

# BLM9D2327S-50PB; BLM9D2327S-50PBG

LDMOS 2-stage integrated Doherty MMIC

Rev. 1 — 6 April 2019

AMPLEON

Product data sheet

## 1. Product profile

### 1.1 General description

The BLM9D2327S-50PB(G) is a dual section, 2-stage fully integrated Doherty MMIC solution using Ampleon's state of the art GEN9 LDMOS technology. For each section, the carrier and peaking device, input splitter and output combiner are integrated in a single package. This multiband device is perfectly suited as general purpose driver or small cell final in the frequency range from 2300 MHz to 2700 MHz. Available in gull wing or flat lead outline.

**Table 1. Performance**

Typical RF performance at  $T_{case} = 25\text{ °C}$ ;  $I_{Dq} = 151\text{ mA}$  (carrier and peaking);  
 $V_{GSq(peaking)} = V_{GSq(carrier)} - 0.6\text{ V}$ . Test signal: single carrier LTE 20 MHz; PAR = 7.2 dB at 0.01% probability on CCDF; measured in an Ampleon  $f = 2600\text{ MHz}$  combined integrated Doherty application circuit.

Test signal	f	V <sub>DS</sub>	P <sub>L(M)</sub>	G <sub>p</sub>	η <sub>D</sub>	ACPR <sub>20M</sub>
	(MHz)	(V)	(dBm)	(dB)	(%)	(dBc)
single carrier LTE	2600	28	47.7	29.0 [1]	25.7 [1]	-39.5 [1]
				28.7 [2]	41.1 [2]	-36.2 [2]

[1] At  $P_{L(AV)} = 5\text{ W}$  (12.7 dB OBO).

[2] At  $P_{L(AV)} = 9.33\text{ W}$  (8 dB OBO).

### 1.2 Features and benefits

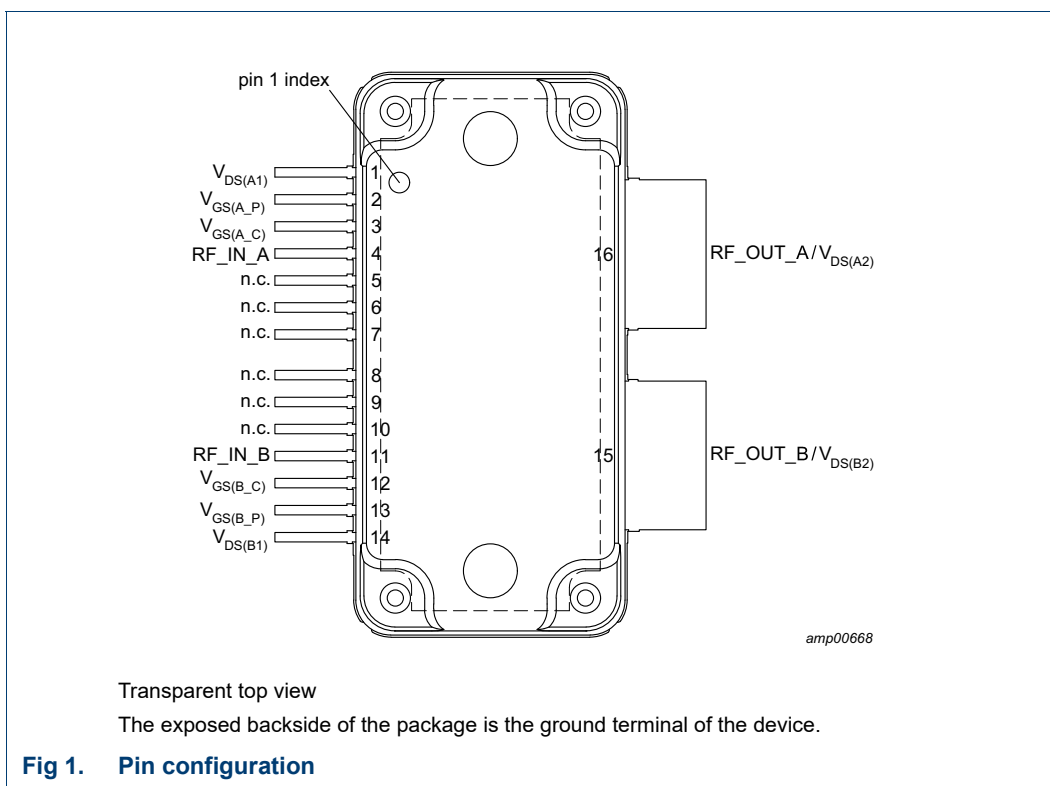
- Integrated input splitter
- Integrated output combiner
- High efficiency
- Designed for broadband operation (frequency 2300 MHz to 2700 MHz)
- High section-to-section isolation enabling multiple combinations
- Independent control of carrier and peaking bias
- Integrated ESD protection
- Excellent thermal stability
- Source impedance 50 Ω; high power gain
- For RoHS compliance see the product details on the Ampleon website

### 1.3 Applications

- RF power MMIC for multi-carrier and multi-standard GSM, W-CDMA and LTE base stations in the 2300 MHz to 2700 MHz frequency range. Possible circuit topologies are the following as also depicted in [Section 8.1](#):
  - ◆ Dual section or single ended
  - ◆ Quadrature combined
  - ◆ Push-pull

## 2. Pinning information

### 2.1 Pinning



### 2.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$V_{DS(A1)}$	1	drain-source voltage of driver stages of section A
$V_{GS(A_P)}$	2	gate-source voltage of peaking of section A
$V_{GS(A_C)}$	3	gate-source voltage of carrier of section A
RF_IN_A	4	RF input section A
n.c.	5	not connected
n.c.	6	not connected
n.c.	7	not connected

