# 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

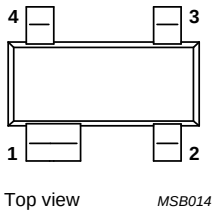
- Gain controlled low noise VHF and UHF amplifiers for 5 V digital and analog television tuner applications.

## 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.

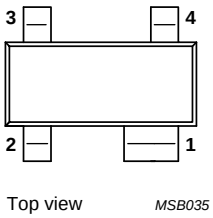
## PINNING

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



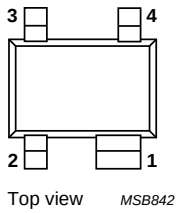

**BF1212; marking code:** LGp

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 |
| $\lvert y_{fs} \rvert$ | 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 MHz | – | 15 | 30 | fF |
| F | noise figure | f = 800 MHz | – | 1.1 | 1.8 | dB |
| $X_{mod}$ | cross-modulation | input level for k = 1 % at 40 dB AGC | 100 | 104 | – | dBμV |
| $T_j$ | junction temperature | | – | – | 150 | °C |

| 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).

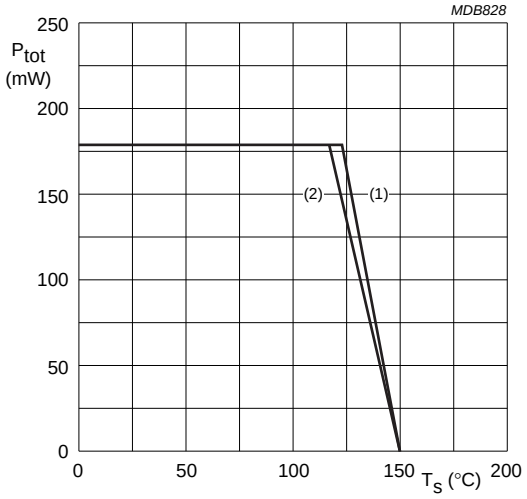
| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | | – | 6 | V |
| $I_D$ | drain current (DC) | | – | 30 | mA |
| $I_{G1}$ | gate 1 current | | – | ±10 | mA |
| $I_{G2}$ | gate 2 current | | – | ±10 | mA |
| $P_{tot}$ | total power dissipation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

**Note**

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

## THERMAL CHARACTERISTICS

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




(1) BF1212WR.
(2) BF1212; BF1212R.

Fig.4 Power derating curve.

**STATIC CHARACTERISTICS**

$T_j$ = 25 °C unless otherwise specified.

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

**Note**

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

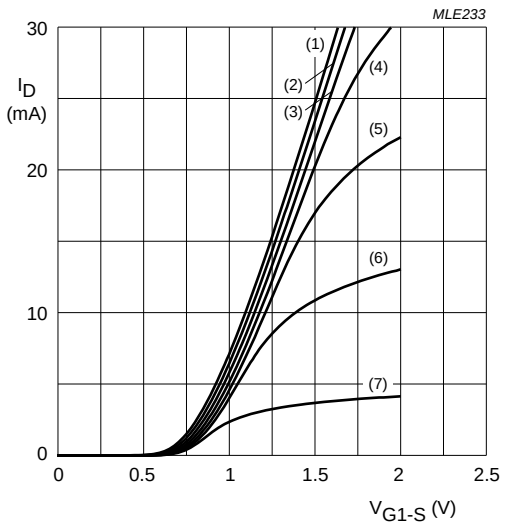
**DYNAMIC CHARACTERISTICS**

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

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

**Note**

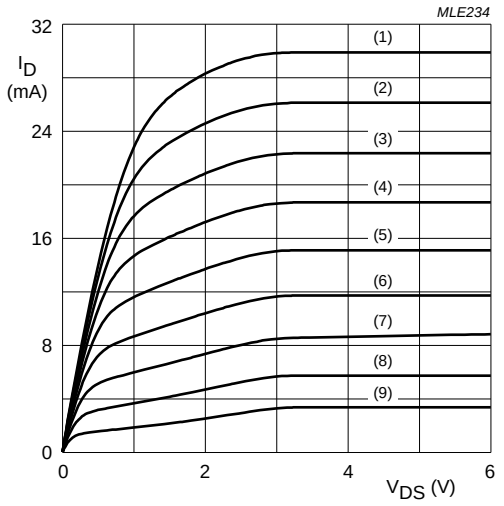
1. Measured in test circuit Fig.21.




