cetec broadcast group

Models TEP3S and TEP3M
Turntable Preamplifiers

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098-2260

TEP 3S, TEP 3M PHONO EQUALIZED PREAMPLIFIERS

SPECIFICATIONS

FREQ. RESPONSE: RIAA (NAB) within typical ± 0.5 db (± 1 db max).

OUTPUT LEVEL, PROGRAM: Ø dbm into 600 ohms balanced, adjustable to below -20 dbm.

OUTPUT LEVEL, MAX: +10 dbm (12 to 14 dbm typical)

DISTORTION: Less than 0.1% (0.03% typical) THD.

INPUT IMPEDANCE: 47K ohms. Can be changed.

SENSITIVITY: 5 millivolts for Ø dbm output at 1 KHz.

NOISE: 70 db below Program Level. More than 80 db below max. output.

HUM: Inaudible and virtually un-measureable. (Below noise)

SEPARATION: Stereo: 70 db typical (65 db min.)

SIZE: Width, 4.5". Height 2.6", Depth 6.5"

WEIGHT: 1 lb. 6 oz.

POWER: 110 to 125 VAC, 50-60 Hz., 0.25A

MOUNTING: Rubber feet plus two single-hole "Z" clamps.

INSTALLATION: Please Read Carefully!

As with all electronic instruments, best performance will be assured by following good wiring practices and proper installation procedures.

RCA type phono input connectors are provided plug a ground terminal for the turntable frame lead and tone-arm shell ground, if part of the tone-arm cable. The tone-arm cable length should not exceed 30 inches, to avoid excessive shunt capacitance which could result in losses of the higher audio frequencies.

Output connections are via an Amphenol 91 series connector. When soldering the output cables, be certain not to leave excess solder on the pins which might distort the mating socket, and carefully remove any remaining flux or rosin before engaging the connector. Additional information will be found in the following DESCRIPTION section under "output".

A common cause of RFI in low-level audio equipment occurs when a connecting cable length represents a multiple of an electrical quarter-wave at the frequency of a nearby transmitter, and thereby acts as an antenna. Connecting cable lengths should be chosen slightly longer than required so they can be re-routed or shortened electrically by folding-over and tying the excess length. Always avoid excess cable lengths and never coil audio connecting cables.

In strong RF fields, these same conditions may apply to the AC power-cords in a system; excess or critical lengths should be avoided. In extreme circumstances it may be necessary to experiment by adding or removing various system grounds

INSTALLATION (cont'd)

to find the best combination.

The output circuit of the TEP-3 series is a transformerless para-phase inverter which avoids the problems associated with cascaded output and input transformers. This contributes significantly to the excellent equalization and freedom from extraneous hum pickup of the TEP-3S. Please read the following description thoroughly to obtain the maximum benefit from this feature.

DESCRIPTION:

The SPARTA TEP 3S (Stereo) and TEP 3M (mono) preamplifiers are completely self-contained and equalized for use with any modern variable-reluctance or magnetic cartridge. They offer a combination of capabilities and performance features rarely, if ever, found in other phono-equalized preamplifiers for broadcast use.

Most significant is the use of a dual (stereo) integrated-circuit (IC) in the amplifier proper. The extremely high open-loop gain (typ.20,000) allows both the operating gain and equalization to depend solely on the characteristics of simple passive components, which provides inherent long-term stability and reliability. In addition, the s/n ratio of the IC is equal to or better than can be obtained in discrete designs, which leaves the noise performance primarily dependent upon the resistors used in the external circuitry.

Other preamplifiers are specified at 10 or 12 mv. input for rated output. But most modern, high-performance cartridges provide less than 10 mv. output at normal program level, with some as low as 5 mv. So the SPARTA TEP 3S and TEP 3M preamplifiers were designed with added gain for the newer low-output cartridges without compromising any other performance feature. An interesting side benefit comes about when gain is adjusted lower to accommodate high-output cartridges; The gain reduction also reduces the noise, resulting in further improvement of the already-excellent noise figure.

The input impedance of each channel is set at 47K ohms by an internal

DESCRIPTION: (cont'd)

resistor. This is the proper value for virtually all monaural and stereo cartridges, but can easily be changed, if need be, by referring to the schematic diagram. Care should be taken to use only deposited-film, low-noise resistors.

