

# BLM9D2325-20AB

LDMOS 2-stage integrated Doherty MMIC

Rev. 1 — 24 July 2017

AMPLEON

Product data sheet

## 1. Product profile

### 1.1 General description

The BLM9D2325-20AB is a 2-stage fully integrated Doherty MMIC solution using Ampleon's state of the art GEN9 LDMOS technology. The carrier and peaking device, input splitter and output combiner are integrated in a single package. This multiband device is perfectly suited as a final device in massive MIMO or small cell applications in the frequency range from 2300 MHz to 2500 MHz. Available in PQFN outline.

**Table 1. Application performance**

Typical RF performance at  $T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $I_{Dq} = 39\text{ mA}$  (driver and final stages);

$V_{GSq(peaking)} = V_{GSq(carrier)} - 0.50\text{ V}$ . Test signal: 3GPP test model 1; 64 DPCH; PAR = 9.9 dB at 0.01 % probability on CCDF.

Test signal	f	V <sub>DS</sub>	P <sub>L(AV)</sub>	G <sub>p</sub>	η <sub>D</sub>	ACPR <sub>5M</sub>
	(MHz)	(V)	(W)	(dB)	(%)	(dBc)
single carrier W-CDMA	2350	28	3.55	27.1	42.1	-36.3

### 1.2 Features and benefits

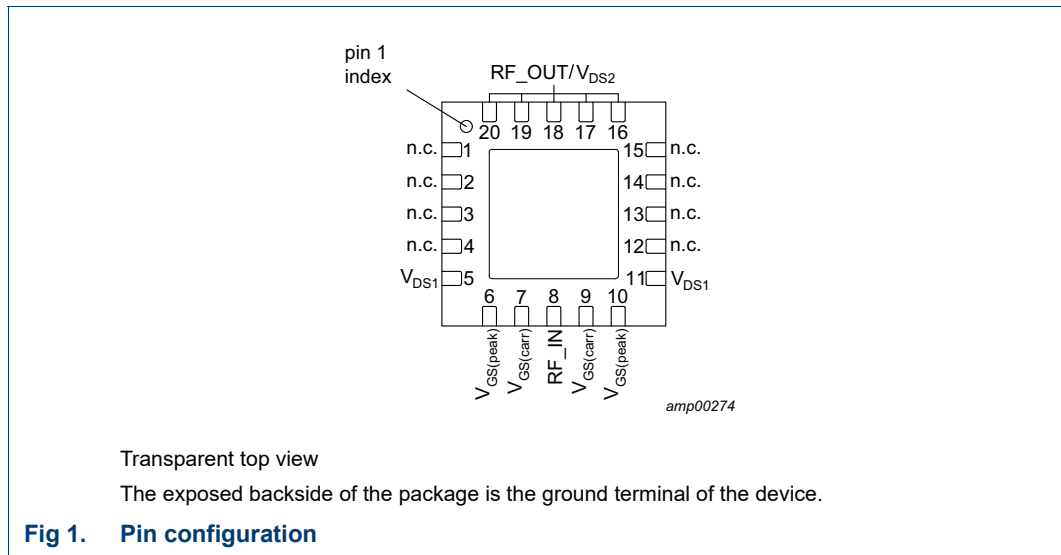
- Integrated input splitter
- Integrated output combiner
- Very high efficiency thanks to asymmetry
- Designed for broadband operation (frequency 2300 MHz to 2500 MHz)
- Independent control of carrier and peaking bias
- Integrated ESD protection
- Excellent thermal stability
- Source impedance 50 Ω; high power gain
- Compliant to Directive 2002/95/EC, regarding restriction of hazardous substances (RoHS)

### 1.3 Applications

- RF power MMIC for multi-carrier and multi-standard GSM, W-CDMA and LTE base stations in the 2300 MHz to 2500 MHz frequency range.

## 2. Pinning information

### 2.1 Pinning



### 2.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
n.c.	1	not connected
n.c.	2	not connected
n.c.	3	not connected
n.c.	4	not connected
$V_{DS1}$	5	drain-source voltage of driver stages
$V_{GS(peak)}$	6	gate-source voltage of peaking
$V_{GS(carr)}$	7	gate-source voltage of carrier
RF_IN	8	RF input
$V_{GS(carr)}$	9	gate-source voltage of carrier
$V_{GS(peak)}$	10	gate-source voltage of peaking
$V_{DS1}$	11	drain-source voltage of driver stages
n.c.	12	not connected
n.c.	13	not connected
n.c.	14	not connected
n.c.	15	not connected
RF_OUT/ $V_{DS2}$	16	RF output / drain-source voltage of final stages
RF_OUT/ $V_{DS2}$	17	RF output / drain-source voltage of final stages
RF_OUT/ $V_{DS2}$	18	RF output / drain-source voltage of final stages

