

17 – 21.5GHz 2.8W Power Amplifier

GaN Monolithic Microwave IC in SMD leadless package

Description

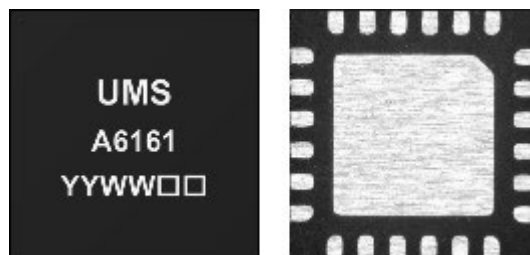
The CHA6161-QKB is a three-stage power amplifier operating in the 17 – 21.5GHz frequency range.

Depending on the biasing point, it can provide between 31dBm and 34.5dBm of output power associated with 43% Power Added Efficiency on average across the frequency band.

This power amplifier operates on a 12 – 20V supply with a drain current of 30 – 120mA.

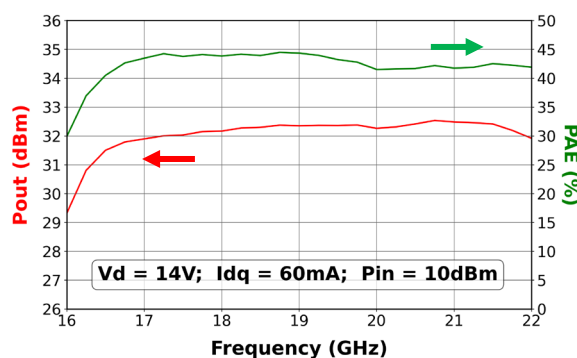
Designed for space applications, it is also ideal for a wide range of microwave systems.

The product is developed on a robust GaN on SiC HEMT process and is provided on low cost SMD RoHS compliant QFN plastic package.



Main Features

- 17 – 21.5 GHz frequency range
- Linear Gain is more than 30dB
- 32dBm Pout @Vd = 14V @Max_PAE
- Associated PAE = 43%
- DC bias: Vd = 14V @Idq = 60mA
- 24 Leads – QFN 4x4mm²
- MSL3



Main Electrical Characteristics

Test conditions : T_{case} = 25°C, Vd = 14V, Idq = 60mA

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	17		21.5	GHz
Gain	Linear Gain		32		dB
Pout	Saturated output Power (Pin = 10dBm)		32		dBm
PAE	Power Added Efficiency (Pin = 10dBm)		43		%

Specifications**Test conditions :** $T_{case} = 25^{\circ}\text{C}$, $V_d = 14\text{V}$, $I_{dq} = 60\text{mA}$

Symbol	Parameter	Min	Typ	Max	Unit
Freq	Frequency range	17		21.5	GHz
Gain	Linear Gain		32		dB
Pout	Saturated output Power ($P_{in} = 10\text{dBm}$)		32		dBm
PAE	Power Added Efficiency ($P_{in} = 10\text{dBm}$)		43		%
I_d	Drain current at saturation ($P_{in} = 10\text{dBm}$)		250		mA
S11	Input Return Loss		8		dB
S22	Output Return Loss		8		dB

Test conditions : $T_{case} = 25^{\circ}\text{C}$, $V_d = 20\text{V}$, $I_{dq} = 60\text{mA}$

Symbol	Parameter	Min	Typ	Max	Unit
Gain	Linear Gain		32		dB
Pout	Saturated output Power ($P_{in} = 10\text{dBm}$)		34.5		dBm
PAE	Power Added Efficiency ($P_{in} = 10\text{dBm}$)		40		%
I_d	Drain current at saturation ($P_{in} = 10\text{dBm}$)		320		mA

These values are representative of on board measurements as defined on the drawing in paragraph "Evaluation mother board".

Recommended Operating Range ^{(1), (2)}

Symbol	Parameter	Values	Unit
V_d	Drain bias voltage range	12 – 20	V
I_{dq}	Drain quiescent current	30 – 120	mA
$T_{junction}$	Maximum junction temperature	200	$^{\circ}\text{C}$
P_{in}	Maximum peak input power overdrive @30mA	15	dBm
P_{in}	Maximum peak input power overdrive @60mA	13	dBm
P_{in}	Maximum peak input power overdrive @120mA	11	dBm

⁽¹⁾ Electrical performances are defined for specified test conditions

⁽²⁾ Electrical performances are not guaranteed over all recommended operating conditions

Recommended Operating Range for Space Application ^{(1), (2)}

Symbol	Parameter	Values	Unit
V_d	Drain bias voltage range	12 – 16	V
I_{dq}	Drain quiescent current	30 – 60	mA
$T_{junction}$	Maximum junction temperature	160	$^{\circ}\text{C}$
P_{in}	Maximum peak input power overdrive @30mA	15	dBm
P_{in}	Maximum peak input power overdrive @60mA	13	dBm

⁽¹⁾ Electrical performances are defined for specified test conditions

⁽²⁾ Electrical performances are not guaranteed over all recommended operating conditions

Absolute Maximum Ratings ⁽³⁾

Symbol	Parameter	Values	Unit
V _d	Drain bias voltage	27	V
V _g	Gate bias voltage	-7 to -1.5	V
I _{dq}	Drain quiescent current	1300	mA
P _{in}	Maximum peak input power overdrive @30mA	16	dBm
P _{in}	Maximum peak input power overdrive @60mA	14	dBm
P _{in}	Maximum peak input power overdrive @120mA	12	dBm
T _{case}	Operating temperature range	-40 to 85	°C
T _{stg}	Storage temperature range	-55 to 150	°C

⁽³⁾ Operation of this device above anyone of these parameters may cause permanent damage.

Typical Bias Conditions

Symbol	Pad N°	Parameter	Values	Unit
V _d	19; 20; 22	Drain bias voltage	12 – 20	V
V _g	8; 10; 11	Gate bias voltage	Set V _g for recommended I _{dq}	V

“Power ON” sequence

1. Bias PA gate voltage at V_g close to V_{pinch-off} (Typically: V_g ≈ -5V)
2. Apply V_{ds} bias voltage (Typically: V_d = 14V)
3. Increase V_{gs} up to quiescent bias drain current I_{dq} (pulsed applied on the gate)
4. Apply RF signal

“Power OFF” sequence

1. Turn off RF signal
2. Bias PA gate voltage at V_g close to V_{pinch-off} (Typically: V_g ≈ -5V)
3. Turn V_{ds} bias voltage to 0V
4. Turn V_{gs} bias voltage to 0V

Device Thermal Performance

All the figures given in this section are obtained assuming that the die is only cooled down by conduction through the package case.

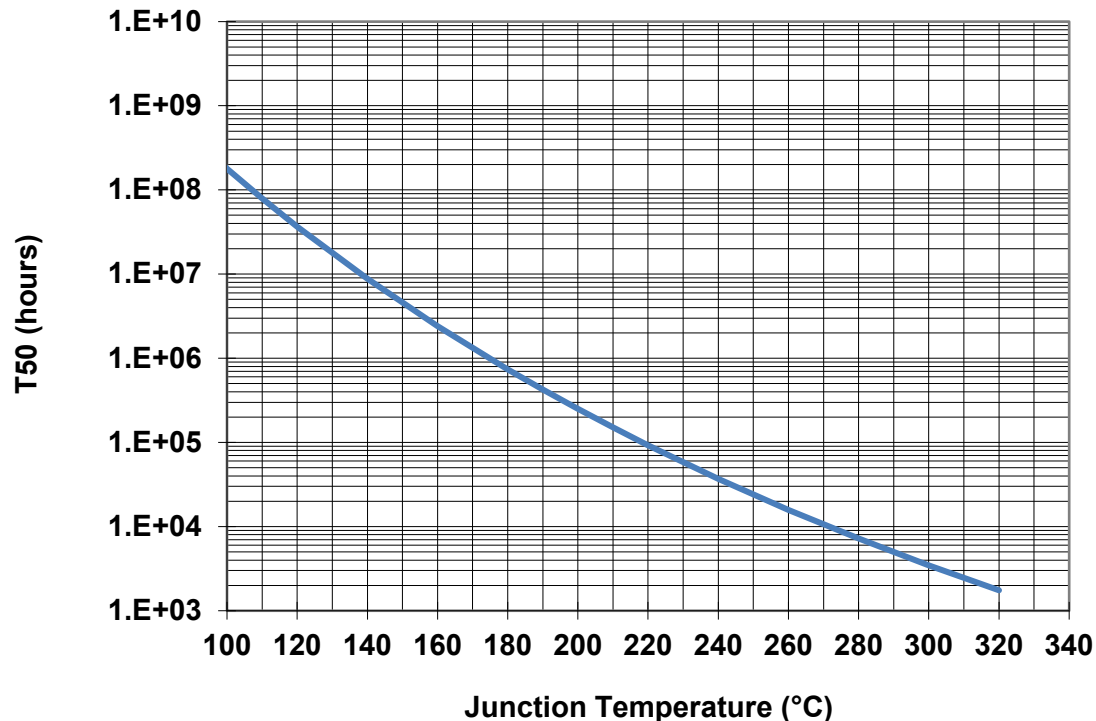
The temperature is monitored at the QFN backside interface (T_{case}).

For nominal operation, the system's maximum temperature must be adjusted to ensure that the junction temperature ($T_{junction}$) remains below the maximum value specified in the Recommended Operating Ratings table.

The system PCB must be designed to comply with this requirement.

Parameter	Conditions	$T_{junction}$ (°C)	R_{TH} (°C/W)	T50 (hours)
$R_{TH}^{(1)}$ Thermal Resistance (Junction to Case)	Vd = 12V Pout = 30dBm Pdis = 2.5W	128	17.1	2E+07
	Vd = 16V Pout = 32.5dBm Pdis = 3.6W	158	20.2	2E+06
	Vd = 20V Pout = 34.5dBm Pdis = 4.6W	195	23.9	3E+05

⁽¹⁾ Assuming 85°C T_{case} .

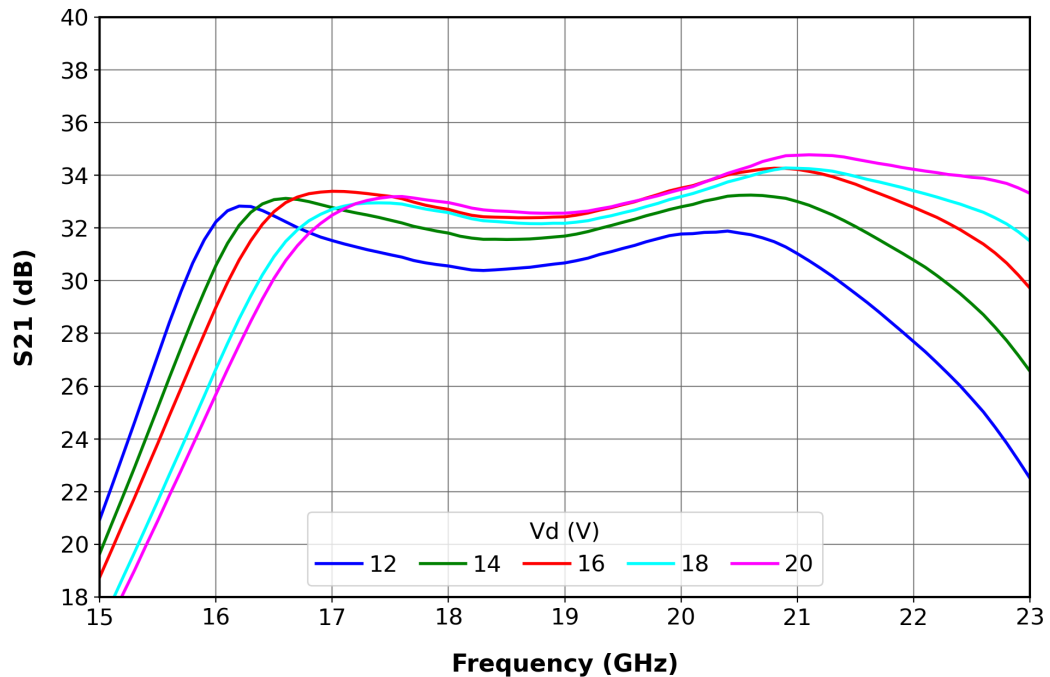


Typical Board Measurements

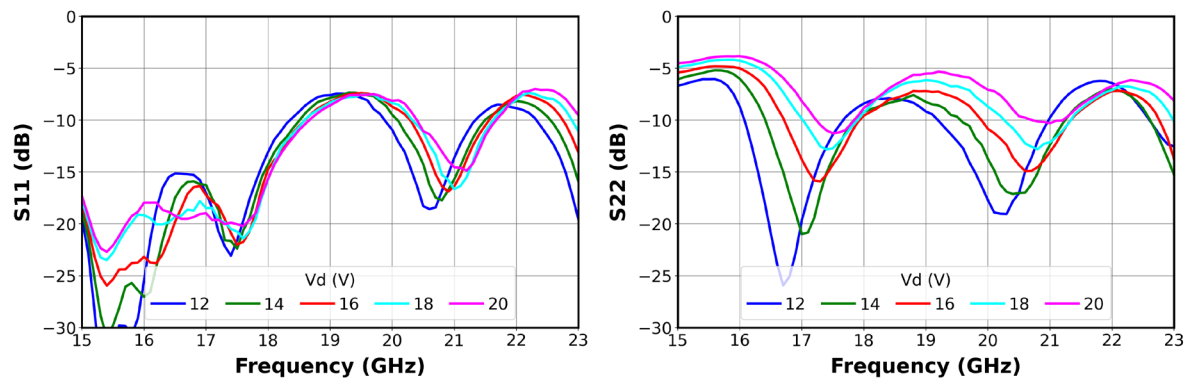
Board losses are de-embedded. Measurements are given in the package reference planes.

