

AN02: Centellax MMIC amplifiers with on-chip power detectors

Centellax designs and manufactures GaAs MMIC amplifiers, many which have an on-chip differential diode power detector. This feature can be used with an external opamp circuit, or a microprocessor with a lookup table, to enable real time output power detection.

Output power detector basics

The block diagram of the on-chip power detector is shown in Figure 1. The circuitry consists of two diodes, one with an RF signal and DC offset (V_{RF}) and the other with only a DC offset (V_{DC}). This topology allows for common mode cancellation of diode temperature drift and good log linearity versus power

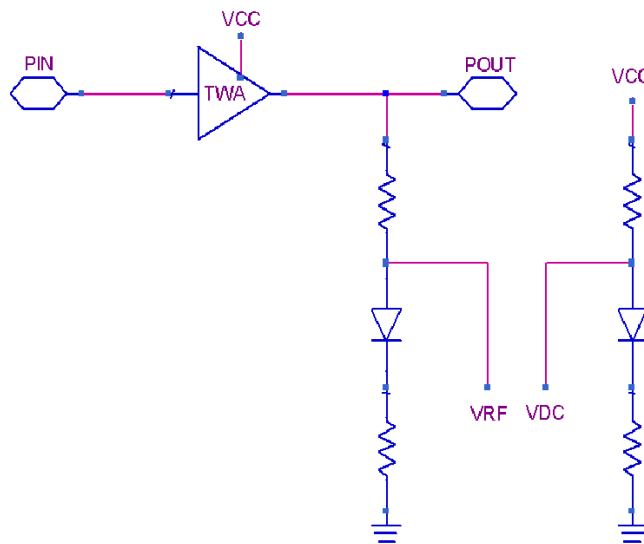


Figure 1 – Simplified on-chip power detector

Most Centellax MMIC amplifiers feature this power detector, but since the nominal DC bias of each amplifier varies, the DC offset voltage will be slightly different from family to family.

This application note details the power detector on the Centellax UAPL65SC, a 0.04-65GHz GaAs MMIC amplifier nominally biased with 8V, 250mA. However, the circuits recommended in this application note will work for all Centellax TWA amplifiers.

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Measurements of the power detector

Differential measurements of the UATL65SC power detector are shown in Figure 2. The graph shows the detector voltage (V_{RF}) with the reference voltage (V_{DC}) removed ($V_{RF} - V_{DC}$), which effectively eliminates the common mode diode temperature drift from the measurement. The difference voltage is plotted at frequencies from 2-40GHz, swept across a range of output power levels.

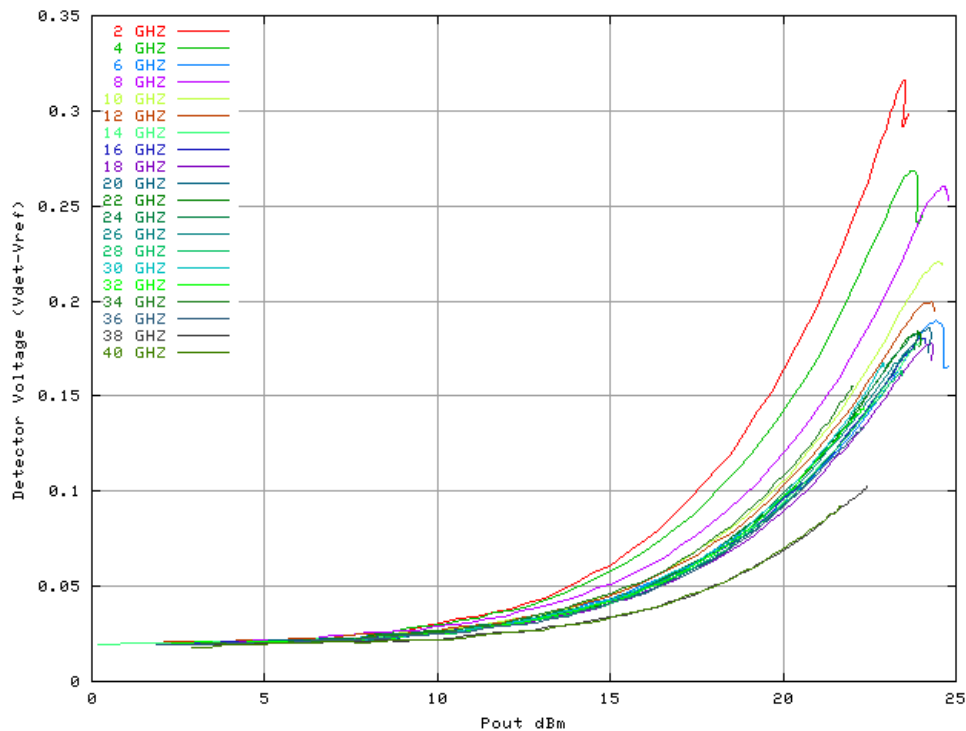


Figure 2 – Differential detector output (linear)

Note the 0.02V DC offset on the measurement. The DC offset can be removed with the same op-amp circuit that is used to generate the difference voltage, shown in Figure 4.

