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SHURE MICROPHONES AND ELECTRONIC COMPONENTS
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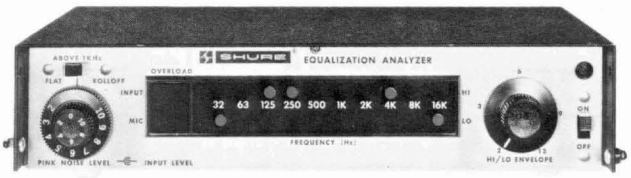
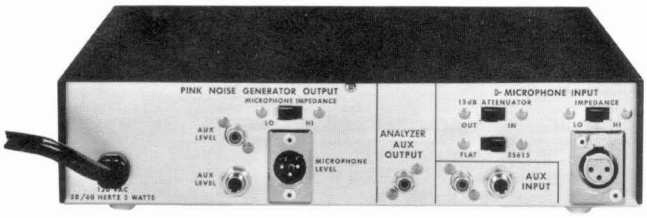
DATA SHEET

MODELS M615AS and M615AS-2E EQUALIZATION ANALYZER SYSTEM





GENERAL

The Shure Model M615AS Equalization Analyzer System is designed to permit rapid and accurate adjustment of the frequency response of a sound reinforcement, monitoring, or playback system incorporating an equalizer such as the Shure Model SR107 Audio Equalizer or M610 Feedback Controller. The M615AS consists of the M615 Equalization Analyzer, ES615 Analyzer Microphone, their various accessories, and a portable case. (The M615 and ES615 are also available separately.)

The M615 provides two major functions. First, it is a source of equal-energy-per-octave random noise ("pink noise"), available at microphone and auxiliary levels with adjustable output, to serve as a test signal source. Second, the M615 accepts the output of the ES615 Analyzer Microphone (or other microphone) or an auxiliary-level signal, and indicates the relative energy in each of 10 octave bands. Two light-emitting diodes (LEDs) for each octave indicate whether the energy is below a given LO (reference) level, above an adjustable HI level, or (if both LEDs are off) between the two levels (within the envelope). The object is to adjust the sound system equalizer to turn off the LEDs of the M615, thereby producing a system response which is within the envelope. With minimum envelope size (2 dB) and all LEDs off, the resultant octave-energy frequency response curve will be smooth within approximately ±1 dB. Two resultant curves may be selected: flat, or the 3 dB per octave rolloff above 1 kHz typical of most desired "house curve" responses. Two overload LEDs, a microphone input attenuator, and an input level control are also provided. A switch provides either microphone input low-frequency response compensation for the ES615 Analyzer Microphone or a flat frequency response characteristic.

The ES615 Analyzer Microphone is an omnidirectional, dynamic, measurement microphone. Its broad, flat frequency response with controlled low-frequency rolloff is designed specifically for use with the M615 Analyzer.

The M615AS includes a microphone cable, swivel adapter, tilt bracket, test/interconnecting cable and system carrying case.

The Model M615AS-2E Equalization Analyzer System is identical to the Model M615AS, except that it contains the Model M615-2E Equalization Analyzer instead of the Model M615. The M615 operates from 108-132 Vac and the M615-2E operates from 90-125 or 180-250 Vac (switch-selectable).

The M615 (only) is listed by Underwriters' Laboratories, Inc., and listed by Canadian Standards Association as certified.

Model M615AS Features:

- Permits rapid and accurate adjustment of octave band equalizers in sound systems
- Pink noise generator with microphone- or aux-level output
- Ten octave bands from 32 Hz to 16 kHz
- Rugged LED High and Low indicators
- Selectable resultant octave-energy curve: flat for near field equalization or 3 dB per octave rolloff above 1 kHz for reverberant field equalization
- LED microphone and input overload indicators to assure accurate equalization
- Adjustable input and pink noise output levels
- Microphone input with high/low impedance selectors, 15 dB attenuator and flat/ES615 frequency response selector switches
- Adjustable envelope from 2 to 12 (±1 to ±6) dB
- Aux output jack for monitoring or connection to accessory instrumentation
- Tilt bracket permits positioning Analyzer at convenient viewing angle
- Sturdy carrying case for all System components

SPECIFICATIONS

EQUALIZATION ANALYZER

All signal levels referred to are pink noise levels.

Inputs

IMPEDANCE	LEVEL	CONNECTOR
High or Low	MIC	3-pin professional female*
High	AUX	phone and phono pin jacks

Outputs

IMPEDANCE	LEVEL	CONNECTOR
Pink Noise Generator High or Low	MIC	3-pin professional male*
Pink Noise Generator High	AUX	phone and phono pin jacks
Analyzer High	AUX	phono pin jack

* Designed to mate with Cannon XL series, Switchcraft A3 (Q.G.) series or equivalent connector

27A1350 (RB)

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PINK NOISE GENERATOR

Output Level (Level control at 10)

AUX LEVEL	HI-Z MIC LEVEL	LO-Z MIC LEVEL
−1 dBV (890 mV)	−29 dBV (35 mV)	−49 dBV (3.5 mV)

Spectrum

Equal energy per octave pink noise, flat ±1 dB, 32 Hz to 16 kHz

Impedance

OUTPUT	DESIGNED FOR USE WITH	ACTUAL
Lo-Imp. Mic Level	25- to 600-ohm microphone circuits	110 ohms balanced
Hi-Imp. Mic Level	33-kilohm microphone circuits	2.3 kilohms unbalanced
Aux Level	High-impedance (10 kilohms or more) unbalanced aux circuits	1.5 kilohms unbalanced

ANALYZER

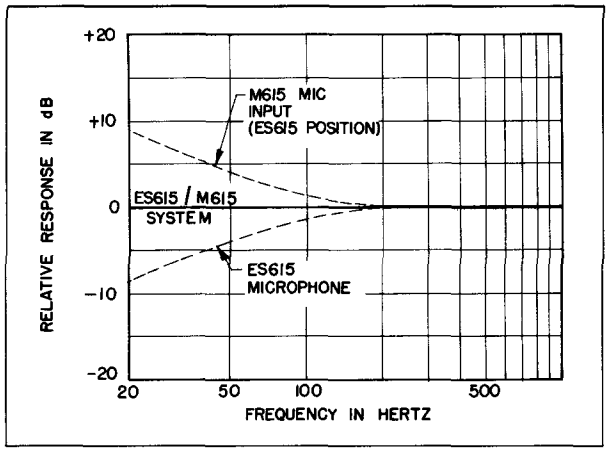
Sensitivity

(Pink noise levels to turn off LO LEDs; INPUT LEVEL control fully clockwise)

INPUT	15 dB ATTENUATOR	INPUT VOLTAGE	SOUND PRESSURE USING ES615 MICROPHONE
Lo-Imp. Mic.	Out	−117 dBV (1.4 μV)	45 dB SPL
	In	−102 dBV (8 μV)	60 dB SPL
Hi-Imp. Mic.	Out	−92 dBV (25 μV)	—
	In	−77 dBV (0.14 mV)	—
Aux	—	−62 dBV (0.79 mV)	—

Flat/ES615 Switch

In ES615 position, complements low-frequency rolloff characteristic of ES615 Microphone (see Figure 1)



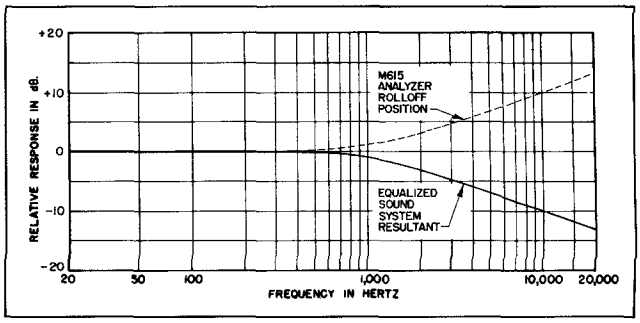
ES615/M615 SYSTEM LOW FREQUENCY RESPONSE

FIGURE 1

Above 1 kHz Switch

FLAT: Used for near-field measurements; produces flat resultant frequency response.

