DATA SHEET

BF904WR
N-channel dual-gate MOS-FET

Product specification
File under Discrete Semiconductors, SC07

1995 Apr 25

Philips Semiconductors

PHILIPS

N-channel dual-gate MOS-FET — BF904WR

FEATURES

- Specially designed for use at 5 V supply voltage
- 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 communications equipment.

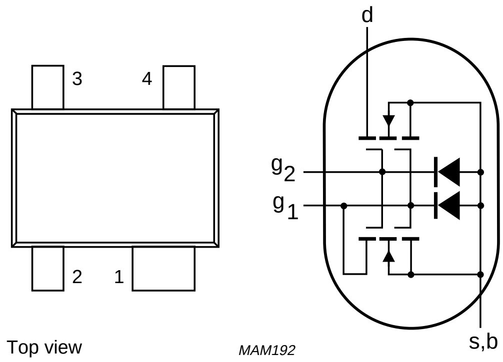
DESCRIPTION

Enhancement type field-effect transistor in a plastic microminiature SOT343R 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



Marking code: MC.

Fig.1 Simplified outline (SOT343R) and symbol.

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		–	–	280	mW
T_j	operating junction temperature		–	–	150	°C
$\lvert y_{fs} \rvert$	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

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	up to T_{amb} = 50 °C; see Fig.2; note 1	–	280	mW
T_{stg}	storage temperature		–65	+150	°C
T_j	operating junction temperature		–	+150	°C

Note

1. Device mounted on a printed-circuit board.

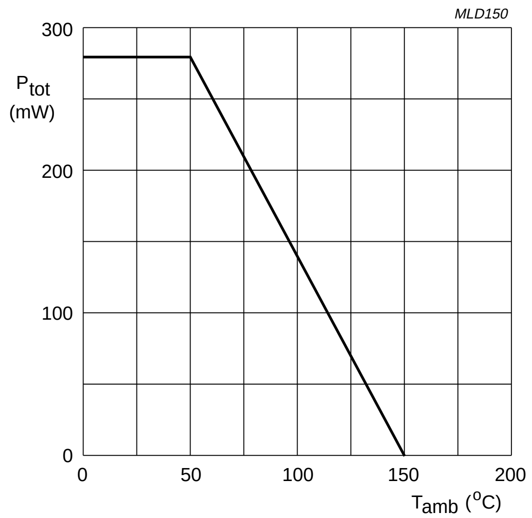


Fig.2 Power derating curve.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient	note 1	350	K/W
$R_{th\ j\text{-}s}$	thermal resistance from junction to soldering point	T_s = 91 °C; note 2	210	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	$V_{G2\text{-}S}$ = 4V; 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	8	13	mA
$I_{G1\text{-}SS}$	gate 1 cut-off current	$V_{G2\text{-}S} = V_{DS} = 0$; $V_{G1\text{-}S}$ = 5 V	–	50	nA
$I_{G2\text{-}SS}$	gate 2 cut-off current	$V_{G1\text{-}S} = V_{DS} = 0$; $V_{G2\text{-}S}$ = 5 V	–	50	nA