The self-contained power-supply is extremely well regulated and will maintain proper performance below 110V AC input. This results in an output hum-level that is virtually un-detectable and completely masked by normal "white" noise produced by various circuit resistances.

OPERATION:

Gain Adjustment: During final test at SPARTA, the gain (sensitivity) of the TEP 3S or TEP 3M is set for Ø dbm output with 10 mv. input. If they were set for higher sensitivity, then operation with a high output cartridge would provide more than Ø dbm output and seriously decrease the available headroom for program peaks. If the output level of your cartridge is unknown and you do not have an NAB test record plus the means to accurately measure the preamp output level, it is suggested that the gain controls be left at the factory setting.

With a test record and a suitable meter, the 1 KHz reference tone at 7 cm/sec velocity (lateral) can be played and the gain controls set for Ø dbm output across 600 ohms (774 mv.) or for -6 dbm (387 mv.) from either plus or minus output to ground (shield). This will assure the maximum program output level while maintaining a minimum of 10 db head room. Note that the 7cm/sec. lateral test tone will produce the same level in each channel of a stereo unit as a 5cm/sec left or right channel only tone will.

OPERATION (Cont'd)

Balance. Since a lateral test-tone should produce equal outputs from each half of a stereo cartridge, the method described automatically assures a balanced output from the preamp system, for the gains are being set also to compensate for any cartridge unbalance. Further tests may be made at other frequencies to determine if the system is retaining proper balance throughout the audio range.

Balance may also be set by playing a mono record and noting the console VU meters. Balance should be accomplished by reducing gain of the channel which is too high, which again insures that gains have not been increased to the detriment of the adequate headroom.

Input is made via a standard phone jack plus a separate front-panel ground stud. The stud is provided for the separate tone-arm-shell ground lead which is often provided and is also the proper place to connect the turntable frame ground. Tone-arm to preamp cables should not be much longer than 30 inches since excessive capacitive loading will affect the cartridge high-frequency response.

Output is taken from the six-pin panel socket using the plug-in connector provided. Refer to the schematic diagram for proper connections, noting that pins 1 and 2 are not used on the TEP 3M (monaural) and taking care to note proper output phasing on the TEP 3S (stereo) as indicated by the polarity indications.

It should also be noted that outputs are true differential balanced-to-ground in the standard versions, and care must be taken that neither output is shorted to ground. If single-ended output is needed for testing purposes, it can be taken from either plus or minus output and ground, with the attendant 6db

Output (cont'd)

reduction in overall output level.

Output connections are normally made with standard, twisted-pair shielded audio cable, although separate single shielded cables will work equally well. The source impedance of the TEP 3S/M is quite low, so cables of any reasonable length may be used. In the interest of RFI reduction, however, the cables should be no longer than required and the shields may be left floating at one end only, usually the source end, to prevent magnetic field pickup. The best arrangement can be determined experimentally for the individual installation.

As stated earlier, hum is virtually non-existent in the TEP 3S/M. If hum is experienced in a final installation, it will most likely be due to pickup in the cartridge or tone-arm leads. This can be determined by shorting the preamp inputs with shorting-plugs. If the hum disappears, it was introduced before the preamp. Similarly, disconnecting the preamp output plug will determine if hum is coming through or from the preamp. If the output cable shield was originally connected to the preamp output shield terminal (3), it should be disconnected and the plug then reinserted to eliminate any ground-loops through the shield. Also, it is worthwhile to determine if the load (console) has a grounded center-tap on the primary of the input transformer. If so, this ground should be broken, so the input is isolated from any possible ground-loops.

Rumble filter. Both the TEP 3S and TEP3M preamps incorporate rumble suppression in the form of a controlled low-frequency characteristic as described in the Circuit Theory section. Response is shaped so as to be nearly 2 db down at 30 Hz and 3 db down at 20Hz., approaching a 12db-per-octave slope at the usual rumble frequencies. The suppression thus obtained is more than

OPERATION (Cont'd)

Rumble filter (cont'd)

adequate for essentially rumble-free operation with any reasonable turntable, without restricting low-frequency reproduction of program material.

