

DATA SHEET

BF904; BF904R N-channel dual gate MOS-FETs

Product specification
File under Discrete Semiconductors, SC07

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Philips Semiconductors



PHILIPS

N-channel dual gate MOS-FETs

BF904; BF904R

FEATURES

- Specially designed for use at 5 V supply voltage
- Short channel transistor with high 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 communications equipment.

DESCRIPTION

Enhancement type field-effect transistor in a plastic microminiature SOT143 and SOT143R package. The

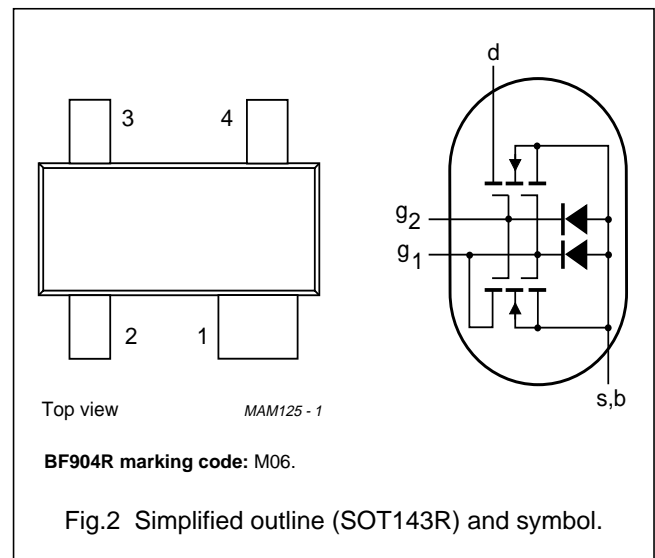
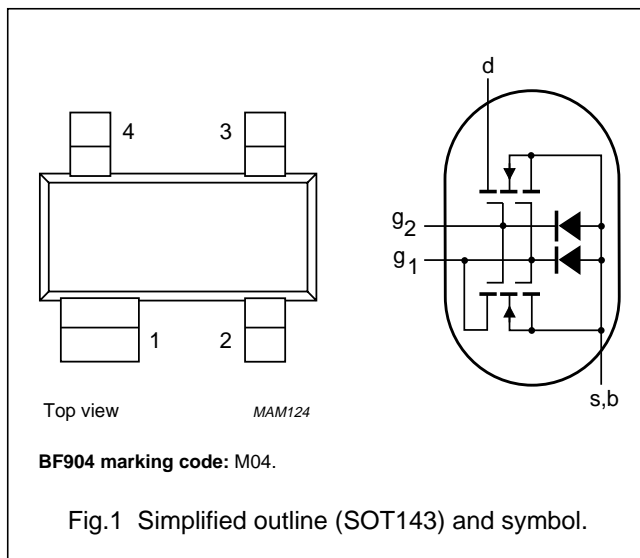
transistor consists of an amplifier MOS-FET with source and substrate interconnected and an internal bias circuit to ensure good cross-modulation performance during AGC.

CAUTION

The device is supplied in an antistatic package. The gate-source input must be protected against static discharge during transport or handling.

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 | | – | – | 30 | mA |
| P _{tot} | total power dissipation | | – | – | 200 | mW |
| T _j | operating junction temperature | | – | – | 150 | °C |
| y _{fs} | forward transfer admittance | | 22 | 25 | 30 | mS |
| C _{ig1-s} | input capacitance at gate 1 | | – | 2.2 | 2.6 | pF |
| C _{rs} | reverse transfer capacitance | f = 1 MHz | – | 25 | 35 | fF |
| F | noise figure | f = 800 MHz | – | 2 | – | dB |

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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 | | – | 30 | mA |
| I_{G1} | gate 1 current | | – | ±10 | mA |
| I_{G2} | gate 2 current | | – | ±10 | mA |
| P_{tot} | total power dissipation BF904 BF904R | see Fig.3 up to $T_{amb} = 50\text{ °C}$; note 1 up to $T_{amb} = 40\text{ °C}$; note 1 | – | 200 200 | mW mW |
| T_{stg} | storage temperature | | –65 | +150 | °C |
| T_j | operating junction temperature | | – | 150 | °C |

Note

1. Device mounted on a printed-circuit board.

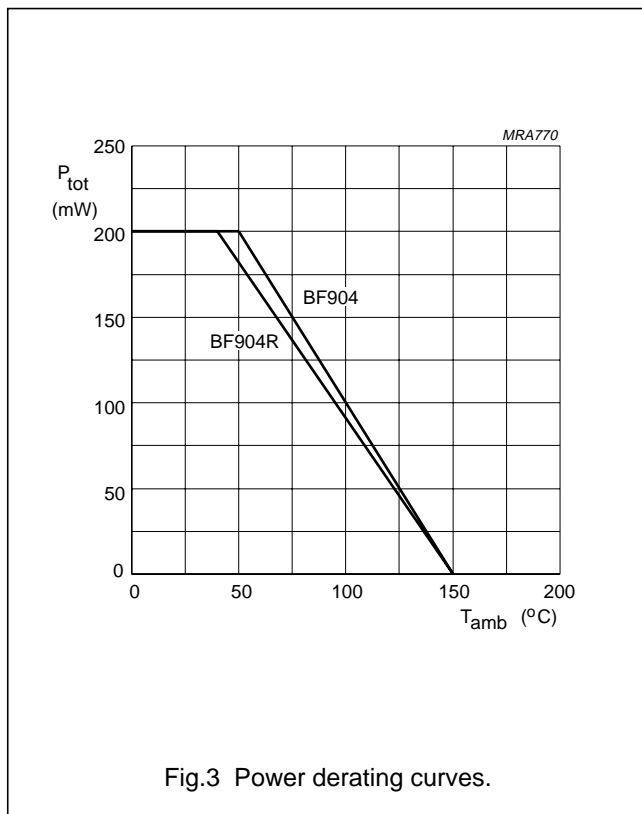


Fig.3 Power derating curves.

