Series 5000 stereo control preamplifier

Part 1.

Designed as the 'perfect partner' to our Series 5000 MOSFET stereo amplifier, this preamp offers many unique features.

David Tilbrook

IN DESIGNING the Series 5000 Stereo Control Preamplifier we have had to look closely at the facilities and options available on existing preamplifiers. The concept that evolved was to design a preamplifier with the accent on versatility and control. We judged that most Series 5000 components will be built by those interested in high quality sound, who will therefore spend a considerable time taping, either from source material or dubbing from one deck to another. The preamp should therefore offer good facilities for taping and tape dubbing.

Tape facilities

Two tape inputs have been provided, either of which can be selected as a source input or used through a conventional tape monitor circuit. Dubbing from one deck to another is simply a matter of selecting the playback deck as an input and selecting the record deck with the tape monitor facility. Now if a tape deck were put into record mode and then selected as a source, its output would be connected via the preamplifier back to its own record input. This forms a feedback loop that would lead to oscillation, probably within the audio spectrum and at full power. To prevent this, this preamplifier automatically mutes the record output to any tape deck that is selected as a source input. If any other source is selected the muting is removed. Thus, both decks can be used simultaneously to record source material.

Metering

Another facility that is *essential* for high quality taping is a really good set of level meters. Unfortunately, those supplied on most cassette and reel to reel decks are of the −20 to +3 VU type and as such are poor indicators of the true audio level. To overcome this problem the Series 5000 Preamp has been provided with two wide dynamic range LED level meters, each with 3 dB resolution and covering the range −48 to +9 dB, so a dynamic range of 57 dB can be displayed. The LED level meter displays *both the peak and the average* of the audio signal at any instant, with the peak indicator having a rapid-attack/slow-decay characteristic that ensures any transient can be easily seen on the display. The prototype has been tested with single pulses and even with pulses as short as 50 μs the transient was accurately recorded and easily spotted.

A 400 Hz sinewave oscillator is also provided and is selected by one of the positions of the tape input selector. This enables calibration of 0 dB on the LED level meters to match the 0 dB reading on the tape deck meters.

This LED level meter will also be valuable in many other projects where accurate monitoring of an audio signal is required. For this reason we have given it a separate project number (ETI-458). Full details were given in the June issue, so many constructors may already have built the LED level meter.

The preamplifier is provided with both *master* and *monitor* volume controls. The master control varies the output to the LED level meters and to the line and tape outputs. In this way the record level can be adjusted. The monitor volume control varies the signal level on the monitor output. Normally the power amplifier would be connected to this output so that the volume can be adjusted without affecting the record level. If the monitor level control is turned fully up, however, and the master control used as the main volume control, the LED level meters indicate the output level below 1.2 V, which corresponds to full power from the power amp. So, in this configuration, the LED level meters function as output level indicators, with full power before clipping occurring at 0 dB.

