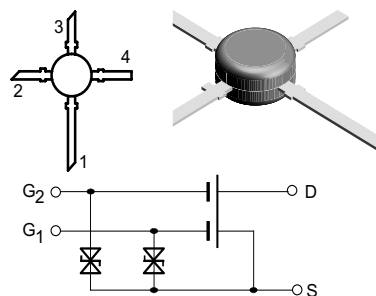


# N-Channel Dual Gate MOS-Fieldeffect Tetrode, Depletion Mode

## Features

- Integrated gate protection diodes
- High cross modulation performance
- Low noise figure
- High gain
- High AGC-range
- Low feedback capacitance
- Low input capacitance
- Lead (Pb)-free component
- Component in accordance to RoHS 2002/95/EC and WEEE 2002/96/EC



Electrostatic sensitive device.  
Observe precautions for handling.

13625

## Applications

Input- and mixer stages especially VHF- and UHF-tuners.

## Mechanical Data

**Case:** TO-50 Plastic case

**Weight:** approx. 124 mg

**Marking:** BF988

### Pinning:

1 = Drain, 2 = Source,  
3 = Gate 1, 4 = Gate 2

## Parts Table

| Part   | Ordering Ccode   | Marking | Package |
|--------|------------------|---------|---------|
| BF988  | BF988A or BF988B | BF988   | TO50    |
| BF988A | BF988A           | BF988   | TO50    |
| BF988B | BF988B           | BF988   | TO50    |

## Absolute Maximum Ratings

T<sub>amb</sub> = 25 °C, unless otherwise specified

| Parameter                           | Test condition           | Symbol                 | Value         | Unit |
|-------------------------------------|--------------------------|------------------------|---------------|------|
| Drain - source voltage              |                          | V <sub>DS</sub>        | 12            | V    |
| Drain current                       |                          | I <sub>D</sub>         | 30            | mA   |
| Gate 1/Gate 2 - source peak current |                          | ± I <sub>G1/G2SM</sub> | 10            | mA   |
| Total power dissipation             | T <sub>amb</sub> ≤ 60 °C | P <sub>tot</sub>       | 200           | mW   |
| Channel temperature                 |                          | T <sub>Ch</sub>        | 150           | °C   |
| Storage temperature range           |                          | T <sub>stg</sub>       | - 55 to + 150 | °C   |

## Maximum Thermal Resistance

| Parameter       | Test condition | Symbol      | Value | Unit |
|-----------------|----------------|-------------|-------|------|
| Channel ambient | 1)             | $R_{thChA}$ | 450   | K/W  |

1) on glass fibre printed board (40 x 25 x 1.5) mm<sup>3</sup> plated with 35 µm Cu

## Electrical DC Characteristics

$T_{amb} = 25\text{ °C}$ , unless otherwise specified

| Parameter                         | Test condition                                                                     | Part   | Symbol             | Min | Typ. | Max  | Unit |
|-----------------------------------|------------------------------------------------------------------------------------|--------|--------------------|-----|------|------|------|
| Drain - source breakdown voltage  | $I_D = 10\text{ }\mu\text{A}$ , $-V_{G1S} = -V_{G2S} = 4\text{ V}$                 |        | $V_{(BR)DS}$       | 12  |      |      | V    |
| Gate 1 - source breakdown voltage | $\pm I_{G1S} = 10\text{ mA}$ , $V_{G2S} = V_{DS} = 0$                              |        | $\pm V_{(BR)G1SS}$ | 7   |      | 14   | V    |
| Gate 2 - source breakdown voltage | $\pm I_{G2S} = 10\text{ mA}$ , $V_{G1S} = V_{DS} = 0$                              |        | $\pm V_{(BR)G2SS}$ | 7   |      | 14   | V    |
| Gate 1 - source leakage current   | $\pm V_{G1S} = 5\text{ V}$ , $V_{G2S} = V_{DS} = 0$                                |        | $\pm I_{G1SS}$     |     |      | 50   | nA   |
| Gate 2 - source leakage current   | $\pm V_{G2S} = 5\text{ V}$ , $V_{G1S} = V_{DS} = 0$                                |        | $\pm I_{G2SS}$     |     |      | 50   | nA   |
| Drain current                     | $V_{DS} = 15\text{ V}$ , $V_{G1S} = 0$ , $V_{G2S} = 4\text{ V}$                    | BF988  | $I_{DSS}$          | 4   |      | 18   | mA   |
|                                   |                                                                                    | BF988A | $I_{DSS}$          | 4   |      | 10.5 | mA   |
|                                   |                                                                                    | BF988B | $I_{DSS}$          | 9.5 |      | 18   | mA   |
| Gate 1 - source cut-off voltage   | $V_{DS} = 15\text{ V}$ , $V_{G2S} = 4\text{ V}$ ,<br>$I_D = 20\text{ }\mu\text{A}$ |        | $-V_{G1S(OFF)}$    |     |      | 2.5  | V    |
| Gate 2 - source cut-off voltage   | $V_{DS} = 15\text{ V}$ , $V_{G1S} = 0$ , $I_D = 20\text{ }\mu\text{A}$             |        | $-V_{G2S(OFF)}$    |     |      | 2.0  | V    |