Table 2. Pin description ...continued

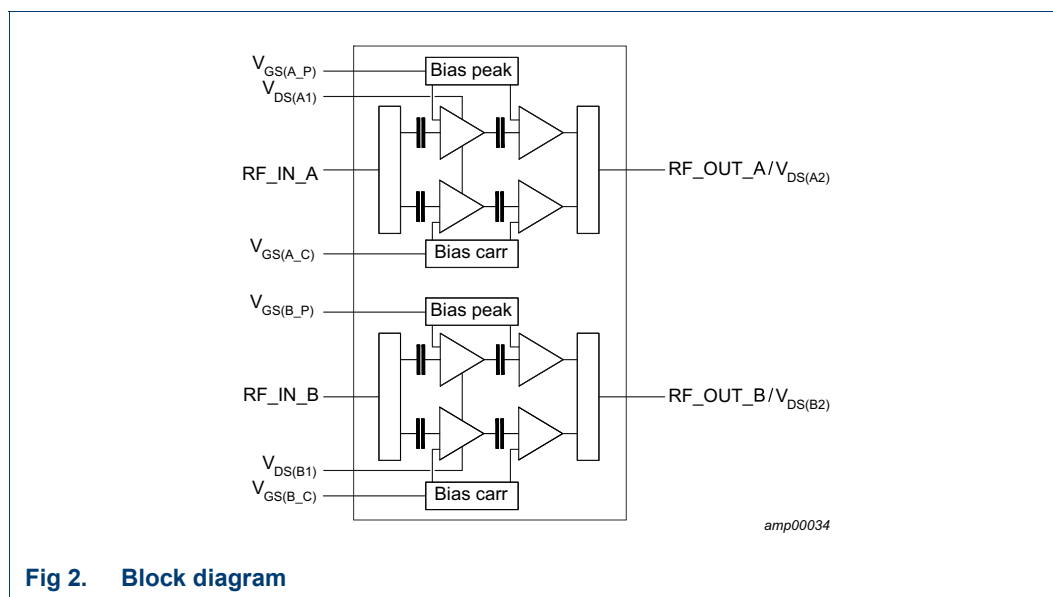
Symbol	Pin	Description
n.c.	8	not connected
n.c.	9	not connected
n.c.	10	not connected
RF_IN_B	11	RF input section B
$V_{GS(B\_C)}$	12	gate-source voltage of carrier of section B
$V_{GS(B\_P)}$	13	gate-source voltage of peaking of section B
$V_{DS(B1)}$	14	drain-source voltage of driver stages of section B
RF_OUT_B/ $V_{DS(B2)}$	15	RF output section B / drain-source voltage of final stages of section B
RF_OUT_A/ $V_{DS(A2)}$	16	RF output section A / drain-source voltage of final stages of section A
GND	flange	RF ground

### 3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BLM9D2327S-50PB		plastic, heatsink small outline package; 16 leads (flat)	OMP-780-16F-1
BLM9D2327S-50PBG		plastic, heatsink small outline package; 16 leads	OMP-780-16G-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		-0.5	+65	V
$V_{GS}$	gate-source voltage		-0.5	+13	V
$T_{stg}$	storage temperature		-65	+150	°C
$T_j$	junction temperature	[1]	-	225	°C
$T_{case}$	case temperature		-	150	°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
$R_{th(j-c)}$	thermal resistance from junction to case	$T_{case} = 90\text{ °C}; P_L = 5\text{ W}$	[1]	2.3
		$T_{case} = 90\text{ °C}; P_L = 10\text{ W}$	[1]	2

[1] When operated with a 1-carrier W-CDMA with PAR = 9.9 dB.

## 7. Characteristics

**Table 6. DC characteristics**

$T_{case} = 25\text{ °C}$ ; per section unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>Carrier</b>						
$V_{GSq}$	gate-source quiescent voltage	$V_{DS} = 28\text{ V}; I_D = 75\text{ mA}$	1.6	2.1	2.5	V
$I_{GSS}$	gate leakage current	$V_{GS} = 1\text{ V}; V_{DS} = 0\text{ V}$	-	-	140	nA
<b>Peaking</b>						
$I_{GSS}$	gate leakage current	$V_{GS} = 1\text{ V}; V_{DS} = 0\text{ V}$	-	-	140	nA
<b>Final stages</b>						
$I_{DSS}$	drain leakage current	$V_{GS} = 0\text{ V}; V_{DS} = 28\text{ V}$	-	-	1.4	μA
<b>Driver stages</b>						
$I_{DSS}$	drain leakage current	$V_{GS} = 0\text{ V}; V_{DS} = 28\text{ V}$	-	-	1.4	μA

**Table 7. RF Characteristics**

Typical RF performance at  $T_{case} = 25\text{ }^{\circ}\text{C}$ ; per section unless otherwise specified;  $V_{DS} = 28\text{ V}$ ;  $I_{DQ} = 75\text{ mA}$  (carrier stage);  $V_{GSQ(peak)} = V_{GSQ(carrier)} - 0.7\text{ V}$ ;  $P_{L(AV)} = 5\text{ W}$ ;  $f = 2700\text{ MHz}$ , measured in an Ampleon straight lead production circuit.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Test signal: pulsed CW [1]						
$G_p$	power gain		24.5	27.5	29.5	dB
$\eta_D$	drain efficiency	$P_L = 5\text{ W (37 dBm)}$	30	34	-	%
		$P_L = P_{L(3dB)}$	45.5	49	-	%
$RL_{in}$	input return loss		-	-14	-10	dB
$P_{L(3dB)}$	output power at 3 dB gain compression		43.1	44	-	dBm

[1]  $t_p = 0.1\text{ ms}$ ;  $\delta = 10\text{ }%$ .

## 8. Application information

**Table 8. Typical performance**

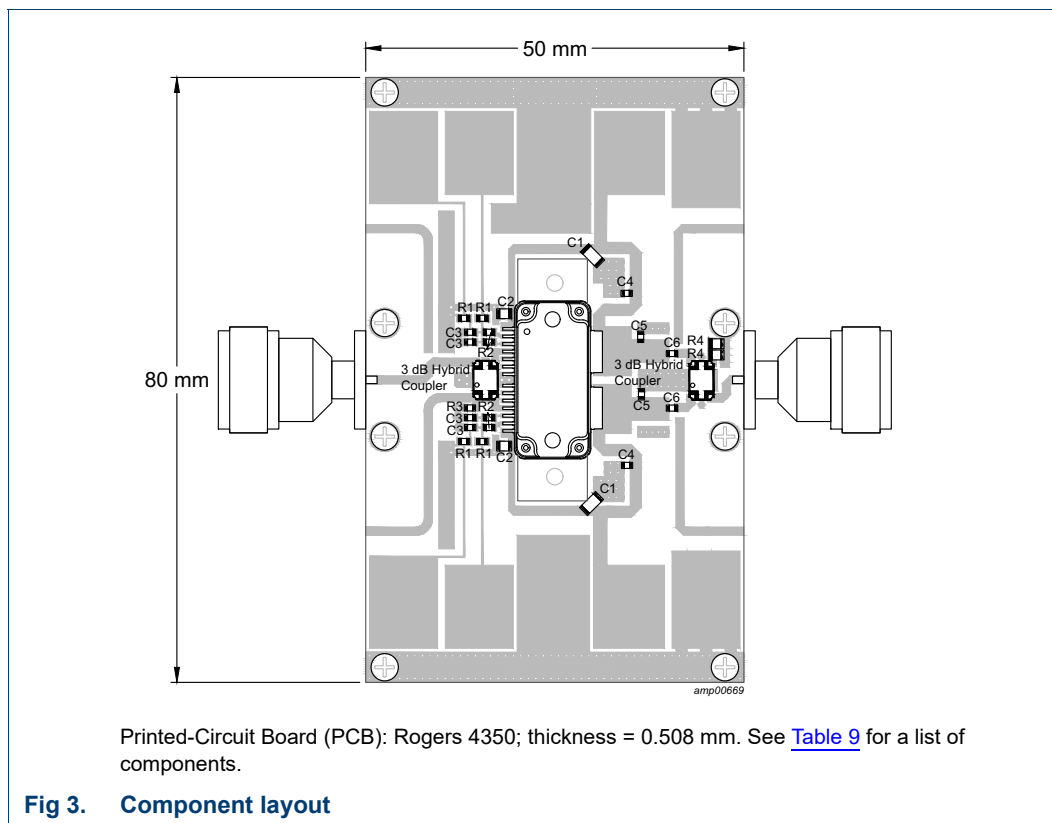
$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  $I_{DQ} = 151\text{ mA}$  (carrier and peaking);  $V_{GSQ(peak)} = V_{GSQ(carrier)} - 0.6\text{ V}$ . Test signal: single carrier LTE 20 MHz; PAR = 7.2 dB at 0.01 % probability CCDF; unless otherwise specified, measured in an Ampleon  $f = 2500\text{ MHz}$  to 2700 MHz combined integrated Doherty application circuit.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$P_{L(3dB)}$	output power at 3 dB gain compression	$f = 2600\text{ MHz}$ [1]	-	47.3	-	dBm
$\phi_{s21}/\phi_{s21(norm)}$	normalized phase response	at 3 dB compression point; $f = 2600\text{ MHz}$ [2]	-	-9.2	-	$^{\circ}$
$\eta_D$	drain efficiency	12.7 dB OBO ( $P_L = 35\text{ dBm}$ ; $P_{L(M)} = 47.7\text{ dBm}$ ); $f = 2600\text{ MHz}$	-	25.7	-	%
$G_p$	power gain	$P_{L(AV)} = 35\text{ dBm}$ ; $f = 2600\text{ MHz}$	-	29	-	dB
$B_{video}$	video bandwidth	$P_{L(AV)}$ set to obtain IMD3 = -40 dBc; 2-tone CW; $f = 2600\text{ MHz}$	-	250	-	MHz
$G_{flat}$	gain flatness	$P_{L(AV)} = 35\text{ dBm}$ ; $f = 2300\text{ MHz}$ to 2700 MHz	-	1.1	-	dB
$ACPR_{20M}$	adjacent channel power ratio (20M)	$P_{L(AV)} = 35\text{ dBm}$ ; $f = 2600\text{ MHz}$	-	-39.5	-	dB
$\Delta G/\Delta T$	gain variation with temperature	$f = 2600\text{ MHz}$ [3]	-	0.04	-	dB/ $^{\circ}\text{C}$
K	Rollett stability factor	$T_{case} = -40\text{ }^{\circ}\text{C}$ ; $f = 1.6\text{ GHz}$ to 5 GHz [3]	-	>2	-	

