

# FURMAN

*Signal Processing*

## TX-24 SERIES SPECIFICATIONS

### INPUTS

**Standard:** Input impedance: 10K Ohms Tip to ground, 20K ohms Tip to Ring.  
Max. input level: +18 dBV.  
Gain: 6 dB max. Connectors: 1/4" TRS phone only.

**Balanced:** Differential input impedance: 20k Ohms.  
Maximum input level: 8.7 Vrms (+18 dBV)  
Gain: 6 dB maximum. Connectors: Both XLR and TRS phone.  
Common Mode Rejection > 80 dB at 60Hz.

### OUTPUTS

**Standard:** Output impedance: Less than 200 Ohms.  
Maximum output level: 8.7 Vrms (+18 dBV) with a minimum terminating load of 2.5k Ohms. Connectors: 1/4" phone.

**Balanced:** Output impedance: Less than 200 Ohms.  
Maximum output level: 17.4 Vrms (+24 dBV), with a minimum terminating load of 5k Ohms. Connectors: Both XLR and TRS phone, may be used simultaneously.

**Muting:** Turn off/Turn off transients less than  $\pm 10$  mV. All signals blocked for approximately 1sec.

### GENERAL

**Freq. Response:** +0,-.5 dB 20 Hz to 20 kHz.

**Distortion:** Less than 0.01% THD with input and output levels up to +18 dBV, from 20 Hz to 20 kHz; Less than 0.003% THD at 0 dBV input and output levels, from 20 Hz to 20 kHz.

**Output Noise:** -97 dBV, 20 Hz to 20 kHz, unweighted.

**S/N ratio:** 109 dB from noise floor to maximum output.

**Freq. Range:** TX-324: 80 Hz to 4 kHz  
TX-424: 40 Hz to 2 kHz (low-mid) and  
320 Hz to 16 kHz (mid-high)  
TX-524: 40 Hz to 2 kHz (subw.-low) and  
80 Hz to 4 kHz (low-mid) and  
320 Hz to 16 kHz (mid-high)

**Filter Slope:** 24 dB/Octave, switchable for Butterworth (constant power sum ) or Cauer (constant voltage sum).

**Limiter:** Attack: 8 ms; Release: 1 sec. Threshold:-20 dBV-+20 dBV.

**Low Cut Filters:** -3 dB at 50 Hz; 6 dB/octave rolloff

**Construction:** Steel chasis, zinc chromate plating; 1/8" thick brushed and black anodized aluminum front panel; glass epoxy PC boards.

**Dimensions:** 1 3/4"(TX-324) or 3 1/2"(TX-425 and TX-524) H x 19" W x 8" D.

**Weight:** TX-324: 6 lbs (2.7 kg); TX-424,TX-525: 8 lbs (3.6 kg).

**Power Req.** 5 Watts; 115 Vac 60 Hz, or 230 VAC 50/60 Hz versions.

### NOTES

0 dBV equals 1 Vrms. Outputs can be connected to less than the indicated minimum load without damage or excessive distortion, but maximum output levels will be reduced.

# Tunable Crossovers 24 dB/Octave

MODELS TX-324  
TX-424  
TX-524

## Owner's Manual

Important Note: To obtain best results from this Furman Sound electronic product, please be sure to read this manual carefully before attempting to use it. Also, to be sure of obtaining full protection under the terms of the Limited Warranty in case your ownership documents are lost, please fill out and return the Warranty Registration Card immediately. Please verify that the serial number shown on the Warranty Card matches the serial number on your unit.

## Introduction

Congratulations on your purchase of a Furman Sound TX-24 Series Tunable Crossover. You have chosen an instrument with outstanding performance specifications, and the versatility to get the most from a wide variety of speaker systems. These units are economical, yet packed with advanced features. The crossovers (also known as Frequency Dividing Networks) in this series can also serve as sharp-cutoff, completely adjustable high/low/bandpass filters in studio, broadcast, or laboratory applications.

As a crossover unit, the TX-324, TX-424, and TX-524 will find their principal uses in two-way, three-way, four-way, and five-way sound systems: that is, systems that use separate speakers or drivers for bass, midrange, treble, etc., and separate power amplifiers to drive them. A TX-24 Series crossover is intended for line-level signal splitting. It should not be confused with the passive type of crossover network which splits the output of a single power amp into separate high-powered signals for woofers, tweeters, or other speakers. Because they use separate power amps for each frequency range, multi-amplified systems make much more efficient use of the total available power than would be possible with conventional passive crossover designs.

Besides their inherent advantages of multi-amplified sound reinforcement, Furman TX-24 Series crossovers offer many sophisticated features designed to protect speakers and obtain optimum performance from them. These include 24-dB/octave rolloff slopes, with zero phase shift response at the crossover points; filters to remove unnecessary and potentially harmful sub-sonic components; the unique Field Select switch, settable for Near Field or Far Field applications; a fast-response hard limiter on each output, with an adjustable threshold, for reduced distortion and positive speaker protection; levels calibrated in dBV for accurate, repeatable setups; turn-on/turn-off transient muting; and a ground-lift switch for eliminating ground-loop hum.

## Multi-Amplifier Systems

The need for crossovers in sound reinforcement systems arises from the impracticality of building truly full range speakers which are capable of operation at high sound pressure levels. Manufacturers of speakers instead resort to building components whose designs are optimized only for limited frequency ranges, or bands. Typically, woofers and sub-woofers are large diameter cone speakers, while midrange units and tweeters are smaller cones, compression drivers suitable for horn loading, piezoelectric transducers, and other types. When limited range components such as these are used, circuits called crossovers are needed to divide the full range electrical signal into bass, treble, and sometimes midrange, sub-bass, and even other still smaller segments. In this way, each component receives only those frequencies which it can convert into sound efficiently and without danger of damage.

The simplest kind of crossover is a passive network (made only of capacitors and inductors) which is fed by the high power signal at the output of a power amplifier. These will usually be found mounted right inside a single speaker cabinet which also houses woofer, tweeter, etc., and connecting wires.

The next level of sophistication, bi-amplification, offers many improvements in performance over the simple passive crossover approach, especially in larger systems. In bi-amplified systems, the crossover divides the less critical line level signal into bass and treble components before power amplification. Then, separate power amps for each frequency range are connected directly to the appropriate speaker or driver. Electronic crossovers are usually used.

The first advantage of bi-amplification is greater efficiency in the use of power. Horn-loaded speakers, especially high-frequency drivers, are usually more efficient in converting electrical energy to sound than woofers. Thus, tweeters in many systems require less power. In a conventional system with a single power amp, the low frequencies use up most of the available amplifier power, leaving little for the highs. The only ways to eliminate the resulting high frequency distortion are to reduce the loudness, or to substitute a higher-power amplifier. Bi-amplification is a better approach.