High frequency filtering. As indicated earlier, the input impedance of the TEP 3S and TEP 3M preamplifiers is 47 K ohms. If a cartridge is terminated in a higher-than-optimum impedance, undesirable high-frequency peaking will result. If a lower value is used, however, the terminating resistor with the cartridge inductance will result in a rolloff of the higher frequencies. Filtering, then, can be obtained simply by providing a lower terminating resistance. The proper value is best determined by trial-and-error until the desired rolloff is obtained. A resistor may then be added directly across the input phone jack(s) without altering components on the circuit board.

MAINTENANCE - Circuit Theory:

Power Supply: The TEP 3S/M power supply is a hard-regulated design capable of supplying 30 to 33 VDC at 40 ma continuous. The output voltage is determined by the values and tolerances of D3, R5 and R6. Since these are 5% tolerance components, it would theoretically be possible for the output voltage to fall between 29.1 and 33.9 volts. In final test, however, one of those components is changed, if required, to hold the voltage within proper limits. The maximum load current is determined primarily by the limits of the power transformer, T1.

Normal operation is as follows: The rectified DC supplied by T1 and diodes D1 and D2 provide a nominal 40 V DC across filter capacitor C2. This voltage will vary between mono and stereo units and also vary with input line voltage. Proper operation can be expected with as low as 34 to 36 volts, however, so long as this voltage is 4 or 5 volts higher than the expected output voltage.

When first turned on, the voltage from C2 causes current-flow through R2, R3 and the emitter-to-base junctions of Q2 and Q1. Q2 is a Darlington driver, or current-multiplier, so Q1 and Q2 may be considered as a single transistor with very high current-gain (h_{fe}).

Q1 will conduct very heavily, delivering current through the load until the output voltage rises to rated level. During this rise, Q3 has not been able to conduct because the emitter has been rising with the output voltage, but the base voltage has been lower than the emitter due to divider R5/R6. With Q3 not conducting, all of the current through R2 and R3 is being used to turn on Q1/Q2.

Power Supply (cont'd)

When the output reaches 22 volts, zener diode D3 begins to conduct and prevents the emitter of Q3 from rising further. But Q3 still cannot conduct until its base voltage has risen 0.6 volts higher than its emitter. This cannot occur, due to divider R5/R6, until the output voltage reaches the proper level.

As the output voltage attempts to rise above normal, Q3 comes into conduction and draws current from R2/R3, which in turn decreases the drive current to Q2. Thus, a state of equilibrium is reached wherein any tendency of the output voltage to change will signal Q2 to cause an increase or decrease in base drive to Q2.

C1 protects diodes D1 and D2 from line transients. C3 prevents dc pulses from the power supply from reaching Q2 and appearing in the output and also causes a slow turn-on characteristic. R1 limits the peak current through the diodes at turn-on and also limits the power dissipation in Q1. C4 filters the zener noise and C5 improves the ac regulation by bypassing the attentuator R5/R6. There is a frequency in the several-hundred KiloHertz region where phase-shift through Q3, Q2 and Q1 would exceed 180 degrees. C6 reduces the loop gain of the regulator circuit to less than unity to prevent oscillation.

Troubleshooting. When servicing solid-state circuits, a knowledge of only a few characteristics of transistors plus the application of a little thought is usually all that is needed. For example (1) a normally-operating silicon transistor will always have a base voltage that is about 0.6 volts different than the emitter, i.e. the emitter-to-base junction must be forward-biased (0.25v for germanium). (2) The collector voltage will always lie between

Troubleshooting (cont'd)

the emitter voltage and the collector supply voltage. (3) If we short the emitter to the base, the transistor should turn off, so the collector will look like an open circuit and the collector voltage will rise towards the supply voltage. Considering these factors, let us now apply them to several possible power supply malfunctions:

1. No output voltage.

a) Voltage across C2 higher than normal would indicate that Q1/Q2 is not conducting. If the voltage at Q2's base indicates that both Q1 and Q2 have normal forward bias, then collectors of Q1 and Q2 must be open. If the bias voltage of Q1 or Q2 is much more than 0.6v each, then either a base or an emitter must be open.

b) Voltage across C2 lower than normal would indicate excessive load current and suggest a shorted C6, in which case Q1 and R1 would be very hot. In this event, either Q1, Q2 or R1 would probably burn open and result in (a) above.

