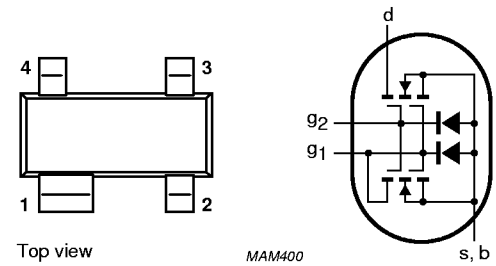
# Dual-gate MOS-FETs BF909A; BF909AR

## FEATURES

- Specially designed for use at 5 V supply voltage
- High forward transfer admittance
- Short channel transistor with high forward transfer admittance to input capacitance ratio
- Low noise gain controlled amplifier up to 1 GHz
- Superior cross-modulation performance during AGC.

## APPLICATIONS

- VHF and UHF applications with 3 to 7 V supply voltage such as television tuners and professional communication equipment.

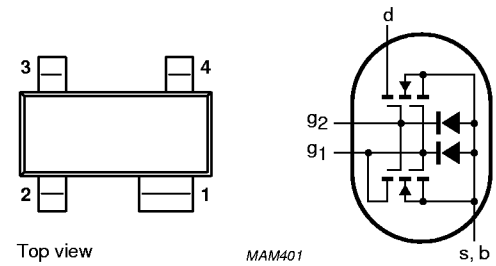



**BF909A marking code:** M33.

Fig.1 Simplified outline (SOT143B) and symbol.

## DESCRIPTION

Enhancement type field-effect transistor in a plastic microminiature SOT143B or SOT143R package.
The transistor consists of an amplifier MOS-FET with source and substrate interconnected and an internal bias circuit to ensure good cross-modulation performance during AGC.




**BF909AR marking code:** M34.

Fig.2 Simplified outline (SOT143R) and symbol.

## PINNING

| PIN | SYMBOL | DESCRIPTION |
|---|---|---|
| 1 | s, b | source |
| 2 | d | drain |
| 3 | $g_2$ | gate 2 |
| 4 | $g_1$ | gate 1 |

## QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | | – | – | 7 | V |
| $I_D$ | drain current | | – | – | 40 | mA |
| $P_{tot}$ | total power dissipation | | – | – | 200 | mW |
| $T_j$ | operating junction temperature | | – | – | 150 | °C |
| $\lvert y_{fs} \rvert$ | forward transfer admittance | | 36 | 43 | 50 | mS |
| $C_{ig1\text{-}s}$ | input capacitance at gate 1 | | – | 3.6 | 4.3 | pF |
| $C_{rs}$ | reverse transfer capacitance | f = 1 MHz | – | 35 | 50 | fF |
| F | noise figure | f = 800 MHz | – | 2 | 2.8 | dB |

**CAUTION**

This product is supplied in anti-static packing to prevent damage caused by electrostatic discharge during transport and handling. For further information, refer to Philips specs.: SNW-EQ-608, SNW-FQ-302A, and SNW-FQ-302B.

## LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_{DS}$ | drain-source voltage | | – | 7 | V |
| $I_D$ | drain current | | – | 40 | mA |
| $I_{G1}$ | gate 1 current | | – | ±10 | mA |
| $I_{G2}$ | gate 2 current | | – | ±10 | mA |
| $P_{tot}$ | total power dissipation | see Fig.3 | | | |
| | BF909A | $T_{amb} \leq 50$ °C; note 1 | – | 200 | mW |
| | BF909AR | $T_{amb} \leq 40$ °C; note 1 | – | 200 | mW |
| $T_{stg}$ | storage temperature | | –65 | +150 | °C |
| $T_j$ | operating junction temperature | | – | 150 | °C |

**Note**

1. Device mounted on a printed-circuit board.

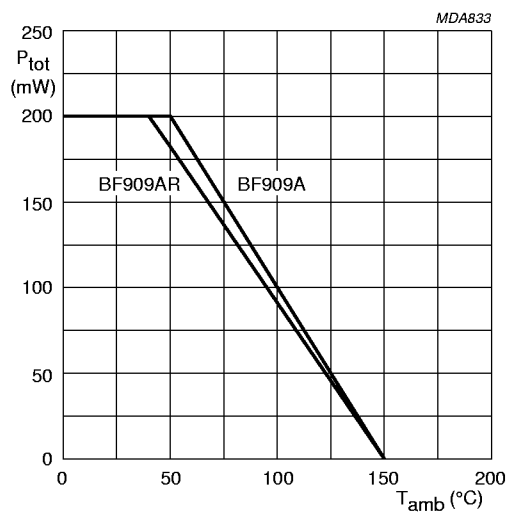



Fig.3 Power derating curves.

## THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|---|---|---|---|---|
| $R_{th\ j\text{-}a}$ | thermal resistance from junction to ambient | note 1 | | |
| | BF909A | | 500 | K/W |
| | BF909AR | | 550 | K/W |
| $R_{th\ j\text{-}s}$ | thermal resistance from junction to soldering point | note 2 | | |
| | BF909A | | 290 | K/W |
| | BF909AR | | 360 | K/W |

**Notes**

1. Device mounted on a printed-circuit board.
2. $T_s$ is the temperature at the soldering point of the source lead.

## STATIC CHARACTERISTICS

$T_j$ = 25 °C unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|---|---|---|---|---|---|
| $V_{(BR)G1\text{-}SS}$ | gate 1-source breakdown voltage | $V_{G2\text{-}S}$ = $V_{DS}$ = 0; $I_{G1\text{-}S}$ = 10 mA | 6 | 15 | V |
| $V_{(BR)G2\text{-}SS}$ | gate 2-source breakdown voltage | $V_{G1\text{-}S}$ = $V_{DS}$ = 0; $I_{G2\text{-}S}$ = 10 mA | 6 | 15 | V |
| $V_{(F)S\text{-}G1}$ | forward source-gate 1 voltage | $V_{G2\text{-}S}$ = $V_{DS}$ = 0; $I_{S\text{-}G1}$ = 10 mA | 0.5 | 1.5 | V |
| $V_{(F)S\text{-}G2}$ | forward source-gate 2 voltage | $V_{G1\text{-}S}$ = $V_{DS}$ = 0; $I_{S\text{-}G2}$ = 10 mA | 0.5 | 1.5 | V |
| $V_{G1\text{-}S(th)}$ | gate 1-source threshold voltage | $V_{G2\text{-}S}$ = 4 V; $V_{DS}$ = 5 V; $I_D$ = 20 μA | 0.3 | 1 | V |
| $V_{G2\text{-}S(th)}$ | gate 2-source threshold voltage | $V_{G1\text{-}S}$ = $V_{DS}$ = 5 V; $I_D$ = 20 μA | 0.3 | 1.2 | V |
| $I_{DSX}$ | drain-source current | $V_{G2\text{-}S}$ = 4 V; $V_{DS}$ = 5 V; $R_{G1}$ = 120 kΩ; note 1 | 12 | 20 | mA |
| $I_{G1\text{-}SS}$ | gate 1 cut-off current | $V_{G1\text{-}S}$ = 5 V; $V_{G2\text{-}S}$ = $V_{DS}$ = 0 | – | 50 | nA |
| $I_{G2\text{-}SS}$ | gate 2 cut-off current | $V_{G2\text{-}S}$ = 5 V; $V_{G1\text{-}S}$ = $V_{DS}$ = 0 | – | 50 | nA |

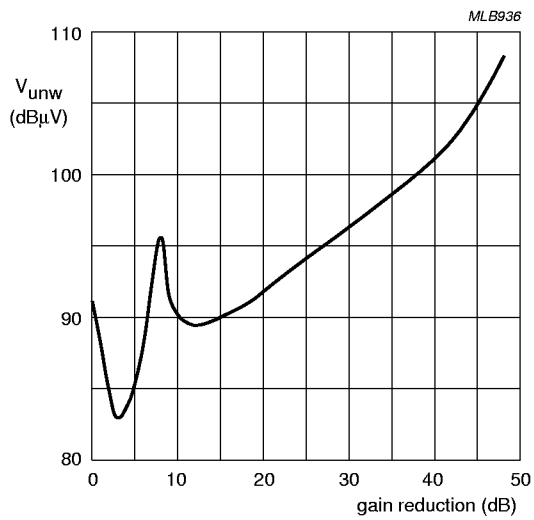
**Note**

1. $R_{G1}$ connects gate 1 to $V_{GG}$ = 5 V; see Fig.18.