For example, if 100 watts is provided for bass in a two-way (bi-amped) system, then 25 to 40 watts will generally be adequate for the tweeter. The two-way system would then use a 100 watt amplifier for bass and a 40 watt amplifier for treble, for a total of 140 watts. However, if, in a conventional system, a signal peak required the full 100 watts to the woofer simultaneously with the full 40 watts to the tweeter, then the single power amplifier would

have to be capable of delivering 266 watts\* to avoid clipping distortion! A 140 watt amplifier would certainly distort on such a peak.

A further advantage is that if a power amp is driven into clipping, the resulting distortion will be less noticeable in the bi-amped system. This is because the distortion products are limited to the range of the amp that is clipped. Thus, if the bass amp clips in a bi-amped system, the obnoxious-sounding higher harmonic distortion products go only to the woofer, which is not capable of reproducing them, so they will not be heard. This is an especially important advantage in systems used for rock music, where occasional clipping on peaks is not an infrequent occurrence.

Other advantages accrue because the power amps in a bi-amped system are coupled directly to the speakers, rather than through a passive crossover network. The absence of the inevitable resistive component in the passive crossover means that no power will be wasted as heat. And the absence of capacitive and inductive loading will improve the transient response and damping factor of the power amp. The result, again, will be cleaner sound reproduction.

The exact frequency which forms the boundary between the bass and treble segments of the audio spectrum is called the crossover point or crossover frequency. Most passive crossovers and some electronic crossovers have only a factory pre-selected, fixed crossover frequency. A further level of sophistication in electronic crossovers, such as all of the Furman models, is to have user-adjustable, or tunable, crossover frequencies. This feature enables any crossover model to be universally applicable to any combination of brands or models of speakers and drivers. Thus, a Furman crossover can never become obsolete if substitutions are made. Moreover, it allows a system's crossover frequencies to be fine-tuned by ear so that all components receive an optimal segment of the audio spectrum.

To sum up, bi-amped systems are superior to single-power-amp, passive high-level crossover systems because they can use smaller power amps to achieve the same sound pressure levels, and because they sound cleaner. This same logic can be applied to still larger systems by making additional frequency divisions. In a tri-amped (three-way) system, two crossover points divide the audio spectrum into Low (bass), Midrange, and High (treble) segments. Each of these may then drive appropriate power amps whose wattage is scaled to the efficiency of the speaker components, which in turn have optimal efficiency in their respective frequency bands. Model TX-324, in addition to its basic use as a stereo (two-channel) 2-way crossover, may also be switched for use in a single 3-way channel. Stereo 3-way systems can be accommodated by a TX-424. The model TX-424 may also be switched for mono 4- or 5-way operation, appropriate for the largest systems. (However, with 5-way operation, a point of diminishing returns is reached. Therefore, 6-way frequency division is not recommended.) In 4-way systems, the four frequency bands are called Sub-woofer, Low, Mid, and High. In 5-way systems, the Mid band is further divided into Low-Mid and High-Mid.

### Special Features of the TX-24 Series

#### Field Select

The Field Select switch on the TX-24 series is a unique Furman development. It enables you to customize the amount of power delivered to the speakers at the crossover point.

In the Far-Field position, the filters are set to a Butterworth configuration. This means that the outputs are -3 dB (half power) at the crossover frequency, causing the summed total power delivered to the speakers to be constant. However, with the switch in this position, listeners who are close to the speakers and "on axis" will hear a small boost at the crossover point. This is due to the "lobe" caused when the outputs of the drivers combine in phase at the crossover point. Nevertheless, this is the setting recommended for most sound reinforcement applications, because as a practical matter: (1) most people in a concert hall will be out of the direct lobe of the speakers, and/or (2) a large percentage of the sound they hear will be reflected, and/or (3) frequently the drivers in the system will not all have identical phase and time delay. The third condition is particularly likely if a compression driver/horn is combined with a cone woofer, or if the components are widely spaced from each other.

\* By Ohm's Law,  $P=I^2R$  (where P is power in watts, I is current in amps, and R is resistance in ohms). Assuming  $R=8$  ohms, I1 for a power of 100 watts would be 3.54 amps, while I2 for 40 watts would be 2.24 amps. If both are required simultaneously, the total current required from a single power amplifier would be  $I1 + I2 = 3.54 + 2.24 = 5.78$  amps. This equates to 266 watts at 8 ohms.

However, in recent years advancements in speaker system technology have led to revolutionary changes. Time and phase relationships among speaker components have received a great deal of attention, and certain systems carefully maintain or correct for their proper alignment. Also, in some situations listeners are located close to the speakers and "on-axis" (in the "near-field").

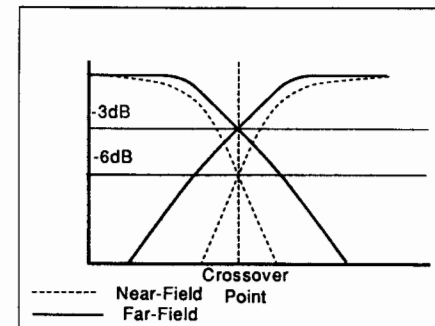


FIGURE 1

For these reasons, the TX-24 Series' design incorporates the Field Select switch. In the Near-Field position, the drivers are -6 dB at the crossover point, which leads to flat on-axis response. This setting is recommended for applications such as recording studio monitoring, and for use with systems which are designed to be phase and time coherent.

In the Near-Field position, the crossover filters take on the Cauer configuration. This filter type is characterized by steeper slopes near the crossover point. This results in the added benefits of less interaction between components, and improved protection for the high frequency driver (see Figure 1).

[Technical note: The Cauer filter selected by the Near Field switch position is quite similar to the Linkwitz-Riley filter featured

on certain competitive products. Both offer the same constant voltage sum at the crossover point, and have similar transient and phase response. The primary difference is that the Cauer filter has a much steeper slope after the first 12 dB of attenuation, with a response zero in the stop band beyond the crossover point. In the passband, the slope is parallel to that of the Linkwitz-Riley filter, which does not have a zero. Furman Sound chose the Cauer configuration for its design because we felt that the advantage in speaker protection of the steeper slope near the crossover point outweighed any possible disadvantage from having a zero buried deep in the stop band.]

#### Limiter

Each crossover in the TX-24 Series includes an Output Limiter on each band as standard. This valuable feature's purpose is to provide a final degree of speaker protection which otherwise would have required the addition of a separate, costly limiter for each frequency band. The built-in limiter controls both momentary peaks and transients which might cause distortion, and also sustained peaks which might exceed a driver's power handling capacity. It puts an absolute limit on maximum output levels by reducing gain rapidly on levels which exceed the adjustable threshold (without causing distortion), yet has no effect on normal program levels which are below threshold. There is one LIMITER THRESHOLD control in the TX-324, and one for each channel in the TX-424 and 524. These allow the user to customize the maximum allowable output level to match any combination of amps and drivers (adjustment of individual bands within a channel is accomplished by means of the input sensitivity controls on the respective amps). LED's next to each OUTPUT control light red when the signal level in that band is sufficiently high to cause limiting. The brightness is approximately proportional to the amount of gain reduction. The limiter feature allows the user to run a system louder, longer, and cleaner, while giving peace of mind that expensive components will survive the performance.

