

# DATA SHEET

## **BF1212; BF1212R; BF1212WR** N-channel dual-gate MOS-FETs

Product specification

2003 Nov 14



# N-channel dual-gate MOS-FETs

## BF1212; BF1212R; BF1212WR

### FEATURES

- Short channel transistor with high forward transfer admittance to input capacitance ratio
- Low noise gain controlled amplifier
- Excellent low frequency noise performance
- Partly internal self-biasing circuit to ensure good cross-modulation performance during AGC and good DC stabilization.

### APPLICATIONS

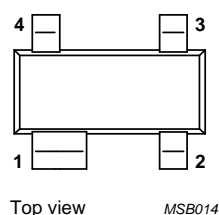
- Gain controlled low noise VHF and UHF amplifiers for 5 V digital and analog television tuner applications.

### DESCRIPTION

Enhancement type N-channel field-effect transistor with source and substrate interconnected. Integrated diodes between gates and source protect against excessive input voltage surges. The BF1212, BF1212R and BF1212WR are encapsulated in the SOT143B, SOT143R and SOT343R plastic packages respectively.

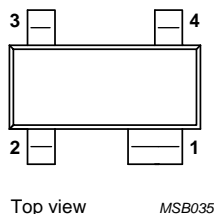
### PINNING

PIN	DESCRIPTION
1	source
2	drain
3	gate 2
4	gate 1



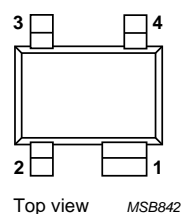
BF1212; marking code: LGp

Fig.1 Simplified outline (SOT143B).



BF1212R; marking code: LKp

Fig.2 Simplified outline (SOT143R).



BF1212WR; marking code: ML

Fig.3 Simplified outline (SOT343R).

### QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{DS}$	drain-source voltage		–	–	6	V
$I_D$	drain current		–	–	30	mA
$P_{tot}$	total power dissipation		–	–	180	mW
$ y_{fs} $	forward transfer admittance		28	33	43	mS
$C_{ig1-ss}$	input capacitance at gate 1		–	1.7	2.2	pF
$C_{rss}$	reverse transfer capacitance	$f = 1 \text{ MHz}$	–	15	30	fF
$F$	noise figure	$f = 800 \text{ MHz}$	–	1.1	1.8	dB
$X_{mod}$	cross-modulation	input level for $k = 1 \%$ at 40 dB AGC	100	104	–	dB $\mu$ V
$T_j$	junction temperature		–	–	150	°C

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**CAUTION**

This product is supplied in anti-static packing to prevent damage caused by electrostatic discharge during transport and handling.

**ORDERING INFORMATION**

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
BF1212	–	plastic surface mounted package; 4 leads	SOT143B
BF1212R	–	plastic surface mounted package; reverse pinning; 4 leads	SOT143R
BF1212WR	–	plastic surface mounted package; reverse pinning; 4 leads	SOT343R

**LIMITING VALUES**

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{DS}$	drain-source voltage		–	6	V
$I_D$	drain current (DC)		–	30	mA
$I_{G1}$	gate 1 current		–	$\pm 10$	mA
$I_{G2}$	gate 2 current		–	$\pm 10$	mA
$P_{tot}$	total power dissipation				
	BF1212; BF1212R	$T_s \leq 116\text{ }^{\circ}\text{C}$ ; note 1	–	180	mW
	BF1212WR	$T_s \leq 122\text{ }^{\circ}\text{C}$ ; note 1	–	180	mW
$T_{stg}$	storage temperature		–65	+150	$^{\circ}\text{C}$
$T_j$	junction temperature		–	150	$^{\circ}\text{C}$

**Note**

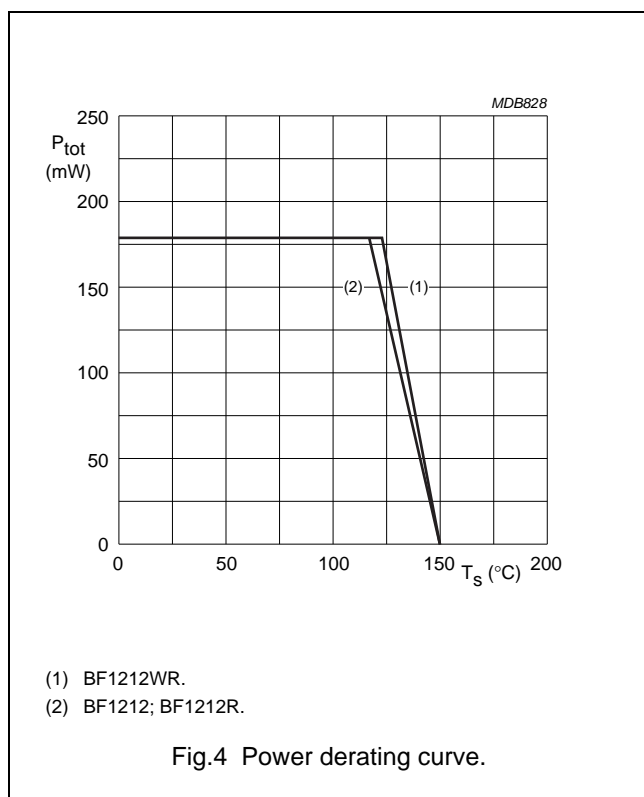
1.  $T_s$  is the temperature of the soldering point of the source lead.