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THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|---------------|---|----------------------------|-------|------|
| $R_{th\ j-a}$ | thermal resistance from junction to ambient | note 1 | 500 | K/W |
| | BF904 | | | |
| $R_{th\ j-s}$ | thermal resistance from junction to soldering point | note 2 | 290 | K/W |
| | BF904 | | | |
| | BF904R | $T_s = 78\ ^\circ\text{C}$ | 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

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

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|-----------------|---------------------------------|--|------|------|------|
| $V_{(BR)G1-SS}$ | gate 1-source breakdown voltage | $V_{G2-S} = V_{DS} = 0$; $I_{G1-S} = 10\ \text{mA}$ | 6 | 15 | V |
| $V_{(BR)G2-SS}$ | gate 2-source breakdown voltage | $V_{G1-S} = V_{DS} = 0$; $I_{G2-S} = 10\ \text{mA}$ | 6 | 15 | V |
| $V_{(F)S-G1}$ | forward source-gate 1 voltage | $V_{G2-S} = V_{DS} = 0$; $I_{S-G1} = 10\ \text{mA}$ | 0.5 | 1.5 | V |
| $V_{(F)S-G2}$ | forward source-gate 2 voltage | $V_{G1-S} = V_{DS} = 0$; $I_{S-G2} = 10\ \text{mA}$ | 0.5 | 1.5 | V |
| $V_{G1-S(th)}$ | gate 1-source threshold voltage | $V_{G2-S} = 4\ \text{V}$; $V_{DS} = 5\ \text{V}$; $I_D = 20\ \mu\text{A}$ | 0.3 | 1 | V |
| $V_{G2-S(th)}$ | gate 2-source threshold voltage | $V_{G1-S} = V_{DS} = 5\ \text{V}$; $I_D = 20\ \mu\text{A}$ | 0.3 | 1.2 | V |
| I_{DSX} | drain-source current | $V_{G2-S} = 4\ \text{V}$; $V_{DS} = 5\ \text{V}$; $R_{G1} = 120\ \text{k}\Omega$; note 1 | 8 | 13 | mA |
| I_{G1-SS} | gate 1 cut-off current | $V_{G2-S} = V_{DS} = 0$; $V_{G1-S} = 5\ \text{V}$ | – | 50 | nA |
| I_{G2-SS} | gate 2 cut-off current | $V_{G1-S} = V_{DS} = 0$; $V_{G2-S} = 5\ \text{V}$ | – | 50 | nA |

Note

1. R_G connects gate 1 to $V_{GG} = 5\ \text{V}$; see Fig.20.

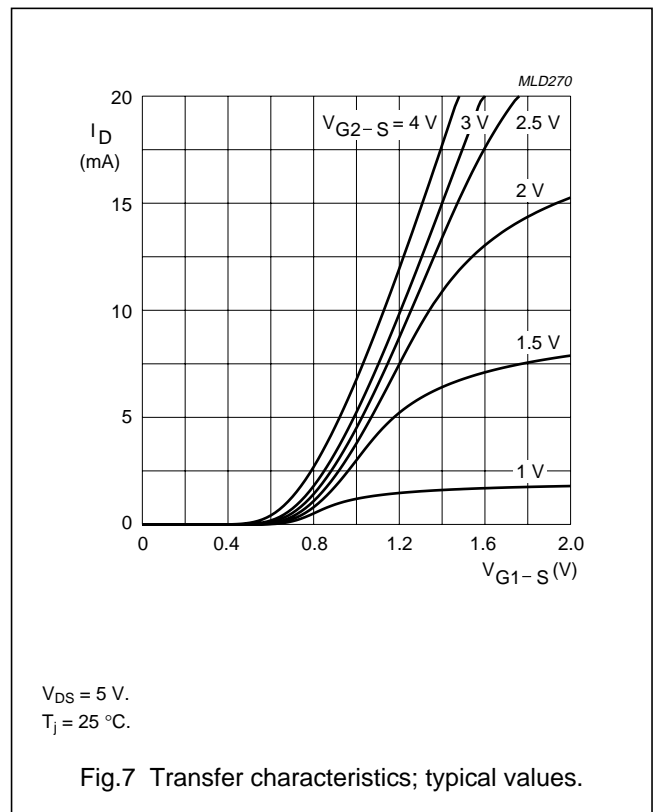
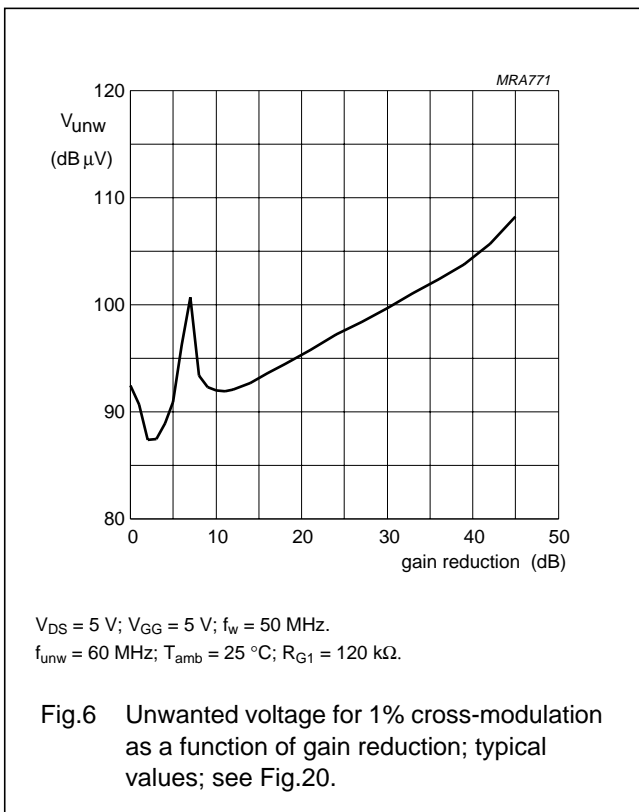
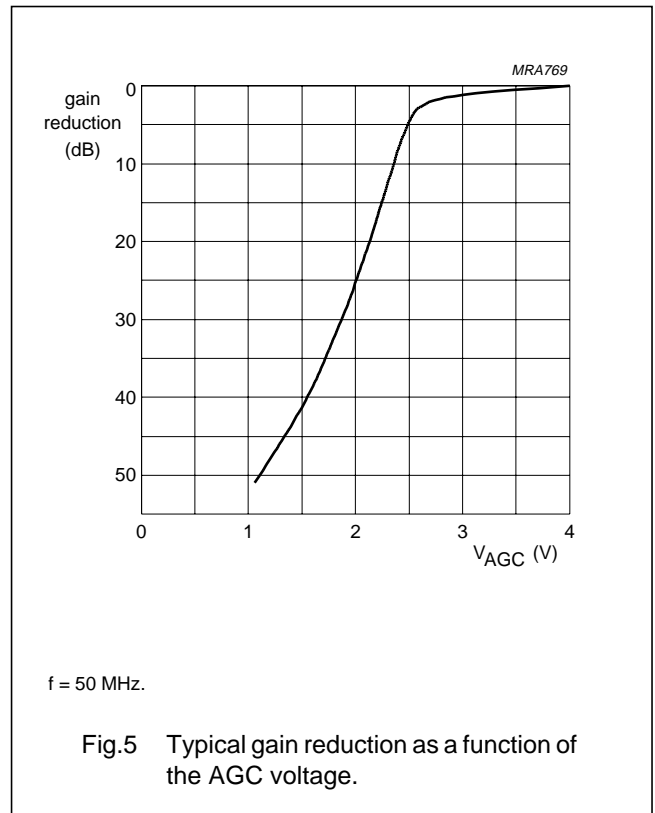
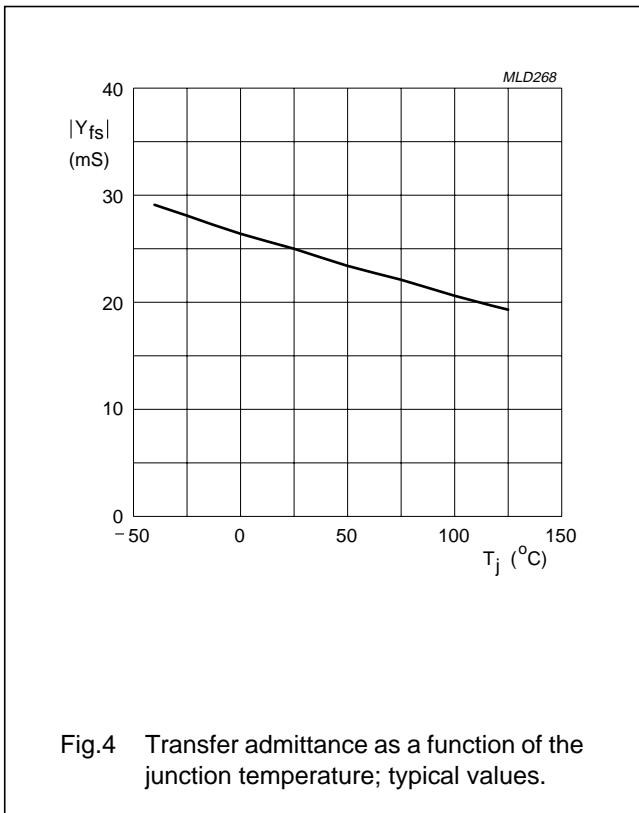
DYNAMIC CHARACTERISTICS