ROLLOFF: Used for reverberant and far-field measurements; produces resultant frequency response rolled off at 3 dB per octave above 1 kHz (see Figure 2)



ABOVE 1 kHz ROLLOFF FREQUENCY RESPONSE

FIGURE 2

Mic Overload

(*Pink noise levels to turn on MIC OVERLOAD LED*)

INPUT	15 dB ATTENUATOR	INPUT VOLTAGE	SOUND PRESSURE USING ES615 MICROPHONE
Lo-Imp. Mic.	Out	−40 dBV (10 mV)	122 dB SPL
	In	−25 dBV (56 mV)	137 dB SPL
Hi-Imp. Mic.	Out	−17 dBV (0.14V)	—
	In	−2 dBV (0.79V)	—

Input Overload

(Pink noise aux input level to turn on INPUT OVERLOAD LED; INPUT LEVEL control fully clockwise)
−25 dBV (56 mV)

Hi/Lo Envelope

2 to 12 dB (±1 to ±6 dB), adjustable

Aux Output Voltage Gain

INPUT	GAIN
Lo-Imp. Mic	+54 dB**
Hi-Imp. Mic	+31 dB**
Aux	−4 dB

** Input attenuator out.

Impedance

INPUT	DESIGNED FOR USE WITH	ACTUAL
Lo-Imp. Mic.	25- to 600-ohm microphones	950 ohms balanced
Hi-Imp. Mic.	33-kilohm microphones	140 kilohms unbalanced
Aux	100-ohm to 10 kilohms high level sources	42 kilohms unbalanced

OUTPUT	DESIGNED FOR USE WITH	ACTUAL
Aux	High-impedance (10 kilohms or more) unbalanced aux circuits	4.7 kilohms unbalanced (with MIC input in use)

Operating Voltage

M615: 108-132 Vac, 50/60 Hz, 5W

M615-2E: 90-125 or 180-250 Vac, 50/60 Hz, 5W

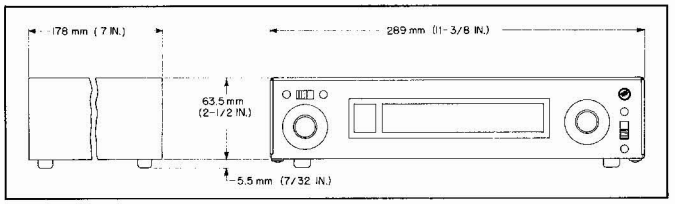
Temperature Range

Operating: −7° to 57°C (20° to 135°F)

Storage: −29° to 71°C (−20° to 160°F)

Dimensions

See Figure 3



OVERALL DIMENSIONS
FIGURE 3

Weight

	M615	M615AS
Net	2.2 kg (4 lb 13 oz)	
Combined Net	2.3 kg (4 lb 15 oz)	5 kg (11 lb)
Packaged	2.9 kg (6 lb 7 oz)	5.6 kg (12 lb 4 oz)

CONTROLS AND CONNECTORS

PINK NOISE LEVEL Control: Sets pink noise generator output level.

INPUT LEVEL Control: Sets input signal level and LO LED threshold to the analyzer.

ABOVE 1 KHZ Switch: Selects either a flat resultant high-frequency response or a smooth resultant high-frequency 3 dB per octave rolloff above 1 kHz.

INPUT OVERLOAD LED: Lights if INPUT LEVEL control is set too high for input signal level, causing erroneous M615 LED indications.

MIC OVERLOAD LED: Lights with excessive microphone input levels, indicating need to switch in 15 dB attenuator or reduce pink noise level.

HI/LO ENVELOPE Control: Adjusts the HI LED threshold relative to the LO LED threshold. The resultant frequency response envelope may be varied from 2 to 12 dB ($\pm$1 to $\pm$6 dB).

HI/LO LEDs: The LO LED for each octave lights if the input signal within its octave is below the lower threshold set by the INPUT LEVEL control. The HI LED for each octave lights if the input signal is above the upper threshold set by the HI/LO ENVELOPE control.

PINK NOISE GENERATOR OUTPUT — AUX LEVEL Connector: Provides pink noise generator output connection to aux-level inputs.

PINK NOISE GENERATOR OUTPUT — MIC LEVEL Connector: Provides pink noise generator output connection to microphone-level inputs.

PINK NOISE GENERATOR OUTPUT — MICROPHONE MIPEDANCE Switch: Selects low- or high-impedance pink noise generator microphone-level output.

MICROPHONE INPUT — 15 dB ATTENUATOR Switch: Reduces microphone input sensitivity to avoid microphone preamplifier overload. Affects microphone input only.

MICROPHONE INPUT — FLAT/ES615 Switch: Selects either flat response or low-frequency boost complementing the response characteristics of the ES615 Analyzer Microphone, making the system response flat. Affects microphone input only.

MICROPHONE INPUT Connector: Provides microphone input to analyzer.

MICROPHONE INPUT — IMPEDANCE Switch: Selects low- or high-impedance microphone input to analyzer.

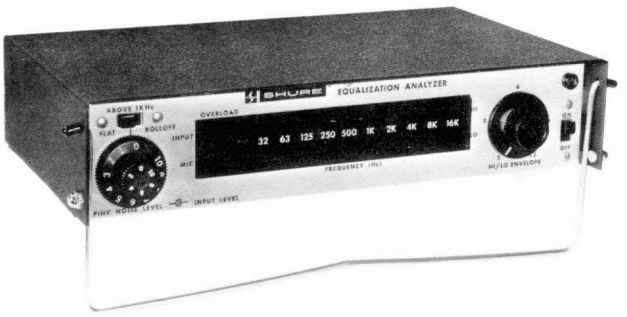
AUX INPUT Connectors: Provides input to analyzer from mixers, amplifiers or other aux level input signals. In addition, accepts aux level output of pink noise generator (using the supplied cable) for self-testing purposes. Automatically disables MICROPHONE INPUT if plug is inserted.

AUX OUTPUT Connector: Provides for monitoring or connection to accessory instrumentation. This connector is in parallel with the analyzer AUX LEVEL input connectors, or monitors the equalized microphone preamplifier output if the AUX INPUT connectors are not in use.

PRELIMINARY SETUP

The following should be performed prior to using the M615AS Equalization Analyzer System:

1. Remove the protective cap from the grille assembly of the ES615 Analyzer Microphone. This cap should be used during transit and storage only.
2. Install the tilt bracket assembly on the M615 Equalization Analyzer as follows: Attach the No. 6-32 machine screws and capnuts in the two *lower* holes at the front of the M615 cover. Make certain the capnuts are on the *outside* of the cover. Insert the ends of the tilt bracket through the two *upper* holes at the front of the M615 cover. Slip the plastic caps over each end of the tilt bracket. Swing the tilt bracket downward against the front panel so that the machine screw heads provide a detent to stop the bracket from sliding (see Figure 4). Note that the M615 can be replaced in its carrying case with the tilt bracket in place and extending straight outward from the front panel.



M615 WITH TILT BRACKET
FIGURE 4

3. Model M615-2E: The Model M615-2E is supplied with a detachable line cord without a three-pin male power connector. Obtain a suitable three-pin male plug and attach it to the line cord. The plug should be installed by qualified service personnel. The brown lead goes to the "hot" or "live" terminal, the blue lead to the neutral terminal, and the green/yellow lead to the ground or earth terminal. Select the proper voltage range (90-125 or 180-250 Vac) using the rear-panel VOLTAGE SELECTOR switch.

SETUP AND OPERATION

In the following setup and operation procedures, the objective is to produce a smooth acoustical frequency response in the audience listening area. This condition is indicated by both LO and HI LEDs being off. However, due to the nature of random noise, a signal near threshold will cause flickering of the LED, rather than a positive on-off indication. It is generally sufficient if one or several LEDs are blinking, but not off completely.

The time required to allow the analyzer to respond to a change and sample sufficient noise to give an accurate indication depends on the octave band observed and the amount of change made. The low-frequency octave bands require more time to stabilize, and major changes in equalization require more time to provide LED indications. Up to 20 seconds may be required for large low-frequency changes, while 1 second is sufficient for mid- and high-frequency changes. Note that when the M615 is turned on, at least one minute is required for the circuits to stabilize and provide proper LED indications.

ANALYZER CHECKOUT

The M615 Analyzer may be checked for proper function prior to use as follows:

1. Connect the line cord to a 108-132 Vac (M615), or 90-125 or 180-250 Vac (M615-2E), 50/60 Hz power source. (Select the proper operating voltage using the VOLTAGE SELECTOR switch.)
2. Connect the supplied test/interconnecting cable between the pink noise generator AUX LEVEL output and the analyzer AUX INPUT.
3. Set the ABOVE 1 kHz switch to FLAT, the HI/LO ENVELOPE control to 2, and the PINK NOISE LEVEL control to approximately 5.
4. Turn on the ON/OFF switch and allow the unit to stabilize for one minute.
5. Slowly adjust the INPUT LEVEL control until all LEDs are off. Note that the low-frequency LEDs (below 500 Hz) will respond more slowly to INPUT LEVEL control adjustment.

This check indicates that the M615 is operating satisfactorily and is ready for use.

While the M615 is factory-calibrated for AUX LEVEL output to AUX INPUT checkout as described above, a similar checkout using the MICROPHONE LEVEL output to MICROPHONE INPUT may be performed. To account for normal slight variations in response between the auxiliary and microphone connections, set the HI/LO ENVELOPE control to 3 for this checkout.

1. Connect the test/interconnecting cable supplied with the ES615 Analyzer Microphone or a similar cable with male and female professional three-pin connectors between the pink noise generator MICROPHONE LEVEL output and the analyzer MICROPHONE INPUT.
2. Set the 15 dB ATTENUATOR switch to OUT, the FLAT/ES615 switch to FLAT, and both IMPEDANCE switches to either HI or LO.
3. Perform the checkout procedure as described above.

If one or more LEDs remain on, an adjustment may be performed (by qualified service personnel only) as described in the *Calibration: Rectifier Level* section.

EQUALIZATION: GENERAL

While the final measure of any equalization effort is a subjective judgement of the quality of the sound delivered to the audience, acoustic measurement instrumentation such as the M615AS Equalization Analyzer System can be of considerable assistance in more efficient and consistent equalization procedures.

The M615AS consists of a pink noise generator (equal energy per octave), an equalization analyzer and an omnidirectional analyzer microphone with a flat response compatible with the analyzer. The analyzer indicates the relative signal amplitude of each octave band for the complete audio spectrum.

In general, equalization analyzer equipment is used to allow equalizer adjustment by measuring sound system performance instead of by subjective evaluation. Connection, setup and operation of the equalizer remains the same. Recommendations regarding various equalization objectives are also generally applicable.

