BBE™
202 SERIES INFORMATION MANUAL

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Thank you for buying the Barcus-Berry Electronics Model 202R Professional Audio Processor. You have selected a component designed with care to solve a set of problems present in all audio systems, large and small. By reading this manual you will be able to gain some understanding into the theory and operation of the Model 202, as well as guidance in maintenance, calibration and troubleshooting.

SPECIAL NOTICE

We suggest that first-time users of the Model 202 read Section II of this manual carefully before using the unit. Experience has shown that reviewing the functions of the various front and rear panel features of the 202 prior to its use can answer most, if not all, of the questions which our Service Department routinely fields. We are most happy to help a user clear up any confusion. For that purpose please call our toll free numbers: 1-800-558-3963 in California and 1-800-233-8346 outside California. Please feel free to contact our Service Department if any questions arise after reviewing this manual.

SECTION I
PRODUCT DESCRIPTION

The BBE Model 202 Audio Processor was designed to help solve a specific set of problems which are present in any sound system. To put the problem in its most simple terms, amplifiers are not completely compatible with dynamic loudspeaker systems. When a constant-voltage output device (the amplifier) drives a transducer (the speaker) which requires a constant-current signal in order to accurately reproduce the audio signal, then phase and amplitude shifts occur which cause the reproduced sound to become 'muddied' and less clear than the original. Additionally, physical limitations in most speaker systems cause further phase and amplitude changes which must be dealt with if the sound system is to perform at its best in reproducing audio. (These problems will be discussed in more detail in Section III of this manual).

To help counter the effects of the speaker/amplifier interface, the Model 202 'preconditions' the signal going to the amplifier. A predetermined phase shift, which has been found to be beneficial to virtually all sound systems, is applied across the audio frequency spectrum. In addition, a front panel control for each channel allows the user to variably adjust the amount of amplitude compensation desired. An indicator light system, consisting of amber, green and red LEDs for each channel, gives an indication of the relative amount of amplitude compensation being provided.

Additional front panel controls allow the unit's line gain, in the process mode, to be adjusted for a given application. A pair of screwdriver adjustments is also provided for a user-variable low-frequency equalization curve. Switches provide for selecting between "Bypass" and "Process", as well as between "Stereo" and "Mono" (A+B).

The Model 202 is a dual channel, rack mountable device which is designed for use in professional applications. It can be interfaced with equipment which operates at average signal levels from --10 to +4 dBm.

Quarter inch 'phone' jacks are provided for use in unbalanced operation. XLR connectors provide for either balanced or unbalanced conditions. An 'international' style power module allows operation from mains voltages found virtually anywhere in the world.

SECTION II
INSTALLATION AND SETUP

The BBE Model 202 is designed to be installed in a standard 19-inch wide EIA rack space. It requires two vertical standard spaces, or 3.5 inches. Two independent channels of processing are provided within the chassis, sharing a common power supply. This allows maximum flexibility in professional applications where, for example, one channel may be used for a house mix feed while the other is used for stage monitor processing (which may require a different process level). The two channels are completely independent except for the common power supply. The increased imaging perceived by many users is due to the fact that the signal to each speaker is being properly compensated for the effects of the amplifier/speaker interface.

POWER SERVICE

An 'international' power module is used to allow the Model 202 to be used on power mains found anywhere in the world. To change the input voltage setting, first remove the detachable line cord. Then slide the power module's transparent window to the left to expose the fuse. Lift the lever marked "FUSE PULL" and remove the fuse. The voltage setting card behind the fuse holder is a fiberglass card which has a hole visible at its edge. It may be removed by inserting a small hooked piece of wire or a similar tool in the hole and easing the card from its connector. The card should be re-oriented so that the desired mains voltage level appears through the power module's output when the card is re-inserted. The card should be re-installed, then the fuse and power cord replaced. The card will automatically program the power transformer for the proper connection at the required supply voltage.

CONNECTIONS

Audio connections to the unit are made with either 1/4 inch 'Phone' plugs (Tip-Sleeve mono type) or XLR connectors.

