

## Introduction

MACOM developed application fixtures for three catalogue devices; the CMPA0527005F, CGHV40030F, and the CGHV40100F to cover 0.5 GHz to 2.5 GHz for Electronic Protect/jamming power amplifier, and other military communications (MilCom) applications. All devices are constructed with MACOM's GaN HEMT technology with the CGHV40100F and CGHV40030F being unmatched devices operating at 50 V. The CMPA0527005F is a GaN MMIC device with the input matched to 50  $\Omega$  and the output unmatched also operating at 50 V. This application note describes the typical performance that has been achieved when three fixtures are assembled together.

Key features of the lineup performance include:

- Frequency Range 0.5 - 2.5 GHz
- Over 52 dB of Small Signal Gain
- Over 40% Lineup Efficiency
- 100 W Saturated Output Power

## Design

The design goal was to create a 0.5 - 2.5 GHz CW capable lineup that can achieve over 100 W of output power using a single 50 V DC supply for the drain. By doing so, system complexity can be reduced to eliminate the need for multiple DC-DC converters thus reducing the overall system efficiency. The first stage utilizes the CMPA0527005F-AMP1 which has been matched to operate across the entire frequency range (delivering up to 8 W of CW output power), but can be narrowband matched if needed in other applications. The second stage utilizes the CGHV40030F-AMP2 GaN HEMT device which has been optimized for linearity under two-tone signal across the band and is operated backed off from PSAT to provide ample headroom to output stage. To complete the lineup, the third stage uses the unmatched CGHV40100F which is housed in a thermally viable package allowing it to deliver 100 W CW.

To test the lineup each fixture, the CMPA0527005F-AMP1 followed by, the CGHV40030F-AMP2, followed by, the CGHV40100F-AMP, as shown in **Figure 1**, were connected in the lab. To reduce the mismatch between the output of the CGHV40030F-AMP2 and the input of the CGHV40100F-AMP, the 7.5 pF capacitor (C2 on the CGHV40100-AMP Application Circuit Schematic) was changed to 2.2 pF. Overall small signal gain of over 52 dB was achieved with good input and output return loss, as shown in **Figure 2**. At saturated power, over 100 W is achieved across the band with a lineup efficiency of over 40% and typical large signal gain of 42 dB, as shown in **Figure 3**. When measured with a two-tone signal the IMD3 remained below -25 dBc across the full frequency range at an average output power of 47 dBm, as shown in **Figure 4**.