[1] Pulsed CW power sweep measurement ( $\delta = 10\text{ }%$ ,  $t_p = 100\text{ }\mu\text{s}$ ).

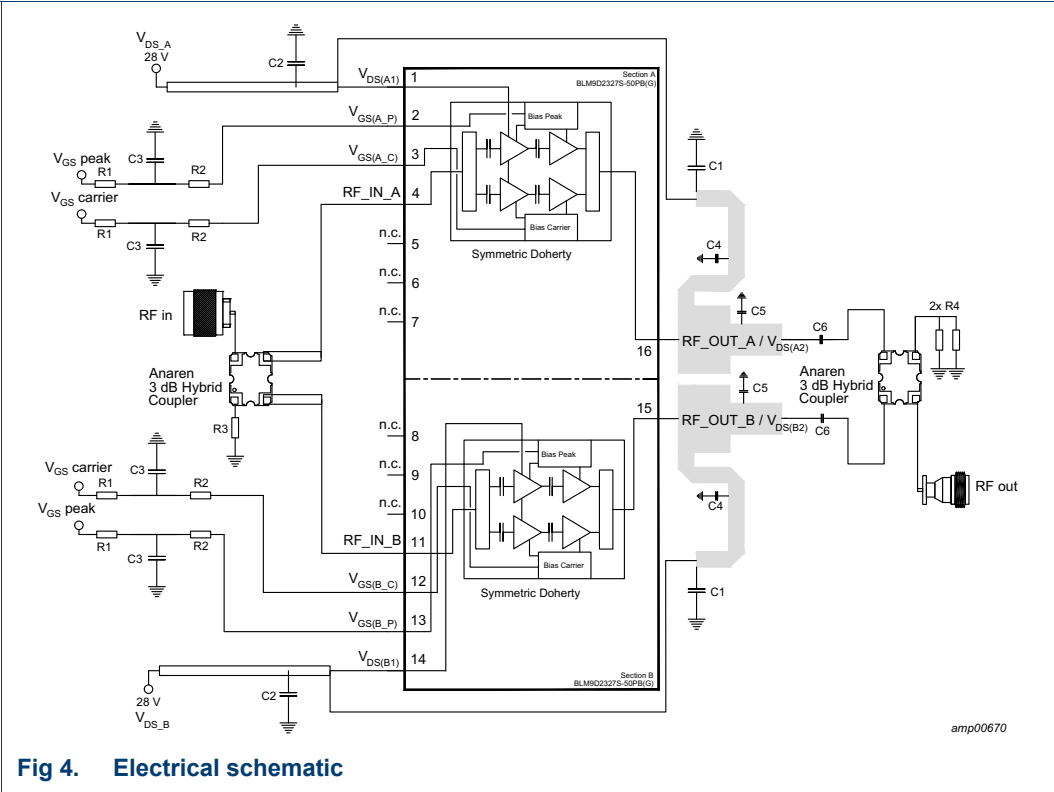
[2] 25 ms CW power sweep measurement.

[3] For both sections (S-parameters measured on dual section evaluation board).