## DYNAMIC CHARACTERISTICS

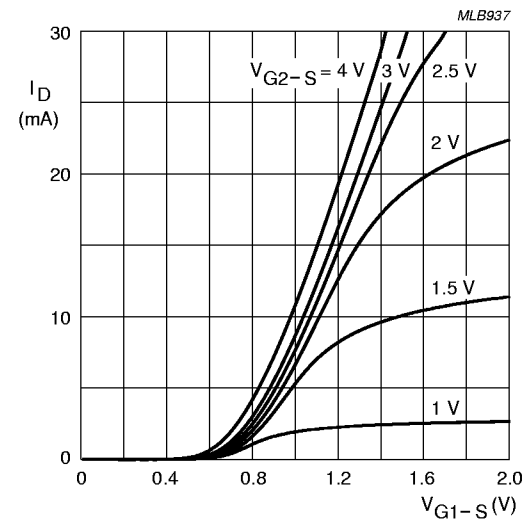
Common source; $T_{amb}$ = 25 °C; $V_{DS}$ = 5 V; $V_{G2\text{-}S}$ = 4 V; $I_D$ = 15 mA; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| $\lvert y_{fs} \rvert$ | forward transfer admittance | pulsed; $T_j$ = 25 °C | 36 | 43 | 50 | mS |
| $C_{ig1\text{-}s}$ | input capacitance at gate 1 | f = 1 MHz | – | 3.6 | 4.3 | pF |
| $C_{ig2\text{-}s}$ | input capacitance at gate 2 | f = 1 MHz | – | 2.3 | 3 | pF |
| $C_{os}$ | drain-source capacitance | f = 1 MHz | – | 2.4 | 3 | pF |
| $C_{rs}$ | reverse transfer capacitance | f = 1 MHz | – | 35 | 50 | fF |
| F | noise figure | f = 800 MHz; $G_S$ = $G_{Sopt}$; $B_S$ = $B_{Sopt}$ | – | 2 | 2.8 | dB |



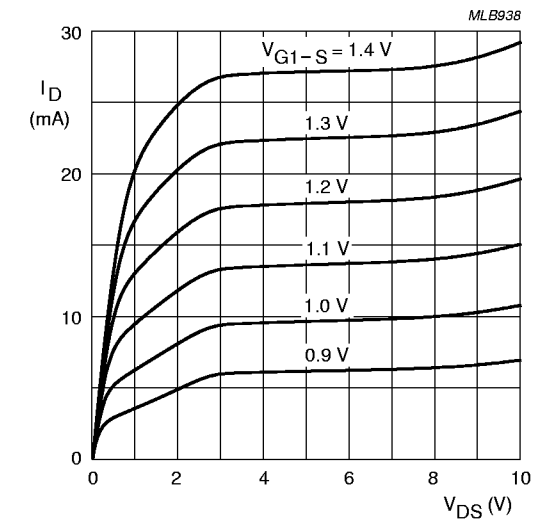

$V_{DS}$ = 5 V; $V_{GG}$ = 5 V; $f_w$ = 50 MHz.
$f_{unw}$ = 60 MHz; $T_{amb}$ = 25 °C; $R_{G1}$ = 120 kΩ.

Fig.4 Unwanted voltage for 1% cross-modulation as a function of gain reduction; typical values; see Fig.18.



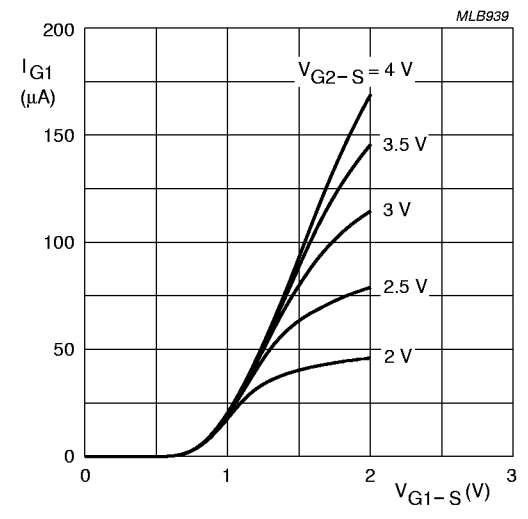

$V_{DS}$ = 5 V; $T_j$ = 25 °C.

