BLM8G0710S-60PB; BLM8G0710S-60PBG

LDMOS 2-stage power MMIC

Rev. 3 — 13 September 2018

AMPLEON

Product data sheet

1. Product profile

1.1 General description

The BLM8G0710S-60PB(G) is a dual section, 2-stage power MMIC using Ampleon's state of the art GEN8 LDMOS technology. This multiband device is perfectly suited as general purpose driver or small cell final in the frequency range from 700 MHz to 1000 MHz. Available in gull wing or straight lead outline.

Table 1. Performance

Typical RF performance at T_{case} = 25 °C.
Test signal: 3GPP test model 1; 64 DPCH; PAR = 9.9 dB at 0.01% probability on CCDF; per section unless otherwise specified in a class-AB production circuit.

Test signal	f	V_{DS}	$P_{L(AV)}$	G_p	η_D	$ACPR_{5M}$
	(MHz)	(V)	(W)	(dB)	(%)	(dBc)
single carrier W-CDMA	957.5	28	6	34.7	26	–40

1.2 Features and benefits

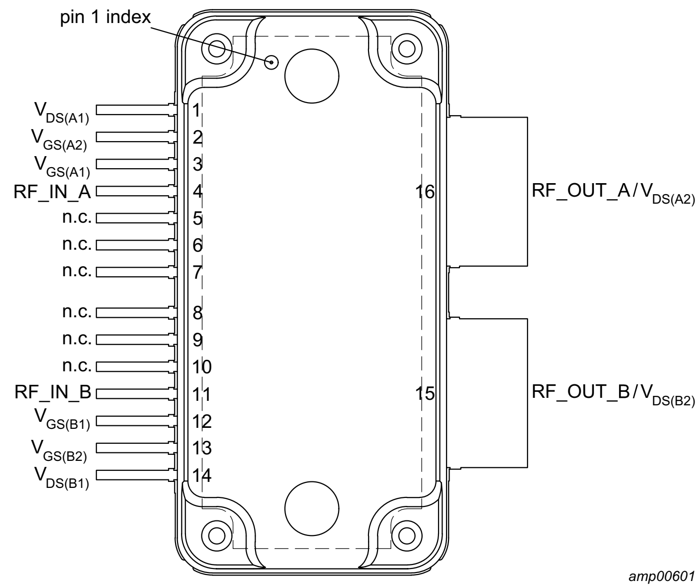
- Designed for broadband operation (frequency 700 MHz to 1000 MHz)
- High section-to-section isolation enabling multiple combinations
- Integrated temperature compensated bias
- Biasing of individual stages is externally accessible
- Integrated ESD protection
- Excellent thermal stability
- High power gain
- On-chip matching for ease of use
- For RoHS compliance see the product details on the Ampleon website

1.3 Applications

- RF power MMIC for W-CDMA base stations in the 700 MHz to 1000 MHz frequency range. Possible circuit topologies are the following as also depicted in Section 8.1:
  - Dual section or single ended
  - Doherty
  - Quadrature combined
  - Push-pull

2. Pinning information

2.1 Pinning



Transparent top view

The exposed backside of the package is the ground terminal of the device.

Fig 1. Pin configuration

2.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$V_{DS(A1)}$	1	drain-source voltage of section A, driver stage (A1)
$V_{GS(A2)}$	2	gate-source voltage of section A, final stage (A2)
$V_{GS(A1)}$	3	gate-source voltage of section A, driver stage (A1)
RF_IN_A	4	RF input section A
n.c.	5	not connected
n.c.	6	not connected
n.c.	7	not connected
n.c.	8	not connected
n.c.	9	not connected
n.c.	10	not connected
RF_IN_B	11	RF input section B
$V_{GS(B1)}$	12	gate-source voltage of section B, driver stage (B1)
$V_{GS(B2)}$	13	gate-source voltage of section B, final stage (B2)
$V_{DS(B1)}$	14	drain-source voltage of section B, driver stage (B1)

Table 2. Pin description *...continued*

Symbol	Pin	Description
RF_OUT_B/$V_{DS(B2)}$	15	RF output section B / drain-source voltage of section B, final stage (B2)
RF_OUT_A/$V_{DS(A2)}$	16	RF output section A / drain-source voltage of section A, final stage (A2)
GND	flange	RF ground

3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BLM8G0710S-60PB	-	plastic, heatsink small outline package; 16 leads (flat)	SOT1211-3
BLM8G0710S-60PBG	-	plastic, heatsink small outline package; 16 leads	SOT1212-3

4. Block diagram

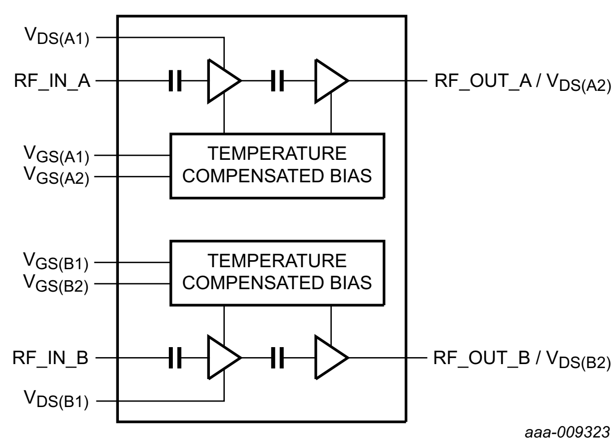


Fig 2. Block diagram

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]	-	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	final stage; T_{case} = 90 °C; P_L = 5 W	[1]	0.9	K/W
		driver stage; T_{case} = 90 °C; P_L = 5 W	[1]	3.7	K/W

[1] When operated with a CW signal.

7. Characteristics

Table 6. DC characteristics

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

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Final stage							
$V_{(BR)DSS}$	drain-source breakdown voltage	V_{GS} = 0 V; I_D = 482 μA		65	-	-	V
V_{GSq}	gate-source quiescent voltage	V_{DS} = 28 V; I_D = 240 mA		1.5	2	2.7	V
		V_{DS} = 28 V; I_D = 240 mA	[1]	1.7	2.65	3.6	V
$\Delta I_{Dq}/\Delta T$	quiescent drain current variation with temperature	−40 °C ≤ T_{case} ≤ +85 °C	[1]	-	1	-	%
I_{DSS}	drain leakage current	V_{GS} = 0 V; V_{DS} = 28 V		-	-	1.4	μA
I_{DSX}	drain cut-off current	V_{GS} = 5.65 V; V_{DS} = 10 V		-	8.3	-	A
I_{GSS}	gate leakage current	V_{GS} = 1.0 V; V_{DS} = 0 V		-	-	140	nA
Driver stage							
$V_{(BR)DSS}$	drain-source breakdown voltage	V_{GS} = 0 V; I_D = 120.6 μA		65	-	-	V
V_{GSq}	gate-source quiescent voltage	V_{DS} = 28 V; I_D = 60 mA		1.5	2	2.7	V
		V_{DS} = 28 V; I_D = 60 mA	[2]	1.7	2.65	3.6	V
$\Delta I_{Dq}/\Delta T$	quiescent drain current variation with temperature	−40 °C ≤ T_{case} ≤ +85 °C	[2]	-	1	-	%
I_{DSS}	drain leakage current	V_{GS} = 0 V; V_{DS} = 28 V		-	-	1.4	μA
I_{DSX}	drain cut-off current	V_{GS} = 5.65 V; V_{DS} = 10 V		-	2.1	-	A
I_{GSS}	gate leakage current	V_{GS} = 1.0 V; V_{DS} = 0 V		-	-	140	nA