Table 2. Pin description ...continued

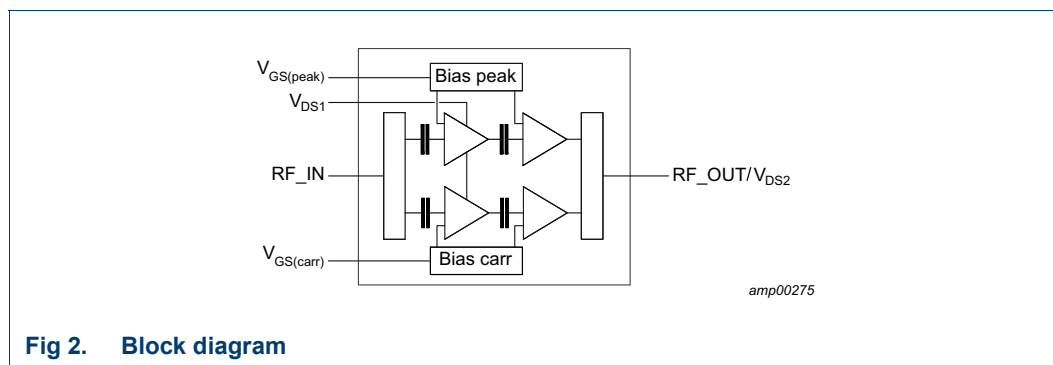
Symbol	Pin	Description
RF_OUT/ $V_{DS2}$	19	RF output / drain-source voltage of final stages
RF_OUT/ $V_{DS2}$	20	RF output / drain-source voltage of final stages
GND	flange	RF ground

### 3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BLM9D2325-20AB	PQFN20	plastic thermal enhanced quad flat package; no leads; 20 terminals; body 8.0 x 8.0 x 2.1 mm	SOT1462-1

### 4. Block diagram



### 5. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{DS}$	drain-source voltage		-	65	V
$V_{GS}$	gate-source voltage		-0.5	+13	V
$T_{stg}$	storage temperature		-65	+150	°C
$T_j$	junction temperature	[1]	-	175	°C

[1] Continuous use at maximum temperature will affect the reliability. For details refer to the online MTF calculator.

## 6. Thermal characteristics

**Table 5. Thermal characteristics**

Measured for total device.

Symbol	Parameter	Conditions	Value	Unit
R <sub>th(j-c)</sub>	thermal resistance from junction to case	T <sub>case</sub> = 90 °C; P <sub>L(AV)</sub> = 3 W [1]	12	K/W
		T <sub>case</sub> = 90 °C; P <sub>L(AV)</sub> = 1.25 W [1]	17	K/W

[1] When operated with a 1-carrier W-CDMA with PAR = 8 dB.

## 7. Characteristics

**Table 6. DC characteristics**

T<sub>case</sub> = 25 °C; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Carrier</b>						
V <sub>GSq</sub>	gate-source quiescent voltage	V <sub>DS</sub> = 28 V; I <sub>D</sub> = 37 mA	1.65	2.2	2.75	V
I <sub>GSS</sub>	gate leakage current	V <sub>GS</sub> = 1 V; V <sub>DS</sub> = 0 V	-	-	140	nA
<b>Peaking</b>						
I <sub>GSS</sub>	gate leakage current	V <sub>GS</sub> = 1 V; V <sub>DS</sub> = 0 V	-	-	140	nA
<b>Final stages</b>						
I <sub>DSS</sub>	drain leakage current	V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 28 V	-	-	1.4	μA
<b>Driver stages</b>						
I <sub>DSS</sub>	drain leakage current	V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 28 V	-	-	1.4	μA

**Table 7. RF Characteristics**

Typical RF performance at T<sub>case</sub> = 25 °C; V<sub>DS</sub> = 28 V; I<sub>Dq</sub> = 37 mA (carrier);

V<sub>GSq(peaking)</sub> = V<sub>GSq(carrier)</sub> - 0.5 V; P<sub>L</sub> = 2 W; f = 2.5 GHz. Unless otherwise specified, measured in an Ampleon production circuit.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Test signal: pulsed CW</b>						
G <sub>p</sub>	power gain		26.5	28	29.5	dB
η <sub>D</sub>	drain efficiency	P <sub>L</sub> = 2 W	35	39	-	%
		P <sub>L</sub> = P <sub>L(3dB)</sub>	45	50	-	%
RL <sub>in</sub>	input return loss		-	-14	-10	dB
P <sub>L(3dB)</sub>	output power at 3 dB gain compression		43	43.4	-	dBm