**THERMAL CHARACTERISTICS**

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j-s}$	thermal resistance from junction to soldering point		
	BF1212; BF1212R	185	K/W
	BF1212WR	155	K/W

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## STATIC CHARACTERISTICS

$T_j = 25^\circ\text{C}$  unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{(BR)DSS}$	drain-source breakdown voltage	$V_{G1-S} = V_{G2-S} = 0\text{ V}$ ; $I_D = 10\text{ }\mu\text{A}$	6	—	V
$V_{(BR)G1-SS}$	gate 1-source breakdown voltage	$V_{G2-S} = V_{DS} = 0\text{ V}$ ; $I_{G1-S} = 10\text{ mA}$	6	10	V
$V_{(BR)G2-SS}$	gate 2-source breakdown voltage	$V_{G1-S} = V_{DS} = 0\text{ V}$ ; $I_{G2-S} = 10\text{ mA}$	6	10	V
$V_{(F)S-G1}$	forward source-gate 1 voltage	$V_{G2-S} = V_{DS} = 0\text{ V}$ ; $I_{S-G1} = 10\text{ mA}$	0.5	1.5	V
$V_{(F)S-G2}$	forward source-gate 2 voltage	$V_{G1-S} = V_{DS} = 0\text{ V}$ ; $I_{S-G2} = 10\text{ mA}$	0.5	1.5	V
$V_{G1-S(th)}$	gate 1-source threshold voltage	$V_{G2-S} = 4\text{ V}$ ; $V_{DS} = 5\text{ V}$ ; $I_D = 100\text{ }\mu\text{A}$	0.3	1.0	V
$V_{G2-S(th)}$	gate 2-source threshold voltage	$V_{G1-S} = 5\text{ V}$ ; $V_{DS} = 5\text{ V}$ ; $I_D = 100\text{ }\mu\text{A}$	0.35	1.0	V
$I_{DSX}$	drain-source current	$V_{G2-S} = 4\text{ V}$ ; $V_{DS} = 5\text{ V}$ ; $R_{G1} = 150\text{ k}\Omega$ ; note 1	8	16	mA
$I_{G1-S}$	gate 1 cut-off current	$V_{G2-S} = V_{DS} = 0\text{ V}$ ; $V_{G1-S} = 5\text{ V}$	—	50	nA
$I_{G2-S}$	gate 2 cut-off current	$V_{G1-S} = V_{DS} = 0\text{ V}$ ; $V_{G2-S} = 4\text{ V}$	—	20	nA

## Note

1.  $R_{G1}$  connects  $G_1$  to  $V_{GG} = 5\text{ V}$ .

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**DYNAMIC CHARACTERISTICS**

Common source;  $T_{amb} = 25\text{ °C}$ ;  $V_{G2-S} = 4\text{ V}$ ;  $V_{DS} = 5\text{ V}$ ;  $I_D = 12\text{ mA}$ ; unless otherwise specified.

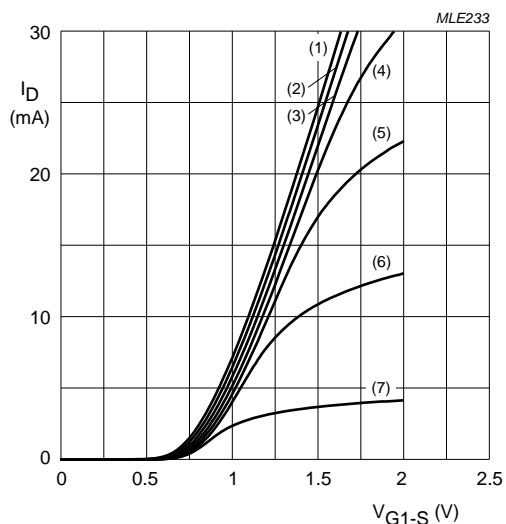
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$ y_{fs} $	forward transfer admittance	pulsed; $T_j = 25\text{ °C}$	28	33	43	mS
$C_{ig1-ss}$	input capacitance at gate 1	$f = 1\text{ MHz}$	–	1.7	2.2	pF
$C_{ig2-ss}$	input capacitance at gate 2	$f = 1\text{ MHz}$	–	1.1	–	pF
$C_{oss}$	output capacitance	$f = 1\text{ MHz}$	–	0.9	–	pF
$C_{rss}$	reverse transfer capacitance	$f = 1\text{ MHz}$	–	15	30	fF
F	noise figure	$f = 11\text{ MHz}$ ; $G_S = 20\text{ mS}$ ; $B_S = 0$	–	4	–	dB
		$f = 400\text{ MHz}$ ; $Y_S = Y_{S(opt)}$	–	0.9	1.6	dB
		$f = 800\text{ MHz}$ ; $Y_S = Y_{S(opt)}$	–	1.1	1.8	dB
$G_{tr}$	power gain	$f = 200\text{ MHz}$ ; $G_S = 2\text{ mS}$ ; $B_S = B_{S(opt)}$ ; $G_L = 0.5\text{ mS}$ ; $B_L = B_{L(opt)}$	–	35	–	dB
		$f = 400\text{ MHz}$ ; $G_S = 2\text{ mS}$ ; $B_S = B_{S(opt)}$ ; $G_L = 1\text{ mS}$ ; $B_L = B_{L(opt)}$	–	30	–	dB
		$f = 800\text{ MHz}$ ; $G_S = 3.3\text{ mS}$ ; $B_S = B_{S(opt)}$ ; $G_L = 1\text{ mS}$ ; $B_L = B_{L(opt)}$	–	25	–	dB
$X_{mod}$	cross-modulation	input level for $k = 1\%$ ; $f_w = 50\text{ MHz}$ ; $f_{unw} = 60\text{ MHz}$ ; note 1				
		at 0 dB AGC	90	–	–	dB $\mu$ V
		at 10 dB AGC	–	89	–	dB $\mu$ V
		at 40 dB AGC	100	104	–	dB $\mu$ V