Test conditions : CW, $T_{\text{case}} = 25^{\circ}\text{C}$, $I_{\text{dQ}} = 60\text{mA}$

Linear gain vs. Freq and Vd



Input & Output Return losses vs. Freq and Vd

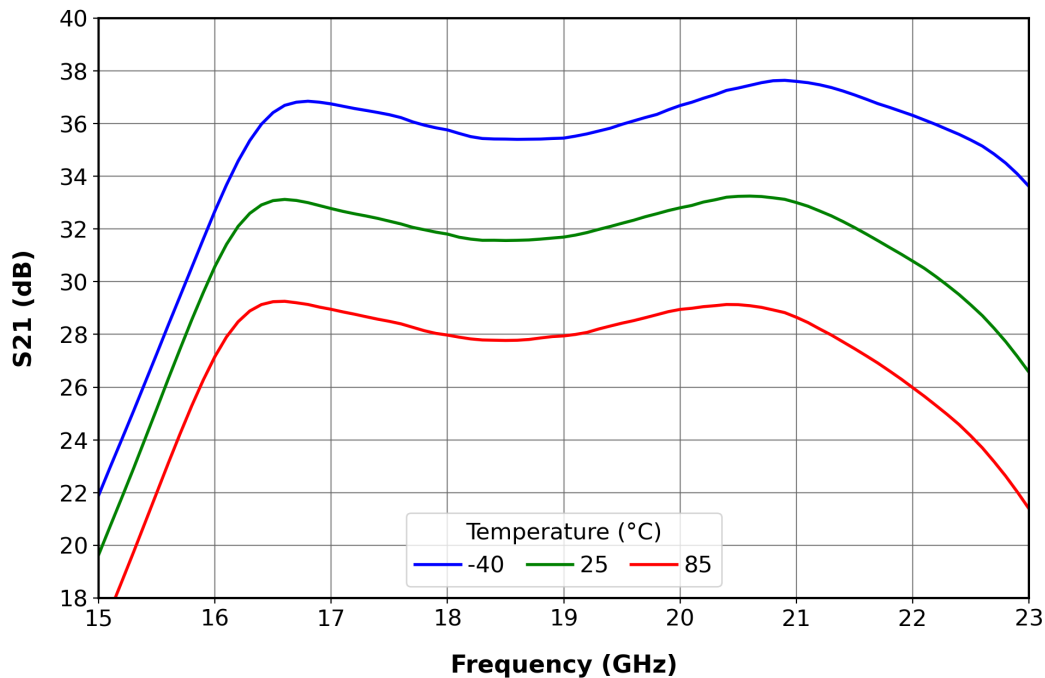


Typical Board Measurements

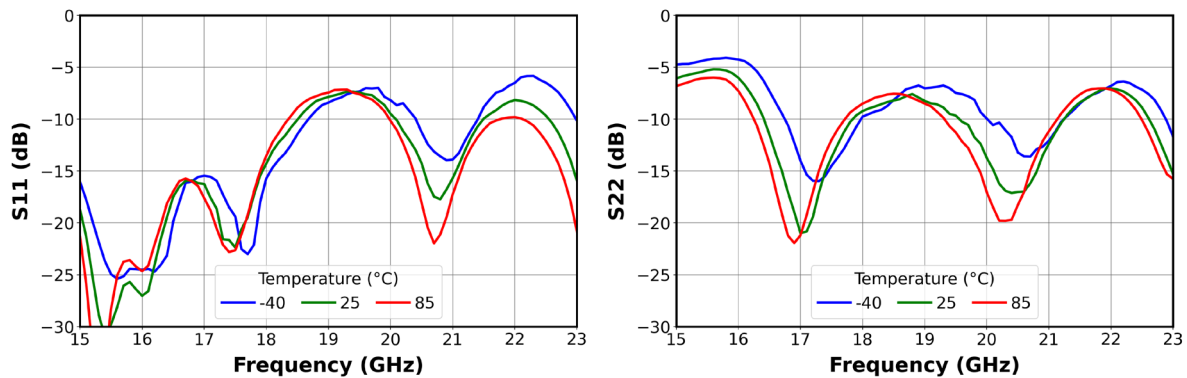
Board losses are de-embedded. Measurements are given in the package reference planes.

Test conditions : CW, $V_d = 14V$, $I_{dq} = 60mA$

Linear gain vs. Freq and Temperature



Input & Output Return losses vs. Freq and Temperature

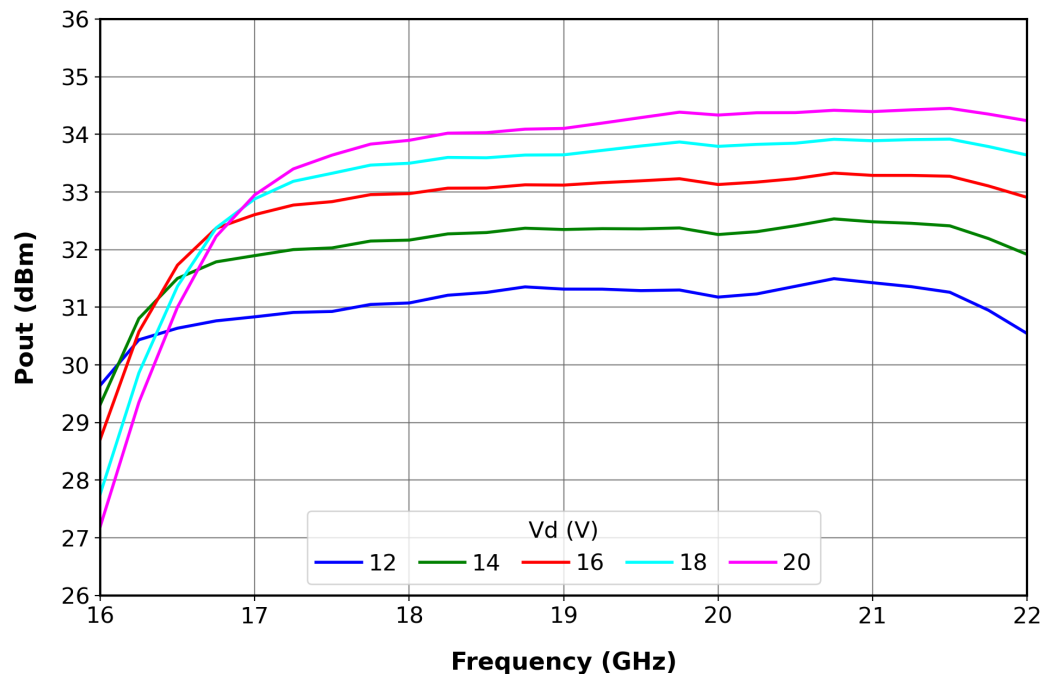


Typical Board Measurements

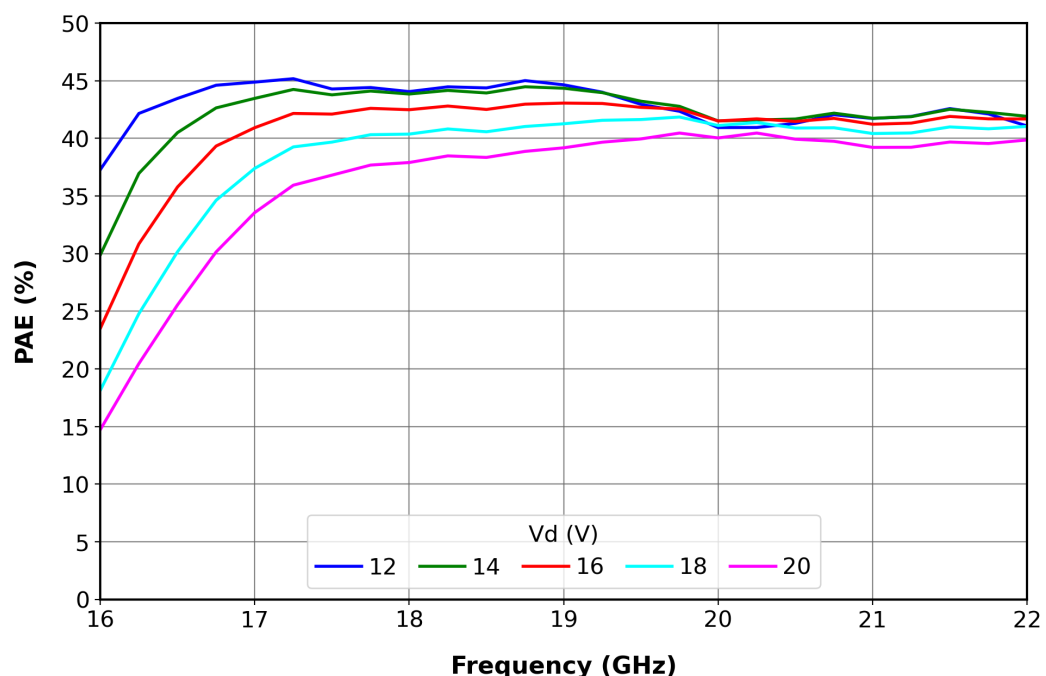
Board losses are de-embedded. Measurements are given in the package reference planes

Test conditions : CW, $T_{\text{case}} = 25^{\circ}\text{C}$, $I_{\text{dQ}} = 60\text{mA}$, $P_{\text{in}} = 10\text{dBm}$

