Vectrawave
RF & Millimeter Wave MMIC Design

8.5 to 10.5GHz - 20W
GaN/SiC Power Amplifier

VM090D

General Description

The VM090D is a Microwave Monolithic Integrated Circuit (MMIC) designed in HEMT (High Electron Mobility Transistor) structure for operating frequency range from 8.5 to 10.5GHz.

The MMIC is developed on 250nm GaN/SiC process and is internally matched through 50Ω RF accesses. It can provide an output power up to 20W and associated power added efficiency of 32% in pulsed mode.

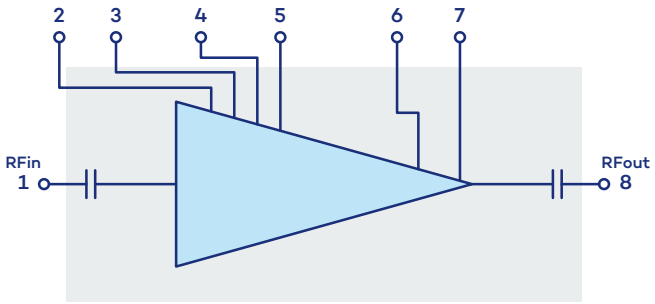
Features

Frequency range	**8.5 – 10.5GHz**
Output Power	**43dBm @Pin = 23dBm**
PAE	**32% @Pin = 23dBm**
Linear Gain	**27dB**
DC bias	**V_D = +28V, I_{DQ} = 190mA, V_G = -2.35V (Typical)**
Chip size	**5 x 1.7 x 0.1 (mm)**

Applications

- Radar
- Test and Measurement

Pins Assignement & Functional Block Diagram



Function	Pin number
RFin	1
V_{G1}	2
V_{D1}	3
V_{G2}	4
V_{D2}	5
V_{G3}	6
V_{D3}	7
RFout	8

Electrical Specifications

Test conditions: unless otherwise noted
- T_{amb} = +25°C
- V_D = +28V
- I_{DQ} = 190mA (V_G=-2.35V Typ.)
- Pulsed mode (pulse width: 30µs, duty cycle: 10%)

Symbol	Parameter	Min	Typ	Max	Unit
F	Frequency range	8.5		10.5	GHz
G	Linear gain		27		dB
S11	Input return loss		-8		dB
S22	Output return loss		-12		dB
Pout	Output power (@Pin=23dBm)		43		dBm
PAE	Associated Power Added Efficiency (@Pin=23dBm)		32		%
I_D	Associated Drain current (@Pin=23dBm)		2.4		A
V_D	Drain voltage		28		V

Recommended Operating Conditions

Symbol	Parameter	Value	Unit
V_D	Drain voltage	28	V
I_{DQ}	Drain quiescent current	190	mA
V_G	Gate voltage	-2.35 (Typ.)	V

Absolute Maximum Ratings

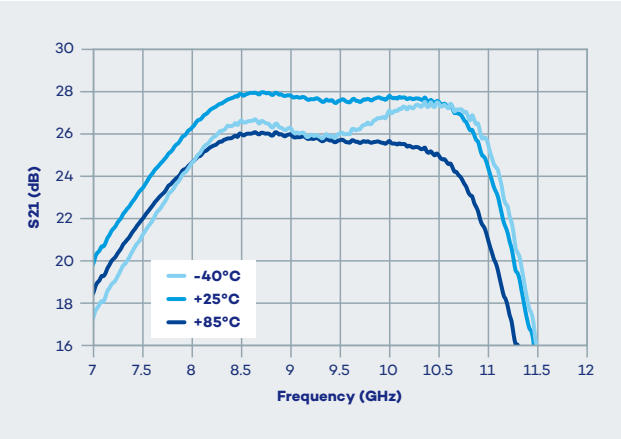
Symbol	Parameter	Value	Unit
V_D	Drain bias voltage	35	V
I_D	Drain bias current	3	A
V_G	Gate bias voltage	-10 to -2	V
Pin	Maximum peak input power overdrive	30	dBm
Tj	Junction temperature	225	°C
Ta	Operating temperature range	-40/+85	°C
Tstg	Storage temperature range	-55/+150	°C

Operation of this device above any of these parameters may cause permanent damage.