Fig.5 Transfer characteristics; typical values.



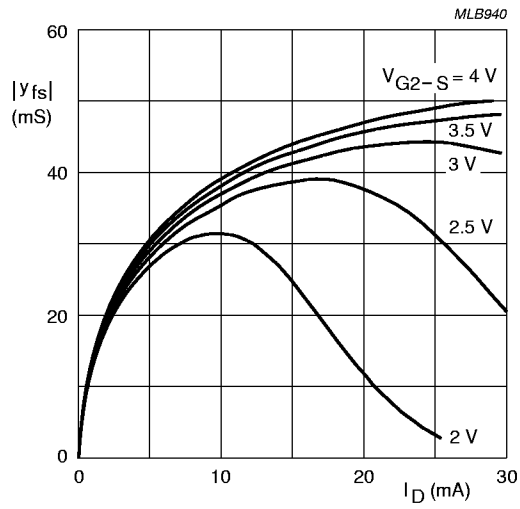

$V_{DS}$ = 5 V; $V_{G2-S}$ = 4 V; $T_j$ = 25 °C.

Fig.6 Output characteristics; typical values.



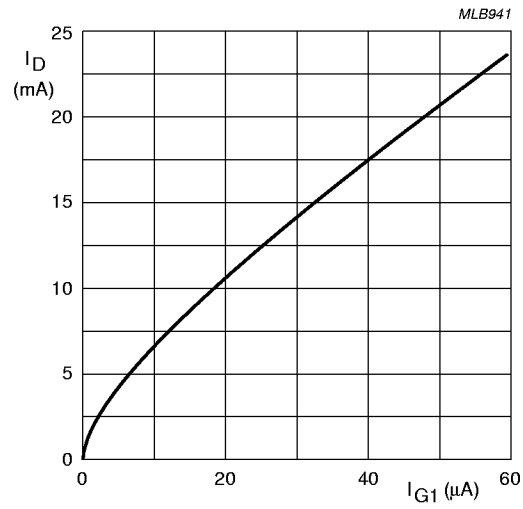

$V_{DS}$ = 5 V; $T_j$ = 25 °C.

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



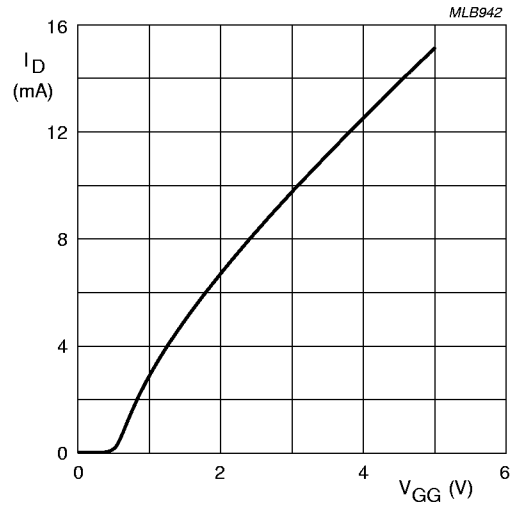

$V_{DS}$ = 5 V; $T_j$ = 25 °C.

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



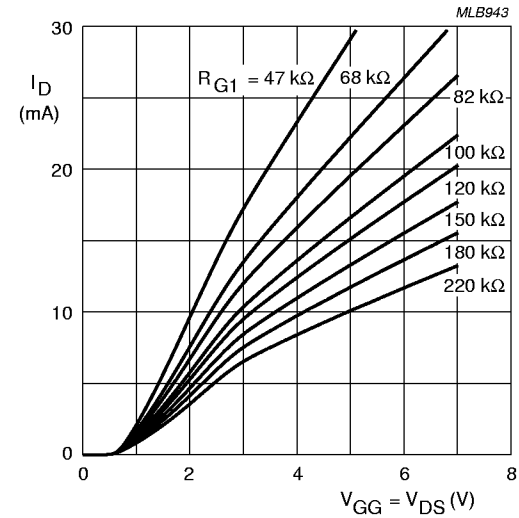

$V_{DS}$ = 5 V; $V_{G2-S}$ = 4 V; $T_j$ = 25 °C.