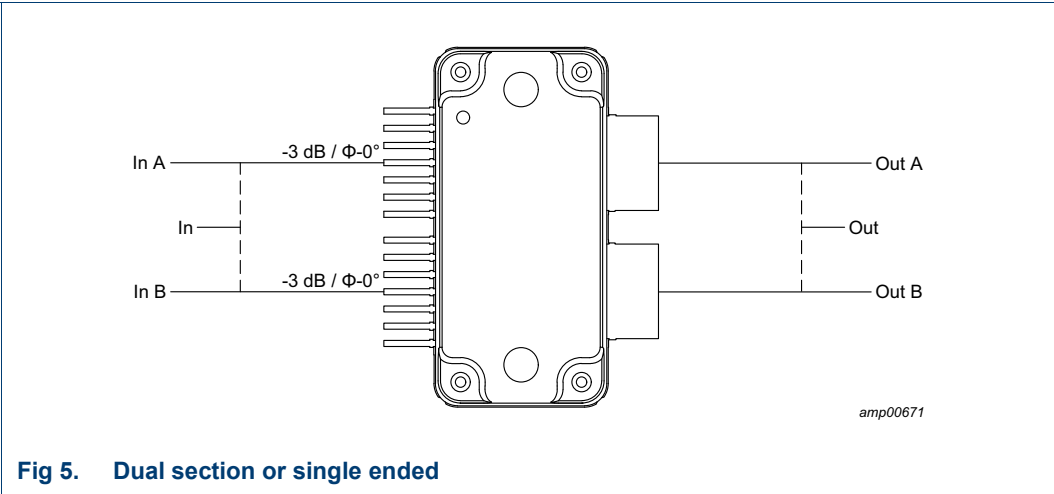


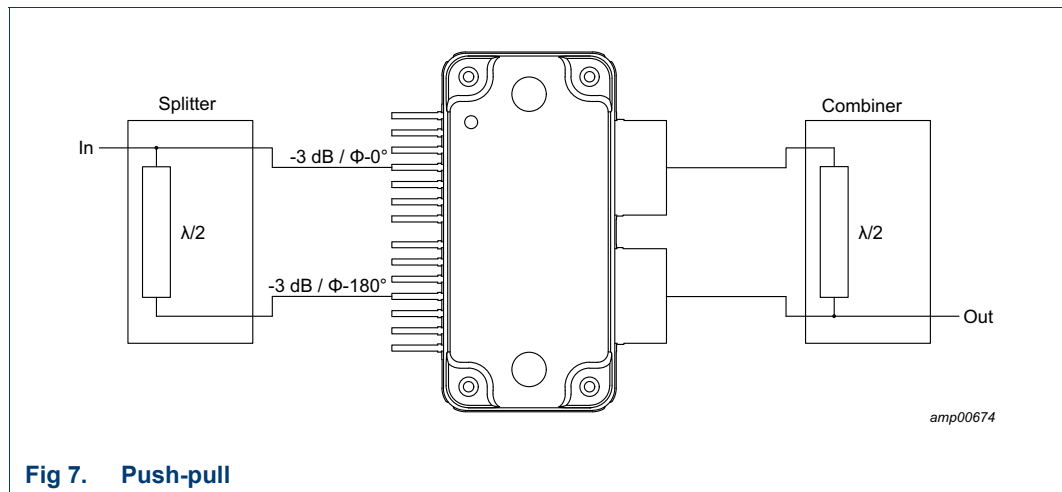
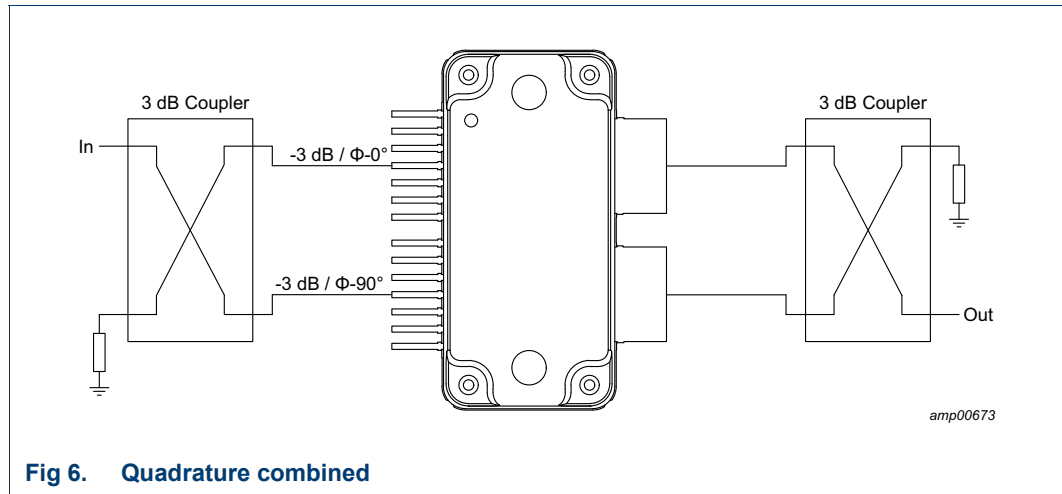
**Table 9. List of components**  
See [Figure 3](#) for component layout.

Component	Description	Value	Remarks
C1	multilayer ceramic chip capacitor	10 $\mu$ F, 50 V	TDK: SMD 1206
C2	multilayer ceramic chip capacitor	10 $\mu$ F, 50 V	Murata: SMD 805
C3	multilayer ceramic chip capacitor	1 $\mu$ F, 6.3 V	Murata: SMD 603
C4	multilayer ceramic chip capacitor	5.1 pF	Murata: SMD 603
C5	multilayer ceramic chip capacitor	1 pF	Murata: SMD 603
C6	multilayer ceramic chip capacitor	6.8 pF	Murata: SMD 603
3 dB Hybrid coupler	3 dB Hybrid coupler	3.0 pF	Anaren: X3C25F1-03S
R1	resistor	820 $\Omega$	Multicomp: SMD 603
R1	resistor	5 $\Omega$	Multicomp: SMD 603
R1	resistor	50 $\Omega$	Multicomp: SMD 603
R1	resistor	100 $\Omega$	Multicomp: SMD 603



8.1 Possible circuit topologies





## 8.2 Ruggedness in a Doherty operation

The BLM9D2327S-50PB and BLM9D2327S-50PBG are capable of withstanding a load mismatch corresponding to  $V_{SWR} = 10 : 1$  through all phases under the following conditions:  $V_{DS} = 32 \text{ V}$ ;  $I_{Dq} = 75 \text{ mA}$  (carrier);  $V_{GSq(peak)} = V_{GSq(carrier)} - 0.7 \text{ V}$ ;  $P_i$  corresponding to  $P_{L(3dB)}$  under  $Z_S = 50 \Omega$  load;  $f = 2700 \text{ MHz}$  (CW);  $T_{case} = 25 \text{ °C}$  per section unless otherwise specified.



### 8.3 Impedance information

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

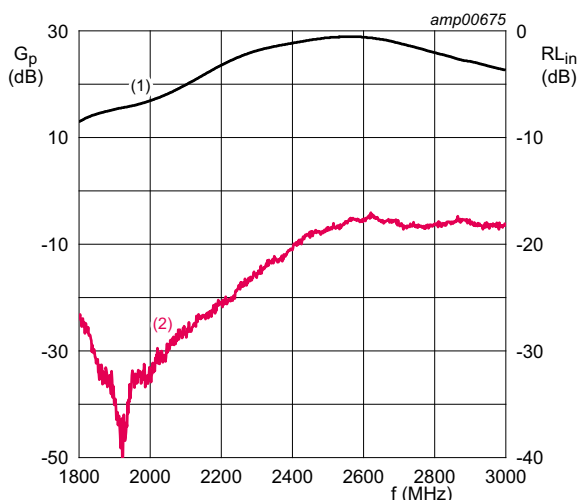
Measured load-pull data per section; test signal: pulsed CW;  $T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  $I_{Dq} = 75\text{ mA}$  (carrier);  $V_{GSq(peak)} = V_{GSq(carrier)} - 0.7\text{ V}$ ;  $t_p = 100\text{ }\mu\text{s}$ ;  $\delta = 10\text{ }\%$ . Typical values per section unless otherwise specified.

f (MHz)	tuned for optimum Doherty operation				
	$Z_L$ ( $\Omega$ )	$G_{p(max)}$ (dB)	$P_L$ (dBm)	$\eta_{add}$ [1] (%)	$\eta_{add}$ [2] (%)
<b>BLM9D2327S-50PB</b>					
2300	5.23 – j2.87	29.00	45.00	51.8	41.4
2400	5.72 – j3.67	29.25	45.07	53.3	41.6
2500	5.78 – j3.70	29.00	45.08	54.4	41.1
2600	6.00 – j4.90	28.90	44.75	55.8	42.0
2700	6.56 – j3.98	28.20	44.60	56.5	38.2
<b>BLM9D2327S-50PBG</b>					
2300	5.36 – j6.75	29.38	45.00	52.5	42.0
2400	5.48 – j6.78	29.30	45.13	53.3	41.6
2500	5.73 – j7.66	29.30	45.13	54.9	41.7
2600	7.64 – j8.50	29.30	44.80	57.7	41.0
2700	6.60 – j8.87	28.25	44.60	56.5	39.3

[1] At 3 dB compression point.

