

Biased Asymmetrical Doherty RF Power Transistor

RF Power Factsheet

1. Biasing Asymmetrical Doherty RF Power Transistor

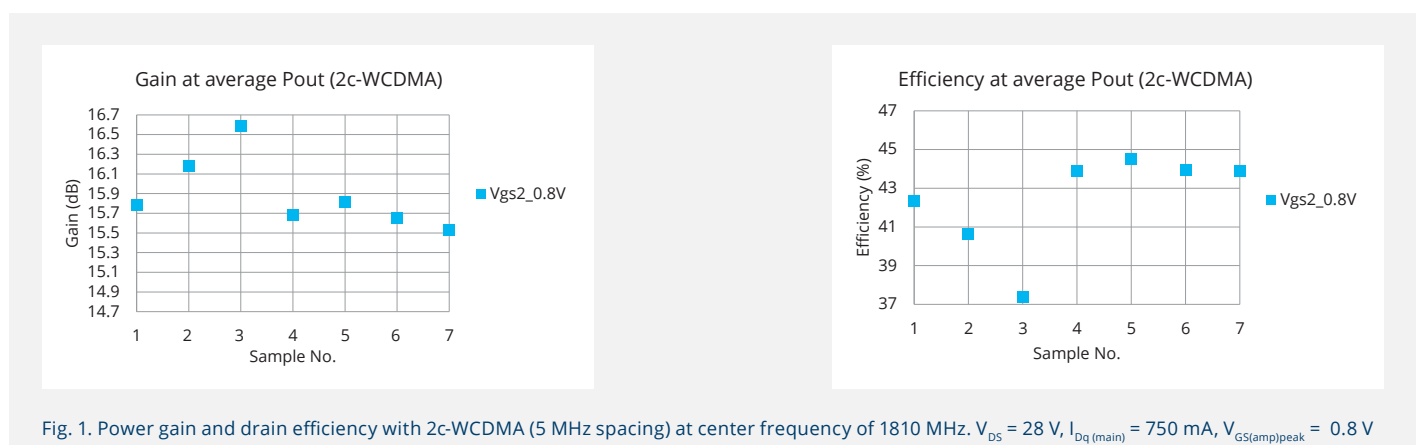
The ever-increasing need for higher efficiency in base station power amplifiers calls on new variants of the Doherty topology. Optimised main and peak amplifiers result in asymmetrical Doherty designs that use different transistors for each path. Until recently, symmetrical push-pull devices have been used in single device Doherty amplifiers. Ampleon's range of LDMOS transistors, however includes dedicated asymmetrical designs that are optimised for efficiency in today's demanding cellular base station market. In order to enjoy the benefits of low spread in RF performance, care must be taken in biasing these devices appropriately. This Factsheet highlights the key aspects of biasing these asymmetrical Doherty devices.

1.1 General Biasing Method of Doherty Amplifiers

In general, the main amplifier of a Doherty device is biased in class-AB at a fixed I_d and the peak amplifier is biased in class-C at a fixed V_{gs} voltage. Owing to spread in semiconductor processing, the V_t (threshold voltage) of LDMOS dies vary. This means that if a transistor is biased at a fixed V_{gs} , its I_d can vary depending on its actual V_t . The RF performance of a transistor, like gain and efficiency, correlates strongly with the I_d and hence, when the I_d varies due to spread of V_t , the RF performance also spreads accordingly.