Pout vs. Freq and Vd



PAE vs. Freq and Vd

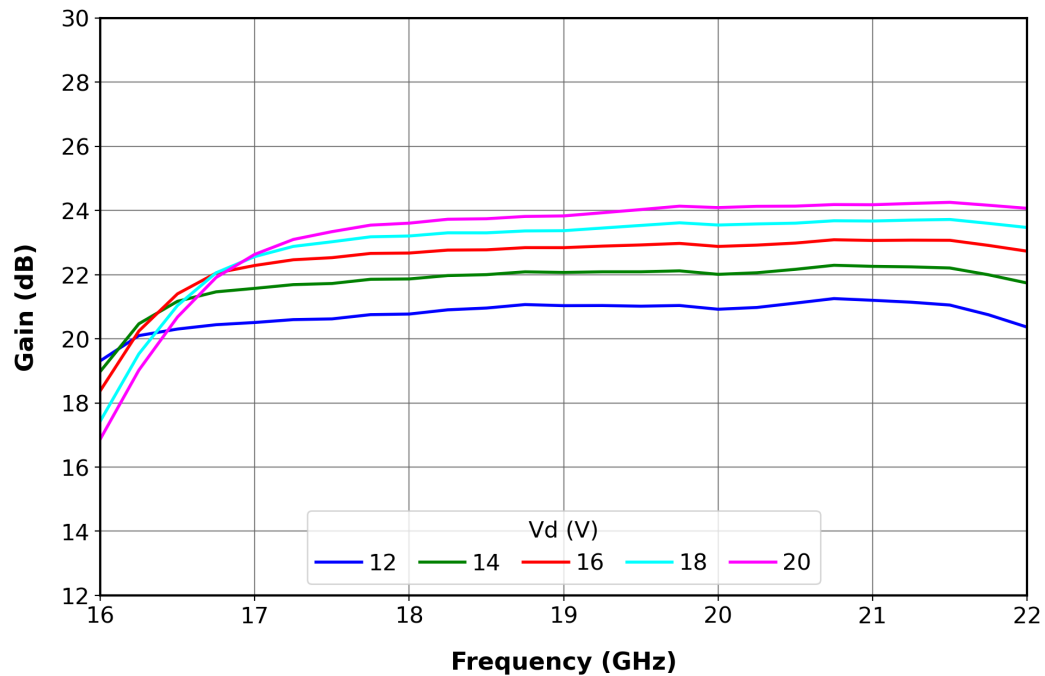


Typical Board Measurements

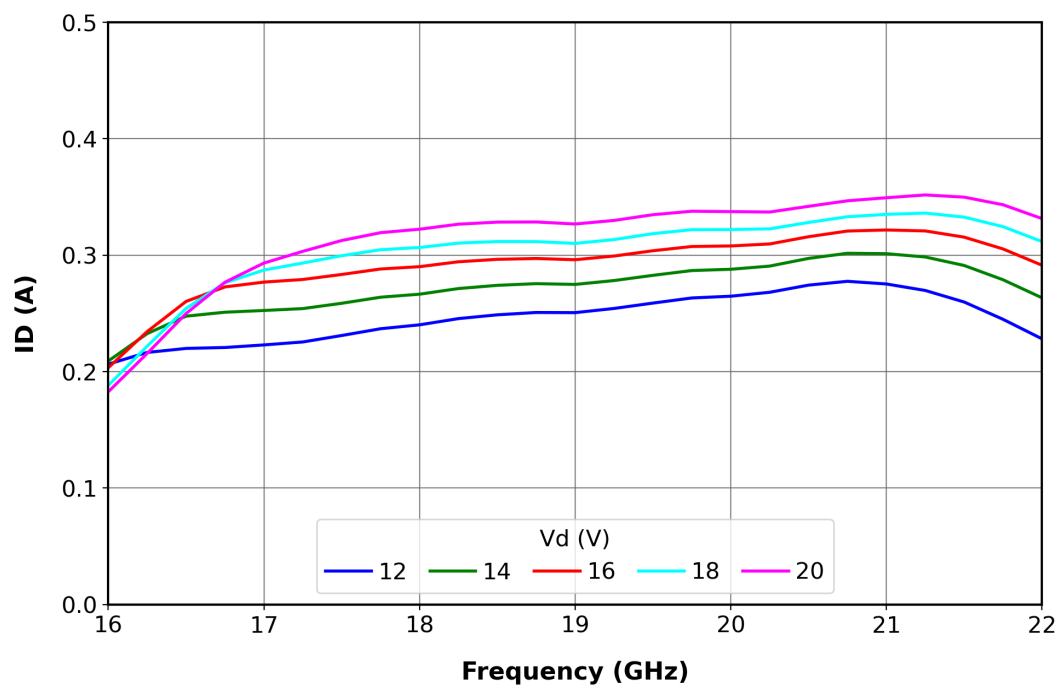
Board losses are de-embedded. Measurements are given in the package reference planes

Test conditions : CW, $T_{case} = 25^{\circ}C$, $I_{dq} = 60mA$, $P_{in} = 10dBm$

Gain vs. Freq and Vd



Id vs. Freq and Vd



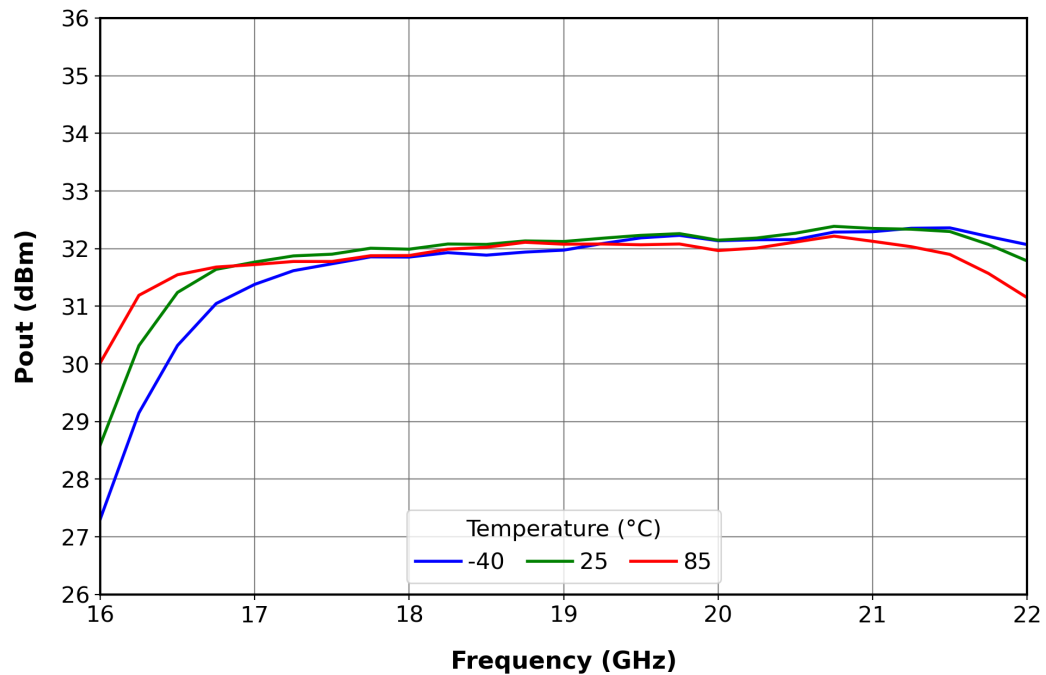
Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes

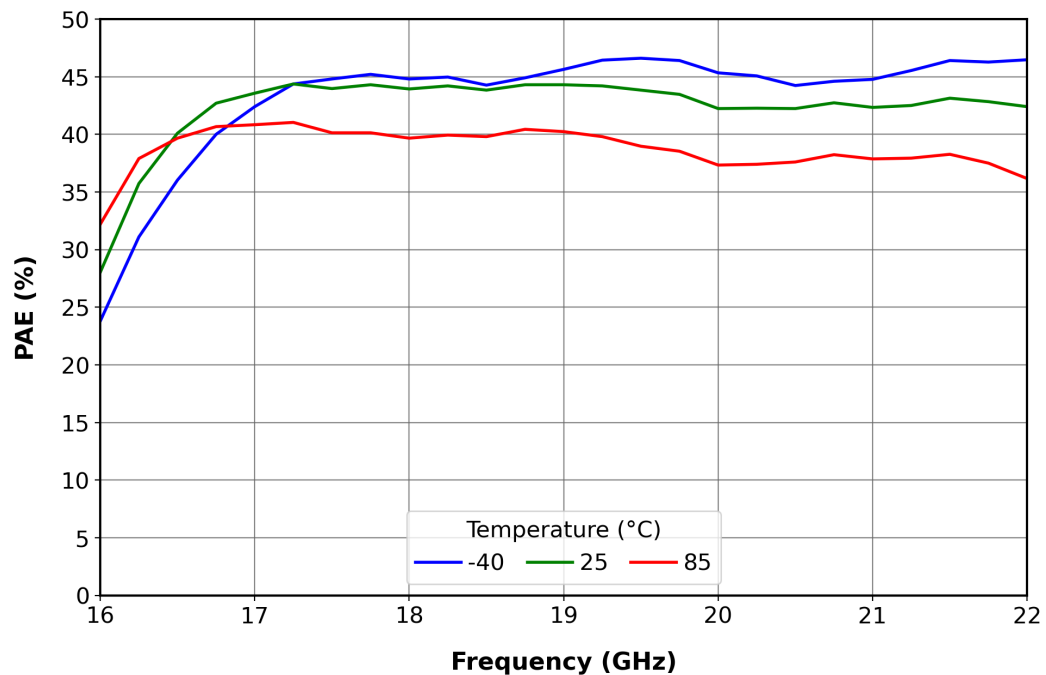
Test conditions : CW, $V_d = 14V$, $I_{dq} = 60mA$,

$P_{in} = 5dBm@-40^{\circ}C$, $P_{in} = 9dBm@25^{\circ}C$, $P_{in} = 13dBm@85^{\circ}C$

Pout vs. Freq and Temperature



PAE vs. Freq and Temperature



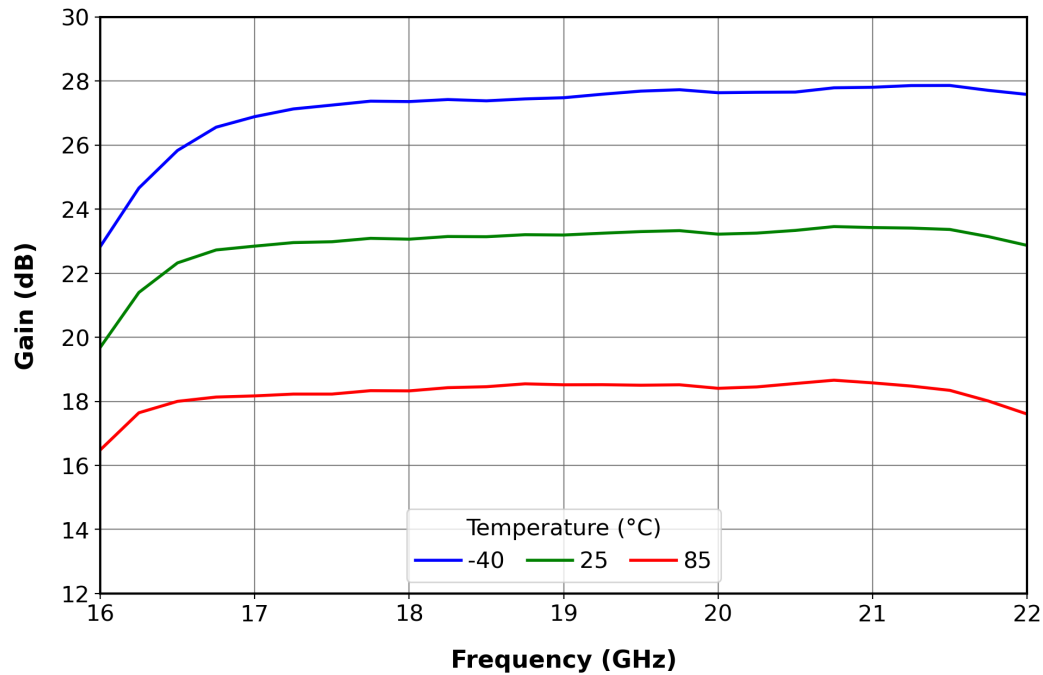
Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes

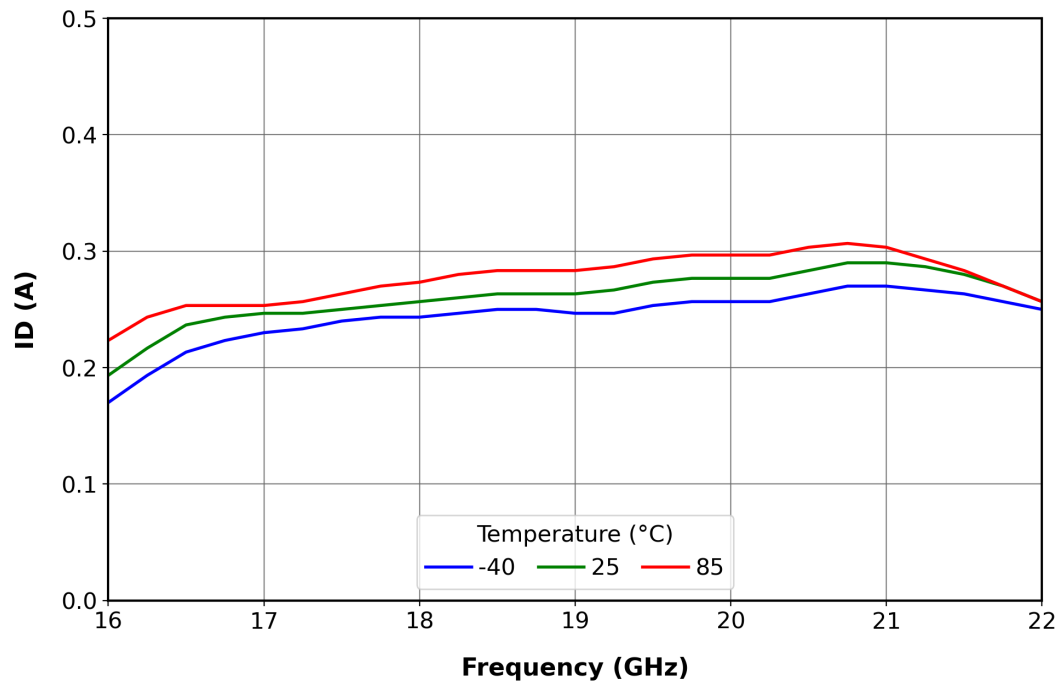
Test conditions : CW, $V_d = 14V$, $I_{dq} = 60mA$,