Inputs and outputs are buffered and driven with active circuitry. When an unbalanced connection is made, the Model 202 automatically switches its output so that the proper signal level and pin connections are made. The unit is shipped with pin 3 of the XLR connectors 'hot'.

Because the Model 202 uses active circuitry at its outputs, care must be taken to insure that the polarity of any circuitry connected to those outputs is correct. A very common mistake is to connect a device to the Model 202's XLR outputs which is set up to have an unbalanced input with pin 2 'hot'. The Model 202 will sense the unbalanced condition and switch itself over to unbalanced mode. However, since it expects pin 3 to be 'hot', the output at pin 3 will be shorted. The result will be either no output at all or a very low level, highly distorted output. If the offending piece of equipment has a switchable input polarity, it should be set to the 'Pin 3 hot' configuration. If this is not possible, a 'polarity switching' cable may be fabricated by modifying a standard male/ female XLR cable so that pins 2 and 3 are reversed at one end.

REMOTE OPERATION

Some applications of the Model 202R may require 'ganging' of units. For example in a large sound system installtion, multiple amplifier 'stacks' may be used, with each 'stack' including a BBE Model 202R. One unit may be used for master control of the others by connecting the 'remote out' jack of the master unit to the 'remote in' jack(s) of the slave unit(s). The control circuitry of the slave unit(s) will be defeated. The front panel process level control on the master will control all slaves as well as the master unit.

INPUT

The Model 202 is designed so that average input levels from -10 to +4 dBm will give excellent results. 'Clip' LEDs are provided to indicate that input levels are approaching excessive amounts. They come on at approximately +20 dBm, the point at which the Model 202 goes into clipping. They thus provide the user with an indication of impending overload.

A LED indicator system is provided to give some guidance in setting process control levels. The front panel knob should first be adjusted so that average program level flashes the green LED intermittently. This setting will calibrate the 202's circuitry for an 'average' amplitude correction appropriate for the program being sent through the unit.

The process level should always be ultimately set by ear. The LED system is useful primarily as a set-up guide. Adjusting the process control to show constant amber LEDs does not necessarily mean too little processing, only that a minimal amount of processing is taking place. By the same token, red does not mean danger -- only that a good deal of processing is taking place.

LINE GAIN ADJUSTMENT

The "Line Gain" control sets the gain of the unit in "Process" mode. Gain in "Bypass" mode is factory set at unity.

TO ADJUST THE LINE GAIN TO UNITY:

-- Set the 'Process Level' controls fully counter-clockwise.
-- Apply a 400 Hz, 0 dBm signal to the input jack for the channel being set up.
-- Adjust the front panel 'Line Gain' screwdriver adjustment until the output level measures 0 dBm.

If so desired, the line gain may be set to other than unity. For example, an "A-B" comparison between process and bypass at unity gain often results in the listener perceiving that the process position provides a 'louder' output. Lowering the line level by about 3 dB will tend to lessen this impression with most listeners.

LOW FREQUENCY GAIN ADJUSTMENT

The 'Low Freq' Level control sets the gain in 'Process' mode from approximately 10 to 125 HZ. The factory setting is unity gain.

TO ADJUST THE LOW FREQUENCY LEVEL:

-- Set the 'Process Level' controls to fully counterclockwise.
-- Apply a signal at 50 Hz, OdBm level to the input jack.
-- Set the output level as desired. The factory setting is unity. However, up to about 4 dB of boost may be applied as desired.

A front panel switch allows operation in either 'Stereo' or 'Mono' modes. When the 'Mono' mode is selected, the two output sections are summed and the added signal presented at both outputs. If a 0 dB signal is applied to one input only, the output will be split evenly between outputs so that each output will read -6 dB.

The 'Stereo' mode allows each channel to be completely independent.

