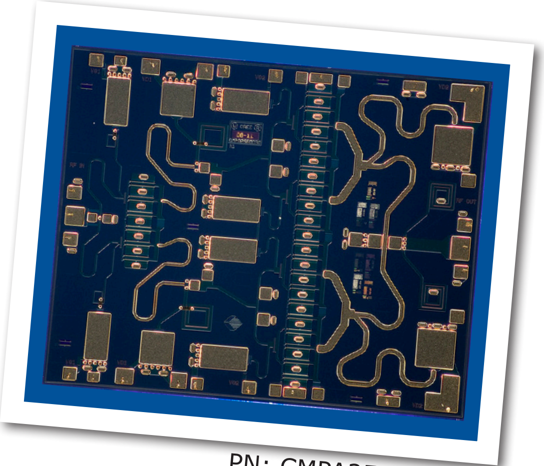
PRELIMINARY

CMPA2560025D

25 W, 2.5 - 6.0 GHz, GaN MMIC, Power Amplifier

Cree's CMP2560025D is a gallium nitride (GaN) High Electron Mobility Transistor (HEMT) based monolithic microwave integrated circuit (MMIC). GaN has superior properties compared to silicon or gallium arsenide, including higher breakdown voltage, higher saturated electron drift velocity and higher thermal conductivity. GaN HEMTs also offer greater power density and wider bandwidths compared to Si and GaAs transistors. This MMIC contains a two-stage reactively matched amplifier design approach enabling very wide bandwidths to be achieved.



PN: CMPA2560025D

Typical Performance Over 2.5-6.0 GHz (T_c = 25˚C)

Parameter	2.5 GHz	4.0 GHz	6.0 GHz	Units
Gain	27.5	24.3	23.1	dB
Saturated Output Power, P_{SAT}[1]	35.8	37.5	25.6	W
Power Gain @ P_{OUT} = 43 dBm	23.1	20.9	16.3	dB
PAE @ P_{OUT} 43 dBm	31.5	32.8	30.7	%

Note[1]: P_{SAT} is defined as the RF output power where the device starts to draw positive gate current in the range of 7-13 mA.

Features

- 24 dB Small Signal Gain
- 25 W Typical P_{SAT}
- Operation up to 28 V
- High Breakdown Voltage
- High Temperature Operation
- Size 0.180 x 0.145 x 0.004 inches

Applications

- Ultra Broadband Amplifiers
- Fiber Drivers
- Test Instrumentation
- EMC Amplifier Drivers

Rev 0.5 – November 2010

Absolute Maximum Ratings (not simultaneous) at 25˚C

Parameter	Symbol	Rating	Units
Drain-source Voltage	V_{DSS}	84	VDC
Gate-source Voltage	V_{GS}	-10, +2	VDC
Storage Temperature	T_{STG}	-65, +150	˚C
Operating Junction Temperature	T_J	225	˚C
Thermal Resistance, Junction to Case (packaged)[1]	$R_{\theta JC}$	2.5	˚C/W
Mounting Temperature (30 seconds)	T_S	320	˚C

Note[1] Eutectic die attach using 80/20 AuSn solder mounted to a 40 mil thick CuW carrier.

Electrical Characteristics (Frequency = 2.5 GHz to 6.0 GHz unless otherwise stated; T_C = 25˚C)

Characteristics	Symbol	Min.	Typ.	Max.	Units	Conditions
DC Characteristics						
Gate Threshold	V_{TH}	-3.8	-3.3	-2.3	V	V_{DS} = 10 V, I_D = 20 mA
Saturated Drain Current	I_{DS}	8.0	9.7	–	A	V_{DS} = 6.0 V, V_{GS} = 2.0 V
Drain-Source Breakdown Voltage	V_{BD}	84	100	–	V	V_{GS} = -8 V, I_D = 20 mA
On Resistance	R_{ON}	–	0.35	–	Ω	V_{DS} = 0.1 V
Gate Forward Voltage	V_{G-ON}	–	1.9	–	V	I_{GS} = 3.6 mA
RF Characteristics						
Small Signal Gain	S21	21	25	–	dB	V_{DD} = 26 V, I_{DQ} = 1200 mA
Power Output at 2.5 GHz	P_{OUT1}	30	–	–	W	V_{DD} = 26 V, I_{DQ} = 1200 mA, P_{IN} ≤ 26 dBm
Power Output at 3.0 GHz	P_{OUT2}	20	25	–	W	V_{DD} = 26 V, I_{DQ} = 1200 mA, P_{IN} ≤ 26 dBm
Power Output at 4.0 GHz	P_{OUT3}	20	30	–	W	V_{DD} = 26 V, I_{DQ} = 1200 mA, P_{IN} ≤ 26 dBm
Power Added Efficiency	PAE	–	35	–	%	V_{DD} = 26 V, I_{DQ} = 1200 mA
Power Gain	G_P	–	20	–	dB	V_{DD} = 26 V, I_{DQ} = 1200 mA
Input Return Loss	S11	–	6	–	dB	V_{DD} = 26 V, I_{DQ} = 1200 mA
Output Return Loss	S22	–	5	–	dB	V_{DD} = 26 V, I_{DQ} = 1200 mA
Output Mismatch Stress	VSWR	–	–	5:1	Ψ	No damage at all phase angles, V_{DD} = 26 V, I_{DQ} = 1200 mA, P_{OUT} = 25W CW