[1] In production circuit with 1.3 kΩ gate feed resistor.

[2] In production circuit with 1.2 kΩ gate feed resistor.

Table 7. RF Characteristics

Typical RF performance at T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 60 mA (driver stage); I_{Dq2} = 240 mA (final stage); $P_{L(AV)}$ = 6 W; unless otherwise specified, measured in an Ampleon wideband straight lead production circuit.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Test signal: single carrier W-CDMA [1]						
G_p	power gain	f = 730.5 MHz	-	35.6	-	dB
		f = 957.5 MHz	33.2	34.7	36.2	dB
η_D	drain efficiency	f = 730.5 MHz	-	23.4	-	%
		f = 957.5 MHz	21	26	-	%

Table 7. RF Characteristics *...continued*

Typical RF performance at T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 60 mA (driver stage); I_{Dq2} = 240 mA (final stage); $P_{L(AV)}$ = 6 W; unless otherwise specified, measured in an Ampleon wideband straight lead production circuit.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
RL_{in}	input return loss	f = 957.5 MHz	-	–17	–10	dB
$ACPR_{5M}$	adjacent channel power ratio (5 MHz)	f = 730.5 MHz	-	–39.5	-	dBc
		f = 957.5 MHz	-	–40	–34.5	dBc
PAR_O	output peak-to-average ratio	f = 730.5 MHz	-	8	-	dB
		f = 957.5 MHz	6.7	8	-	dB
Test signal: CW [2]						
$\Delta\varphi_{s21}$	phase response difference	between sections	–10	-	+10	deg
$\Delta\|s_{21}\|^2$	insertion power gain difference	between sections	–0.5	-	+0.5	dB

[1] 3GPP test model 1; 64 DPCH; PAR = 9.9 dB at 0.01% probability on CCDF.

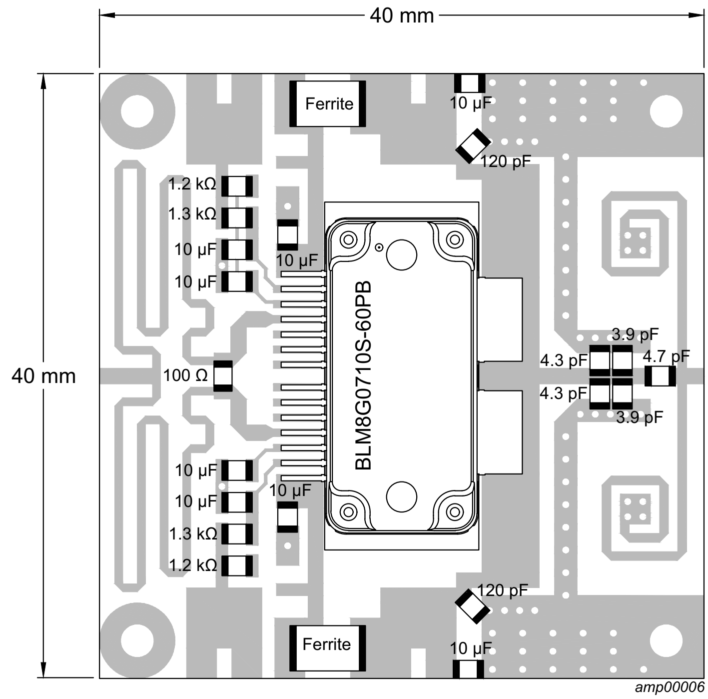
[2] f = 957.5 MHz.

8. Application information

Table 8. Typical performance

Test signal: 1-tone pulsed CW; RF performance at T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq} = 600 mA unless otherwise specified, measured in an Ampleon wideband f = 700 MHz to 1000 MHz class AB application circuit.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$P_{L(1dB)}$	output power at 1 dB gain compression	f = 800 MHz	-	74	-	W
η_D	drain efficiency	at $P_{L(1dB)}$; f = 800 MHz	-	58.4	-	%
G_p	power gain	$P_{L(AV)}$ = 11.2 W; f = 800 MHz	-	36.5	-	dB
B_{video}	video bandwidth	2-tone CW; $P_{L(AV)}$ = 40 W; f = 881.5 MHz	-	154	-	MHz
G_{flat}	gain flatness	$P_{L(AV)}$ = 11.2 W; f = 700 MHz to 1000 MHz	-	0.3	-	dB
$\Delta G/\Delta T$	gain variation with temperature	f = 800 MHz	-	0.03	-	dB/°C
$\|s_{12}\|^2$	isolation	between sections A and B; $P_{L(AV)}$ = 8 W; f = 800 MHz	-	24.5	-	dB
K	Rollett stability factor	T = –40 °C; f = 0.1 GHz to 3 GHz	-	>1.2	-	



Printed-Circuit Board (PCB): Rogers 4350; thickness = 0.508 mm.