Common source; $T_{amb} = 25\ ^\circ\text{C}$; $V_{DS} = 5\ \text{V}$; $V_{G2-S} = 4\ \text{V}$; $I_D = 10\ \text{mA}$; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-------------|------------------------------|---|------|------|------|------|
| $ y_{fs} $ | forward transfer admittance | pulsed; $T_j = 25\ ^\circ\text{C}$ | 22 | 25 | 30 | mS |
| C_{ig1-s} | input capacitance at gate 1 | $f = 1\ \text{MHz}$ | – | 2.2 | 2.6 | pF |
| C_{ig2-s} | input capacitance at gate 2 | $f = 1\ \text{MHz}$ | 1 | 1.5 | 2 | pF |
| C_{os} | drain-source capacitance | $f = 1\ \text{MHz}$ | 1 | 1.3 | 1.6 | pF |
| C_{rs} | reverse transfer capacitance | $f = 1\ \text{MHz}$ | – | 25 | 35 | fF |
| F | noise figure | $f = 200\ \text{MHz}$; $G_S = 2\ \text{mS}$; $B_S = B_{Sopt}$ | – | 1 | 1.5 | dB |
| | | $f = 800\ \text{MHz}$; $G_S = G_{Sopt}$; $B_S = B_{Sopt}$ | – | 2 | 2.8 | dB |