Analyzer equipment usually is used first to establish the desired house curve, which is the sound system response characteristic preferred for that particular application. For playback equalization the analyzer microphone is located in the main audience area and connected to the equalization analyzer input. The noise generator is connected to the audio console or mixer input and the volume adjusted to provide a sound level at least 10 dB above the room ambient noise level. In such an arrangement the analyzer is placed in close proximity to the equalizer so that, as equalizer adjustments are made, the results are easily observed. Adjustment for a flat response in the audience area of a large room will usually result in an overly bright sound. Common practice is to adjust for 3 dB per octave rolloff of the high frequencies starting at about 1 kHz for reverberant-field equalization. Frequency response is then checked in other locations in the audience area and, if necessary, the equalizer is readjusted slightly to improve the average response for the entire audience area. Final equalization adjustments are based on listening tests using typical program material.

Home entertainment system equalization using instrumentation is similar to playback equalization, except that an amplifier (or amplifier portion of a receiver) is used instead of a mixer, the analyzer microphone is placed in the desired listening location instead of the main audience area and the system is equalized flat for near-field equalization.

Equalization of a sound reinforcement system using instrumentation is the same as for playback equalization. The sound system is equalized initially to produce the desired house curve with all microphones turned off. The individual microphone volume controls are then increased equally (assuming microphones have similar characteristics) or to the approximate use settings, below the feedback threshold. The mixer master gain control is then increased slowly while observing the equalization analyzer. As the feedback threshold is approached, the analyzer will show a prominent increase in amplitude of the frequency band where feedback is about to, or does, occur. This band is then suppressed using the appropriate equalizer filter control. This process is repeated until the major feedback tendencies have been sup-

pressed and a reasonable sound volume level can be produced. A talk or other performance test of each open microphone is then conducted and the quality of the sound produced is sampled by listening in various locations throughout the audience area. Additional equalization adjustments are made based on the listening evaluation, while taking care to avoid any significant reduction in the feedback threshold previously achieved.

Equalization of a stage monitor system using analyzer equipment is similar to playback or house system equalization except that measurements and evaluation are confined to the performer's stage area. The pink noise generator is connected to the mixer input and the audio console or mixer volume adjusted to provide an output from the monitor speakers at least 10 dB above the ambient noise level. A person is placed in front of the lead performer's microphone (to simulate performance conditions) and the analyzer microphone is placed next to the person at ear level to sample the sound field in that area. The analyzer microphone output is viewed on the equalization analyzer and initial response adjustments, such as low-frequency rolloff, are made. The audio console or mixer volume control for the performer's microphone is then set to a stable point slightly below the feedback threshold. The monitor master gain control is gradually increased until an obvious increase in amplitude in a particular frequency band is noted on the equalization analyzer. This is the onset of feedback and the appropriate equalizer filter control is used to reduce the system response in this area. This process is continued until satisfactory gain before feedback and the desired response is achieved. A voice test of each performer microphone position is made to determine if an adequate feedback threshold is attainable. Final adjustment of the equalizer and/or individual channel tone controls (if available) is made to improve quality or intelligibility of the sound presented to the performers.

OPERATION

This section contains basic instructions for connecting and operating the M615AS Equalization Analyzer System. It should be noted that individual room acoustics, equipment characteristics, and increasing operator proficiency will all contribute to the development of equalization analysis techniques which may differ somewhat from the guidelines described here.

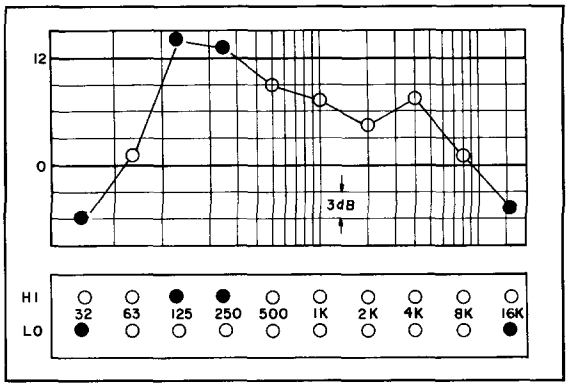
Connections

Interconnect the units of the sound system as for normal operation. Connect the M615 pink noise generator output to the input of the console, mixer, preamplifier (either microphone, or aux level using the supplied test/interconnecting cable), amplifier or receiver, and, if the M615 microphone-level output is used, set the MICROPHONE IMPEDANCE switch as required. Connect the ES615 Analyzer Microphone to the M615 microphone input. Set the FLAT/ES615 switch to ES615 and the microphone input IMPEDANCE switch to LO. If a flat-response equalization microphone rather than the ES615 is to be used, set the FLAT/ES615 switch to FLAT and the IMPEDANCE switch as required.

Sound Reinforcement Systems

1. Place the speakers of the sound reinforcement system in listening area locations to provide optimum audience coverage. Maximum coverage in many installations is obtained with the speakers on each side of the sound source and as far forward as possible. Assuming a single speaker to either side of the sound source, the speakers should be positioned so that an imaginary line from the center of each speaker runs to the back row of the audience area. For "clustered" speaker installations covering a wide area, each speaker should be positioned so that its angle of coverage slightly overlaps that of the speaker next to it as their sound output enters the audience area. The pink noise generator output of the M615 may be used (at low system power levels) to provide an audible signal source for speaker placement checkout. A listening test of the audience area may be made for dead zones, frequency response variations, or other symptoms of improper coverage. Avoid listening to speaker pattern overlap areas, as these are apt to be erratic.
2. Set the front-panel ABOVE 1 kHz switch as required. A system equalized using the ROLLOFF position provides a smooth 3 dB per octave rolloff starting at 1 kHz, which usually results in the most pleasing audience reaction. Research has shown that a perfectly flat frequency response curve generally yields an overly bright sound that is made more natural by using this gradual high-frequency rolloff. The FLAT position is normally used only for near-field equalization particularly in small or acoustically "dead" rooms, or for electrical equalization of preamplifiers, tape recorders, and amplifiers.
3. Set the 15 dB ATTENUATOR switch to OUT, the HI/LO ENVELOPE control to 12, and the PINK NOISE LEVEL control to 0. Place the ES615 or other equalization microphone on a microphone stand at a seated listening height, approximately on-axis to one of the speakers and mid-way between the speaker and the rear of the audience area. Turn on all units in the system and allow one minute warmup time. Starting at 0, turn the INPUT LEVEL control slowly up until the first LO LED goes out or flickers. Note the INPUT LEVEL control setting and reduce it by approximately 3. This assures that the input sensitivity is low enough to prevent the ambient noise level from affecting equalization results. If the MIC input is being used and the initial INPUT LEVEL control setting is 4 or less, the 15 dB ATTENUATOR switch should be set to IN and the process repeated. If the INPUT OVERLOAD LED comes on during adjustment of the INPUT LEVEL control, the control setting is too high and must be reduced for proper LO LED indications. IMPORTANT: The equalization procedure requires a stable ambient noise level. Extraneous noise such as construction, rehearsal, or loud conversation will interfere with measurements and adjustments.
4. Slowly increase the PINK NOISE LEVEL control until one to three HI LEDs go on. Most LO LEDs will go out; those remaining on at either end of the spectrum indicate the bandwidth limits of the sound reinforcement system. It is important to note that any attempts to equalize at these bandwidth limits must be done judiciously. Excessive boosting of these frequencies

can cause power amplifier overloading and possible speaker damage. Figure 5 shows a typical room response prior to equalization, with initial peaks occurring around 125 and 250 Hz. Initial equalizer adjustments for this condition would be a reduction of the 125 and 250 Hz filter control settings to turn these HI LEDs off. (For clarity, the high-frequency rolloff is not depicted.)



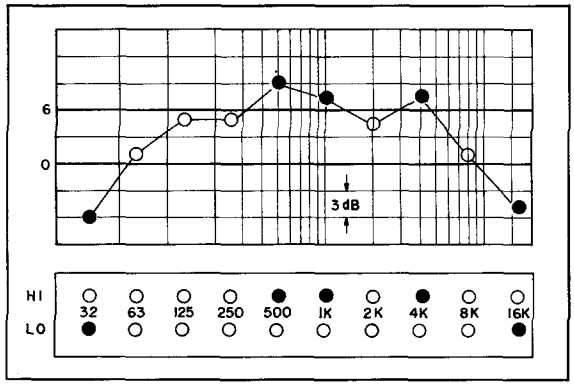
TYPICAL ROOM RESPONSE
BEFORE EQUALIZATION

FIGURE 5

5. Observe which HI LEDs have turned on and slowly adjust the corresponding equalizer frequency filter control in the "cut" direction until those LEDs just turn off. Do not adjust the equalization control any more than necessary to turn the LED off. Note that in the process of reducing an equalizer control to turn a HI LED off, the LO LEDs of one or both adjacent octave bands may turn on as a result of normal filter interaction. Simply slightly readjust the equalizer controls of the affected octave bands until the LO LEDs again go out.

6. When both HI and LO LEDs are off, slowly reduce the HI/LO ENVELOPE control. Some HI LEDs will begin to turn on, indicating relative peaks in response. Repeat step 5 to eliminate these peaks. Figure 6 shows the room response of Figure 5 after initial equalization of the low frequencies. Note that as the HI/LO ENVELOPE control has been reduced, the 500, 1K and 4K peaks are now outside the envelope and these HI LEDs have turned on. Equalizer adjustments would now be made to turn these LEDs off.