## Electrical AC Characteristics

$T_{amb} = 25\text{ °C}$ , unless otherwise specified

$V_{DS} = 8\text{ V}$ ,  $I_D = 10\text{ mA}$ ,  $V_{G2S} = 4\text{ V}$ ,  $f = 1\text{ MHz}$

| Parameter                | Test condition                                                        | Symbol          | Min  | Typ. | Max | Unit |
|--------------------------|-----------------------------------------------------------------------|-----------------|------|------|-----|------|
| Forward transadmittance  |                                                                       | $ y_{21s} $     | 21   | 24   |     | mS   |
| Gate 1 input capacitance |                                                                       | $C_{issg1}$     |      | 2.1  | 2.5 | pF   |
| Gate 2 input capacitance | $V_{G1S} = 0$ , $V_{G2S} = 4\text{ V}$                                | $C_{issg2}$     |      | 1.2  |     | pF   |
| Feedback capacitance     |                                                                       | $C_{rss}$       |      | 25   |     | fF   |
| Output capacitance       |                                                                       | $C_{oss}$       |      | 1.05 |     | pF   |
| Power gain               | $G_S = 2\text{ mS}$ , $G_L = 0.5\text{ mS}$ ,<br>$f = 200\text{ MHz}$ | $G_{ps}$        |      | 28   |     | dB   |
|                          | $G_S = 3.3\text{ mS}$ , $G_L = 1\text{ mS}$ ,<br>$f = 800\text{ MHz}$ | $G_{ps}$        | 16.5 | 20   |     | dB   |
| AGC range                | $V_{G2S} = 4\text{ to } -2\text{ V}$ , $f = 800\text{ MHz}$           | $\Delta G_{ps}$ | 40   |      |     | dB   |
| Noise figure             | $G_S = 2\text{ mS}$ , $G_L = 0.5\text{ mS}$ ,<br>$f = 200\text{ MHz}$ | F               |      | 1    |     | dB   |
|                          | $G_S = 3.3\text{ mS}$ , $G_L = 1\text{ mS}$ ,<br>$f = 800\text{ MHz}$ | F               |      | 1.5  |     | dB   |

### Common Emitter S-Parameters

$V_{DS} = 8\text{ V}$ ,  $V_{G2S} = 4\text{ V}$ ,  $Z_0 = 50\ \Omega$ ,  $T_{amb} = 25\text{ }^\circ\text{C}$ , unless otherwise specified