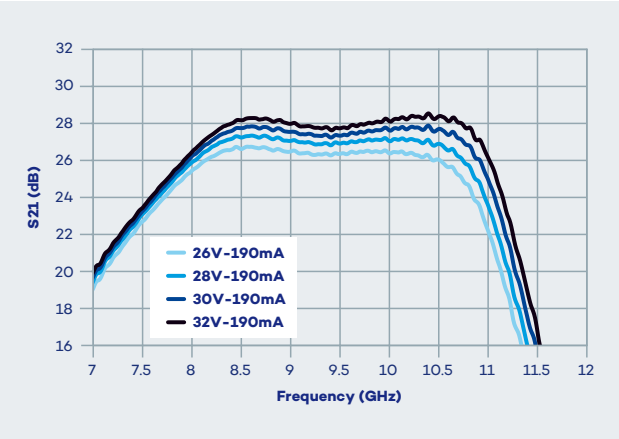
Typical Performance
(Small signal / Board Measurement)

Test conditions: unless otherwise specified
- Reference plane: connector access
- V_D = +28V
- I_{DQ} = 190mA (V_G = -2.35V Typ.)
- Pin = -20dBm

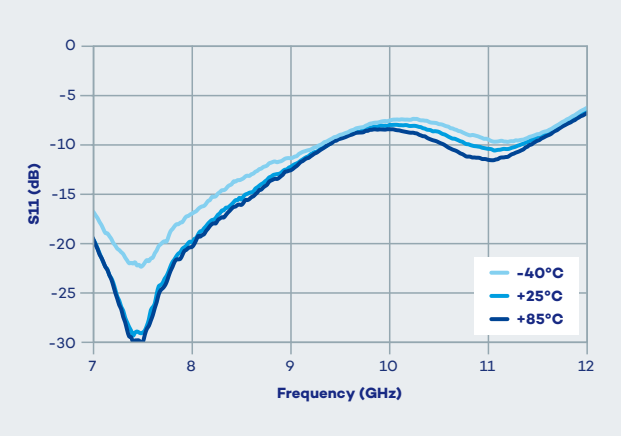
Gain vs Frequency vs Temperature



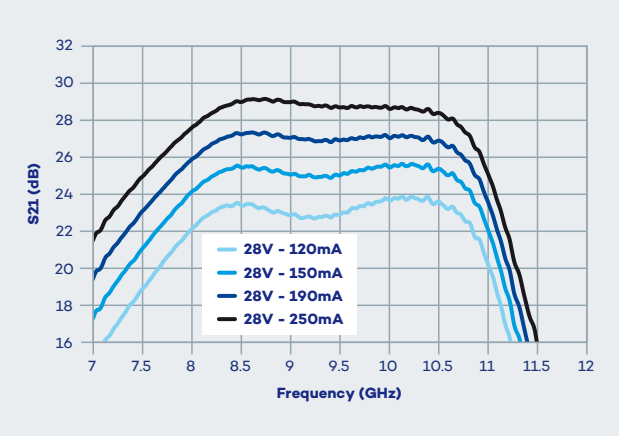
Gain vs Frequency vs V_D



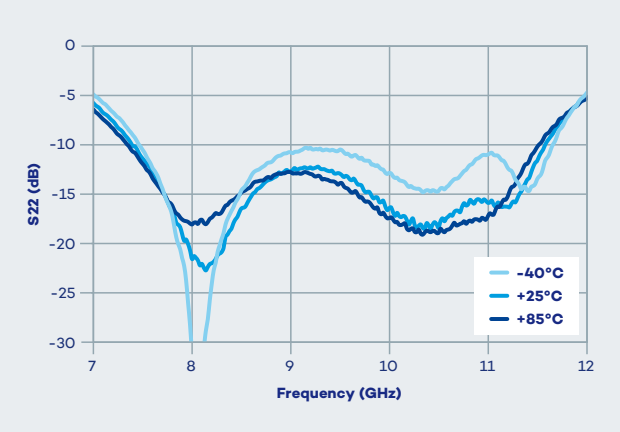
Input Return Loss vs Frequency vs Temperature



Gain vs Frequency vs I_{DQ}



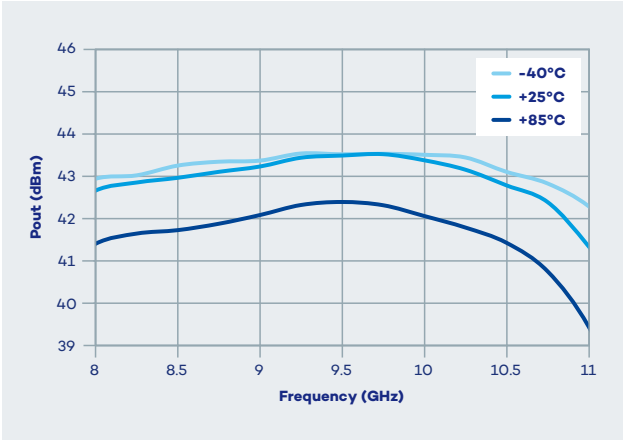
Output Return Loss vs Frequency vs Temperature