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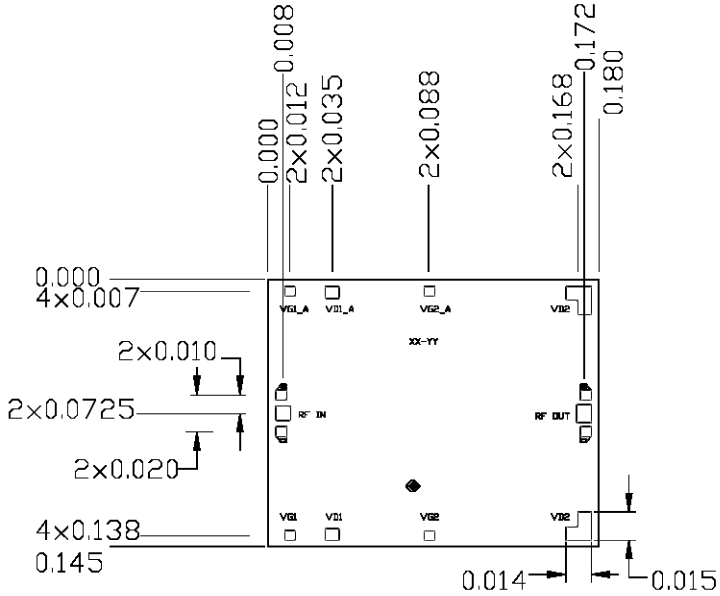
Die Dimensions (units in inches)



Overall die size 0.180 x 0.145 (+0/-0.005) inches, die thickness 0.004 inches.
All Gate and Drain pads must be wire bonded for electrical connection.

Pad Number	Function	Description	Pad Size (in)	Note
1	RF-IN	RF-Input pad. Matched to 50 ohm. Requires gate control from an external bias –T from -1.5 V to -2.5 V and external blocking capacitor.	0.008” x 0.008”	3
2	VG1_A	Gate control for stage 1. V_G ~ 1.5 - 2.5 V.	0.014” x 0.014”	1,2
3	VG1_B	Gate control for stage 1. V_G ~ 1.5 - 2.5 V.	0.014” x 0.014”	1,2
4	VD1_A	Drain supply for stage 1. V_D = 26 V.	0.019” x 0.016”	1
5	VD1_B	Drain supply for stage 1. V_D = 26 V.	0.019” x 0.016”	1
6	VG2_A	Gate control for stage 2A. V_G ~ 1.5 - 2.5 V.	0.014” x 0.014”	1
7	VG2_B	Gate control for stage 2A. V_G ~ 1.5 - 2.5 V.	0.014” x 0.014”	1
8	VD2_A	Drain supply for stage 2A. V_D = 26 V.	A	1
9	VD2_B	Drain supply for stage 2B. V_D = 26 V.	A	1
10	RF-Out	This pad is DC blocked internally. The DC impedance ~ 0 ohm due output matching circuit. Requires external matching circuit for optimal performance for f >4.0 GHz.	0.008” x 0.008”	3

Notes:
[1] Attach bypass capacitor to port 2-9 per application circuit.
[2] VG1_A and VG1_B is connected internally so it would be enough to connect either one for proper operation.
[3] The RF Input and Output pad have a ground-signal-ground with a pitch of 10 mil (250 um).