**Note**

1. Measured in test circuit Fig.21.

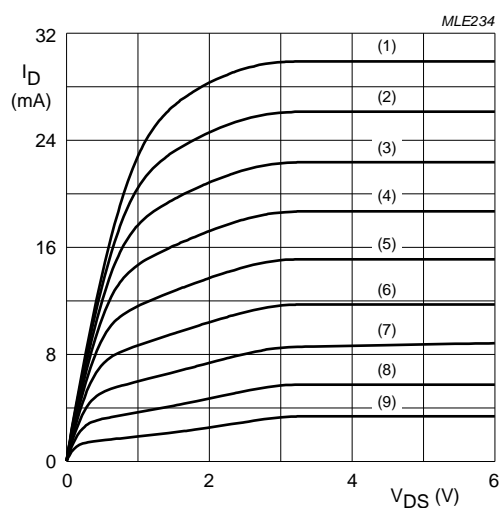
## N-channel dual-gate MOS-FETs

## BF1212; BF1212R; BF1212WR



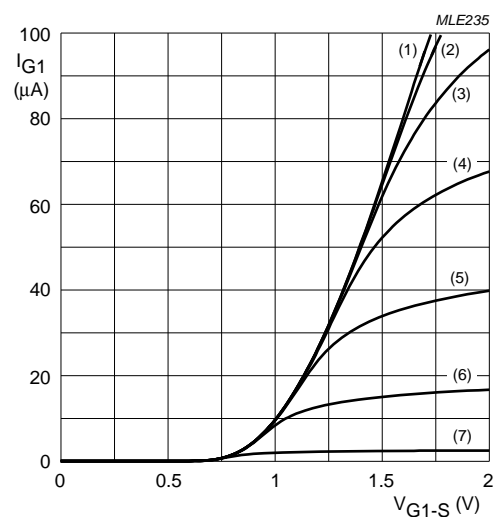
- (1)  $V_{G2-S} = 4 \text{ V.}$  (5)  $V_{G2-S} = 2 \text{ V.}$   $V_{DS} = 5 \text{ V.}$   
 (2)  $V_{G2-S} = 3.5 \text{ V.}$  (6)  $V_{G2-S} = 1.5 \text{ V.}$   $T_j = 25^\circ\text{C.}$   
 (3)  $V_{G2-S} = 3 \text{ V.}$  (7)  $V_{G2-S} = 1 \text{ V.}$   
 (4)  $V_{G2-S} = 2.5 \text{ V.}$

Fig.5 Transfer characteristics; typical values.



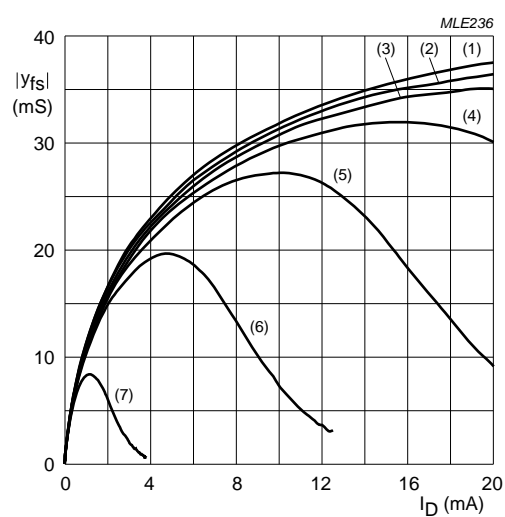
- (1)  $V_{G1-S} = 1.6 \text{ V.}$  (6)  $V_{G1-S} = 1.1 \text{ V.}$   $V_{G2-S} = 4 \text{ V.}$   
 (2)  $V_{G1-S} = 1.5 \text{ V.}$  (7)  $V_{G1-S} = 1.0 \text{ V.}$   $T_j = 25^\circ\text{C.}$   
 (3)  $V_{G1-S} = 1.4 \text{ V.}$  (8)  $V_{G1-S} = 0.9 \text{ V.}$   
 (4)  $V_{G1-S} = 1.3 \text{ V.}$  (9)  $V_{G1-S} = 0.8 \text{ V.}$   
 (5)  $V_{G1-S} = 1.2 \text{ V.}$

Fig.6 Output characteristics; typical values.



- (1)  $V_{G2-S} = 4 \text{ V.}$  (5)  $V_{G2-S} = 2 \text{ V.}$   $V_{DS} = 5 \text{ V.}$   
 (2)  $V_{G2-S} = 3.5 \text{ V.}$  (6)  $V_{G2-S} = 1.5 \text{ V.}$   $T_j = 25^\circ\text{C.}$   
 (3)  $V_{G2-S} = 3 \text{ V.}$  (7)  $V_{G2-S} = 1 \text{ V.}$   
 (4)  $V_{G2-S} = 2.5 \text{ V.}$

Fig.7 Gate 1 current as a function of gate 1 voltage; typical values.

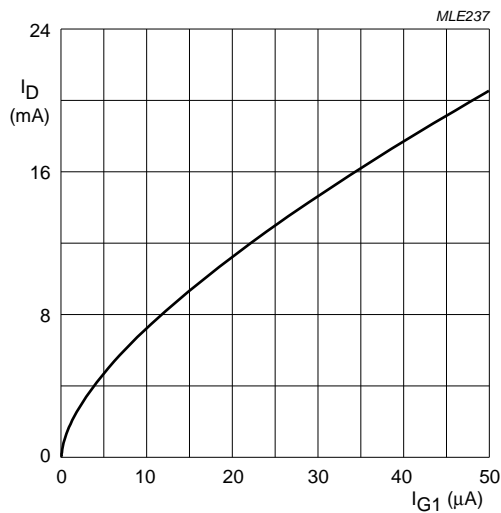


- (1)  $V_{G2-S} = 4 \text{ V.}$  (5)  $V_{G2-S} = 2 \text{ V.}$   $V_{DS} = 5 \text{ V.}$   
 (2)  $V_{G2-S} = 3.5 \text{ V.}$  (6)  $V_{G2-S} = 1.5 \text{ V.}$   $T_j = 25^\circ\text{C.}$   
 (3)  $V_{G2-S} = 3 \text{ V.}$  (7)  $V_{G2-S} = 1 \text{ V.}$   
 (4)  $V_{G2-S} = 2.5 \text{ V.}$

Fig.8 Forward transfer admittance as a function of drain current; typical values.