2. Output voltage high.

This would indicate that Q3 is not diverting current from R2/R3, allowing Q2/Q1 to turn on full. Check for normal zener voltage at the emitter of Q3 and then for normal base voltage at Q3. An open zener will raise the Q3 emitter, or an open R5 will lower the Q3 base -- either one will turn off Q3. If the emitter-to-base voltage of Q3 is normal, then Q3 must have an open collector.

3. Output Voltage low.

In all such cases, the first step is to determine the status of Q3 by

3. Output Voltage low; (cont'd)

measuring emitter and base voltages. Next, determine that Q3 is responding to the base voltage by shorting Q3 emitter to base -- the output voltage should rise. If it does rise, it almost certainly indicates a failure in the base divider such as an open R6 or shorted C5. If it does not rise it is very likely that Q3 has an emitter to collector short.

It can be seen by the examples given that the basic approach in transistor servicing is one of determining if the transistor has normal emitter-to-base bias, and then noting if the collector responds normally to a change of this bias, such as complete removal. This explains in part why most companies including SPARTA do not provide transistor sockets -- it is much too easy to determine if a transistor is operable without introducing the liklihood of intermittent socket contacts, quite aside from the added cost factor.

Preamplifier. The TEP 3S and TEP 3M preamplifiers utilize an integrated-circuit operational amplifier; a term which aptly describes its common useage in performing mathematical operations. And the characteristics which make it valuable in computers also make it ideal for use as an equalized preamp.

An "op-amp" is characterized by having differential input terminals; that is, a plus or non-inverting input and a minus or inverting input, and also by having extremely high open-loop gain capability as compared to its normal operating-level gain.

A signal applied to the plus, or non-inverting input, will appear amplified at the output terminal and in-phase with the input signal. The IC op-amp used in the TEP 3 series has a typical open-loop gain of 20,000, so the output will try to be 20,000 times larger than the input signal.

If the output signal is now connected back to the minus, or inverting input, the fed-back signal will act to cancel the input signal. Cancellation will only take place when the two input signals are equal in amplitude and phase (the necessary phase-inversion takes place at the minus, or inverting input), and so, if all the output also appears at the minus input, the output is forced to follow the original signal input and we have a unity-gain, voltage-follower.

Maintenance of the TEP 3 series preamps is made very easy by applying the principle just described to set the DC operating point of the IC amplifier, so that two simple DC voltage measurements are all that is required to assure the IC is operating properly and is capable of responding to the input signal.

Transistors and ICs do, of course, have frequency limitations, but these are included in the original circuit design. And any subsequent failure of a solid-state device will invariably affect both the AC and DC operation of the device. So again, if the IC will respond properly to the DC voltages used to set the operating-point, it will also respond properly to normal signal inputs.

Referring to the schematic diagram, when the circuit is first turned ON, capacitor C2 charges very rapidly to 8 volts or so, or one-half of the voltage at pin 14 of the IC, through divider R3/R2. This voltage also appears through R1 as an input voltage to the IC, so the output at pin 1 swings towards the supply as fast as it can charge C9. At the same time, the output voltage begins to charge C3 through R4, R6 and R7 (We will ignore D1 for the moment).

Because of the high value of R7, C3 will require nearly 40 seconds to charge to 8 volts, but once it does it will cancel the input voltage at pin 5, since the voltage of C3 is also present at the inverting input, pin 6 of the IC. The output voltage will now fall until it is equal to the voltage at pin 5 and a state of equilibrium is reached. Any attempt at deviation appears as an error-voltage at pin 6, and the full open-loop gain of the IC is used to hold the output in agreement with the plus input.

Maintenance (Cont'd)

Since the time-constant of C3/R7 is quite long, the voltage across C3 can only respond to the average, or very low frequencies in the output. At frequencies in the audio range, C3 appears as a near short-circuit so gain is no longer limited to one, or unity. Diode D1 is added so that at turn-on capacitor C3 can charge more rapidly through R4 up to 7.4 volts (the 8 volt reference less the 0.6 volt diode drop). As C3 continues to charge the diode drops out of conduction and plays no further part. This allows the circuit to turn on and stabilize in 10 seconds or less.