#### Output Muting

Special circuitry in each TX-24 Series Crossover mutes all outputs for approximately one second at the instant when the unit is turned on or off. The purpose, again, is another degree of speaker protection. Frequently, when a system is powered up or down, transients in one or more components in the signal chain may cause a dangerously loud low frequency popping noise. This can be avoided if the power amp volume controls are turned down for the system power-up or power-down. However, this can be inconvenient or impractical if there are many power amps, if their volume controls are best left at carefully calibrated positions, or if inexperienced operators use the system. With a TX-24 crossover, a single master power switch can be successfully used for an entire system which is preset to normal operating levels. This can be done without risk, because the built-in muting accomplishes essentially the same thing as turning down all the power amp volume controls.

### Description of Controls

**Front Panel:** Note that because both the TX-324 and the TX-424 offer both mono and stereo operation, each front panel control has a dual label. Stereo functions are labeled in white, while mono functions are labeled in blue. Some controls are identified in blue as "NOT USED" because they are not functional in mono operation.

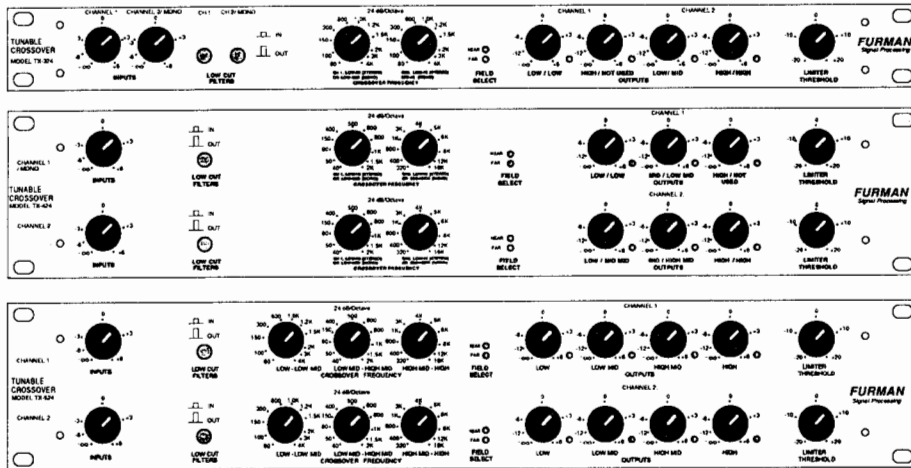


FIGURE 2

**INPUTS:** The front panel INPUT controls, in conjunction with the OUTPUT controls, give the TX-24 Series user great flexibility in matching system levels to optimum levels for power amplification. They may, if desired, be used as master faders for the entire system. They are calibrated directly in dB, with the unity gain (i.e., 0 dB, no gain or loss) in the 12 o'clock position. The fully clockwise position adds 6 dB to system gain. On initial installation, 0 dB is the recommended starting point, and in fact will be appropriate for a majority of applications. Note that there are two INPUT controls in each TX-24 Series crossover. Both are used in stereo operation; in mono operation, only the second is functional.

**LOW-CUT FILTERS:** These high-pass filters cut all frequencies below 50 Hz at the gentle rate of 6 dB per octave. This frequency was chosen because it is a typical frequency to which many vented bass enclosures are tuned. Amplified bass frequencies below this point will tend to cause potentially damaging excessive cone excursions. For this reason, it is recommended that the LOW-CUT FILTERS be set to the In position when using vented bass or sub-woofer cabinets. Its use is optional with sealed (infinite baffle) cabinets, which are less subject to damage from this cause because the interior air pressure limits cone movement. Note that when in mono mode, the right button on the TX-324, or the lower button on the TX-424, should be used; the other button is non-functional.

**CROSSOVER FREQUENCY:** These allow the exact crossover frequency or filter cutoff point to be varied over an approximately six octave range. The crossover frequency should be chosen in accordance with the speaker manufacturer's specifications for the frequency response of the components used. Usually a minimum crossover point is chosen which will not damage high frequency drivers. Compression drivers and horns are particularly susceptible to damage from having low frequency power fed into them. It will never hurt to set the crossover frequency higher than the minimum. However, avoid setting it to more than triple the recommended minimum, because any higher setting will force the low frequency speakers to work too hard while not using the high frequency drivers' full capacity. The CROSSOVER FREQUENCY control may now be varied over this limited range, to locate by ear the optimum setting. As the crossover point is varied, the high-pass and low-pass cutoff frequencies track each other, with the response curves always intersecting at a point either 3 or 6 dB down from the response level in the passbands (depending on the setting of the FIELD SELECT switch).

In the TX-324 or 424 stereo mode, if the left and right speaker systems are

identical, the CROSSOVER FREQUENCY controls would normally be set to the same frequencies. In the TX-324's mono mode, the left control sets the Low/Mid crossover point and the right control sets the Mid/High crossover point. In the TX-424's mono mode, in 5-way usage, the upper left control sets the Sub-Woofer/Low crossover point; the upper right control sets the Low/Low-Mid point; the lower left control sets the Low-Mid/High-Mid point; and the lower right control sets the High-Mid/High point. When using the TX-424 for mono 4-way operation, only four of the five outputs will be used. It is suggested that the lowest (Sub-Woofer) output be the one not used. In this case, the SUBW-LOW frequency control must be left at the lowest setting, fully counterclockwise.

**FIELD SELECT:** There are two Light-Emitting-Diode (LED) indicators visible on the front panel. These simply indicate the position of the rear panel NEAR FIELD-FAR FIELD switch. One or the other LED's will always be lit when the unit is powered, so they serve as a "power on" indicator. See the discussion of Field Select in the Special Features section above for information on the proper setting of this switch.

**OUTPUTS:** There is a separate output control for each segment of the audio spectrum. These duplicate, to some extent, the function of the individual volume controls on the power amps (if present). However, since they are all in one place, they make the task of balancing the levels fed to the various speaker components much more convenient. Also, they are located at a point in the circuitry before the internal limiter. The unity gain setting is labeled 0 dB, and is located at the 12:00 (straight up) position of the knob. Up to 6 dB of additional gain is available. However, if there is insufficient gain, it is generally preferable to make it up earlier in the signal chain -- at the mixer if possible, or at the crossover input. In most systems the bass component is the least efficient and thus requires the most power. Therefore, the lowest output (Low or Sub-Woofer) will usually be set to 0 dB, and the other output control(s) will be at somewhat lower settings, chosen with the goal of making their levels match up acoustically with the bass. When using the crossover's OUTPUT controls for system balancing, it is most convenient to leave all the power amp volume controls at maximum (unless one or more is needed to set special limiter thresholds. See next paragraph.) If a pink noise source and spectrum analyzer are used for room equalization, any slight error in the adjustment of the output levels will be compensated by the equalizer setting.