Fig 3. Component layout for class-AB application circuit

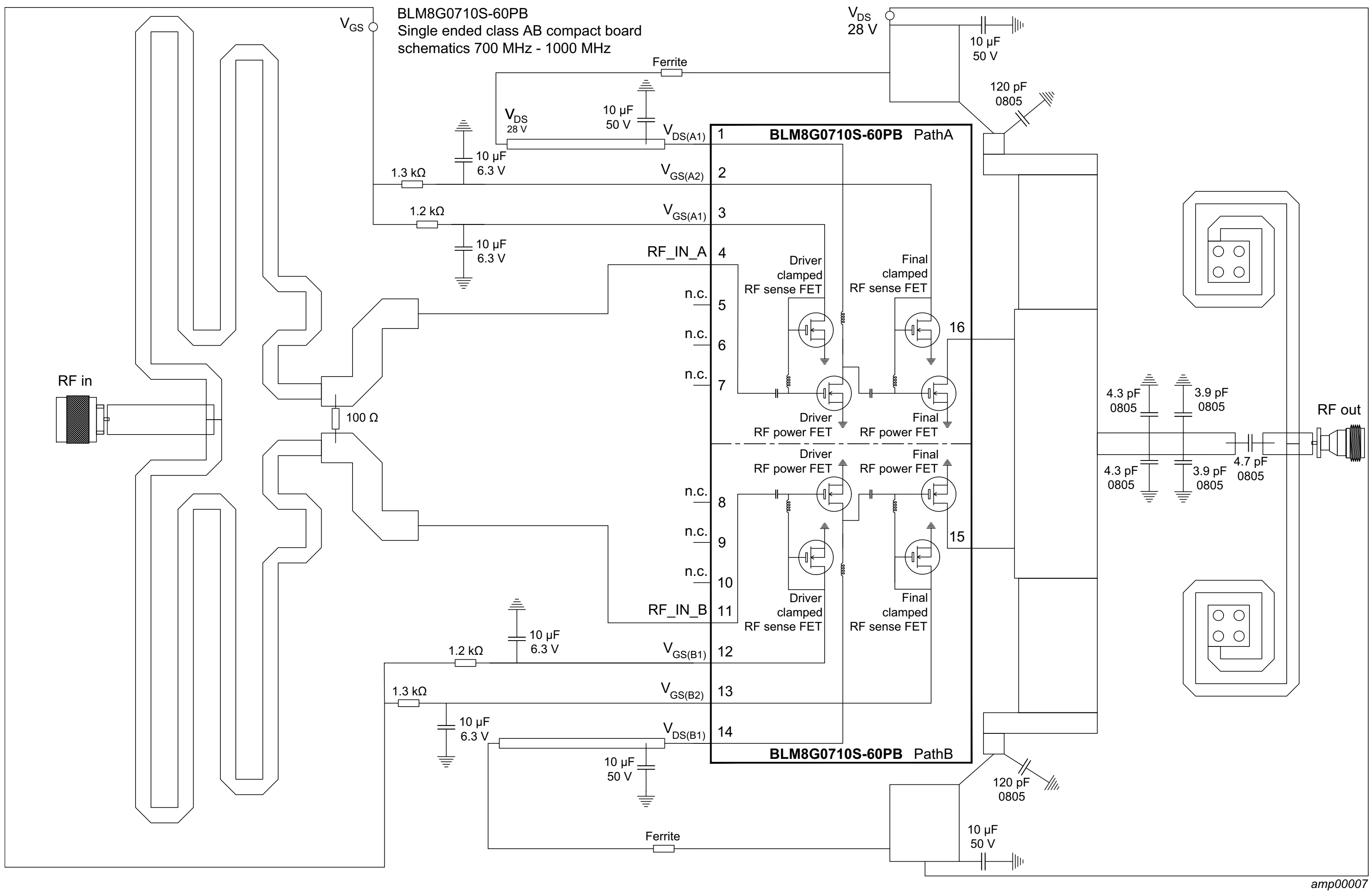


Fig 4. Electrical schematic

8.1 Possible circuit topologies

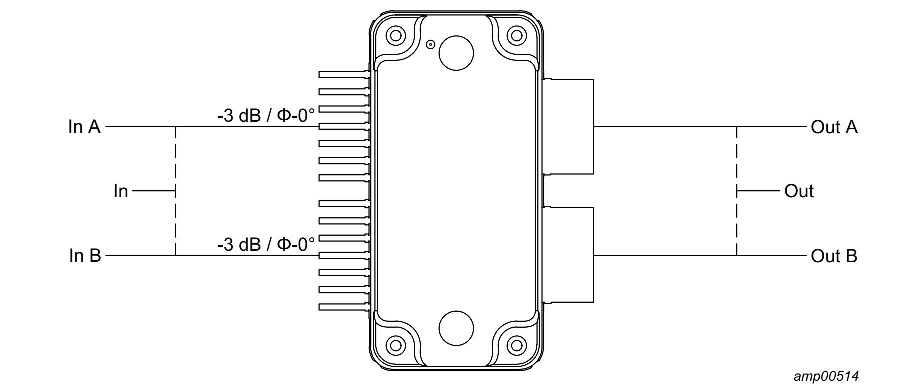


Fig 5. Dual section or single ended

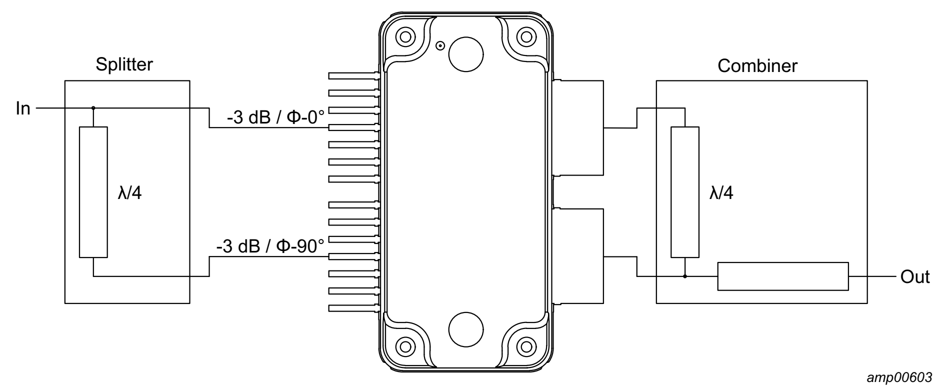


Fig 6. Doherty

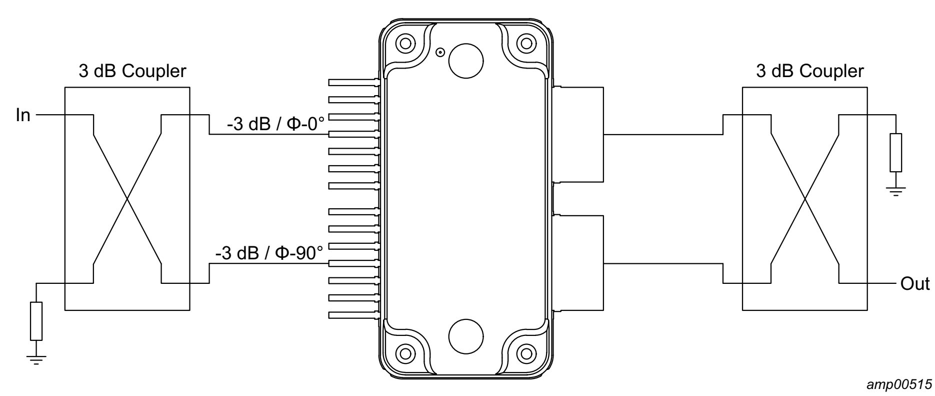


Fig 7. Quadrature combined

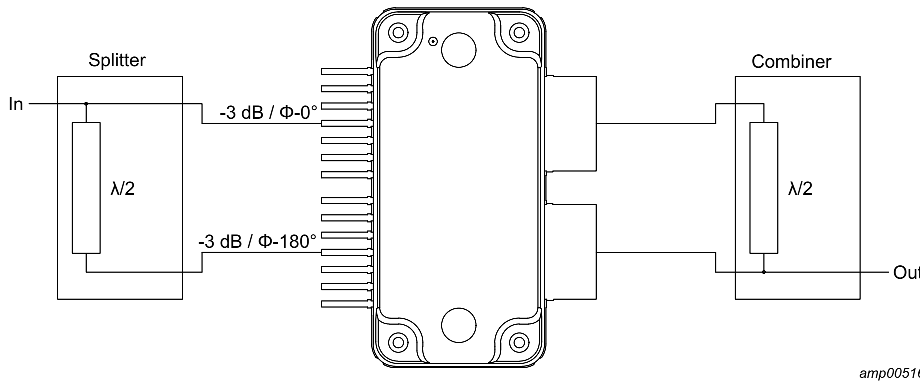


Fig 8. Push-pull

8.2 Ruggedness in class-AB operation

The BLM8G0710S-60PB and BLM8G0710S-60PBG are capable of withstanding a load mismatch corresponding to VSWR = 30 : 1 through all phases under the following conditions: V_{DS} = 32 V; I_{Dq1} = 60 mA; I_{Dq2} = 192 mA; P_i = 13 dBm, P_i is measured at CW and corresponding to $P_{L(3dB)}$ under Z_S = 50 Ω; f = 840 MHz.

8.3 Impedance information

Table 9. Typical impedance tuned for maximum output power

Measured load-pull data per section; test signal: pulsed CW; T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 60 mA; I_{Dq2} = 240 mA; t_p = 100 µs; δ = 10 %; Z_S = 50 Ω. Typical values unless otherwise specified.

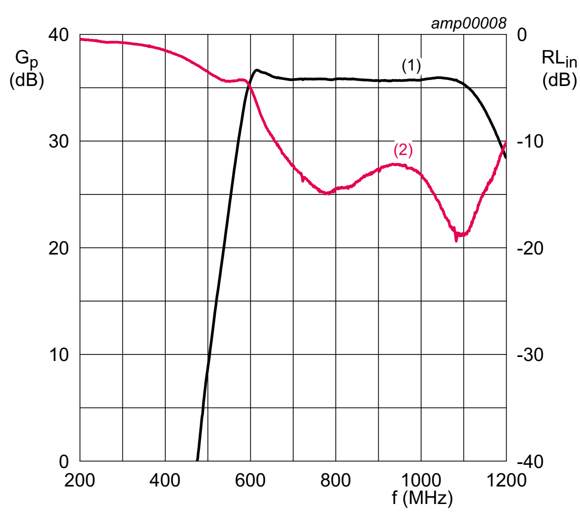
	tuned for maximum output power					tuned for maximum power added efficiency				
f	Z_L	$G_{p(max)}$	P_L	η_{add}	AM-PM conversion	Z_L	$G_{p(max)}$	P_L	η_{add}	AM-PM conversion
(MHz)	(Ω)	(dB)	(dBm)	(%)	(deg)	(Ω)	(dB)	(dBm)	(%)	(deg)
