SOUND IN SYNCS AUDIO LIMITER AM6/9

Introduction

The AM6/9 Audio Limiter accepts audio and pilot-tone input signals and provides an audio-plus-pilot-tone output which is held at a constant amplitude over the working range (18 dB) of the limiter.

The limiter contains two signal chains, a main chain and a side chain. The main chain includes a variable-gain element and a delay network; the side chain includes a further variable-gain element, together with circuits in which the input signals are measured and a control voltage for the variable-gain elements derived. Variable-gain is achieved by using field-effect transistors which exhibit a change in drain-to-source resistance when the gate-to-source voltage is varied.

The unit is constructed on a CH1/26B chassis with index-pin positions 30 and 40. Power supplies at +24V are required.

General Specification

Inputs	
Audio	0 dB maximum w.r.t. 1 mW.
Pilot Tone	15·625 kHz at a nominal level of −25 dB w.r.t. 1mW.
Output	0 dB maximum w.r.t. 1mW when feeding a 600Ω load.
Input and Output Impedances	600Ω
Limiting Characteristics	w.r.t. 1mW the threshold is preset to correspond to an input of −18 dB giving an operating range of 18 dB. Over the operating range the output is nominally 0 dB, any variations are less than ±0·5 dB.
Recovery Time	approximately 7 seconds
Main-chain Frequency Response	±0·15 db between 30 Hz and 14 kHz
Harmonic Distortion	predominantly second: less than 0·1% at 1 kHz over the entire operating range.
Signal-to-noise Ratio	70 dB weighted.

General Description

A simplified block diagram of the AM6/9 is given in Fig. 1. To prevent excessive overshoot when handling transient signals, the limiter gain must be reduced immediately before the arrival of a transient peak. This is done by using two signal chains, a delayed main chain and an undelayed side chain, which contain matched variable-gain stages. Both variable-gain stages are fed with the same control potential and this is produced as described below.

The signal presented to the side chain is passed via the gain-control stage TR10 to integrated circuit IC1 where it is amplified by 50 dB. The amplified signal is then rectified to produce a d.c. control potential; this is compared with a reference voltage and the resulting potential is used to control the variable-gain stages TR10 and TR2.

The delay network in the main signal chain provides sufficient delay to allow the side chain to react to transients before they reach the main chain variable-gain stage (TR2). The remainder of the main chain consists of two cascaded feedback amplifiers which provide an unbalanced output of 0 dB into a 600-ohm load.

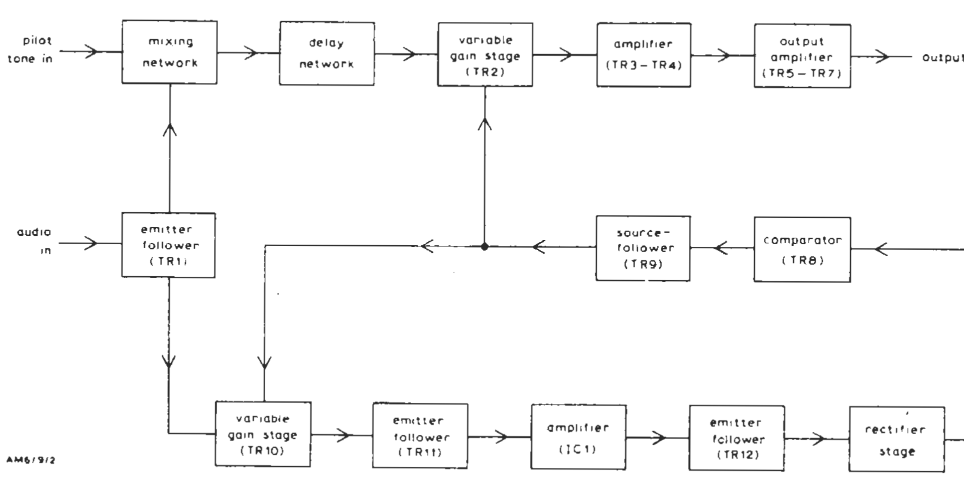

Fig. 1 Block Diagram of the AM6/9

Circuit Description

A circuit diagram of the AM6/9 is given in Fig.2.

Main Chain

The audio input signal to the unit is fed to emitter-follower TR1 where a tapped load provides an attenuated feed to the side chain; the main feed is applied, via a resistor network in which it is mixed with the pilot-tone signal, to the delay network. The delay network has an impedance of 600 ohms and provides a total delay of approximately 320 μs.