**Three-Stage Lineup of MilCom Lineup**  
(100 W, 0.5 - 2.5 GHz, 50 V)

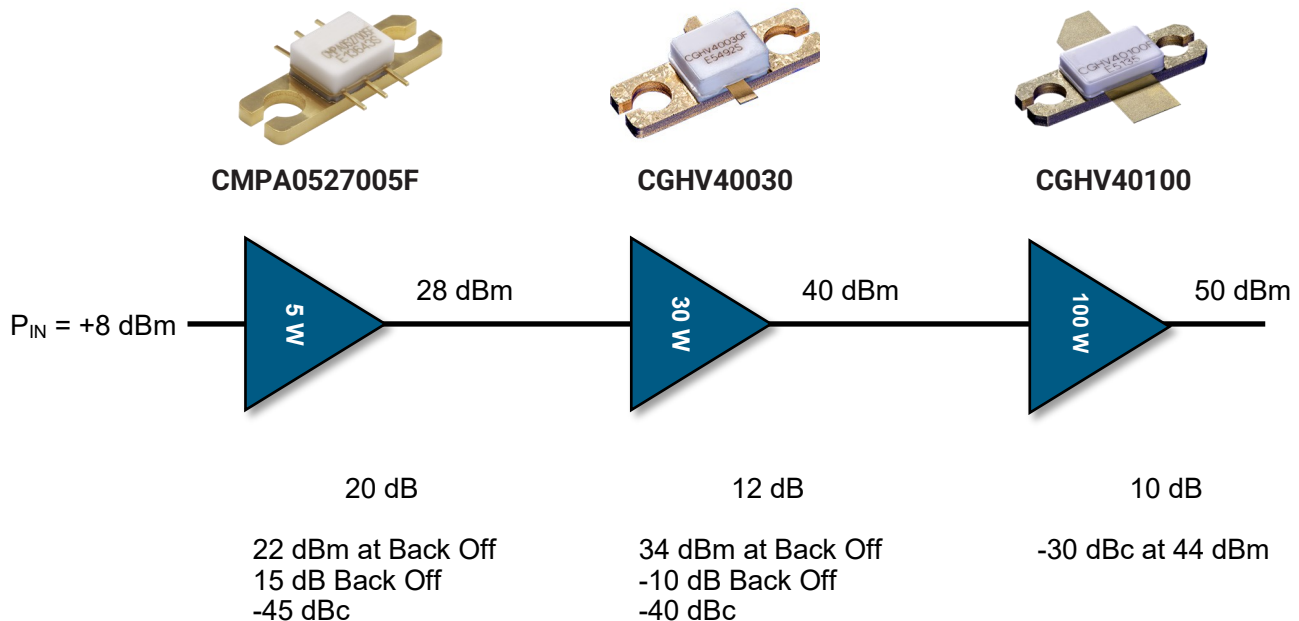


Figure 1

**S-Parameters of 50 V MilCom Lineup**  
Full Lineup S-Parameters (VD = 50 V, IDQ = 800 mA)

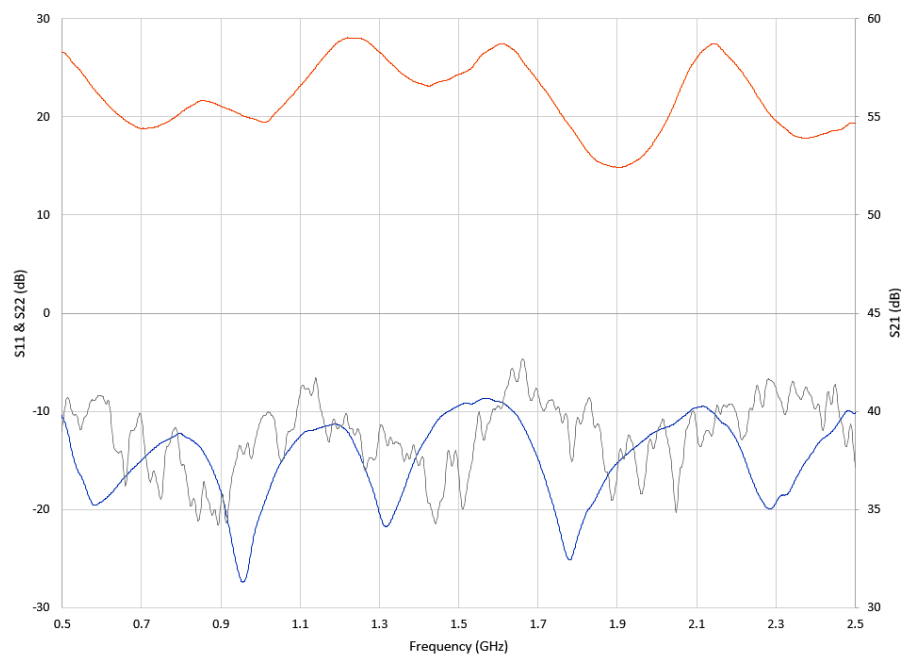


Figure 2

**Saturated Power Performance of 50 V MilCom Lineup**  
Full Lineup Power, Gain, Efficiency at  $P_{SAT}$  ( $V_D = 50$  V,  $I_{DQ} = 800$  mA,  $I_G = 0$  mA, CW)

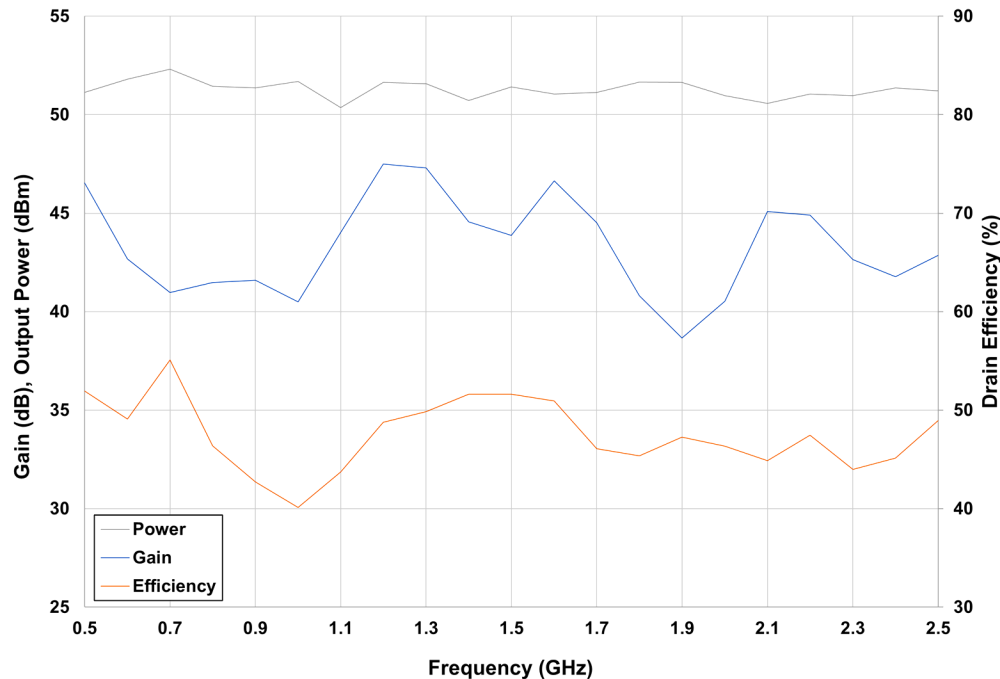


Figure 3

**Two-Tone Performance of 50 V MilCom Lineup**  
Full Lineup IMD3 -  $P_{OUT}$  ( $V_D = 50$  V,  $I_{DQ} = 800$  mA, two-tone 1 MHz spacing)