To assure that the IC is operating normally, it is only necessary to measure the voltage at pin 5 and then check to see that pin 1 has the same voltage. If the output voltage is high, the next check is to see if this voltage is getting back to pin 6. Incidentally, these measurements must be made with a high-impedance VTVM or FETVM. If the voltage at pin 6 is also higher than pin 5, the IC is defective. Conversely, if the output is low, it can only be due to an external short or defective IC.

In the stereo TEP 3S these measurements must of course be made for both halves of the IC, using the appropriate pin numbers as indicated on the schematic. It should be noted that IC failures are quite rare, and it is worthwhile to be very sure before going to the expense and trouble of replacing one. If it does become necessary it should be removed very carefully to avoid damaging the PC board. Use of a solder-removing tool or wick is strongly recommended.

Audio operation of the IC amplifier is identical to the DC and low-frequency operation described with the exception of the gain changes allowed by the components in the external feedback network. For all frequencies in the audio range, capacitor C3 is essentially a short-circuit so that R4 now becomes part of a voltage-divider in the feedback path.

At the lowest audio frequencies, the gain is the highest, more than 60db, since the capacitors C6 and C7 have very little effect and the output signal must now be quite high in order to produce a cancelling signal through the feed-back network. As the input frequencies increase, however, more feedback occurs through C6 and C7 and the closed-loop gain decreases accordingly.

So it is apparent that the gain and frequency response are determined strictly by the values and tolerances in the feedback network, primarily R6, R7, C6 and C7. If it is suspected that the amplifier is not within the nominal 0.5 db of the RIAA/NAB curve, this should be carefully verified with an audio generator and output meter known to be accurate within 0.1 db over the audio range. It is not sufficient to rely upon a test record and playback cartridge, since even the best of these are subject to variations of plus or minus a db or more.

Rumble filtering is provided by capacitors C9 and C10 plus resistors R9 through R13. These components allow a rolloff of nearly 2 db at 30 Hz and 3 db at 20 Hz, with a curve approaching 12 db/octave below 20 Hz. In addition, C3 becomes ineffective at 12 to 15 Hz, allowing an even more rapid rolloff towards unity gain.

The output amplifier, Q4, is a paraphase inverter which supplies a balanced, differential output to the external 600 ohm load. The emitter signal is a replica of the base signal, but the collector signal is equal in amplitude and out of phase with the emitter. Therefore, the output amplifier provides a transformerless output with 6 db of added gain, without the weight, bulk, hum-pickup or frequency limitations associated with transformers.

Several side-benefits of operational amplifiers are of incidental interest: If the open-loop gain were infinite, rather than just high, the application of negative feedback would reduce distortion to zero because the output would be forced to follow the input exactly. In the TEP 3s, the nominal open-loop gain is 86 db whereas the maximum closed-loop gain is slightly over 60 db. This assures a minimum of more than 20 db of feedback, which accounts for the extremely low distortion, typically 0.03%.

The same negative feedback has the effect of raising the input impedance in direct proportion, so that the actual input impedance of the preamplifier becomes that of the input terminating resistor, R1. This assures perfect termination for the cartridge simply by selecting the correct resistor. Negative feedback also lowers the output impedance which provides a pure voltage drive for the equalizing components in the feedback network. This further assures that performance depends solely on the feedback components.

The end result is a preamplifier which is hum-free, and represents state-of-the-art performance in regards to noise, distortion and faithful reproduction.

TEP-3 OUTPUT CONNECTIONS

BALANCED

Pin 1 Right output (+)

Pin 2 Right output (-)

Pin 3 Common (See Note)

Pin 4 Left output (-)

Pin 5 Left output (+)

Note: In balanced lines the shield is normally left floating at the audio source and is connected to ground at the audio console. But, if RFI is experienced, it may be necessary to ground the shield at the TEP-3 also.

UNBALANCED

Pin 1 (Not used)

Pin 2 Right output

Pin 3 Common Shield

Pin 4 Left Output

Pin 5 (not used)

Note: Pins 1 & 2 not used on TEP-3M

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High voltage transformers, modulation transformers, reactors and filter chokes carry an extended warranty of 50% of the replacement cost being allowed should failure occur during the second year. Century II Tape Cartridge Equipment is warranted for a period of two (2) years.