The detector output shows good log linearity, as shown in Figure 3.

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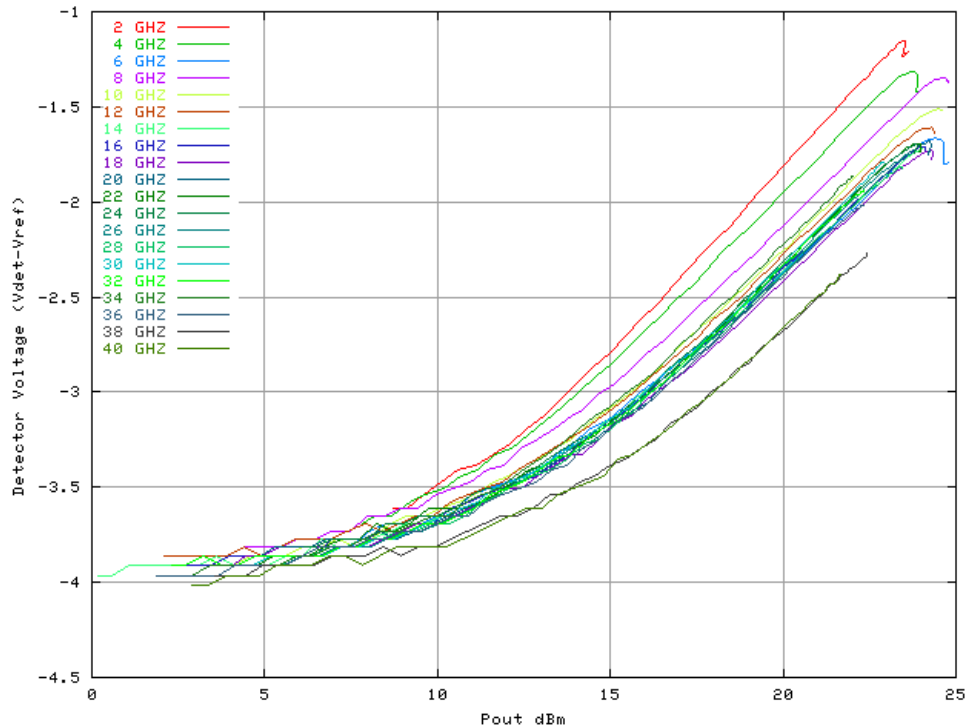


Figure 3 – Differential detector output (logarithmic)

However, much improved log linearity can be achieved by removing the DC offset from the difference voltage, as discussed in the next section. Removing the small DC offset enables the full dynamic range of the detector.

Power detector measurements with offset adjustment

To obtain the full dynamic range of the device, the DC offset voltage must be removed from the difference voltage. This improves the low power noise floor and the log linearity as shown in Figure 6.

An example opamp circuit to determine the difference voltage, with DC offset removed, is shown in Figure 4; this circuit is designed for unity gain (the 50kΩ feedback resistor can be increased for higher voltage output).

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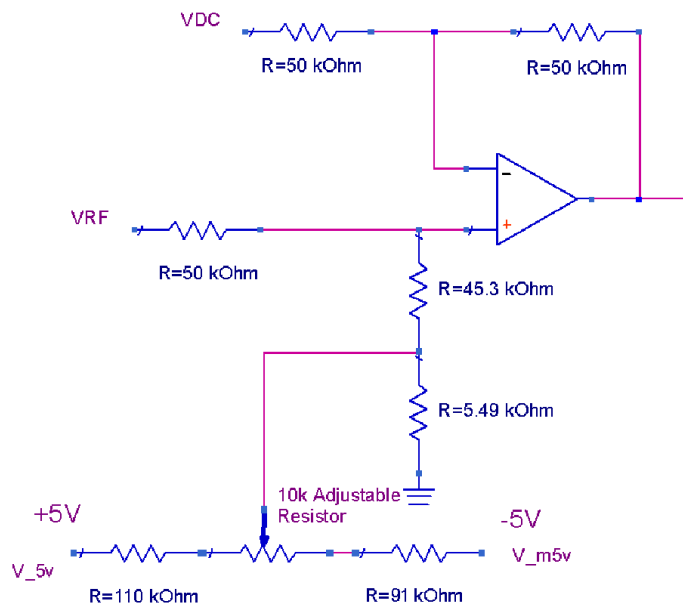


Figure 4 – Op-amp circuit to remove the DC offset voltage

The DC offset can be removed by adjusting the 10kΩ resistor in the divider network connected to the V_{RF} op-amp input.