(1) $V_{G2-S}$ = 4 V.
(2) $V_{G2-S}$ = 3.5 V.
(3) $V_{G2-S}$ = 3 V.
(4) $V_{G2-S}$ = 2.5 V.
(5) $V_{G2-S}$ = 2 V.
(6) $V_{G2-S}$ = 1.5 V.
(7) $V_{G2-S}$ = 1 V.

$V_{DS}$ = 5 V.
$T_j$ = 25 °C.

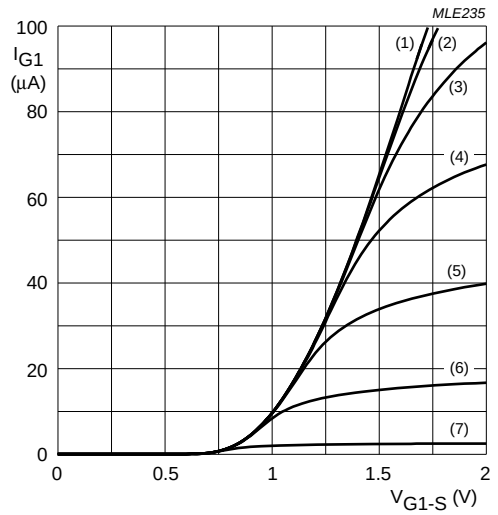
Fig.5 Transfer characteristics; typical values.




(1) $V_{G1-S}$ = 1.6 V.
(2) $V_{G1-S}$ = 1.5 V.
(3) $V_{G1-S}$ = 1.4 V.
(4) $V_{G1-S}$ = 1.3 V.
(5) $V_{G1-S}$ = 1.2 V.
(6) $V_{G1-S}$ = 1.1 V.
(7) $V_{G1-S}$ = 1.0 V.
(8) $V_{G1-S}$ = 0.9 V.
(9) $V_{G1-S}$ = 0.8 V.

$V_{G2-S}$ = 4 V.
$T_j$ = 25 °C.

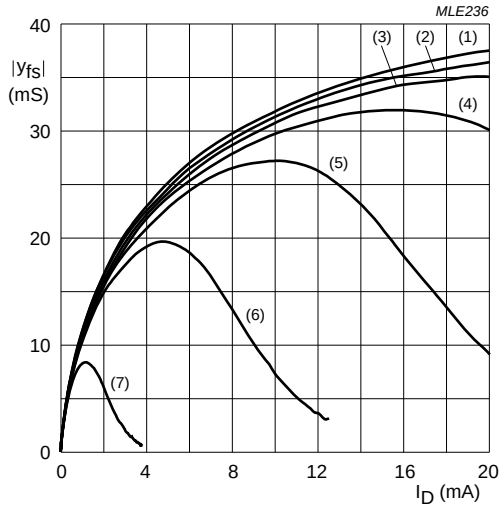
Fig.6 Output characteristics; typical values.




(1) $V_{G2-S}$ = 4 V.
(2) $V_{G2-S}$ = 3.5 V.
(3) $V_{G2-S}$ = 3 V.
(4) $V_{G2-S}$ = 2.5 V.
(5) $V_{G2-S}$ = 2 V.
(6) $V_{G2-S}$ = 1.5 V.
(7) $V_{G2-S}$ = 1 V.

$V_{DS}$ = 5 V.
$T_j$ = 25 °C.

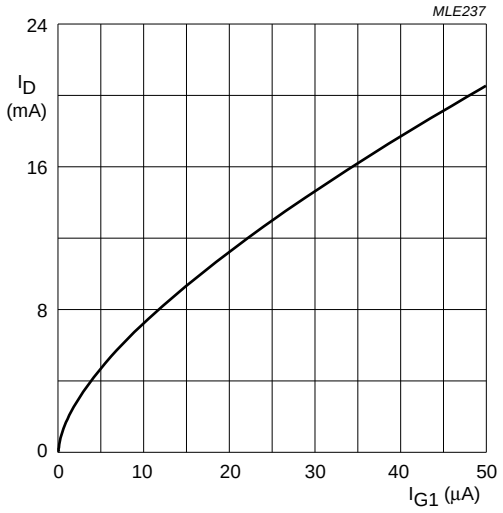
Fig.7 Gate 1 current as a function of gate 1 voltage; typical values.




(1) $V_{G2-S}$ = 4 V.
(2) $V_{G2-S}$ = 3.5 V.
(3) $V_{G2-S}$ = 3 V.
(4) $V_{G2-S}$ = 2.5 V.
(5) $V_{G2-S}$ = 2 V.
(6) $V_{G2-S}$ = 1.5 V.
(7) $V_{G2-S}$ = 1 V.