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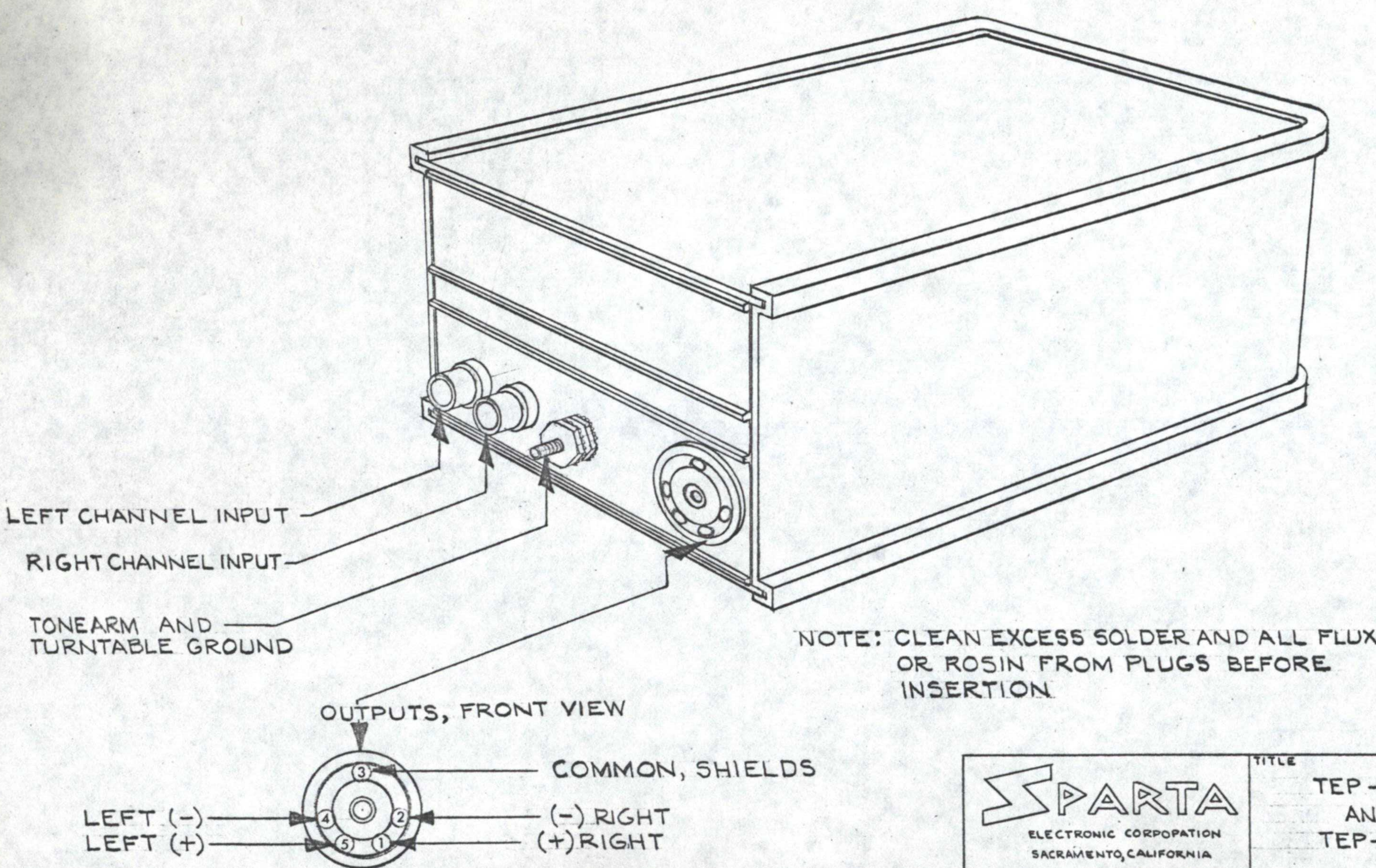