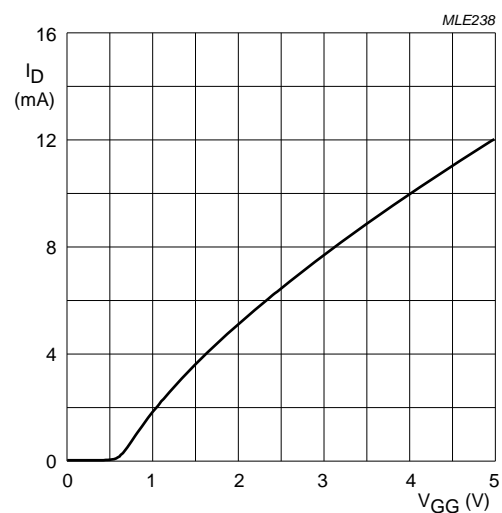
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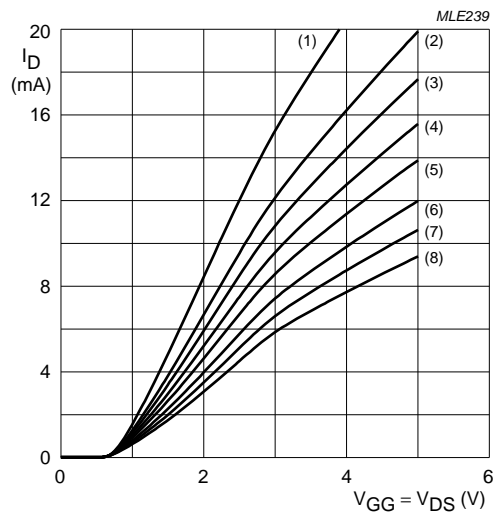
$V_{DS} = 5\text{ V}$ ;  $V_{G2-S} = 4\text{ V}$ .  
 $T_j = 25\text{ }^{\circ}\text{C}$ .

Fig.9 Drain current as a function of gate 1 current; typical values.



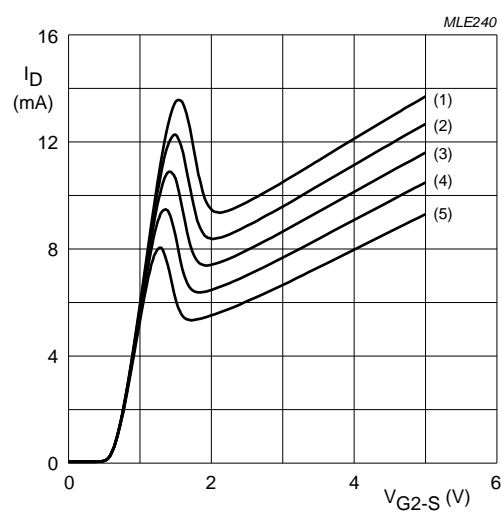
$V_{DS} = 5\text{ V}$ ;  $V_{G2-S} = 4\text{ V}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ .  
 $R_{G1} = 150\text{ k}\Omega$  (connected to  $V_{GG}$ ); see Fig.21.

Fig.10 Drain current as a function of gate 1 supply voltage; typical values.



(1)  $R_{G1} = 47\text{ k}\Omega$ . (5)  $R_{G1} = 120\text{ k}\Omega$ .  $V_{G2-S} = 4\text{ V}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ .  
(2)  $R_{G1} = 56\text{ k}\Omega$ . (6)  $R_{G1} = 150\text{ k}\Omega$ .  $R_{G1}$  connected to  $V_{GG}$ ;  
(3)  $R_{G1} = 82\text{ k}\Omega$ . (7)  $R_{G1} = 180\text{ k}\Omega$ . see Fig.21.  
(4)  $R_{G1} = 100\text{ k}\Omega$ . (8)  $R_{G1} = 220\text{ k}\Omega$ .

Fig.11 Drain current as a function of gate 1 and drain supply voltage; typical values.

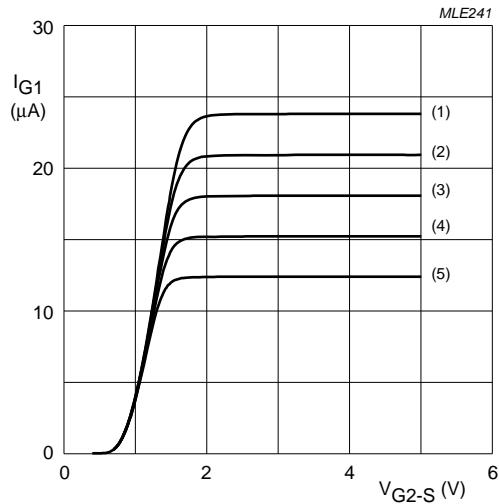


(1)  $V_{GG} = 5\text{ V}$ . (4)  $V_{GG} = 3.5\text{ V}$ .  $V_{DS} = 5\text{ V}$ ;  $T_j = 25\text{ }^{\circ}\text{C}$ .  
(2)  $V_{GG} = 4.5\text{ V}$ . (5)  $V_{GG} = 3\text{ V}$ .  $R_{G1} = 150\text{ k}\Omega$   
(3)  $V_{GG} = 4\text{ V}$ . (connected to  $V_{GG}$ ); see Fig.21.

Fig.12 Drain current as a function of gate 2 voltage; typical values.