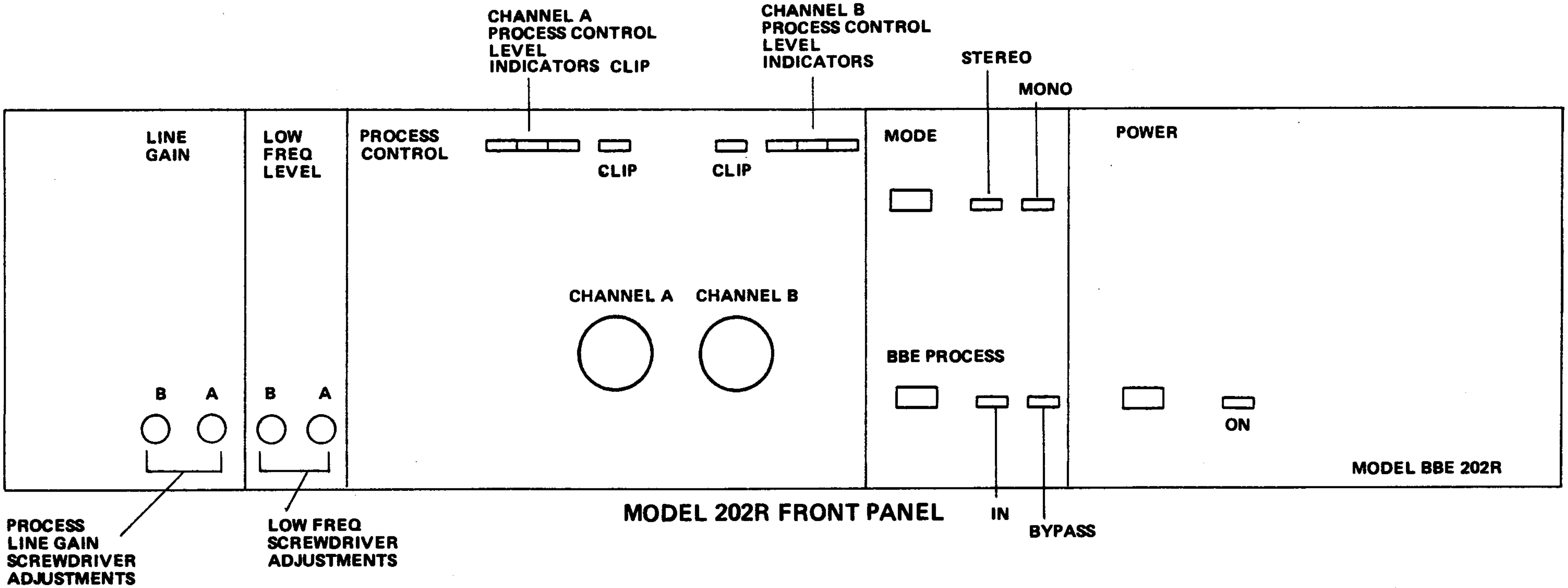
The front panel 'Process/Bypass' switch allows the Model 202 to be selected or bypassed without physically removing it from the circuit. Bypass is an electronically buffered function.

SECTION III
THEORY OF OPERATION

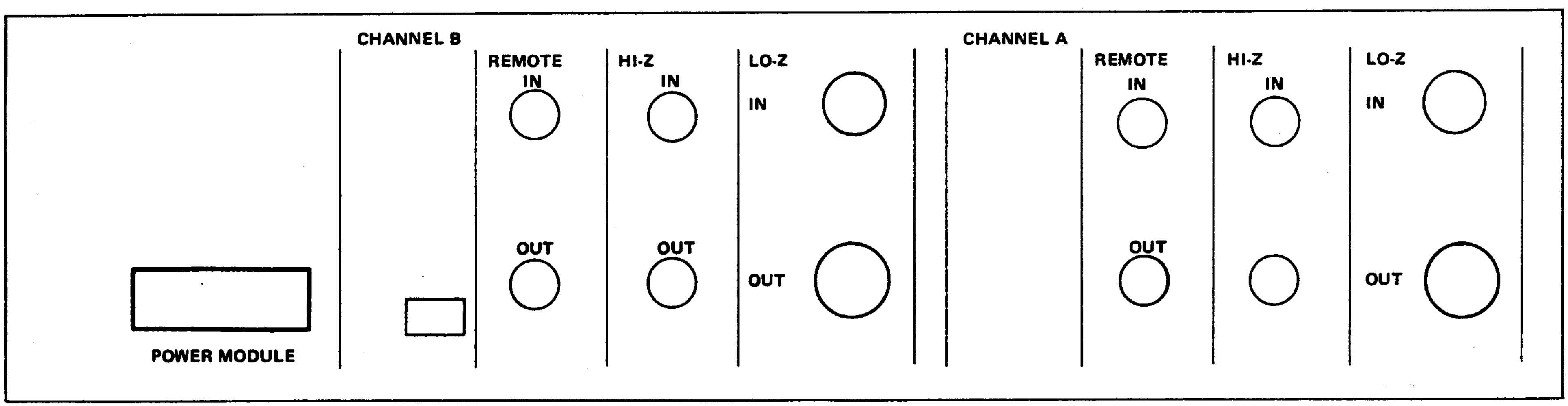
Dynamic loudspeakers, as a family, have difficulty dealing with the electrical signals which the amplifier supplies. These difficulties cause major phase and amplitude non-linearities, which make the sound reproduced by a speaker differ significantly from the sound produced by the original source.