BLM8G0710S-60PB										
700	3.0 + j2.1	36.1	47.2	55.1	2.4	4.2 + j5.2	37.6	45.3	65.7	–1.5
720	3.0 + j1.7	35.9	47.3	53.4	2.5	4.4 + j5.0	37.8	45.4	64.6	–1.0
740	3.0 + j1.7	35.8	47.4	54.8	3.0	4.2 + j4.5	37.5	45.7	64.7	–0.2
760	3.0 + j1.3	35.4	47.4	53.5	3.0	4.1 + j4.8	37.2	45.4	64.3	–0.9
780	3.3 + j1.3	35.3	47.5	55.0	2.4	4.0 + j4.4	37.0	45.7	63.7	–1.3
800	3.2 + j0.9	35.2	47.5	53.8	3.1	3.9 + j4.2	37.0	45.8	64.0	–1.0
820	3.3 + j1.0	35.0	47.5	54.9	2.4	4.1 + j3.8	36.7	46.0	63.6	–0.1
840	3.4 + j0.5	34.8	47.5	53.2	2.3	3.8 + j4.0	36.8	45.7	63.4	–1.3
860	3.5 + j0.5	34.7	47.5	53.8	2.1	3.8 + j3.8	36.7	45.7	63.1	–1.2
880	3.4 + j0.4	34.8	47.4	53.2	1.8	4.0 + j3.5	36.7	45.9	63.1	–0.3
900	3.4 + j0.3	34.7	47.4	53.4	2.1	3.7 + j3.6	36.8	45.7	63.0	–0.9
920	3.4 + j0.4	34.7	47.4	54.4	1.4	3.8 + j3.7	36.8	45.5	63.0	–0.5
940	3.5 + j0.0	34.5	47.3	52.9	1.1	3.5 + j3.2	36.6	45.7	62.3	–0.5
960	3.5 – j0.1	34.2	47.3	52.7	1.3	3.5 + j3.1	36.4	45.7	62.0	–0.3
980	3.5 – j0.1	34.2	47.3	53.9	0.4	3.4 + j2.8	36.2	45.8	62.2	–1.0
BLM8G0710S–60PBG										

Table 9. Typical impedance tuned for maximum output power *...continued*

Measured load-pull data per section; test signal: pulsed CW; T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 60 mA; I_{Dq2} = 240 mA; t_p = 100 µs; δ = 10 %; Z_S = 50 Ω. Typical values unless otherwise specified.