Die Assembly Notes:

- Recommended solder is AuSn (80/20) solder. Refer to Cree’s website for the Eutectic Die Bond Procedure application note at http://www.cree.com/products/wireless_appnotes.asp
- Vacuum collet is the preferred method of pick-up.
- The backside of the die is the Source (ground) contact.
- Die back side gold plating is 5 microns thick minimum.
- Thermosonic ball or wedge bonding are the preferred connection methods.
- Gold wire must be used for connections.
- Use the die label (XX-YY) for correct orientation.

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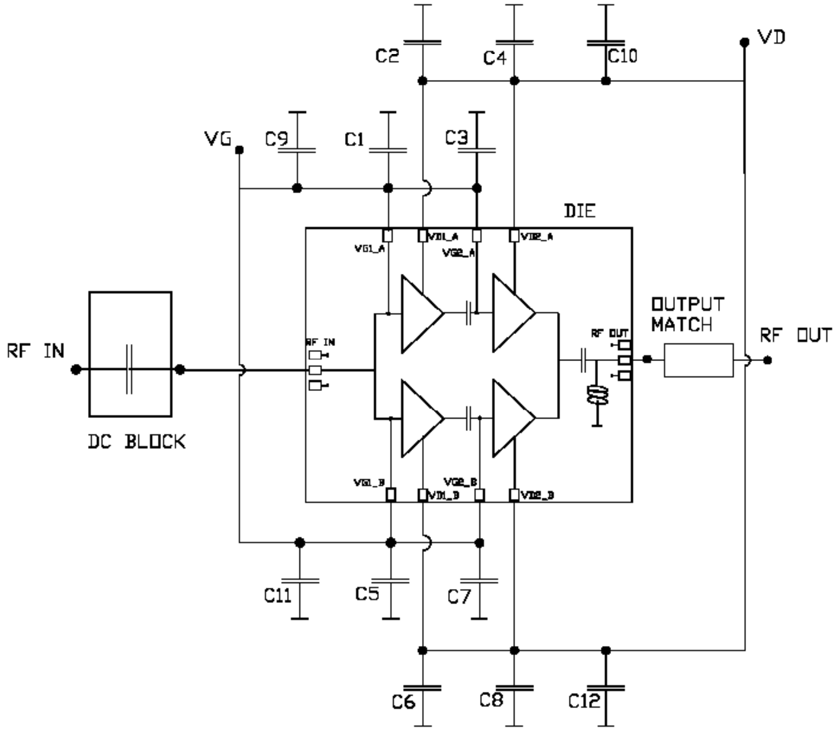
Block Diagram Showing Additional Capacitors & Output Matching Section for Operation Over 2.5 to 6.0 GHz



Designator	Description	Quantity
C1,C2,C3,C4,C5,C6,C7,C8	CAP, 120pF, +/-10%, SINGLE LAYER, 0.030", Er 3300, 100V, Ni/Au TERMINATION	8
C9,C10,C11,C12	CAP, 680pF, +/-10%, SINGLE LAYER, 0.070", Er 3300, 100V, Ni/Au TERMINATION	4

Notes:

[1] An additional microstripline of 31 ohm impedance and electrical length of 72° at 6.0 GHz at the output of the MMIC is required to optimize overall performance in the 2.5 to 6.0 GHz frequency band.

[2] The input, output and decoupling capacitors should be attached as close as possible to the die- typical distance is 5 to 10 mils with a maximum of 15 mils.

[3] The MMIC die and capacitors should be connected with 2 mil gold bond wires.

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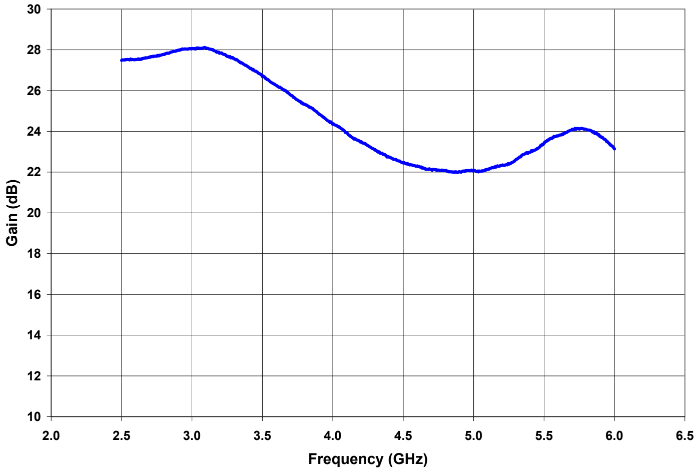
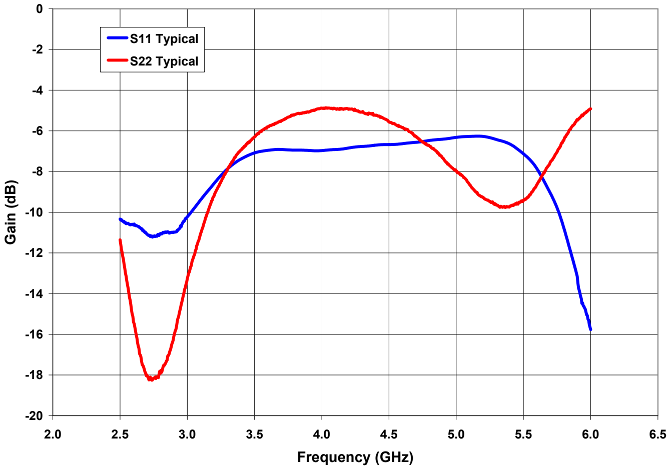
Typical Performance of the CMPA2560025D as Measured in CMPA2560025F-TB