At bass frequencies, major problems in phase-accurate reproduction arise from attempts to drive a physical mass a relatively large distance very quickly, have it stop its motion essentially instantly, and return accurately to its point of origin. The speaker cone's mass causes inertia which resists acceleration. As it is asked to respond rapidly to the attack of a bass note, some time delay to the rise time of that note results. As the applied waveform reaches its maximum amplitude in a positive direction, the speaker cone is still accelerating. As the waveform begins its descent to its maximum negative amplitude, the speaker retains momentum in a positive direction, thus causing an 'overshoot' condition.

Finally, the combined mechanical impedance of the speaker's surround and spider assemblies, and its enclosure, slow the motion of the speaker cone to a halt, somewhere beyond the time when the electrical signal had already reached its maximum. The whole exercise continues, of course, following the negative excursion of the waveform with a similar time delay and overshoot. The net result is a loss of percussive qualities with a general muddying of the sound.



MODEL 202R FRONT PANEL



MODEL 202R REAR PANEL

At the higher frequencies, the effects of trying to drive a finite impedance with a fast-rising waveform result in further distortions in the coherence of the musical signal being reproduced. A typical full-range speaker can exhibit as much as 45 degrees of phase lag at 5 kHz with respect to the sound source; as much as 60 degrees at 20 kHz. Obviously, a speaker which is optimized by the design to reproduce a specific, limited frequency range will exhibit less phase distortion when used in its intended range than a speaker which has been designed to reproduce the entire audio spectrum. Nevertheless, the amount of phase lag in a dedicated tweeter, for example, is still at a significant level.

As with the lower frequency drivers discussed previously, the mass of the high frequency driver must also affect its response. As expected, attempting to drive a finite mass with an extremely fast rise-time signal results in an amplitude attenuation which increases with the frequency of the input signal. As will be shown shortly, this energy inefficiency occurs precisely in the spectral areas where musical 'reality' is most directly affected.

Phase problems have, in the past, often been relegated to a position of secondary importance in audio system design. However, it is becoming increasingly apparent that phase integrity is essential to accurate sound reproduction. Research shows that the information which the listener translates into the recognizable characteristics of a live performance are intimately tied to the complex time and amplitude relationships between fundamental and harmonic components of a given musical note or sound. These relationships define a sound's envelope.

As already stated, the distortions that a speaker system imposes upon a musical program are frequency- and amplitude-related. In plain fact, the speaker has its worst problems precisely in the range we have described as being crucial to accurate program reproduction. With a perfectly reproduced musical note, the harmonics reach the listener's ear in a time relationship directly related to their frequencies--as the frontal 'attack transient' propagates, the higher the frequency, the faster its slew rate, and therefore the earlier it arrives at the listener's ear. When this complex time

relationship among harmonics is modified by a speaker, the harmonics no longer reach the listener's ear in the proper order. Due to speaker nonlinearities, the higher orders are delayed more. Therefore, a lower order harmonic may reach the listener's ear first or perhaps even simultaneously with that of a higher frequency. In some cases, the fundamental may be so time-shifted relative to the harmonic structure that it can reach the listener's ear ahead of some or all harmonics.