   Continue reducing the HI/LO ENVELOPE control and eliminating peaks that appear. When a satisfactory envelope has been obtained, move the equalization microphone to other positions in the listening area and note which HI or LO LEDs turn on. It may be necessary to readjust the INPUT LEVEL control for a minimum number of lit LEDs due to level differences between locations. The HI/LO ENVELOPE control setting may be increased to determine the extent of response changes at the new location. At this point, corrective action may be taken by either slight adjustment of the equalizer frequency filters, readjustment of speaker positions, or physical changes such as the addition or removal of sound-absorbing material. It is important to note that major changes to the equalizer settings obtained in the main listening area should not be made.

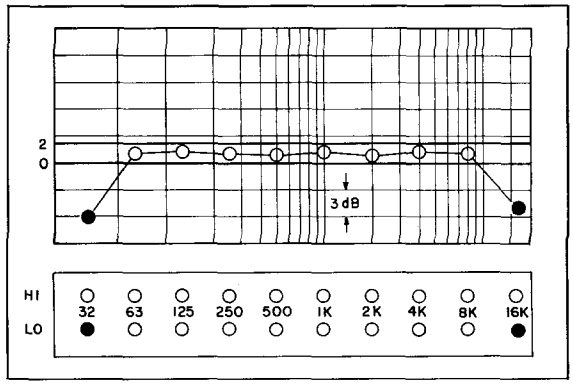


TYPICAL ROOM RESPONSE AFTER
LOW-FREQUENCY EQUALIZATION

FIGURE 6

7. The sound system has now been equalized to provide a smooth, controlled-rolloff frequency response, free of major irregularities. Figure 7 shows the final room response after equalization, with the HI/LO ENVELOPE control at 2 (±1) dB. Note that no attempt has been made to "boost" the frequencies beyond the bandwidth limits of the system.

   At this point, feed the system with program-type material (live or recorded) and make slight adjustments to brighten or otherwise modify equalized response using the system's tone controls.



TYPICAL ROOM RESPONSE
AFTER EQUALIZATION

FIGURE 7

Stage Monitor Systems

Equalization of stage monitor systems is performed principally to eliminate feedback while providing the performer with an intelligible source of the sound required for the performance.

1. Connect the performer's microphone to the sound system and adjust the levels to a point just below feedback. Place the ES615 or other equalization microphone at the performer's ear level (facing forward

toward the monitor speaker), and connect the ES615 to the M615. Make certain someone is standing in the performer's position to simulate performance conditions.

2. It is advisable to roll off the low-frequency response of the system by reducing the settings of the equalizer frequency controls below 250 Hz. Attenuation of frequencies in this range reduces low-frequency noise pickup without affecting intelligibility.

3. Set the ABOVE 1 kHz switch to FLAT. This position is used for near-field conditions such as are encountered in stage monitor setups.

4. Set the 15 dB ATTENUATOR switch to OUT, and HI/LO ENVELOPE control to 12, and the PINK NOISE LEVEL control to 0. Turn on all units in the system and allow one minute warmup time. Starting at 0, turn the INPUT LEVEL control slowly up until the first LO LED goes out or flickers. Note the INPUT LEVEL control setting and reduce it by approximately 3. This assures that the input sensitivity is low enough to prevent the ambient noise level from affecting equalization results. If the MIC input is being used and the initial INPUT LEVEL control setting is 4 or less, the 15 dB ATTENUATOR switch should be set to IN and the process repeated. If the INPUT OVERLOAD LED comes on during adjustment of the INPUT LEVEL control, the control setting is too high and must be reduced for proper LO LED indications. IMPORTANT: The equalization procedure requires a stable ambient noise level. Extraneous noise such as construction, rehearsal or loud conversation will interfere with measurements and adjustments.

5. Slowly increase the PINK NOISE LEVEL control until one to three HI LEDs go on. Most LO LEDs will go out; those remaining on at either end of the spectrum indicate the bandwidth limits of the monitor system. It is important to note that any attempts to equalize at these bandwidth limits must be done judiciously. Excessive boosting of these frequencies can reduce intelligibility, and cause power amplifier overloading and possible speaker damage.

6. Observe which LEDs have turned on and slowly adjust the corresponding equalizer frequency filter control in the "cut" direction until those LEDs just turn off. Do not adjust the equalization control any more than necessary to turn the LED off. Note that in the process of reducing an equalizer control to turn a HI LED off, the LO LEDs of one or both adjacent octave bands may turn on as a result of normal filter interaction. Simply slightly readjust the equalizer controls of the affected octave bands until the LO LEDs again go out.

7. When both HI and LO LEDs are off, slowly reduce the HI/LO ENVELOPE control. Some HI LEDs will begin to turn on, indicating relative peaks in response. Repeat step 6 to eliminate these peaks. Continue reducing the HI/LO ENVELOPE control and eliminating peaks that appear. When a satisfactory envelope has been obtained, set the audio console or mixer volume control for the performer's microphone to a stable point slightly below the feedback threshold. Gradually increase the monitor master gain control until an obvious increase in amplitude in a particular frequency band is noted on the M615. This is the onset of feedback; adjust the appropriate equalizer filter control to reduce the system response in this area. Continue this process until satisfactory gain before feedback and the desired response is achieved. Make a voice test of each performer microphone position to determine if an adequate feedback threshold is attainable. Final adjustment of the equalizer and/or individual channel tone controls (if available) may then be made to improve quality or intelligibility of the sound presented to the performers.

Home Entertainment Systems

Home entertainment (hi-fi) systems incorporating an equalizer may be properly equalized using the M615 as follows.

1. Set all controls on the hi-fi system to flat. Set the volume control to maximum or, if a loudness compensation switch is provided, turn the loudness switch off. Place the ES615 microphone in the desired listening area, at approximately listening height and facing the normal listening direction (front center).

2. Set the ABOVE 1 kHz switch as required. Although the FLAT position is applicable to most home entertainment system (near-field) setups, in large or "live" rooms a far- or reverberant-field condition may sometimes be encountered in which the ROLLOFF position could be used. This position provides a smooth 3 dB per octave rolloff which has been found to be most pleasing to audiences in larger listening areas.

3. Connect the pink noise generator output to the receiver or amplifier auxiliary input of one channel.

4. Set the 15 dB ATTENUATOR switch to OUT, the HI/LO ENVELOPE control to 12, and the PINK NOISE LEVEL control to 0. Turn on all units in the system and allow one minute warmup time. Starting at 0, turn the INPUT LEVEL control slowly up until the first LO LED goes out or flickers. Note the INPUT LEVEL control setting and reduce it by approximately 3. This assures that the input sensitivity is low enough to prevent the ambient noise level from affecting equalization results. With the MIC input in use, if the initial INPUT LEVEL control setting is 4 or less, the 15 dB ATTENUATOR switch should be set to IN and the process repeated. If the INPUT OVERLOAD LED comes on during adjustment of the INPUT LEVEL control, the control setting is too high and must be reduced for proper LED indications. IMPORTANT: The equalization procedure requires a stable ambient noise level. Extraneous noise such as TV, air conditioners, or loud conversation will interfere with measurements and adjustments.

5. Slowly increase the PINK NOISE LEVEL control until one to three HI LEDs go on. Most LO LEDs will go out; those remaining on at either end of the spectrum indicate the bandwidth limits of the system. It is important to note that any attempts to equalize at these bandwidth limits must be done judiciously. Excessive boosting of these frequencies can cause amplifier overloading and possible speaker damage.

CAUTION: Excessively high signal levels for long periods of time may damage many hi-fi speakers. Equalization analysis should be performed at as low a signal level as possible.

6. Observe which HI LEDs have turned on and slowly adjust the corresponding equalizer frequency filter control in the "cut" direction until those LEDs just turn off. Do not adjust the equalization control any more than necessary to turn the LED off. Note that in the process of reducing an equalizer control to turn a HI LED off, the LO LEDs of one or both adjacent octave bands may turn on as a result of nor*mal filter interaction. Simply slightly readjust the* equalizer controls of the affected octave bands until the LO LEDs again go out.
7. When both HI and LO LEDs are off, slowly reduce the HI/LO ENVELOPE control. Some HI LEDs will begin to turn on, indicating relative peaks in response. Repeat step 6 to eliminate these peaks. Continue reducing the HI/LO ENVELOPE control and eliminating peaks that appear until a satisfactory envelope has been obtained.
8. Connect the pink noise generator output to the receiver or amplifier auxiliary input of the other channel and repeat steps 4 through 7 for the other channel.
9. Once equalization of the hi-fi system has been achieved, the system equalization or tone controls can be adjusted slightly to satisfy personal preference.

SERVICING

WARNING

Voltages in this equipment are hazardous to life. Refer servicing to qualified service personnel.

Disassembly

Disconnect ac power. The M615 cover may be removed by removing one screw at the top center of the front and rear panels and one screw at each side of the chassis bottom.

Printed circuit assembly A1 may be removed by disconnecting connectors J7 and J8 from the board (see Parts Placement diagram), and removing the board from the nylon fasteners by squeezing the upper protruding tabs on the circuit board side inward and sliding the board outward and off the fasteners.

