BF1216

Dual N-channel dual gate MOSFET

Rev. 01 — 29 April 2010 **Product data sheet**

1. Product profile

1.1 General description

The BF1216 is a combination of two dual gate MOSFET amplifiers with shared source and gate2 leads.

The source and substrate are interconnected. Internal bias circuits enable DC stabilization and very good cross modulation performance during AGC. Integrated diodes between the gates and source protect against excessive input voltage surges. The transistor is available as a SOT363 micro-miniature plastic package.

CAUTION

This device is sensitive to ElectroStatic Discharge (ESD). Therefore care should be taken during transport and handling.

1.2 Features and benefits

- Two low noise gain controlled amplifiers in a single package; both with a partly integrated bias
- Superior cross modulation performance during AGC
- High forward transfer admittance
- High forward transfer admittance to input capacitance ratio

1.3 Applications

- Gain controlled low noise amplifiers for VHF and UHF applications running on a 5 V supply voltage
  - digital and analog television tuners
  - professional communication equipment

1.4 Quick reference data

Table 1. Quick reference data for amplifier A and B

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{DS}	drain-source voltage	DC		-	-	6	V
I_D	drain current	DC		-	-	30	mA
P_{tot}	total power dissipation	$T_{sp} \leq 107$ °C	[1]	-	-	180	mW
$\|y_{fs}\|$	forward transfer admittance	f = 100 MHz; T_j = 25 °C; I_D = 18 mA		23	27	38	mS
$C_{iss(G1)}$	input capacitance at gate1	f = 100 MHz	[2]	-	2.5	-	pF
C_{rss}	reverse transfer capacitance	f = 100 MHz	[2]	-	25	-	fF
NF	noise figure	f = 400 MHz; $Y_S = Y_{S(opt)}$		-	1.0	-	dB
		f = 800 MHz; $Y_S = Y_{S(opt)}$		-	1.5	-	dB
Xmod	cross modulation	input level for k = 1 % at 40 dB AGC; f_w = 50 MHz; f_{unw} = 60 MHz	[3]	105	107	-	dBμV
T_j	junction temperature			-	-	150	°C

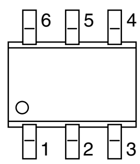
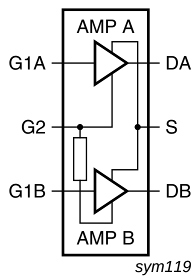
[1] T_{sp} is the temperature at the soldering point of the source lead.

[2] Calculated from S-parameters.

[3] Measured in Figure 17 test circuit.

2. Pinning information

Table 2. Discrete pinning

Pin	Description	Simplified outline	Graphic symbol
1	gate1 (amplifier A)		
2	gate2		
3	gate1 (amplifier B)		
4	drain (amplifier B)		
5	source		
6	drain (amplifier A)		

3. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
BF1216	-	plastic surface-mounted package; 6 leads	SOT363

4. Marking

Table 4. Marking

Type number	Marking	Description
BF1216	M5p	made in Hong Kong
	M5t	made in Malaysia
	M5w	made in China

5. Limiting values

Table 5. Limiting values

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

Symbol	Parameter	Conditions		Min	Max	Unit
Per MOSFET						
V_{DS}	drain-source voltage			-	6	V
I_D	drain current	DC		-	30	mA
I_{G1}	gate1 current			-	±10	mA
I_{G2}	gate2 current			-	±10	mA
P_{tot}	total power dissipation	$T_{sp} \leq 107$ °C	[1]	-	180	mW
T_{stg}	storage temperature			–65	+150	°C
T_j	junction temperature			-	150	°C

[1] T_{sp} is the temperature at the soldering point of the source lead.

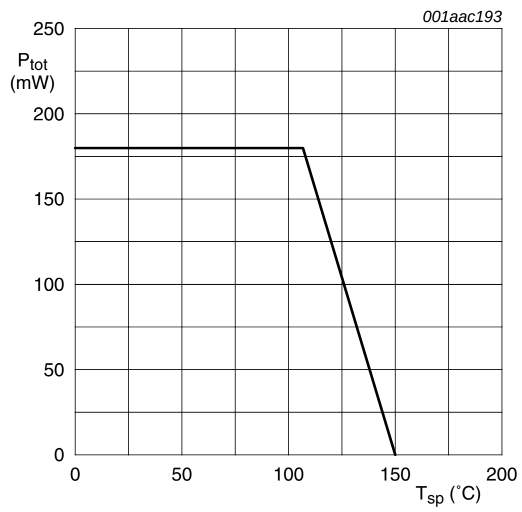


Fig 1. Power derating curve

6. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-sp)}$	thermal resistance from junction to solder point		240	K/W