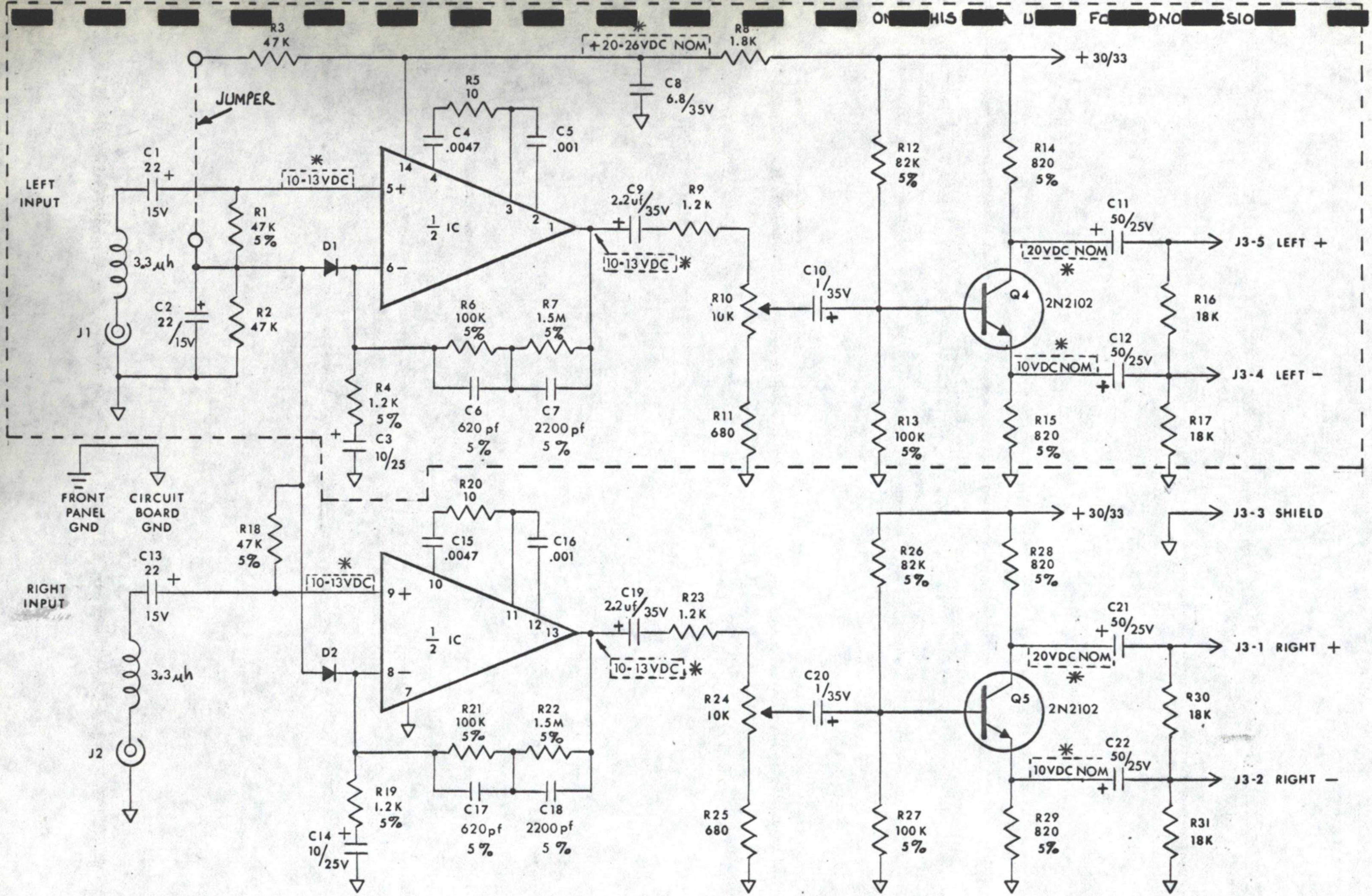
October 1, 1977