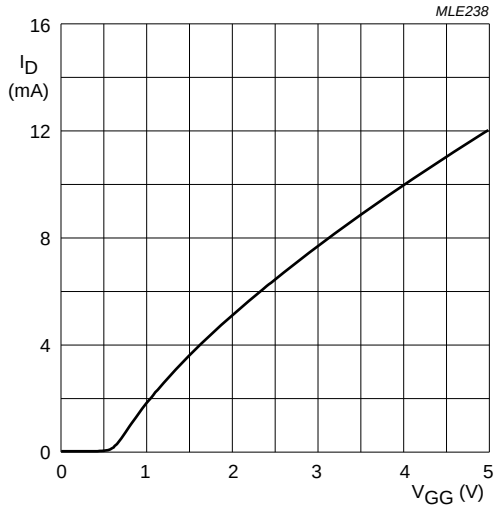
$V_{DS}$ = 5 V.
$T_j$ = 25 °C.

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



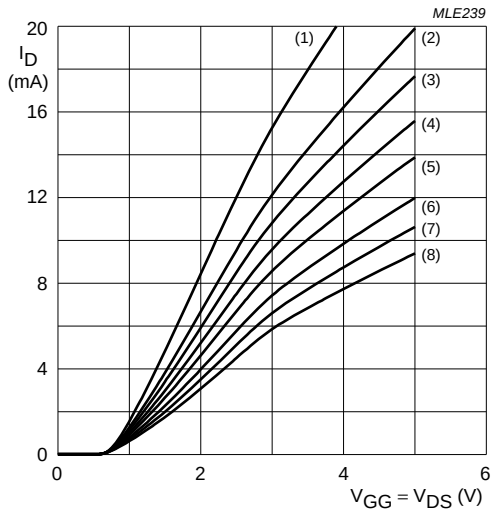

$V_{DS}$ = 5 V; $V_{G2-S}$ = 4 V.
$T_j$ = 25 °C.

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




$V_{DS}$ = 5 V; $V_{G2-S}$ = 4 V; $T_j$ = 25 °C.
$R_{G1}$ = 150 kΩ (connected to $V_{GG}$); see Fig.21.

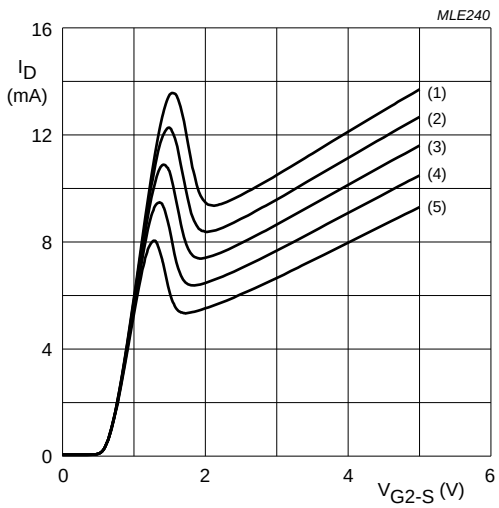
Fig.10 Drain current as a function of gate 1 supply voltage; typical values.




(1) $R_{G1}$ = 47 kΩ.
(2) $R_{G1}$ = 56 kΩ.
(3) $R_{G1}$ = 82 kΩ.
(4) $R_{G1}$ = 100 kΩ.
(5) $R_{G1}$ = 120 kΩ.
(6) $R_{G1}$ = 150 kΩ.
(7) $R_{G1}$ = 180 kΩ.
(8) $R_{G1}$ = 220 kΩ.

$V_{G2-S}$ = 4 V; $T_j$ = 25 °C.
$R_{G1}$ connected to $V_{GG}$; see Fig.21.

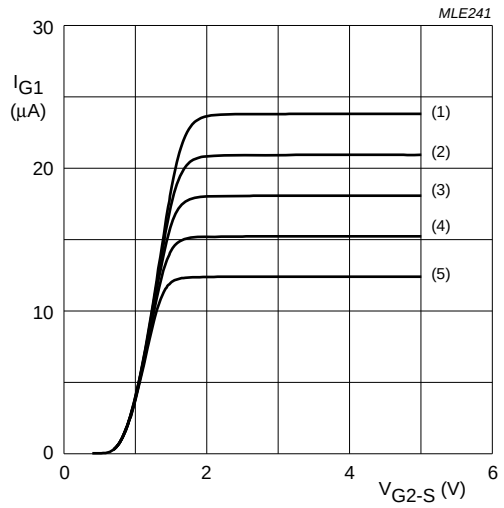
Fig.11 Drain current as a function of gate 1 and drain supply voltage; typical values.