**LIMIT LED'S:** An LED is located to the right of each OUTPUT control. It glows red when the signal level in that band is high enough to cause limiting. The brightness is an approximate indication of the amount of gain reduction, so that if an LED is glowing brightly, it means that a considerable amount of limiting is taking place. A lot of limiting is not in itself harmful, but to maximize your program's dynamic range, adjust the system levels so that the LED's flash only occasionally.

**LIMITER THRESHOLD:** The TX-324 has one LIMITER THRESHOLD control which affects both channels. The TX-424 and TX-524 each have two, one for each channel in stereo mode. In the TX-424's mono mode, the top control sets the threshold for the Sub-Woofer, Low, and Low Mid outputs; the bottom control is for the High Mid and High outputs. The knob position indicates the level at which limiting will occur, adjustable over a 40 dB range. The fully clockwise position, +20, coincides with the crossover's maximum output capability, so this is the setting which is equivalent to no limiting. Since one control covers several crossover outputs, if different thresholds are required for different outputs, set the LIMITER THRESHOLD control to the highest, and reduce the volume control on the power amp for the channel(s) needing lower threshold(s) by the number of dB lower that channel must be set than the crossover control indicates. For a general discussion of the use of the limiter feature, see the section on Special Features above.

**Rear Panel:** Note that all jacks have a label above and a label below. These labels apply to both the 1/4-inch phone jacks, and, if the unit is a balanced version, to the Cannon XLR-style connectors to the left of the labels. The upper labels apply when the MONO-STEREO slide switch is set to the upper, or stereo, position. The lower labels apply when the switch is in the lower, or mono, position.

**ON-OFF Switch:** This switch applies AC power to the crossover. When on, one of the two FIELD SELECT LED's on a TX-324, or on each channel of a TX-424 or TX-524, will be lit to indicate that the unit is actually receiving power. For convenience, it is recommended that the crossover and any other rack-mounted equipment be powered through a switchable outlet box, such as the Furman Sound PL-8 or PL-PLUS Power Conditioner and Light Modules. Either unit provides an easy way to power up the whole rack with one front panel switch, provides discreet illumination on dark stages and in studios as well, and filters and absorbs transients from the AC line, particularly important with digital electronics. (Use of the PL-PLUS is recommended if power amplifiers are installed in the same rack as

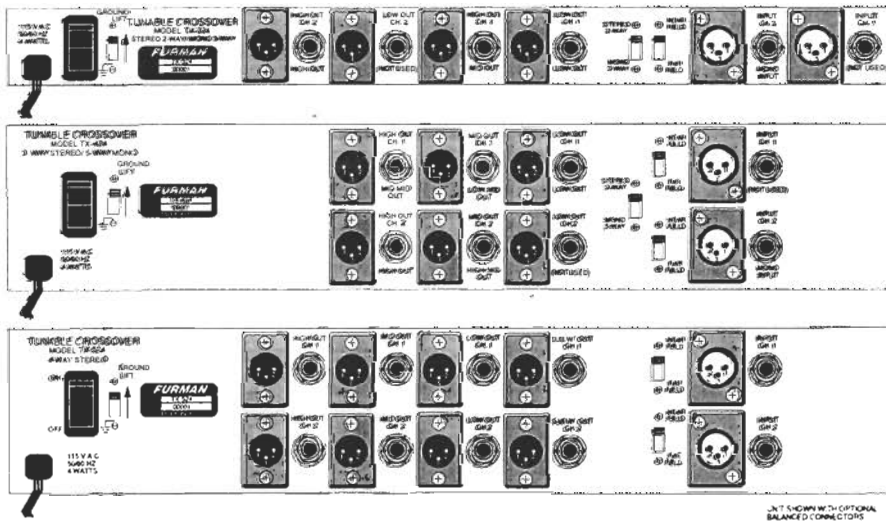


FIGURE 3

the crossover(s).) If you do use a switchable outlet box, leave the crossover's ON-OFF switch in the On position at all times. All crossovers in the TX-24 Series contain special "Output Muting" circuitry which suppresses the signal outputs for approximately one second at the time when the power is turned on or off. This is to automatically protect the speakers from a loud "pop" from a turn-on or turn-off transient. Because of this, an entire system can be turned on with one master power switch without risk of damage.

**GROUND LIFT SWITCH:** In many installations, hum-causing ground loops are formed by the common connections of various pieces of equipment to the powerline ground, and/or by chassis to chassis contact, as in an equipment rack with metal rails. Sliding the GROUND LIFT Switch up completely isolates the signal ground on the input and output connectors from the chassis, breaking these ground loops. The chassis remains connected to the ground pin on the AC line cord for safety, and to provide shielding against RF interference.

**NOTE:** the ground lift can be rendered ineffective by 3 pin audio connectors that connect pin 1 (signal ground) to the metal shell of the connector (chassis ground). The connection from pin 1 to the shell is optional on all 3 pin connectors, and can be removed (by opening up the connector and disconnecting it) if necessary. Try both switch positions, and leave the switch in the position that results in the least hum in your system.

**INPUTS and OUTPUTS:** The TX-24 Series Crossovers are designed to process high level audio signals in the -10 to +4 dbm range. All units, whether they have the Balanced Option installed or not, can accommodate either unbalanced (2-conductor, tip and sleeve) or balanced (3-conductor, tip, ring, and sleeve) lines at the 1/4" phone jack inputs. All cables connecting to either inputs or outputs must be shielded.

**BALANCED OPTION:** Balanced connections offer the benefits of cancellation of hum, noise, and RF interference which may be picked up in the interconnecting cables. If the Balanced Option has been installed, Cannon XLR-style connectors will be provided in addition to the standard 1/4" phone jacks for all inputs and outputs. Also, while even "standard" units can accept balanced lines at their inputs, the "Balanced Option" units add special circuitry to enhance the hum and noise cancelling properties (common-mode rejection) of the inputs. For any balanced connections, shielded, twisted pair cable must be used and wired as follows: Pin 1 and/or Sleeve -- shield; Pin 2 and/or Tip -- signal positive; and Pin 3 and/or Ring -- signal negative. Both outputs may be used simultaneously, if desired; however, no more than one input should be used at a time.

**CAUTION!** Do not connect an unbalanced line to the Balanced Output connector. If an unbalanced line is used in the output circuit, connect it to the phone jack output only. Use of XLR-to-phone adaptors with TX-24 Series Crossovers is not recommended.

**MONO-STEREO Switch:** The TX-324 and TX-424 have the capacity to be used as two completely separate and independent crossovers (stereo position). When the switch is set to mono,

the two sections are linked together to make a single channel unit with twice as many frequency divisions as each stereo channel had. In stereo mode, most often the two channels would be used for the left and right channels of a stereo program. However, as the interchannel crosstalk is very low, they may also be used for completely independent programs. The TX-524 does not have a mono mode, and so this switch is not present.