| $I_D/\text{mA}$ | $f/\text{MHz}$ | S11        |       | S21        |       | S12        |       | S22        |       |
|-----------------|----------------|------------|-------|------------|-------|------------|-------|------------|-------|
|                 |                | LOG<br>MAG | ANG   | LOG<br>MAG | ANG   | LOG<br>MAG | ANG   | LOG<br>MAG | ANG   |
|                 |                |            | deg   |            | deg   |            | deg   |            | deg   |
| 5               | 100            | -0.02      | -7.8  | 6.01       | 168.4 | -56.27     | 83.0  | -0.02      | -3.6  |
|                 | 200            | -0.10      | -15.3 | 5.87       | 156.3 | -50.61     | 76.6  | -0.06      | -7.3  |
|                 | 300            | -0.31      | -22.8 | 5.69       | 144.2 | -47.70     | 70.9  | -0.13      | -10.6 |
|                 | 400            | -0.56      | -30.2 | 5.42       | 132.9 | -46.19     | 65.6  | -0.20      | -14.2 |
|                 | 500            | -0.87      | -37.3 | 5.17       | 121.5 | -45.46     | 60.6  | -0.28      | -17.5 |
|                 | 600            | -1.26      | -44.3 | 4.85       | 110.6 | -45.84     | 55.4  | -0.36      | 20.5  |
|                 | 700            | -1.59      | -50.9 | 4.54       | 100.4 | -47.31     | 58.6  | -0.43      | -23.8 |
|                 | 800            | -2.04      | -58.0 | 4.25       | 90.2  | -48.19     | 63.3  | -0.49      | -26.8 |
|                 | 900            | -2.42      | -64.4 | 4.02       | 80.6  | -50.37     | 81.5  | -0.52      | -30.2 |
|                 | 1000           | -2.88      | -71.4 | 3.78       | 70.8  | -49.48     | 115.6 | -0.54      | -33.4 |
|                 | 1100           | -3.39      | -78.3 | 3.42       | 60.5  | 47.92      | 131.7 | -0.66      | -36.8 |
|                 | 1200           | -3.94      | -85.2 | 3.21       | 51.6  | -44.65     | 153.0 | -0.66      | -40.1 |
|                 | 1300           | -4.46      | -91.8 | 3.01       | 42.0  | -41.76     | 159.8 | -0.66      | -43.9 |
| 10              | 100            | -0.02      | -8.3  | 7.84       | 168.5 | -55.67     | 83.0  | -0.04      | -3.7  |
|                 | 200            | -0.11      | -16.1 | 7.70       | 156.6 | -50.01     | 76.4  | -0.09      | -7.4  |
|                 | 300            | -0.35      | -24.0 | 7.49       | 144.8 | -47.20     | 70.3  | -0.16      | -10.8 |
|                 | 400            | -0.62      | -31.6 | 7.21       | 133.6 | -45.60     | 65.1  | -0.23      | -14.3 |
|                 | 500            | -0.97      | -39.2 | 6.93       | 122.5 | -44.88     | 60.0  | -0.31      | 17.9  |
|                 | 600            | -1.39      | -46.4 | 6.59       | 111.9 | -45.25     | 54.5  | -0.42      | -20.9 |
|                 | 700            | -1.76      | -53.2 | 6.27       | 101.9 | -46.51     | 57.4  | -0.48      | -24.1 |
|                 | 800            | -2.25      | -60.3 | 5.97       | 92.1  | -47.19     | 61.4  | -0.55      | -27.3 |
|                 | 900            | -2.67      | -67.1 | 5.71       | 82.8  | -49.28     | 76.0  | -0.58      | -30.6 |
|                 | 1000           | -3.16      | -74.1 | 5.46       | 73.3  | -48.99     | 107.1 | -0.60      | -33.8 |
|                 | 1100           | -3.72      | -81.1 | 5.07       | 63.3  | -48.03     | 123.3 | -0.73      | -37.2 |
|                 | 1200           | -4.30      | -88.0 | 4.85       | 54.6  | -45.15     | 147.6 | -0.73      | -40.6 |
|                 | 1300           | -4.87      | -94.4 | 4.63       | 45.4  | -42.46     | 157.6 | -0.73      | -44.3 |
| 15              | 100            | -0.01      | -8.4  | 8.62       | 168.6 | -55.26     | 83.0  | -0.07      | -3.7  |
|                 | 200            | -0.13      | -16.4 | 8.46       | 156.8 | -49.61     | 76.3  | -0.12      | -7.5  |
|                 | 3000           | -0.37      | -24.5 | 8.26       | 145.2 | -46.70     | 70.3  | -0.20      | -11.0 |
|                 | 400            | -0.66      | -32.3 | 7.96       | 134.0 | -45.10     | 64.9  | -0.27      | -14.4 |
|                 | 500            | -1.02      | -39.8 | 7.66       | 122.9 | -44.38     | 59.7  | -0.36      | -18.0 |
|                 | 600            | -1.47      | -47.0 | 7.33       | 112.3 | -44.65     | 54.3  | -0.47      | -20.9 |
|                 | 700            | -1.85      | -54.1 | 6.98       | 102.6 | -45.72     | 57.0  | -0.53      | -24.2 |
|                 | 800            | -2.36      | -61.3 | 6.68       | 92.8  | -46.29     | 60.0  | -0.61      | -27.4 |
|                 | 900            | -2.80      | -67.9 | 6.42       | 83.7  | -48.18     | 71.9  | -0.64      | -30.6 |
|                 | 1000           | -3.30      | -75.0 | 6.15       | 74.3  | -48.49     | 98.7  | -0.66      | -33.9 |
|                 | 1100           | 3.89       | -82.0 | 5.75       | 64.6  | -47.93     | 114.8 | -0.77      | -37.3 |
|                 | 1200           | -4.49      | -88.8 | 5.52       | 56.0  | -45.75     | 141.2 | -0.79      | -40.8 |
|                 | 1300           | -5.06      | -95.2 | 5.30       | 46.9  | -43.05     | 153.4 | -0.79      | -44.5 |