Printed circuit assembly A9 may be removed by first removing two screws on the bottom of the chassis which secure the metal shield associated with Assembly A9. Lift the shield and circuit assembly upward and out of the chassis. Remove the circuit assembly from the shield by squeezing the upper protruding tabs of the nylon fasteners on the circuit board side, and sliding the board outward and off the fasteners.

The multiple printed circuit assembly consisting of A2 through A8 may be removed by first removing four screws on the bottom of the chassis. Carefully lift the assembly upward and out of the chassis. As the assembly becomes clear of the chassis, remove connectors J9, J10, J11 and J901. Remove the top support bracket and metal bracket from the LED end of the boards. *Printed circuit assemblies A3 through A8 may now be re*moved from motherboard A2 by pulling outward. Always pull boards and connectors straight to avoid bending male pins.

Filter/Rectifier/Comparator Replacement

When replacing one of the Filter/Rectifier/Comparator printed circuit assemblies (A3 through A7), the filter center frequency (TUNE: RX03, RX15)* and rectifier (LEVEL: RX01, RX16)* potentiometers must be calibrated as follows. Note that TUNE and LEVEL potentiometers for two filter frequencies are present on each assembly. The TUNE adjustment for each frequency must be performed before the LEVEL adjustment.

Calibration: Filter Center Frequency

To calibrate the filter center frequency, set INPUT LEVEL control to 10 and apply a −40 dBV (10 mV) sinusoidal input signal at the desired frequency to the analyzer aux input. Connect the signal from test point TP201 to the horizontal input of an oscilloscope. Connect the signal from the filter test point (TPX02) to the vertical input of the oscilloscope. (The signals must be obtained using a probe with a 1k resistor in series with and as close to the tip of the probe as possible.) Adjust the oscilloscope *to produce a circular or elliptical Lissajous pattern.* Adjust the TUNE potentiometer (RX03) until a straight line denoting 0° phase shift is observed on the oscilloscope. Repeat this procedure for the other filter frequency on the assembly using test point TPX03 and TUNE potentiometer RX15.

Calibration: Rectifier Level

If the Filter/Rectifier/Comparator assembly has been replaced, make certain the TUNE potentiometers have been adjusted prior to LEVEL potentiometer adjustment. If, during the Analyzer Checkout procedure, one or more LEDs remain on, the LEVEL potentiometer for that frequency may be readjusted slightly as follows.

To calibrate the rectifier level, set the ABOVE 1 kHz switch to the FLAT position and apply the AUX LEVEL output of the pink noise generator to the analyzer AUX INPUT. Set the PINK NOISE LEVEL control to 5 and carefully adjust the INPUT LEVEL control until all 10 LO LEDs blink randomly on and off except for the frequencies requiring calibration. Adjust the LEVEL potentiometer (RX01 or RX16) until the associated LO LED blinks randomly. Repeat this procedure for any other frequency requiring adjustment.

Printed Circuit Assembly Connectors

Printed circuit assembly connectors J7 through J11, J201 through J206, and J901 use the AMP Incorporated Commercial Interconnect System. To replace a lead and its associated connector contact, proceed as follows. Using a scribe or other pointed instrument, depress the contact through the slots at both sides of the connector housing. This will free the contact and allow it to be removed from the rear of the connector housing. Trim a new lead so that ⅛ inch of wire appears. Insert the trimmed lead in a new contact (Shure Part No. 56A225). Crimp the wire and the lead insulation to the contact. *Solder the wire to the crimped connection. Insert the new* contact (with attached lead) in the connector housing, pushing firmly to lock the contact.

* For reference designations containing "X" (RX03, TPX02, etc.), substitute the appropriate board number (3 through 7) for the board being adjusted.

MODEL M615 REPLACEMENT PARTS LIST

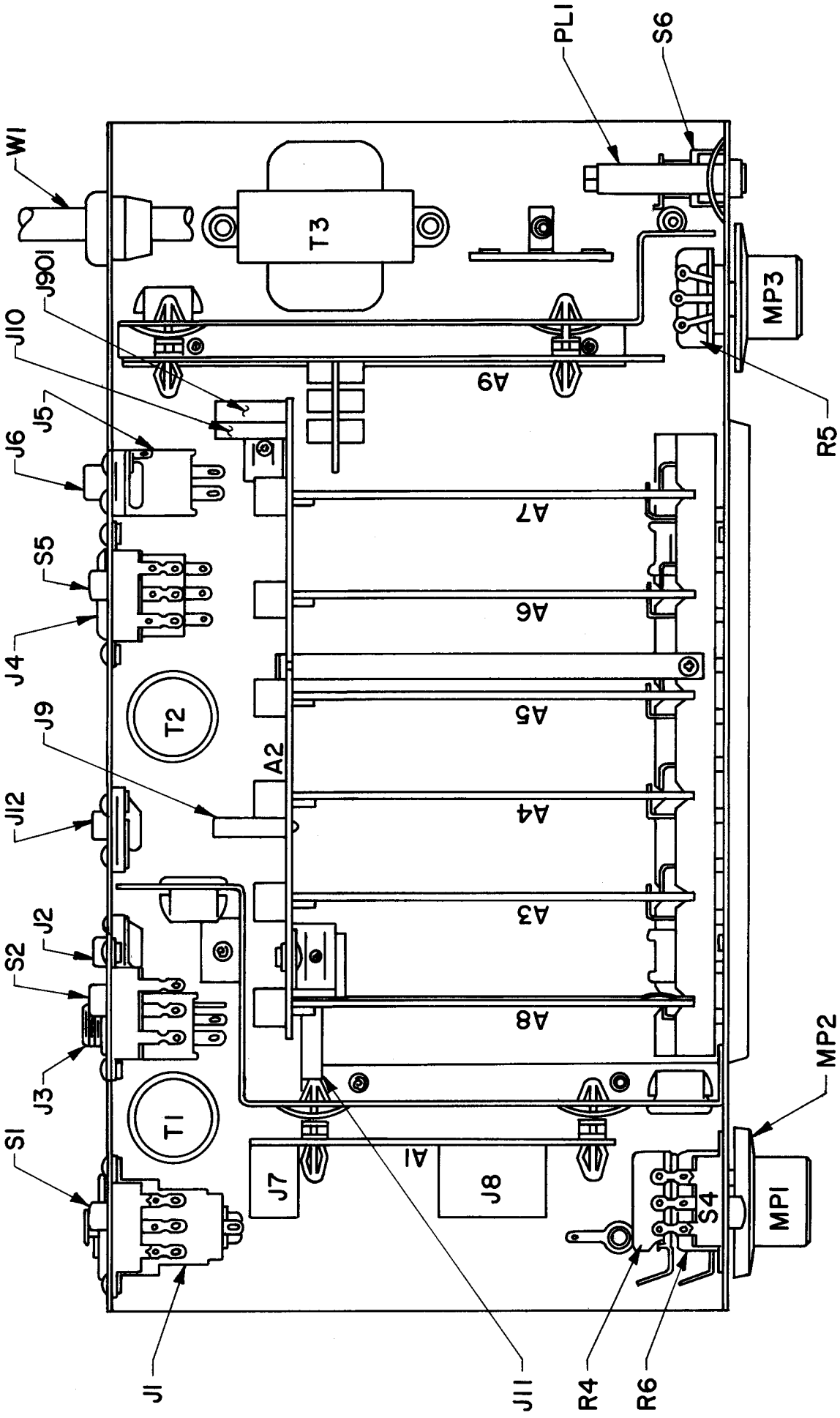
Reference Designation	Replacement Kit No. *	Replacement Kit Consists Of:			Commercial Alternate
		Qty.	Part No.	Description	
A1	—	—	90A2430	Printed Circuit Assembly, Preamplifier	None
A2	—	—	90A2435	Printed Circuit Assembly, Overload Detector and Mother Board	None
A3	—	—	90A2432	Printed Circuit Assembly, 32 & 63 Hz	None
A4	—	—	90B2432	Printed Circuit Assembly, 125 & 250 Hz	None
A5	—	—	90C2432	Printed Circuit Assembly, 500 & 1,000 Hz	None
A6	—	—	90D2432	Printed Circuit Assembly, 2 & 4 kHz	None
A7	—	—	90E2432	Printed Circuit Assembly, 8 & 16 kHz	None
A8	—	—	90A2667	Printed Circuit Assembly, Noise Generator	None
A9	—	—	90A2598	Printed Circuit Assembly, Power Supply	None
D101-102, D301-302, . . . D701-702	—	—	86A415	Diode, Silicon, Computer, 75V	TI or GE 1N4148
D303-306, . . . D703-706, D801-802	—	—	86D422	Diode, Light-Emitting	Monsanto MV5075C
D901-908, D910	RKC21	4	86A404	Silicon Rectifier, 100V, ½A	Motorola 1N4002
D909	—	—	86A423	Zener Diode, Silicon, 27V	Motorola 1N4750A
F1	—	—	90F2281	Fuse, Slo-Blo ⅛A, 250V (M615-2E only)	Littelfuse 315.125
J1	—	—	95B246	Connector, Female 3-Pin Audio	Switchcraft D3F
J2	—	—	95B634	Connector, Phono Jack, Grounded Shell	Switchcraft 3512A
J3	—	—	95C658	Connector, Phone Jack, Shorting	Switchcraft 112A
J4	—	—	95B247	Connector, Male, 3-Pin Audio	Switchcraft D3M
J5	—	—	90AK2600	Connector, Phone Jack, Shorting	Switchcraft 111
J6, J12	—	—	95C450	Connector, Phono Jack, Grounded Shell	Switchcraft 3511A
J7A-J11D, J201A-J206J, J901A-D	—	—	56A225	Connector Contact (only)	None
J13	—	—	95A689	Ac Receptacle (M615-2E only)	None
MP1	—	—	90A1715A	Knob, INPUT LEVEL	None

* Parts listed as RKC Kits should be ordered by that kit number. Any orders received for piece parts where RKC Kit number is shown will be shipped in RKC quantities.