$P_{in} = 5dBm@-40^{\circ}C$, $P_{in} = 9dBm@25^{\circ}C$, $P_{in} = 13dBm@85^{\circ}C$

Gain vs. Freq and Temperature



Id vs. Freq and Temperature

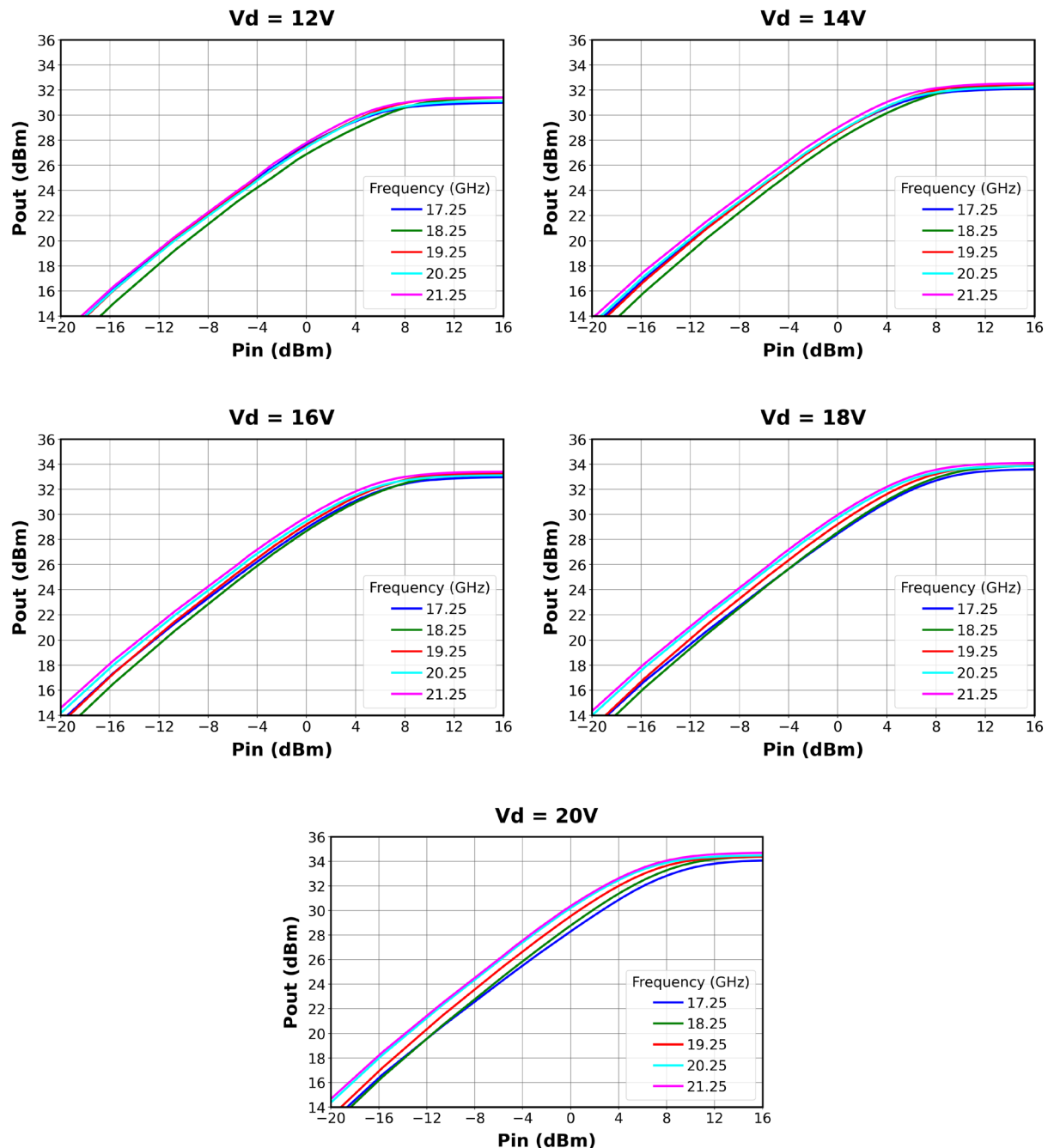


Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

Test conditions : CW, $T_{\text{case}} = 25^{\circ}\text{C}$, $I_{\text{dq}} = 60\text{mA}$

Pout vs. Pin and Freq for different Vd

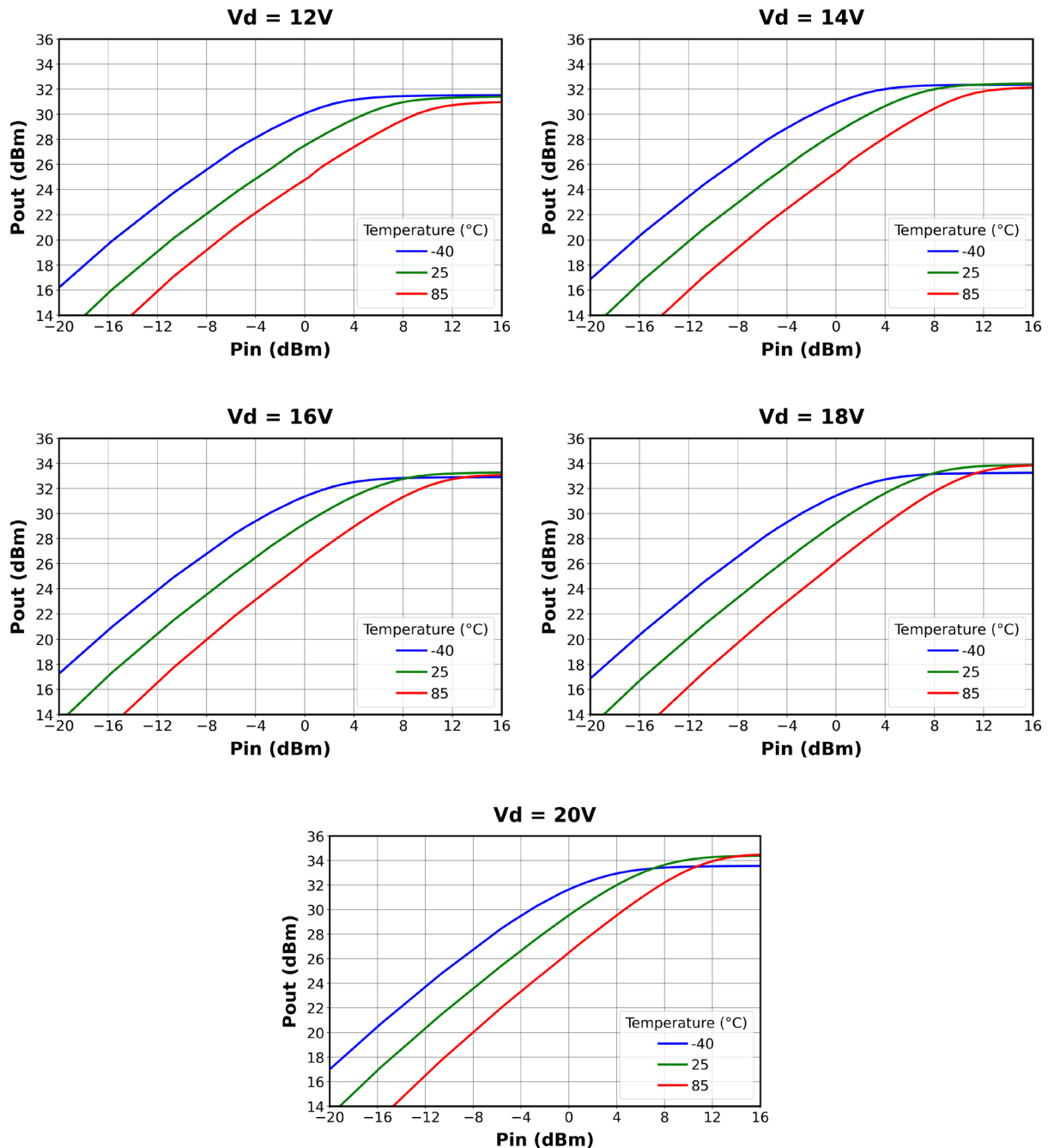


Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

Test conditions : CW, Frequency = 19.25GHz, Idq = 60mA

Pout vs. Pin and Temperature for different Vd

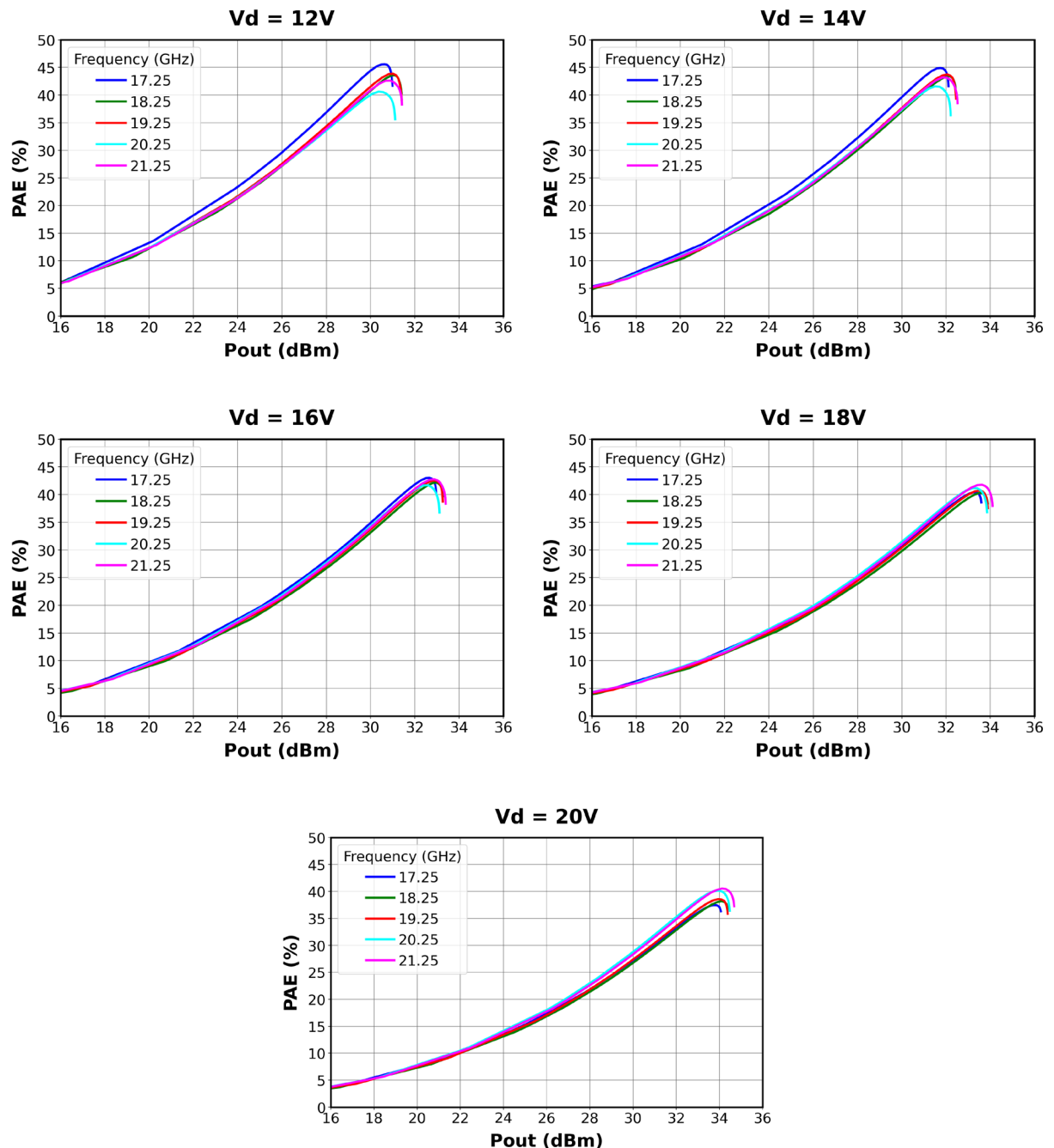


Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

Test conditions : CW, $T_{\text{case}} = 25^{\circ}\text{C}$, $I_{\text{dq}} = 60\text{mA}$