Note

1. R_G connects gate 1 to V_{GG} = 5 V.

DYNAMIC CHARACTERISTICS

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

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

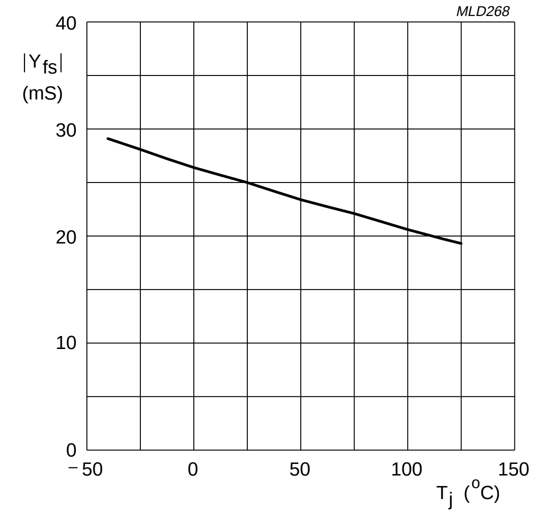
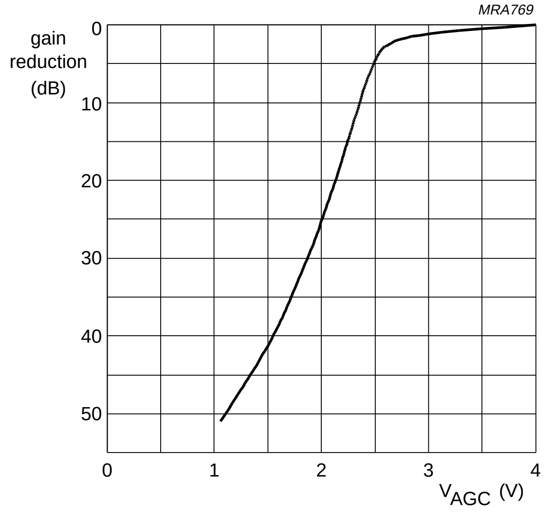
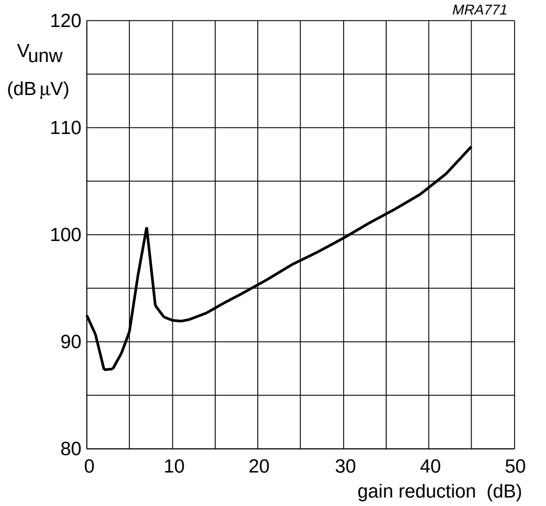


Fig.3 Forward transfer admittance as a function of junction temperature; typical values.



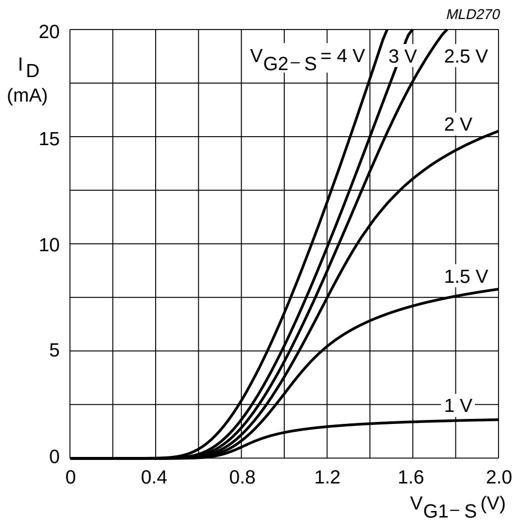
f = 50 MHz.
T_j = 25 °C.

Fig.4 Typical gain reduction as a function of AGC voltage.



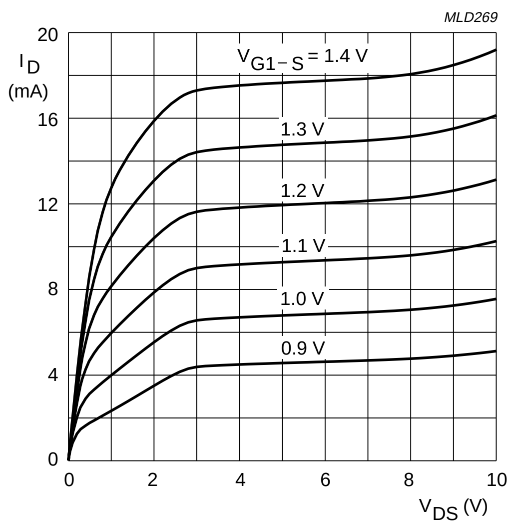
V_{GG} = 5 V; f_w = 50 MHz.
f_{unw} = 60 MHz; T_{amb} = 25 °C; R_{G1} = 120 kΩ.