7. Static characteristics

Table 7. Static characteristics

T_j = 25 °C.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Per MOSFET; unless otherwise specified						
$V_{(BR)DSS}$	drain-source breakdown voltage	$V_{G1-S} = V_{G2-S} = 0$ V; $I_D = 10$ μA				
		amplifier A	6	-	-	V
		amplifier B	6	-	-	V
$V_{(BR)G1-SS}$	gate1-source breakdown voltage	$V_{G2-S} = V_{DS} = 0$ V; $I_{G1-S} = 10$ mA	6	-	10	V
$V_{(BR)G2-SS}$	gate2-source breakdown voltage	$V_{G1-S} = V_{DS} = 0$ V; $I_{G2-S} = 10$ mA	6	-	10	V
$V_{F(S-G1)}$	forward source-gate1 voltage	$V_{G2-S} = V_{DS} = 0$ V; $I_{S-G1} = 10$ mA	0.5	-	1.5	V
$V_{F(S-G2)}$	forward source-gate2 voltage	$V_{G1-S} = V_{DS} = 0$ V; $I_{S-G2} = 10$ mA	0.5	-	1.5	V
$V_{G1-S(th)}$	gate1-source threshold voltage	$V_{DS} = 5$ V; $V_{G2-S} = 4$ V; $I_D = 100$ μA	0.3	-	1.0	V
$V_{G2-S(th)}$	gate2-source threshold voltage	$V_{DS} = 5$ V; $V_{G1-S} = 5$ V; $I_D = 100$ μA	0.4	-	1.0	V
I_{DS}	drain-source current	$V_{G2-S} = 4$ V [1]				
		amplifier A; $V_{DS(A)} = 5$ V; $R_{G1(A)} = 39$ kΩ	-	-	24	mA
		amplifier B; $V_{DS(B)} = 5$ V; $R_{G1(B)} = 39$ kΩ	-	-	24	mA
I_{G1-S}	gate1 cut-off current	$V_{G2-S} = 0$ V; $V_{DS(A)} = V_{DS(B)} = 0$ V				
		amplifier A; $V_{G1-S(A)} = 5$ V	-	-	50	nA
		amplifier B; $V_{G1-S(B)} = 5$ V	-	-	50	nA
I_{G2-S}	gate2 cut-off current	$V_{G2-S} = 4$ V; $V_{DS(A)} = V_{DS(B)} = 0$ V; $V_{G1-S(A)} = V_{G1-S(B)} = 0$ V	-	-	20	nA

[1] R_{G1} connects gate1 to $V_{GG} = 5$ V; see Figure 17.

8. Dynamic characteristics

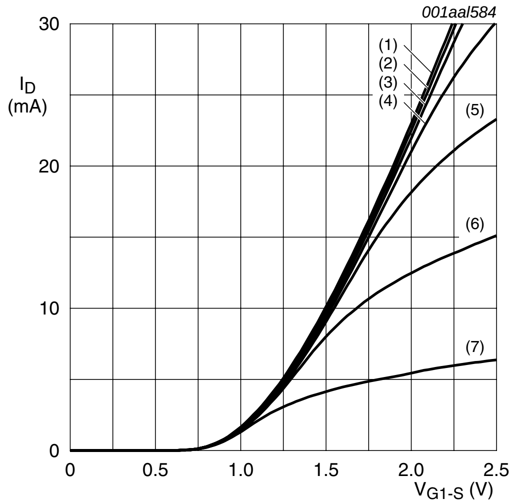
Table 8. Dynamic characteristics for amplifier A and B
Common source; T_{amb} = 25 °C; V_{G2-S} = 4 V; V_{DS} = 5 V; I_D = 19 mA.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$\lvert y_{fs} \rvert$	forward transfer admittance	f = 100 MHz; T_j = 25 °C; I_D = 18 mA		23	27	38	mS
$C_{iss(G1)}$	input capacitance at gate1	f = 100 MHz	[1]	-	2.5	-	pF
$C_{iss(G2)}$	input capacitance at gate2	f = 100 MHz	[1]	-	2.4	-	pF
C_{oss}	output capacitance	f = 100 MHz	[1]	-	0.8	-	pF
C_{rss}	reverse transfer capacitance	f = 100 MHz	[1]	-	25	-	fF
G_{tr}	transducer power gain	amplifier A; $B_S = B_{S(opt)}$; $B_L = B_{L(opt)}$	[1]				
		f = 200 MHz; G_S = 2 mS; G_L = 0.5 mS		-	34	-	dB
		f = 400 MHz; G_S = 2 mS; G_L = 1 mS		-	30	-	dB
		f = 800 MHz; G_S = 3.3 mS; G_L = 1 mS		-	26	-	dB
		amplifier B; $B_S = B_{S(opt)}$; $B_L = B_{L(opt)}$	[1]				
		f = 200 MHz; G_S = 2 mS; G_L = 0.5 mS		-	34	-	dB
		f = 400 MHz; G_S = 2 mS; G_L = 1 mS		-	30	-	dB
		f = 800 MHz; G_S = 3.3 mS; G_L = 1 mS		-	26	-	dB
NF	noise figure	f = 11 MHz; G_S = 20 mS; B_S = 0 S		-	-	5	dB
		f = 400 MHz; $Y_S = Y_{S(opt)}$		-	1.0	-	dB
		f = 800 MHz; $Y_S = Y_{S(opt)}$		-	1.5	-	dB
Xmod	cross modulation	input level for k = 1 % at 40 dB AGC; f_w = 50 MHz; f_{unw} = 60 MHz	[2]				
		at 0 dB AGC		90	104	-	dBμV
		at 10 dB AGC		-	100	-	dBμV
		at 20 dB AGC		-	104	-	dBμV
		at 40 dB AGC		105	107	-	dBμV