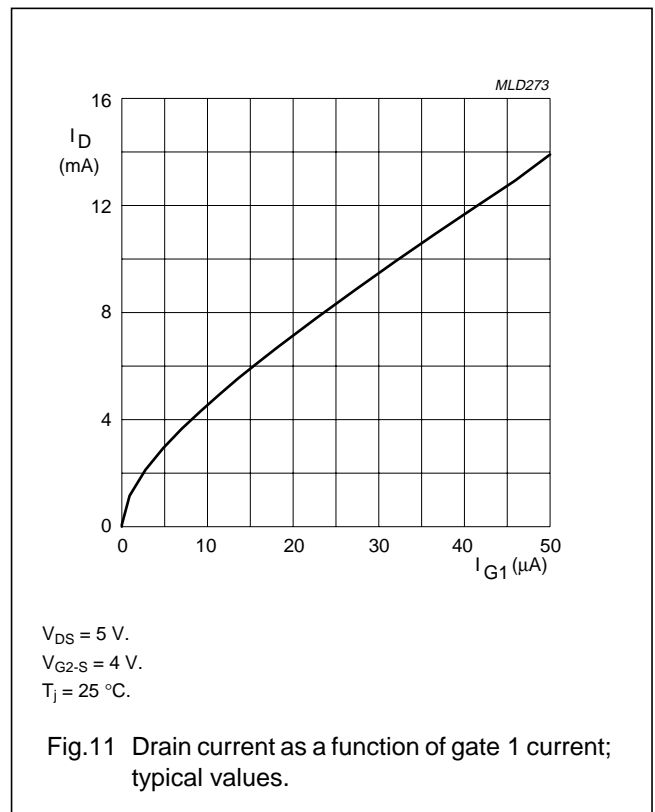
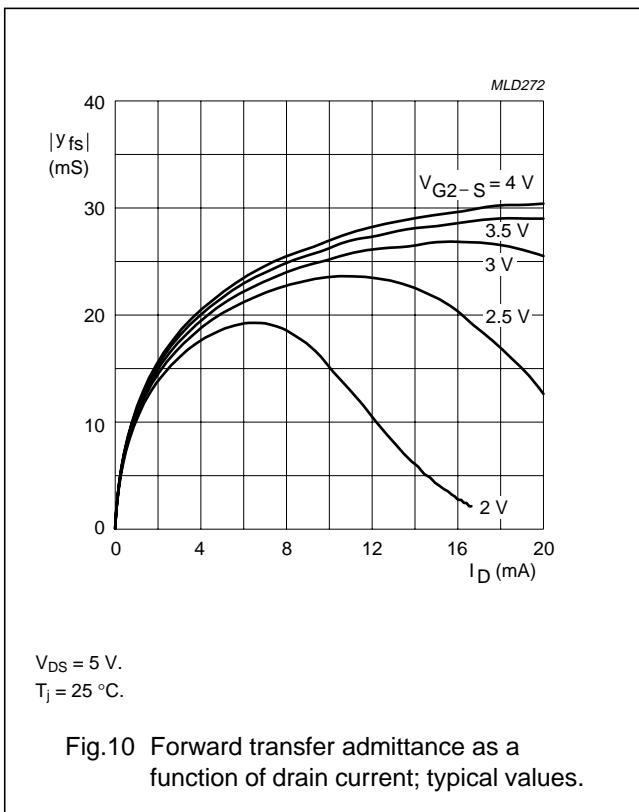
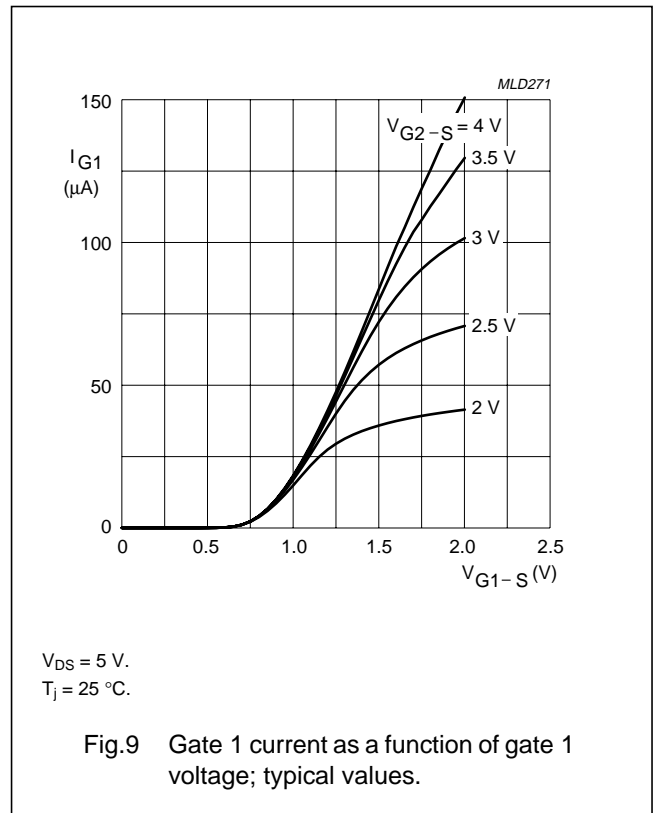
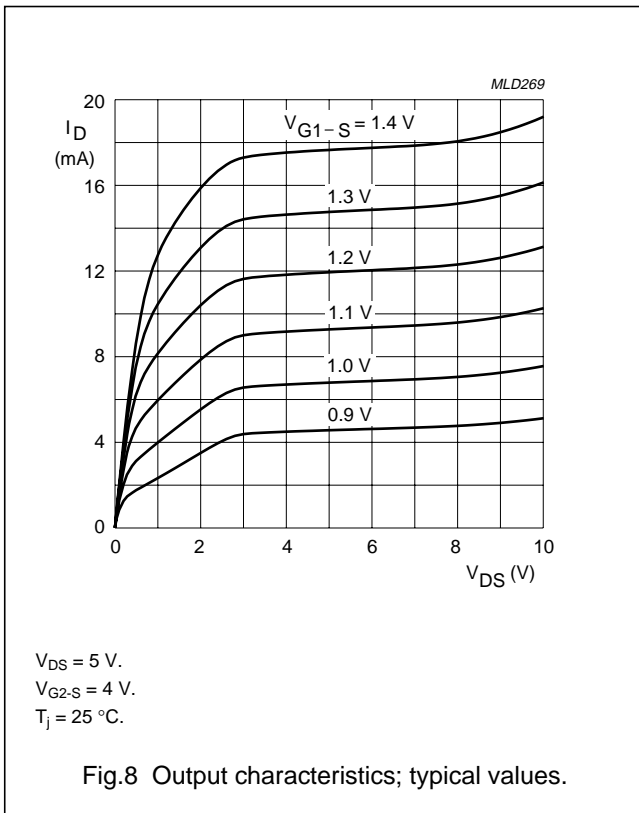
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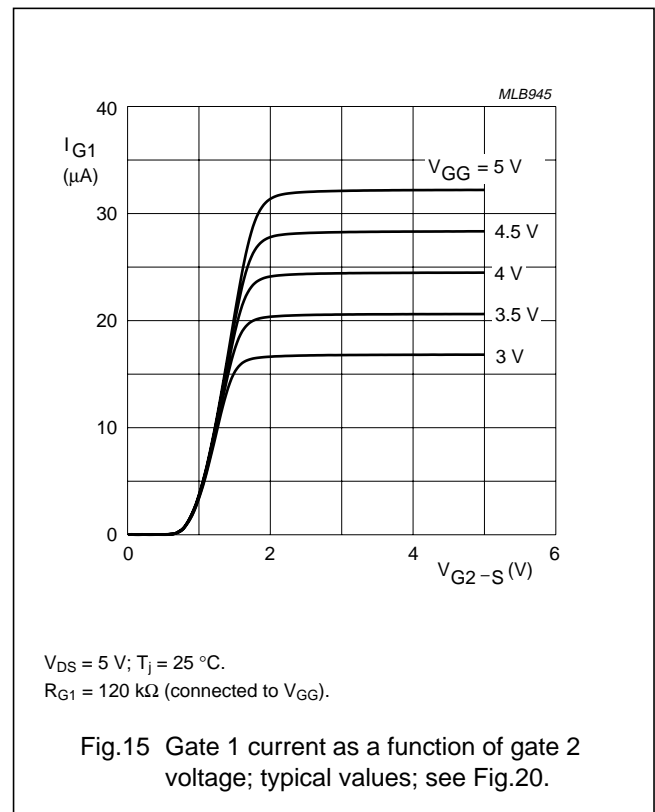