**NEAR FIELD-FAR FIELD Switch:** The position this switch is set to is indicated by which of the two FIELD SELECT LED's on the front panel is illuminated. In the TX-424 and the TX-524, there are two switches, which may be set independently when the unit is used in stereo mode. In mono mode, both switches should be set the same way. See the Field Select section under Special Features above for more information on how to choose the proper setting for this switch.

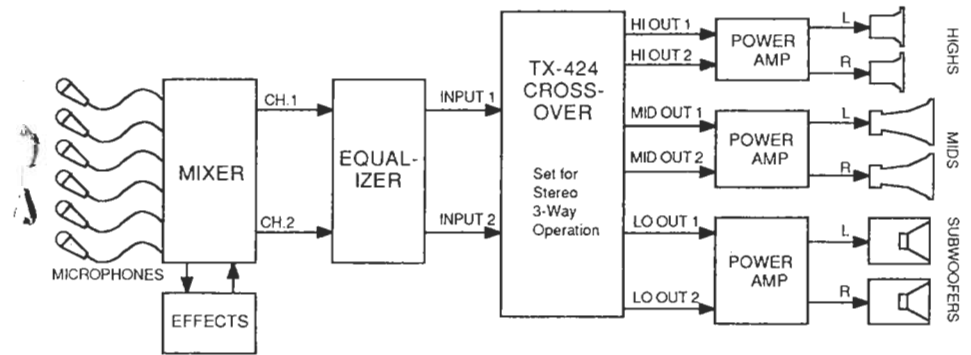
**Installation**

The TX-24 Series Crossovers are intended for mounting in standard 19" equipment racks. Such racks are readily available in a wide variety of sizes and styles from electronic parts suppliers. Stereo stores often carry attractive furniture-like racks. In addition, very rugged, roadworthy portable racks with covers (flight cases) are available from a number of manufacturers. These may be ordered in sizes suitable for just one unit, or large enough for many rack-mount units. Another alternative is to build a simple rack out of wood. Standard racks come equipped with mounting rails with holes tapped for 10-32 screws. Be sure to use only 10-32 screws for installation (in particular, beware of 10-24 screws--they will fit if forced but will strip the threads). To avoid marring the panel finish when tightening the screws, we suggest using oval or flat head screws with plastic cup washers, also usually available at electronic stores.

In sound system installations, the customary place for mounting the crossover is in the same rack with the power amps. However, in portable sound systems, it may be more convenient to locate the crossover in the sound mixing booth in the rear center of the concert hall. The TX-24 series' output impedances are low enough to drive lines of the necessary length. The only disadvantage to this arrangement is the necessity of multiple lines returning the crossover's various outputs to the stage. (The power amps should always be located near the speakers.)

A TX-24 Series Crossover is designed to process line level signals. Its inputs will typically be connected to the outputs of a P.A. system mixer, or to the outputs of an equalizer, if used. The crossover's outputs will go to the inputs of the power amplifiers. Care must be taken that power amp outputs go only to the correct speaker component, and never to the crossover. See Figure 4 below for an example of a system that uses a TX-424 in stereo mode.

For best results, all cables plugged into a crossover should be shielded. Balanced connections should use shielded twisted-pair cable. See the section Rear Panel: Inputs and Outputs above for hints on wiring cables.



TYPICAL P.A. SYSTEM INTERCONNECTIONS

FIGURE 4

### If Hum or Buzz is Encountered

Occasionally, in the course of creating a complex sound reinforcement system with many individual components, unacceptable levels of hum or buzz will become audible. Sometimes it will not be possible to identify any one piece of equipment in the signal path which is the cause. This may be because the problem is a system-wide "ground loop". Ground loops occur when there is more than one path to ground, the system's point of zero potential. The hum or buzz introduced into the system varies with the area of the loop defined by the multiple paths to ground, so that the problem is likely to be greater when there are long cable runs. The GROUND LIFT Switch found on each Furman Sound product is a good place to try to break a system grounding problem, because in the "Lift" position it isolates the signal ground from the chassis.

If excessive hum is still present in the system regardless of the position of the GROUND LIFT switch, the alternate path to ground probably is located in equipment other than the crossover. If you have a Balanced Option unit, the following special wiring technique may help:

The exceptionally high common-mode rejection of the Balanced Option inputs can be useful if the power line ground for the signal source is not at the same potential as the crossover's ground (though no more different than 5 volts RMS). This situation often arises if the mixer is located hundreds of feet away from the crossover and power amps on stage, and it usually creates a hum-causing ground loop. Disconnecting Pin 1 at the crossover end of the connecting cable only may solve the hum problem. See the diagram below.

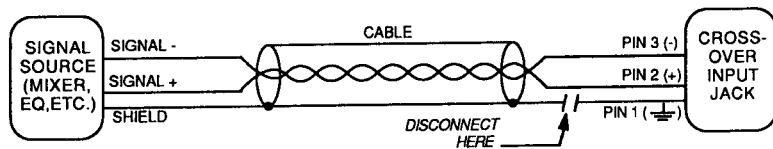


FIGURE 5: CONNECTION METHOD FOR SEVERE GROUND DIFFERENCES

### Circuit Description and Troubleshooting

**CAUTION!** This section is intended to assist the professional user with considerable experience in electronics to accomplish emergency repairs. Under no circumstances should persons without electronics troubleshooting experience and training undertake repairs on their own. There are no user serviceable parts inside the TX-324, TX-424, or TX-524. Any problems should be referred to the factory or other qualified service personnel.

**Integrated Circuits:** Each printed circuit board in a TX-24 Series crossover uses up to 20 IC's, identified as IC1 to IC20. IC1 and IC2 are used only in the optional XLR Balanced versions. All these IC's, except IC12, are type TL072CP, manufactured by Texas Instruments. National Semiconductor's LF353 may be substituted in any location. Both kinds are internally compensated, high slew rate dual op-amps. IC12 is a CMOS analog switch, CD4016B, to switch between Near and Far Field.

The problem most likely to be encountered in the field will be failure of one of the op-amp IC's. However, it should be noted that IC's do not wear out with use and the passage of time. If they do fail, it invariably means that the IC had some hidden manufacturing defect. Symptoms may include a loss of signal and/or buzz in one or both channels. Since all the IC's are installed in sockets, simple substitution will usually be the fastest way to find the defective one. Be sure to disconnect the crossover from AC power before removing IC's.

**Differential Amps:** These are precision unity-gain stages whose purpose is to provide common-mode rejection of any hum, noise, or RF interference that may have been picked up in the cables connecting to the input circuit. The optional XLR Balanced units use an additional dual op-amp to create floating balanced inputs with completely symmetrical loading on the plus and minus input lines, and with a very high impedance to ground. In these units, trimpots R11 and R28 are used to adjust the common-mode rejection. Greater than 80 dB of cancellation for 60 Hz signals should be achieved.