	tuned for maximum output power					tuned for maximum power added efficiency				
f	Z_L	$G_{p(max)}$	P_L	η_{add}	AM-PM conversion	Z_L	$G_{p(max)}$	P_L	η_{add}	AM-PM conversion
(MHz)	(Ω)	(dB)	(dBm)	(%)	(deg)	(Ω)	(dB)	(dBm)	(%)	(deg)
700	3.0 + j0.6	36.3	47.5	55.1	0.3	4.5 + j3.6	37.7	45.8	66.1	–3.2
720	3.0 + j0.6	36.4	47.5	55.6	0.6	4.4 + j3.1	37.7	46.1	65.7	–2.2
740	2.9 + j0.3	35.9	47.6	54.6	1.9	4.1 + j3.4	37.3	45.8	65.4	–2.0
760	3.0 + j0.2	35.6	47.7	56.0	0.6	4.4 + j2.8	37.0	46.1	65.1	–2.2
780	3.3 – j0.1	35.5	47.7	55.9	0.9	4.3 + j2.9	37.0	46.0	64.7	–2.9
800	3.3 – j0.5	35.4	47.7	54.4	0.8	3.9 + j2.6	37.0	46.1	64.4	–3.2
820	3.3 – j0.5	35.8	47.7	55.2	1.3	4.1 + j2.3	37.3	46.2	64.0	–1.8
840	3.3 – j0.5	35.5	47.6	55.4	1.3	4.1 + j2.1	36.6	46.3	63.7	–1.3
860	3.5 – j0.9	34.5	47.7	54.9	0.6	3.8 + j2.0	35.9	46.3	63.7	–2.5
880	3.4 – j1.0	34.7	47.6	54.2	–0.1	3.6 + j2.0	36.4	46.1	63.1	–3.2
900	3.4 – j1.2	34.8	47.6	54.2	0.0	3.7 + j1.8	36.5	46.1	63.3	–2.7
920	3.4 – j1.1	35	47.6	55.4	–0.4	3.7 + j1.8	36.6	45.9	63.2	–1.9
940	3.5 – j1.4	34.7	47.5	54.7	–0.3	3.8 + j1.6	36.4	46.0	62.8	–1.2
960	3.5 – j1.6	34.4	47.5	54.9	–0.4	3.5 + j1.3	36.1	46.0	62.8	–2.2

8.4 Graphs

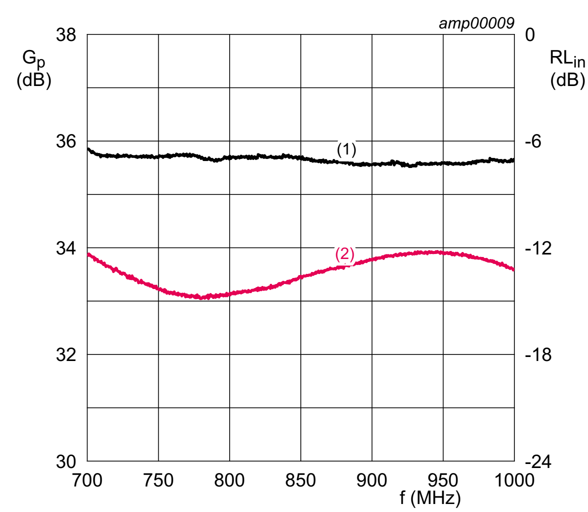


T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 60 mA; I_{Dq2} = 240 mA; P_L = 2 W. Per section.

(1) magnitude of G_p

(2) magnitude of RL_{in}

Fig 9. Wideband power gain and input return loss as function of frequency; typical values

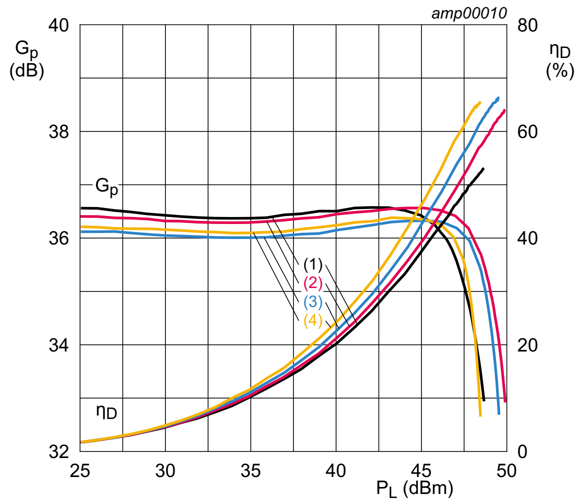


T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 60 mA; I_{Dq2} = 240 mA; P_L = 2 W. Per section.

(1) magnitude of G_p

(2) magnitude of RL_{in}

Fig 10. In-band power gain and input return loss as function of frequency; typical values



T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 60 mA; I_{Dq2} = 240 mA. Per section.

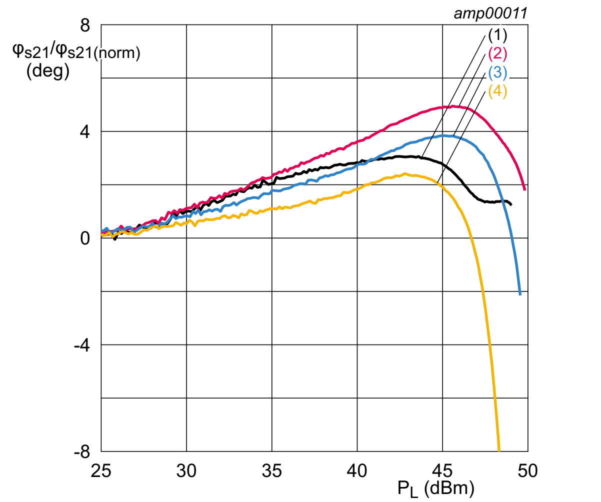
(1) f = 700 MHz

(2) f = 800 MHz

(3) f = 900 MHz

(4) f = 1000 MHz

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



Normalized at P_L = 22 dBm; T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 60 mA; I_{Dq2} = 240 mA. Per section.