# Typical Characteristics ( $T_{amb} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

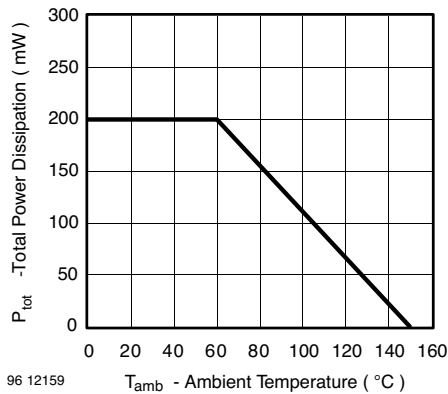


Figure 1. Total Power Dissipation vs. Ambient Temperature

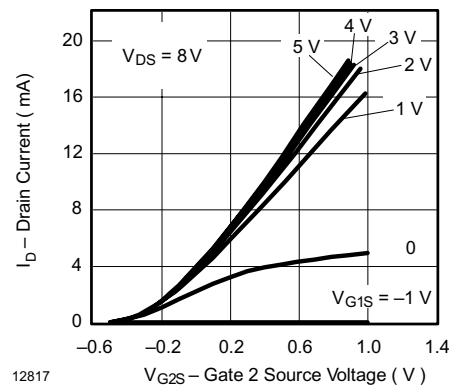


Figure 4. Drain Current vs. Gate 2 Source Voltage

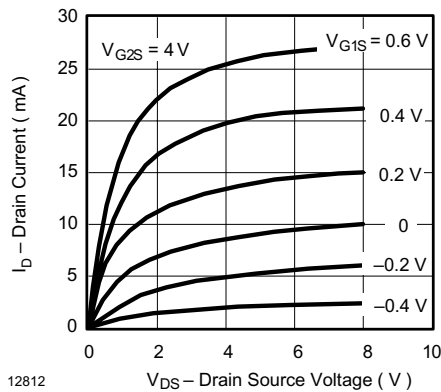


Figure 2. Drain Current vs. Drain Source Voltage

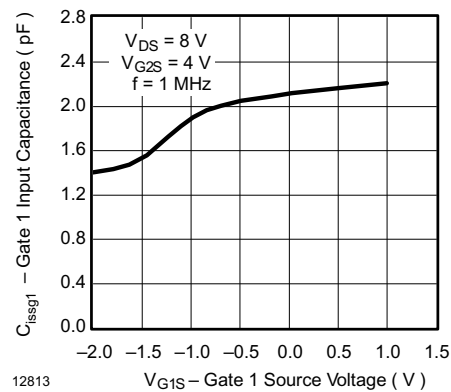


Figure 5. Gate 1 Input Capacitance vs. Gate 1 Source Voltage

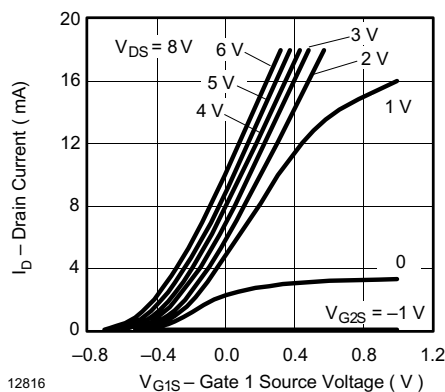


Figure 3. Drain Current vs. Gate 1 Source Voltage

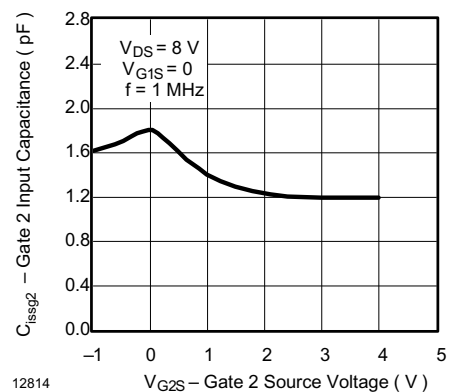