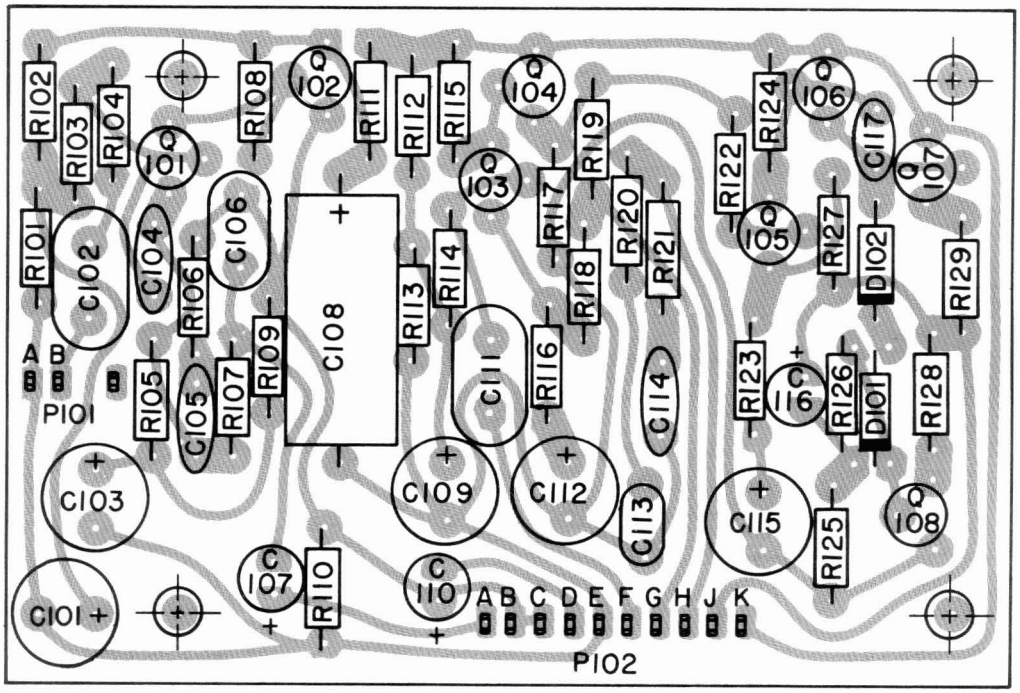
MODEL M615 REPLACEMENT PARTS LIST (Continued)

Reference Designation	Replacement Kit No. *	Replacement Kit Consists Of:			Commercial Alternate
		Qty.	Part No.	Description	
MP2	—	—	65B931A	Knob, PINK NOISE LEVEL	None
MP3	—	—	90E1662	Knob, HI/LO ENVELOPE	None
PL1	RKC45	1	80A79	Lamp, Indicator, Neon	Leecraft 36N1311-6
Q101, Q103, Q105, Q802-803, Q805-807	RKC89	4	86A350	Transistor, Silicon, NPN	Motorola 2N5210
Q102, Q104, Q106, Q801, Q804, Q808	—	—	86A348	Transistor, Silicon, PNP	Motorola 2N5087
Q107	RKC65	1	86A334	Transistor, Silicon, NPN	TI TIS92
Q108	RKC66	1	86A335	Transistor, Silicon, PNP	TI TIS93
Q809	—	—	86A373	Transistor, Field Effect, N-Channel	Siliconix or Intersil E230
Q901	—	—	86A374	Transistor, Silicon, NPN	Motorola 2N4922
R4/R6	—	—	46A064	Potentiometer, Dual, Audio Taper, 50k/50k	None
R5	—	—	46A065	Potentiometer, Modified Log Taper, 5k	None
R301, R316, R401, R416, R501, R516, R601, R616, R701, R716	—	—	46A062	Trimmer Potentiometer, 2.5k	CTS V101S252B
R303, R315, R403, R415, R503, R515, R603, R615, R703, R715	—	—	46B062	Trimmer Potentiometer, 30k	CTS V101S253B
S1-5	—	—	55B83	Switch, Slide, DPDT	Switchcraft 46206LR
S6	—	—	55B103	Switch, Slide, DPDT (M615)	Switchcraft 46206LR
S6	—	—	55A126	Switch, Slide, DPDT (M615-2E)	Marquardt 4021.0101
S7	—	—	55A116	Switch, Slide, DPDT (M615-2E only)	Marquardt 4021.0201
T1-2	—	—	90F2150	Transformer & Shield Assembly	None
T3	—	—	51A269	Transformer, Power (M615)	None
T3	—	—	51A274	Transformer, Power (M615-2E)	None
U201, U302	—	—	86A806	Integrated Circuit, Quad Comparator	Raytheon LM339DB, RCA CA339G, TI SN72339N
U301	—	—	86A805	Integrated Circuit, Quad Operational Amplifier	Raytheon RC3403ADB
W1	—	—	95A632	Cable and Plug Assembly, Ac (M615)	None
W1	—	—	90A1888	Cable and Plug Assembly, Ac (M615-2E)	None

* Parts listed as RKC Kits should be ordered by that kit number. Any orders received for piece parts where RKC Kit number is shown will be shipped in RKC quantities.

