2.3 Compressor/Limiter TG12413

2.3.1 Purpose

By means of a switch, this can be used either as a 2:1 compressor or as a limiter with up to 20dB of compression or limiting.
The circuit diagram is shown on Drawing No. TG12413 D101.

2.3.2.1 Circuit Description

The input enters the board at terminal 5 and is attenuated about 10dB by an L pad, R78, R79. The series combination C24, R80 provides a small amount of frequency characteristic correction at the top of the audio band.

The output of the pad is coupled by C1 to the base of VT1, an emitter follower, the emitter of which is connected to the base of VT6. VT5 and VT6 form a long tail pair, the tail being mainly the collector impedance of VT24.

Zener diodes have the property that their impedance is approximately a logarithmic function of the current. Two diodes are provided in each of the collector circuits of VT5 and VT6. The voltage gain of each of these transistors is therefore the ratio of the impedance of the two zener diodes in the collector circuit to the impedance in the emitter circuit, R19 or R21. The impedance of these zener diodes is determined by a control current supplied by VT24.

The total signal at the collectors of VT5 and VT6 therefore contains the desired signal in push-pull, together with an undesired control signal in push-push. It is most important that no appreciable amount of control signal shall appear in push-pull. To achieve this, the diodes are selected as matched pairs before being fitted. D1 and D3 is one matched pair, and D2 and D4 is another matched pair and these components must only be replaced as matched pairs.

Although only VT6 is directly fed with signal, in order to maintain the balance of VT5 and VT6 with changes of temperature it is necessary to provide these two transistors with similar bias supplies. The base of VT5 is therefore fed from an emitter follower, having base and emitter resistances equal to those of VT1. The bias chain is common to the two transistors as far as possible, R7 and R15 being common. For initial balancing AOT7 and AOT9 are provided. In order to avoid the need for high values of the AOT transistors, R8 and R9 are made much less than R4 and R5. In order to equalise the resistances seen by the bases of VT1 and VT4, R12 is added.

The transmission of signal to the base of VT4 is prevented by C5. In order to further improve the matching of the pairs of zener diodes, at the low impedance (high control current) end of their range of operation, R16 and AOT8 and AOT10 are included. If any component which affects the balance of VT5 and VT6 has to be replaced, the setting-up procedure for AOT7, 8, 9 and 10 must be carried out.

The collectors of VT5 and VT6 are connected to the bases of another long tail pair VT10 and VT8, the long tail being the collector impedance of VT9. This stage provides a gain of about 7dB for the push-pull signal and rejects the push-push signal.

A d.c. coupled unity gain pair VT11, VT12 is connected to the collector of VT10. The low impedance output from this pair is coupled through C9 to the Output Control S3. This provides ±10dB of control in 1dB steps. Its total resistance is 32K1 and it forms the whole of the input resistance of a standard virtual earth line amplifier VT25, 26, 28 & 29. With S3 in its central position (0dB) the gain from its input to the output of the line amplifier is 14dB.

The output of the line amplifier is connected to terminals 19 and 23 of S1, the slider of which is connected to output terminals 16, 17. Terminal 21 of this section of S1 is connected to the input terminal 5 so that in this position, the input is routed directly to the output.

For the control chain, another push-pull amplifying stage VT2, VT3 is direct coupled to VT8, VT10 and provides about 9dB of gain. The collectors of this stage are a.c. coupled to the bases of a further push-pull pair VT13, VT14. The earthy ends of the base resistors of VT13 and VT14 are connected to a low impedance point, held at about - 13.3V by an emitter follower VT7, which provides temperature compensation for VT13 and VT14. These two transistors are connected as a long tail push-pull pair, and the output is taken from the collectors through diodes D6 and D7 to the base of an emitter follower VT15. The combination of VT13, VT14, D6, D7, and VT15 provides a back-off system which requires the signal level at the bases of VT13, VT14 and hence the output signal level, to exceed a predetermined value before any signal appears at the emitter of VT15. Less back-off is required for compression than for limiting. To effect this, the Compress-Out-Limit switch short-circuits a part of the tail resistance (R32, AOT5, AOT6) thereby increasing the current in VT13 and VT14 and so reducing the collector potential.