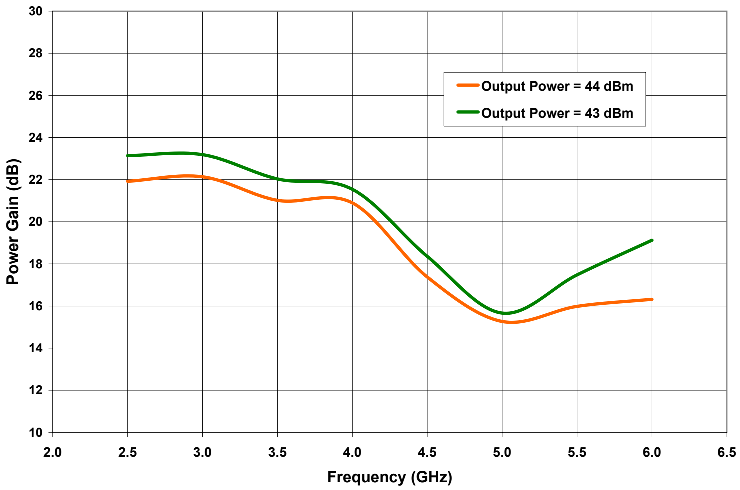
Small Signal Gain vs Frequency



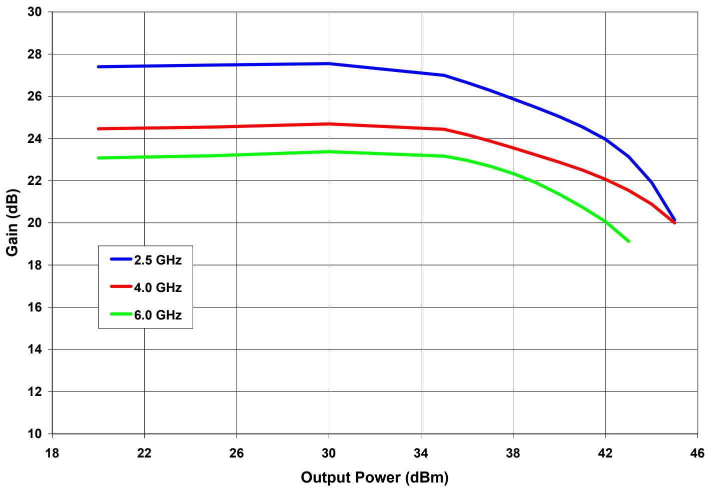
Input & Output Return Losses vs Frequency