Fig.5 Unwanted voltage for 1% cross-modulation as a function of gain reduction; typical values; see Fig.19.



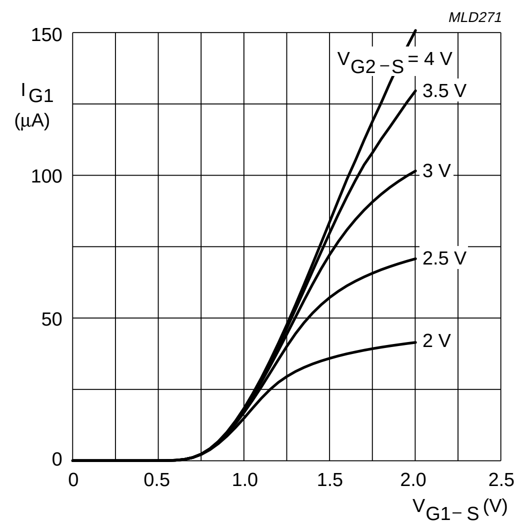
V_{DS} = 5 V.
T_j = 25 °C.

Fig.6 Transfer characteristics; typical values.



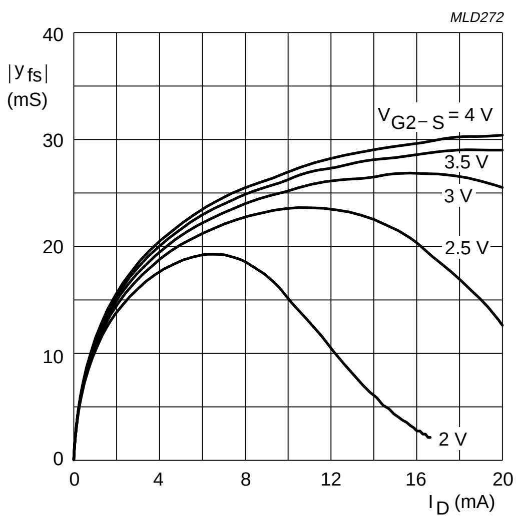
$V_{G2\text{-}S}$ = 4 V.
T_j = 25 °C.

Fig.7 Output characteristics; typical values.



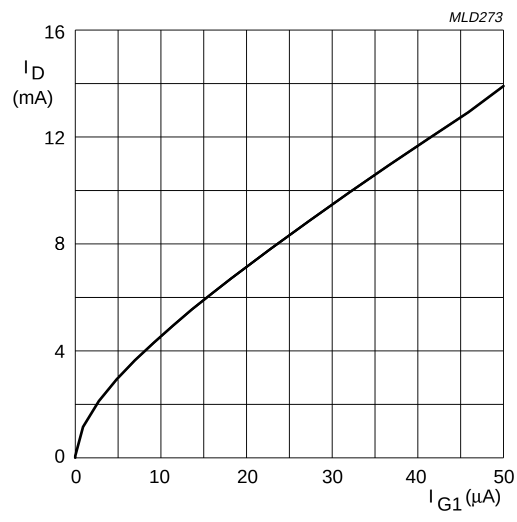
V_{DS} = 5 V.
T_j = 25 °C.

Fig.8 Gate 1 current as a function of gate 1 voltage; typical values.



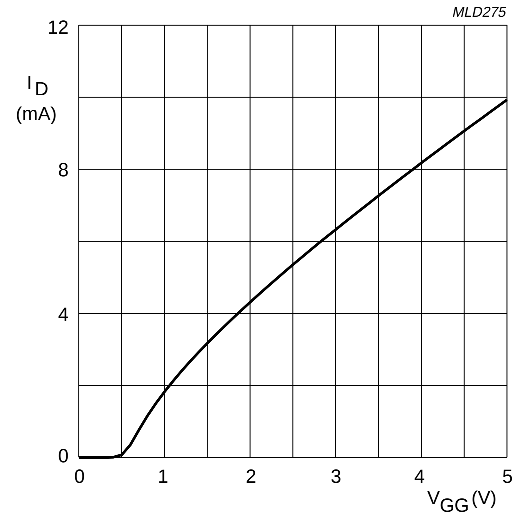
V_{DS} = 5 V.
T_j = 25 °C.

