metrical shape of the gain-curve of the common-emitter amplifier is mainly determined by the h_{FE} roll-off of the driver- and power transistors.

Table 1. Measured performance versus PSpice simulation.

	PSpice	Measured
Open-loop gain	79dB	77dB
Open-loop –3dB b/w	825Hz	1150Hz
Closed-loop o/p imp. (mΩ)	29	30
Closed-loop o/p imp. 3dB	16kHz	14.5kHz

Residual currents in the output transistors of the common-emitter amplifier are well controlled, see **Fig. 4**.

As you can see in **Fig. 5**, the maximum output voltage of the common-emitter amplifier is close to the rail to rail limit. The dissipation of driver and power transistors in overdrive is shown in **Fig. 6**. This illustrates the low power dissipation of the bias-control loop used in the common-emitter amplifier.

Open-loop gain and phase characteristics, **Fig. 7**, show a unity gain phase margin of 45°. The phase margin for β of 1/34 is 85°. Magnitude and phase of the output impedance are given in **Fig. 8**.

Setting up

We implemented **Figure 9** on a pcb, **Fig. 10**, and used it for measurements.

By adjusting R_7, the quiescent current of the power transistors $Tr_{11,12}$ was set to 100mA. Note that due to the spread in transistor parameters, a manual control of the quiescent current is necessary. This is usual for power

Mathematical AC analysis of a common-emitter amplifier

In order to gain insight into the common-emitter amplifier, a mathematical AC analysis on a macro model like **Fig. A** can be used. Frequency-dependent behaviour of the open-loop transfer, the closed-loop output impedance and distortion are studied here.

The macro model of the common-emitter amplifier consists of a voltage to current converter, A_1, representing the input stage, followed by a current controlled current source, A_2, representing a two-stage current amplifier.

Miller capacitor C_m connects across the current-gain stage. The dominant source of distortion in A_2 is the current gain dependence of the emitter current – h_{FE} roll-off. This distortion is modelled by a current source connected in parallel with the output current source. The open-loop transfer function of the common-emitter amplifier can be written as,

where,

$$Z_{C0} = \frac{1}{G_1 F_1 \beta} \tag{12}$$

$$z_{ZC} = \frac{1}{R_p C_m} \tag{13}$$

$$p_{ZC} = \frac{1}{\left(\frac{F_1 + 1 - G_1 R_p \beta}{F_1 G_1 \beta}\right) C_m} \tag{14}$$

Closed-loop frequency dependence of the distortion is given by,

$$\frac{V_{out}}{I_d} \propto \frac{1 + \frac{s}{z_{DC}}}{1 + \frac{s}{p_{DC}}} \tag{15}$$