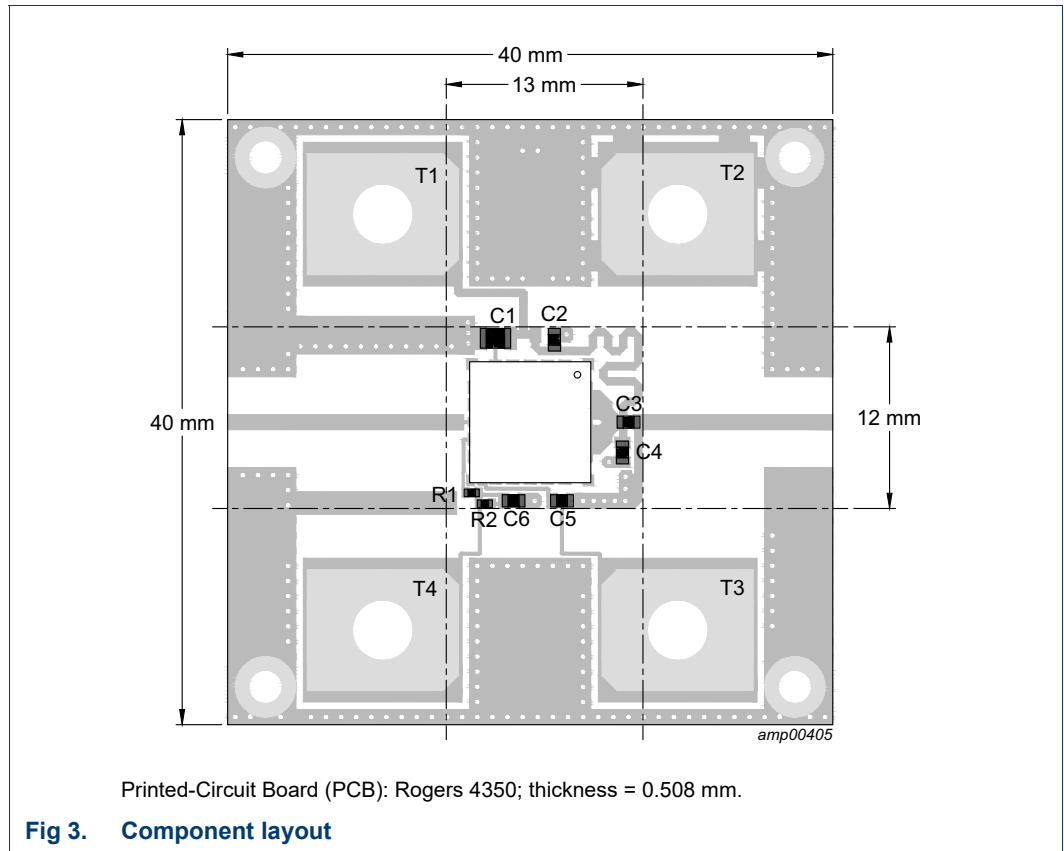
## 8. Application information

**Table 8. Typical performance**

Test signal: 1-carrier W-CDMA;  $T_{case} = 25\text{ °C}$ ;  $V_{DS} = 28\text{ V}$ ;  $I_{DQ} = 39\text{ mA}$  (driver and final stages); test model 1; 64 DPCH; PAR = 9.9 dB at 0.01 % probability CCDF; unless otherwise specified, measured in an Ampleon 2300 MHz to 2400 MHz frequency band asymmetrical Doherty application circuit.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$P_{L(3dB)}$	output power at 3 dB gain compression	f = 2350 MHz <a href="#">[1]</a>	-	43.3	-	dBm
$\varphi_{s21}/\varphi_{s21(norm)}$	normalized phase response	f = 2350 MHz; at 3 dB compression point <a href="#">[2]</a>	-	-14.2	-	°
$\eta_D$	drain efficiency	8 dB OBO ( $P_{L(AV)} = 35.5\text{ dBm}$ ); f = 2350 MHz	-	42.1	-	%
$G_p$	power gain	$P_{L(AV)} = 35.5\text{ dBm}$ ; f = 2350 MHz	-	27.1	-	dB
$B_{video}$	video bandwidth	$P_{L(AV)} = 38.5\text{ dBm}$ set to obtain IMD3 = -30 dBc; 2-tone CW; f = 2350 MHz	-	216	-	MHz
$G_{flat}$	gain flatness	$P_{L(AV)} = 35.5\text{ dBm}$ ; f = 2300 MHz to 2400 MHz	-	0.7	-	dB
ACPR <sub>5M</sub>	adjacent channel power ratio (5M)	$P_{L(AV)} = 35.5\text{ dBm}$ ; f = 2350 MHz	-	-36.3	-	dBc
$\Delta G/\Delta T$	gain variation with temperature	f = 2350 MHz	-	0.04	-	dB/°C
K	Rollett stability factor	$T_{case} = -40\text{ °C}$ ; f = 0.15 GHz to 5 GHz <a href="#">[3]</a>	-	>1.7	-	

- [1] Pulsed CW power sweep measurement ( $\delta = 10\%$ ,  $t_p = 100\text{ }\mu\text{s}$ ).
- [2] 25 ms CW power sweep measurement.
- [3] S-parameters measured with load-pull jig.



**Table 9. Demo test circuit list of components**

See [Figure 3](#) for component layout.

Component	Description	Value	Remarks
C1	multilayer ceramic chip capacitor	10 $\mu$ F, 50 V	Murata: GRM31CR61H106KA12L
C2	multilayer ceramic chip capacitor	7.5 $\pm$ 0.5 pF	Murata: GQM1875C2E7R5BB12
C3	multilayer ceramic chip capacitor	2.4 $\pm$ 0.5 pF	Murata: GQM1875C2E2R4BB12
C4	multilayer ceramic chip capacitor	3.0 $\pm$ 0.5 pF	Murata: GQM1875C2E3R0BB12
C5, C6	multilayer ceramic chip capacitor	1 $\mu$ F, 6.3 V	TDK: C1608X5R0J106K080AB
J1	SMA Coaxial panel connector male		Hubner & Suhner: 13_SMA-50-0-2/111_N
J2	SMA Coaxial panel connector female		Hubner & Suhner: 13_SMA-50-0-2/111_N
R1	SMD resistor	820 $\Omega$ , $\pm$ 1 %	Multicomp: MC805
R2	SMD resistor	5.1 $\Omega$ , $\pm$ 1 %	Multicomp: MC805
T1, T2, T3, T4	PCB Terminal	6.35 mm $\times$ 0.81 mm; 4.1 mm	TE connectivity