(1) $V_{GG}$ = 5 V.
(2) $V_{GG}$ = 4.5 V.
(3) $V_{GG}$ = 4 V.
(4) $V_{GG}$ = 3.5 V.
(5) $V_{GG}$ = 3 V.

$V_{DS}$ = 5 V; $T_j$ = 25 °C.
$R_{G1}$ = 150 kΩ (connected to $V_{GG}$); see Fig.21.

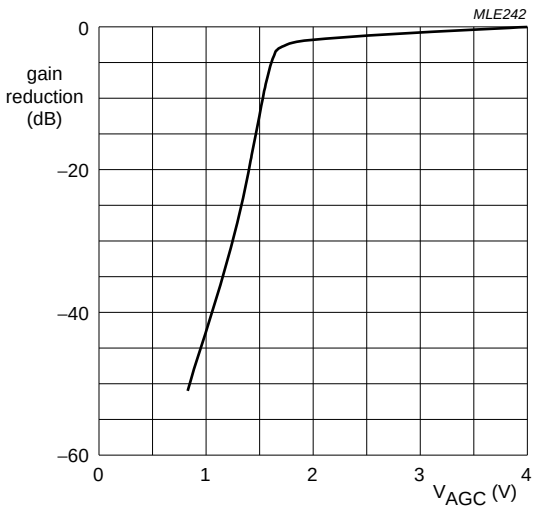
Fig.12 Drain current as a function of gate 2 voltage; typical values.




(1) $V_{GG}$ = 5 V.
(2) $V_{GG}$ = 4.5 V.
(3) $V_{GG}$ = 4 V.
(4) $V_{GG}$ = 3.5 V.
(5) $V_{GG}$ = 3 V.

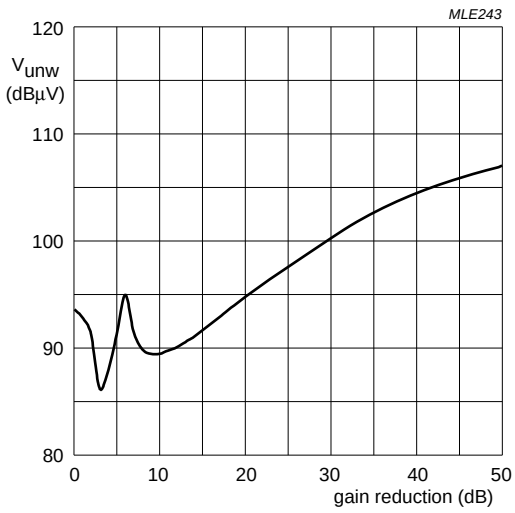
$V_{DS}$ = 5 V; $T_j$ = 25 °C.
$R_{G1}$ = 150 kΩ (connected to $V_{GG}$); see Fig.21.

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



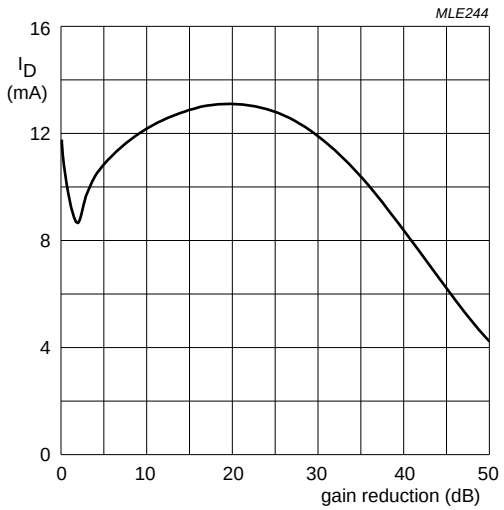

$V_{DS}$ = 5 V; $V_{GG}$ = 5 V; $R_{G1}$ = 150 kΩ (connected to $V_{GG}$); see Fig.21; f = 50 MHz; $T_{amb}$ = 25 °C.

