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A NEW VISION/PULSE DISTRIBUTION AMPLIFIER

INTRODUCTION

Distribution amplifiers fulfil, broadly speaking, three main functions. Firstly, the amplifier can produce a number of isolated outputs from one video signal, each identical with the original. Secondly, the amplifier may be required to have a small amount of gain in order to make up for the loss in coaxial cables and equalizing networks. A third use is for the distribution throughout a studio centre of timing pulses from central synchronizing pulse generators.

For several years these functions have been served by the B4002 series of distribution amplifiers, many thousands of which are in service throughout the world.

With the growth of colour television and the increased complexity of the modern television centre, a distribution amplifier of superior performance has become desirable. Since a television signal may pass through many identical distribution amplifiers on its way from camera to transmitter, it is particularly important that each amplifier introduces the very minimum of distortion and that variations in performance (particularly gain and delay) due, for example to changes in ambient temperature, mains voltage and component aging, are also adequately controlled. It is also desirable that the amplifier should occupy the minimum of rack space consistent with good access and with due regard to the problem of heat dissipation.

The new Distribution Amplifier, type B4004, has been designed to meet these requirements, and to provide the added bonus of a single unit for either video or pulse distribution. Figure 1 shows a general view of the new amplifier module and the housing into which it slides. The module housing is mounted on a 19in × 5¼in rack mounted frame, each amplifier being retained by a captive screw on the front panel. The rear panel of the housing carries the six output and two bridging input BNC sockets, together with the mains input connections. By keeping the size and number of components to a minimum, the width of each amplifier module is only 1·6 inches; 10 modules can thus be accommodated across the rack. Large heat dissipators fitted to the output transistors and generous ventilating holes in the top and bottom of the housing ensure adequate cooling for the unit.

ELECTRICAL DESIGN

The main essential features of a high grade distribution amplifier are:

(a) Flat frequency response over the video band.
(b) Equality of signal level between outputs.
(c) High input impedance.
(d) Accurate output impedance match.

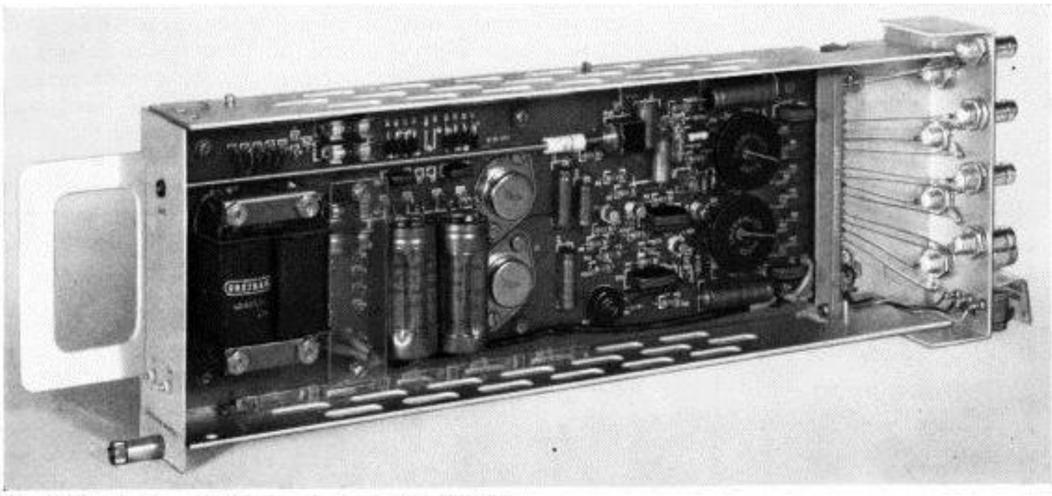

Fig.1 General view, Distribution Amplifier, type B4004.

(e) Good isolation between outputs.
(f) Low crosstalk between amplifiers.
(g) Minimum delay, constant over the video band and consistent at subcarrier frequency.
(h) Good differential phase and gain response.
(j) Lack of low-frequency bounce.

These features have been achieved by careful design of the individual stages of the amplifier and by the use of the maximum amount of overall negative feedback.

Figure 2 is a simplified circuit of the amplifier. The input stage is a differential amplifier, or 'long-tailed pair', consisting of two very high-frequency, high-gain transistors. This balanced arrangement gives high input impedance, good d.c stability, and simplifies the application of the overall negative feedback.

Stray capacitances have been kept to a minimum by careful component layout, resulting in a low value of input return loss without the necessity for 'coiling out' and its consequent unwanted delay, sufficient compensation being produced by the self inductance of the wiring between the input coaxial sockets and the printed wiring edge connector.

The two amplifying stages each have a small amount of local negative feedback produced by their emitter resistors. This helps to define the open-loop gain and, in the case of the input stage, the transistor input impedance characteristic is linearized with a consequent reduction in distortion. The local feedback reduces the mid-band open-loop gain to approximately 32dB, this being adequate for good performance but low enough to permit sufficient margins of stability to be achieved. Shaping networks in each stage control the open loop response to give a phase margin of 50° and a gain margin of 8dB.