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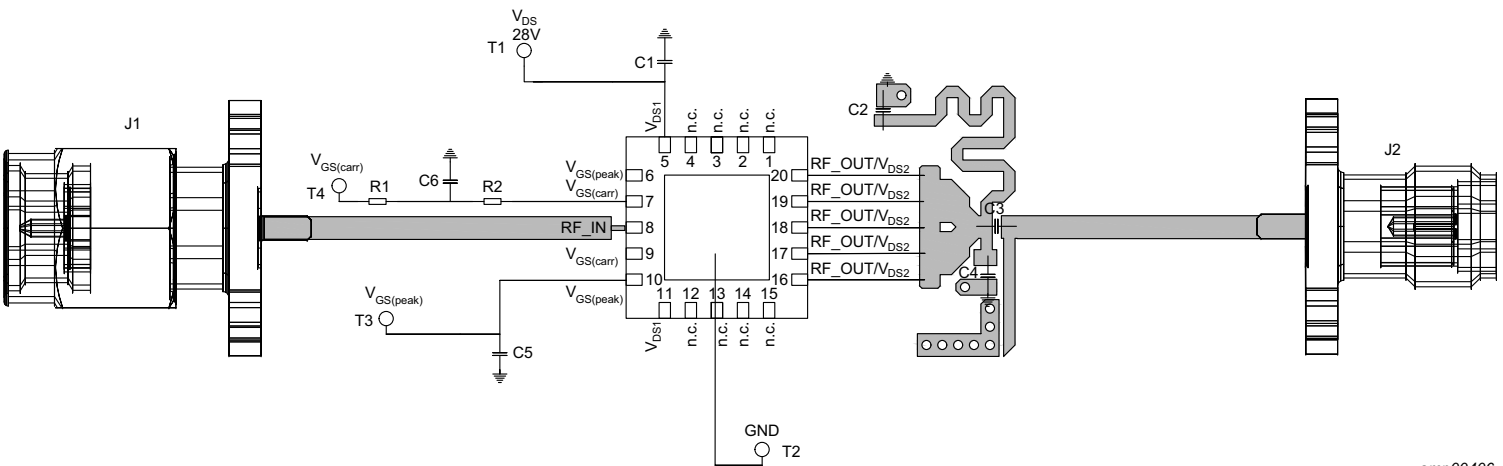


Fig 4. Electrical schematic

### 8.1 Ruggedness in a Doherty operation

The BLM9D2325-20AB is capable of withstanding a load mismatch corresponding to VSWR = 10 : 1 through all phases under the following conditions:  $V_{DS} = 32 \text{ V}$ ;  $I_{Dq} = 35 \text{ mA}$  (carrier);  $V_{GSq(\text{peaking})} = V_{GSq(\text{carrier})} - 0.5 \text{ V}$ ;  $P_1$  corresponding to  $P_{L(3\text{dB})}$  under  $Z_S = 50 \Omega$  load;  $f = 2500 \text{ MHz}$  (CW);  $T_{\text{case}} = 25 \text{ }^\circ\text{C}$ .