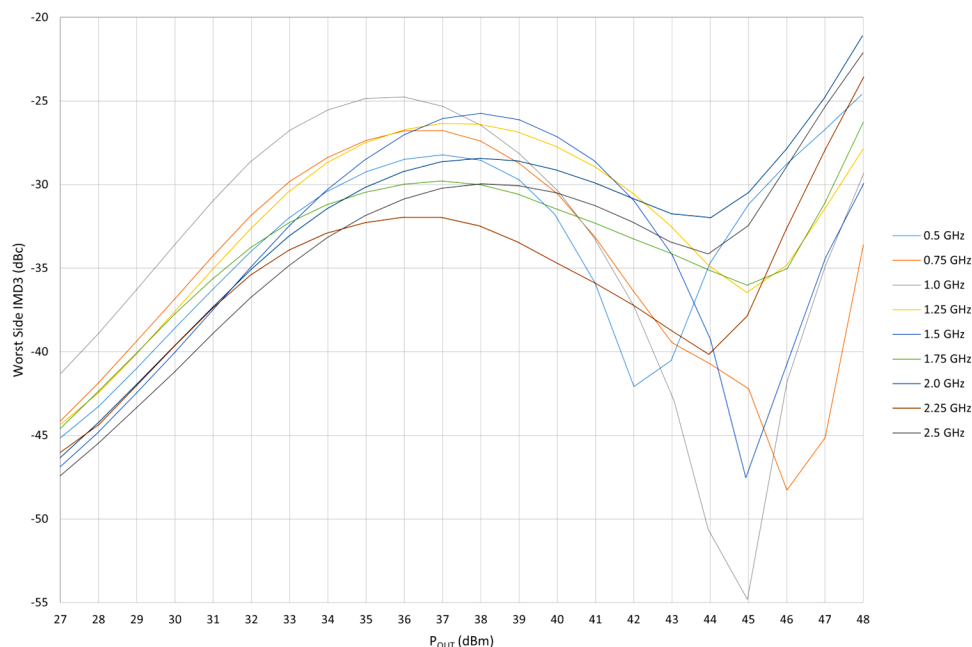


Figure 4

## **Space Study**

Individually, the CMPA0527005F-AMP1 is constructed on a 2.6" x 1.7" PCB, the CGHV40030F-AMP2 circuit on a 2.6" x 1.7" PCB, and the CGHV40100F-AMP circuit on a 4" x 2.5" PCB. All three PCBs use a RO4350B 20 mil thick substrate. Together, the three circuits can be combined onto one 7" x 3.6" PCB without redesign. It is possible to further reduce this size by matching the device's impedances to one another. Under their current format, the circuits match the gate and drain impedance of each Cree GaN HEMT to 50 ohms. Alternatively, space can be saved by matching the output impedance of the CMPA0527005F to the input impedance of the CGHV40030F, and the output impedance of the CGHV40030F to the input impedance of the CGHV40100F. The Z-Source, input impedance, and the Z-Load, output impedance, of each transistor can be found using MACOM's proprietary large signal models.

## **Conclusion**

With its high power and high efficiency, the three-stage lineup presented in this application note is perfect for multiple MilCom applications. Running under saturated condition, the lineup generates over 50 dBm of output power, over 40% of drain efficiency, 42 dB of typical power gain. Under two tone testing, the worst case IMD3 is approximately -25 dBc when sweeping output power from 27 - 47 dBm.

MACOM Technology Solutions Inc. ("MACOM"). All rights reserved.

These materials are provided in connection with MACOM's products as a service to its customers and may be used for informational purposes only. Except as provided in its Terms and Conditions of Sale or any separate agreement, MACOM assumes no liability or responsibility whatsoever, including for (i) errors or omissions in these materials; (ii) failure to update these materials; or (iii) conflicts or incompatibilities arising from future changes to specifications and product descriptions, which MACOM may make at any time, without notice. These materials grant no license, express or implied, to any intellectual property rights.

THESE MATERIALS ARE PROVIDED "AS IS" WITH NO WARRANTY OR LIABILITY, EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHT, ACCURACY OR COMPLETENESS, OR SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES WHICH MAY RESULT FROM USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.