[1] Calculated from S-parameters.

[2] Measured in Figure 17 test circuit.

8.1 Graphs for amplifiers A and B



(1) V_{G2-S} = 4.0 V.

(2) V_{G2-S} = 3.5 V.

(3) V_{G2-S} = 3.0 V.

(4) V_{G2-S} = 2.5 V.

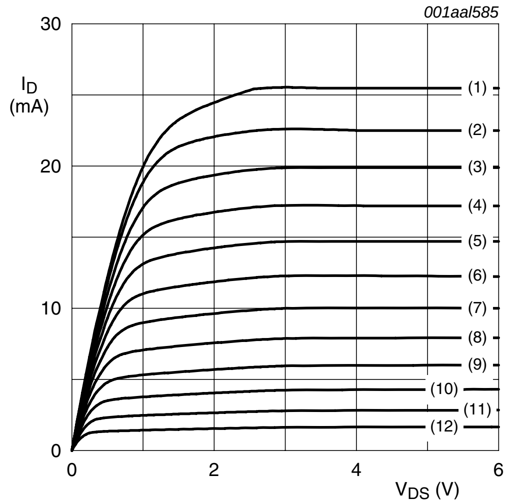
(5) V_{G2-S} = 2.0 V.

(6) V_{G2-S} = 1.5 V.

(7) V_{G2-S} = 1.0 V.

V_{DS} = 5 V; T_j = 25 °C.

Fig 2. Transfer characteristics; typical values



(1) V_{G1-S} = 2.1 V.

(2) V_{G1-S} = 2.0 V.

(3) V_{G1-S} = 1.9 V.

(4) V_{G1-S} = 1.8 V.

(5) V_{G1-S} = 1.7 V.

(6) V_{G1-S} = 1.6 V.

(7) V_{G1-S} = 1.5 V.

(8) V_{G1-S} = 1.4 V.

(9) V_{G1-S} = 1.3 V.

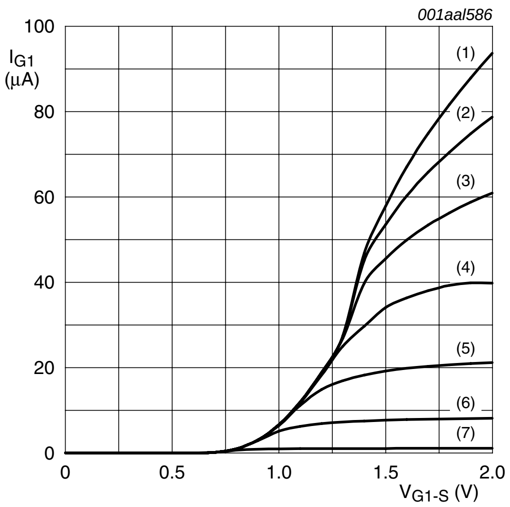
(10) V_{G1-S} = 1.2 V.

(11) V_{G1-S} = 1.1 V.

(12) V_{G1-S} = 1.0 V.

V_{G2-S} = 4 V; T_j = 25 °C.

Fig 3. Output characteristics; typical values



(1) V_{G2-S} = 4.0 V.