Removing the DC offset decreases the lower range of the detector from +13dBm to +5dBm, illustrated by comparing Figure 3 and Figure 6. This effectively increases the dynamic range of the power detector by 8dB.

Figure 5 shows the linear output voltage with the DC offset removed as per the op-amp circuit shown above. Figure 6 shows the same corrected output voltage plotted on a logarithmic scale. The linearity is excellent from +5dBm to the maximum range of the detector.

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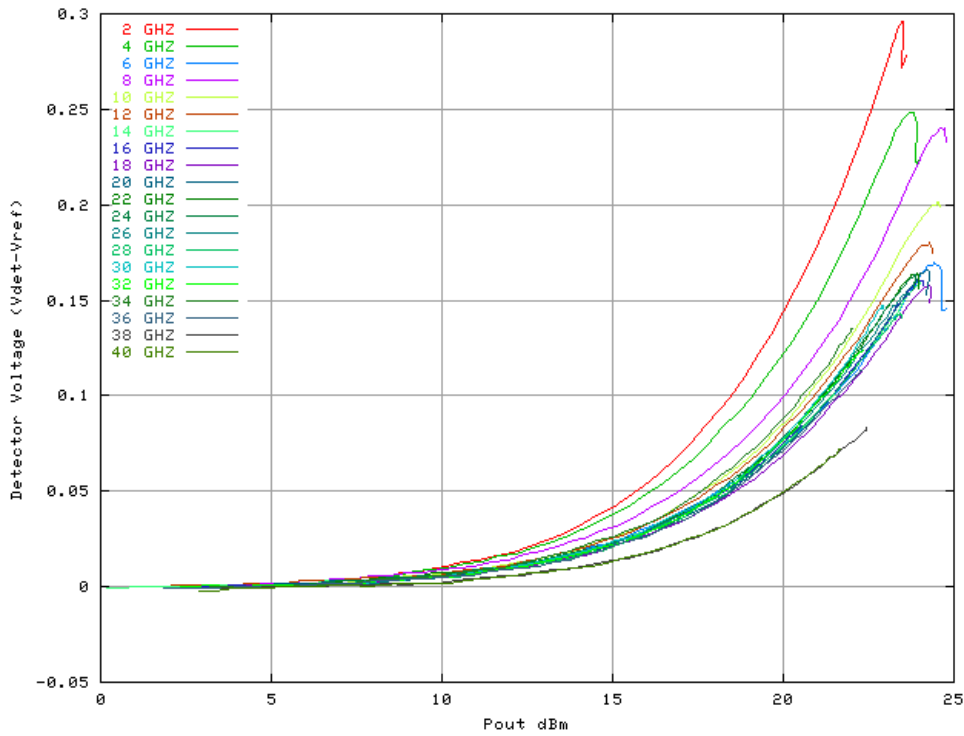


Figure 5 – Offset-removed detector output (linear)