Figure 6. Gate 2 Input Capacitance vs. Gate 2 Source Voltage

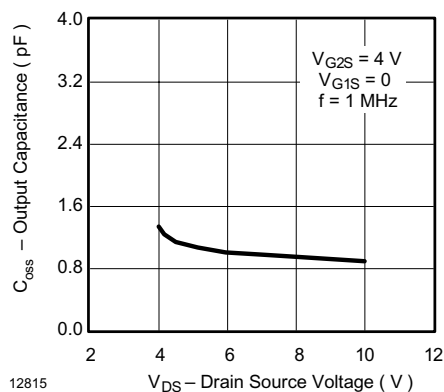


Figure 7. Output Capacitance vs. Drain Source Voltage

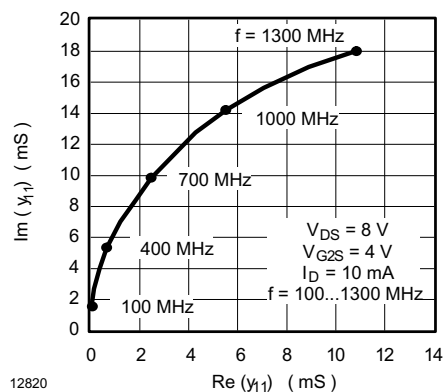


Figure 10. Short Circuit Input Admittance

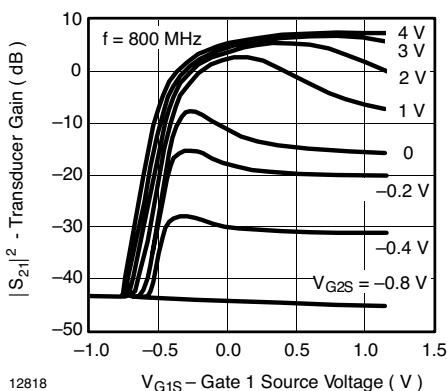


Figure 8. Transducer Gain vs. Gate 1 Source Voltage

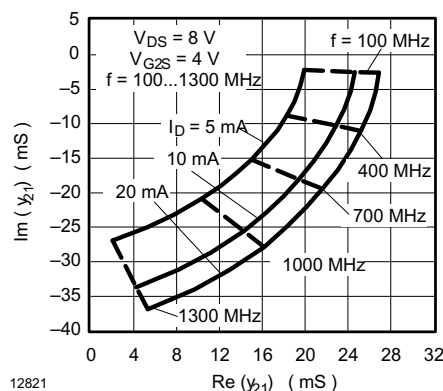


Figure 11. Short Circuit Forward Transfer Admittance

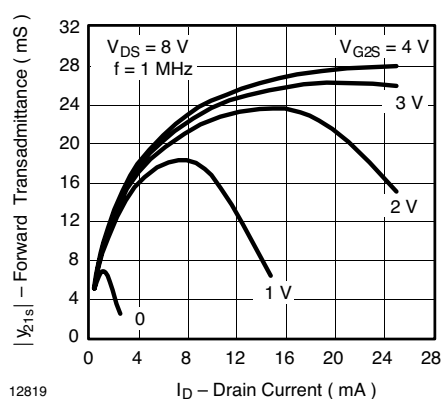


Figure 9. Forward Transadmittance vs. Drain Current

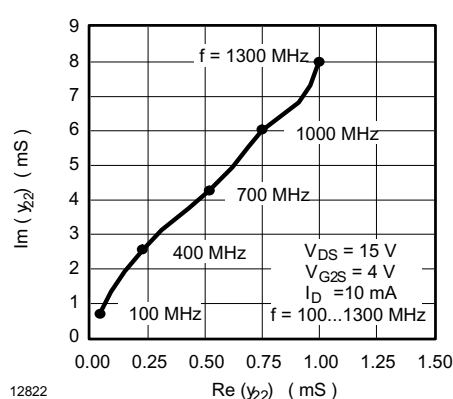
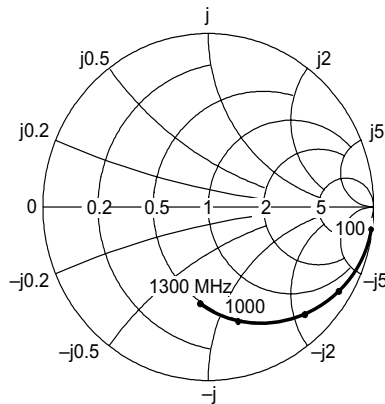