[2] At 36.5 dBm (nearly 8 dB OBO point).

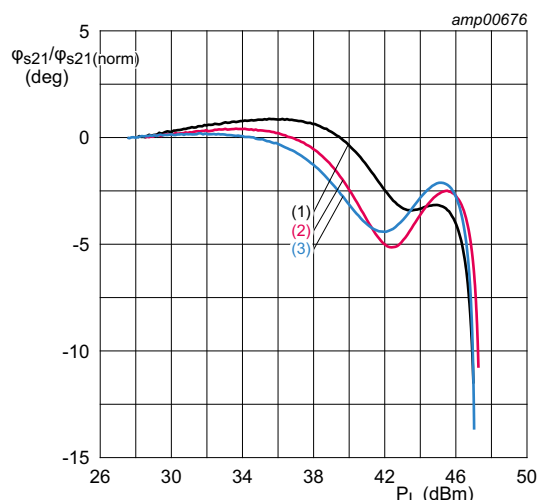
## 8.4 Graphs



$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  
 $I_{Dq(A\_P)} + I_{Dq(A\_C)} = 151\text{ mA}$  (carrier and peaking);  
 $V_{GSq(peaking)} = V_{GSq(carrier)} - 0.6\text{ V}$ .  
 Test signal: small signal frequency sweep.

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

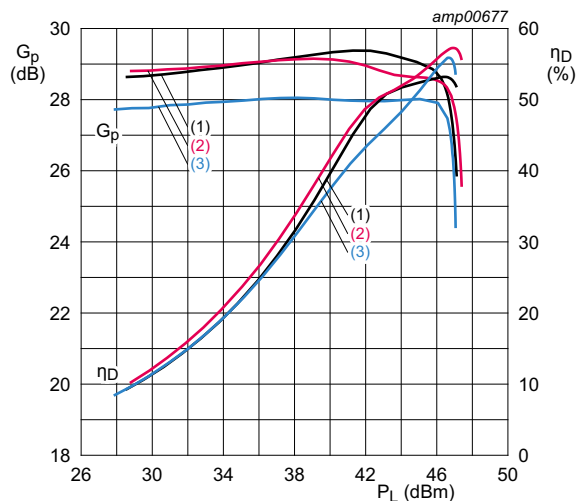
**Fig 8. Wideband power gain and input return loss as function of frequency; typical values**



$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  
 $I_{Dq(A\_P)} + I_{Dq(A\_C)} = 151\text{ mA}$  (carrier and peaking);  
 $V_{GSq(peaking)} = V_{GSq(carrier)} - 0.6\text{ V}$ .  
 Test signal: 25 ms CW power sweep.

- (1)  $f = 2496\text{ MHz}$
- (2)  $f = 2600\text{ MHz}$
- (3)  $f = 2690\text{ MHz}$

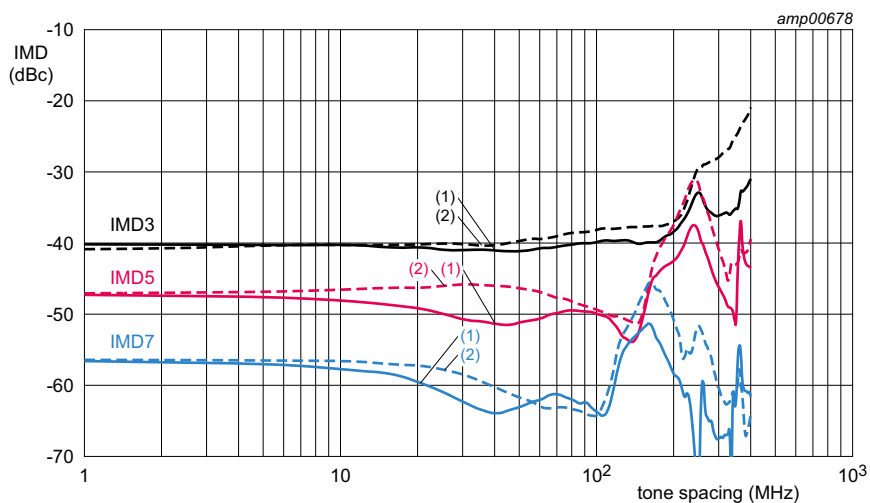
**Fig 9. Normalized phase response as a function of output power; typical values**



$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  
 $I_{Dq(A\_P)} + I_{Dq(A\_C)} = 151\text{ mA}$  (carrier and peaking);  
 $V_{GSq(peaking)} = V_{GSq(carrier)} - 0.6\text{ V}$ .  
 Test signal: pulsed CW power sweep ( $\delta = 10\%$ ;  $t_p = 100\text{ }\mu\text{s}$ ).

- (1)  $f = 2496\text{ MHz}$
- (2)  $f = 2600\text{ MHz}$
- (3)  $f = 2690\text{ MHz}$

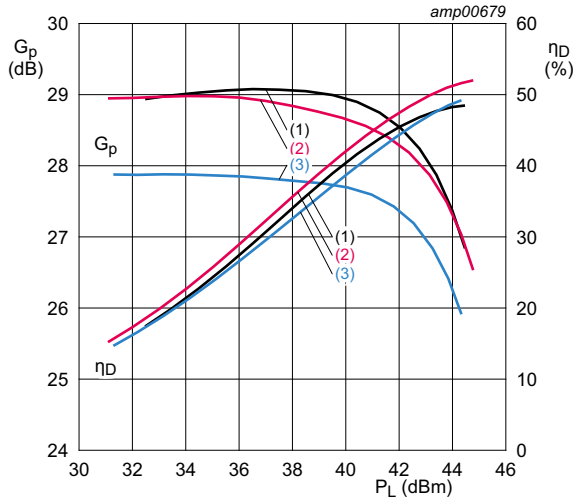
Fig 10. Power gain and drain efficiency as function of output power; typical values



$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  
 $I_{Dq(A\_P)} + I_{Dq(A\_C)} = 151\text{ mA}$  (carrier and peaking);  
 $V_{GSq(peaking)} = V_{GSq(carrier)} - 0.6\text{ V}$ .  
 $P_{L(AV)} = 3.16\text{ W}$ .  
 Test signal: 2-tone CW;  $f_c = 2600\text{ MHz}$ .