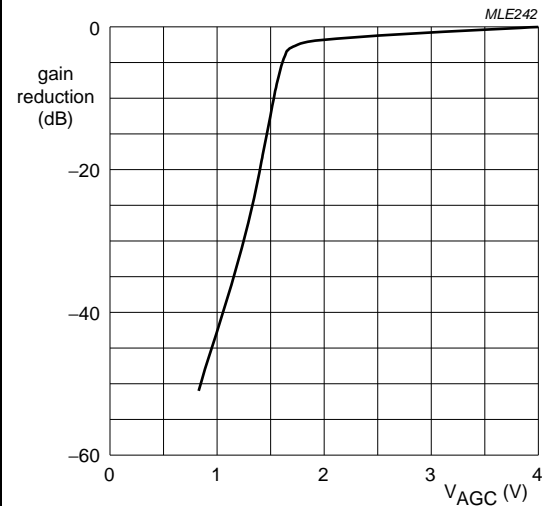
N-channel dual-gate MOS-FETs

BF1212; BF1212R; BF1212WR



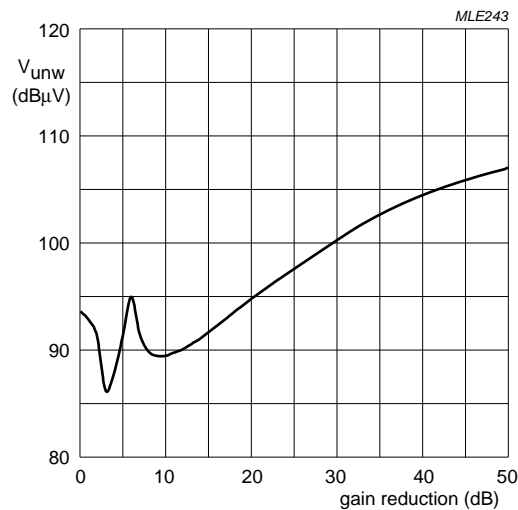
(1)  $V_{GG} = 5$  V. (4)  $V_{GG} = 3.5$  V.  $V_{DS} = 5$  V;  $T_j = 25$  °C.  
(2)  $V_{GG} = 4.5$  V. (5)  $V_{GG} = 3$  V.  $R_{G1} = 150$  k $\Omega$   
(3)  $V_{GG} = 4$  V. (connected to  $V_{GG}$ );  
see Fig.21.

Fig.13 Gate 1 current as a function of gate 2 voltage; typical values.



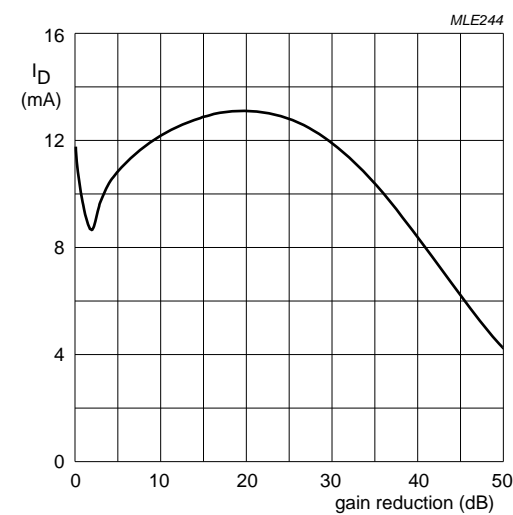
$V_{DS} = 5$  V;  $V_{GG} = 5$  V;  $R_{G1} = 150$  k $\Omega$  (connected to  $V_{GG}$ );  
see Fig.21;  $f = 50$  MHz;  $T_{amb} = 25$  °C.

Fig.14 Typical gain reduction as a function of AGC voltage.



$V_{DS} = 5$  V;  $V_{GG} = 5$  V;  $R_{G1} = 150$  k $\Omega$  (connected to  $V_{GG}$ );  
see Fig.21;  $f = 50$  MHz;  $f_{unw} = 60$  MHz;  $T_{amb} = 25$  °C.

Fig.15 Unwanted voltage for 1% cross-modulation as a function of gain reduction; typical values.



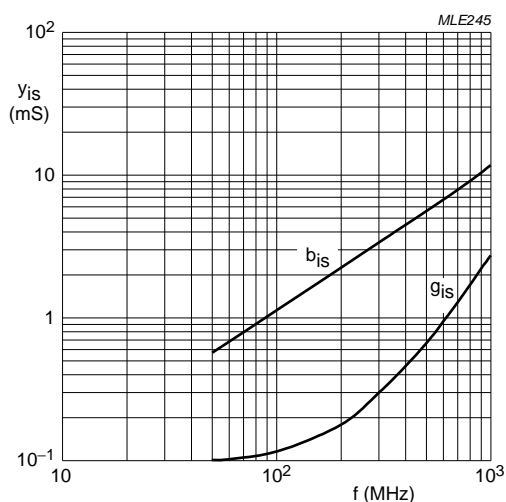
$V_{DS} = 5$  V;  $V_{GG} = 5$  V;  $R_{G1} = 150$  k $\Omega$  (connected to  $V_{GG}$ );  
see Fig.21;  $f = 50$  MHz;  $T_{amb} = 25$  °C.

Fig.16 Drain current as a function of gain reduction; typical values.



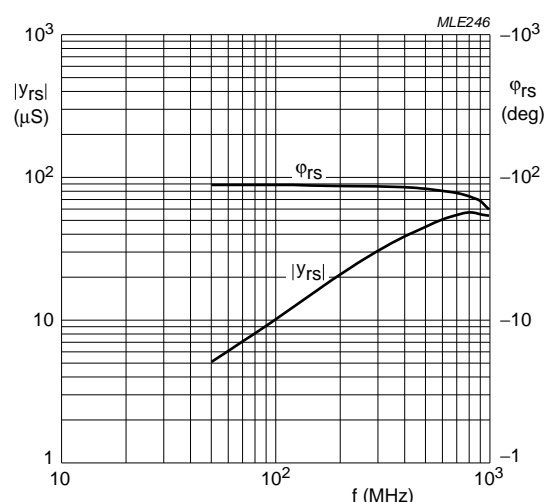
## N-channel dual-gate MOS-FETs

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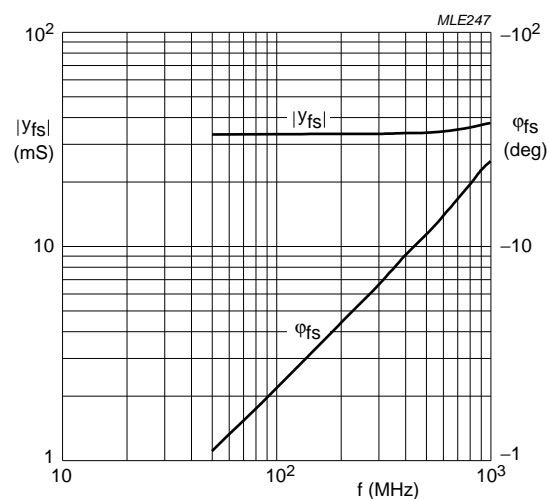
$V_{DS} = 5$  V;  $V_{G2} = 4$  V.  
 $I_D = 12$  mA;  $T_{amb} = 25$  °C.