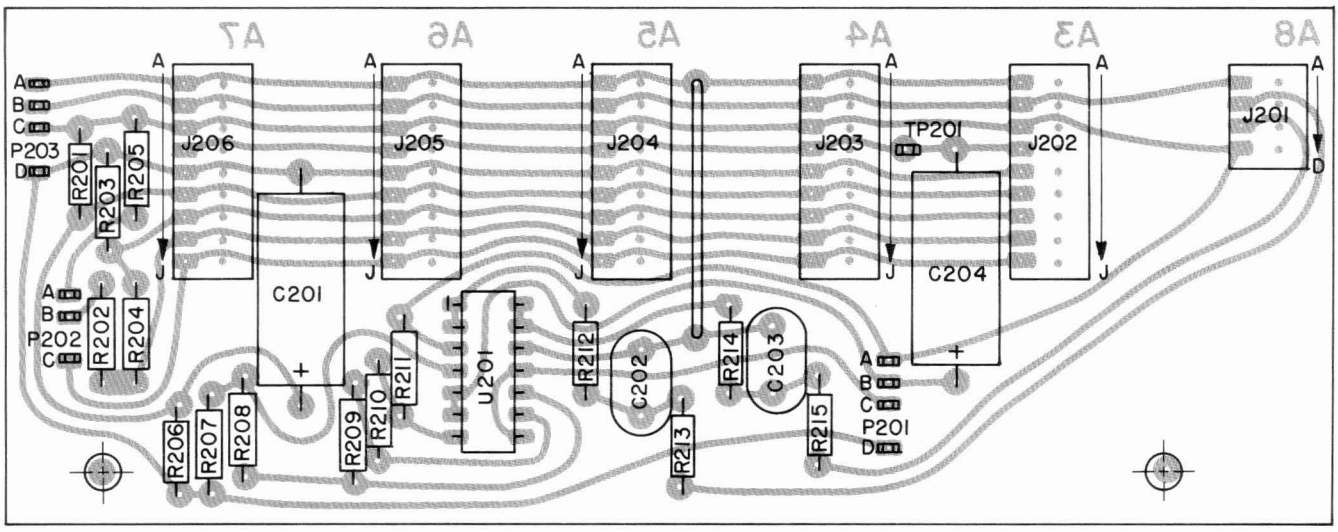


MODEL M615 PARTS PLACEMENT



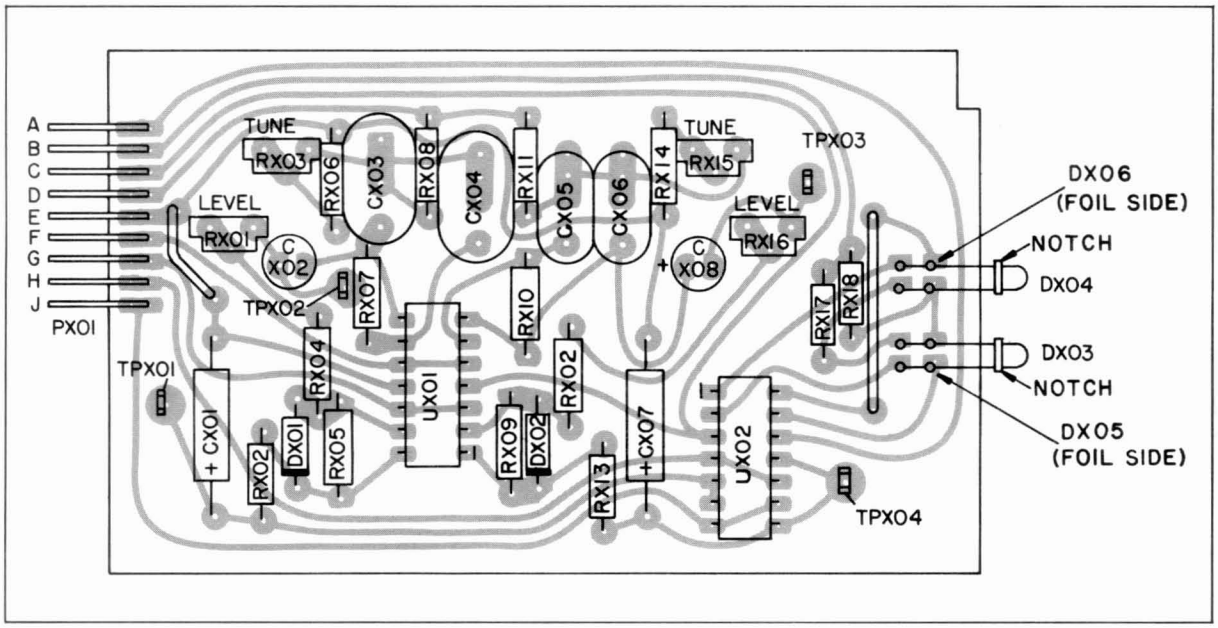
2430-1/629-1

PRINTED CIRCUIT ASSEMBLY A1



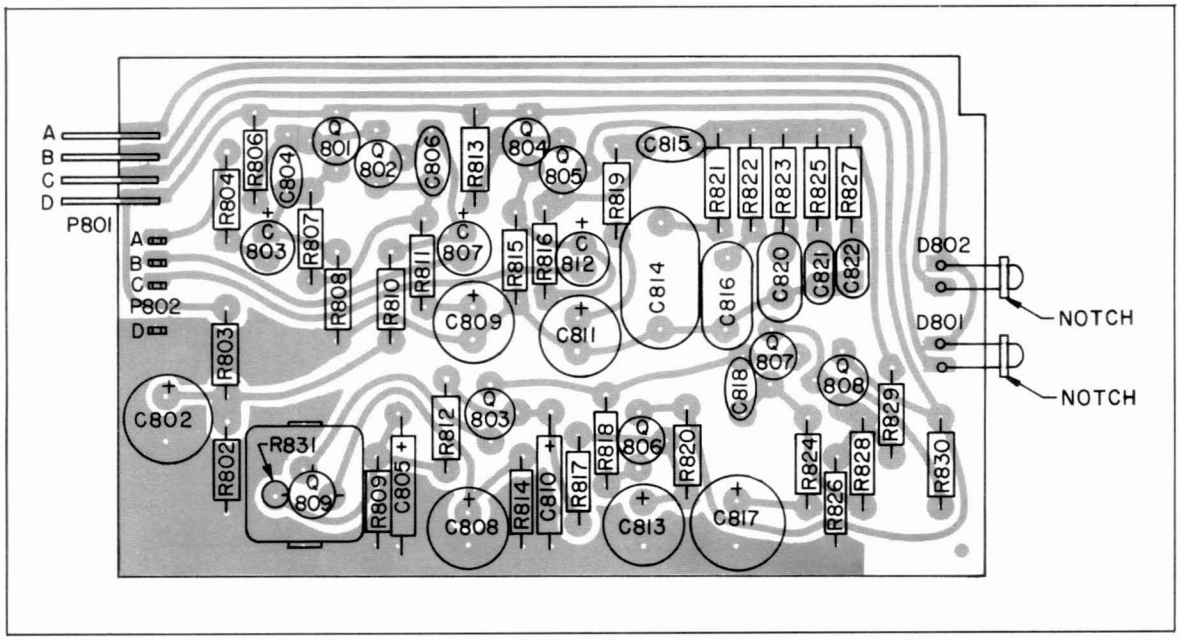
2435-1/2431-2/686-3

PRINTED CIRCUIT ASSEMBLY A2



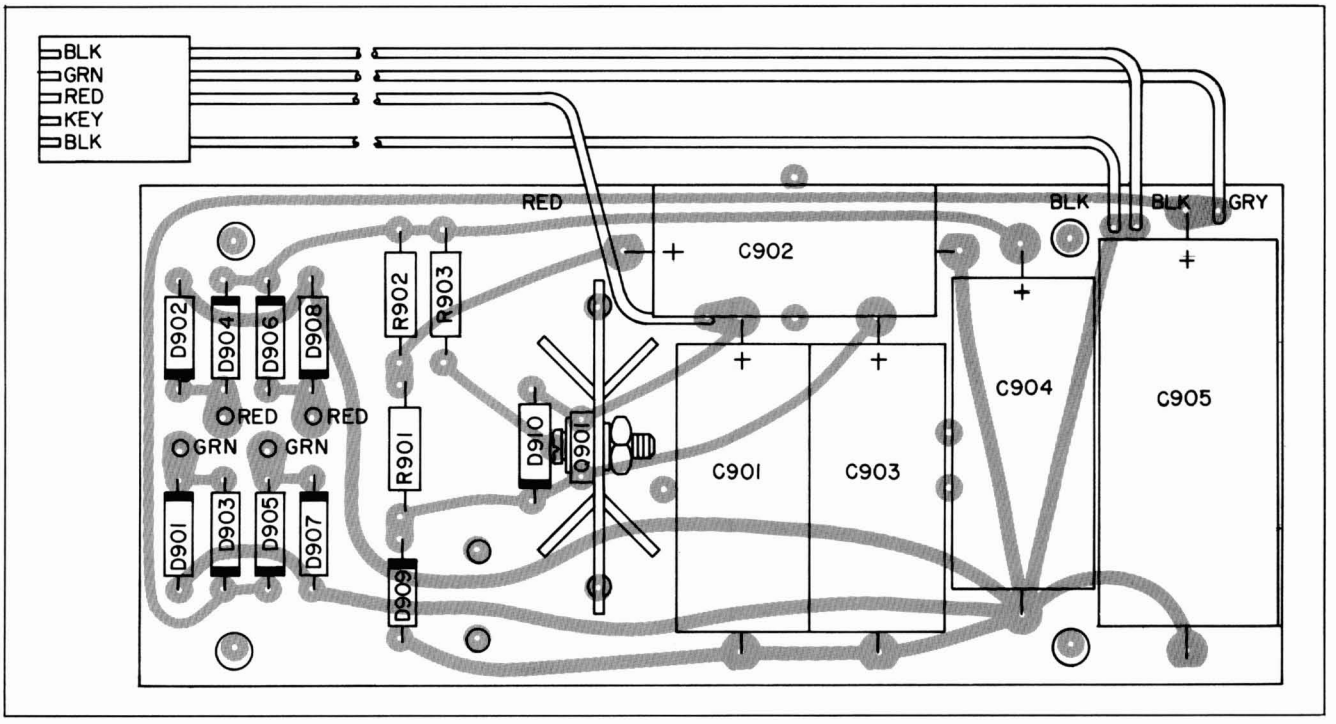
2432-1/631-2

PRINTED CIRCUIT ASSEMBLIES A3-A7



2667-4/812-2

PRINTED CIRCUIT ASSEMBLY A8



2598-3/689-1

PRINTED CIRCUIT ASSEMBLY A9

FURNISHED ACCESSORIES

Tilt Bracket 47A100
Carrying Case 65A1130B
Test/Interconnecting Cable 95A844

REPLACEMENT PARTS

M615 parts readily available through local electronics parts distributors are not shown on the accompanying parts list. Values are shown on the circuit diagram. Commercial parts not readily available and unique parts are shown on the parts list and may be ordered directly from the factory. The commercial alternates shown on the parts list are not necessarily equivalent, but may be used in the event that direct factory replacements are not immediately available. To maintain the highest possible performance and reliability, Shure factory replacement parts should be used.

In addition to the parts list and circuit diagram, a parts placement diagram and printed wiring assembly layouts are provided to assist in parts location and identification.