Fig.9 Forward transfer admittance as a function of drain current; typical values.



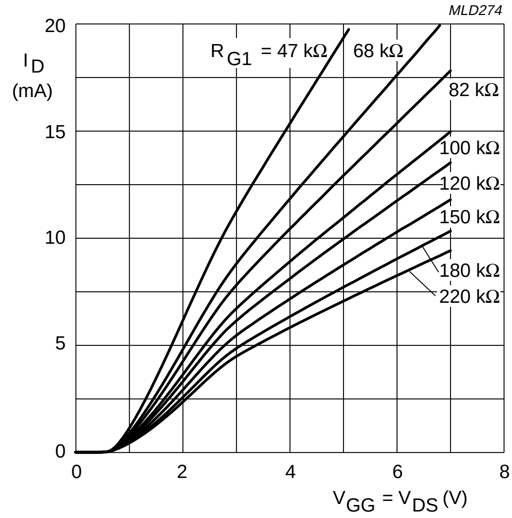
V_{DS} = 5 V; $V_{G2\text{-}S}$ = 4 V.
T_j = 25 °C.

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



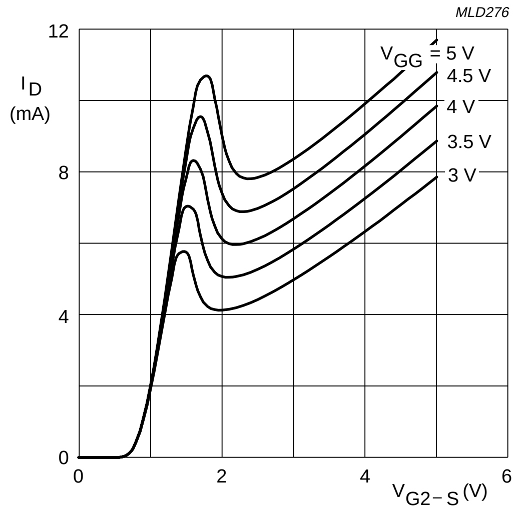
V_{DS} = 5 V; $V_{G2\text{-}S}$ = 4 V.
R_{G1} = 120 kΩ (connected to V_{GG}); T_j = 25 °C.

Fig.11 Drain current as a function of gate 1 supply voltage (= V_{GG}); typical values; see Fig.19.



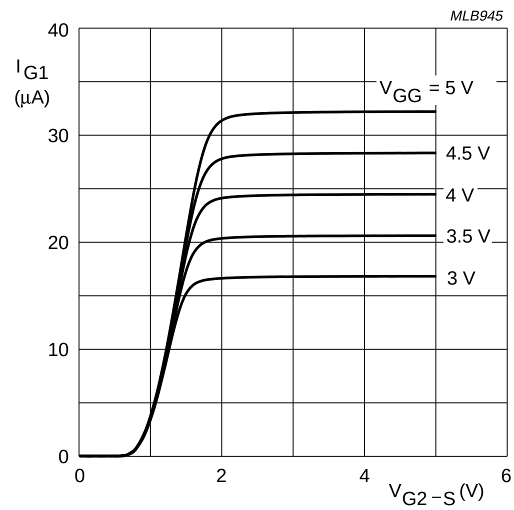
$V_{G2\text{-}S}$ = 4 V.
R_{G1} connected to V_{GG}; T_j = 25 °C.

Fig.12 Drain current as a function of gate 1 (= V_{GG}) and drain supply voltage; typical values; see Fig.19.



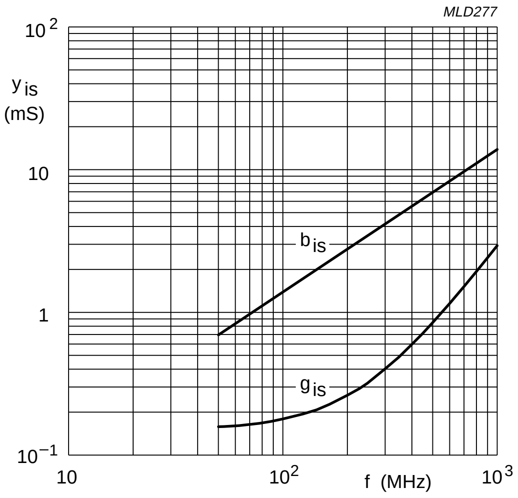
V_{DS} = 5 V; T_j = 25 °C.
R_G = 120 kΩ (connected to V_{GG}).