The amplitude of the delayed signal is varied by changes in the drain-to-source resistance of TR2 with respect to the fixed resistance of R13; resistors R15 and R63 compensate for any slight mis-match between variable-gain stages TR2 and TR10. The control voltage for TR2 passes through the secondary winding of transformer T1 at which point a fraction of the audio signal present across the transistor is superimposed on the d.c. potential applied to the gate electrode. The addition of an audio signal to the control voltage in this way results in a considerable reduction in second-harmonic distortion.

Transistors TR3 and TR4 form a two-stage amplifier which has both a.c. and d.c. feedback. The amplifier gain when resistor R19 is 9·1 kilohms is 29 dB and is determined by the ratio of R19 and R18. The d.c. operating point is stabilised by feedback obtained from the junction of R23 and R24. Capacitor C40 gives a slight increase in gain at frequencies above 12 kHz to compensate for h.f. losses in the delay network.

The output amplifier has a conventional configuration and comprises transistors TR5, TR6 and TR7. Negative feedback (a.c. and d.c.) is applied to the emitter of TR5 from the junction of R31 and R32. Variable resistor R33 functions as an output level control and is adjusted to give an input-to-output gain of 0 dB when the unit is connected to a 600-ohm load.

Side Chain

The attenuated audio signal derived from TR1 is applied to variable-gain stage TR10. This stage functions in the same manner as TR2 but, because harmonic distortion is not important in the side chain, the refinement provided for the main chain by transformer T1 is omitted.

The signal developed across TR10 is fed via emitter-follower TR11 to integrated circuit IC1 which functions as a non-inverting operational amplifier, the stage gain being determined by the ratio of R54 to R55 and R56. The output of IC1 is fed via emitter-follower TR12 to the primary winding of transformer T2. Capacitor C39 charges to the d.c. potential of the output of IC1 and this potential is fed back to the inverting input (pin 2) of IC1. Because pin 3 of IC1 is maintained at +11·5V, d.c. equilibrium is established when pin 2 (and hence the output) is at 11·5V also; when this condition is established, d.c. ceases to flow in the primary winding of T2.

The function of diode D6 is to ensure that both inputs of IC1 are maintained at similar potentials when the unit is first powered. This precaution is necessary because of the finite time taken by C39 to charge to its operating potential.

Derivation of Control Voltage

The output of transformer T2 is rectified by a full-wave bridge circuit and is then fed to transistor TR8 where it is compared with a reference potential derived from D2. When the rectified voltage present at the base of TR8 exceeds the reference potential applied to the emitter, the transistor conducts and C33 is discharged via D3 and R40. The control voltage applied via TR9 to the variable-gain stages is modified in accordance with the state of C33; the control voltage operating range is set by means of R45.

When limiting occurs in steady-state conditions, for example with a sine-wave input, transistor TR8 conducts on the rectified peaks of the signal and sufficient charge is removed from C33 to compensate for the recharging effect of R41 and R42. The combination of C33, C34 and R42 ensures that, when transient overloads are received, C33 is discharged rapidly; the recovery rate is slower than the discharge rate although partial recovery occurs fairly rapidly because of charge sharing between C33 and C34. The control voltage thus responds rapidly to transients and this ensures fast operation of the side-chain variable-gain stage, TR10.

Fast operation is not required for the main-chain variable-gain stage because the signal is delayed; therefore a filter is incorporated in the control-voltage feed to TR2 to remove fast edges and thus produce a progressive reduction in gain up to the time when a transient signal emerges from the delay line. In the steady limiting state, the filter also reduces the sawtooth component of the control voltage and so minimises the second-harmonic distortion which would otherwise be produced.

Maintenance Adjustments

Standing Bias Control R45

This control should not require adjustment unless D1, D2, D4, D5, TR8, TR9 or any of the associated resistors and capacitors have been replaced. If, however, it is desired to check the setting of the control proceed as follows:

(i) Insert the AM6/9 in a coder and feed the coder audio input with 1-kHz tone at a level of −10 dB.

(ii) Connect a 600-ohm Amplifier-detector to the *Mon Audio to A.D.C.* jack on the FL1/36 unit and remove the UN23/530 unit.

(iii) Turn R45 anti-clockwise until the amplifier-detector displays a constant level.

(iv) Set this level to a convenient reading and turn R45 clockwise until the level falls by 0·5 to 1·0 dB.

(v) Before using the coder check that presets R56 (Limiting Level) and R33 (Output Level) are correctly adjusted as detailed in the Instruction on the parent unit (Sound in Syncs Coder CD2M/505).