Power Gain vs Frequency



Gain vs Output Power as a Function of Frequency



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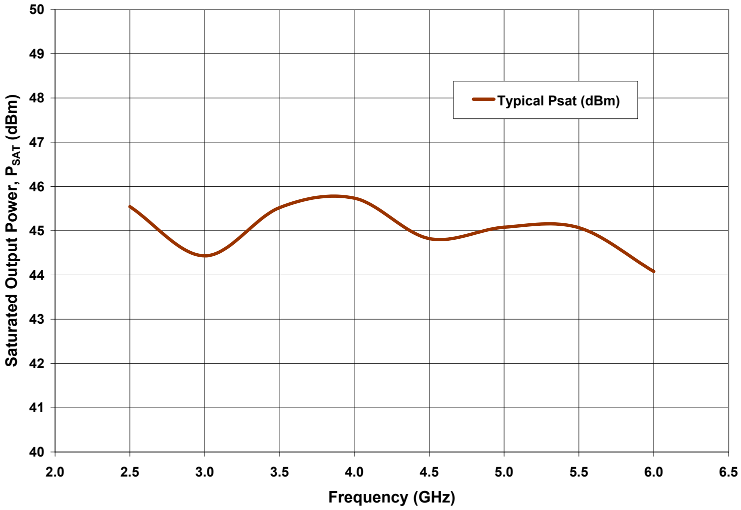
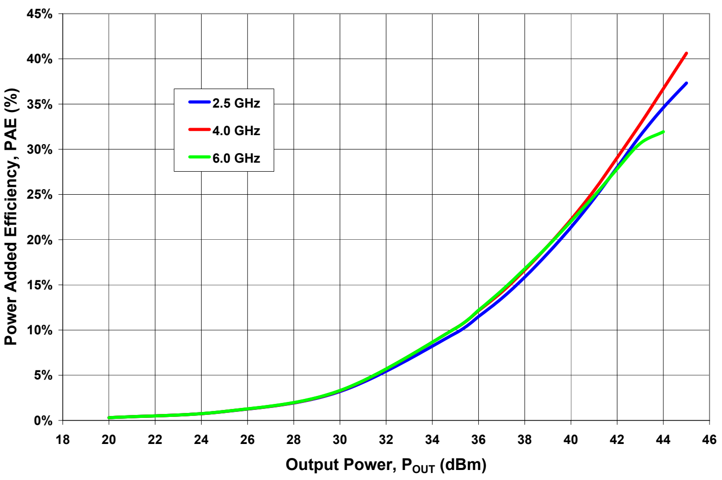
Saturated Output Power Performance (P_{SAT}) vs Frequency



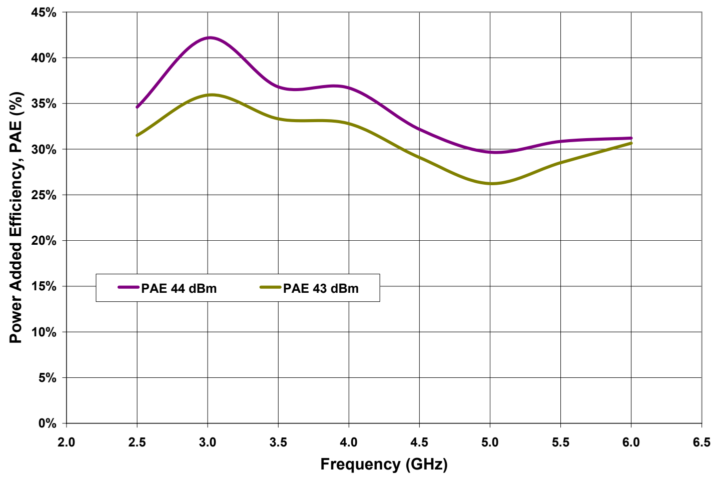
Frequency (GHz)	P_{SAT} (dBm)	P_{SAT} (W)
2.5	45.54	35.8
3.0	44.43	27.7
3.5	45.52	35.7
4.0	45.74	37.5
4.5	44.82	30.4
5.0	45.08	32.2
5.5	45.07	32.1
6.0	44.08	25.6

Note: P_{SAT} is defined as the RF output power where the device starts to draw positive gate current in the range of 7-13 mA.

