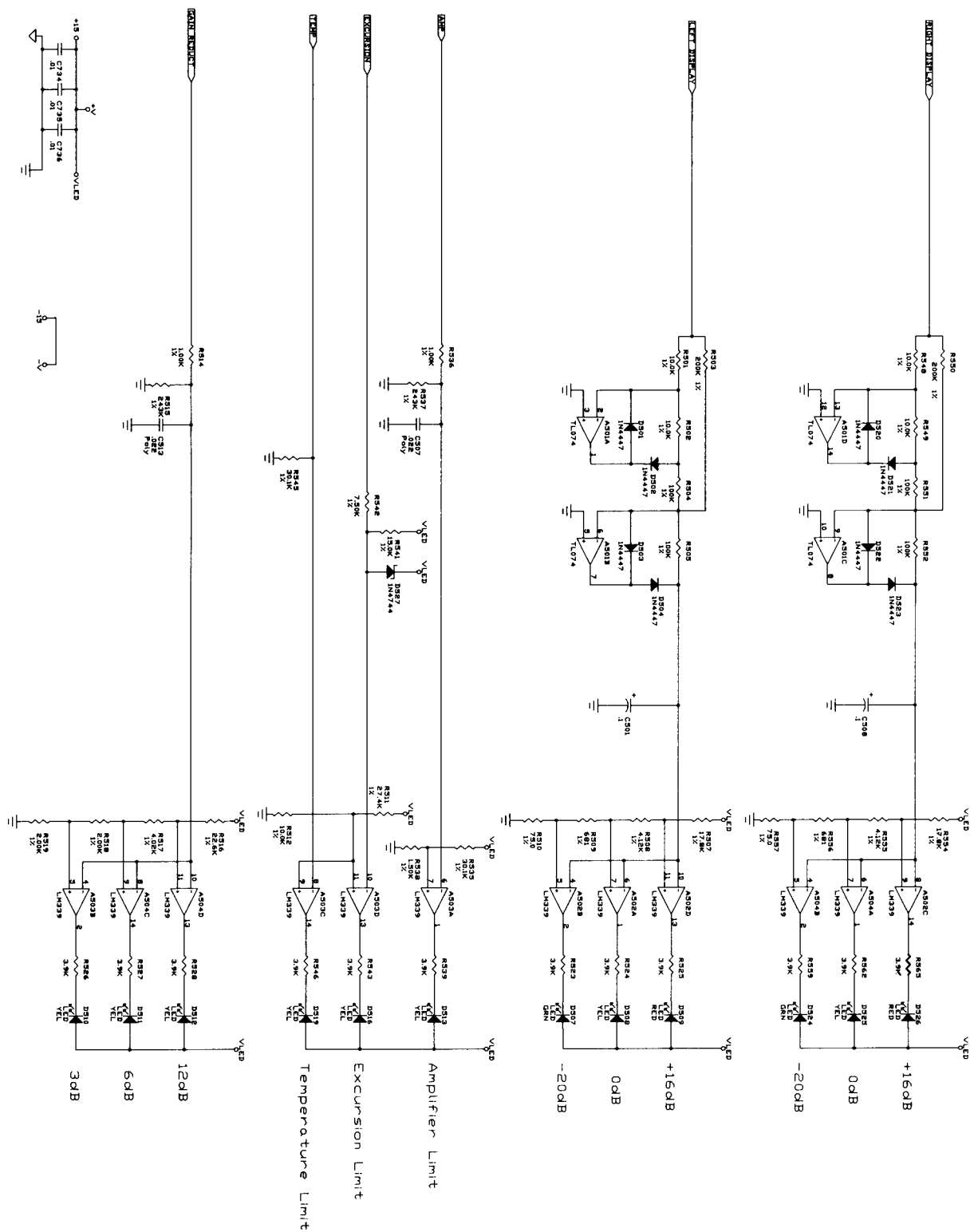
DMC-21815



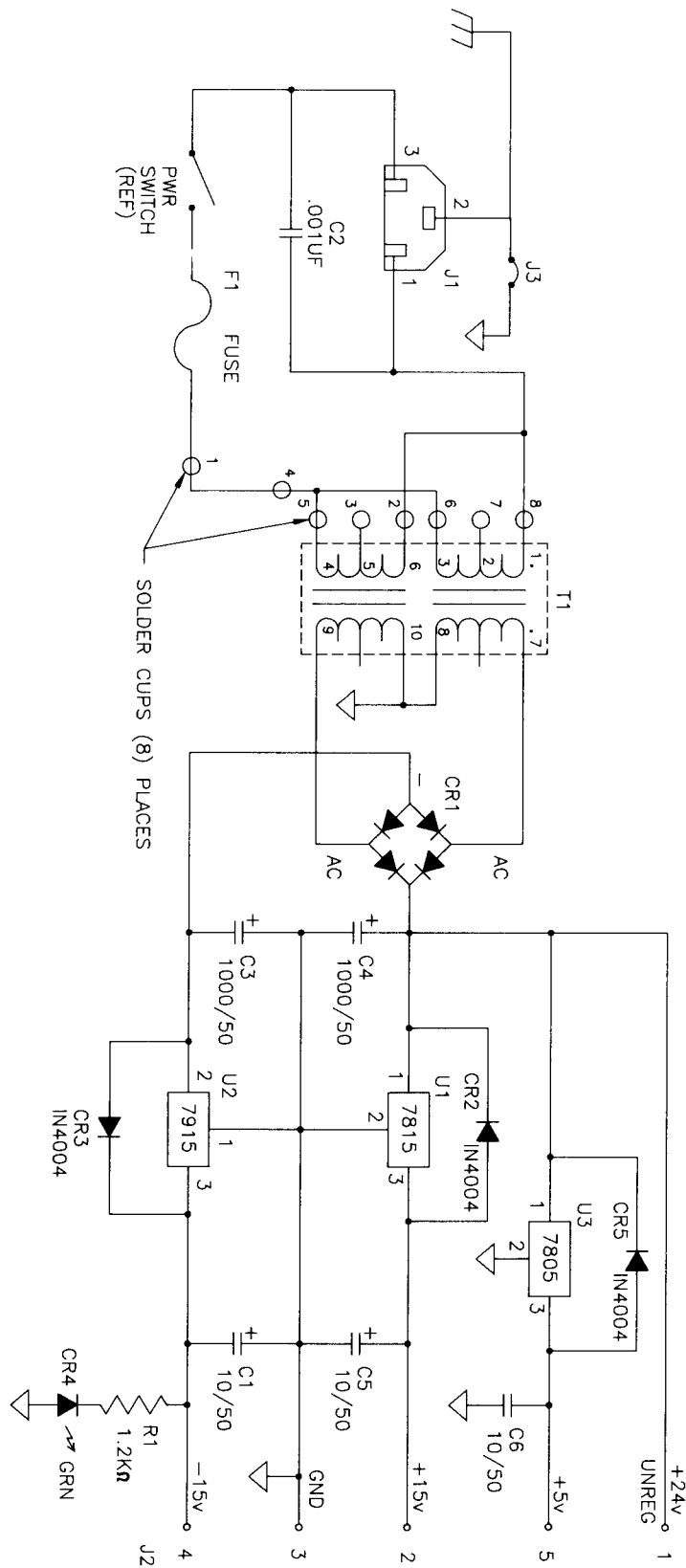


SCHEMATIC — DMC-2181S / Page 3 of 5





SCHEMATIC — DMC-2181S / Page 5 of 5



WARRANTY (Limited)

Electro-Voice products are guaranteed against malfunction due to defects in materials or workmanship for a specified period, as noted in the individual product-line statement(s) below, or in the individual product data sheet or owner's manual, beginning with the date of original purchase. If such malfunction occurs during the specified period, the product will be repaired or replaced (at our option) without charge. The product will be returned to the customer prepaid. **Exclusions and Limitations:** The Limited Warranty does not apply to: (a) exterior finish or appearance; (b) certain specific items described in the individual product-line statement(s) below, or in the individual product data sheet or owner's manual; (c) malfunction resulting from use or operation of the product other than as specified in the product data sheet or owner's manual; (d) malfunction resulting from misuse or abuse of the product; or (e) malfunction occurring at any time after repairs have been made to the product by anyone other than Electro-Voice or any of its authorized service representatives. **Obtaining Warranty Service:** To obtain warranty service, a customer must deliver the product, prepaid, to Electro-Voice or any of its authorized service representatives together with proof of purchase of the product in the form of a bill of sale or receipted invoice. A list of authorized service representatives is available from Electro-Voice at 600 Cecil Street, Buchanan, MI 49107 (616/695-6831) and/or Electro-Voice West, at 8234 Doe Avenue, Visalia, CA 93291 (209/651-7777). **Incidental and Consequential Damages Excluded:** Product repair or replacement and return to the customer are the only remedies provided to the customer. Electro-Voice shall not be liable for any incidental or consequential damages including, without limitation, injury to persons or property or loss of use. Some states do not allow the exclusion or limitation of incidental or consequential damages so the above limitation or exclusion may not apply to you. **Other Rights:** This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Electro-Voice Electronics are guaranteed against malfunction due to defects in materials or workmanship for a period of three (3) years from the date of original purchase. Additional details are included in the Uniform Limited Warranty statement.