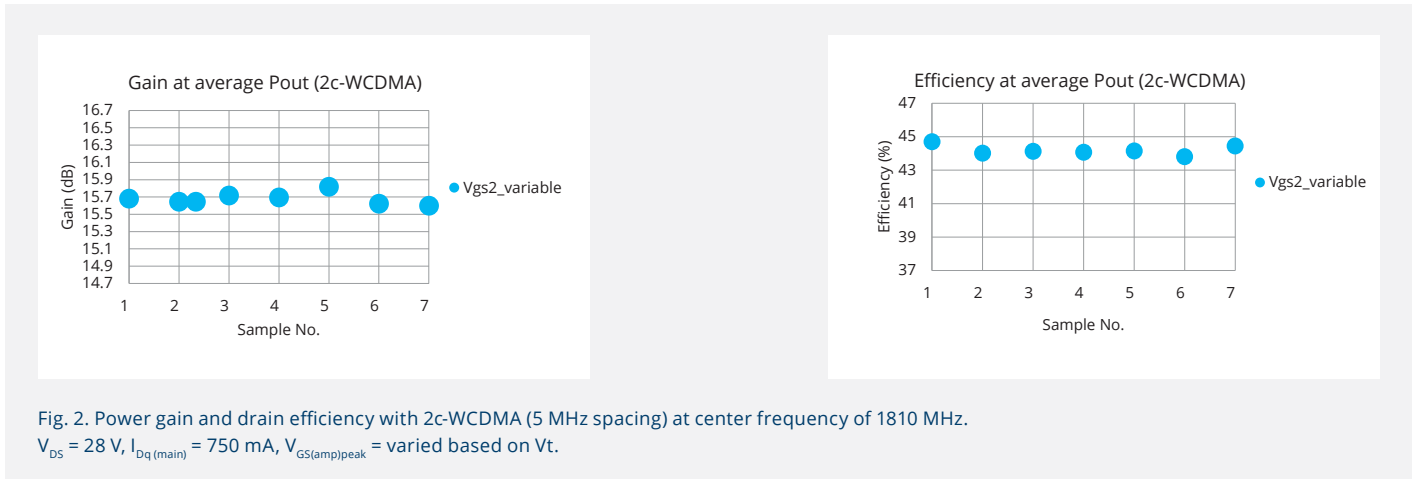
The main amplifier is biased in class-AB at fixed I_d . Any spread in V_t of the LDMOS dies' main amplifier can be compensated by measuring the actual I_d for each device and then adjusting the V_{gs} , such that the I_d is maintained. The peak amplifier is biased in class-C where no I_d flows until it is driven by a relatively high RF signal level. Therefore, the compensation method as described for the main amplifier, cannot be directly applied to the peak amplifier.

If the peak amplifier is not compensated for its V_t spread, the RF performance of the Doherty amplifier would show a significantly higher spread. The graphs below show the spread of gain and efficiency of BLF8G20LS-260A device in its Doherty test circuit at average output power of 50 W at 28 V, where the main amplifier is biased at fixed I_d of 750 mA and the peak amplifier is biased at a fixed V_{gs} of 0.8 V. Two of the seven transistors (No. 2 and No.3) chosen for this test have significantly different V_t values of the LDMOS dies used in peak amplifier compared to the rest.



1.2 Recommended Biasing Method of Doherty Amplifiers

The spread in RF performance shown in the graphs on the previous page could be reduced by compensating for the spread in V_t of peak devices. Instead of biasing the peak amplifier with fixed V_{gs} value, the idea is to follow a two step process. First step is to bias the peak device to a predefined class-AB I_d value. In this way, the V_{gs} needed is determined and then in the second step the class-C V_{gs} bias value is found by taking a fixed offset from the V_{gs} value found in first step. This method ensures that the V_{gs} bias voltage for the LDMOS dies in the peak amplifier tracks its V_t shift for each transistor and hence helps to significantly reduce the spread in RF performance. The graphs below show the spread of RF performance using this concept.



1.3 Biasing Information in Datasheet

The Ampleon datasheets of asymmetrical Doherty devices currently mention only the typical V_{gs} value for the peak amplifier. The limits of RF parameters like gain, efficiency, RL and ACPR with 1c-WCDMA or 2c-WCDMA published in Ampleon datasheets of asymmetrical Doherty devices are derived based on RF measurements in Doherty test circuit using the above mentioned biasing technique.

Contact Information

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