### 8.2 Impedance information

**Table 10. Typical impedance for optimum Doherty operation**

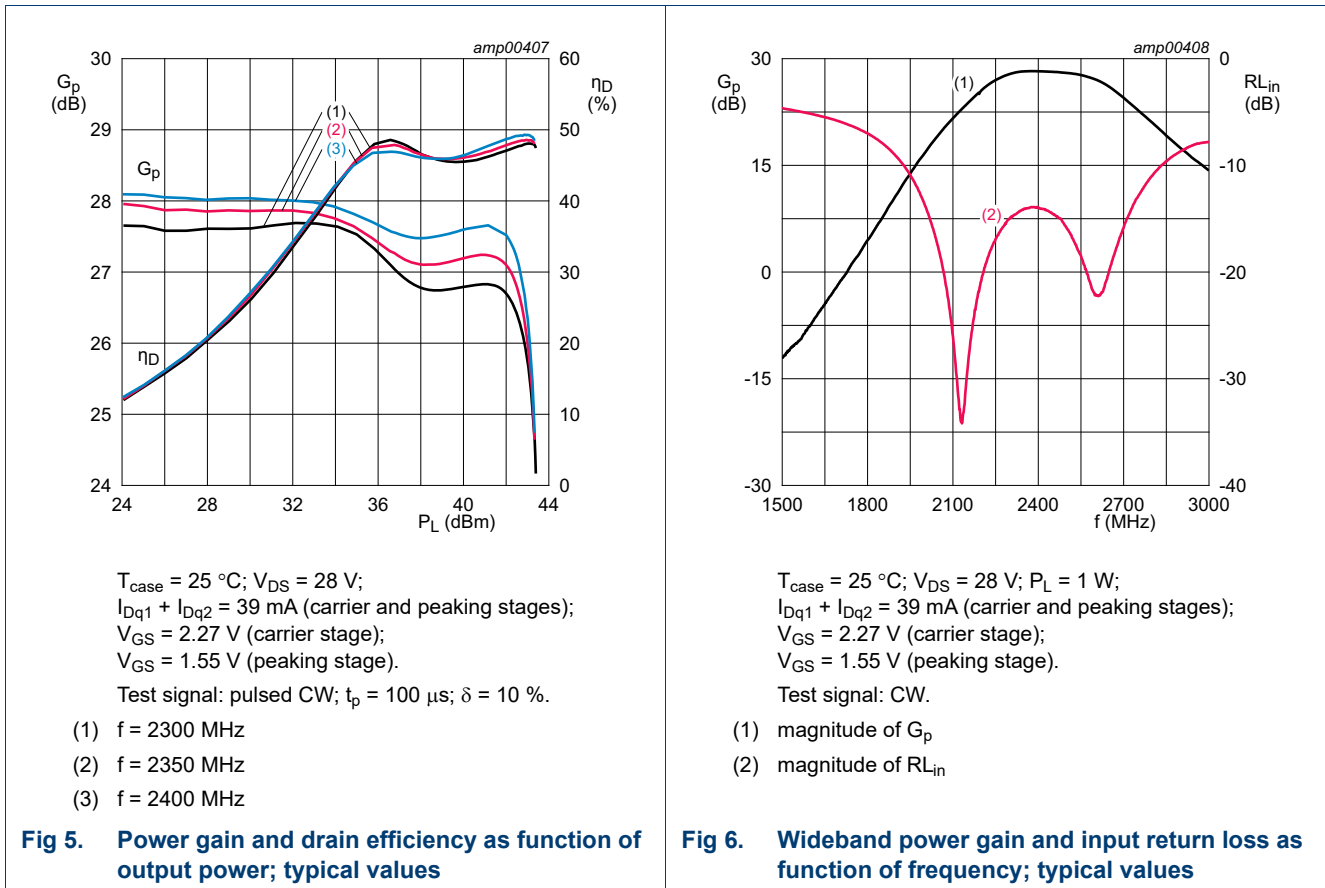
Measured load-pull data per section; test signal: pulsed CW;  $T_{\text{case}} = 25 \text{ }^\circ\text{C}$ ;  $V_{DS} = 28 \text{ V}$ ;  $I_{Dq} = 35 \text{ mA}$  (carrier);  $V_{GSq(\text{peaking})} = V_{GSq(\text{carrier})} - 0.5 \text{ V}$ ;  $t_p = 100 \mu\text{s}$ ;  $\delta = 10 \%$ . Typical values.

f (MHz)	tuned for optimum Doherty operation				
	$Z_L$ ( $\Omega$ )	$G_{p(\text{max})}$ (dB)	$P_L$ (dBm)	$\eta_{\text{add}}$ [1] (%)	$\eta_{\text{add}}$ [2] (%)
2300	5.30 – j0.46	27.80	43.70	52.10	50.90
2400	5.63 – j1.31	28.40	44.00	55.00	54.00
2500	5.67 – j1.31	28.30	44.10	56.90	54.80

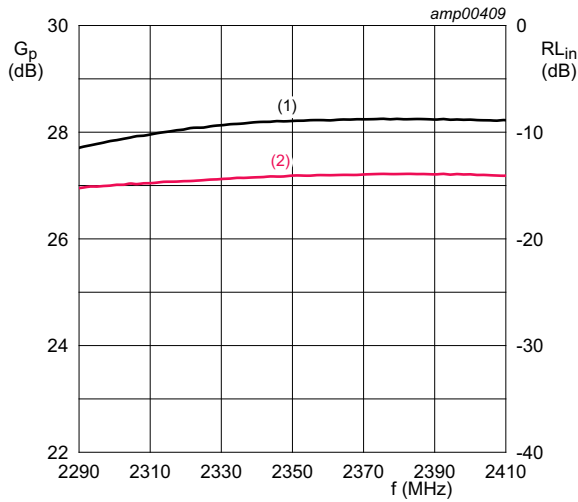
[1] at 43 dBm (nearly 3 dB compression point).

[2] at 35 dBm (nearly 8 dB OBO point).

### 8.3 Graphs





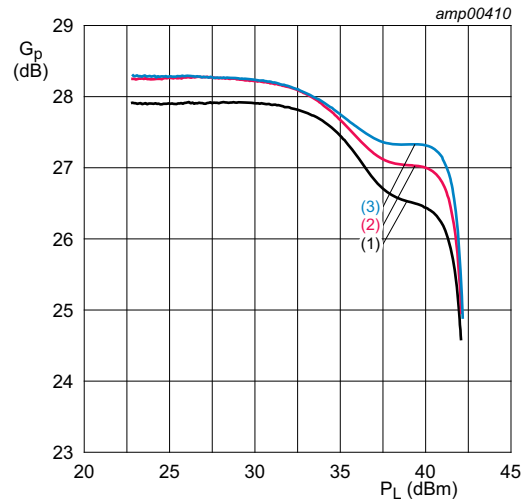


$T_{case} = 25\text{ }^\circ\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  $P_L = 1\text{ W}$ ;  
 $I_{Dq1} + I_{Dq2} = 39\text{ mA}$  (carrier and peaking stages);  
 $V_{GS} = 2.27\text{ V}$  (carrier stage);  
 $V_{GS} = 1.55\text{ V}$  (peaking stage).