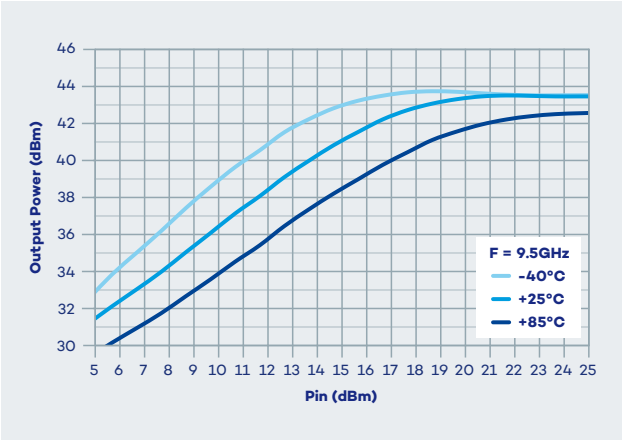
Typical Performance
(Large signal / Board Measurement)

Test conditions: unless otherwise specified
- Reference plane: die access
- V_D = +28V
- I_{DQ} = 190mA (V_G = -2.35V Typ.)
- Pin = +23dBm
- Pulsed mode (pulse width: 30µs, duty cycle: 10%)

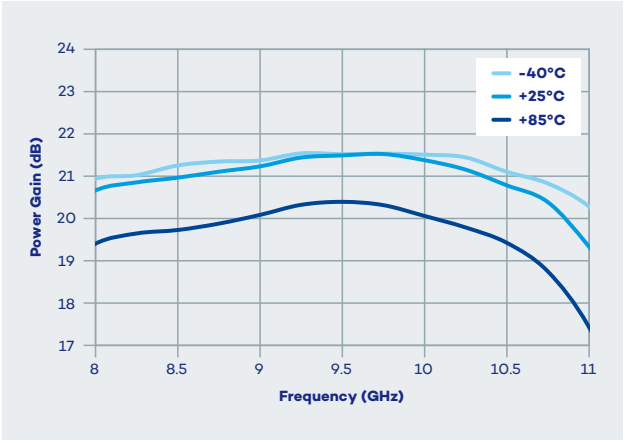
Output Power vs Frequency vs Temperature



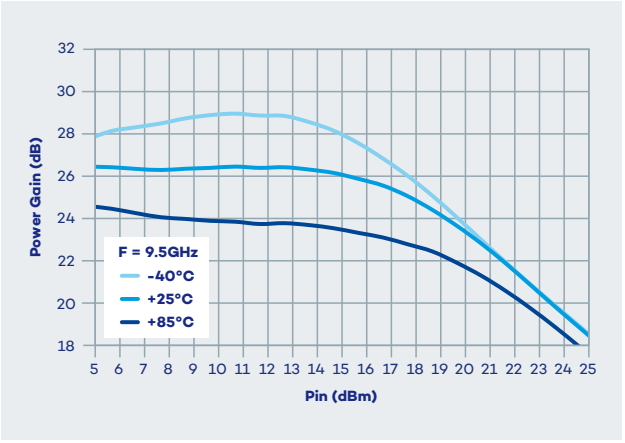
Output Power vs Input Power vs Temperature