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



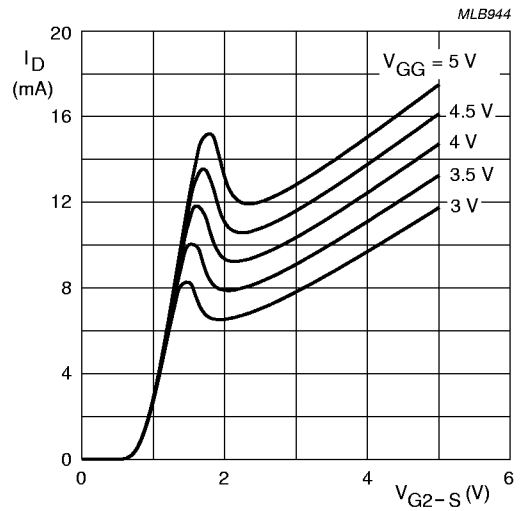

$V_{DS}$ = 5 V; $V_{G2-S}$ = 4 V; $R_{G1}$ = 120 kΩ (connected to $V_{GG}$); $T_j$ = 25 °C.

Fig.10 Drain current as a function of gate 1 supply voltage (= $V_{GG}$); typical values; see Fig.18.



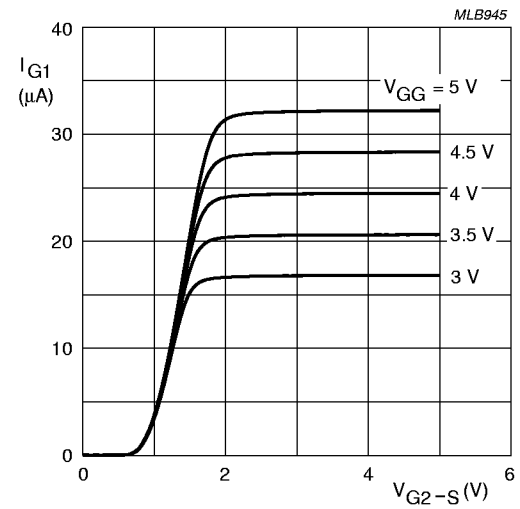

$V_{G2-S}$ = 4 V; $R_{G1}$ connected to $V_{GG}$; $T_j$ = 25 °C.

Fig.11 Drain current as a function of gate 1 (= $V_{GG}$) and drain supply voltage; typical values; see Fig.18.



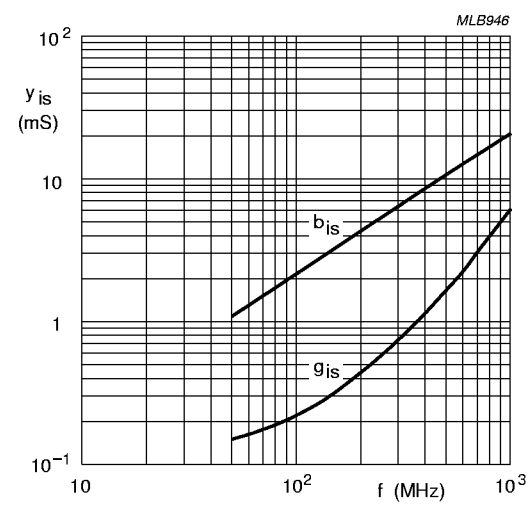

$V_{DS}$ = 5 V; $T_j$ = 25 °C; $R_{G1}$ = 120 kΩ (connected to $V_{GG}$).

Fig.12 Drain current as a function of gate 2 voltage; typical values; see Fig.18.



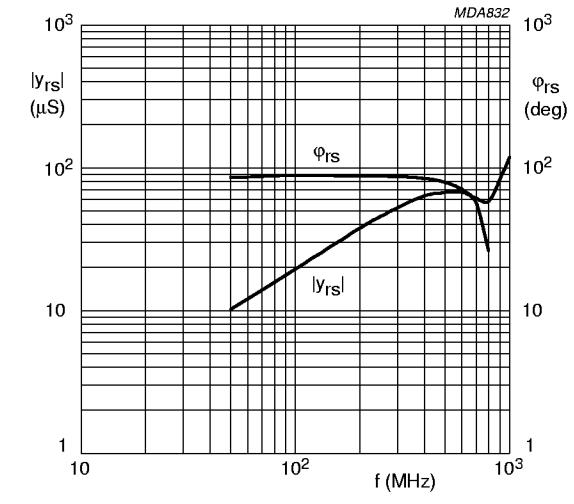

$V_{DS}$ = 5 V; $T_j$ = 25 °C; $R_{G1}$ = 120 kΩ (connected to $V_{GG}$).