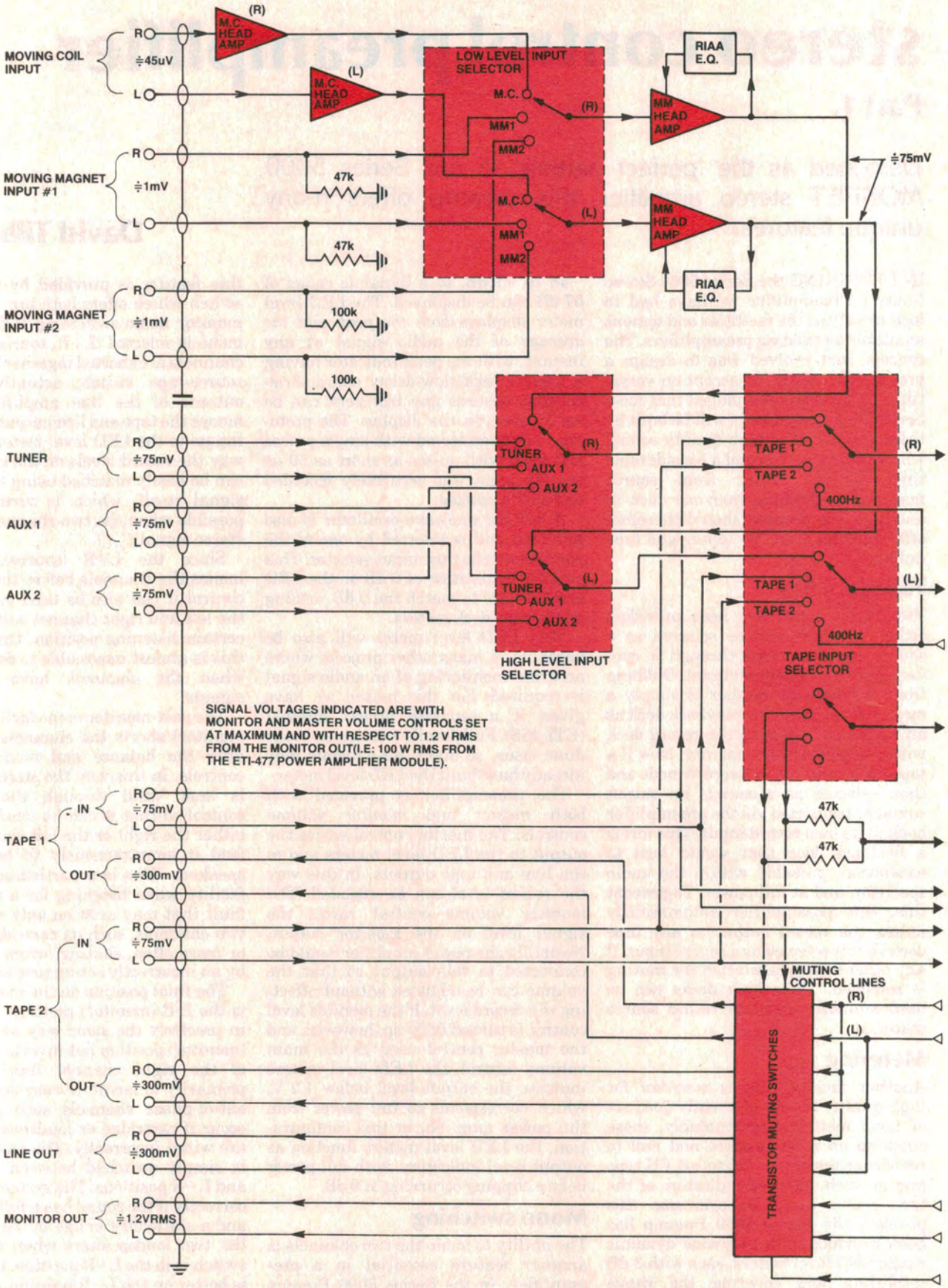
Mono switching

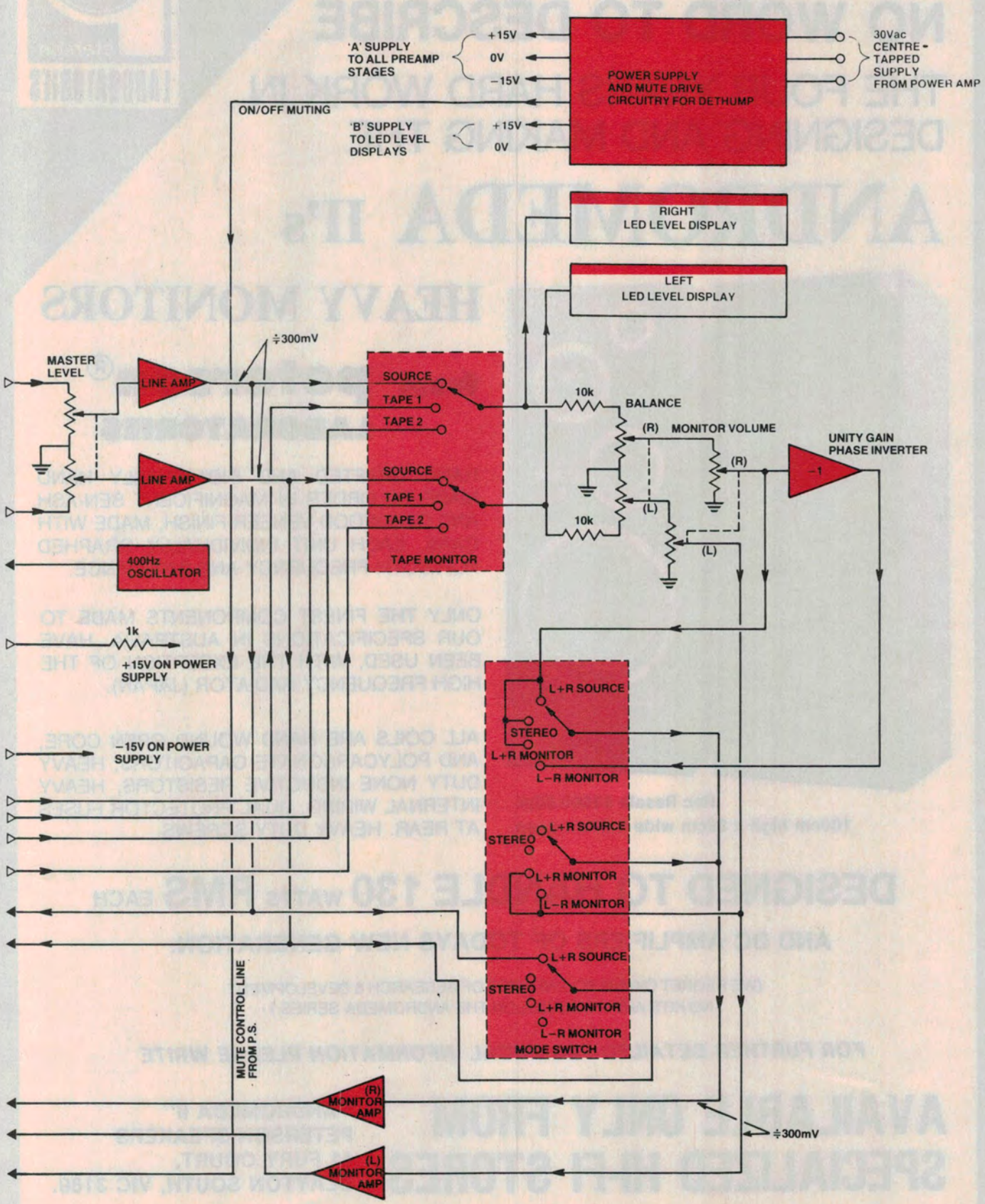
The ability to mono the two channels is another feature essential in a preamplifier. In the Series 5000 Preamp this feature is provided by the *mode* switch which offers both pre- and post-monitor mono switching. If the source mono is selected (L+R, source) the two channels are shorted together before the source-tape switch, actually at the outputs of the line amplifiers. This monos the tape and line outputs, and the inputs to the LED level meters. In this way the record levels on the tape decks can be easily matched using the source signal itself, which is virtually impossible when the two channels have a stereo signal.

Since the L+R (source) position monos the channels before the balance control it can also be used to optimise the left and right channel balance for a certain listening position. Once again, this is almost impossible to do properly when the channels have different signals.

The post-monitor mono facility (L+R, monitor) shorts the channels together *after* the balance and monitor level controls. In this way the stereo content is kept valid through the balance control so that it can be used to select either the right or the left channel and feed it simultaneously to both loudspeakers. This is a particularly useful facility when listening for a suspected fault that may exist on only one of the two channels, such as cartridge faults, or more often, skating errors produced by an incorrectly set-up tone arm.