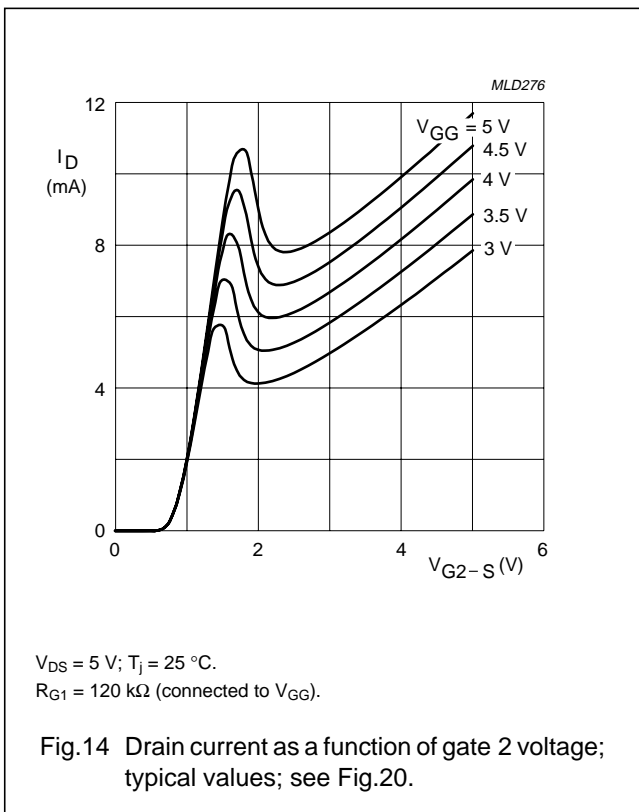
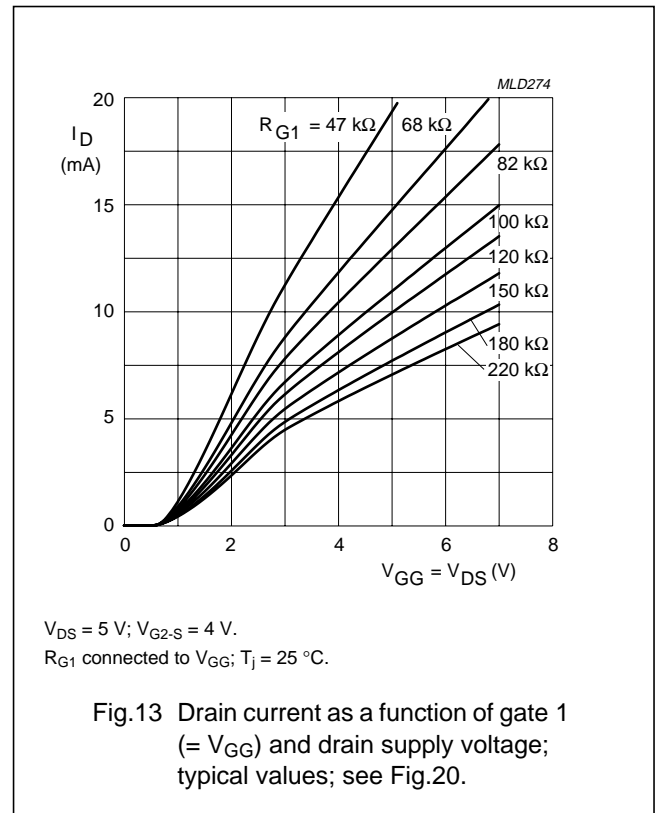
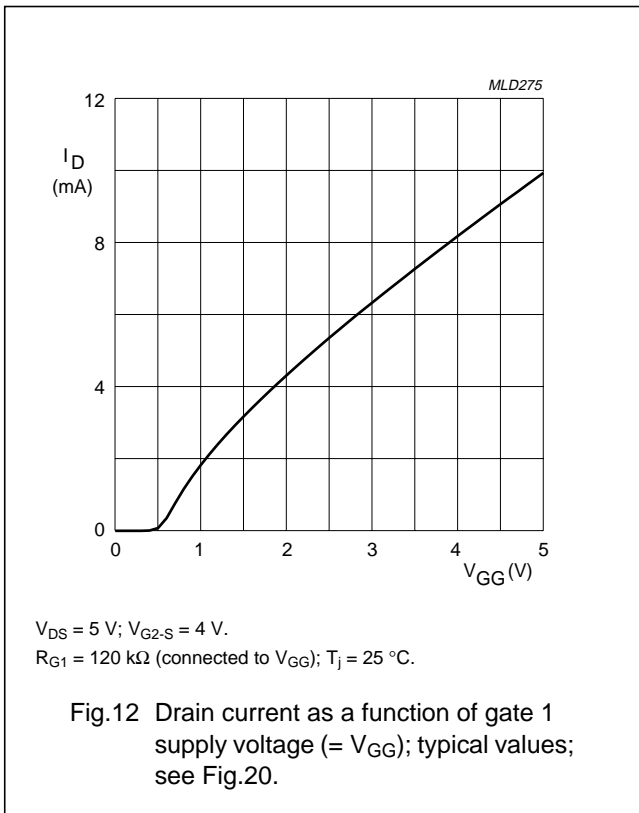
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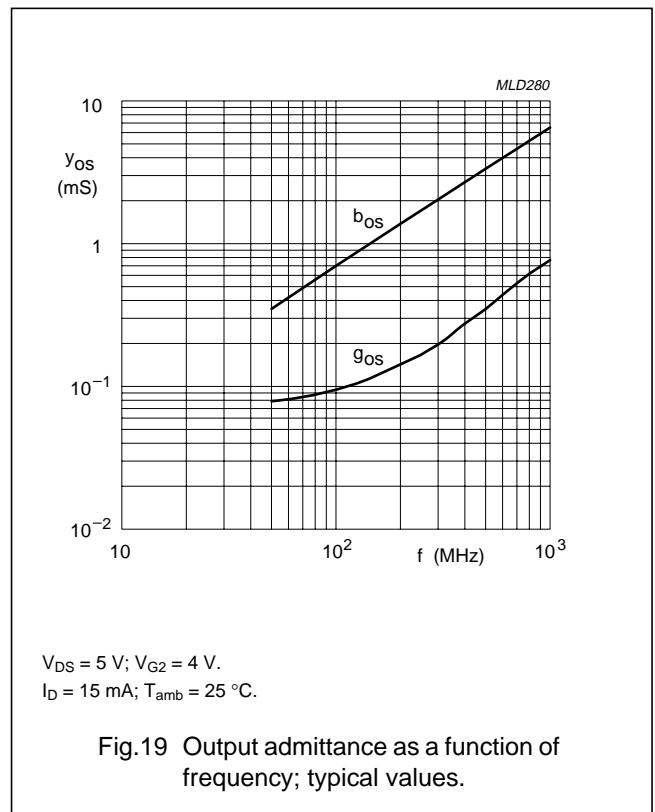