**Filters:** The state-variable circuit is used here for its simplicity and ease of tuning. The high-pass and low-pass outputs are in phase and are used simultaneously. The filter

circuit has four poles, and may be switched for either Butterworth (Far Field) or Cauer (Near Field) response. The rear panel Field Select switch turns on analog switch IC12 in the Near Field position, modifying the filter to a constant-voltage-sum Cauer response shape, down -6 dB at the crossover point. The filter stage has 6 dB of gain to allow a unity gain setting when the INPUT controls are set to 12 o'clock.

**Power Supply:** The power supply is on a separate PC board. It provides plus and minus 15 volts DC using 3-pin regulators IC1-4. The positive regulators are type uA78M15C, and the negative ones are uA79M15C. The power supply board also contains circuitry to create a delayed control signal to mute the outputs.

**Summing Gain Stage:** This provides 6 dB of gain to allow a 0 dB setting when the OUTPUT controls are at 12 o'clock. The low and high pass signals are combined with signals from IC12 at this point to create the Cauer response shape.

**Output Limiters and Buffers:** These are unity gain buffers until the output level exceeds the LIMITER THRESHOLD set by potentiometer R201. Limiting is achieved by turning on the FET's Q3, Q10, Q17, and Q24, which shunt part of the signal from the summing gain stages to ground. Balanced outputs are created by inverting the output of the limiter stage.

**Output Muting:** All output signals pass through series FET's. These are normally-off devices, and are turned on about one second after power is applied to the crossover. They turn off very quickly when power is removed.

### Limited Warranty

Each Furman Sound Tunable Crossover is warranted against failures due to defective parts or faulty workmanship for a period of one year after delivery to the original owner. During this period, Furman Sound will make any necessary repairs without charge for parts or labor. However, shipping charges to and from the factory or repair station shall be borne by the customer. This warranty applies only to the original owner and is not transferable. Also, it does not apply to repairs done other than by the Furman Sound factory or Authorized Repair Stations.

This Limited Warranty shall be cancelled by Furman Sound at its sole option if the Tunable Crossover is subjected to physical abuse, or is electrically or physically modified without written authorization from Furman Sound. "Physical abuse" includes, but is not limited to, connecting the output of a power amplifier directly to any input or output jack on the crossover. Furman Sound's liability under this warranty is limited to repair or replacement of the defective unit.

Furman Sound will not be responsible for incidental or consequential damages resulting from the use or misuse of its products. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

When returning any equipment for repair, please be sure that it is adequately cushioned against damage in shipment, that it is insured, and that a note is enclosed giving your name, address, phone number, and a description of the problem.

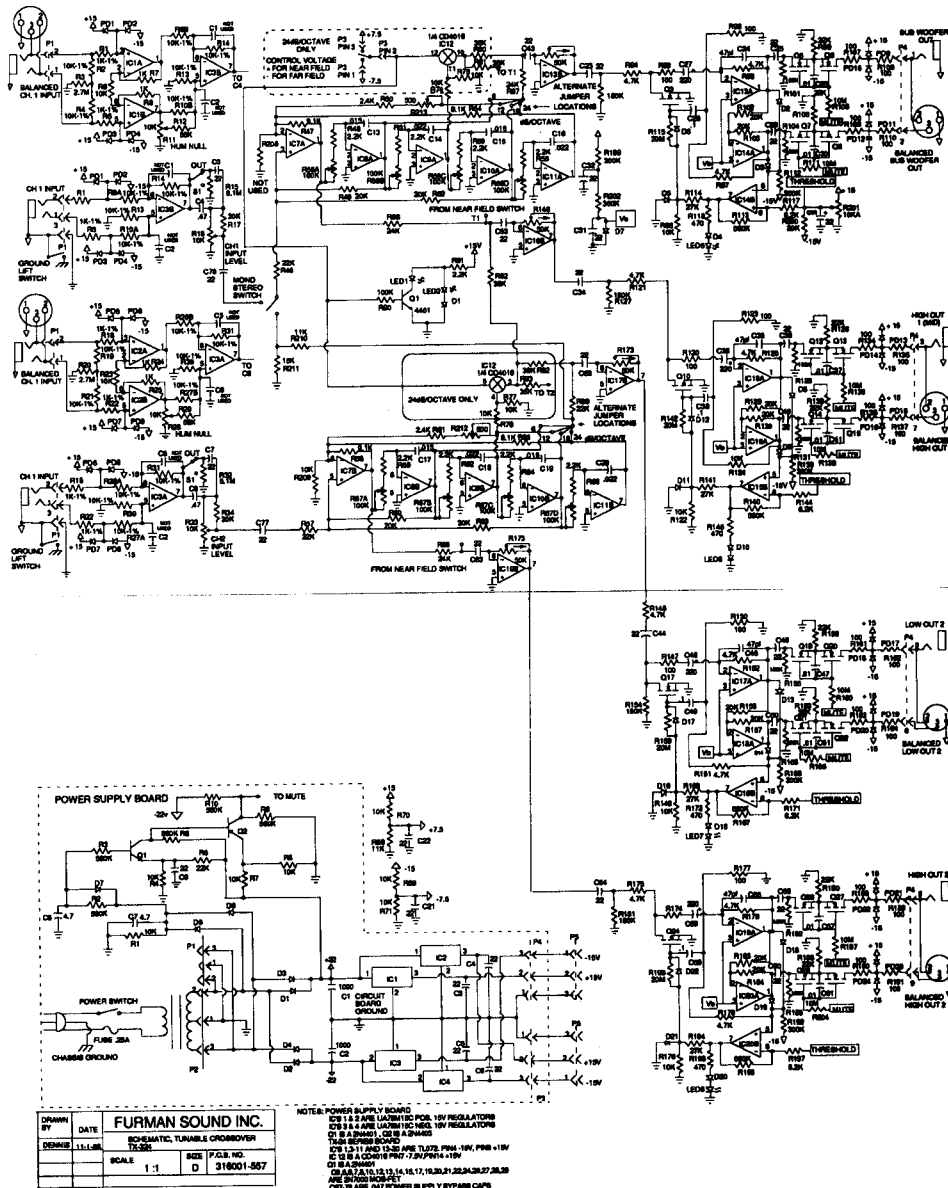
### Other Furman Sound Products

PQ-4	Parametric Equalizer	PL-8	Power Conditioner/Rack Light
SG-10	Sweep Graphic Equalizer	PL-PLUS	Enhanced Power Cond./Rack Light
GQ-15	Stereo 15-Band Graphic Eq	PB-40	Patch Bay
GQ-31	31-Band Graphic Equalizer	LC-3A	Limiter/Compressor
GQ-62	Stereo 31-Band Graphic Eq	LC-X	Expander/Compressor/Limiter
TX-3A	2 Way/3 Way Crossover	LC-6	Stereo Compressor/Gate
TX-324	2 Way/3 Way, 24 dB/Oct Crossover	QN-4A	Quad Noise Gate
TX-424	3 Way/5 Way, 24 dB/Oct Crossover	RV-3	Digital Reverberation System
TX-524	Stereo 4 Way, 24 dB/Oct Crossover	SC-1, 2	Security Covers
MM-4A	4 x 1 Rackmount Mixer	VU-40	Stereo System Monitor (Power Meter)
MM-8A	4 x 2 Rackmount Mixer	HA-6	Headphone/Monitor Amplifier