The final position on the mode switch is the L-R (monitor) position. This acts in precisely the same way as the L+R (monitor) position but inverts the phase of the right channel first. This is primarily to facilitate easy detection of out-of-phase channels such as would occur if cartridge or loudspeaker leads are wired incorrectly. The mode switch is simply switched between the L+R and L−R positions. The system is set up correctly if the sound has a full bass end and a stationary image in the centre of the two loudspeakers when the mode switch is in the L+R position. If the bass is better on the L−R position, however,▶


MOVING COIL INPUT
R
≒45uV
L
M.C. HEAD AMP
(R)
(L)
LOW LEVEL INPUT SELECTOR
M.C.
MM1
MM2
RIAA E.Q.
MM HEAD AMP
≒75mV
MOVING MAGNET INPUT #1
≒1mV
47k
MOVING MAGNET INPUT #2
100k
TUNER
AUX 1
AUX 2
HIGH LEVEL INPUT SELECTOR
TAPE 1
TAPE 2
400Hz
TAPE INPUT SELECTOR
SIGNAL VOLTAGES INDICATED ARE WITH MONITOR AND MASTER VOLUME CONTROLS SET AT MAXIMUM AND WITH RESPECT TO 1.2 V RMS FROM THE MONITOR OUT(I.E: 100 W RMS FROM THE ETI-477 POWER AMPLIFIER MODULE).
IN
OUT
≒300mV
MUTING CONTROL LINES
TRANSISTOR MUTING SWITCHES
LINE OUT
MONITOR OUT
≒1.2VRMS


'A' SUPPLY TO ALL PREAMP STAGES
+15V
0V
−15V
POWER SUPPLY AND MUTE DRIVE CIRCUITRY FOR DETHUMP
30Vac CENTRE-TAPPED SUPPLY FROM POWER AMP
ON/OFF MUTING
'B' SUPPLY TO LED LEVEL DISPLAYS
+15V
0V
RIGHT LED LEVEL DISPLAY
LEFT LED LEVEL DISPLAY
MASTER LEVEL
LINE AMP
LINE AMP
÷300mV
SOURCE
TAPE 1
TAPE 2
SOURCE
TAPE 1
TAPE 2
TAPE MONITOR
10k
BALANCE
(R) MONITOR VOLUME
(L)
10k
(L)
(R)
UNITY GAIN PHASE INVERTER
−1
400Hz OSCILLATOR
1k
+15V ON POWER SUPPLY
−15V ON POWER SUPPLY
L+R SOURCE
STEREO
L+R MONITOR
L−R MONITOR
L+R SOURCE
STEREO
L+R MONITOR
L−R MONITOR
L+R SOURCE
STEREO
L+R MONITOR
L−R MONITOR
MODE SWITCH
MUTE CONTROL LINE FROM P.S.
(R) MONITOR AMP
(L) MONITOR AMP
÷300mV

then the system has an out-of-phase channel. The surest way to perform this test is to position the loudspeakers directly facing one another and approximately 50 mm apart. The bass should drop *dramatically* when the L−R position is selected.

Block diagram

The overall configuration of the Series 5000 Stereo Control Preamp is best seen by looking at the block diagram. The preamp has both moving coil and moving magnet cartridge inputs. The moving coil phono input is fed directly to a moving coil input preamplifier which amplifies the output of the cartridge up to typical moving magnet signal voltages. The *low level input* selector switch determines which of the three cartridge inputs is sent to the RIAA-equalised phono preamp stage. The output of this stage is around 75 mV for a 1 mV input signal to one of the moving magnet inputs. The *high level input* selector switch selects between the output of the phono preamp and one of three other line level inputs (the tape input and two auxiliary inputs).

The output of the high level input selector is fed to the *tape input* selector together with the two tape inputs and the output of the inbuilt 400 Hz oscillator. A third set of contacts on the switch is used to drive the *muting* transistors whenever a tape input is selected as a source.

The output from the tape input selector switch is fed through the master level control and line amplifiers to the tape and line outputs, and to the LED level meters and tape-source switch, through the balance and monitor volume controls and via the monitor amplifiers to the main monitor output.