Fig.17 Input admittance as a function of frequency; typical values.



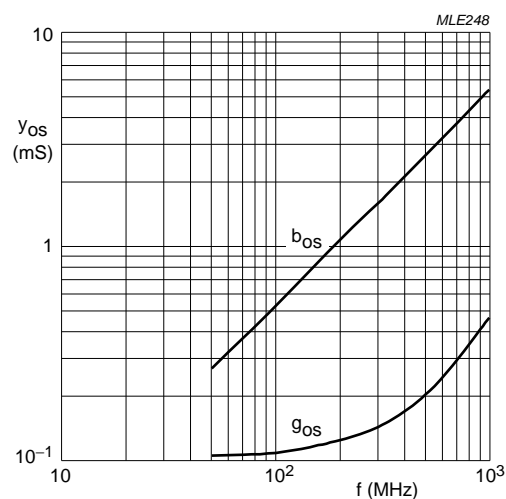
$V_{DS} = 5$  V;  $V_{G2} = 4$  V.  
 $I_D = 12$  mA;  $T_{amb} = 25$  °C.

Fig.18 Reverse transfer admittance and phase as functions of frequency; typical values.



$V_{DS} = 5$  V;  $V_{G2} = 4$  V.  
 $I_D = 12$  mA;  $T_{amb} = 25$  °C.

Fig.19 Forward transfer admittance and phase as functions of frequency; typical values.



$V_{DS} = 5$  V;  $V_{G2} = 4$  V.  
 $I_D = 12$  mA;  $T_{amb} = 25$  °C.

Fig.20 Output admittance as a function of frequency; typical values.

N-channel dual-gate MOS-FETs

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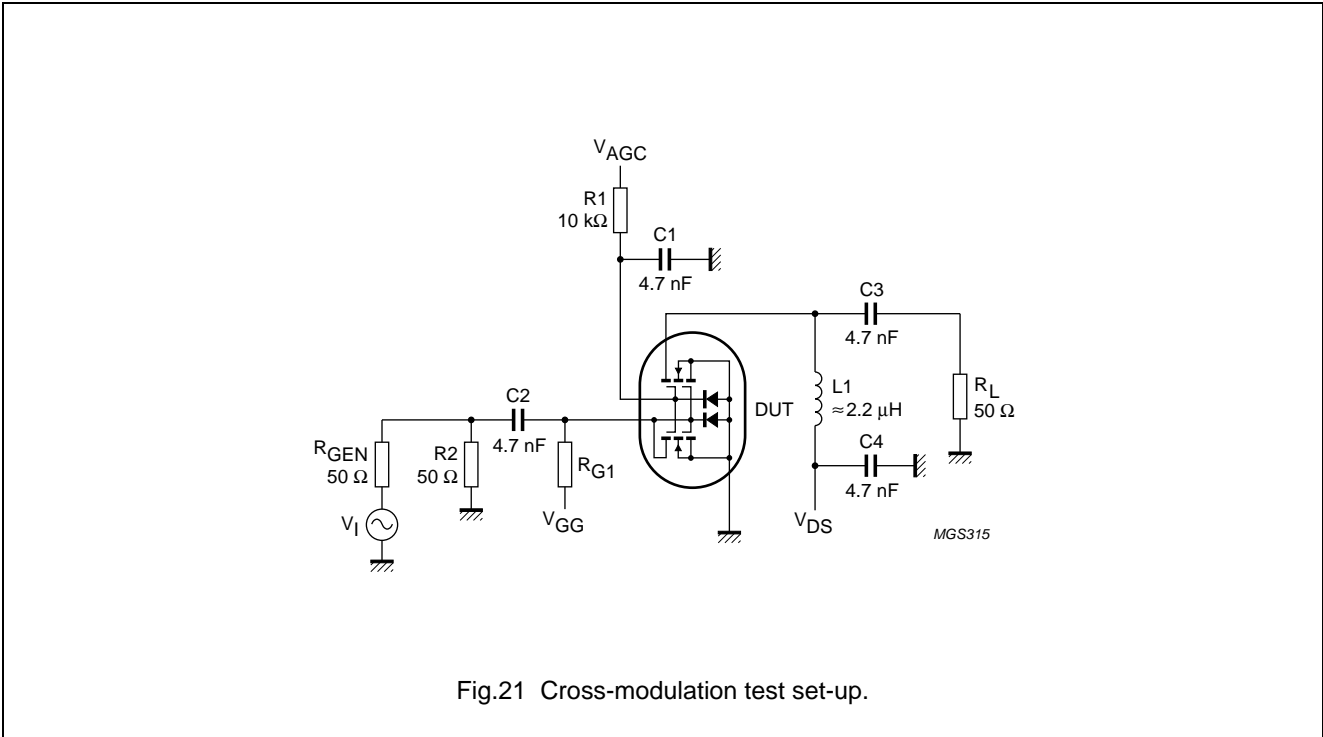


Fig.21 Cross-modulation test set-up.