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



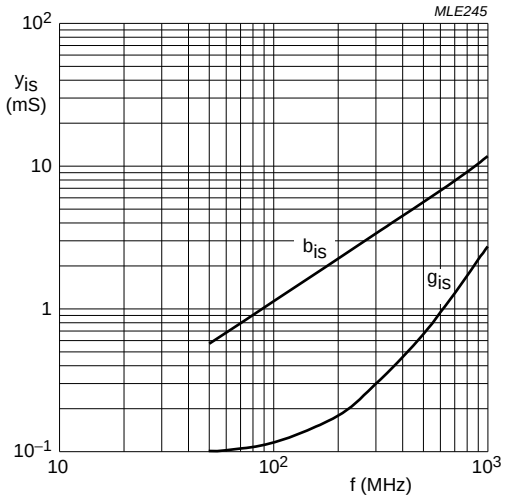

$V_{DS}$ = 5 V; $V_{GG}$ = 5 V; $R_{G1}$ = 150 kΩ (connected to $V_{GG}$); see Fig.21; f= 50 MHz; $f_{unw}$ = 60 MHz; $T_{amb}$ = 25 °C.

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



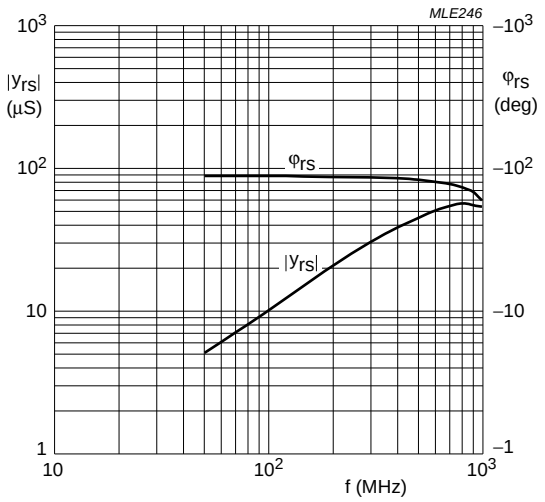

$V_{DS}$ = 5 V; $V_{GG}$ = 5 V; $R_{G1}$ = 150 kΩ (connected to $V_{GG}$); see Fig.21; f= 50 MHz; $T_{amb}$ = 25 °C.

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



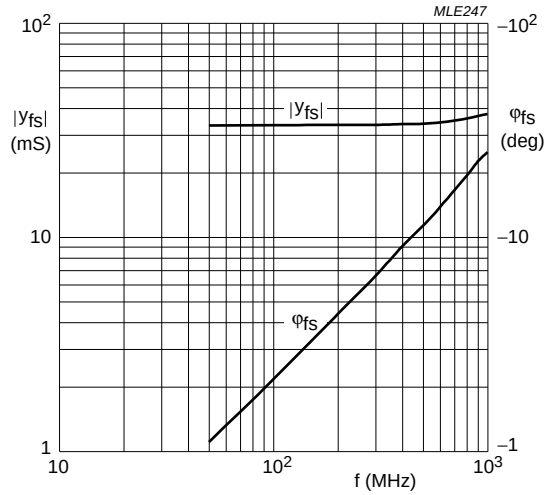

$V_{DS}$ = 5 V; $V_{G2}$ = 4 V.
$I_D$ = 12 mA; $T_{amb}$ = 25 °C.

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



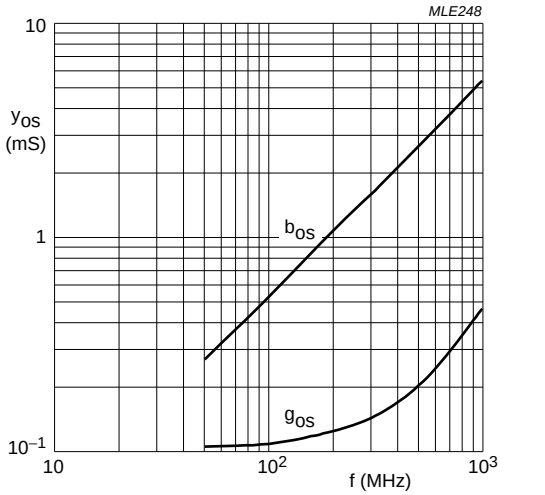

$V_{DS}$ = 5 V; $V_{G2}$ = 4 V.
$I_D$ = 12 mA; $T_{amb}$ = 25 °C.

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.

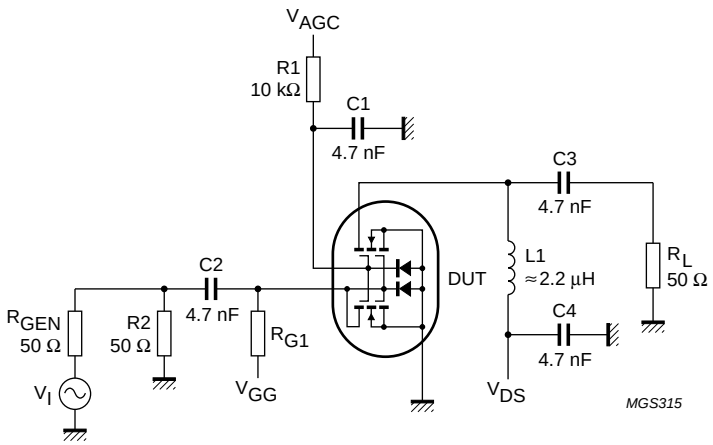



Fig.21 Cross-modulation test set-up.