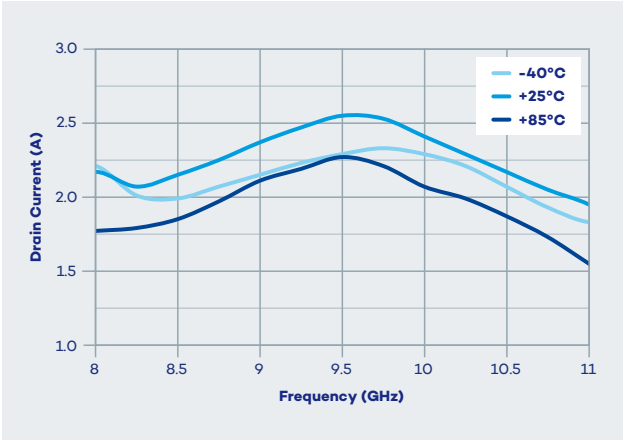
Power Gain vs Frequency vs Temperature



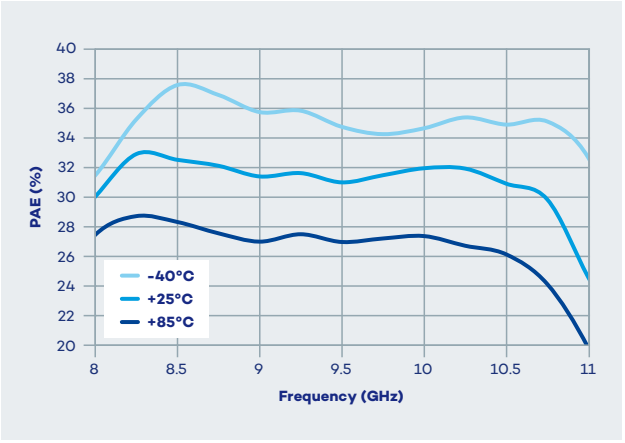
Gain vs Input Power vs Temperature



Drain Current vs Frequency vs Temperature



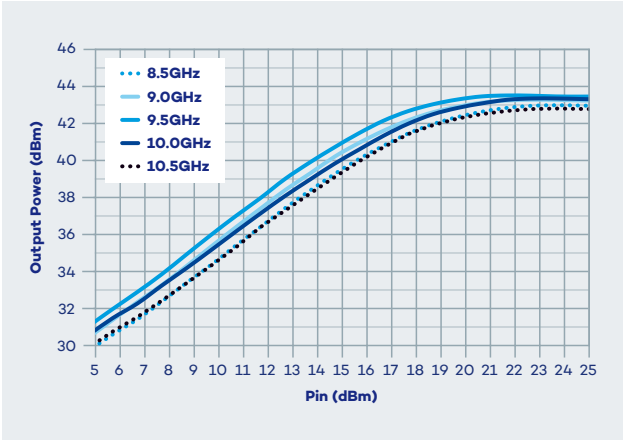
PAE vs Frequency vs Temperature



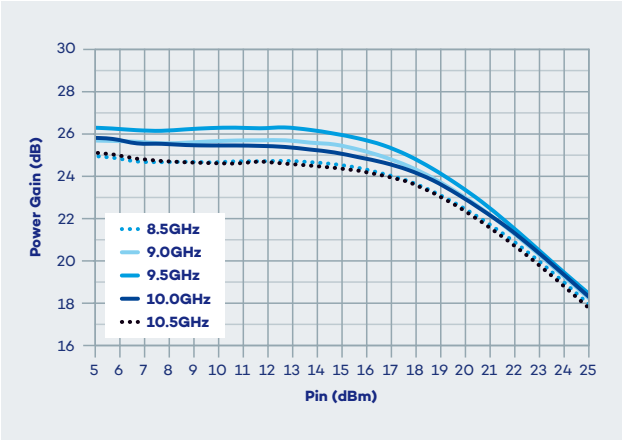
Typical Performance
(Large signal / Board Measurement)

Test conditions: unless otherwise specified
- Reference plane: die access
- V_D = +28V
- I_{DQ} = 190mA (V_G = -2.35V Typ.)
- T_{amb} = +25°C
- Pulsed mode (pulse width: 30µs, duty cycle: 10%)

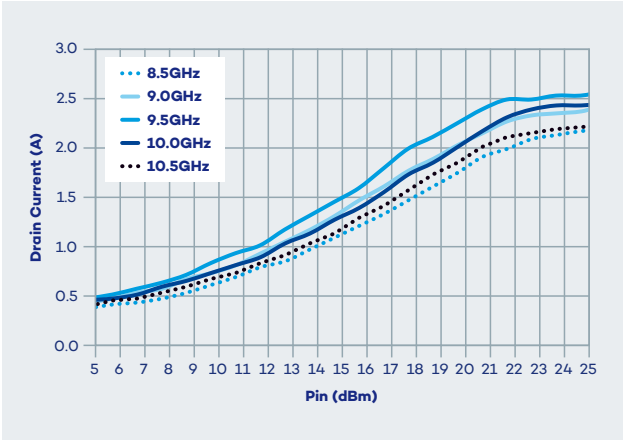
Output Power vs Input Power vs Frequency