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

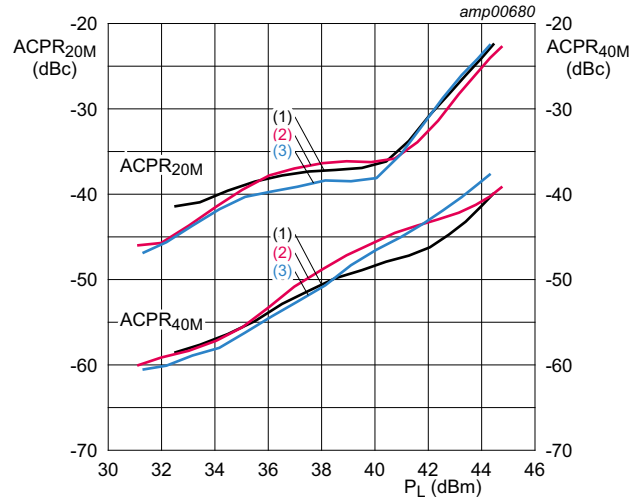
Fig 11. Intermodulation distortion as a function of tone spacing; typical values



$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  
 $I_{Dq(A\_P)} + I_{Dq(A\_C)} = 151\text{ mA}$  (carrier and peaking);  
 $V_{GSq(peaking)} = V_{GSq(carrier)} - 0.6\text{ V}$ .  
 Test signal: 1-carrier LTE; PAR 7.2 dB at 0.01 % probability CCDF.

- (1)  $f = 2496\text{ MHz}$
- (2)  $f = 2600\text{ MHz}$
- (3)  $f = 2690\text{ MHz}$

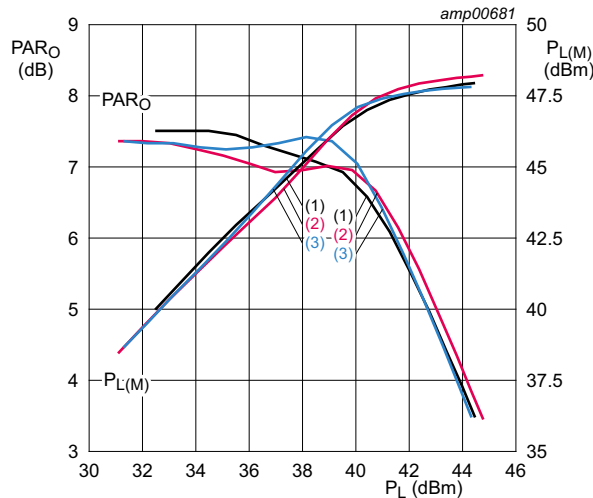
**Fig 12. Power gain and drain efficiency as function of output power; typical values**



$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  
 $I_{Dq(A\_P)} + I_{Dq(A\_C)} = 151\text{ mA}$  (carrier and peaking);  
 $V_{GSq(peaking)} = V_{GSq(carrier)} - 0.6\text{ V}$ .  
 Test signal: 1-carrier LTE; PAR 7.2 dB at 0.01 % probability CCDF.

- (1)  $f = 2496\text{ MHz}$
- (2)  $f = 2600\text{ MHz}$
- (3)  $f = 2690\text{ MHz}$

**Fig 13. Adjacent channel power ratio as a function of output power; typical values**



$T_{case} = 25\text{ }^{\circ}\text{C}$ ;  $V_{DS} = 28\text{ V}$ ;  
 $I_{Dq(A\_P)} + I_{Dq(A\_C)} = 151\text{ mA}$  (carrier and peaking);  
 $V_{GSq(peaking)} = V_{GSq(carrier)} - 0.6\text{ V}$ .  
 Test signal: 1-carrier LTE; PAR 7.2 dB at 0.01 % probability CCDF.

- (1)  $f = 2496\text{ MHz}$
- (2)  $f = 2600\text{ MHz}$
- (3)  $f = 2690\text{ MHz}$