Test signal: CW.

- (1) magnitude of  $G_p$
- (2) magnitude of  $RL_{in}$

**Fig 7. In-band power gain and input return loss as function of frequency; typical values**

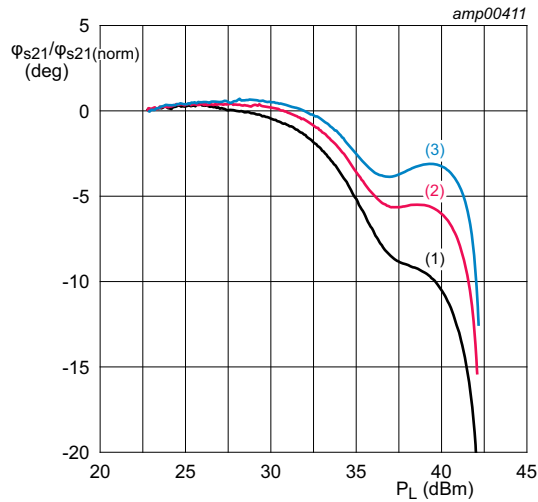


$T_{case} = 25\text{ }^\circ\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  
 $I_{Dq1} + I_{Dq2} = 39\text{ mA}$  (carrier and peaking stages);  
 $V_{GS} = 2.27\text{ V}$  (carrier stage);  
 $V_{GS} = 1.55\text{ V}$  (peaking stage).

Test signal: 25 ms CW power sweep.

- (1)  $f = 2300\text{ MHz}$
- (2)  $f = 2350\text{ MHz}$
- (3)  $f = 2400\text{ MHz}$

**Fig 8. Power gain as a function of output power; typical values**

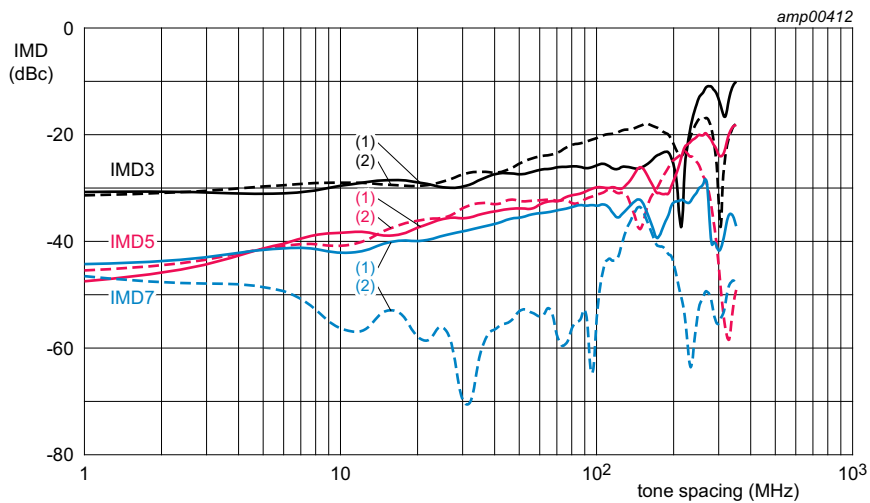


$T_{\text{case}} = 25\text{ }^\circ\text{C}$ ;  $V_{\text{DS}} = 28\text{ V}$ ;  $I_{\text{Dq1}} + I_{\text{Dq2}} = 39\text{ mA}$  (carrier and peaking stages);  
 $V_{\text{GS}} = 2.27\text{ V}$  (carrier stage);  $V_{\text{GS}} = 1.55\text{ V}$  (peaking stage).

Test signal: 25 ms CW power sweep.

- (1)  $f = 2300\text{ MHz}$
- (2)  $f = 2350\text{ MHz}$
- (3)  $f = 2400\text{ MHz}$

**Fig 9. Normalized phase response as a function of output power; typical values**

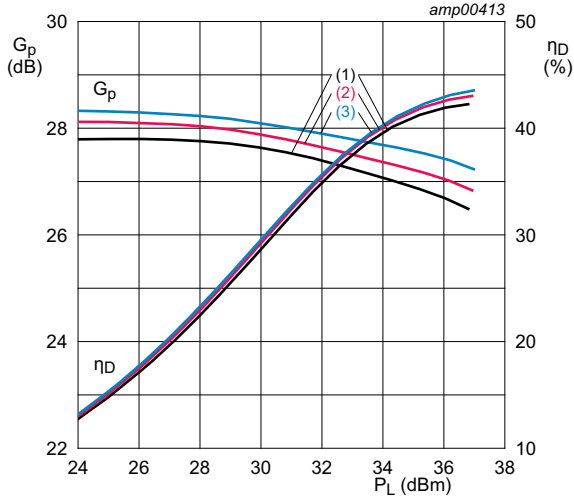


$T_{\text{case}} = 25\text{ }^\circ\text{C}$ ;  $V_{\text{DS}} = 28\text{ V}$ ;  $I_{\text{Dq1}} + I_{\text{Dq2}} = 39\text{ mA}$  (carrier and peaking stages);  
 $V_{\text{GS}} = 2.27\text{ V}$  (carrier stage);  $V_{\text{GS}} = 1.55\text{ V}$  (peaking stage).