**Table 1** Scattering parameters:  $V_{DS} = 5\text{ V}$ ;  $V_{G2-S} = 4\text{ V}$ ;  $I_D = 12\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$

f (MHz)	S11		S21		S12		S22	
	MAGNITUDE (ratio)	ANGLE (deg)	MAGNITUDE (ratio)	ANGLE (deg)	MAGNITUDE (ratio)	ANGLE (deg)	MAGNITUDE (ratio)	ANGLE (deg)
50	0.990	−3.39	3.288	176.5	0.0005	86.9	0.990	−1.66
100	0.988	−6.76	3.280	173.0	0.0011	85.6	0.990	−3.30
200	0.983	−13.40	3.261	166.1	0.0021	81.2	0.991	−6.62
300	0.974	−19.86	3.218	159.0	0.0030	77.5	0.991	−9.92
400	0.969	−26.46	3.205	152.6	0.0039	74.6	0.994	−13.30
500	0.958	−32.73	3.141	145.9	0.0045	72.4	0.994	−16.56
600	0.947	−38.83	3.086	139.5	0.0049	70.9	0.993	−19.77
700	0.936	−44.75	3.017	133.1	0.0051	69.5	0.991	−22.78
800	0.924	−50.51	2.949	126.9	0.0051	69.9	0.981	−25.77
900	0.910	−56.18	2.870	120.5	0.0049	69.8	0.984	−28.72
1000	0.896	−61.64	2.785	114.7	0.0045	72.7	0.980	−31.77

**Table 2** Noise data:  $V_{DS} = 5\text{ V}$ ;  $V_{G2-S} = 4\text{ V}$ ;  $I_D = 12\text{ mA}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$

f (MHz)	Fmin (dB)	$\Gamma_{opt}$		Rn ( $\Omega$ )
		(ratio)	(deg)	
400	0.9	0.695	13.87	28.5
800	1.1	0.634	30.30	32.85

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PACKAGE OUTLINES

Plastic surface-mounted package; 4 leads

SOT143B

The technical drawing illustrates the SOT143B package in three views: top, side, and a detailed view of the lead (labeled 'detail X'). The top view shows a rectangular body with four leads numbered 1, 2, 3, and 4. Dimensions include D (body length), B (body width), e (lead pitch), e<sub>1</sub> (lead width), b<sub>p</sub> (lead width at base), b<sub>1</sub> (lead width at tip), and y (lead thickness). The side view shows the package height with dimensions A, A<sub>1</sub>, H<sub>E</sub>, and E. The lead detail view shows the lead profile with dimensions Q, L<sub>p</sub>, c, and A<sub>1</sub>. A scale bar indicates 0 to 2 mm.

DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub> max	b <sub>p</sub>	b <sub>1</sub>	c	D	E	e	e <sub>1</sub>	H <sub>E</sub>	L <sub>p</sub>	Q	v	w	y
mm	1.1 0.9	0.1	0.48 0.38	0.88 0.78	0.15 0.09	3.0 2.8	1.4 1.2	1.9	1.7	2.5 2.1	0.45 0.15	0.55 0.45	0.2	0.1	0.1

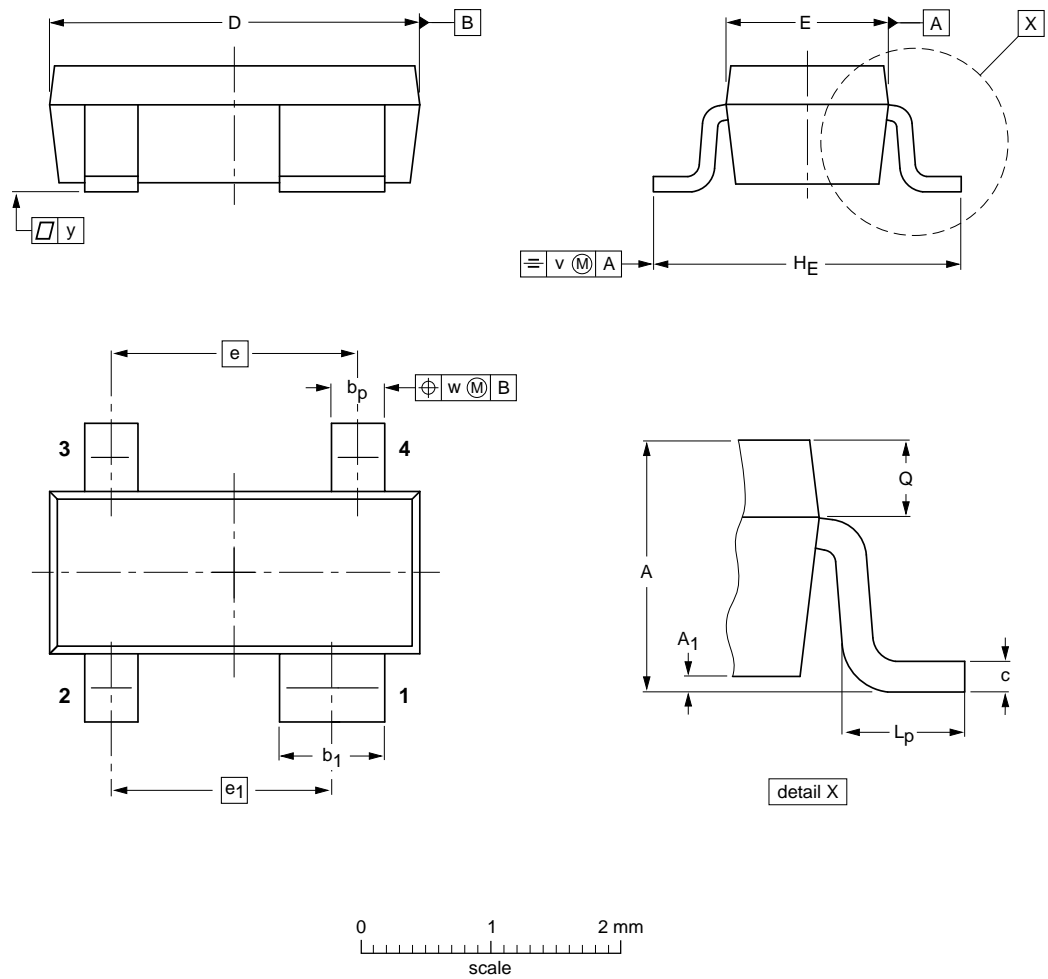
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT143B						04-11-16 06-03-16