If two harmonics arrive at the same time, masking occurs -- essentially, the harmonic with the lower amplitude is not heard at a normal level, or possibly cannot be heard at all. Slight overlaps result in changes in the amplitude of the already time-displaced harmonics. The listener perceives changes in the reproduced sound. Such relative terms as 'muddy' and 'smeared' are often used to describe the consequent loss of musical integrity. With extreme sound coloration it becomes difficult to tell the difference between instruments. For example, an oboe and a clarinet may easily sound alike. Important sound information is lost to the listener.

Barcus-Berry Electronics' Engineering department has conducted extensive studies of many speaker systems during the past ten years. These studies have shown that, while there are differences among various speaker designs in the magnitude of their needs for correction, the overall trend in the type of corrections needed is remarkably consistent. With this knowledge it has been possible to arrive at a 'model speaker'. With the 'model' it has been possible to arrive at an 'idealized' solution to the amplifier/speaker interface problem.

The hardware implementation of this correction has been designated for the professional sound market as the BBE Model 202. In essence, it applies the knowledge gained in our studies to precompensate the audio signal. Using our understanding of the behavior of the interface model, we have designed the electronic 'complement' of the interface error. The BBE™ process imparts fixed phase correction for the full program and dynamic corrections to the high frequencies where most harmonic information exists. This is done by breaking the signal into three bands, with crossovers at 150 Hz and 1200 Hz. The low frequency band has an adjustable level relative to the midband. The midband is then used as a point of reference to make dynamic amplitude corrections in both positive and negative directions to the high frequency band. Detectors monitor the levels of incoming midband and high band information and do an intelligent 'comparing of notes' to determine the harmonic content of the program. This information is used to determine the amount of high frequency harmonic content present at the final output of the Model 202.

SECTION IV
PRODUCT TEST AND EVALUATION

Because the amplitude processing performed by the Model 202 is done on a dynamic basis, it is extremely difficult to use standard tests such as swept measurements to evaluate the performance of the unit. The frequency response, harmonic distortion level, and other characteristics of the Model 202 vary drastically with both varying input and position of the front panel 'process level' control. However, a basic series of tests may be performed to assure a user that a unit is operating and calibrated properly.

SPECIFICATION CHECKOUT FOR MODEL 202

NOTE: All tests are carried out using sine waves at a nominal input level of 0.775 VRMS. (0 dBu)

1. Turn power on. The red Power LED should light. Set the 'Mode' switch to 'Stereo'. Set the 'Process' switch to 'Process'.
2. Set Channel A and Channel B front panel 'Process Control' knobs fully counterclockwise.
3. The 'Stereo' LED should be lit. The 'In' (BBE Process) LED should be lit.
4. Apply a 500 Hz signal to the input. Output level should be 0 dB. See Section II of this manual to adjust.
   If test is successful, set front panel control so that the green 'process' LED just lights. Go on to Step 5.

5. Apply a 50 Hz signal to the input. Output level should be 0 dB. See Section II of this manual to adjust.
6. Do not readjust front panel knob from the setting made in Step 4. Apply a 5kHz signal to the input. Output level should be -3 dB ±½ dB. This value is set by internal adjustment. See Section V of this manual if calibration is necessary.
7. With a 500 Hz signal applied to the input, vary the position of the front panel knob. As the knob is rotated clockwise, the 'process indicator' tricolor LED array should move progressively from amber to green to red. As the knob is rotated counterclockwise the lights should move back from red to green to amber.
8. Apply a signal at 500 Hz, at a level of +20 dBu (7.7VRMS). The red Clip Indicator LED should be lit.

This completes the basic functional checkout.

SECTION V
MAINTENANCE AND CALIBRATION

Maintenance of the Model 202 is limited to cleaning of the outer surfaces of the unit. Any mild cleanser such as Formula 409 may be used. The chassis and cover are anodized aluminum, while the front panel is aluminum covered with a polycarbonate overlay. A simple periodic cleaning of dust and dirt should be sufficient.