The signal voltages shown on the circuit are with respect to a 1.2 V signal from the monitor output and with the master and monitor level controls fully up. In this condition the average signal voltages at the input to the LED level meters will be around 300 mV. Since the preamplifier is never run with the level meters off scale it is impossible for the preamplifier to overload any stage after the line amplifiers; this is another distinct advantage offered by the LED level meters. As stated earlier, typical signal voltages at the input to the master level control are around 75 mV for a 1 mV input signal to one of the MM inputs. Most moving magnet cartridges produce maximum output signal voltages of the order of 60 to 80 mV. Some higher output cartridges may produce signals as high as 120 to 140 mV but these are generally the exception. Allowing for a signal input voltage of, say, 140 mV, the output voltages from the main phono amplifier will be approximately 10 V RMS. So this stage must be provided with adequate supply voltage and slew rate capabilities so that overload cannot occur. Fortunately this is not particularly difficult, necessitating a supply voltage of around 15 V and a slew rate of approximately 1 V/μs.

A more detailed discussion of the slew rate requirements of phono stages will be included in part two of this series of articles on the Series 5000 Preamp.

Using op-amps?!

The basis of the Series 5000 Preamplifier is a new audio op-amp by Signetics, the NE5534N and its low noise complement, the NE5534AN. These devices are capable of truly *superb* performance. There is a popular misconception among audiophiles that op-amp stages cannot 'sound' as good as discrete designs. This undoubtedly has come about due to the introduction of some earlier amplifiers that used 741s, or similar devices, which are simply not suitable for audio applications. The noise performance of these earlier op-amps was mediocre and their slew rate figures were typically less than 1 V/μs. If we consider the output stage of a preamplifier, for example, the maximum output signal voltage from the stage is required to be around 1 V and this dictates a slew rate substantially higher than is possible from a 741 op-amp. The result is slew limiting distortion or TIM (transient intermodulation distortion).

The slew rate figures for the 5534, however, are *in excess* of 10 V/μs, giving the device a large-signal bandwidth of around 10 MHz and maintaining the open-loop gain at 10 kHz at greater than 6000. This is important since it ensures that the negative feedback loop of the stage will not be degraded at higher frequencies. The noise performance of the 5534 is equally good, being equal to or better than the best discrete input stages for input impedances above 1000 ohms.

In order to test the 5534, a high quality moving magnet input stage and a line amplifier stage were built with discrete transistors. Actually these stages were originally designed for the Series 5000 Preamplifier before the 5534s were available. These stages were compared with similar stages designed around the 5534s and both objective and subjective testing was carried out. Both the discrete and IC stages gave measured distortion figures less than 0.001% at all operating frequencies up to 20 kHz. The noise figures were similar and none of the stages gave any indication of slew rate limiting. The subjective testing was carried out by comparing the two phono amps and then the two line amps. The input signal was sent via a selector switch to the inputs of the two stages and the levels matched by potentiometers at the outputs. The wipers of the pots were then connected to a second set of contacts on the selector switch. This configuration allows both the input and the output of the unused stage to be disconnected from the circuit so that no possibility of interaction exists.

After many hours of experimenting with this circuit we were *still unable to determine which stage was operating at any one time.* The op-amp circuit, however, contains approximately half the number of components of the discrete design.

A complete data sheet for the NE5534N will be included with part two of this series.

Tone controls?

As stated earlier, the Series 5000 Preamplifier is intended as a high quality linear preamp, and as such, the conventional tone control circuits have been omitted. This is becoming the accepted practice on high quality preamplifers, since the usual tone control facilities are very seldom used in good sound systems. More importantly, their presence can impair the sound quality unless provision is available to completely remove them from the circuit. If control over the frequency response of the system is required it is usually to overcome problems associated with room acoustics, and conventional tone controls are practically useless. A 1/3-octave graphic equaliser is much more effective and can be incorporated into the system easily. The equaliser is placed in the monitor output circuit, between the output and the power amplifier input, leaving the line output of the preamp free as a general purpose non-equalised output.

In following articles we will describe the specifications and construction of the Series 5000 Preamp as well as the problems that must be overcome to ensure the best possible performance.●