**Fig 14. Output peak-to-average ratio and peak output power as function of output power; typical values**

## 9. Package outline

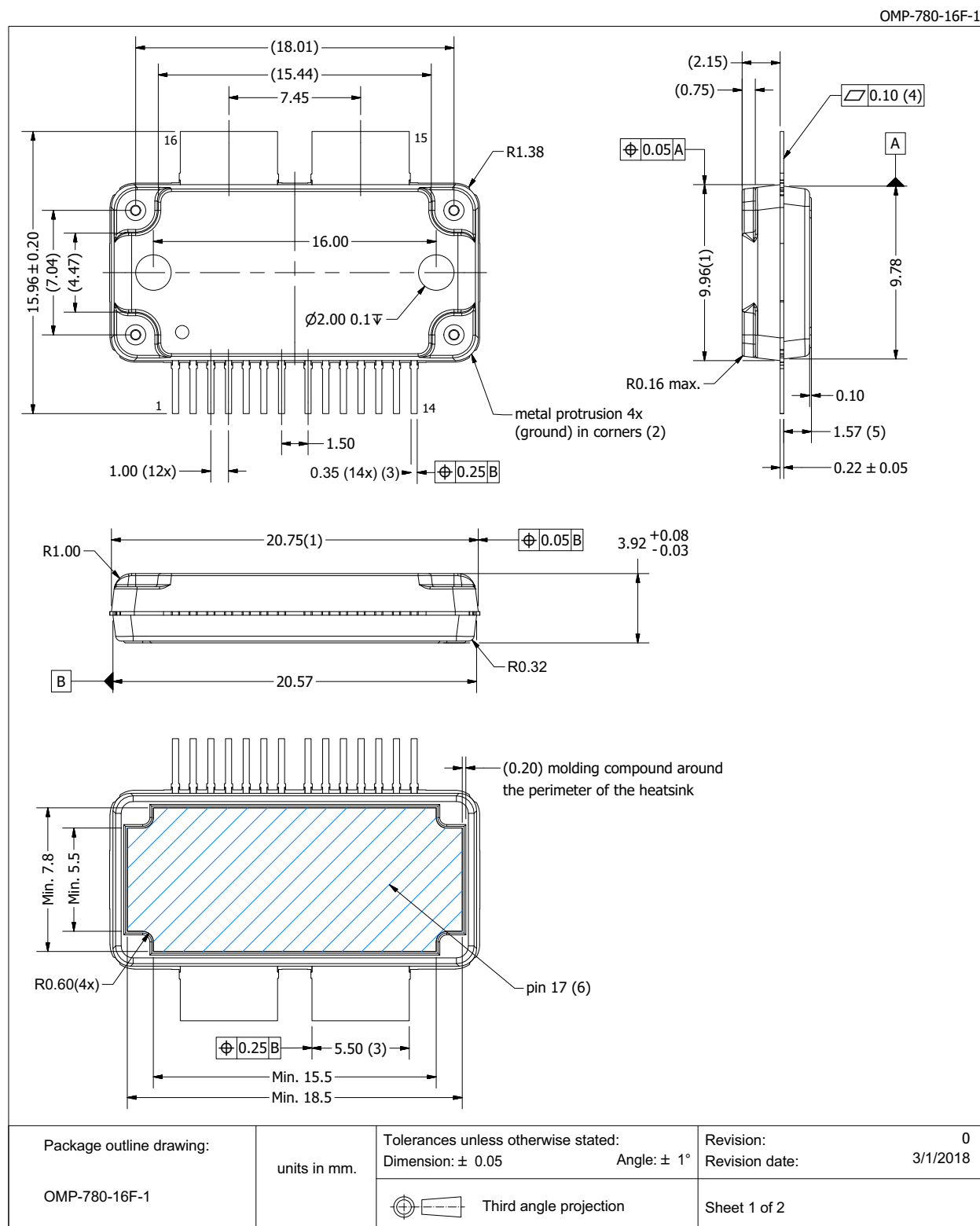
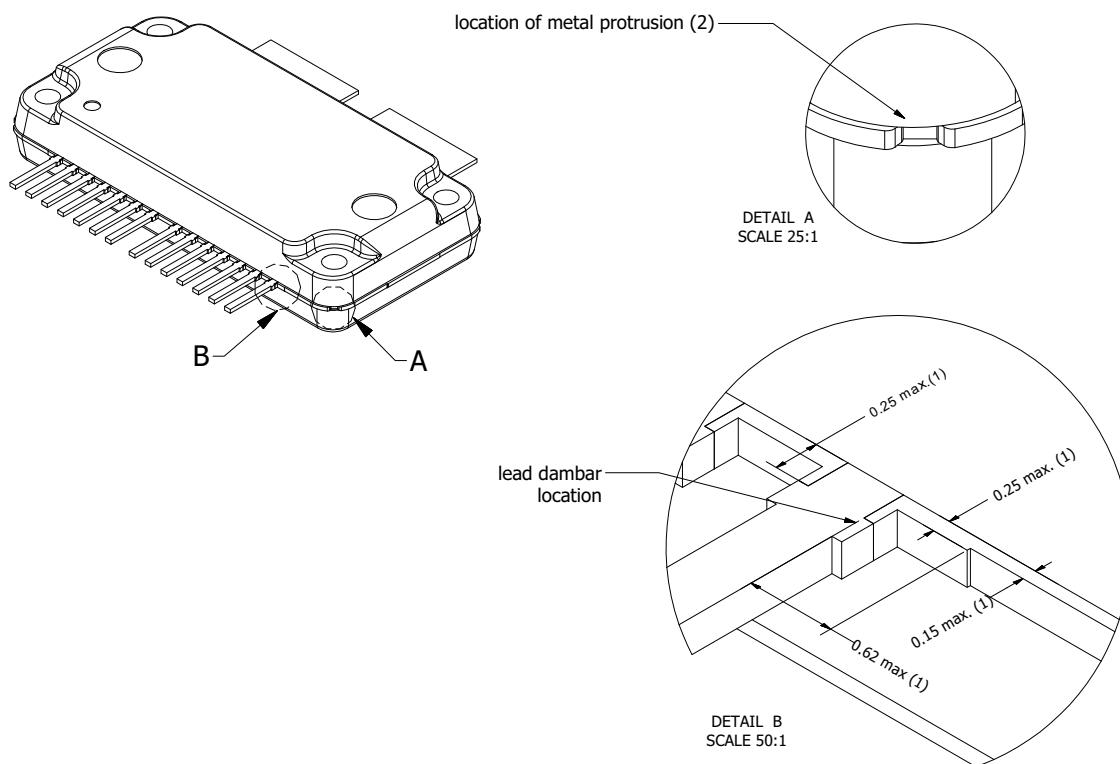


Fig 15. Package outline OMP-780-16F-1 (sheet 1 of 2)

OMP-780-16F-1

Drawing Notes	
Items	Description
(1)	Dimensions are excluding mold protrusion. Areas located adjacent to the leads have a maximum mold protrusion of 0.25 mm (per side) and 0.62 mm max. in length. In between the 14 leads the protrusion is 0.25 mm. max. At all other areas the mold protrusion is maximum 0.15 mm per side. See also detail B.
(2)	The metal protrusion (tie bars) in the corner will not stick out of the molding compound protrusions (detail A).
(3)	The lead dambar (metal) protrusions are not included. Add 0.14 mm max to the total lead dimension at the dambar location.
(4)	The lead coplanarity over all leads is 0.1 mm maximum.
(5)	Dimension is measured 0.5 mm from the edge of the top package body.
(6)	The hatched area indicates the exposed metal heatsink.
(7)	The leads and exposed heatsink are plated with matte Tin (Sn).




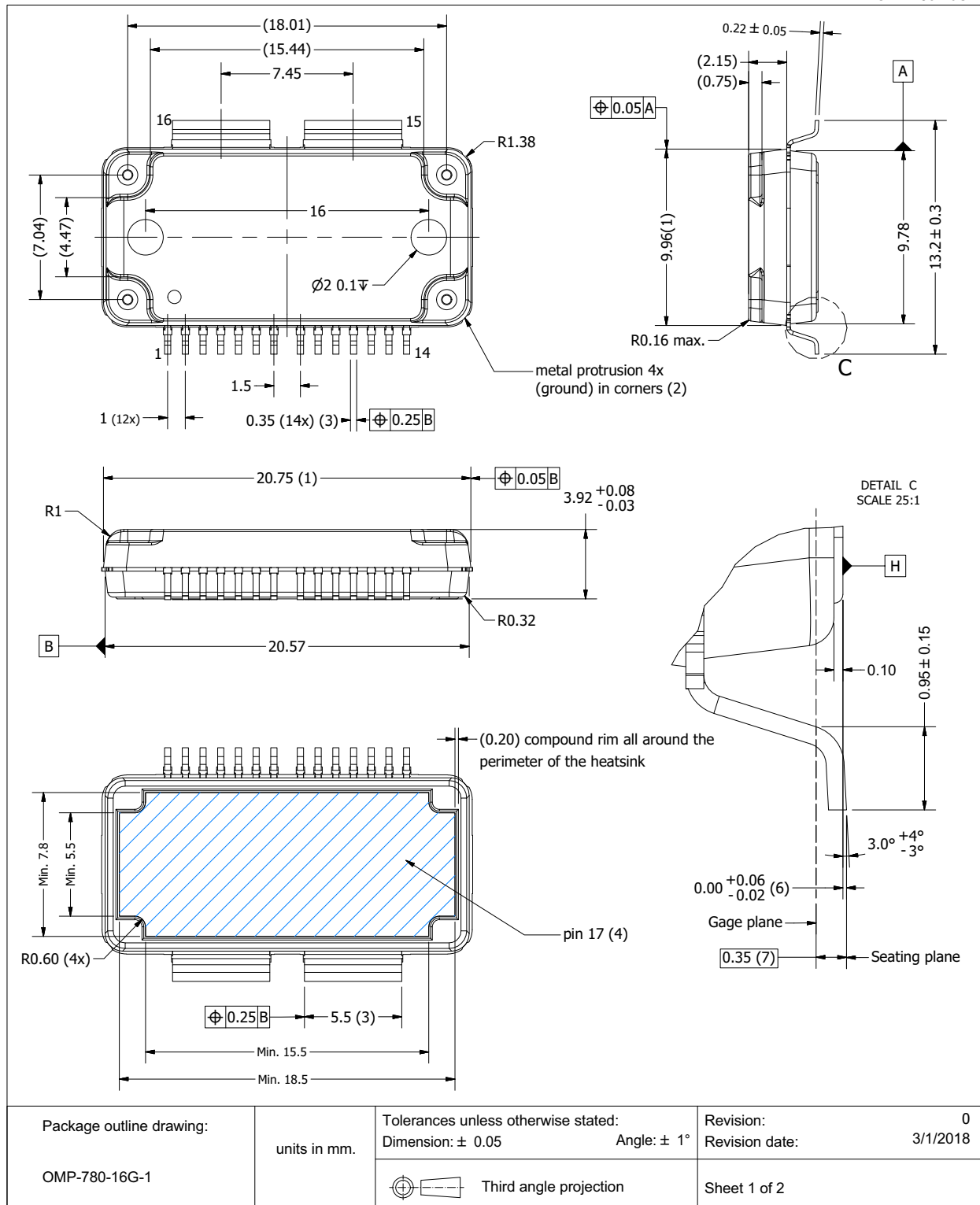
Package outline drawing:	units in mm.	Tolerances unless otherwise stated: Dimension: $\pm 0.05$ Angle: $\pm 1^\circ$	Revision: 0 Revision date: 3/1/2018
OMP-780-16F-1		 Third angle projection	Sheet 2 of 2