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

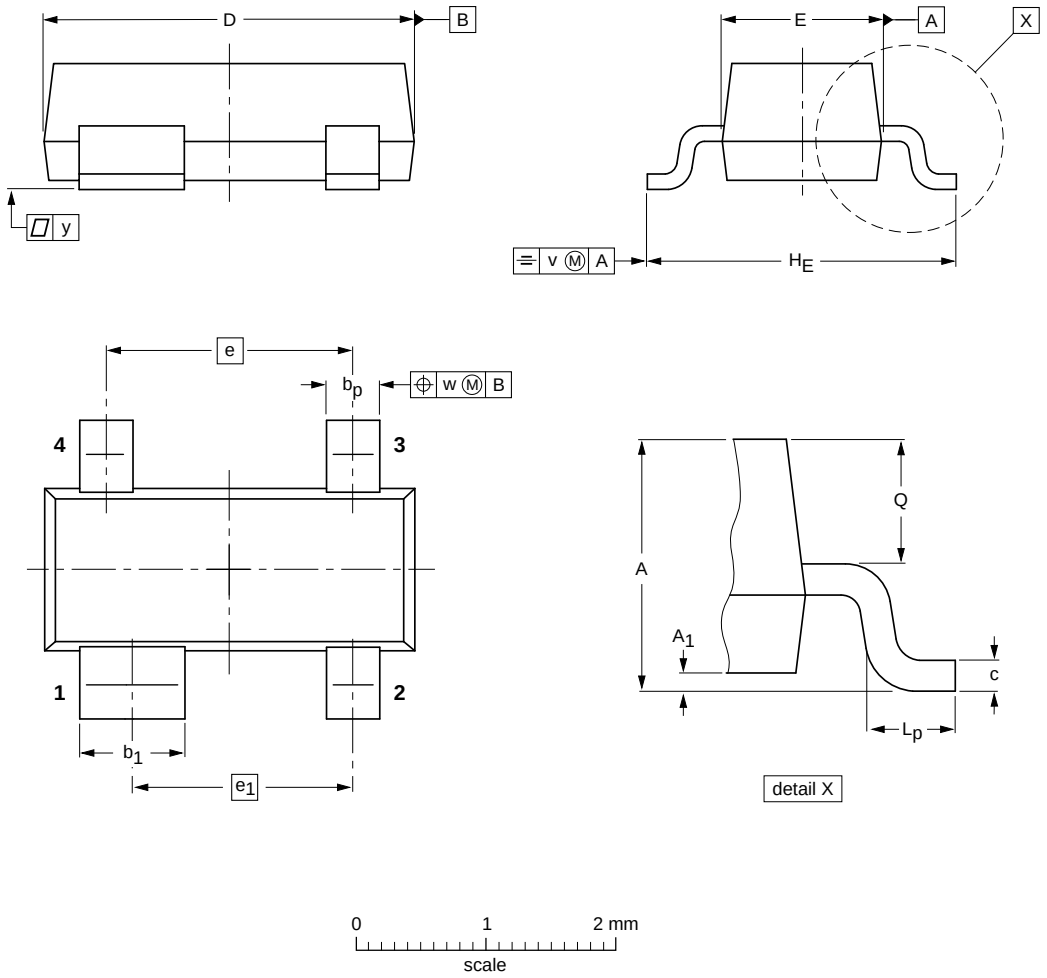
| f (MHz) | $s_{11}$ | | $s_{21}$ | | $s_{12}$ | | $s_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| | MAGNITUDE (ratio) | ANGLE (deg) | MAGNITUDE (ratio) | ANGLE (deg) | MAGNITUDE (ratio) | ANGLE (deg) | MAGNITUDE (ratio) | ANGLE (deg) |
| 50 | 0.990 | −3.39 | 3.288 | 176.5 | 0.0005 | 86.9 | 0.990 | −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 V; $V_{G2-S}$ = 4 V; $I_D$ = 12 mA; $T_{amb}$ = 25 °C

| f (MHz) | $F_{min}$ (dB) | $\Gamma_{opt}$ | | $R_n$ (Ω) |
|---|---|---|---|---|
| | | (ratio) | (deg) | |
| 400 | 0.9 | 0.695 | 13.87 | 28.5 |
| 800 | 1.1 | 0.634 | 30.30 | 32.85 |