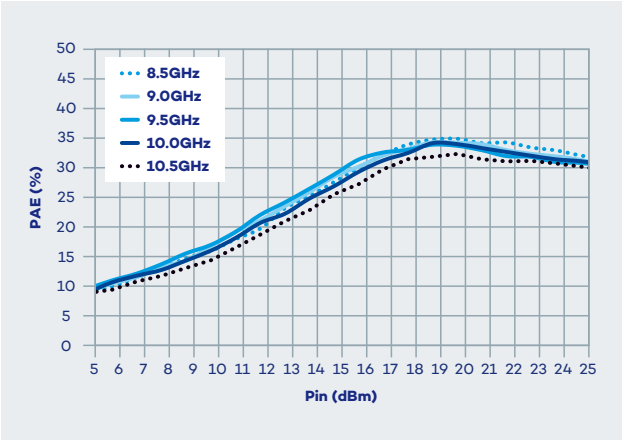
Gain vs Input Power vs Frequency



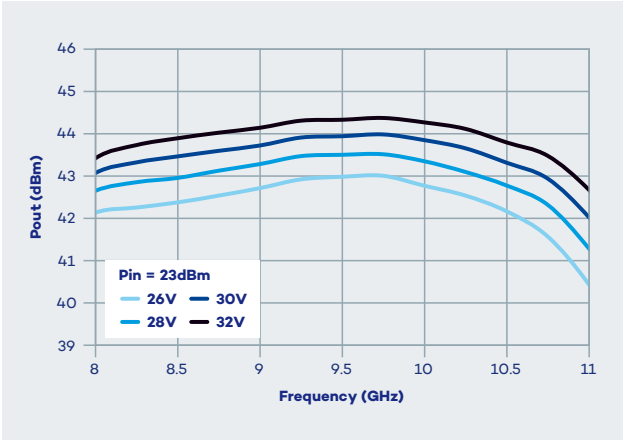
Drain Current vs Input Power vs Frequency



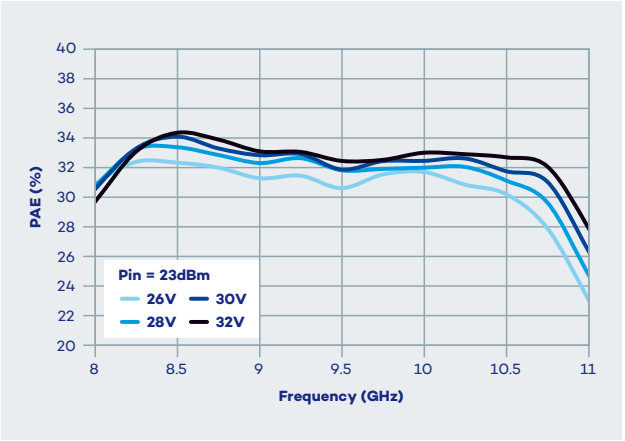
PAE vs Input Power vs Frequency



Output Power vs Frequency vs V_D



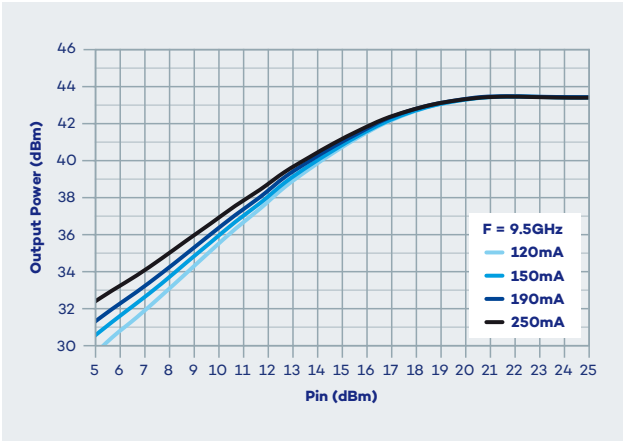
PAE vs Frequency vs V_D



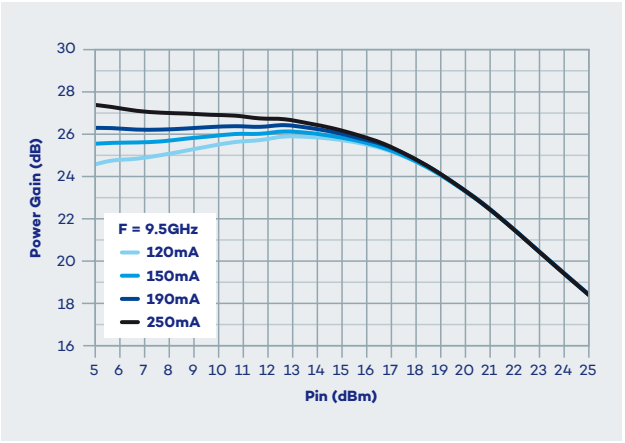
Typical Performance
(Large signal / Board Measurement)