Electro-Voice Speakers and Speaker Systems are guaranteed against malfunction due to defects in materials or workmanship for a period of five (5) years from the date of original purchase. The Limited Warranty does not apply to burned voice coils or malfunctions such as cone and/or coil damage resulting from improperly designed enclosures. Electro-Voice active electronics associated with the speaker systems are guaranteed for three (3) years from the date of original purchase. Additional details are included in the Uniform Limited Warranty statement.

Electro-Voice Flying Hardware (including enclosure-mounted hardware and rigging accessories) is guaranteed against malfunction due to defects in materials or workmanship for a period of one (1) year from the date of original purchase. Additional details are included in the Uniform Limited Warranty statement.

Service and repair address for this product: Electro-Voice, Inc., 600 Cecil Street, Buchanan, Michigan 49107.

Specifications subject to change without notice.

PARTS LIST

Power Supply Board Assembly (27-01-038255)		
C1,C5,C6	15-01-124502	Capacitor, 10uf, 50 volt, aluminum electrolytic, Radial Lead
C3,C4	15-01-124505	Capacitor, 1000uf, 50 volt, aluminum electrolytic, Radial Lead
C2	15-02-026884	Capacitor, 0.01uf, 250 volt, ceramic, UL approved
U1	17-01-121660	I.C., voltage regulator, +15V, LM7815
U2	17-01-121659	I.C., voltage regulator, -15V, LM7915
U3	17-01-119087	I.C., voltage regulator, +5V, LM7805
CR1	48-02-037580	Bridge Rectifier, 1.5 amp, pc mount
CR2, CR3, CR5	48-02-042787	Diode, 1N4004, 400V, 1A
CR4	39-01-124973	LED, green
F1	51-04-124634	Fuse, 175mA, 250V, slow blow
T1	56-08-025906	Transformer, power, pc mount
DMC-2181S Main Board Assembly (27-01-036051)		
C1,C3,C4,C5,C26, C27,C28,C29	15-06-027320	Capacitor, 0.0015uf, 50V, 5%, mylar
C2,C37,C55,C56, C57,C72,C73,C74, C81,C82,C83	15-06-027395	Capacitor, 0.01uf, 50V, 10%, mylar
C9,C202	15-06-124353	Capacitor, 100pf, 100V, 10%
C10	15-02-028803	Capacitor, 330pf, 50V, 10%
C11	15-01-028850	Capacitor, 1uf, 35V, aluminum electrolytic, radial lead
C12	15-01-028703	Capacitor, 4.7uf, 63V, aluminum electrolytic, radial lead
C13	15-06-037649	Capacitor, 0.001uf, 100V, 2%, poly
C14	15-06-125113	Capacitor, 220pf, poly
C15	15-06-028065	Capacitor, 0.01uf, 50V, 2%, poly
C20,C21,C22,C23, C32,C33,C34,C35, C52,C59,C60, C208,C211,C220	15-06-037653	Capacitor, 0.1uf, 100V, 2%, poly
C24,C36	15-06-028856	Capacitor, 0.12uf, 50V, 10%
C25,C31,C54,C71,	15-01-027327	Capacitor, 47uf, 25V, 20%, aluminum electrolytic, radial lead
C80,C206,C221, C41 C50,C51,C58, C67 C68,C75,C76, C77		15-02-027325 Capacitor, 150pf, 100V, 5%, ceramic
C53,C70,C79	15-01-027316	Capacitor, 100uf, 35V, aluminum electrolytic, radial lead
C61,C62,C63,C64	15-06-037655	Capacitor, 0.0018uf, 100V, 2%, poly
C69,C78	15-06-026822	Capacitor, 0.1uf, 50V, 5%, mylar
C201,C203,C212, C214	15-01-122935	Capacitor, 10uf, 35V, 20%
C207,C209,C210, C217,C218,C219	15-06-037651	Capacitor, 0.047uf, 100V, 2%, poly
C213	15-06-038214	Capacitor, 0.012uf, 100V, 2%, poly
C222	15-01-027317	Capacitor, 1000uf, 35V, aluminum electrolytic, radial lead
C223	15-06-038211	Capacitor, 0.33uf, 100V, 2%, poly
C224	15-01-028154	Capacitor, 22uf, 16V, aluminum electrolytic, radial lead
C501,C508	15-02-124808	Capacitor, 0.1uf, 100V, axial lead
C507,C513	15-06-028020	Capacitor, 0.022uf, 50V, 10%, mylar
C700-C736	15-02-100307	Capacitor, 0.01uf, 100V, type Z5U ceramic
A1,A3,A6,A8,A9, A10,A12,A13, A14,A15,A16	17-01m122832	I.C., NE5532
A2	17-01-028905	I.C., dbx2150A
A4,A11,A501	17-01-124461	I.C., TL074
A5	17-01-028907	I.C., NE5517N
A7	17-01-028906	I.C., CA3046

