reception. The FM frequency response was measured from 10 MHz to 3 GHz, where thermal effects are negligible and modulation of the carrier density produces corresponding refractive index fluctuations (Fig. 2). The total bias current was 90 mA peak-to-peak square-wave modulation applied to the back segment. The FM response was constant to within ±0·5 dB to 1·5 GHz with a 3 dB point at 2 GHz.

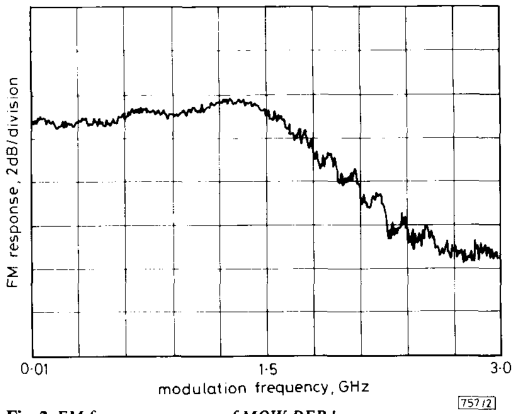

Fig. 2 *FM frequency response of MQW DFB laser*

Discussion: The large thermal tuning ranges reported in this Letter depend on the cavity supporting singlemode, narrow-linewidth emission over a wide range of bias currents. This requires the absence of mode hopping or multimode emission induced by spatial hole burning (SHB). The extent to which DFB lasers show modal instability varies with device and bias current, and between batches. We found that singlemode operation in LPE devices was limited to a maximum tuning current of less than 200 mA. In contrast, MQW lasers with the same geometry and heatsinking exhibit singlemode operation with linewidths less than 30 MHz at tuning currents of 480 mA. We believe this significant improvement in performance is due to reduced SHB and tentatively attribute this to the greater uniformity of the MQW device. The active layer of LPE lasers exhibits thickness fluctuations, which will affect confinement factor, coupling coefficient and hence the axial-gain/carrier-density relationship. This effect is greatly reduced in MOVPE MQW devices. However, improved uniformity and reduced linewidth broadening factor in MQW devices will suppress electronic tuning [7], and therefore tend to offset any potential enhancement by the highly sublinear dependence of gain on carrier density [8]. This conclusion is supported by the electronic tuning ranges measured for MQW devices (Table 1) which showed no improvement over those we previously obtained for LPE devices.

Conclusions: Tuning ranges up to 7·2 nm, with an output-power variation of 2·5 dB over 80% of the range, have been demonstrated with linewidths less than 30 MHz. The tuning rate of the predominantly thermal mechanism allows channel switching in a millisecond time frame, and is suitable for broadband multichannel reception. The FM response of these devices is flat from 10 MHz to 1·5 GHz demonstrating their suitability as tunable sources in FSK systems.

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BRIDGE AMPLIFIER WITH FEEDFORWARD ERROR CORRECTION

D. L. Danyuk and G. V. Pilko

Indexing terms: Circuit theory and design, Bridge amplifiers, Feedforward error correction

The Letter presents a new method for designing and constructing a bridge amplifier using feedforward error correction. Two practical configurations are discussed. Improvements can be achieved in the performance of a conventional bridge amplifier by adding only a few passive components.

Introduction: Bridge amplifiers offer many potential advantages over single push-pull amplifiers: high power, high voltage swing for moderate-voltage components, lower power dissipation per output device and the capability of operating with high-impedance loads [1]. They are almost essential if power supply voltage is limited.

The bridge configuration is also useful in isolating an amplifier output from ground to eliminate ground-related interference and negative influence of noisy ground to the signal [2]. Conventional bridge amplifier topologies are well documented [1].

An effective technique for reducing amplifier distortion has been reported [3, 4]. It uses two separate amplifiers with floating load. One of the amplifiers controls the instantaneous potential of one output terminal with respect to ground. The output voltage of the main amplifier contains a distorted original signal. The auxiliary amplifier controls error in the output signal of the main amplifier and feeds the other output terminal. Because the error correction output voltage is small compared with the output signal, both amplifiers must be capable of bearing a large output current because of their series connection.

It seems convenient to apply this principle to a conventional bridge amplifier system.

Linearisation technique: The basic configuration of the feedforward bridge amplifier is presented in Fig. 1. The feedforward signal is applied to the second half of the amplifier.