PAE vs. Pout and Freq for different Vd



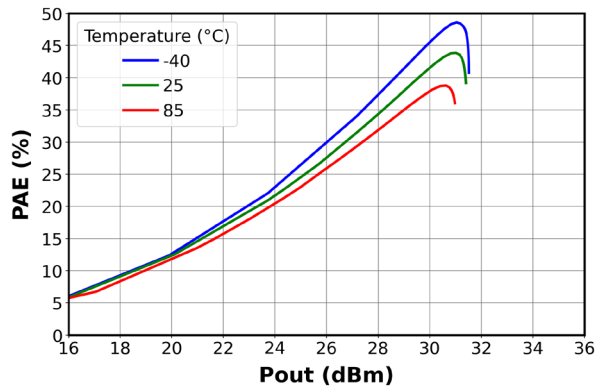
Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

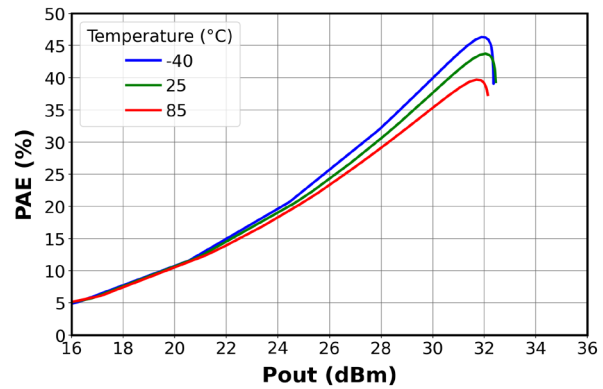
Test conditions : CW, Frequency = 19.25GHz, Idq = 60mA

PAE vs. Pout and Temperature for different Vd

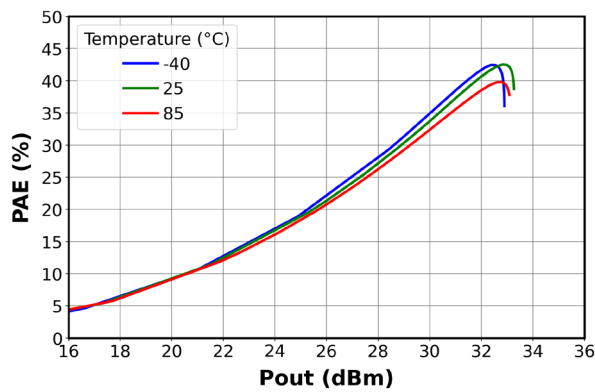
Vd = 12V



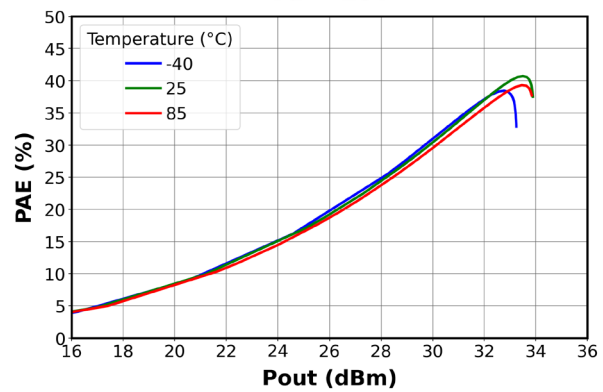
Vd = 14V



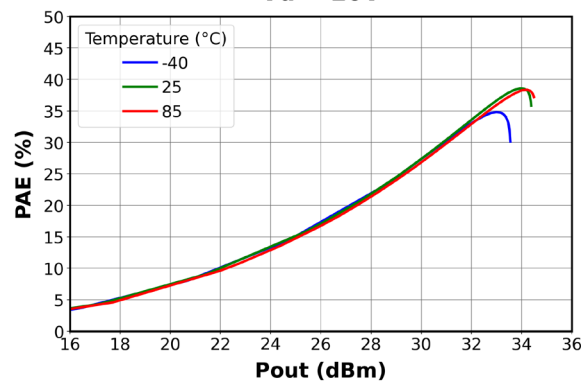
Vd = 16V



Vd = 18V



Vd = 20V

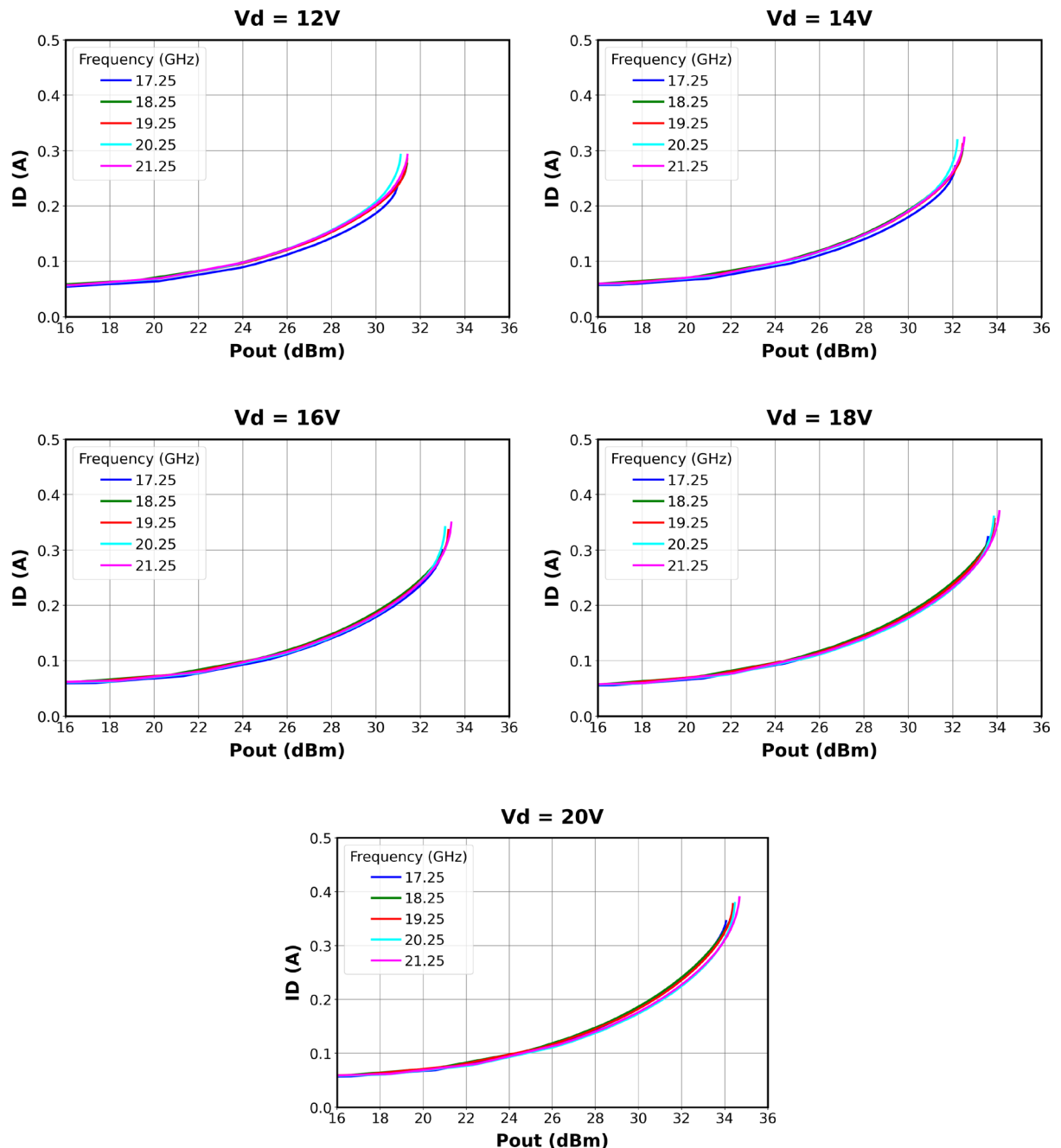


Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

Test conditions : CW, $T_{\text{case}} = 25^{\circ}\text{C}$, $I_{\text{dq}} = 60\text{mA}$