(2) V_{G2-S} = 3.5 V.

(3) V_{G2-S} = 3.0 V.

(4) V_{G2-S} = 2.5 V.

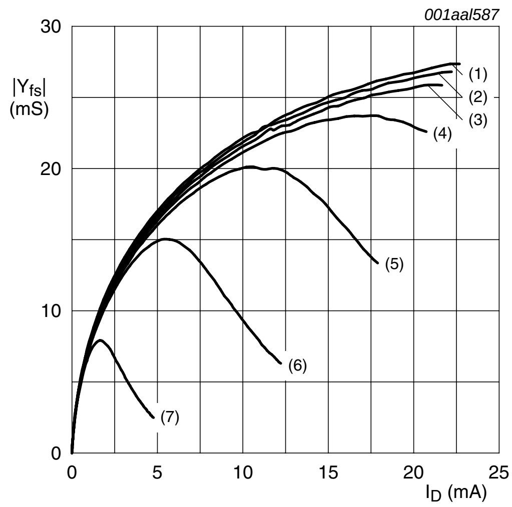
(5) V_{G2-S} = 2.0 V.

(6) V_{G2-S} = 1.5 V.

(7) V_{G2-S} = 1.0 V.

V_{DS} = 5 V; T_j = 25 °C.

Fig 4. Gate1 current as a function of gate1 voltage; typical values



(1) V_{G2-S} = 4.0 V.

(2) V_{G2-S} = 3.5 V.

(3) V_{G2-S} = 3.0 V.

(4) V_{G2-S} = 2.5 V.

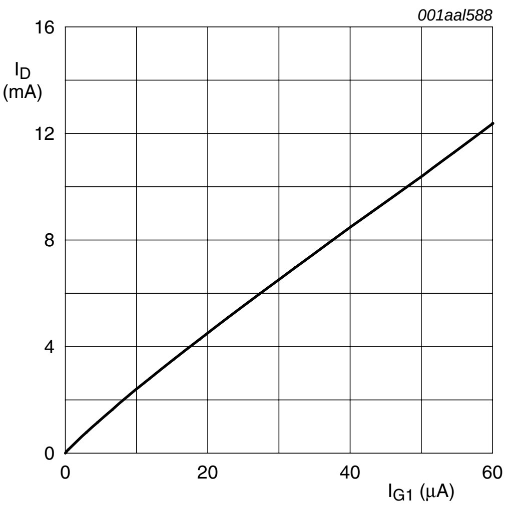
(5) V_{G2-S} = 2.0 V.

(6) V_{G2-S} = 1.5 V.

(7) V_{G2-S} = 1.0 V.

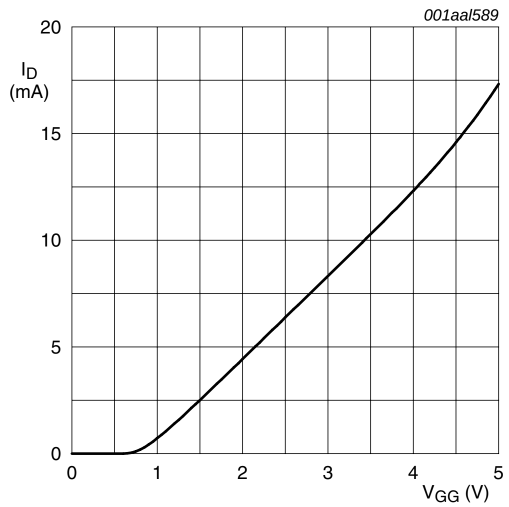
V_{DS} = 5 V; T_j = 25 °C.

Fig 5. Forward transfer admittance as a function of drain current; typical values



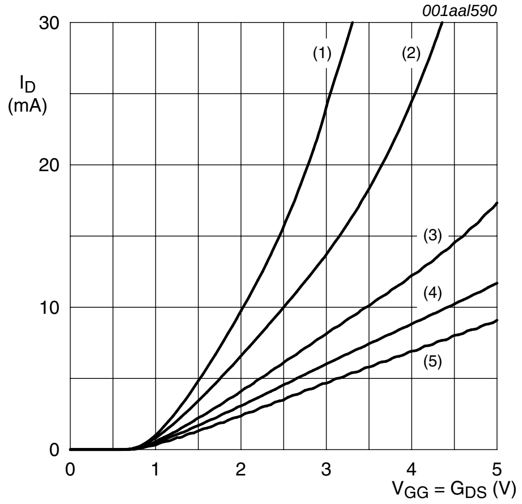
V_{DS} = 5 V; V_{G2-S} = 4 V; T_j = 25 °C.