Calibration should be performed if parts are replaced or if the performance checkout described in Section IV indicates a problem with calibration. Long-term use has shown that over the life of this unit there is little or no drift of components which would cause a change in calibration; a very conservative design philosophy has resulted in a piece of equipment which runs very cool and should give years of trouble-free service.

CALIBRATION PROCEDURE FOR THE BBE MODEL 202

Equipment Required: Audio Signal Generator
AC Voltmeter

This procedure details calibration of Channel A. Comments (in brackets) pertain to Channel B.

All tests are done with a signal level of OdBu (.775 VRMS)

1. Set signal generator to 500 Hz. Apply signal to Channel A Hi-Z input. . Connect voltmeter to Channel A Hi-Z output.
2. Set front panel controls at mid-scale.
3. Connect a clip lead from the center wiper lug of each front panel pot to ground (this disables the detectors).
4. Set trimmers R6 and R9 fully counterclockwise. (R70 and R71 for Channel B)
5. Set 'Mode' switch for Stereo.
6. Set 'Process' switch for Process (green LED on)
7. Adjust the Channel A Line Level Trim (accessible from the front panel) so that the output reads 0 dB.
8. Set the signal generator to 50 Hz.
9. Adjust the Channel A Low Freq Level trimmer (accessible from the front panel) so that the output reads 0 dB.
10. Set the signal generator to 5 Khz.
11. Set PC Board trimmer R9 (R71 for Channel B) so that the output reads 0 dB.
12. Repeat Steps 7 thru 11 as necessary until readings are correct at all three frequencies. The settings interact to some degree.
13. Set the signal generator to 500 Hz. Remove the clip lead from the center wiper of the front panel pot.
14. Turn the front panel pot fully counterclockwise. Measure the DC voltage at the left side of the pot. Note this value (it should be approximately +0.50 Volt DC).

15. Set the signal generator to 5KHz. Turn the front panel pot fully clockwise. Adjust R6 (R70 for Channel B) so that the DC voltage measured at the right side of the front panel pot is the same as the reading taken in Step 14 $\pm$ 0.03 volt except negative. (approximately -0.50V)

This completes the calibration.

SECTION VI
SERVICE AND TROUBLESHOOTING

SERVICE

We recommend that if at all possible a Model 202 which requires repair be sent to our facility. We can normally turn a repair job around in a short time and get it back into the customer's hands far faster than would be the case should someone attempt a repair who has had no experience with the unit. We also appreciate being able to add reliability data to our files so that future revisions may be undertaken if necessary to improve any evolutionary reliability problems.

PROBLEM TROUBLESHOOTING

This section is provided to help the user work his way through routine problems and to help us perform a preliminary diagnosis should a defect in the Model 202 be discovered.

1. No sound whatsoever:
   A. Power LED is not lit.
      – Check that the detachable power cord is plugged in fully.
      – Check that the fuse is intact. Unplug the power cord from the unit, then slide the power module's clear window to the side to gain access to the fuse.

- Check that the voltage selector card is set for the correct voltage. If the unit is set up for 220 Volts and operated at 120 Volts, for example, the relays will not pull in. If a 110 Volt unit is plugged into 220 Volts, the fuse will blow.

B. Power LED is lit.
  - Check to see that Phone Jack input and output plugs are inserted into the 'Hi-Z' jacks, not the 'Remote' jacks.

2. No sound in 'Process'; unit works in 'Bypass'.
   A problem exists with the BBE hybrid. Replace and recalibrate.

3. Badly distorted and/or low level output.
   See the Installation and Setup Section. Polarity of the XLR connectors is probably reversed.

If service is needed and it is determined that the problem is on the PC board, the board may be removed from the unit and sent for repair to save on shipping costs. To remove the board, pull free the five wire harness board connectors and the six locknuts, then lift the PC board free of the unit.

For those who choose to attempt repair themselves, a schematic follows. It will be noted that the BBE process is contained within a "black box" on the schematic, which is our proprietary thick film hybrid. All other parts used in the Model 202 are standard parts and should be readily available.