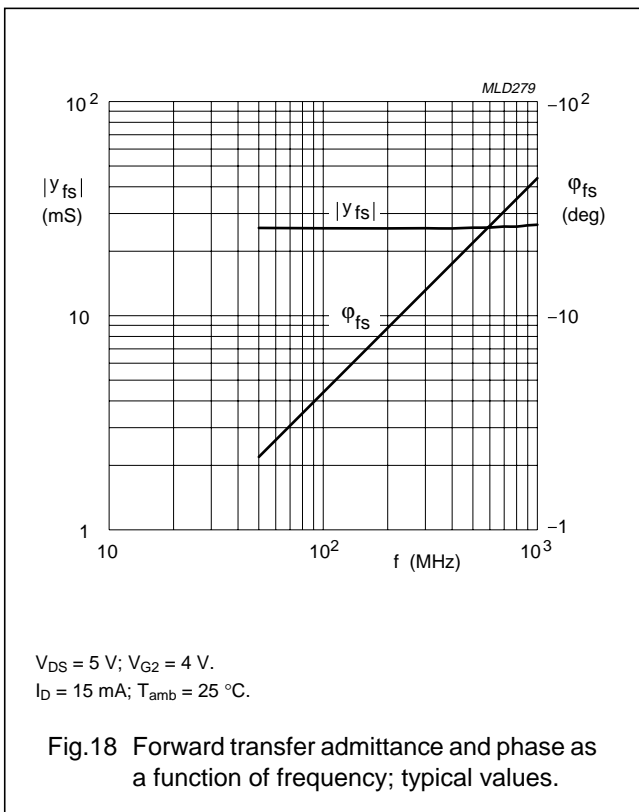
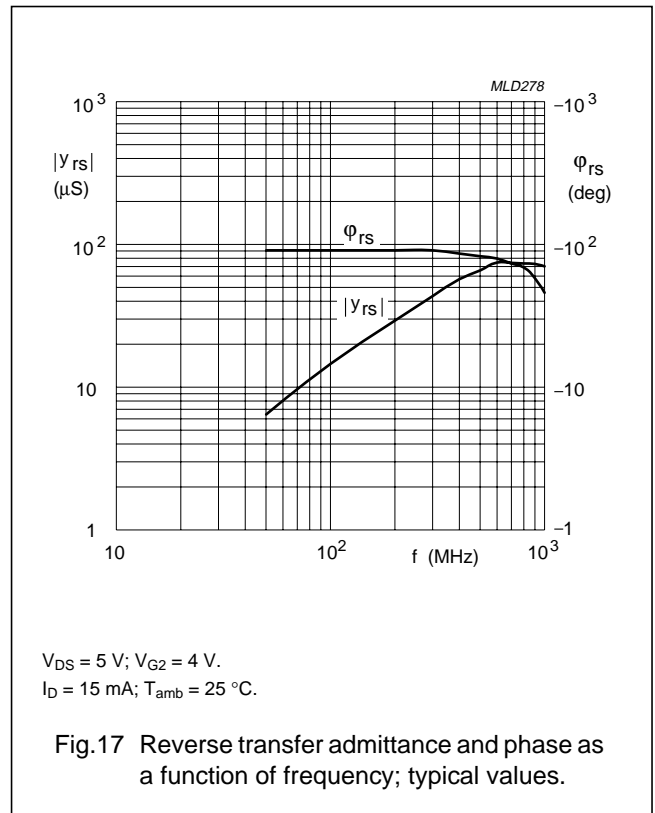
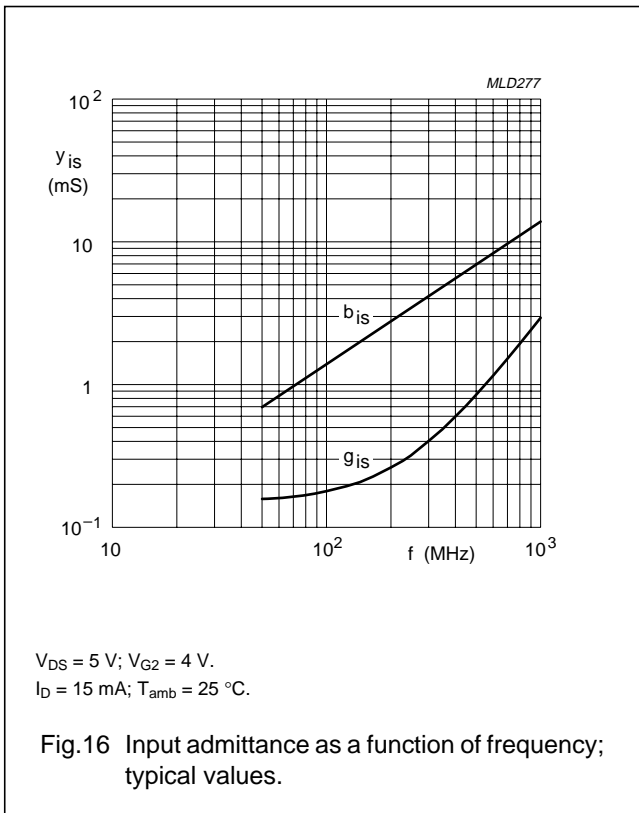
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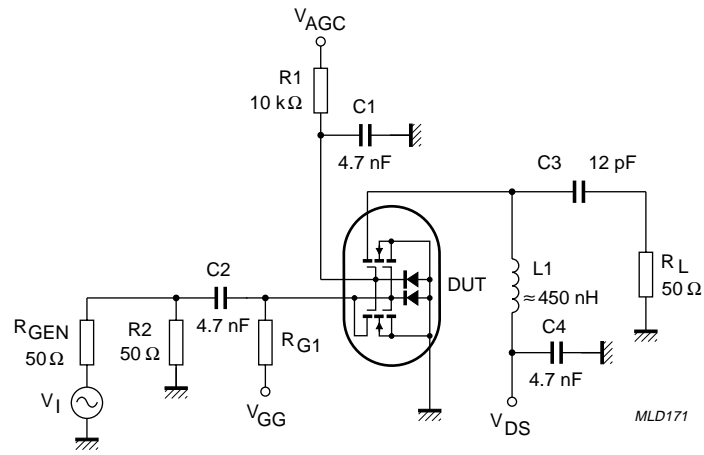