VT16 and VT17 are connected as a d.c. coupled virtual earth amplifier. In the 'compress' condition, the gain is quite low being about 3dB (the ratio of R41 to R38). In the 'limit' condition R39 with D8, D9 and D10 in series are shunted across R38, thereby increasing the gain to about 20dB. The purpose of the diodes is to round off the sharp knee, which would otherwise be present in the transfer characteristic.

The emitter of VT17 is connected through D11 and R47 to C18 so that, when the emitter swings positively, C18 charges. When operating as a limiter the charging time constant is about 8ms, this having been found to be the optimum value. When operating as a compressor C10 is connected in shunt with C18 by S1 and the charging time constant is then about 47ms. C18 and C10, when in circuit, discharge through a Recovery control S2, which provides recovery time constants of approximately 0.05, 0.1, 0.25, 0.5, 1 and 2 seconds in the limit condition and 0.25, 0.5, 1.2, 2.5, 5 and 10 seconds in the compress condition.

The control voltage across C18 is fed to a d.c. coupled unity gain pair of transistors VT20, VT21. The current in this stage is determined by VT23 and is about 1mA. Thus the standing potential of the collector of VT23 is about -14V and its excursions are identical with the control voltage at C18. VT24 converts these voltage excursions into current variations, the effective emitter load being R64 and R68 in parallel. This equals 4K7 and therefore a control current of 0.21mA per control volt is generated. The control current is fed to VT5 and VT6 and hence to the gain controlling zener diodes D1, D2, D3 and D4. It also passes through a

meter, connected to terminals 34 and 35, which is calibrated in decibels of voltage gain.

The meter calibration is -10 to +10, top to bottom, and the scale outside this is coloured red. The red section above -10 covers 3dB of an 8dB overload margin before peak clipping occurs. In the overload margin the total harmonic distortion at a frequency of 1kHz is of the order of 0.5% but is normally less than 0.2% in the normal working range of levels. Left hand and right hand meters are provided for the left and right channels.

For the purpose of temperature compensation, the base of VT23 is held by the emitter of an emitter follower VT22, the base of which is held at about -15.5V by R58 and R59.

VT27 has its base held at -6.7V by R71 and R72, and for normal signal levels is cut off. In the overload region it becomes conducting, thereby connecting R69, in shunt with R64 and R68 as emitter load of VT24. The relation between control current and control voltage thus changes to about 1.2mA per volt. This rapid rise of control current with rise of control voltage minimises distortion in the 8dB overload region. When switched to act as a compressor, the function in the overload region is that of a limiter.

The Hold control RV1 is a 10K linear potentiometer. It is fed through R63 from the point which is decoupled from the +20V supply by R45, C16, and which feeds the collector of VT17 and the emitter of VT21. This results in the upper end of the Hold control being at about +10V. The potential from the slider is connected via D12 to the junction of D11 and R47. Thus the Hold control sets a potential below which the effective control voltage cannot fall. This determines the increase of gain with falling signal level, and hence controls the amount of compression or limiting.

The earthy lead from the Recovery switch is taken to the slider of the Hold control so that the discharge of C18 is exponential to the potential on the slider.

Terminal 36 is connected to a ganging switch. When this is switched to the ‘gang’ position this terminal is connected to the corresponding terminal of the limiter in the other channel of the stereo pair. In this condition both units are controlled by whichever control voltage is higher, and the Recovery controls should be set to the same setting.

The Hold control should never be set so as to allow the meter to enter the lower red band or distortion may result.

Drawing No. TG12345 AE378 gives some notes on the use of this limiter.