DMC-2181S Main Board Assembly (cont.)			DMC-2181S Main Board Assembly (cont.)		
A201,A202,A203, A204	17-01-027338	I.C., RC4136	R124	47-03-038294	Resistor, 267k Ω , 1%, 1/4W
A502,A503,A504	17-01-028867	I.C., LM339	R264	47-03-038295	Resistor, 357k Ω , 1%, 1/4W
J1,J3	21-01-124470	Connector, XLR, female, right angle	R508,R555	47-03-108444	Resistor, 4.12k Ω , 1%, 1/4W
J2	21-01-028908	Connector, 1/4 inch phono jack, right angle	R226	47-03-109434	Resistor, 20.0k Ω , 1%, 1/4W
J4,J5,J8	21-01-124642	Connector, XLR, male, right angle	R3,R4,R6,R7,R16, R63,R64,R66,R67, R108,R109,R114, R115,R116,R125, R126,R128,R129, R131,R132,R134, R135,R137,R139, R140,R159,R160, R163,R212,R213, R216,R222,R224, R225,R227,R237, R238,R242,R249, R268,R501,R502, R512,R548,R549	47-03-109437	Resistor, 10.0k Ω , 1%, 1/4W
D507,D524	39-01-028846	LED, round, green	R23,R127,R130, R133,R136, R261,R262	47-03-119034	Resistor, 61.9k Ω , 1%, 1/4W
D508,D510,D511, D512,D513,D516, D511,D525	39-01-028894	LED, round, yellow	R17,R219,R221, R514,R536	47-03-121532	Resistor, 1.00k Ω , 1%, 1/4W
D509,D526	39-01-028893	LED, round, red	R511	47-03-122858	Resistor, 27.4k Ω , 1%, 1/4W
R13	47-01-028860	Resistor, 51 Ω , 5%, 1/4W	R10	47-03-124486	Resistor, 249k Ω , 1%, 1/4W
R523,R524,R525, R526,R527,R528, R539,R543,R546, R559,R562,R565	47-01-102092	Resistor, 3.9k Ω , 5%, 1/4W	R231,R260	47-03-124488	Resistor, 1.00M Ω , 1%, 1/4W
R276	47-01-102095	Resistor, 5.10k Ω , 5%, 1/4W	R223,R228	47-03-124615	Resistor, 30.1k Ω , 1%, 1/4W
R515,R537	47-03-026839	Resistor, 243k Ω , 1%, 1/4W	R516	47-03-124657	Resistor, 22.6k Ω , 1%, 1/4W
R27,R28,R29,R545	47-03-027304	Resistor, 30.1 Ω , 1%, 1/4W	R538	47-03-124669	Resistor, 1.50k Ω , 1%, 1/4W
R54,R73	47-03-027328	Resistor, 806 Ω , 1%, 1/4W	R14,R214	47-03-124672	Resistor, 4.75k Ω , 1%, 1/4W
R21	47-03-027330	Resistor, 26.7k Ω , 1%, 1/4W	R151	47-03-124685	Resistor, 12.1k Ω , 1%, 1/4W
R143	47-03-027374	Resistor, 6.81k Ω , 1%, 1/4W	R56,R75	47-03-124696	Resistor, 4.99k Ω , 1%, 1/4W
R12,R36,R40, R218,R220,R41, R269,R504,R505, R551,R552	47-03-028173	Resistor, 100k Ω , 1%, 1/4W	R51,R55,R68,R72, R74,R144	47-03-124697	Resistor, 3.24k Ω , 1%, 1/4W
R121	47-03-028176	Resistor, 9.09k Ω , 1%, 1/4W	R52,R53,R69,R70	47-03-124699	Resistor, 1.15k Ω , 1%, 1/4W
R93,R94,R122, R123,R155,R156	47-03-028178	Resistor, 24.3k Ω , 1%, 1/4W	R507,R554	47-03-124724	Resistor, 17.8k Ω , 1%, 1/4W