## PACKAGE OUTLINES

**Plastic surface-mounted package; 4 leads** **SOT143B**

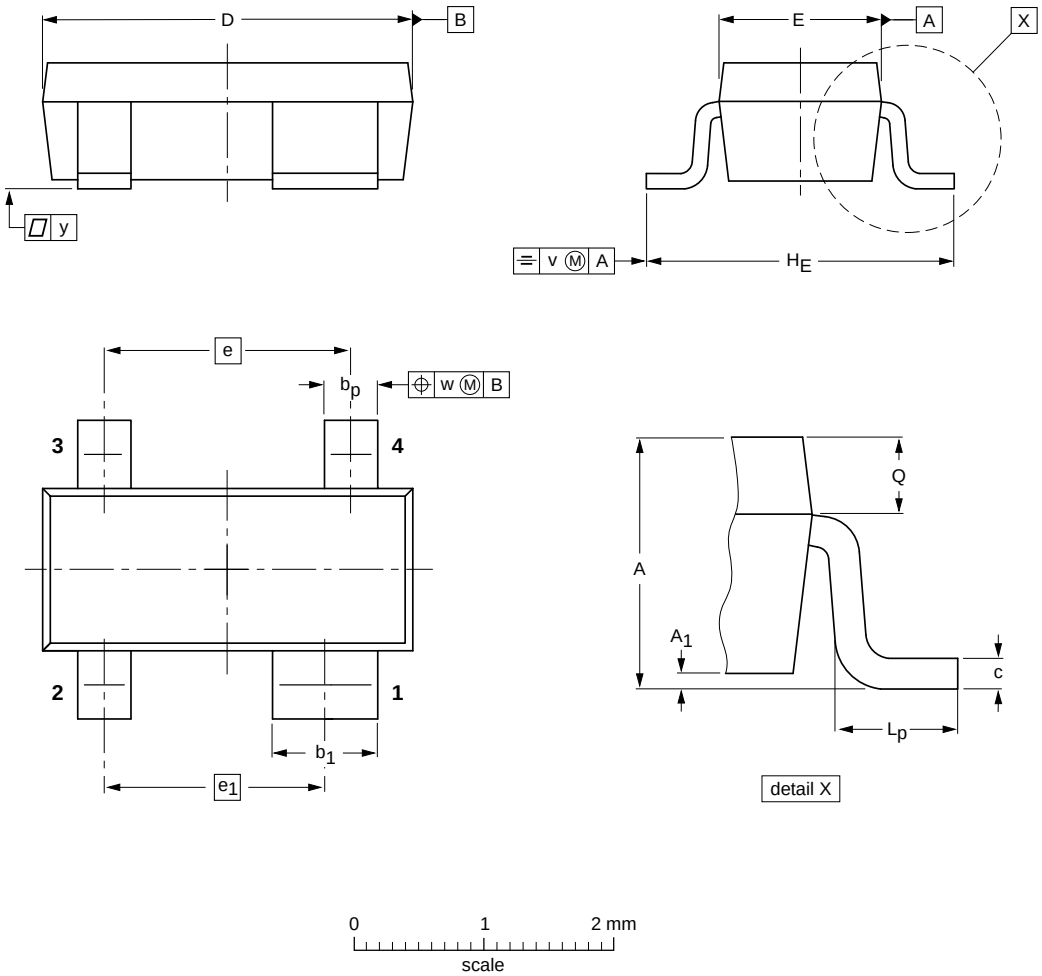



**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ max | $b_p$ | $b_1$ | c | D | E | e | $e_1$ | $H_E$ | $L_p$ | Q | v | w | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.1<br>0.9 | 0.1 | 0.48<br>0.38 | 0.88<br>0.78 | 0.15<br>0.09 | 3.0<br>2.8 | 1.4<br>1.2 | 1.9 | 1.7 | 2.5<br>2.1 | 0.45<br>0.15 | 0.55<br>0.45 | 0.2 | 0.1 | 0.1 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT143B | | | | | | ~~04-11-16~~<br>06-03-16 |