Fig.20 Cross-modulation test set-up.

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Table 1 Scattering parameters: $V_{DS} = 5\text{ V}$; $V_{G2-S} = 4\text{ V}$; $I_D = 10\text{ mA}$

| 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) |
| 40 | 0.989 | -3.4 | 2.420 | 175.7 | 0.000 | 79.9 | 0.993 | -1.6 |
| 100 | 0.985 | -8.3 | 2.414 | 169.1 | 0.001 | 78.3 | 0.992 | -3.9 |
| 200 | 0.976 | -16.4 | 2.368 | 158.8 | 0.003 | 80.3 | 0.987 | -7.8 |
| 300 | 0.958 | -24.1 | 2.301 | 148.5 | 0.004 | 73.7 | 0.980 | -11.4 |
| 400 | 0.942 | -32.0 | 2.251 | 138.8 | 0.005 | 70.7 | 0.974 | -15.2 |
| 500 | 0.918 | -39.3 | 2.170 | 129.5 | 0.005 | 67.2 | 0.966 | -18.7 |
| 600 | 0.899 | -46.0 | 2.080 | 120.7 | 0.005 | 67.8 | 0.958 | -22.2 |
| 700 | 0.876 | -52.6 | 2.001 | 112.1 | 0.005 | 68.6 | 0.951 | -25.5 |
| 800 | 0.852 | -58.8 | 1.924 | 103.2 | 0.005 | 72.9 | 0.944 | -28.9 |
| 900 | 0.823 | -64.9 | 1.829 | 94.7 | 0.005 | 78.7 | 0.937 | -32.1 |
| 1000 | 0.800 | -70.9 | 1.747 | 86.5 | 0.005 | 88.3 | 0.933 | -35.2 |
| 1200 | 0.750 | -82.4 | 1.621 | 70.7 | 0.005 | 120.5 | 0.928 | -41.7 |
| 1400 | 0.719 | -92.7 | 1.535 | 54.6 | 0.008 | 139.8 | 0.930 | -48.4 |
| 1600 | 0.682 | -102.5 | 1.424 | 39.4 | 0.010 | 137.8 | 0.924 | -54.9 |
| 1800 | 0.642 | -109.8 | 1.349 | 22.5 | 0.013 | 156.8 | 0.928 | -62.9 |
| 2000 | 0.602 | -116.5 | 1.283 | 1.1 | 0.018 | 175.1 | 0.928 | -73.1 |
| 2200 | 0.547 | -124.9 | 1.130 | -15.1 | 0.014 | 172.6 | 0.887 | -81.0 |
| 2400 | 0.596 | -128.7 | 1.018 | -49.1 | 0.040 | -163.9 | 0.837 | -95.8 |
| 2600 | 0.682 | -132.6 | 0.979 | -79.4 | 0.077 | -164.0 | 0.778 | -109.6 |
| 2800 | 0.771 | -142.5 | 0.804 | -116.2 | 0.120 | 178.8 | 0.629 | -119.5 |
| 3000 | 0.793 | -157.5 | 0.541 | -153.5 | 0.149 | 158.3 | 0.479 | -119.9 |