Fig 6. Drain current as a function of gate1 current; typical values



V_{DS} = 5 V; V_{G2-S} = 4 V; R_{G1} = 39 kΩ; T_j = 25 °C.

Fig 7. Drain current as a function of gate1 supply voltage (V_{GG}); typical values



(1) R_{G1} = 10 kΩ.

(2) R_{G1} = 20 kΩ.

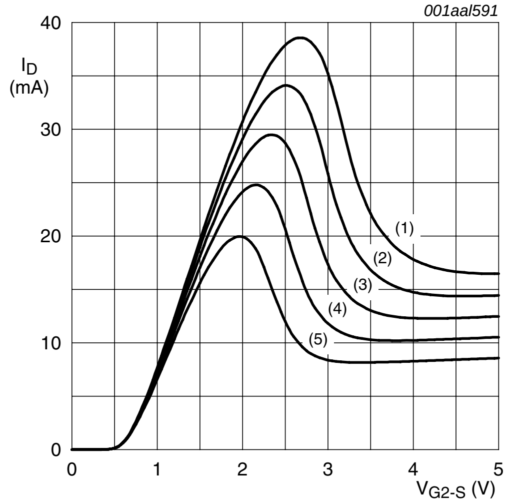
(3) R_{G1} = 40 kΩ.

(4) R_{G1} = 60 kΩ.

(5) R_{G1} = 80 kΩ.

V_{G2-S} = 4 V; T_j = 25 °C.

Fig 8. Drain current as a function of V_{DS} and V_{GG}; typical values



(1) V_{GG} = 5.0 V.

(2) V_{GG} = 4.5 V.

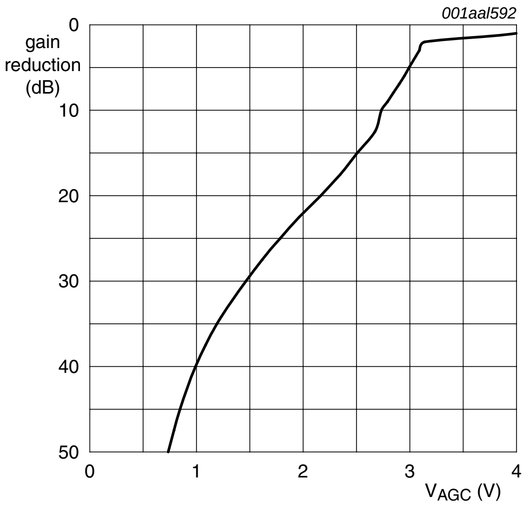
(3) V_{GG} = 4.0 V.

(4) V_{GG} = 3.5 V.

(5) V_{GG} = 3.0 V.

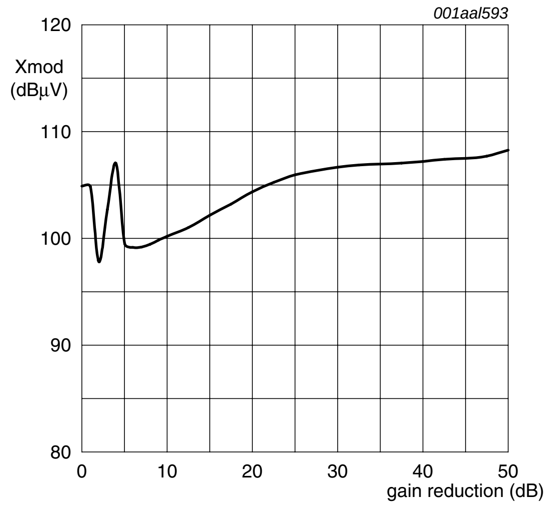
T_j = 25 °C; R_{G1} = 39 kΩ (connected to V_{GG}).

Fig 9. Drain current as a function of gate2 voltage; typical values



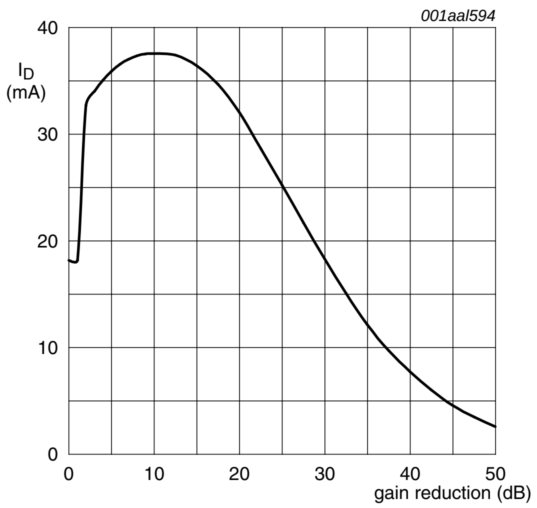
V_{DS} = 5 V; V_{GG} = 5 V; nominal I_D = 19 mA; R_{G1} = 39 kΩ; f = 50 MHz; T_j = 25 °C; see Figure 17.