Test conditions: unless otherwise specified
- Reference plane: die access
- V_D = +28V
- T_{amb} = +25°C
- Pulsed mode (pulse width: 30µs, duty cycle: 10%)

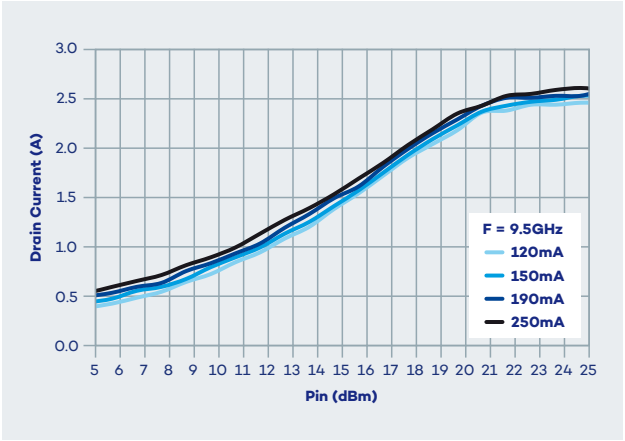
Output Power vs Input Power vs I_{DQ}



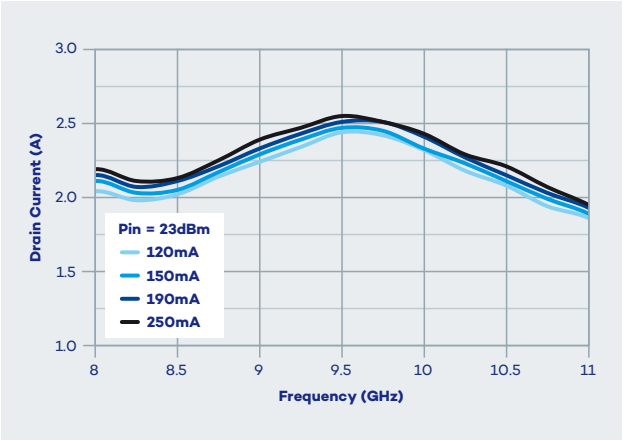
Gain vs Input Power vs I_{DQ}



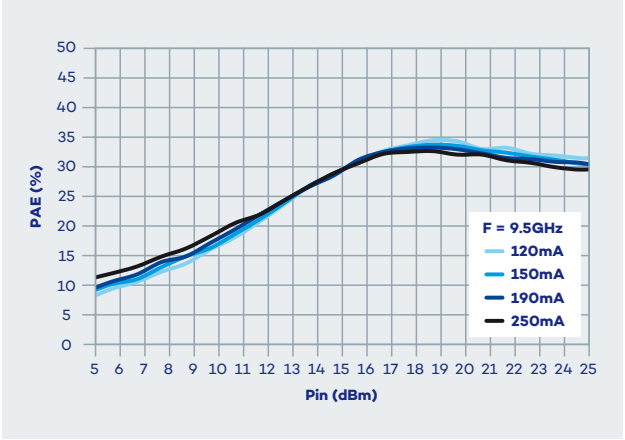