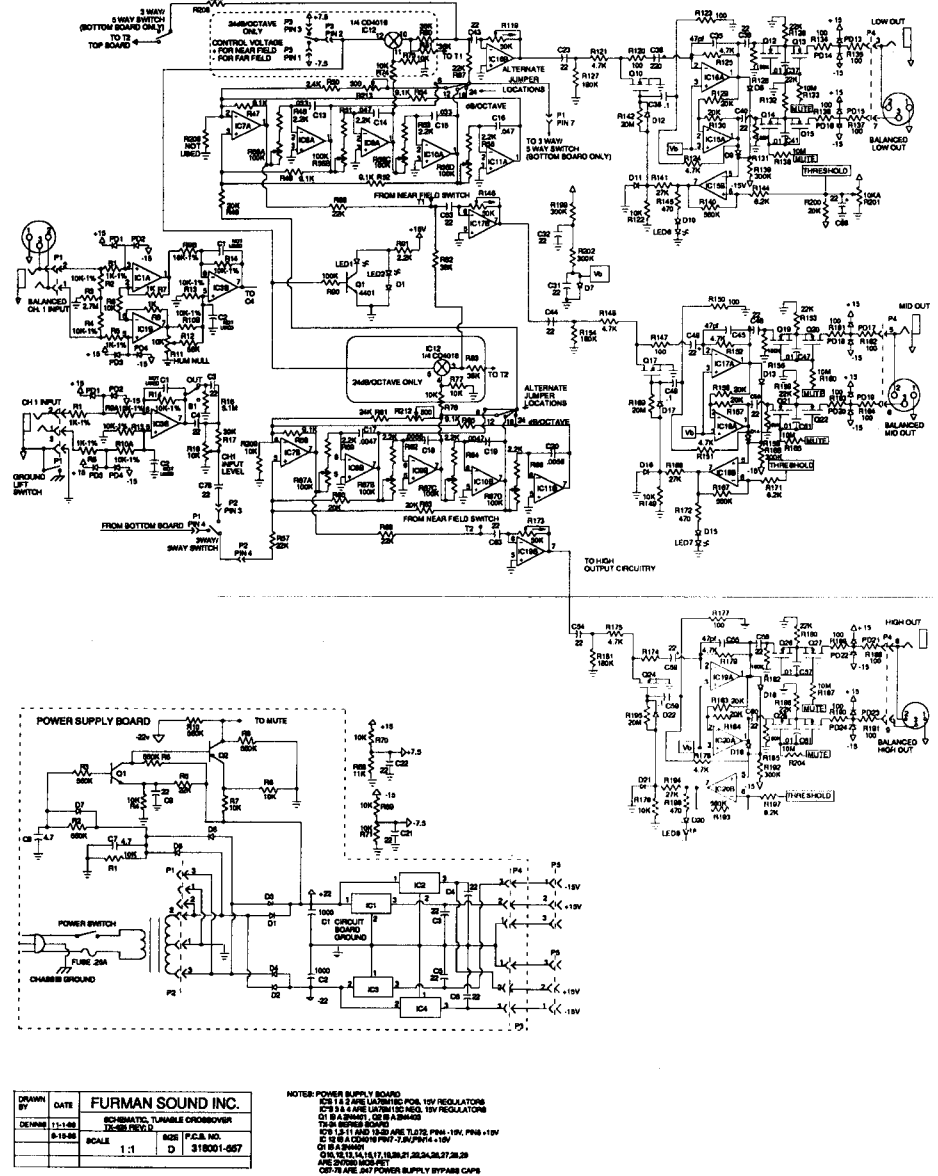
Please call or write Furman Sound if you would like a copy of our latest catalog.