The output stage is a complementary emitter follower which gives low output impedance, low phase shift and good linearity. The emitter follower produces a source voltage of substantially zero impedance which is fed to a number of outputs each having a separate source resistance. The application of negative voltage feedback reduces the emitter impedance to the order of a few milli-ohms, thereby achieving two results. First, the impedance of each output source is determined solely by the source resistors, which have been specified to have a close tolerance and low temperature coefficient. Second, the isolation between outputs is very high. (The isolation between any two outputs is equal to the attenuation produced by a T-network, the series arms of which are the source resistors, the shunt arm being the emitter output impedance).

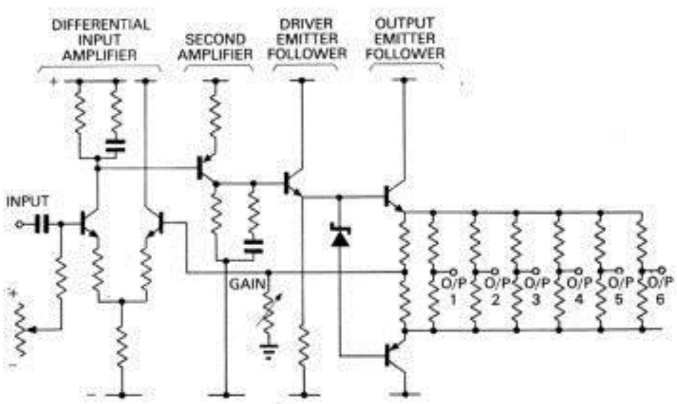

Fig.2 Distribution amplifier, simplified circuit diagram.

Each output is taken from the junction of two 150Ω resistors which appear in parallel to the video signal and in series to the d.c standing current. This arrangement gives both an accurate 75Ω source impedance for each output and stable d.c operating conditions.

Where the amplifier is required to handle 4V negative pulses, the output resistor values are modified to 300Ω and 100Ω to enable the lower transistor to give an increased voltage swing.

In the output stage the negative feedback voltage is derived from a network similar to those of the main outputs. The variable resistor shown in the feedback path consists of a network comprising a preset variable resistor with an extended spindle brought out to the front panel and a number of fixed resistors which may be connected into circuit as required by means of links, thereby changing the range of gain variation produced by the control. The links are normally connected to give an overall voltage gain of 0dB, the control having a range of ±0·25dB, this being sufficient for the intended purpose of adjusting for component tolerances. Alternative link connections enable the gain to be set to 3dB, or to cover a range from −3dB to +6dB.

The integral regulated power supply unit contributes significantly to the high performance of the amplifier. Although a cost saving could have been achieved by the use of a common supply unit for several amplifiers, the problem of maintaining adequate crosstalk protection between amplifiers would far outweigh any advantage.

The mains transformer is of 'C' core construction with a quasi-astatic arrangement of windings, giving reduced stray magnetic field. The primary windings are balanced by virtue of their series/parallel arrangement, i.e 200V-250V/100V-125V, and the secondaries by the equal loads imposed by the positive and negative supplies.

The availability of integrated circuit voltage regulators has enabled the design of the power supply to be reduced to a basic minimum, namely, transformer, rectifier, reservoir capacitor and regulator, with a consequent improvement in reliability. Moreover, the high degree of immunity of the regulator against input variations has obviated the necessity for mains voltage tappings within the broad ranges of the series/parallel arrangement.

A circuit diagram of the dual regulated supply unit is shown in figure 3. The power supply contributes less than 0·5mV peak-to-peak hum and periodic noise measured at the amplifier output. The tolerance on the regulator output voltage is such that no provision is necessary for adjustment. Full protection against accidental overload or

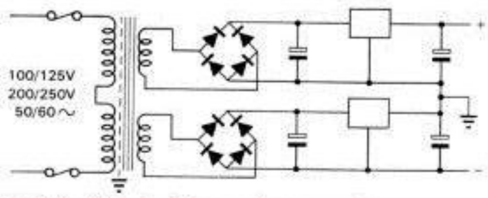

Fig.3 Simplified circuit diagram of power supply.

short circuit is built into the integrated circuit device which is virtually immune from the effects of temperature variation.

The use of precision resistors on the output circuits ensures the equality of output voltage to within ½%, and an impedance match to give a return loss with a 'T' pulse better than 30dB. Stability of gain with temperature change is less than 0·001dB per °C.

The particular choice of output circuit gives low differential gain and phase distortion, these being less than 0·1% and 0·1° respectively, at standard level subcarrier frequency. The low output impedance gives an isolation between outputs, typically better than 70dB and, at subcarrier frequency, better than 45dB.

An input return loss of better than 46dB measured with a 'T' pulse has been achieved without the need for 'coiling out' — which in turn contributes to the reduction of the overall delay to less than 10ns. With the gain adjusted to exactly zero, all amplifiers have the same delay at subcarrier frequency within 0·2ns. This particular characteristic is of great merit when units are interchanged for maintenance purposes, ensuring consistency of sub carrier phase.

The application of an adequate measure of negative feedback provides a frequency response level from very low frequencies up to 5MHz within ±0·02dB, and to 8MHz within 0·2dB, and also ensures good temperature stability of all parameters.

The time constant of the input circuit is such that the tilt on a 50Hz square wave is less than 0·05% per ms (i.e 0·5% total). Moreover, the very low frequency response is such that the overshoot is less than 4%.

CONCLUSION

The Distribution Amplifier, type B4004, is a compact, multi-purpose unit of stable, high performance. Up to sixty outputs are available from 5¼in of rack space for a total power consumption of only 60W.