I_{d} vs. P_{out} and Freq for different V_{d}

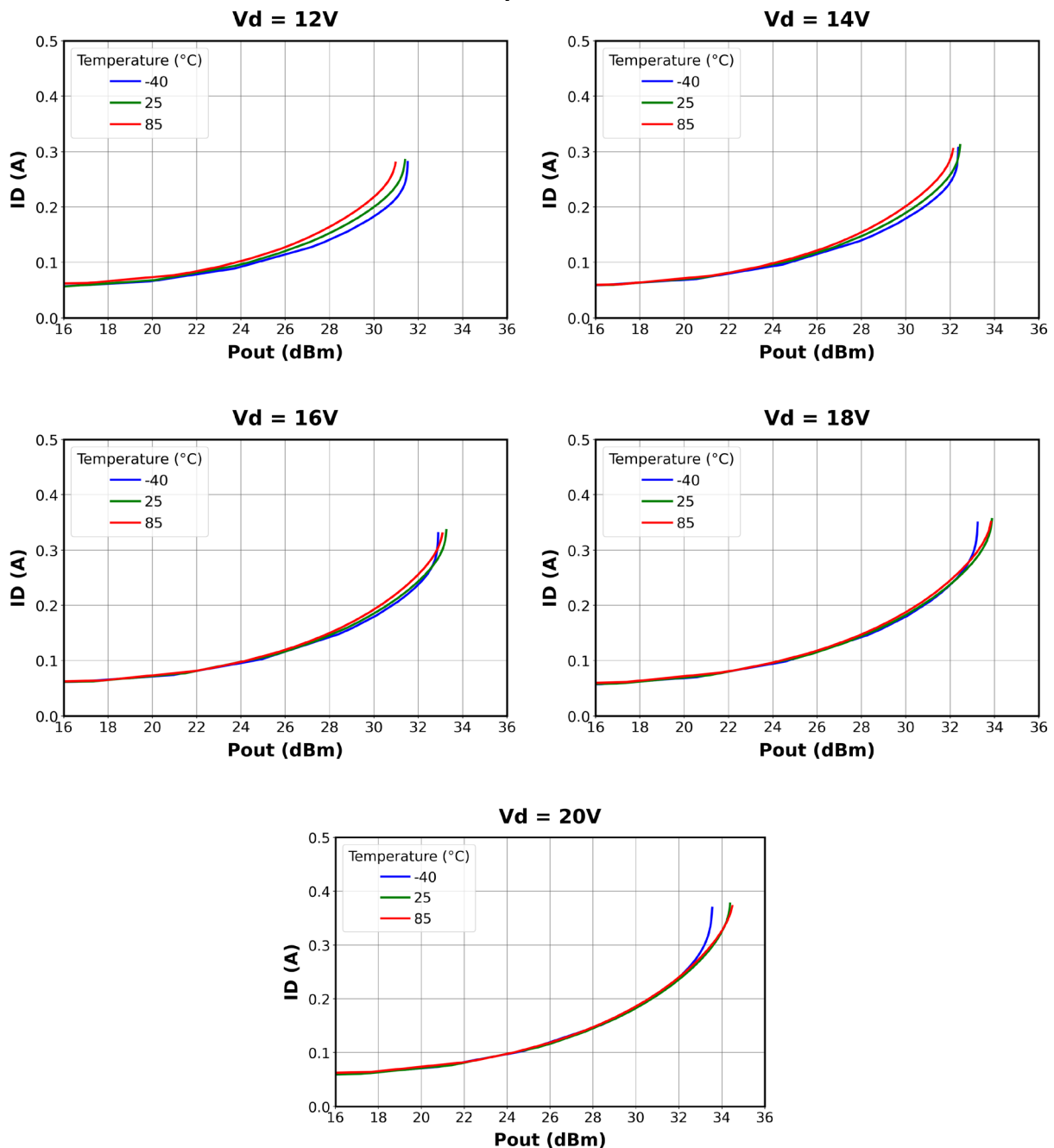


Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

Test conditions : CW, Frequency = 19.25GHz, $I_{dq} = 60\text{mA}$

I_d vs. P_{out} and Temperature for different V_d

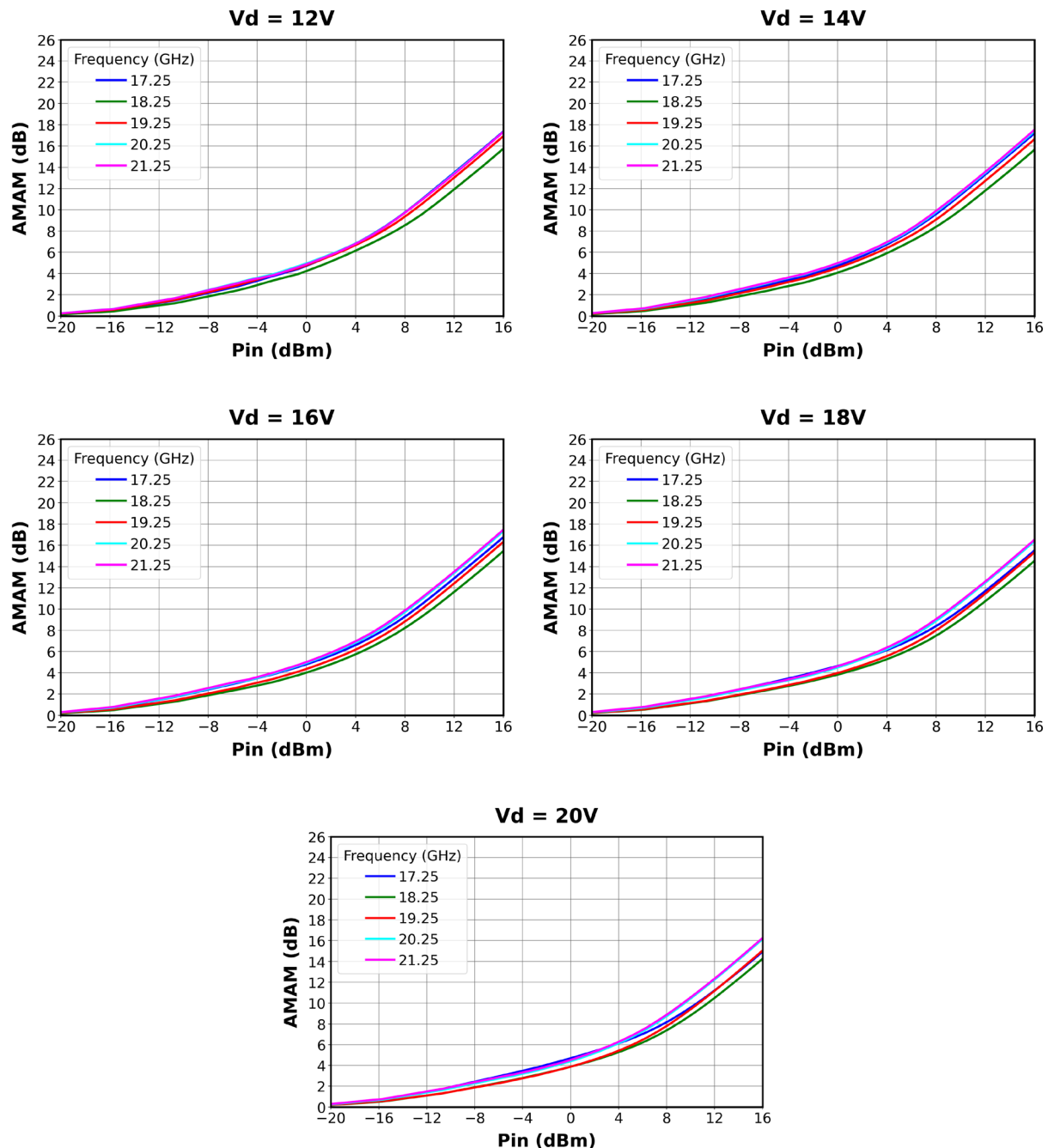


Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

Test conditions : CW, $T_{\text{case}} = 25^{\circ}\text{C}$, $I_{\text{dq}} = 60\text{mA}$

AMAM vs. Pin and Freq for different Vd



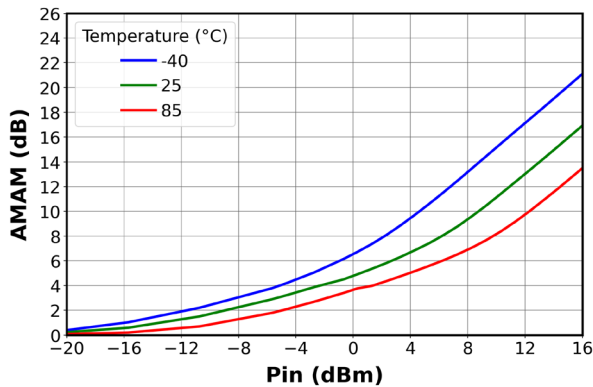
Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

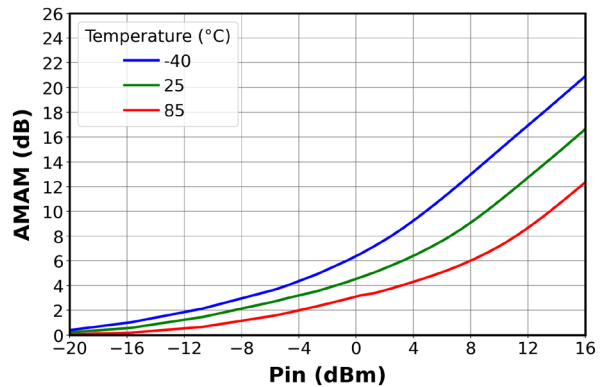
Test conditions : CW, Frequency = 19.25GHz, Idq = 60mA

AMAM vs. Pin and Temperature for different Vd

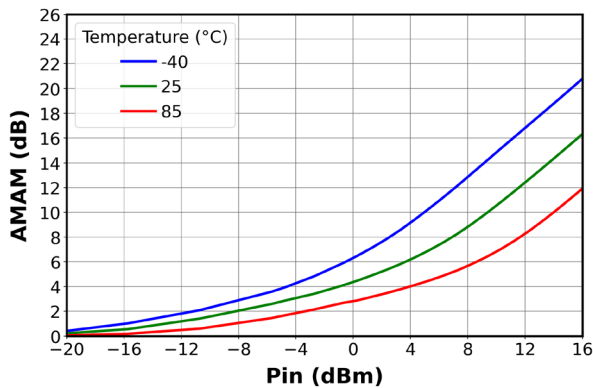
Vd = 12V



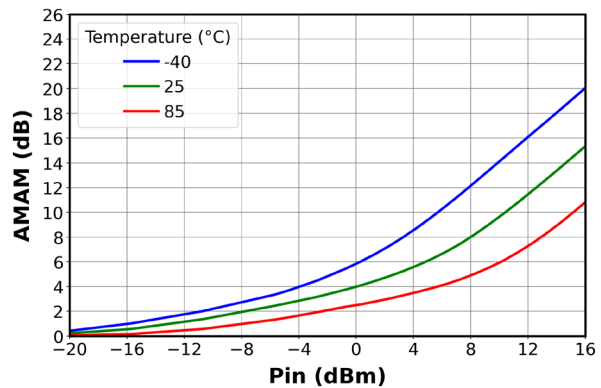
Vd = 14V



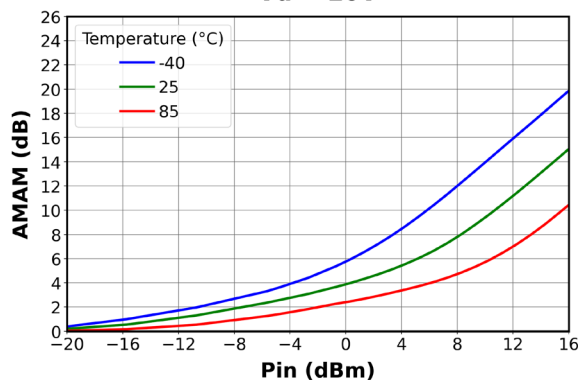
Vd = 16V



Vd = 18V



Vd = 20V

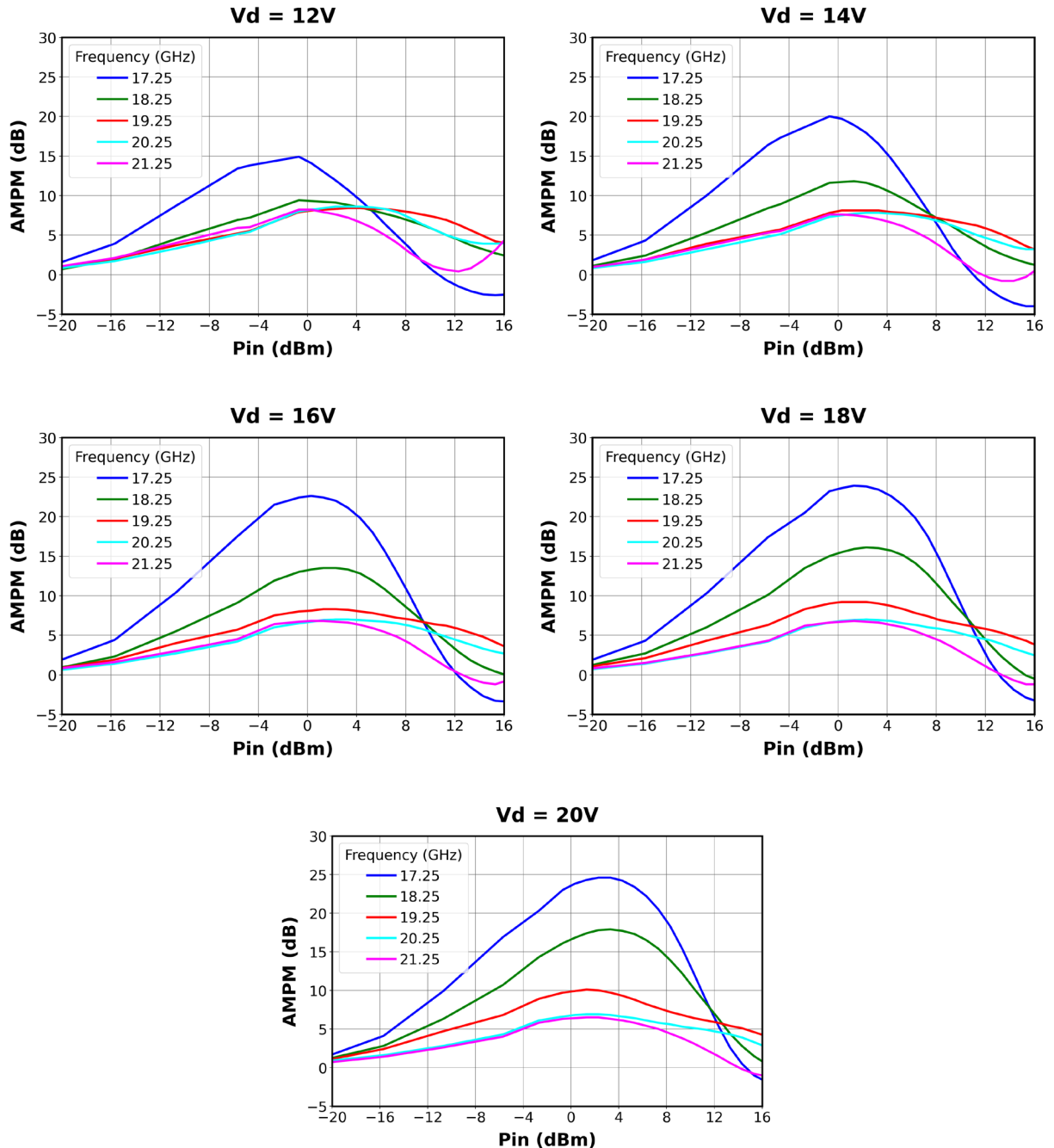


Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

Test conditions : CW, $T_{\text{case}} = 25^{\circ}\text{C}$, $I_{\text{dq}} = 60\text{mA}$