R150	47-03-028207	Resistor, 14.3k Ω , 1%, 1/4W	R210,R243,R542	47-03-124805	Resistor, 7.50k Ω , 1%, 1/4W
R239	47-03-028208	Resistor, 14.7k Ω , 1%, 1/4W	R267	47-03-124837	Resistor, 39.2k Ω , 1%, 1/4W
R518,R519	47-03-028210	Resistor, 2.00k Ω , 1%, 1/4W	R37	47-03-124957	Resistor, 2.21k Ω , 1%, 1/4W
R1,R8,R15,R61, R79,R118,R142, R162,R248,R272	47-03-028229	Resistor, 20.0k Ω , 1%, 1/4W	R91,R120,R157	47-06-027344	Potentiometer, 50K-B K86, CC, 16mm, vertical
R503,R550	47-03-028230	Resistor, 200k Ω , 1%, 1/4W	R26	47-06-027459	Potentiometer, 5K, trimmer
R270	47-03-028231	Resistor, 511k Ω , 1%, 1/4W	R204	47-06-028055	Potentiometer, 50K-B 20%, TBM, 16mm, vertical
R20	47-03-028237	Resistor, 13.0k Ω , 1%, 1/4W	R11	47-06-028818	Potentiometer, 50K, trimmer
R18,R24,R25,R541	47-03-028238	Resistor, 15.0k Ω , 1%, 1/4W	R266,R273	47-06-028910	Potentiometer, 100K, 6mm trimmer
R31,R32,R217, R229,R230,R234	47-03-028240	Resistor, 51.1k Ω , 1%, 1/4W	D1,D2,D3,D4,D5,D8 D9,D10,D11,D12,D13 D100,D101,D102, D103,D104,D105, D201,D202,D203, D204,D205,D206, D207,D208,D209, D210,D211,D212, D213,D215,D216, D218,D219,D220, D501,D502,D503, D504,D520,D521, D522,D523	48-01-027340	Diode, Signal, 1N4447
R153,R517	47-03-028241	Resistor, 3.92k Ω , 1%, 1/4W	D205,D206	48-01-028163	Diode, zener, 6.2V, 1N5234
R19	47-03-028245	Resistor, 68.1k Ω , 1%, 1/4W	D526	48-01-028891	Diode, zener, 15V, 1N4744
R152	47-03-028248	Resistor, 3.01k Ω , 1%, 1/4W	D221	48-01-028896	Diode, zener, 3.9V, 1N4730A
R57,R58,R59,R60, R71,R76,R77,R78	47-03-028208	Resistor, 14.7k Ω , 1%, 1/4W	SW1A	51-02-028058	Switch, push ON/push OFF
R263	47-03-028259	Resistor, 33.2k Ω , 1%, 1/4W	T1,T2,T3	56-07-026392	transformer, audio output
R535	47-03-028269	Resistor, 110k Ω , 1%, 1/4W			
R22,R30,R90,R92, R119,R154,R158	47-03-028695	Resistor, 5.11k Ω , 1%, 1/4W			
R240	47-03-037198	Resistor, 105k Ω , 1%, 1/4W			
R9	47-03-037659	Resistor • 13.7k Ω , 1%, 1/4W			
R146	47-03-037660	Resistor, 3.32k Ω , 1%, 1/4W			
R2,R5,R62,R65,R117 R141,R145,R161	47-03-037770	Resistor, 100 Ω , 1%, 1/4W			
R232,R233	47-03-038076	Resistor, 90.9k Ω , 1%, 1/4W			
R271	47-03-038077	Resistor, 3.57M Ω , 1%, 1/4W			
R509,R556	47-03-038176	Resistor, 681 Ω , 1%, 1/4W			
R33,R34,R35, R38,R215	47-03-038217	Resistor, 475k Ω , 1%, 1/4W			
R39	47-03-038219	Resistor, 2.67k Ω , 1%, 1/4W			
R510,R557	47-03-038222	Resistor, 75.0 1%, 1/4W			
R235	47-03-038293	Resistor, 1.30k Ω , 1%, 1/4W			