Fig.13 Gate 1 current as a function of gate 2 voltage; typical values; see Fig.18.



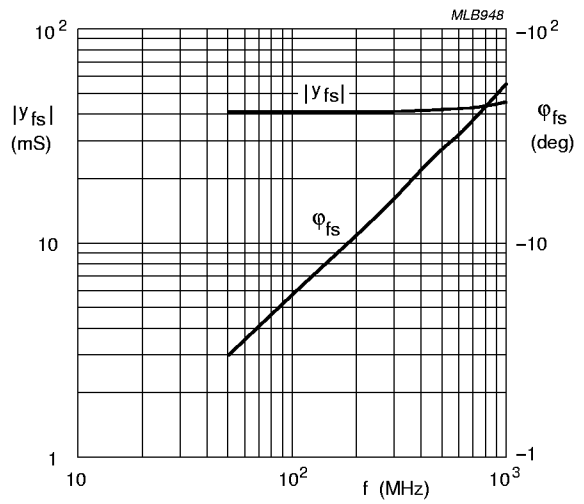

$V_{DS}$ = 5 V; $V_{G2}$ = 4 V; $I_D$ = 15 mA; $T_{amb}$ = 25 °C.

Fig.14 Input admittance as a function of frequency; typical values.



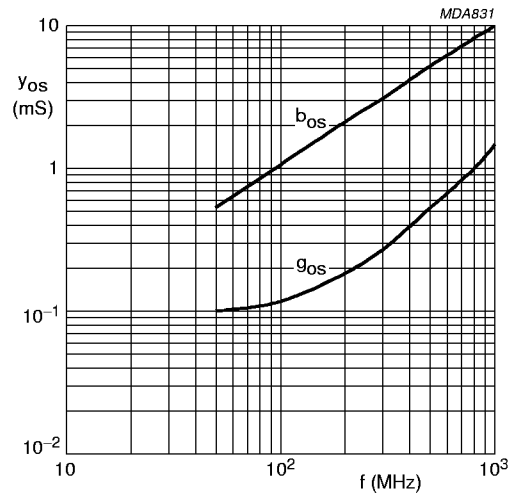

$V_{DS}$ = 5 V; $V_{G2}$ = 4 V; $I_D$ = 15 mA; $T_{amb}$ = 25 °C.

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




$V_{DS}$ = 5 V; $V_{G2}$ = 4 V; $I_D$ = 15 mA; $T_{amb}$ = 25 °C.

Fig.16 Forward transfer admittance and phase as a function of frequency; typical values.




$V_{DS}$ = 5 V; $V_{G2}$ = 4 V; $I_D$ = 15 mA; $T_{amb}$ = 25 °C.

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

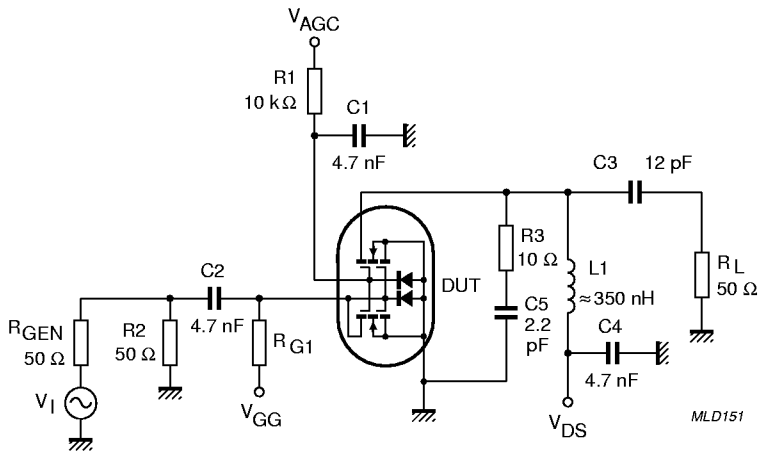



Fig.18 Cross-modulation test set-up.