Test signal: 2-tone CW;  $f_c = 2350\text{ MHz}$ .

- (1) IMD low
- (2) IMD high

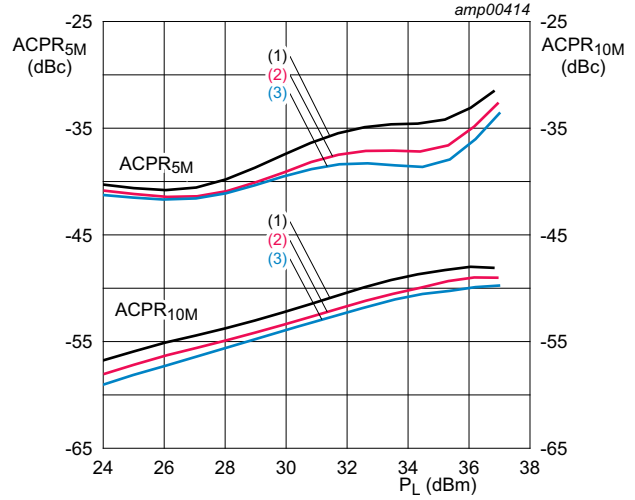
**Fig 10. Intermodulation distortion as a function of tone spacing; typical values**



$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  
 $I_{Dq1} + I_{Dq2} = 39\text{ mA}$  (carrier and peaking stages);  
 $V_{GS} = 2.27\text{ V}$  (carrier stage);  
 $V_{GS} = 1.55\text{ V}$  (peaking stage).  
 Test signal: 1-carrier W-CDMA; test model 1; 64 DPCH;  
 PAR = 9.9 dB at 0.01 % probability CCDF.

(1)  $f = 2300\text{ MHz}$   
 (2)  $f = 2350\text{ MHz}$   
 (3)  $f = 2400\text{ MHz}$

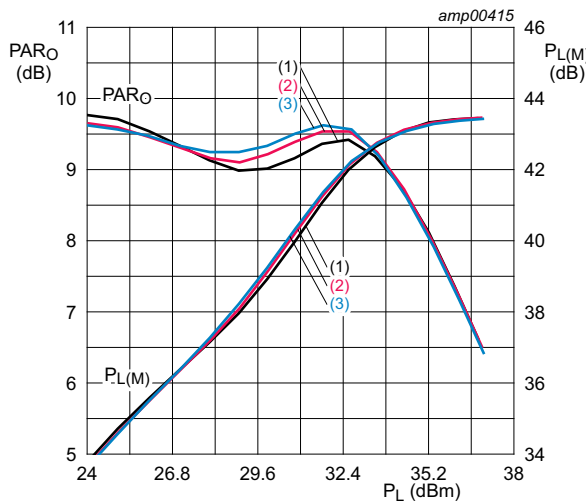
**Fig 11. Power gain and drain efficiency as function of output power; typical values**



$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  
 $I_{Dq1} + I_{Dq2} = 39\text{ mA}$  (carrier and peaking stages);  
 $V_{GS} = 2.27\text{ V}$  (carrier stage);  
 $V_{GS} = 1.55\text{ V}$  (peaking stage).  
 Test signal: 1-carrier W-CDMA; test model 1; 64 DPCH;  
 PAR = 9.9 dB at 0.01 % probability CCDF.

(1)  $f = 2300\text{ MHz}$   
 (2)  $f = 2350\text{ MHz}$   
 (3)  $f = 2400\text{ MHz}$

**Fig 12. Adjacent channel power ratio as a function of output power; typical values**



$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  $I_{Dq1} + I_{Dq2} = 39\text{ mA}$  (carrier and peaking stages);  
 $V_{GS} = 2.27\text{ V}$  (carrier stage);  $V_{GS} = 1.55\text{ V}$  (peaking stage).  
 Test signal: 1-carrier W-CDMA; test model 1; 64 DPCH; PAR = 9.9 dB at 0.01 % probability CCDF.

(1)  $f = 2300\text{ MHz}$   
 (2)  $f = 2350\text{ MHz}$   
 (3)  $f = 2400\text{ MHz}$

**Fig 13. Output peak-to-average ratio and peak output power as function of output power; typical values**

9. Package outline

PQFN20: plastic thermal enhanced quad flat package; no leads; 20 terminals; body 8.0 x 8.0 x 2.1 mm