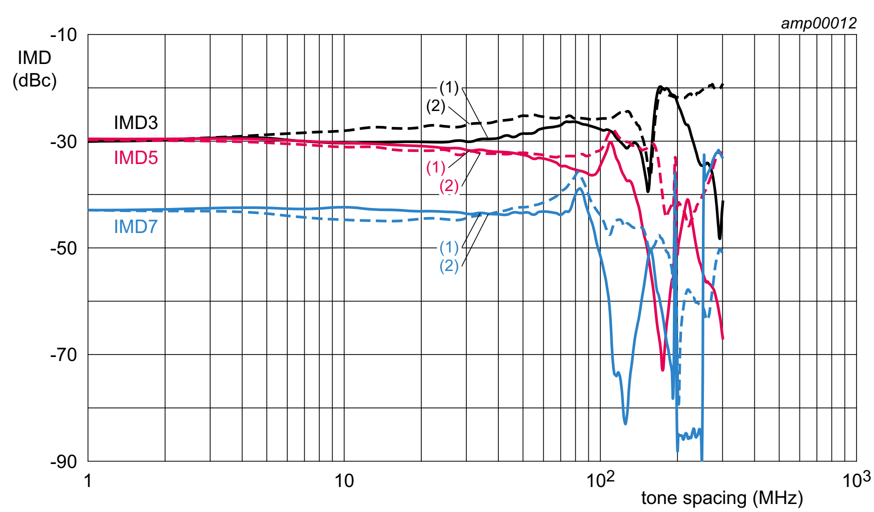
(1) f = 700 MHz

(2) f = 800 MHz

(3) f = 900 MHz

(4) f = 1000 MHz

Fig 12. Normalized phase response as a function of output power; typical values

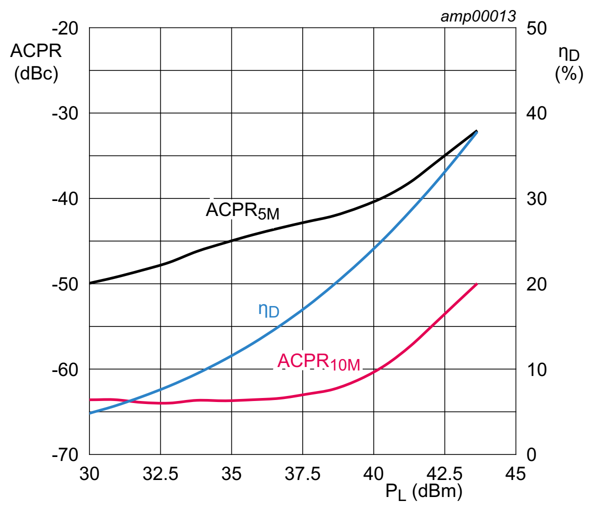


T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 60 mA; I_{Dq2} = 240 mA; f = 881.5 MHz; 2-tone CW, P_L = 20 W. Per section.

(1) IMD low

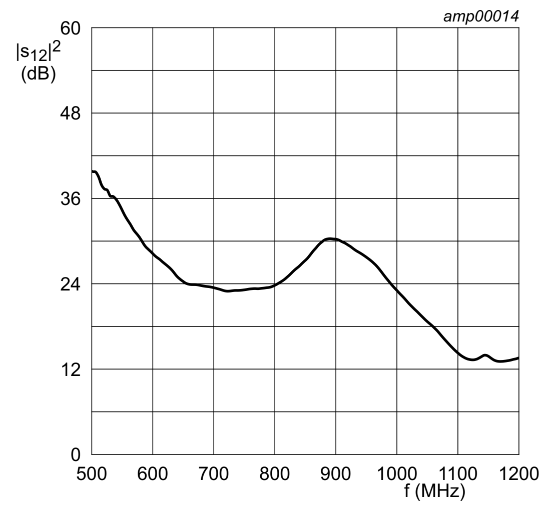
(2) IMD high

Fig 13. Intermodulation distortion as a function of tone spacing; typical values



T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 60 mA; I_{Dq2} = 240 mA: f = 900 MHz; 1-carrier W-CDMA; test model 1; PAR = 9.9 dB at 0.01% probability on CCDF. Per section

Fig 14. Adjacent channel power ratio and drain efficiency as function of output power; typical values

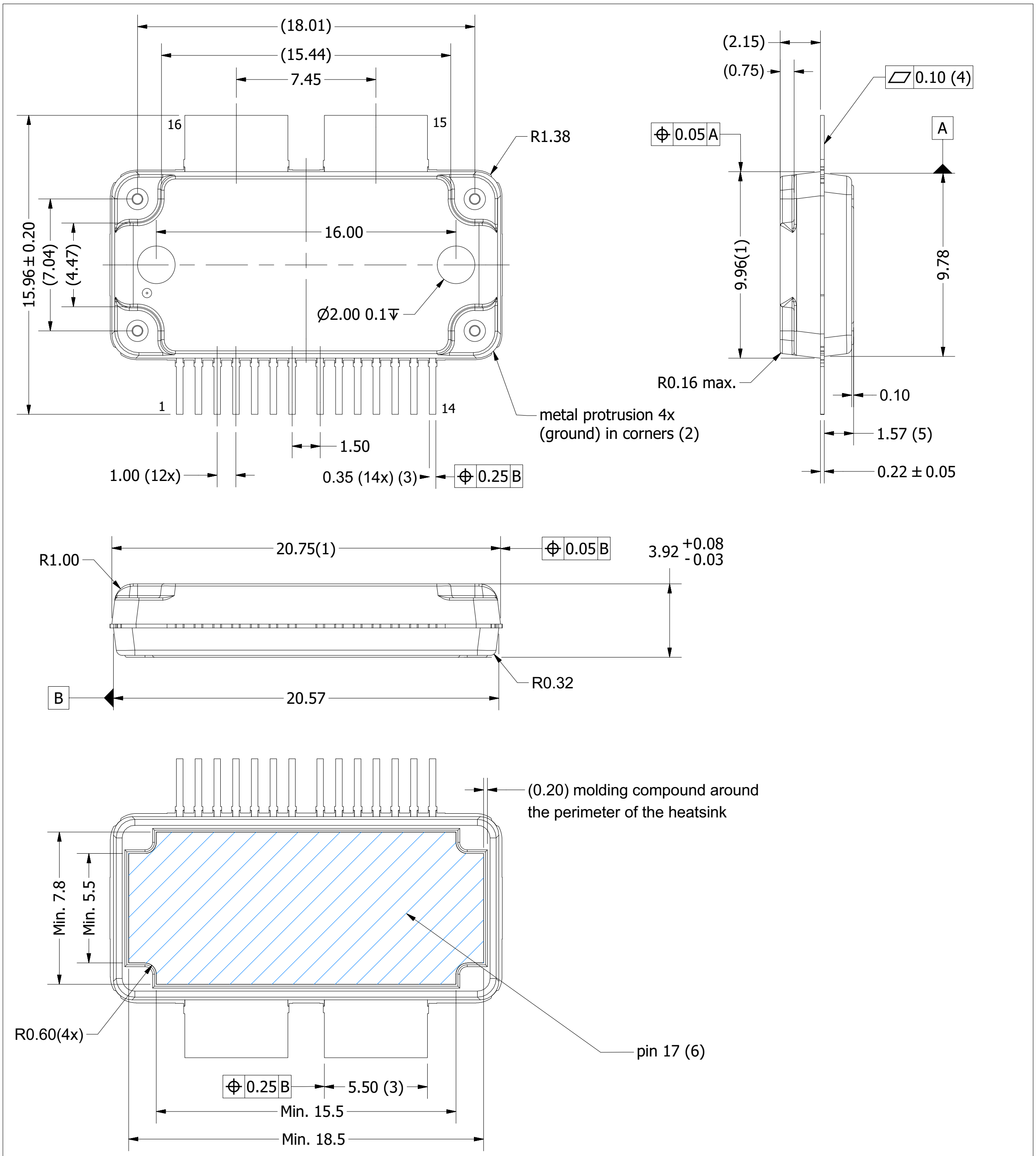


T_{case} = 25 °C; V_{DS} = 28 V; I_{Dq1} = 40 mA; I_{Dq2} = 260 mA, measured on evaluation board.