Drain Current vs Input Power vs I_{DQ}



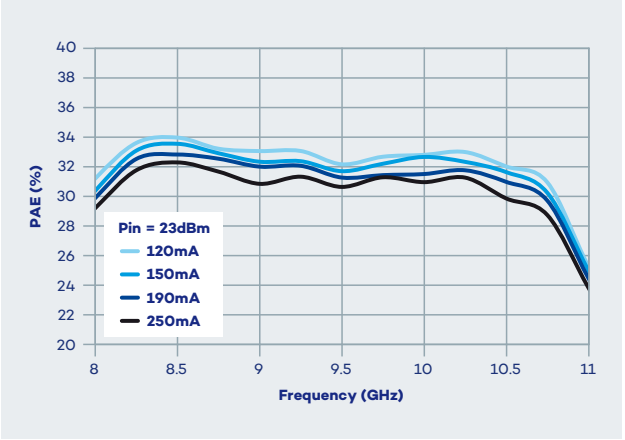
Drain Current vs Frequency vs I_{DQ}



PAE vs Input Power vs I_{DQ}

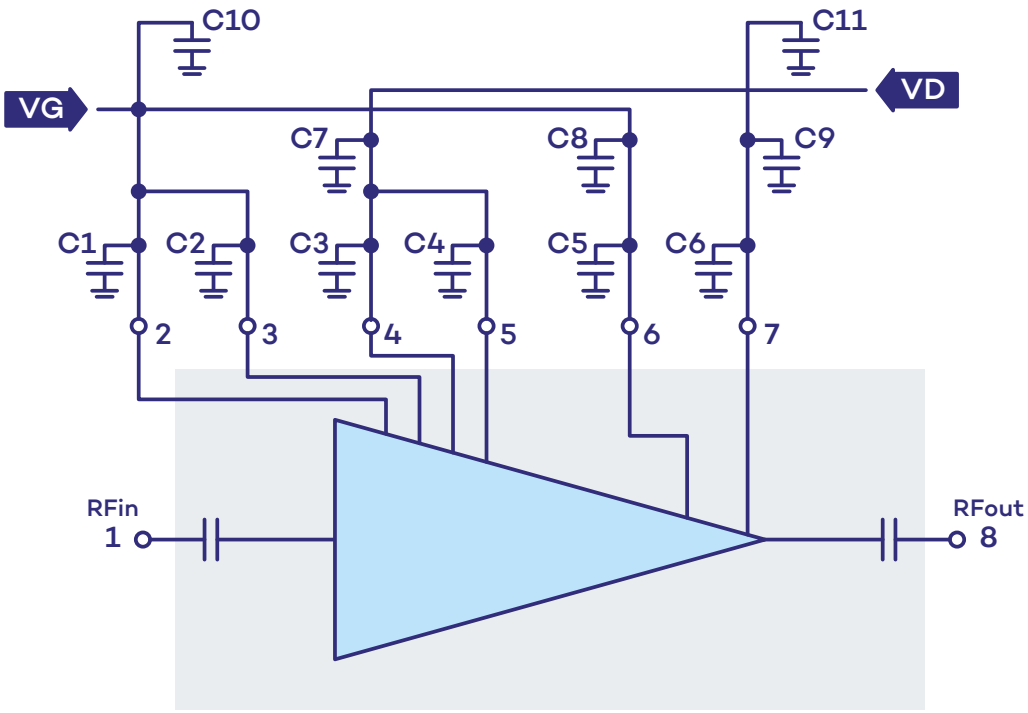


PAE vs Frequency vs I_{DQ}



Application circuit

- C1 to C6 = 180pF
- C7 to C9 = 1nF
- C10 = 100µF
- C11 = 1µF
- C1 to C9 should be MIM capacitors