Fig 10. Typical gain reduction as a function of the AGC voltage; typical values



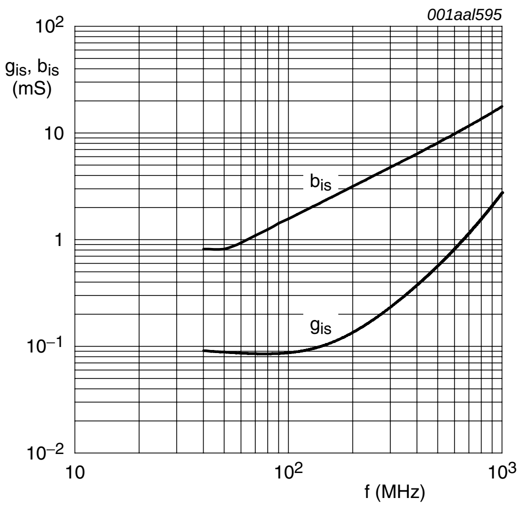
V_{DS} = 5 V; V_{GG} = 5 V; nominal V_{G2-S} = 4 V; R_{G1} = 39 kΩ; f_w = 50 MHz; f_{unw} = 60 MHz; nominal I_D = 19 mA; T_j = 25 °C; see Figure 17.

Fig 11. Unwanted voltage for 1 % cross modulation as a function of gain reduction; typical values



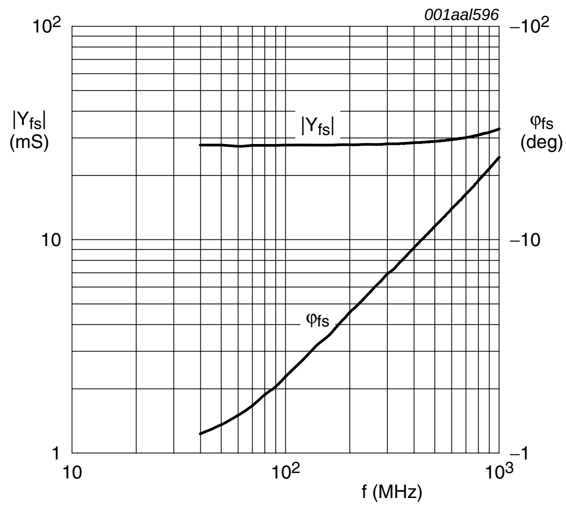
V_{DS} = 5 V; V_{GG} = 5 V; nominal V_{G2-S} = 4 V; R_{G1} = 39 kΩ; f_w = 50 MHz; nominal I_D = 19 mA; T_j = 25 °C; see Figure 17.

Fig 12. Typical drain current as a function of gain reduction; typical values



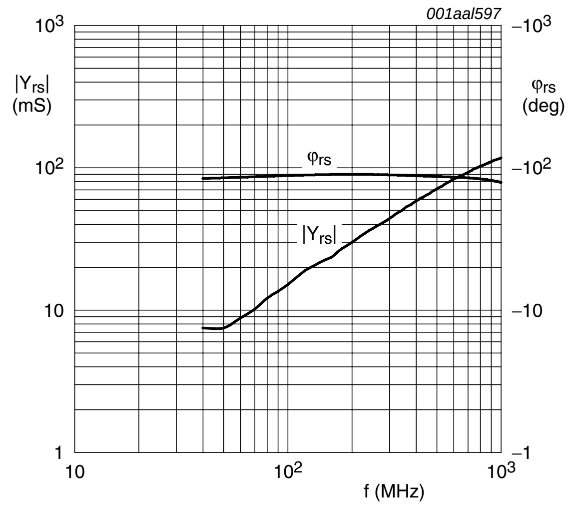
$V_{DS(A)} = 5$ V; $V_{G2\text{-}S} = 4$ V; $V_{DS(B)} = 0$ V; $I_{D(A)} = 19$ mA; and vice versa.