Fig 16. Package outline OMP-780-16F-1 (sheet 2 of 2)

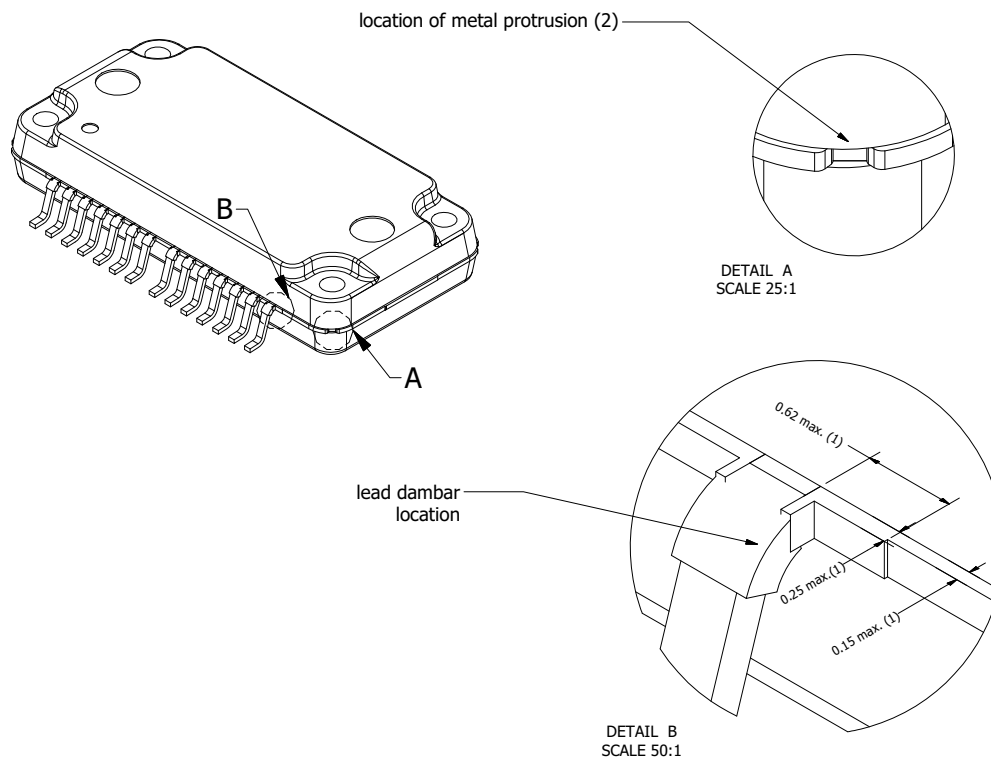
OMP-780-16G-1



**Fig 17. Package outline OMP-780-16G-1 (sheet 1 of 2)**

OMP-780-16G-1

Drawing Notes	
Items	Description
(1)	Dimensions are excluding mold protrusion. Areas located adjacent to the leads have a maximum mold protrusion of 0.25 mm (per side) and 0.62 mm max. in length. In between the 14 leads the protrusion is 0.25 mm max. At all other areas the mold protrusion is maximum 0.15 mm per side. See also detail B.
(2)	The metal protrusion (tie bars) in the corner will not stick out of the molding compound protrusions (detail A).
(3)	The lead dambar (metal) protrusions are not included. Add 0.14 mm max to the total lead dimension at the dambar location.
(4)	The hatched area indicated the exposed heatsink.
(5)	The leads and exposed heatsink are plated with matte Tin (Sn).
(6)	Dimension is measured with respect to the bottom of the heatsink Datum H. Positive value means that the bottom of the heatsink is higher than the bottom of the lead.
(7)	Gage plane (foot length) to be measured from the seating plane.




Package outline drawing:	units in mm.	Tolerances unless otherwise stated: Dimension: $\pm 0.05$ Angle: $\pm 1^\circ$	Revision: 0 Revision date: 3/1/2018
OMP-780-16G-1		 Third angle projection	Sheet 2 of 2

Fig 18. Package outline OMP-780-16G-1 (sheet 2 of 2)



## 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	C2A <a href="#">[1]</a>
Human Body Model (HBM); According to ANSI/ESDA/JEDEC standard JS-001	1B <a href="#">[2]</a>

[1] CDM classification C2A is granted to any part that passes after exposure to an ESD pulse of 500 V.

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

## 11. Abbreviations

Table 12. Abbreviations

Acronym	Description
CCDF	Complementary Cumulative Distribution Function
CW	Continuous Wave
ESD	ElectroStatic Discharge
GEN9	Ninth Generation
GSM	Global System for Mobile Communications
LDMOS	Laterally Diffused Metal Oxide Semiconductor
LTE	Long Term Evolution
MMIC	Monolithic Microwave Integrated Circuit
MTF	Median Time to Failure
OBO	Output Back Off
PAR	Peak-to-Average Ratio
RoHS	Restriction of Hazardous Substances
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
BLM9D2327S-50PB_S-50PBG v.1	20190406	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".

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Date of release: 6 April 2019

Document identifier: BLM9D2327S-50PB\_S-50PBG