AMPM vs. Pin and Freq for different Vd



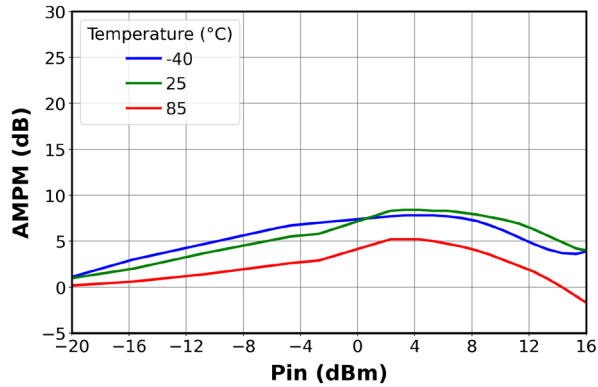
Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

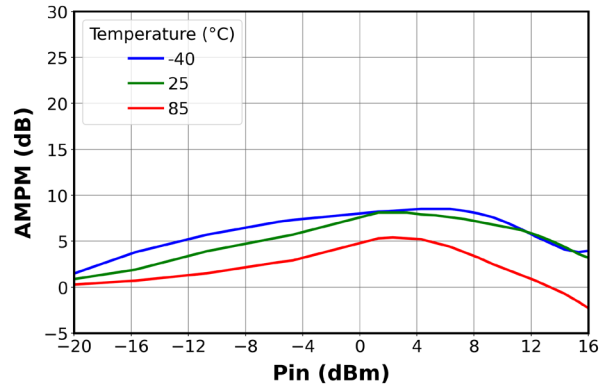
Test conditions : CW, Frequency = 19.25GHz, Idq = 60mA

AMPM vs. Pin and Temperature for different Vd

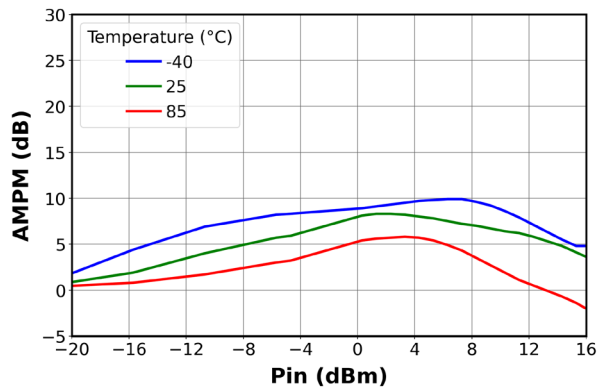
Vd = 12V



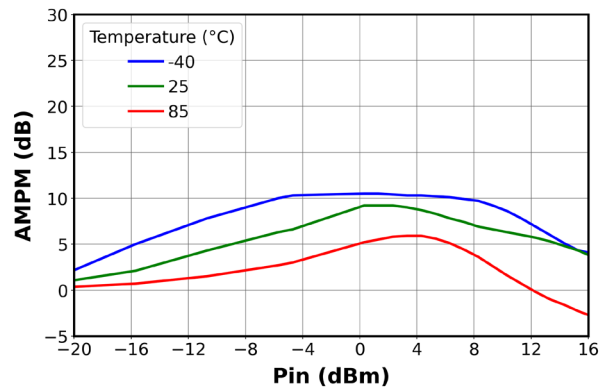
Vd = 14V



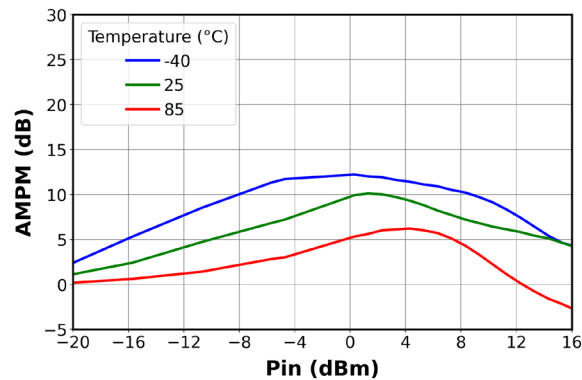
Vd = 16V



Vd = 18V



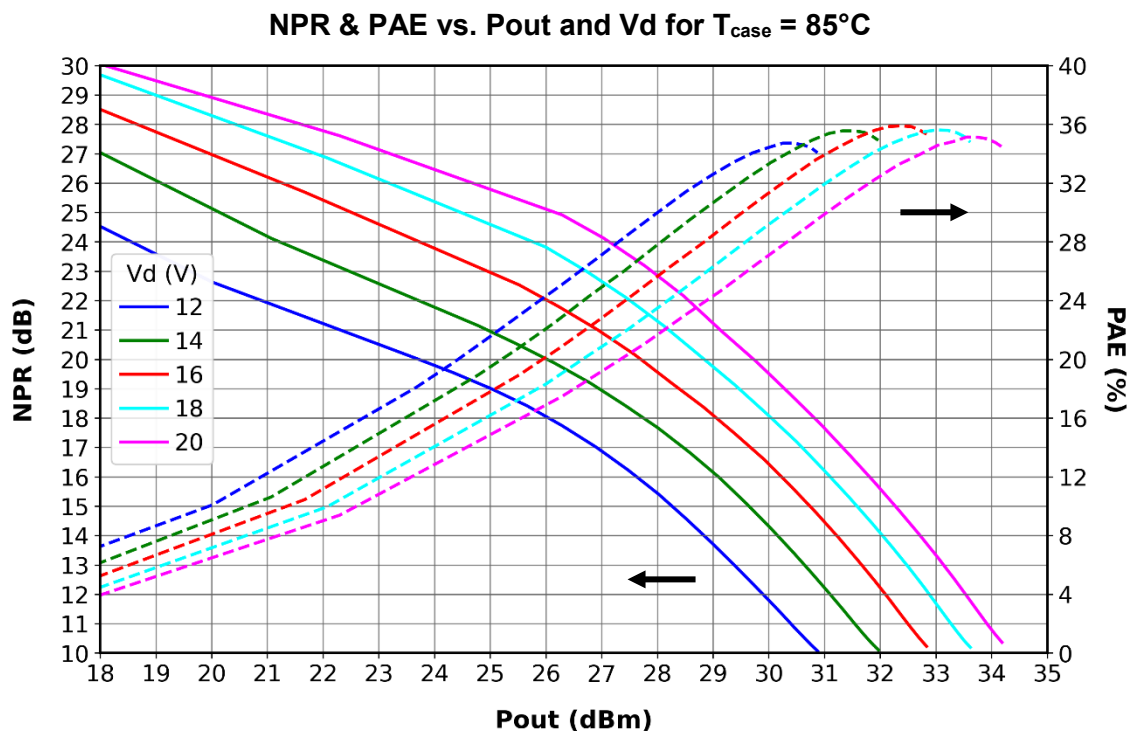
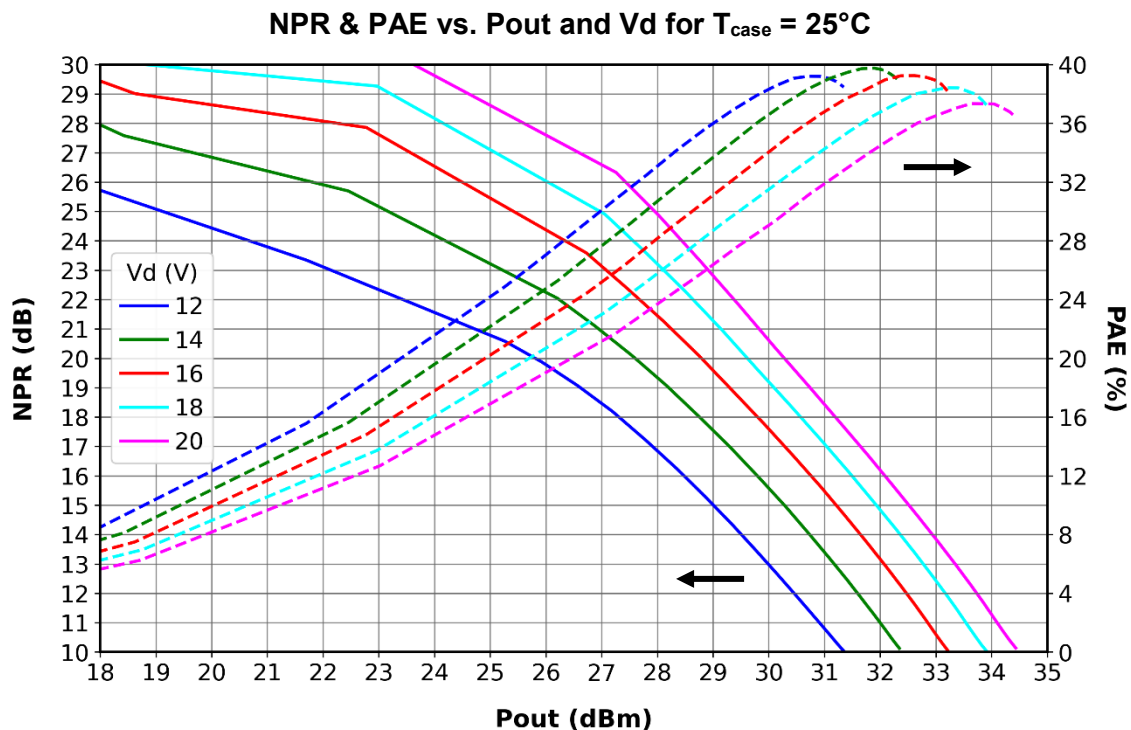
Vd = 20V



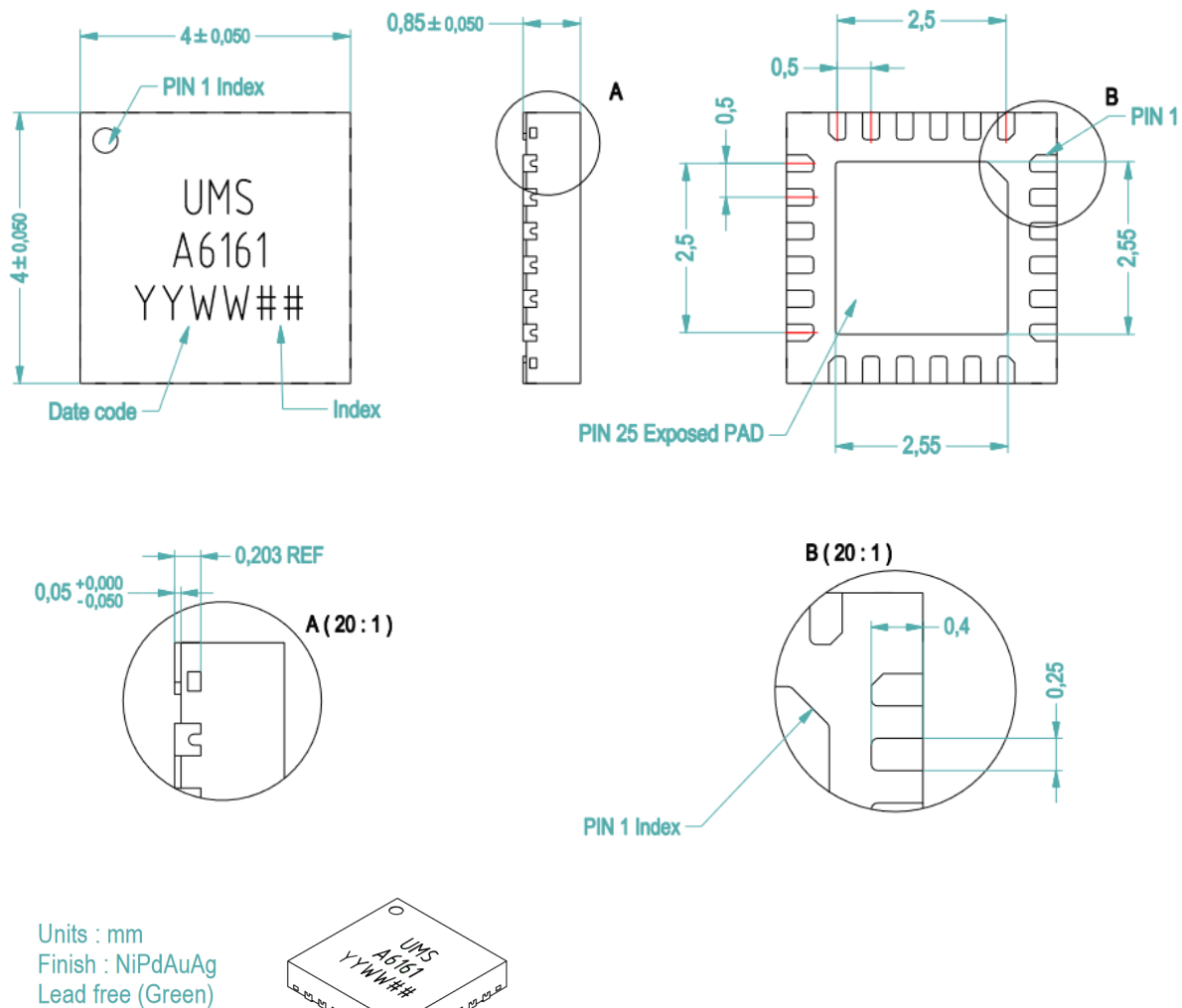
Typical Board Measurements

Board losses are de-embedded. Measurements are given in the package reference planes.