Fig 13. Input admittance as a function of frequency; typical values



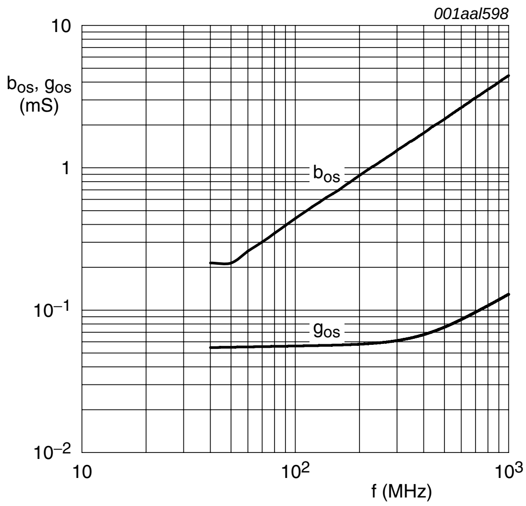
$V_{DS(A)} = 5$ V; $V_{G2\text{-}S} = 4$ V; $V_{DS(B)} = 0$ V; $I_{D(A)} = 19$ mA; and vice versa.

Fig 14. Forward transfer admittance and phase as a function of frequency; typical values



$V_{DS(A)} = 5$ V; $V_{G2\text{-}S} = 4$ V; $V_{DS(B)} = 0$ V; $I_{D(A)} = 19$ mA; and vice versa.

Fig 15. Reverse transfer admittance and phase as a function of frequency; typical values



$V_{DS(A)} = 5$ V; $V_{G2\text{-}S} = 4$ V; $V_{DS(B)} = 0$ V; $I_{D(A)} = 19$ mA; and vice versa.

Fig 16. Output admittance as a function of frequency; typical values

8.2 Scattering parameters for amplifiers A and B

Table 9. Scattering parameters for amplifiers A and B

$V_{DS(A)}$ = 5 V; V_{G2-S} = 4 V; $I_{D(A)}$ = 19 mA; $V_{DS(B)}$ = 0 V; $V_{G1-S(B)}$ = 0 V; T_{amb} = 25 °C; Z_0 = 50 Ω; typical values.

f (MHz)	s_{11}		s_{21}		s_{12}		s_{22}	
	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)	Magnitude (ratio)	Angle (degree)
40	0.9910	–4.73	2.76	175.80	0.00074	99.46	0.9946	–1.29
100	0.9888	–9.07	2.75	171.94	0.00150	86.12	0.9941	–2.65
200	0.9853	–18.19	2.73	163.86	0.00292	79.56	0.9929	–5.31
300	0.9762	–27.09	2.69	155.90	0.00420	74.12	0.9916	–7.92
400	0.9656	–35.80	2.65	148.17	0.00540	69.71	0.9900	–10.49
500	0.9502	–44.45	2.59	140.50	0.00634	65.32	0.9882	–13.05
600	0.9331	–52.89	2.52	132.96	0.00709	61.01	0.9855	–15.66
700	0.9155	–61.08	2.45	125.69	0.00751	57.66	0.9830	–18.24
800	0.8966	–69.01	2.38	118.59	0.00782	54.58	0.9810	–20.75
900	0.8755	–76.72	2.30	111.71	0.00792	52.37	0.9798	–23.19
1000	0.8550	–84.10	2.22	105.07	0.00783	50.60	0.9785	–25.68

8.3 Noise data for amplifiers A and B

Table 10. Noise data for amplifiers A and B

$V_{DS(A)}$ = 5 V; V_{G2-S} = 4 V; $I_{D(A)}$ = 19 mA, T_{amb} = 25 °C; typical values.

f (MHz)	NF_{min} (dB)	Γ_{opt}		r_n (ratio)
		(ratio)	(degree)	
400	1.0	0.788	28.9	0.903
800	1.5	0.673	58.8	0.725