SOT1462-1

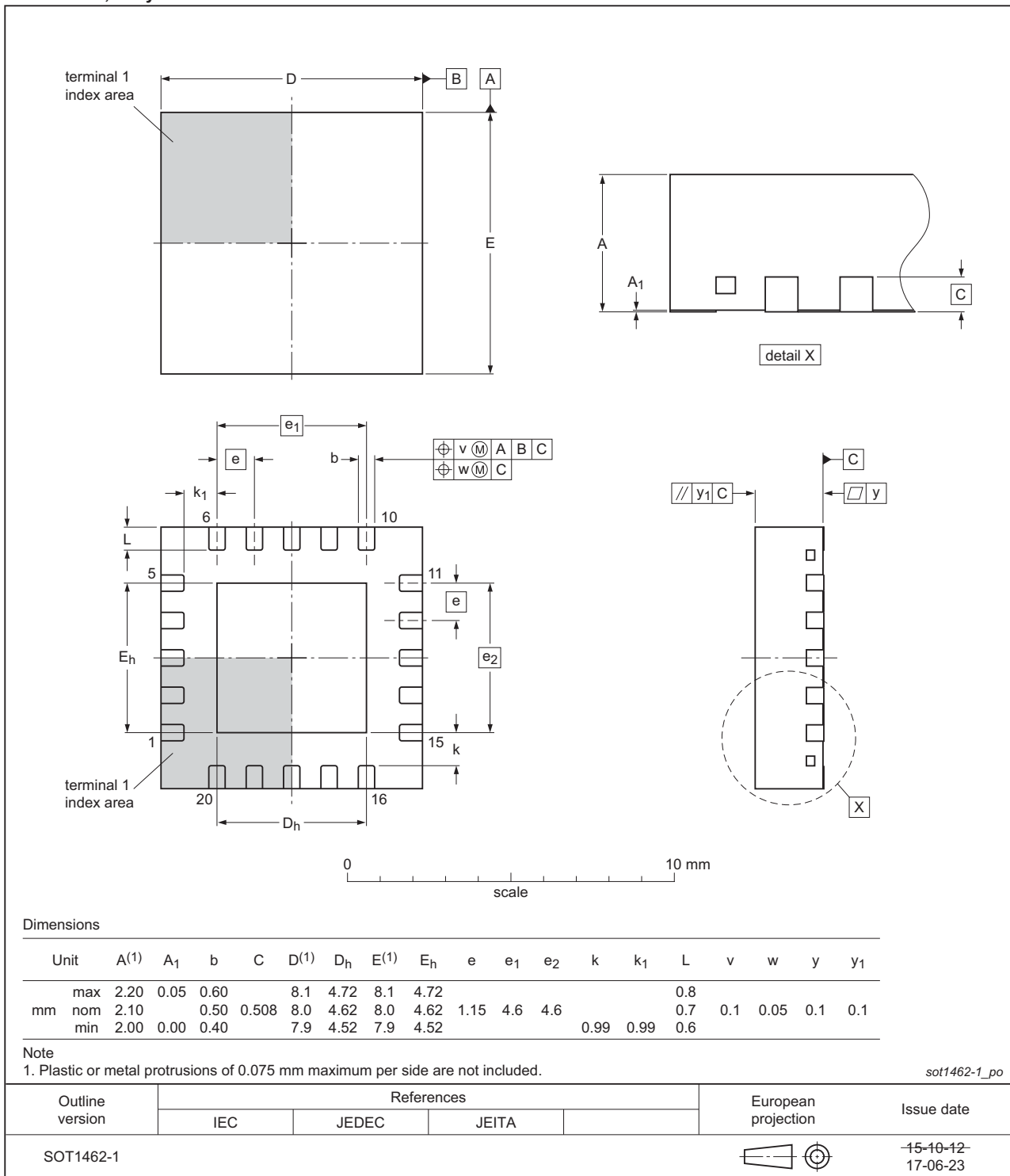


Fig 14. Package outline SOT1462-1 (PQFN20)

## 10. Handling information

**CAUTION**



This device is sensitive to ElectroStatic Discharge (ESD). Observe precautions for handling electrostatic sensitive devices.

Such precautions are described in the *ANSI/ESD S20.20*, *IEC/ST 61340-5*, *JESD625-A* or equivalent standards.

**Table 11. ESD sensitivity**

ESD model	Class
Charged Device Model (CDM); According to ANSI/ESDA/JEDEC standard JS-002	C2B <a href="#">[1]</a>
Human Body Model (HBM); According to ANSI/ESDA/JEDEC standard JS-001	1B <a href="#">[2]</a>

[1] CDM classification C2B is granted to any part that passes after exposure to an ESD pulse of 750 V, but fails after exposure to an ESD pulse of 1000 V.

[2] HBM classification 1B is granted to any part that passes after exposure to an ESD pulse of 500 V, but fails after exposure to an ESD pulse of 1000 V.

## 11. Abbreviations

**Table 12. Abbreviations**

Acronym	Description
3GPP	3rd Generation Partnership Project
CCDF	Complementary Cumulative Distribution Function
CW	Continuous Wave
DPCH	Dedicated Physical CHannel
ESD	ElectroStatic Discharge
GEN9	Ninth Generation
GSM	Global System for Mobile Communications
LDMOS	Laterally Diffused Metal Oxide Semiconductor
LTE	Long Term Evolution
MIMO	Multiple Input Multiple Output
MMIC	Monolithic Microwave Integrated Circuit
MTF	Median Time to Failure
OBO	Output Back Off
PAR	Peak-to-Average Ratio
SMD	Surface Mounted Device
VSWR	Voltage Standing-Wave Ratio
W-CDMA	Wideband Code Division Multiple Access

## 12. Revision history

**Table 13. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
BLM9D2325-20AB v.1	20170724	Product data sheet	-	-

## 13. Legal information

### 13.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.ampleon.com>.

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