Fig 15. Section A to B isolation as a function of frequency; typical values

9. Package outline

SOT1211-3

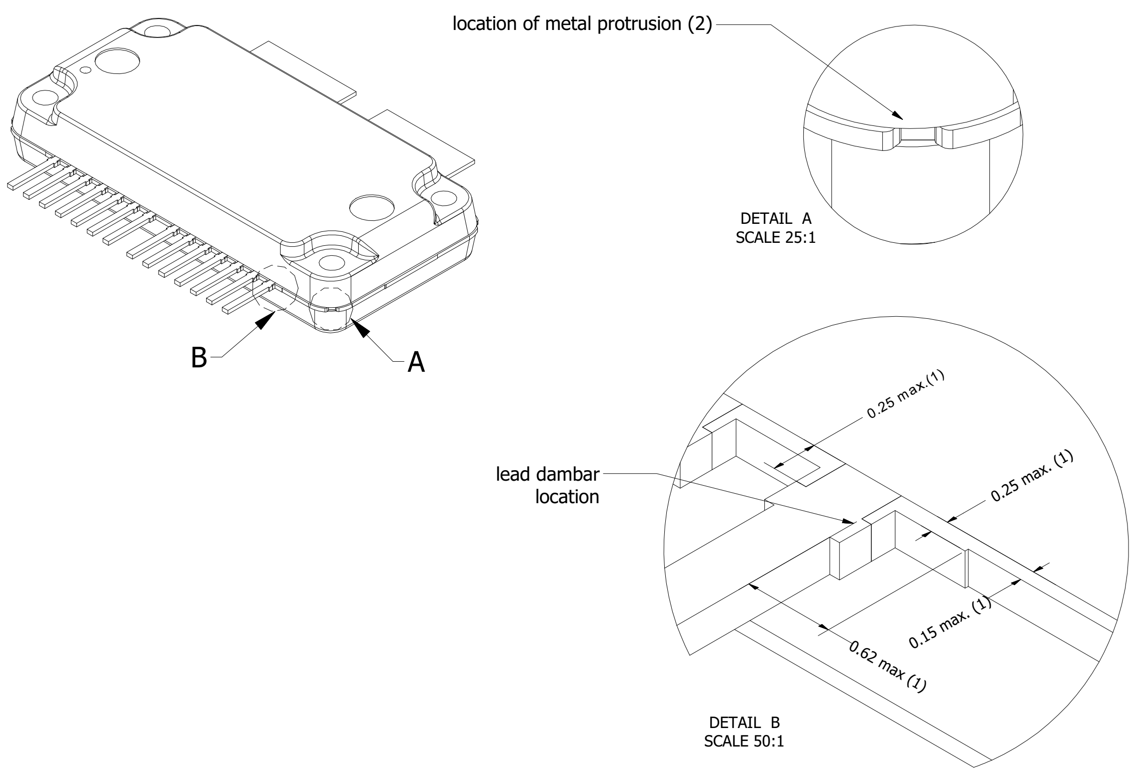


Package outline drawing: SOT1211-3	units in mm.	Tolerances unless otherwise stated: Dimension: ± 0.05 Angle: ± 1°	Revision: 1 Revision date: 7/26/2018
		Third angle projection	Sheet 1 of 2

Fig 16. Package outline SOT1211-3 (sheet 1 of 2)

SOT1211-3

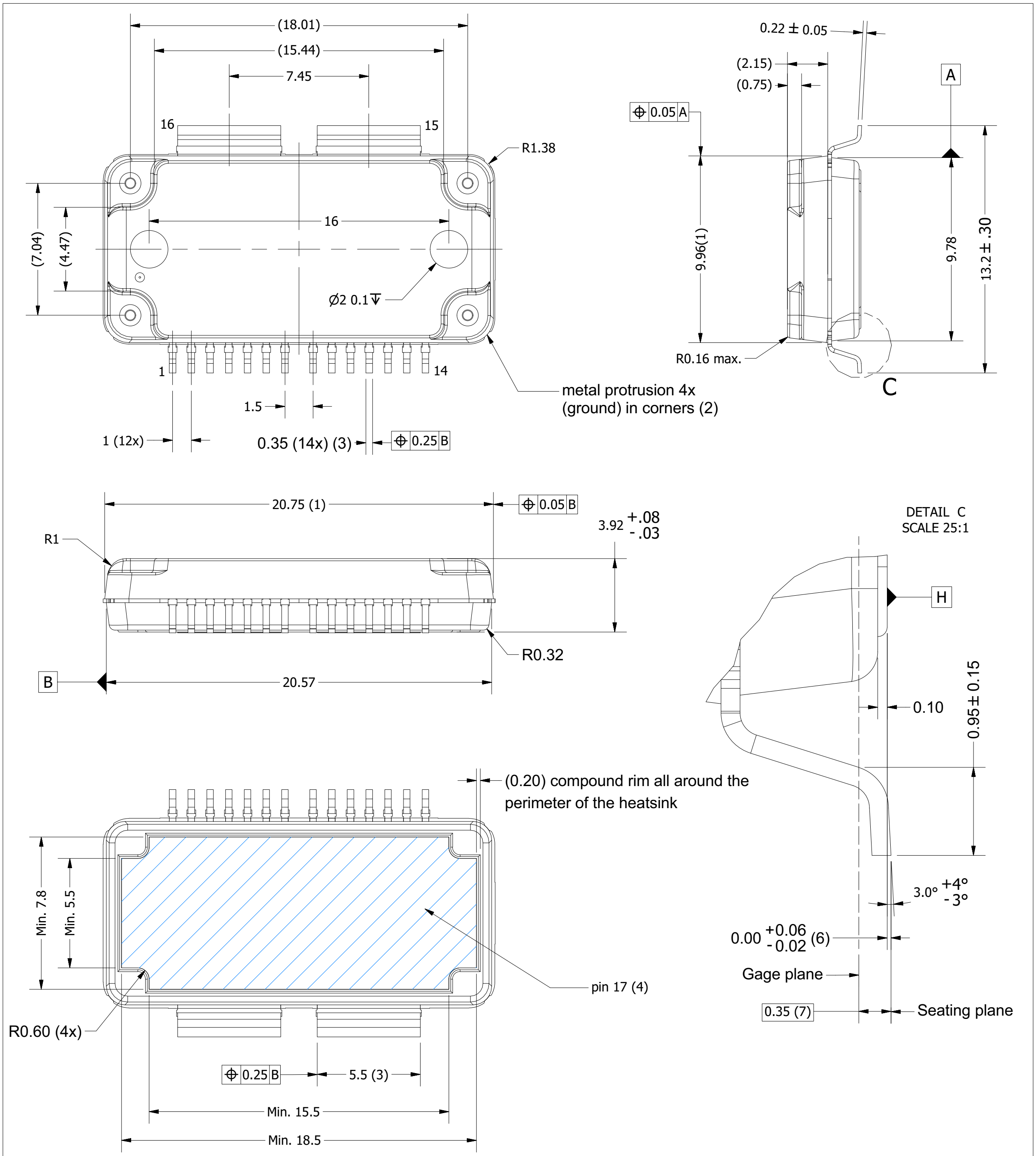
Drawing Notes	
Items	Description
(1)	Dimensions are excluding mold protrusion. Areas located adjacent to the leads have a maximum mold protrusion of 0.25 mm (per side) and 0.62 mm max. in length. In between the 14 leads the protrusion is 0.25 mm. max. At all other areas the mold protrusion is maximum 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: SOT1211-3	units in mm.	Tolerances unless otherwise stated: Dimension: ± 0.05 Angle: ± 1°	Revision: 1 Revision date: 7/26/2018
		Third angle projection	Sheet 2 of 2