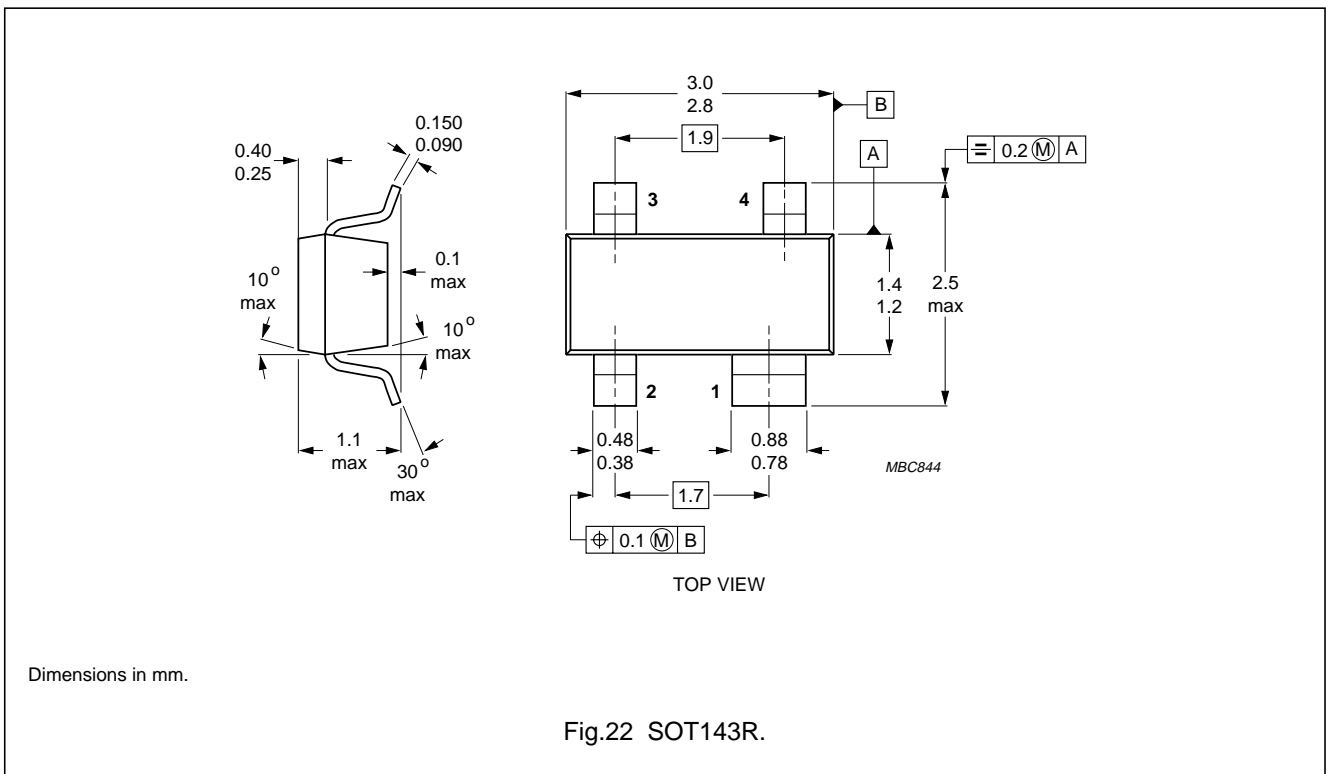
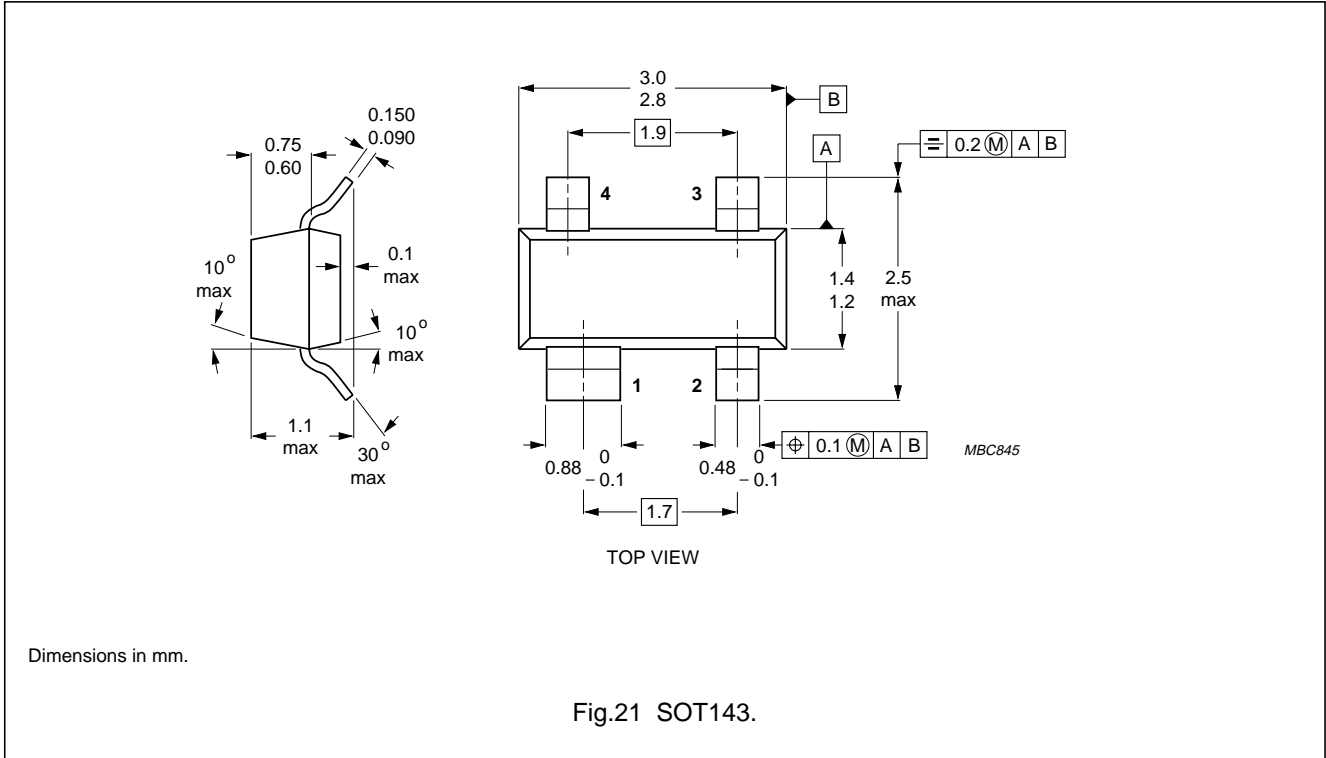
Table 2 Noise data: $V_{DS} = 5\text{ V}$; $V_{G2-S} = 4\text{ V}$; $I_D = 10\text{ mA}$

| f (MHz) | F _{min} (dB) | Γ _{opt} | | r _n |
|------------|--------------------------|------------------|-------|----------------|
| | | (ratio) | (deg) | |
| 800 | 2.00 | 0.686 | 49.6 | 50.40 |

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PACKAGE OUTLINES



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DEFINITIONS

| Data Sheet Status | |
|---|---|
| Objective specification | This data sheet contains target or goal specifications for product development. |
| Preliminary specification | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification | This data sheet contains final product specifications. |
| Limiting values | |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. | |
| Application information | |
| Where application information is given, it is advisory and does not form part of the specification. | |

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