Test conditions : $I_{dq} = 60\text{mA}$, Bandwidth = 1GHz, Center Freq = 19.45GHz, Notch = 10%



Package Outline

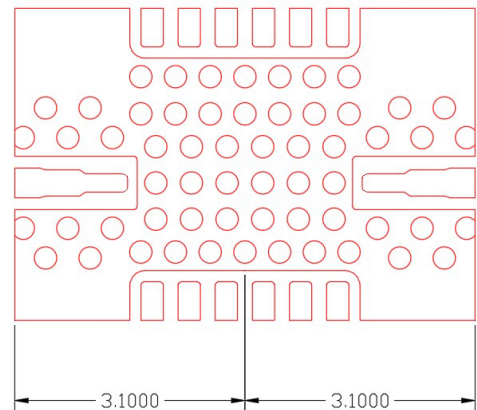


Units :	mm	1- NC	11- VG3	21- GND ⁽¹⁾
Finish :	NiPdAuAg	2- NC	12- NC	22- VD1
MSL Rating :	MSL3	3- GND ⁽¹⁾	13- NC	23- NC
Lead Free (Green)		4- RFin	14- GND ⁽¹⁾	24- NC
From the standard :	JEDEC MO-220 VGGD	5- GND ⁽¹⁾	15- RFout	25- GND ⁽¹⁾
		6- NC	16- GND ⁽¹⁾	
NC :	Not Connected	7- NC	17- NC	
		8- VG1	18- NC	
		9- GND ⁽¹⁾	19- VD3	
		10- VG2	20- VD2	

⁽¹⁾ It is strongly recommended to ground all pins marked "GND" through the PCB board. Ensure that the PCB board is designed to provide the best possible ground to the package.

Definition of measurements reference planes

The reference planes used measurements given above are symmetrical from the symmetrical axis of the package (see drawing beside). The input and output reference planes are located at 3.1mm offset (input wise and output wise respectively) from this axis.

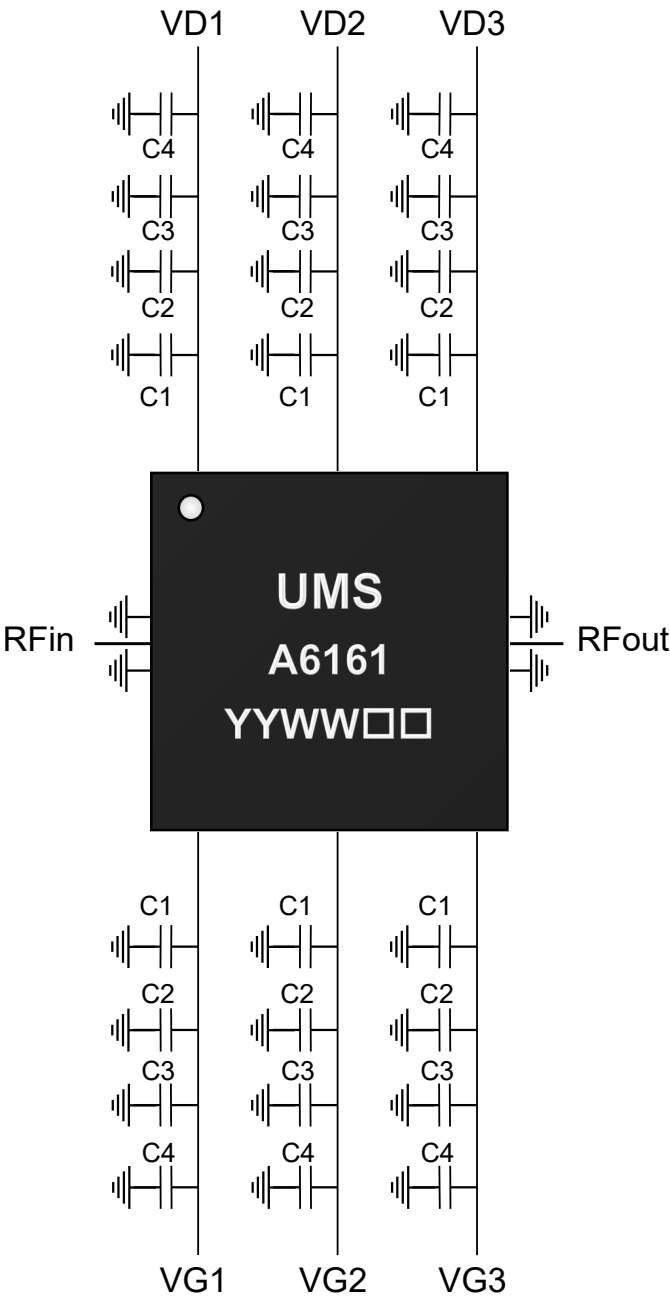
**ESD sensitivity**

Parameter	Classification	Standard
Human Body Model (HBM)	1A	ANSI/ESDA/JEDEC - JS-001

Package Information

Parameter	Value
Package body material	RoHS-compliant
	Low stress Injection Molded Plastic
Lead finish	NiPdAuAg
MSL Rating	MSL3

Recommended Assembly Plan

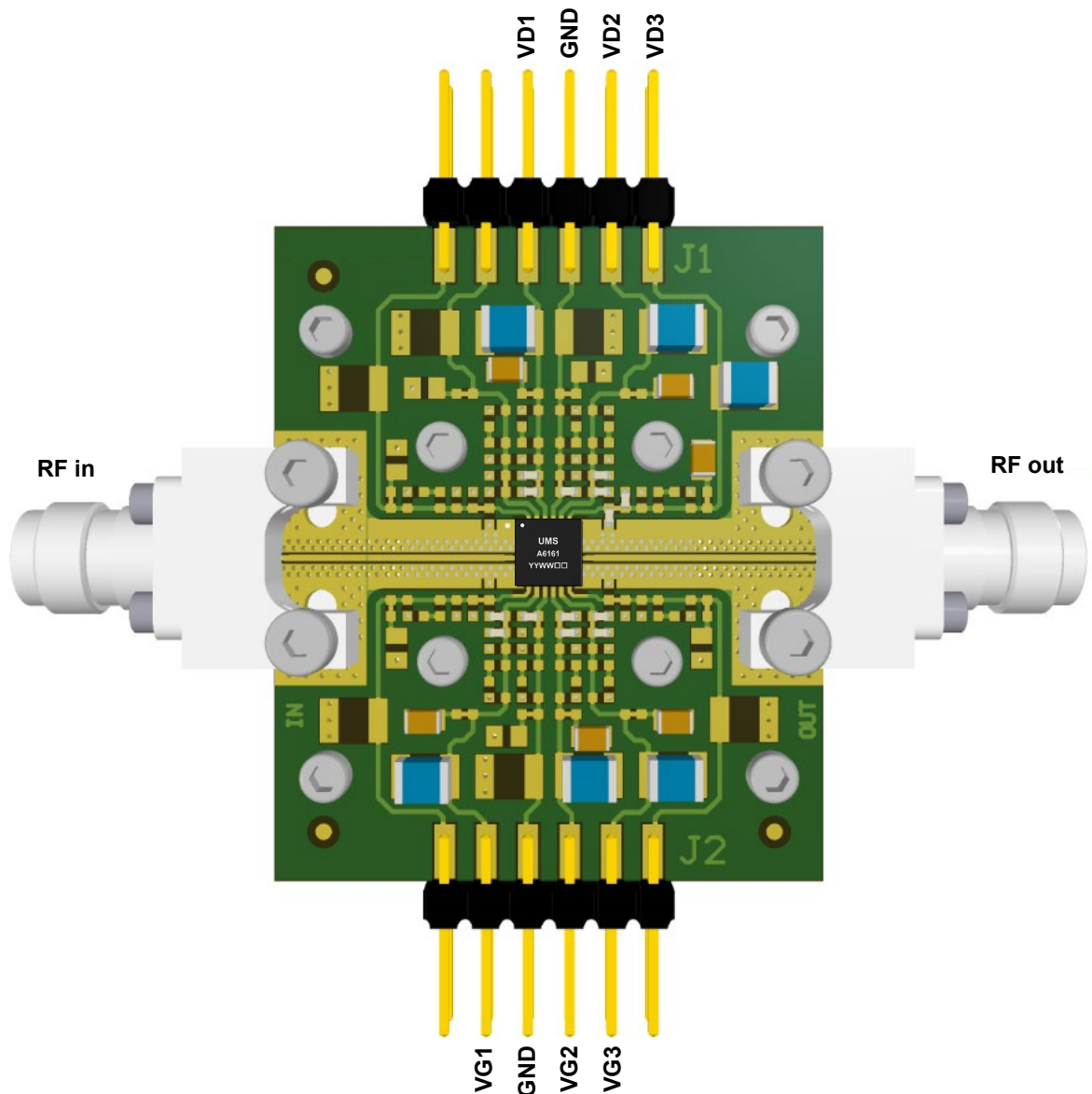


Bill of Materials

Label	Value	Description
C1	RF	Capacitor 120pF ±15% 50V
C2	RF	Capacitor 10nF ±10% 50V
C3	RF	Capacitor 1µF ±10% 50V
C4	RF	Capacitor 10µF ±10% 50V

Evaluation Board

- Compatible with the proposed footprint.
- Based on typically Ro4350 / 8mils or equivalent.
- Using a micro-strip to coplanar transition to access the package.
- Recommended for the implementation of this product on a module board.
- Decoupling capacitors of 120pF, 10nF, 1μF, 10μF ±10% are recommended for all DC accesses.
- See application note AN0017 for details.



Note: All board measurements are performed using shielded cables, even for DC bias, to ensure safe operation.

Recommended package footprint

Refer to the application note AN0017 available at <https://www.ums-rf.com> for package footprint recommendations.

SMD mounting procedure

For the mounting process standard techniques involving solder paste and a suitable reflow process can be used. For further details, see application note AN0017 at <https://www.ums-rf.com>.

Recommended environmental management

UMS products are compliant with the regulation in particular with the directives RoHS N°2011/65 and REACH N°1907/2006. More environmental data are available in the application note AN0019 also available at <https://www.ums-rf.com>.

Recommended ESD management

Refer to the application note AN0020 available at <https://www.ums-rf.com> for ESD sensitivity and handling recommendations for the UMS package products.

Description of Evaluation Board

Refer to the application note AN0031 available at <https://www.ums-rf.com> for the description of Evaluation Board for Packaged Die and recommendations for this UMS package product.

Ordering Information

QFN 4x4 package:

CHA6161-QKB/XY

Stick: XY = 20

Tape & reel: XY = 21

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