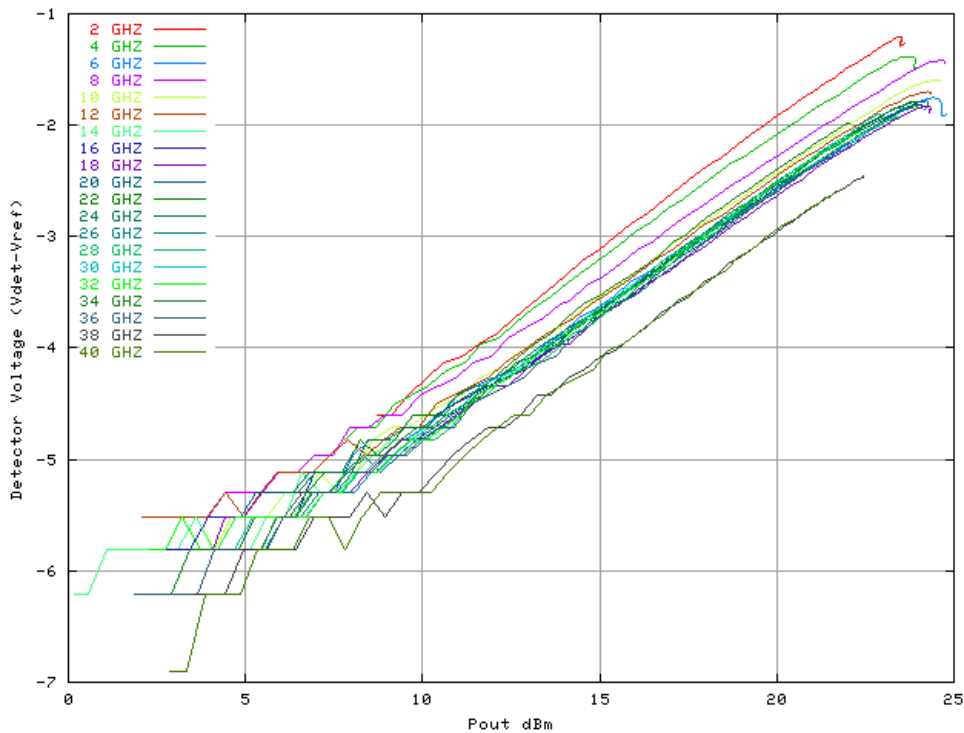


Figure 6 – Offset-removed detector output (logarithmic)

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The power detector difference voltage is also very stable across a wide temperature range, as shown in Figure 7.

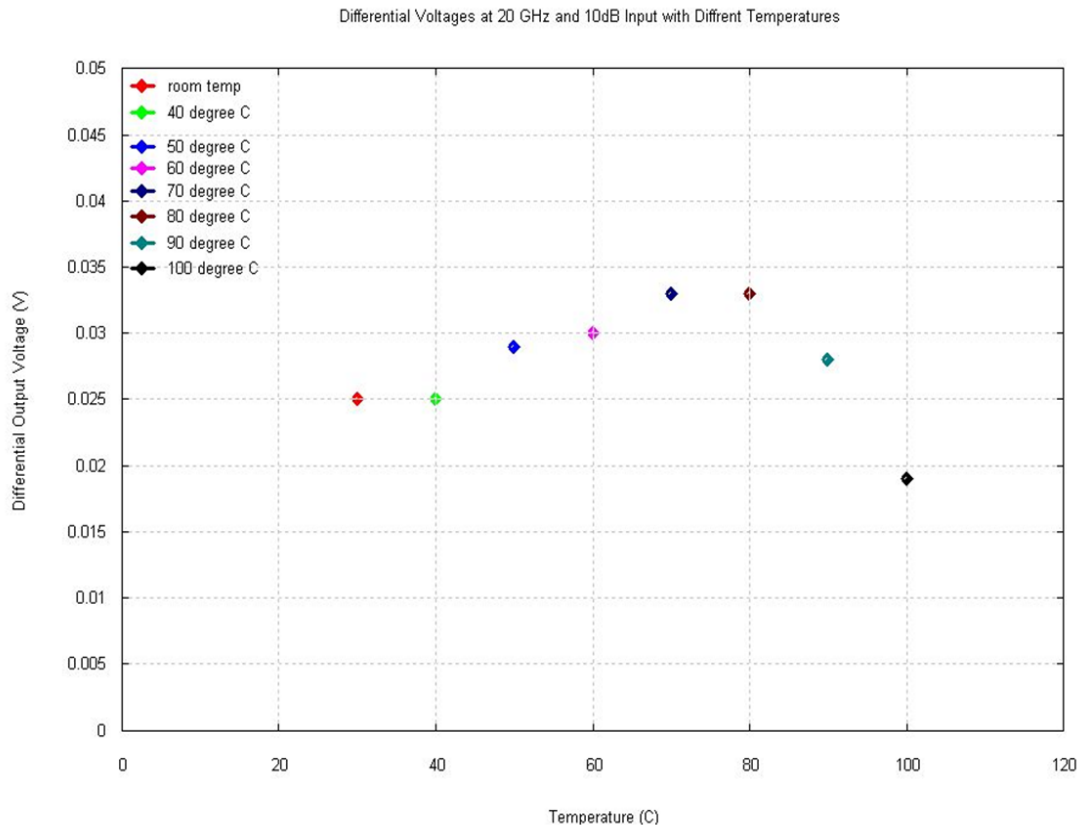


Figure 7 – Detector voltage temperature tracking

Information on Centellax MMIC amplifiers is available from the Centellax website at: http://www.centellax.com/products/microwave/amplifier_ics.shtml

Please contact Centellax application engineers at support@centellax.com for additional information, or sales and marketing at sales@centellax.com for price and delivery information.