Fig 17. Package outline SOT1211-3 (sheet 2 of 2)

SOT1212-3

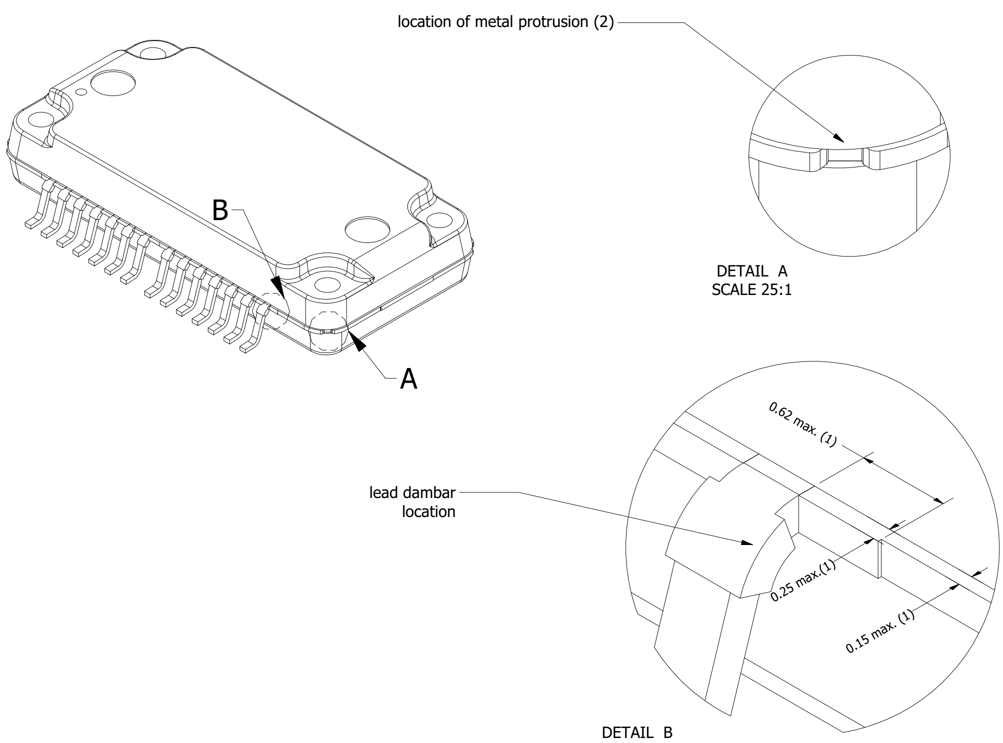


Package outline drawing: SOT1212-3	units in mm.	Tolerances unless otherwise stated: Dimension: ± 0.05	Angle: ± 1°	Revision: 1 Revision date: 7/26/2018
		Third angle projection		Sheet 1 of 2

Fig 18. Package outline SOT1212-3 (sheet 1 of 2)

SOT1212-3

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: SOT1212-3	units in mm.	Tolerances unless otherwise stated: Dimension: ± 0.05 Angle: ± 1°	Revision: 1 Revision date: 7/26/2018
		Third angle projection	Sheet 2 of 2

Fig 19. Package outline SOT1212-3 (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 10. ESD sensitivity

ESD model	Class
Charged Device Model (CDM); According to ANSI/ESDA/JEDEC standard JS-002	C1 [1]
Human Body Model (HBM); According to ANSI/ESDA/JEDEC standard JS-001	1B [2]

[1] CDM classification C1 is granted to any part that passes after exposure to an ESD pulse of 250 V.

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

11. Abbreviations

Table 11. Abbreviations

Acronym	Description
AM	Amplitude Modulation
3GPP	3rd Generation Partnership Project
CCDF	Complementary Cumulative Distribution Function
CW	Continuous Wave
DPCH	Dedicated Physical CHannel
ESD	ElectroStatic Discharge
GEN8	Eighth Generation
LDMOS	Laterally Diffused Metal Oxide Semiconductor
MMIC	Monolithic Microwave Integrated Circuit
MTF	Median Time to Failure
PAR	Peak-to-Average Ratio
PM	Phase Modulation
RoHS	Restriction of Hazardous Substances
VSWR	Voltage Standing Wave Ratio
W-CDMA	Wideband Code Division Multiple Access

12. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BLM8G0710S-60PB_S-60PBG v.3	20180913	Product data sheet	-	BLM8G0710S-60PB_ S-60PBG v.2
Modifications	• Figure 1 on page 2: figure updated • Table 3 on page 3: package outline versions changed to SOT1211-3 and SOT1212-3 • Figure 3 on page 6: figure updated • Figure 5 on page 8: figure updated • Figure 6 on page 8: figure updated • Figure 7 on page 8: figure updated • Figure 8 on page 9: figure updated • Table 9 on page 9: typo corrected • Section 9 on page 13: package outline versions changed from SOT1211-2 and SOT1212-2 to SOT1211-3 and SOT1212-3 • Table 10 on page 17: added table			
BLM8G0710S-60PB_S-60PBG v.2	20160322	Product data sheet	-	BLM8G0710S-60PB_ S-60PBG v.1
BLM8G0710S-60PB_S-60PBG v.1	20160225	Product data sheet	-	-

13. Legal information

13.1 Data sheet status

Document status[1][2]	Product status[3]	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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15. Contents

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