GUARANTEE

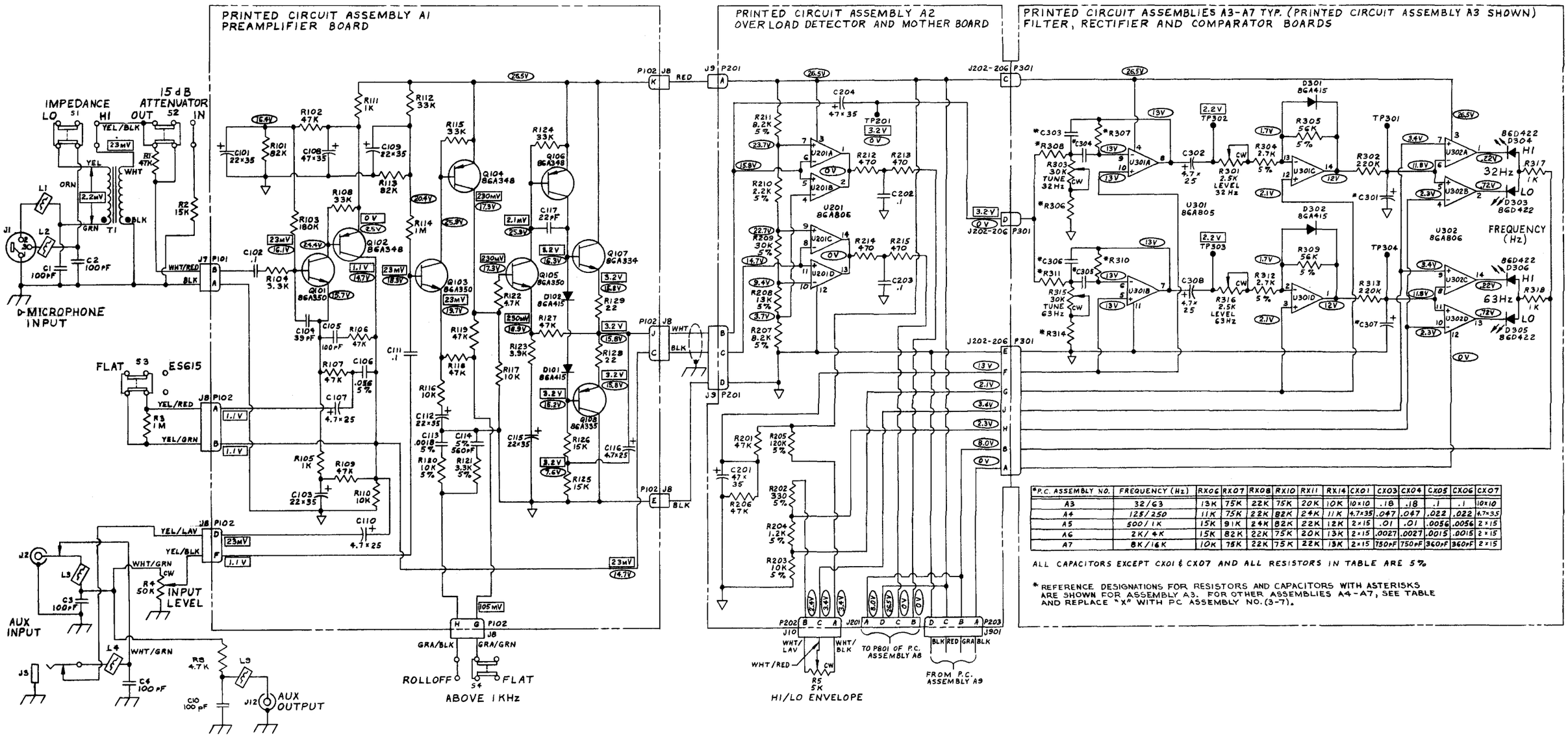
This Shure product is guaranteed in normal use to be free from electrical and mechanical defects for a period of one year from date of purchase. Please retain proof of purchase date. This guarantee includes all parts and labor. This guarantee is in lieu of any and all other guarantees or warranties, express or implied, and there shall be no recovery for any consequential or incidental damages.

SHIPPING INSTRUCTIONS

Carefully repack the unit and return it prepaid to:

Shure Brothers Incorporated
Attention: Service Department
1501 West Shure Drive
Arlington Heights, Illinois 60004

If outside the United States, return the unit to your dealer or Authorized Shure Service Center for repair. The unit will be returned to you prepaid.



*P.C. ASSEMBLY NO.	FREQUENCY (Hz)	RX06	RX07	RX08	RX10	RX11	RX14	CX01	CX03	CX04	CX05	CX06	CX07
A3	32/63	13K	75K	22K	75K	20K	10K	10×10	.18	.18	.1	.1	10×10
A4	125/250	11K	75K	22K	82K	24K	11K	4.7×35	.047	.047	.022	.022	4.7×35
A5	500/1K	15K	91K	24K	82K	22K	12K	2×15	.01	.01	.0056	.0056	2×15
A6	2K/4K	15K	82K	22K	75K	20K	13K	2×15	.0027	.0027	.0015	.0015	2×15
A7	8K/16K	10K	75K	22K	75K	22K	13K	2×15	750pF	750pF	360pF	360pF	2×15

ALL CAPACITORS EXCEPT CX01 & CX07 AND ALL RESISTORS IN TABLE ARE 5%

* REFERENCE DESIGNATIONS FOR RESISTORS AND CAPACITORS WITH ASTERISKS ARE SHOWN FOR ASSEMBLY A3. FOR OTHER ASSEMBLIES A4-A7, SEE TABLE AND REPLACE "X" WITH PC ASSEMBLY NO. (3-7).

NOTES:

1. ALL CAPACITORS IN µF AND 50V OR MORE UNLESS OTHERWISE SHOWN. ELECTROLYTIC CAPACITORS SHOWN IN µF × VOLTS.
2. ALL RESISTORS 1/4W, 10% UNLESS OTHERWISE SHOWN.
3. THE FOLLOWING SYMBOLS DENOTE:
   CHASSIS GROUND; P.C. BOARD GROUND; DC VOLTAGE; AC VOLTAGE
4. ALL VOLTAGES MEASURED WITH AC LINE = 120 V, 60 Hz. PINK NOISE LEVEL SET FULL CW AND INPUT LEVEL ADJUSTED TO PRODUCE 3.2 VAC AT TP201. INPUT SIGNAL TO LO IMPEDANCE MICROPHONE INPUT FROM PINK NOISE GENERATOR LO IMPEDANCE OUTPUT. 15 DB ATTENUATOR SET TO OUT POSITION, FLAT/ES615 SWITCH TO FLAT POSITION, ABOVE 1KHZ SWITCH SET TO FLAT POSITION, AND HI/LO ENVELOPE CONTROL SET FULL CW.
   AC VOLTAGES MEASURED WITH 10 MEGOHM AVERAGE-RESPONDING AC VTVM.
   DC VOLTAGES MEASURED WITH 10 MEGOHM VTVM. VALUES ARE TYPICAL AND MAY VARY ± 15%.

MODEL M615 CIRCUIT DIAGRAM

PRINTED CIRCUIT ASSEMBLY A8
PINK NOISE GENERATOR BOARD

R820 470K
R817 330K
R812 270K
R809 100K
R818 4.7K
R831 330K
R814 6.8K
R803 270K
R802 390K
R830 33K
R824 1K
R826 10K
R828 100K
R829 100K
R813 33K
R819 1K
R816 100K
R815 10K
R806 33K
R811 1K
R810 1M
R807 100K
R808 10K
R804 1K
R821 75K 5%
R822 22K 5%
R823 7.5K 5%
R825 2.2K 5%
R827 750 5%
C813 47x16
C810 15x15
C805 15x15
C808 47x16
C802 22x35
C817 22x35
C818 39pF
C815 39pF
C814 .33 5%
C816 .1 5%
C820 .033 5%
C821 .01 5%
C822 .0033 5%
C811 47x16
C812 4.7x25
C807 4.7x25
C806 39pF
C804 5pF
C809 47x16
C803 4.7x25
Q806 86A350
Q803 86A350
Q809 86A373
Q808 86A348
Q807 86A350
Q804 86A348
Q805 86A350
Q801 86A348
Q802 86A350
26.5V
15.3V
14.8V
13.0V
8.1V
7.5V
2.0V
4.7V
25.9V
7 mV
10.3V
13.0V
12.6V
10.45V
9.8V
14 mV
7.8V
14 mV
14.6V
14 mV
14.0V
25.9V
1.0V
12.0V
14mV
0V
14mV
0V
0V
26.5V
0V
8V
P802 J11
P801
WHT/BLK
WHT
SHIELD
CW
RC 50K
PINK NOISE LEVEL
TO J201 OF P.C. ASSEMBLY A2
OVERLOAD
D802 86D422 INPUT
D801 86D422 MIC
WHT/LAV
L5
J6
AUX LEVEL
C6 100pF
L6
J5
AUX LEVEL
C7 100pF
1.0V
P802 J11
A
WHT/LAV
R7 47K
R8 2.2K
45mV
MICROPHONE IMPEDANCE
HI
55
LO
ORN
YEL
WHT
3.2mV
ORN
BLK
GRN
T2
L7
L8
J4
MICROPHONE LEVEL
C8 100pF
C9 100pF

PRINTED CIRCUIT ASSEMBLY A9
POWER SUPPLY BOARD

POWER SG
OFF
ON
BRN
120 VAC 50/60 HERTZ 5 WATTS
BLK
GRN
WHT
PL1
BLK
BLK
T3
RED
RED
GRN
GRN
30.5V
7.2V
D902
D904
D908
D906
B6A404 (4)
39.3V
800mV PEAK-TO-PEAK RIPPLE
R903 27 1/2W
R902 560 1/2W
R901 680 1/2W
C904 220x60
C902 220x40
C903 220x40
C901 220x40
Q901 B6A374
D910 B6A404
D909 27V B6A423
38.6V
27.5V
26.5V
RED
26.5V
BLK
GRA
8V
BLK
0V
D901
D903
D907
D905
B6A404 (4)
8V
200mV PEAK-TO-PEAK RIPPLE
C905 1000x25
D
C
B
A
J901
TO P203 OF P.C. ASSEMBLY A2

J13
L
N
BRN
GRN/YEL
BLU
~ AC (MAINS) POWER
OFF
ON
SG
ON POWER
BRN
F1 1/8 A SLO-BLO
BRN
S7
115 VAC
220 VAC
BLU
PL1
BLU
T3
BLK
BLK/RED
BLK/WHT
BLK/GRN
RED
RED
GRN
GRN

M615-2E POWER SUPPLY

A1287-11-7
B1287-11-2

MODEL M615 CIRCUIT DIAGRAM