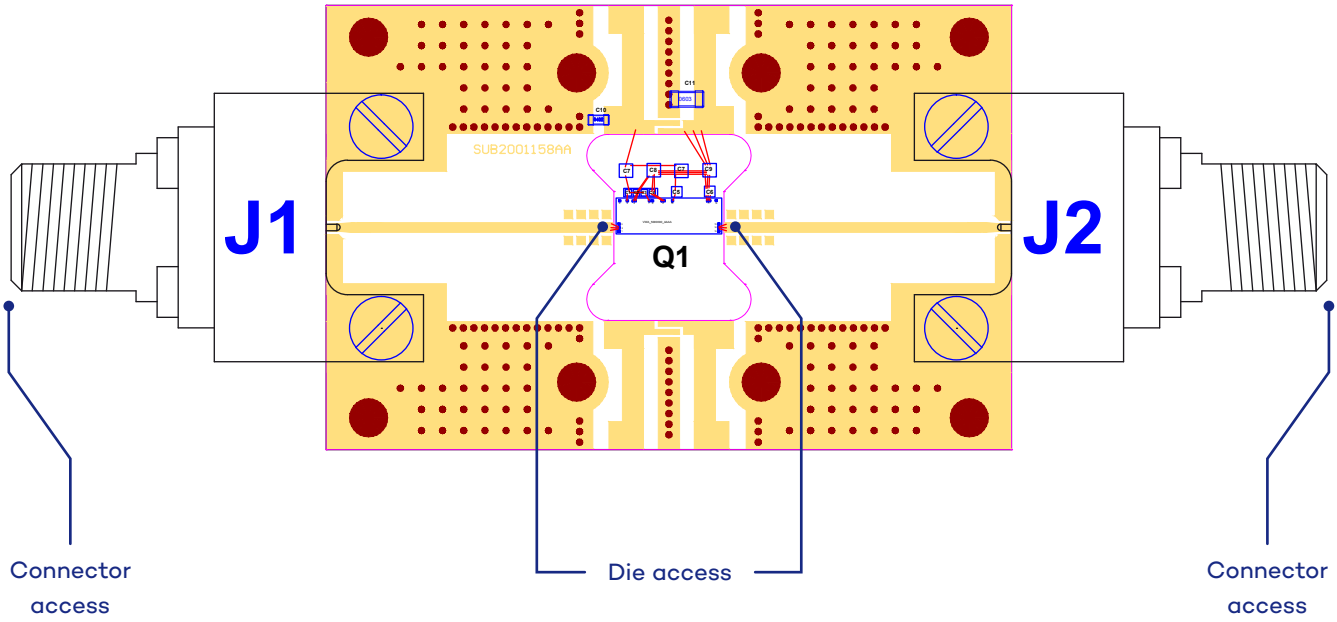
Bias-up procedure

1. Apply V_G = -3V
2. Apply V_D = +28V
3. Adjust V_G to obtain
the specificied I_{DQ} = 190 mA
(V_G = -2.35V Typ.)
4. Apply RF signal in pulsed mode

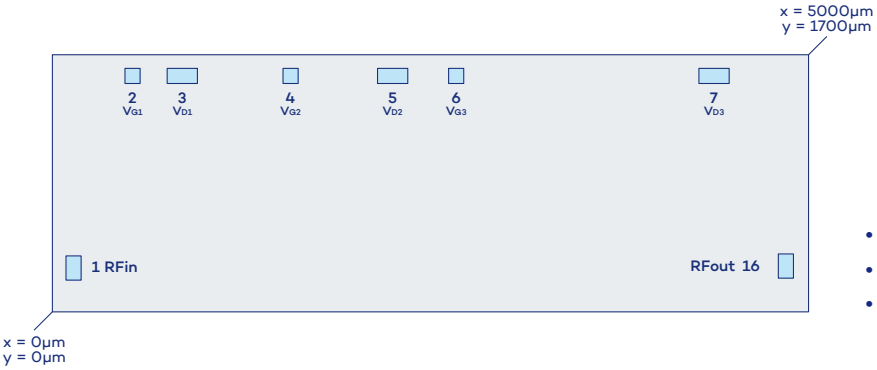
Bias-down procedure

1. Turn off RF signal
2. Reduce V_G = -3V
3. Apply V_D = 0V
4. Turn off power supply

Evaluation Board (EVB) Layout Assembly



Die Layout & Pin Out



- Die size = 5000µm x 1700µm
- Die thickness = 100µm
- Die size tolerance = 50µm

Pad number	Pad center X (µm)	Pad center Y (µm)	Size (µm x µm)	Name	Function
1	140	290	100 x 160	RFin	RF Input
2	530	1560	100 x 100	V_{G1}	Gate Bias
3	859	1560	200 x 100	V_{D1}	Drain Bias
4	1575	1560	100 x 100	V_{G2}	Gate Bias
5	2250	1560	200 x 100	V_{D2}	Drain Bias
6	2670	1560	100 x 100	V_{G3}	Gate Bias
7	4375	1560	200 x 100	V_{D3}	Drain Bias
8	4850	303	100 x 160	RFout	RF Output

- Die bottom must be connected to ground (RF and DC)

Ordering information

Product Code	Parameter
VM090D	8.5 to 10.5GHz - 20W GaN/SiC Power Amplifier in die form

Associated Material

- Packaged die
- Die Evaluation Board (die EVB)
- Packaged die Evaluation Board (packaged die EVB)
- Mechanical files (DXF)
- Measurents files (S2P)

Product Compliance Information

Solderability
Use only AuSn (80/20) solder and limit exposure to temperature above 300 °C during 3-4 minutes, maximum.

ESD Sensitivy Rating
Test: Human Body Model (HBM)
Std: JEDEC Standard JESD22-A114

RoHS-Compliance
This part is compliant with EU 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment).

Other attributes
- Lead Free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A (C15H12Br402) Free
- PFOS Free
- SVHC Free

Contact information

For the latest specifications, additional product information, worldwide sales and distribution locations, and information about Vectrawave.

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