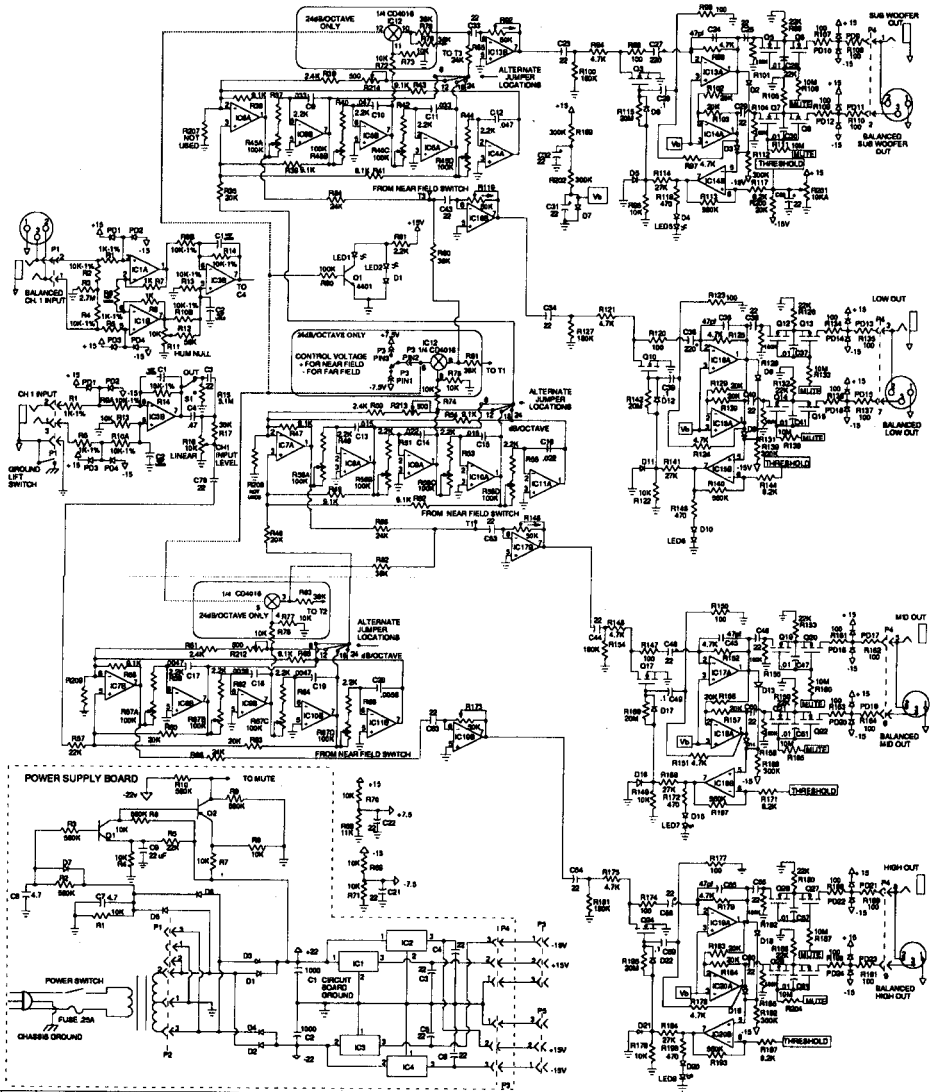
### SCHEMATIC DIAGRAM, TX-324



### SCHEMATIC DIAGRAM, TX-424



# SCHEMATIC DIAGRAM, TX-524



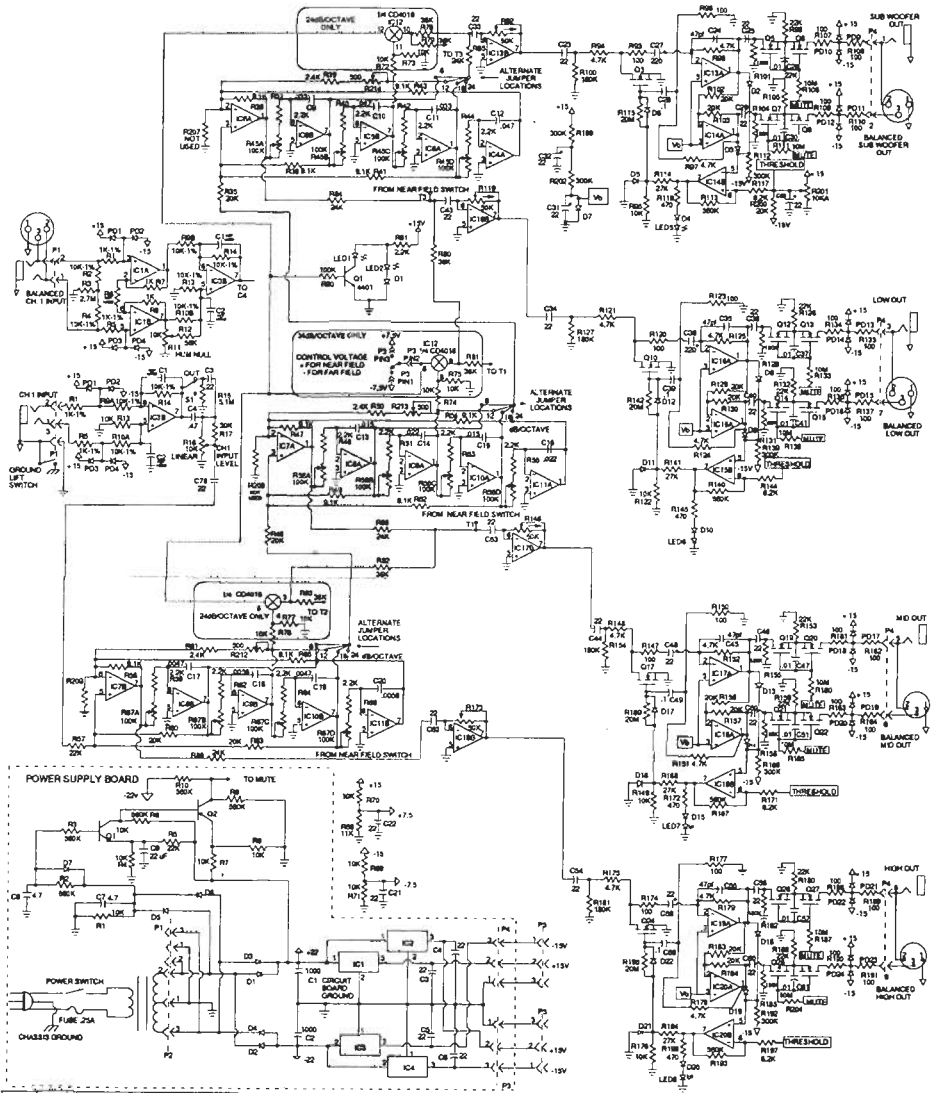
DESIGN BY	DATE	<b>FURMAN SOUND INC.</b>		
DESIGN 11-1-68		SCHEMATIC, TUNABLE CROSSOVER TX-524 (REV. 2)		
9-13-68		SCALE	SIZE	P.C.B. NO.
		1:1	D	318001-557

NOTES: POWER SUPPLY BOARD  
 IC8 IS 2 AMP. ULTIMATE POS. 10V REGULATORS  
 IC9 IS 1 AMP. ULTIMATE NEG. 10V REGULATORS  
 C1 IS A 5000PF. C2 IS A 5000PF.  
 C3 IS 1.5μF. C4 IS 1.5μF. C5 IS 1.5μF. C6 IS 1.5μF. C7 IS 1.5μF. C8 IS 1.5μF. C9 IS 1.5μF. C10 IS 1.5μF. C11 IS 1.5μF. C12 IS 1.5μF. C13 IS 1.5μF. C14 IS 1.5μF. C15 IS 1.5μF. C16 IS 1.5μF. C17 IS 1.5μF. C18 IS 1.5μF. C19 IS 1.5μF. C20 IS 1.5μF. C21 IS 1.5μF. C22 IS 1.5μF. C23 IS 1.5μF. C24 IS 1.5μF.  
 C1 IS 5000PF. C2 IS 5000PF. C3 IS 1.5μF. C4 IS 1.5μF. C5 IS 1.5μF. C6 IS 1.5μF. C7 IS 1.5μF. C8 IS 1.5μF. C9 IS 1.5μF. C10 IS 1.5μF. C11 IS 1.5μF. C12 IS 1.5μF. C13 IS 1.5μF. C14 IS 1.5μF. C15 IS 1.5μF. C16 IS 1.5μF. C17 IS 1.5μF. C18 IS 1.5μF. C19 IS 1.5μF. C20 IS 1.5μF. C21 IS 1.5μF. C22 IS 1.5μF. C23 IS 1.5μF. C24 IS 1.5μF.





# SCHEMATIC DIAGRAM, TX-524



DRAWN BY	DATE	<b>FURMAN SOUND INC.</b>	
DESIGNED	1-15-66	SCHEMATIC, TUNABLE CROSSOVER TX-524 REV. D	
DWG. NO.	8-13-66	SIZE	P.C.B. NO.
SCALE	1:1	D	316001-557

NOTE: POWER SUPPLY BOARD  
 C1 IS 3 ARE ULTRALINE FOR 15V REGULATORS  
 C2 IS 3 ARE ULTRALINE NEG. 15V REGULATORS  
 C18 IS 3WATT 25 0.5-5WATT  
 TX-524 SPEAKER BOARD  
 C12 IS 15 11W 15-20 ARE R102 PWR 15W PWR 15W  
 C12 IS A CD4018 PWR 7.5W PWR 14 15W  
 C18 IS 3WATT  
 C24 IS 7.5 TO 12 15 14 17 18 20 21 22 24 27 28 29  
 ARE 50000 MICROF  
 C27-78 ARE 047 POWER SUPPLY BYPASS CAPS