N-channel dual-gate MOS-FETs

BF1212; BF1212R; BF1212WR

Plastic surface-mounted package; reverse pinning; 4 leads

SOT143R



DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub> max	b <sub>p</sub>	b <sub>1</sub>	c	D	E	e	e <sub>1</sub>	H <sub>E</sub>	L <sub>p</sub>	Q	v	w	y
mm	1.1 0.9	0.1	0.48 0.38	0.88 0.78	0.15 0.09	3.0 2.8	1.4 1.2	1.9	1.7	2.5 2.1	0.55 0.25	0.45 0.25	0.2	0.1	0.1

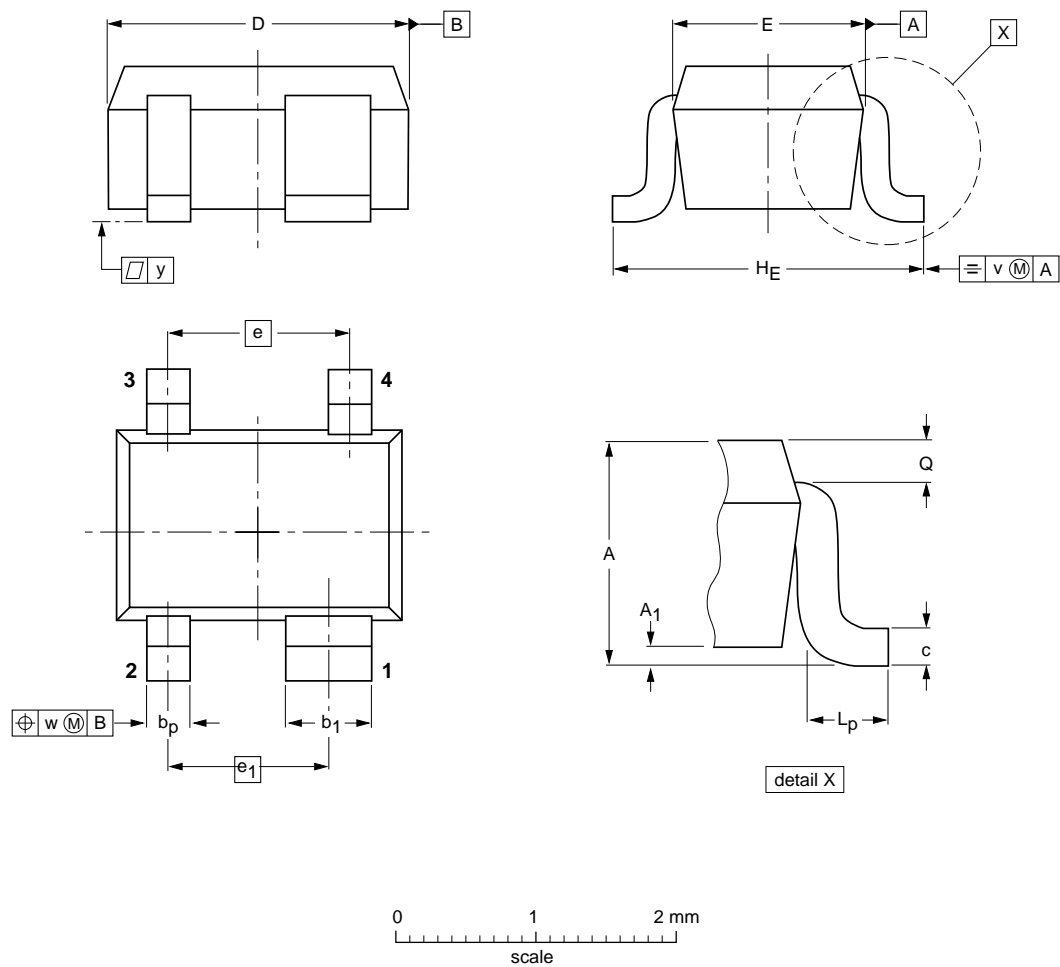
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT143R			SC-61AA			04-11-16 06-03-16

N-channel dual-gate MOS-FETs

BF1212; BF1212R; BF1212WR

Plastic surface-mounted package; reverse pinning; 4 leads

SOT343R



DIMENSIONS (mm are the original dimensions)

UNIT	A	A <sub>1</sub> max	b <sub>p</sub>	b <sub>1</sub>	c	D	E	e	e <sub>1</sub>	H <sub>E</sub>	L <sub>p</sub>	Q	v	w	y
mm	1.1 0.8	0.1	0.4 0.3	0.7 0.5	0.25 0.10	2.2 1.8	1.35 1.15	1.3	1.15	2.2 2.0	0.45 0.15	0.23 0.13	0.2	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT343R						97-05-21 06-03-16

## N-channel dual-gate MOS-FETs

## BF1212; BF1212R; BF1212WR

## DATA SHEET STATUS

DOCUMENT STATUS <sup>(1)</sup>	PRODUCT STATUS <sup>(2)</sup>	DEFINITION
Objective data sheet	Development	This document contains data from the objective specification for product development.
Preliminary data sheet	Qualification	This document contains data from the preliminary specification.
Product data sheet	Production	This document contains the product specification.

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N-channel dual-gate MOS-FETsBF1212; BF1212R; BF1212WR

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## **Customer notification**

This data sheet was changed to reflect the new company name NXP Semiconductors, including new legal definitions and disclaimers. No changes were made to the technical content, except for package outline drawings which were updated to the latest version.

## **Contact information**

For additional information please visit: <http://www.nxp.com>

For sales offices addresses send e-mail to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

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