IMPORTANT :
SEE INSTRUCTIONS FOR
BALANCED VS. UNBALANCED HOOKUP.



NOTE: CLEAN EXCESS SOLDER AND ALL FLUX OR ROSIN FROM PLUGS BEFORE INSERTION

SPARTA ELECTRONIC CORPORATION SACRAMENTO, CALIFORNIA				TITLE TEP - 3S AND TEP-3M
DWN. B.SCUDDER	DATE 12-8-69	SCALE 1/1	SHT 1 OF 1	DWG.NO. P-7 B
APPD.				



L DCR 6684
K ECR 612
J ECR 585
H ECR 560
G ECR 535
F ECR 471 & 504
E ECR 336
D ECR 307
C ECR 189

D1,2: 1N4005
I.C.: FSC MuA 739
MOT MC 1303 (RAYTHEON 4739)

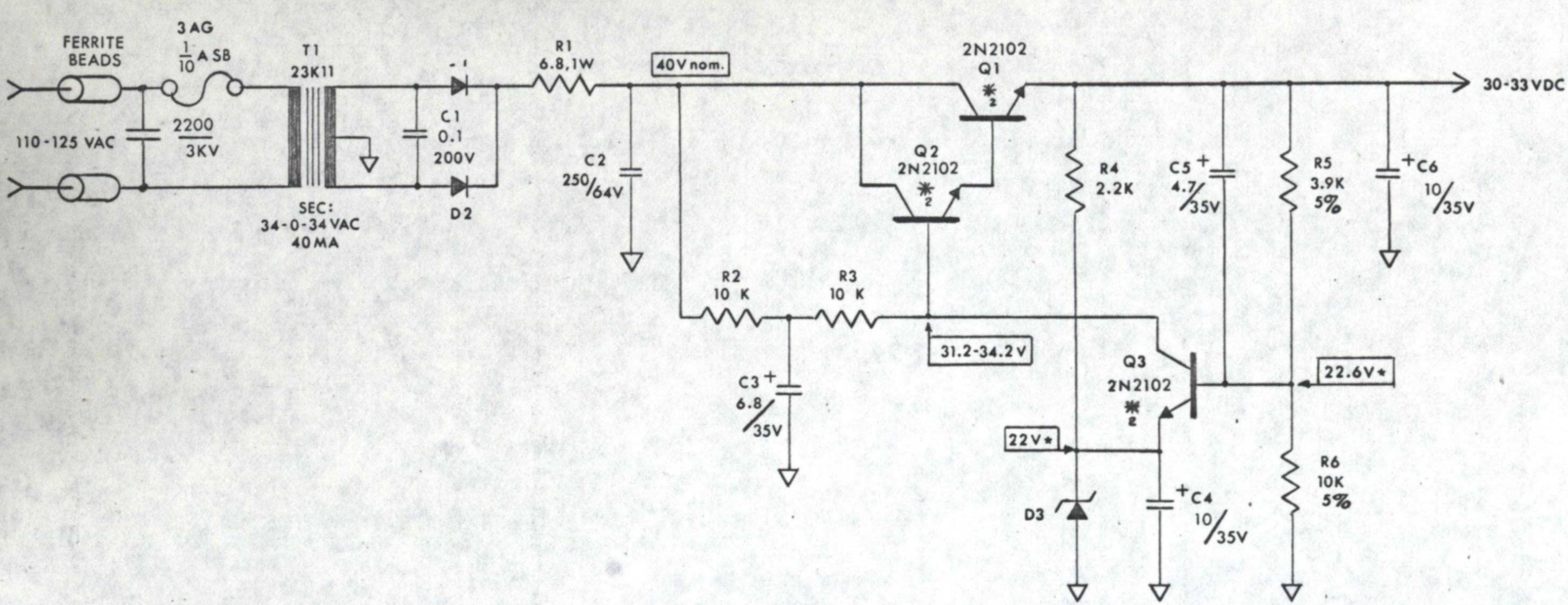
Note: Right channel deleted in mono TEP3M version.
All resistors are $1/2$W 10% unless otherwise noted.

*Refer to circuit description, page 11

SPARTA ELECTRONIC CORP

TEP3S (STEREO)
TEP3M (MONO)
PHONO EQUALIZED PREAMPLIFIER

drawn	checked	date	revised	number
SMU	RKO	3MAR70	20NOV73	S-30L



* Refer to circuit description.

D1, D2: 0.5A, 100PIV; 1N4002 or equiv.

D3: 1N5251B, 22V, 400MW, 5%

*2 Q1, Q2, and Q3 is 2N2102 or 2N3053

K ECR 1025
J ECR 632
H ECR 612
G ECR 585
F ECR 560
E ECR 535
D ECR 469 & 506
C: ECR 336
B: ECR 189

SPARTA ELECTRONIC CORP

TEP3 S/M
POWER SUPPLY
30 VDC, 40 MA

drawn	checked	date	revised	number
SMU	RFO	4MAR70	20NOV73	S-31K