Figure 12. Short Circuit Output Admittance

$V_{DS} = 8\text{ V}$ ,  $I_D = 10\text{ mA}$ ,  $V_{G2S} = 4\text{ V}$ ,  $Z_0 = 50\ \Omega$

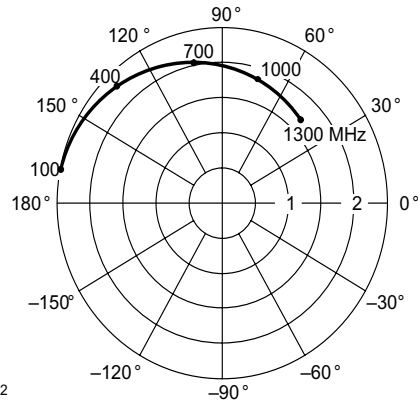
$S_{11}$



12960

Figure 13. Input Reflection Coefficient

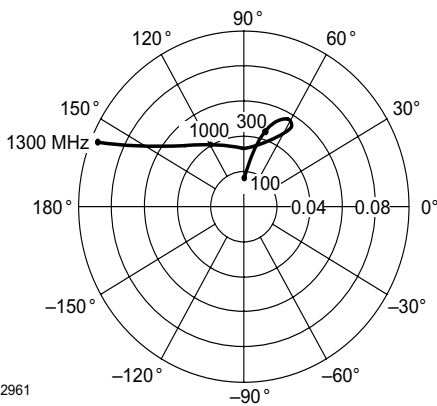
$S_{21}$



12962

Figure 15. Forward Transmission Coefficient

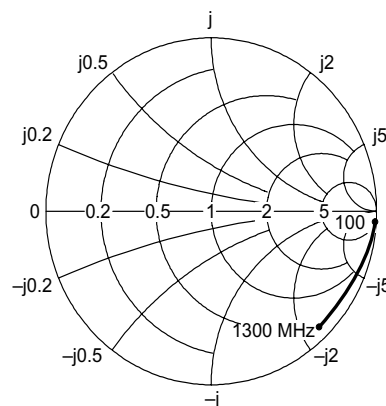
$S_{12}$



12961

Figure 14. Reverse Transmission Coefficient

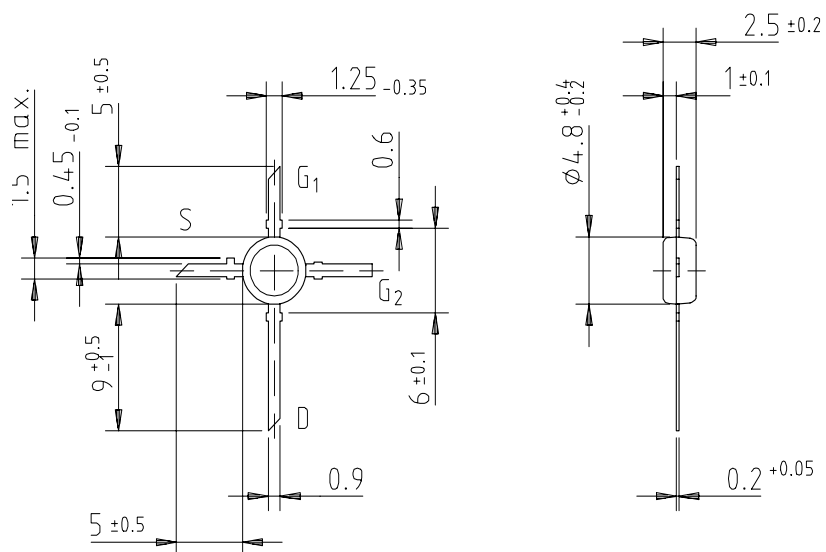
$S_{22}$



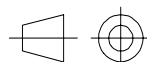
12963

Figure 16. Output Reflection Coefficient

## Package Dimensions in mm



96 12242



technical drawings  
according to DIN  
specifications

## **Ozone Depleting Substances Policy Statement**

It is the policy of Vishay Semiconductor GmbH to

1. Meet all present and future national and international statutory requirements.
2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

Vishay Semiconductor GmbH has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively
2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA
3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

Vishay Semiconductor GmbH can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.

We reserve the right to make changes to improve technical design  
and may do so without further notice.

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Vishay Semiconductor GmbH, P.O.B. 3535, D-74025 Heilbronn, Germany





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