**Plastic surface-mounted package; reverse pinning; 4 leads** **SOT143R**

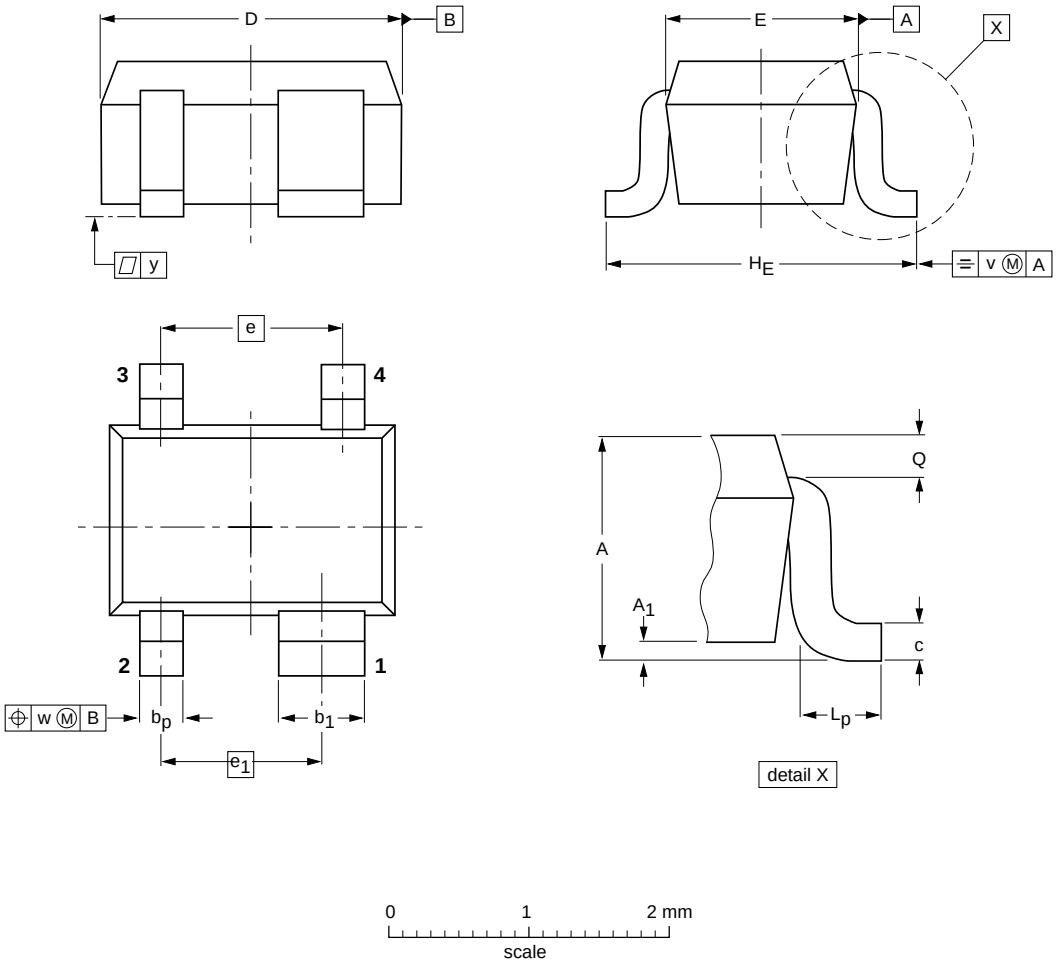



**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ max | $b_p$ | $b_1$ | c | D | E | e | $e_1$ | $H_E$ | $L_p$ | Q | v | w | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.1<br>0.9 | 0.1 | 0.48<br>0.38 | 0.88<br>0.78 | 0.15<br>0.09 | 3.0<br>2.8 | 1.4<br>1.2 | 1.9 | 1.7 | 2.5<br>2.1 | 0.55<br>0.25 | 0.45<br>0.25 | 0.2 | 0.1 | 0.1 |

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

**Plastic surface-mounted package; reverse pinning; 4 leads** **SOT343R**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ max | $b_p$ | $b_1$ | c | D | E | e | $e_1$ | $H_E$ | $L_p$ | Q | v | w | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.1<br>0.8 | 0.1 | 0.4<br>0.3 | 0.7<br>0.5 | 0.25<br>0.10 | 2.2<br>1.8 | 1.35<br>1.15 | 1.3 | 1.15 | 2.2<br>2.0 | 0.45<br>0.15 | 0.23<br>0.13 | 0.2 | 0.2 | 0.1 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT343R | | | | | | ~~97-05-21~~<br>06-03-16 |

## DATA SHEET STATUS

| DOCUMENT STATUS[1] | PRODUCT STATUS[2] | 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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### Contact information

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