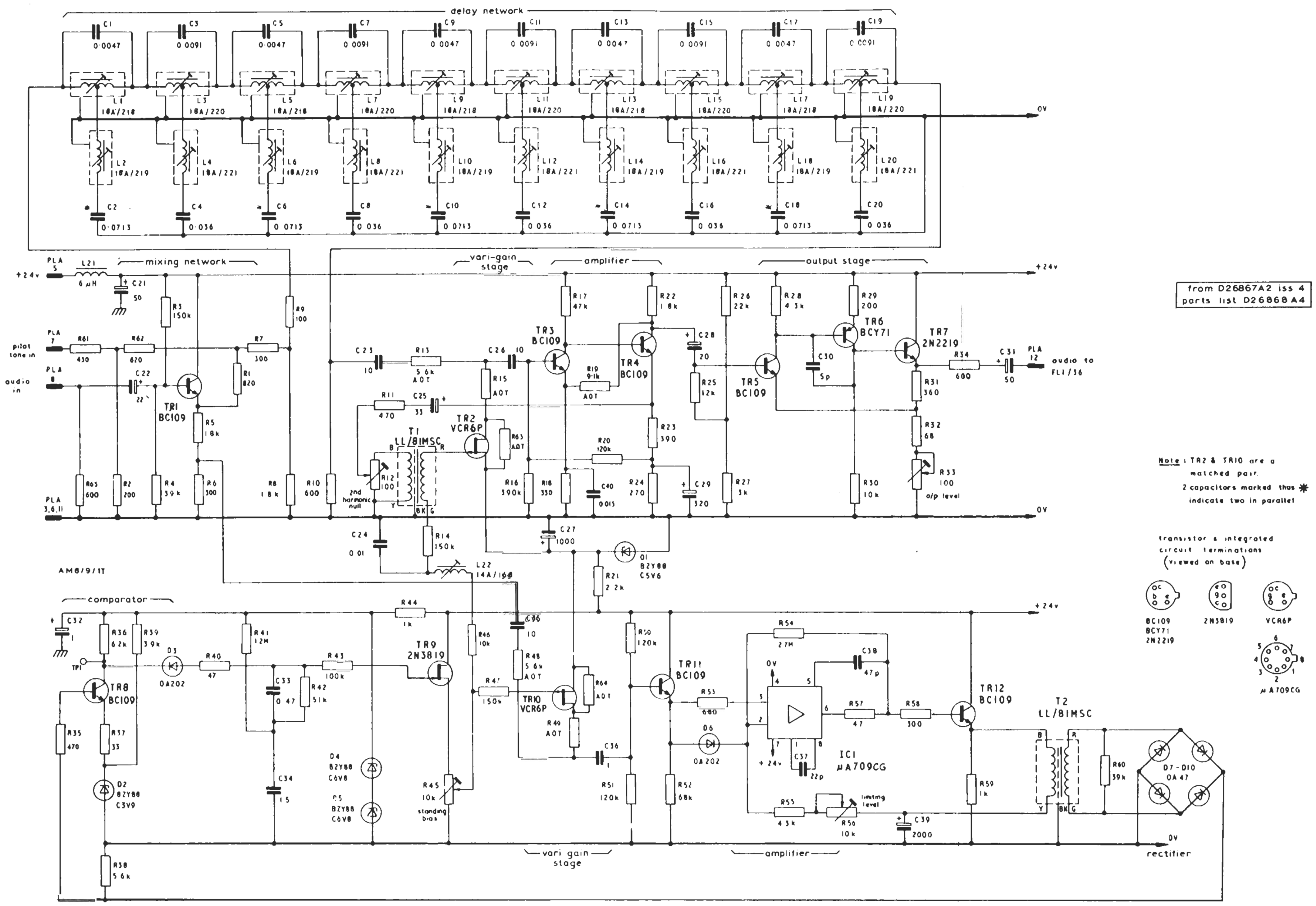

Fig.2 Circuit of the Audio Limiter AM6/9

Fault Finding

Typical d.c. and signal voltage levels for a correctly-aligned AM6/9 limiter are given below.

(a) D.C. Levels

Test Point	*e*	*b*	*c*
TR1	4·3V	–	–
TR3	520mV	–	4·5V
TR4	4V	–	11·2V
TR5	1·1V	–	23·0V
TR6	–	–	4·1 to 7·8V*
TR7	3·4 to 7·1V*		–
C29+	1·6V		
C39+	11·3V		

*Dependant on the setting of R33

(b) Signal Levels (Input of –10 dB at 1 kHz)

TR3 collector	190 mV p-p
TR4 collector	1V p-p
TR5 collector	150 mV p-p
TR6 collector	4·9V p-p
IC1 pin 6	9V p-p

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