9. Test information

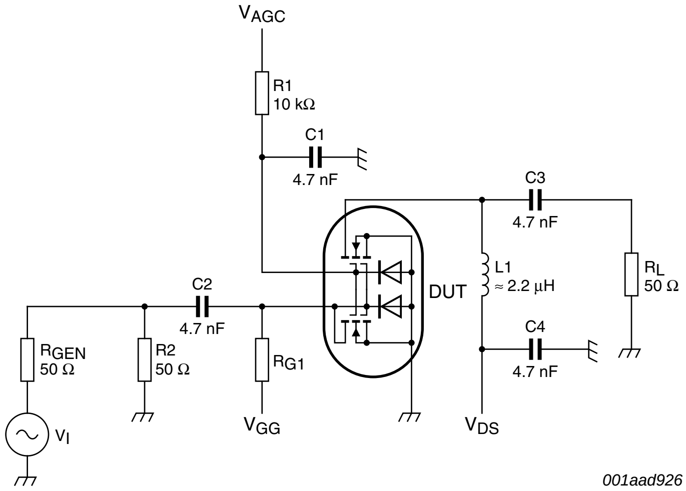
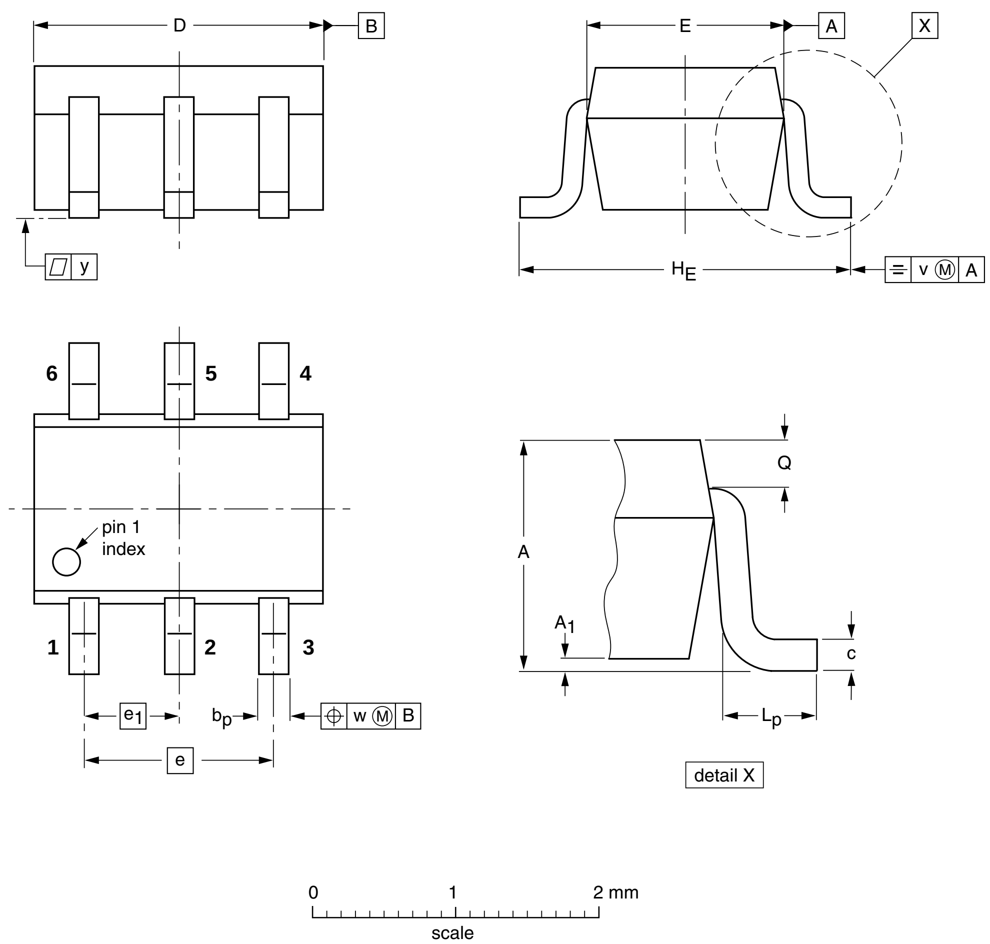


Fig 17. Cross modulation test setup for one MOSFET

10. Package outline

Plastic surface-mounted package; 6 leads **SOT363**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1 max	b_p	c	D	E	e	e_1	H_E	L_p	Q	v	w	y
mm	1.1 0.8	0.1	0.30 0.20	0.25 0.10	2.2 1.8	1.35 1.15	1.3	0.65	2.2 2.0	0.45 0.15	0.25 0.15	0.2	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT363			SC-88			~~04-11-08~~ 06-03-16

Fig 18. Package outline SOT363

11. Abbreviations

Table 11. Abbreviations

Acronym	Description
AGC	Automatic Gain Control
MOSFET	Metal-Oxide Semiconductor Field-Effect Transistor
UHF	Ultra High Frequency
VHF	Very High Frequency

12. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BF1216_1	20100429	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.nxp.com.

13.2 Definitions

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14. Contact information

For more information, please visit: **http://www.nxp.com**

For sales office addresses, please send an email to: **salesaddresses@nxp.com**

15. Contents

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