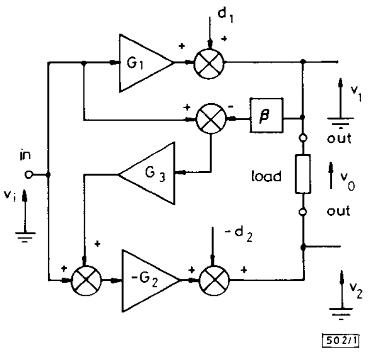

Fig. 1 *Basic configuration of feedforward bridge amplifier*

The gains of the amplifier halves are designated G_1 and G_2, and their distortions d_1 and d_2, respectively. The output signal can be written as

$$v_0 = v_1 - v_2 \tag{1}$$

$$v_1 = v_i G_1 + d_1 \tag{2}$$

$$v_2 = -[v_1 + (v_i - \beta v_i G_1 - \beta d_1)G_3]G_2 - d_2 \tag{3}$$

where v_i is the input voltage, β the subtractor network attenuation function, and G_3 the gain of the correction amplifier. It follows from eqns. 1–3 that

$$v_0 = v_i[G_1 + G_2 + (1 - \beta G_1)G_2 G_3] + (d_1 + d_2 - \beta d_1 G_2 G_3) \tag{4}$$

The first term on the right-hand side of eqn. 4 shows gain and the second term shows distortion. Under assumptions that the amplifier halves are identical ($G_1 = G_2$, $d_1 = d_2$) and that the output voltage is symmetrical with respect to ground ($\beta G_1 = 1$), distortion is minimised when

$$G_3 = (d_1 + d_2)/\beta d_1 G_2 = 2 \tag{5}$$

If eqn. 5 holds, the distortion does not appear at the output and

$$v_0 = v_i(G_1 + G_2) = 2v_i G_1 \tag{6}$$

The proposed technique minimises differential-mode distortion products at the output terminals and does nothing to common-mode interference, such as hum, generated in the power supply.

Two practical configurations are illustrated in Fig. 2. The necessary design constraints are $R_2 = R_1R_3/(2R_3 - R_1)$, $R_4 = R_1R_3/(3R_3 - 3R_1)$, $R_5 = R_3$, $R_6 = R_3/2$ for the circuit shown in Fig. 2*a* and $R_2 = R_1R_3/(3R_1 + 2R_3)$, $R_4 = R_1R_3/(3R_1 + 3R_3)$, $R_5 = R_6 = R_3$, $R_7 = 2R_1R_3/(2R_1 + 3R_3)$ for the circuit shown in Fig. 2*b*. R_2 sets the feedback network attenuation for the upper half to be equal to that of the lower half, thus making them perfectly symmetrical. A highpass filtering circuit might be connected in series with R_6 to maintain a high rejection of hum induced by the common power supply.

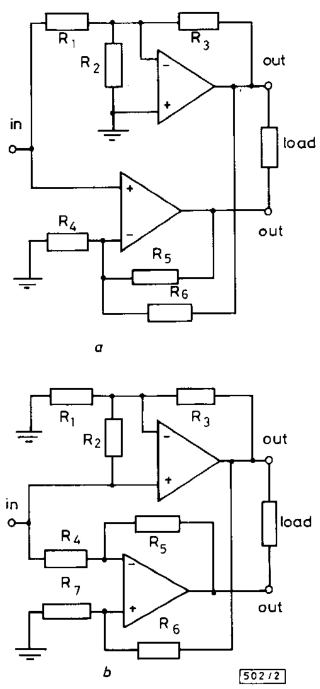

Fig. 2 *Practical circuits of bridge amplifier with feedforward error correction*

Conclusions: A bridge amplifier with feedforward error correction is discussed. Only minor modifications are required for a conventional circuit to be able to use this technique.

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NEW METHOD OF IN-SERVICE FAULT LOCALISATION IN PASSIVE OPTICAL SUBSCRIBER LOOPS

J. W. Verhoof

Indexing terms: Optical communications, Time-domain reflectometry

A new method of detecting fibre breaks in a passive optical subscriber network without interruption to nonaffected customers is demonstrated. For these live measurements, an optical frequency domain reflectometry technique (OFDR) is used. No separate wavelength or additional components in the network are required. An integration facility on the AM/VSB TV-transmission system, without affecting TV-picture quality, is realised.

Introduction: It is accepted worldwide that the future technology required to fulfil user demands on narrowband and broadband services will be the fibre to the home (FTTH) technology. The most future-proof and economic way to realise this is to use a passive optical network (PON). In the PON a number of customers share one fibre from the exchange termination (ET) to the distribution point (DP) where this fibre is split using optical power splitters. From the DP an individual fibre runs to the home of the customer where it ends in the network termination (NT).