**Table 1** Scattering parameters: $T_{amb}$ = 25 °C; $V_{DS}$ = 5 V; $V_{G2\text{-}S}$ = 4 V; $I_D$ = 15 mA

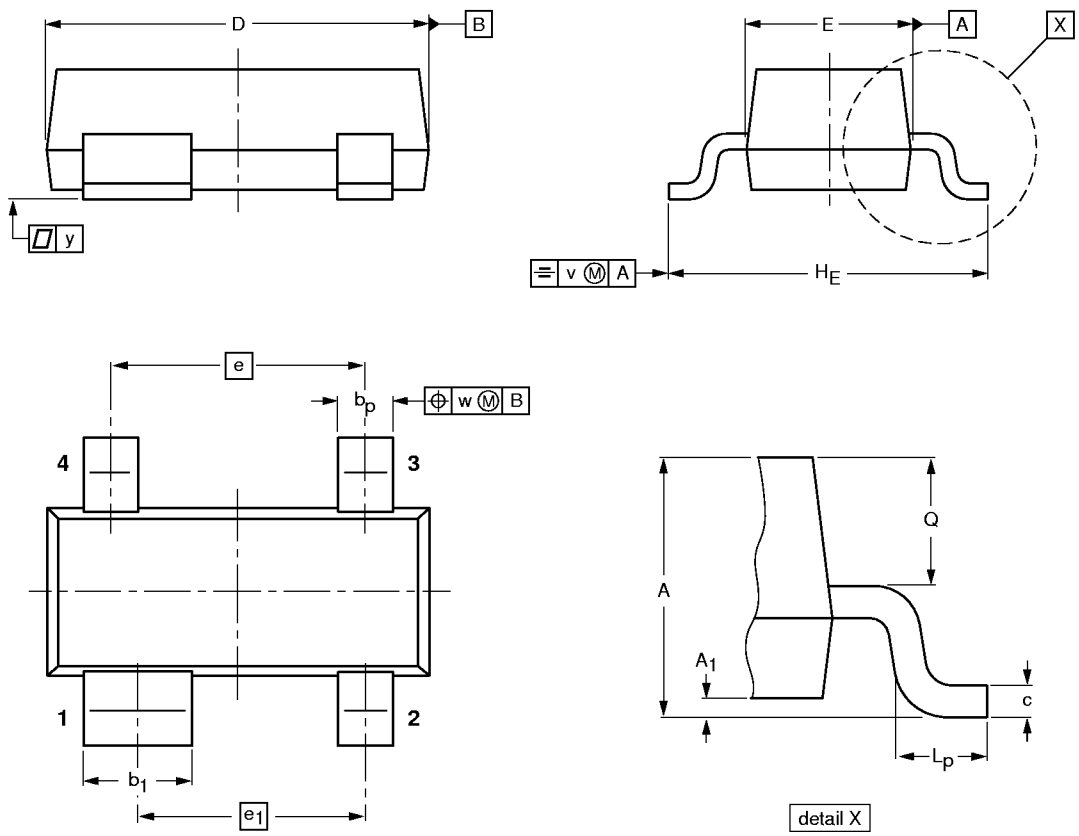
| f (MHz) | $S_{11}$ | | $S_{21}$ | | $S_{12}$ | | $S_{22}$ | |
|---|---|---|---|---|---|---|---|---|
| | MAGNITUDE (ratio) | ANGLE (deg) | MAGNITUDE (ratio) | ANGLE (deg) | MAGNITUDE (ratio) | ANGLE (deg) | MAGNITUDE (ratio) | ANGLE (deg) |
| 50 | 0.988 | −5.9 | 4.258 | 172.8 | 0.001 | 89.1 | 0.990 | −3.2 |
| 100 | 0.982 | −11.9 | 4.219 | 165.4 | 0.002 | 81.9 | 0.998 | −6.4 |
| 200 | 0.964 | −23.4 | 4.090 | 151.7 | 0.004 | 73.9 | 0.979 | −12.6 |
| 300 | 0.939 | −34.3 | 3.899 | 138.4 | 0.005 | 66.8 | 0.969 | −18.6 |
| 400 | 0.911 | −44.7 | 3.708 | 125.9 | 0.005 | 61.7 | 0.956 | −24.4 |
| 500 | 0.883 | −54.2 | 3.467 | 114.2 | 0.005 | 60.5 | 0.944 | −29.9 |
| 600 | 0.853 | −62.9 | 3.246 | 103.3 | 0.005 | 63.3 | 0.934 | −35.1 |
| 700 | 0.828 | −70.9 | 3.036 | 92.7 | 0.004 | 72.4 | 0.924 | −40.1 |
| 800 | 0.805 | −78.3 | 2.843 | 82.5 | 0.004 | 97.9 | 0.916 | −45.1 |
| 900 | 0.777 | −85.4 | 2.634 | 72.6 | 0.005 | 121.3 | 0.906 | −50.0 |
| 1000 | 0.749 | −91.8 | 2.450 | 63.2 | 0.006 | 138.7 | 0.890 | −54.9 |