Power Added Efficiency vs Output Power as a Function of Frequency



PAE at 43 dBm and 44 dBm Output Power vs Frequency



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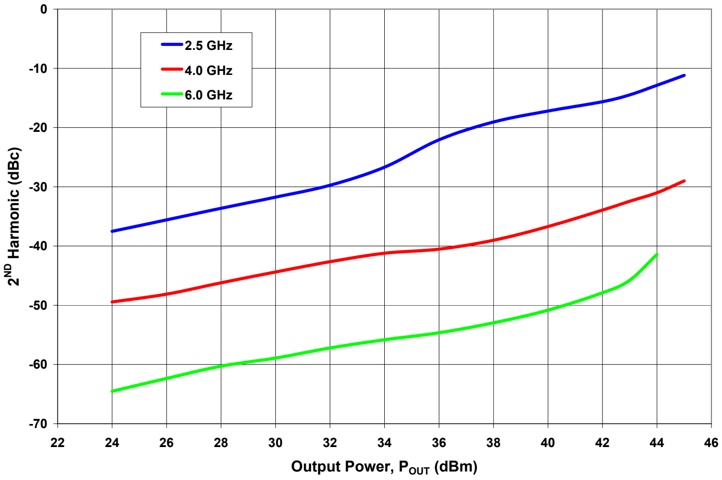
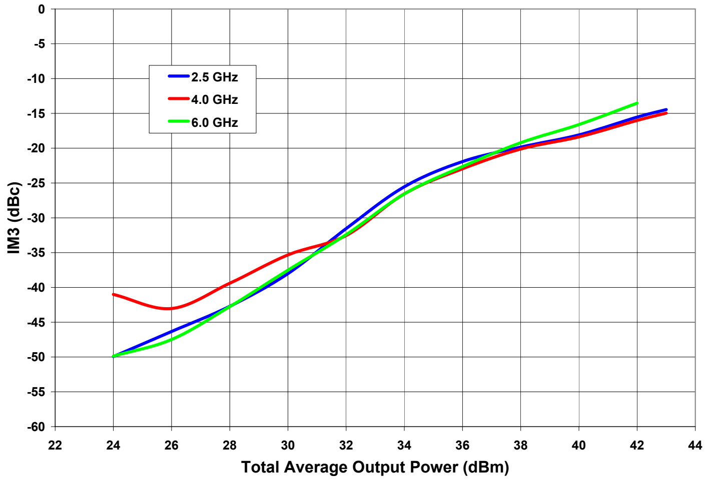
Typical Performance of the CMPA2560025D as Measured in CMPA2560025F-TB

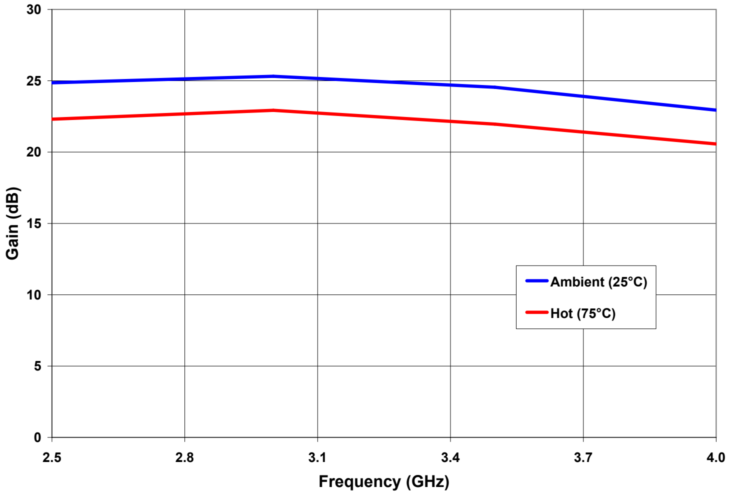
2ND Harmonic vs Output Power as a Function of Frequency



IM3 vs Total Average Power as a Function of Frequency



Gain at P_{OUT} of 40 dBm at 25°C & 75°C vs Frequency



Note: The temperature coefficient is -0.05 dB/°C

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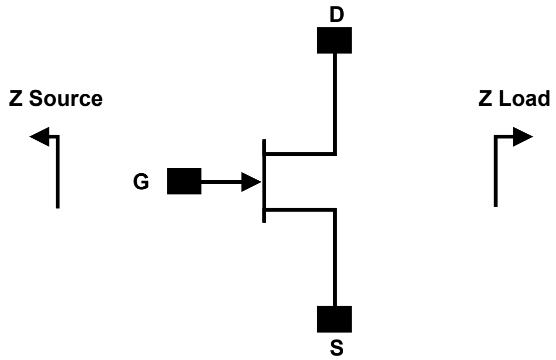
Source and Load Impedances



Frequency (MHz)	Z Source	Z Load
2500	50 + j0	36.2 - j15.4
3000	50 + j0	32.7 – j15.4
3500	50 + j0	29.6 - j14.7
4000	50 + j0	27.0 - j13.8
4500	50 + j0	24.8 - j12.1
5000	50 + j0	23.0 - j10.4
5500	50 + j0	21.6 - j8.6
6000	50 + j0	20.6 - j6.7

Note 1. V_{DD} = 26V, I_{DQ} = 1200mA in the 780019 package.
Note 2. Optimized for P_{SAT}
Note 3: The quoted impedances are those presented to the die by the CMPA2560025F-TB demonstration amplifier, fully de-imbedded to the die bond pad reference plane.

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