**Table 2** Noise data: $T_{amb}$ = 25 °C; $V_{DS}$ = 5 V; $V_{G2\text{-}S}$ = 4 V; $I_D$ = 15 mA

| f (MHz) | $F_{min}$ (dB) | $\Gamma_{opt}$ | | $r_n$ |
|---|---|---|---|---|
| | | (ratio) | (deg) | |
| 800 | 2.00 | 0.603 | 67.71 | 0.581 |

## PACKAGE OUTLINES

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

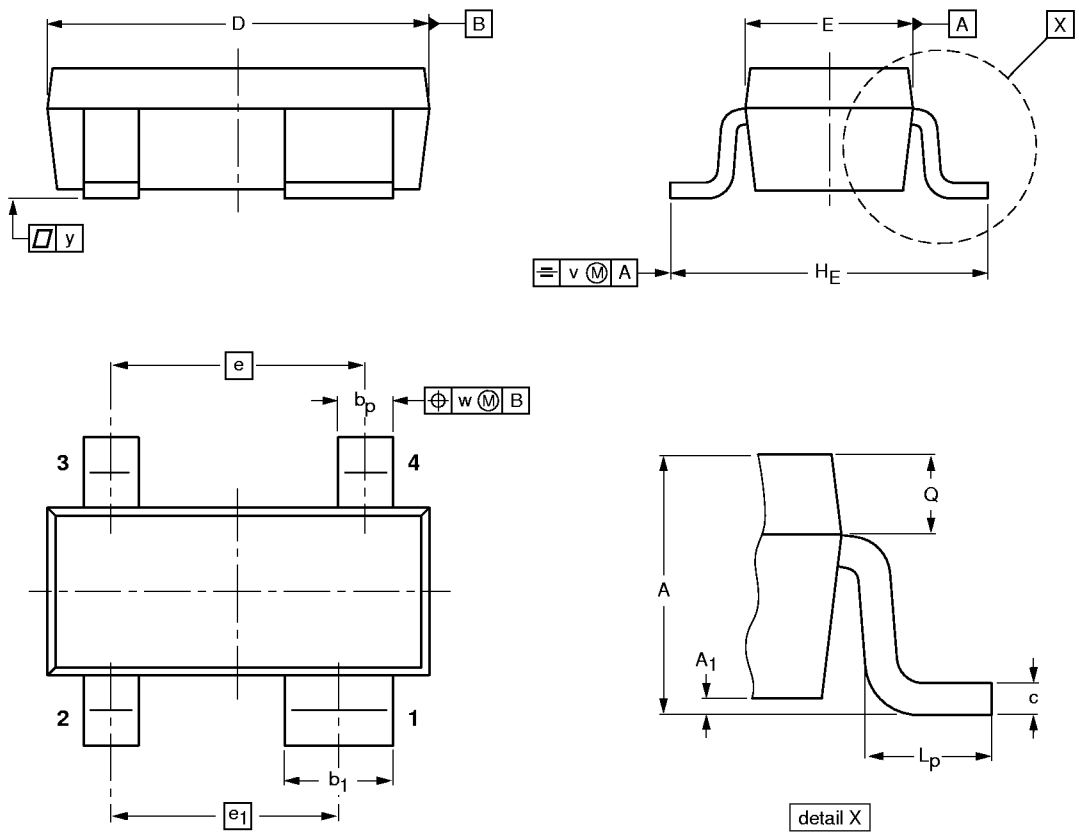



**DIMENSIONS (mm are the original dimensions)**

| 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 | EIAJ | | | |
| SOT143B | | | | | | 97-02-28 |

**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 | EIAJ | | | |
| SOT143R | | | | | | 97-03-10 |