Fig.13 Drain current as a function of gate 2 voltage; typical values; see Fig.19.



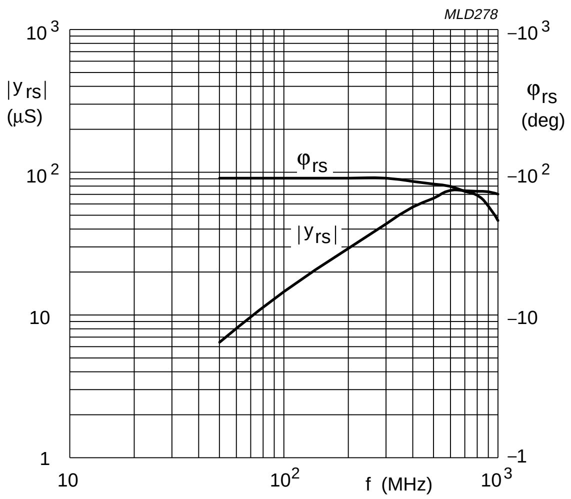
V_{DS} = 5 V; T_j = 25 °C.
R_G = 120 kΩ (connected to V_{GG}).

Fig.14 Gate 1 current as a function of gate 2 voltage; typical values; see Fig.19.



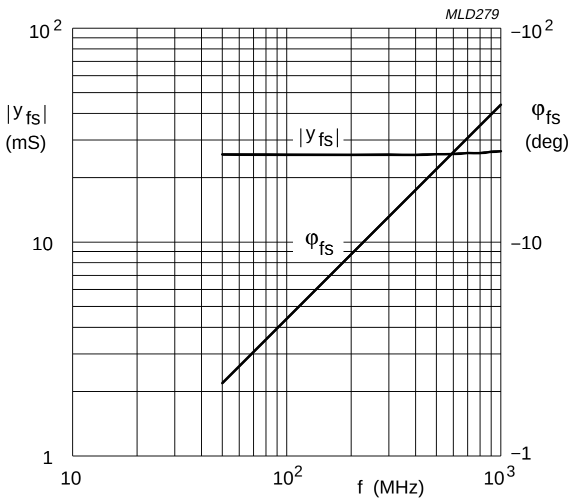
V_{DS} = 5 V; V_{G2} = 4 V.
I_D = 10 mA; T_{amb} = 25 °C.

Fig.15 Input admittance as a function of frequency; typical values.



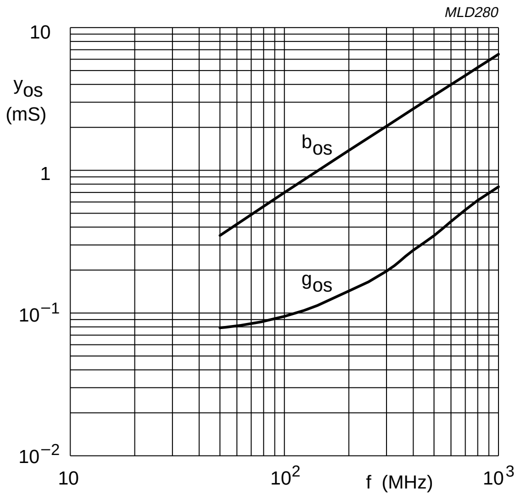
V_{DS} = 5 V; V_{G2} = 4 V.
I_D =10 mA; T_{amb} = 25 °C.

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



V_{DS} = 5 V; V_{G2} = 4 V.
I_D = 10 mA; T_{amb} = 25 °C.

Fig.17 Forward transfer admittance and phase as a function of frequency; typical values.



V_{DS} = 5 V; V_{G2} = 4 V.
I_D = 10 mA; T_{amb} = 25 °C.

Fig.18 Output admittance as a function of frequency; typical values.

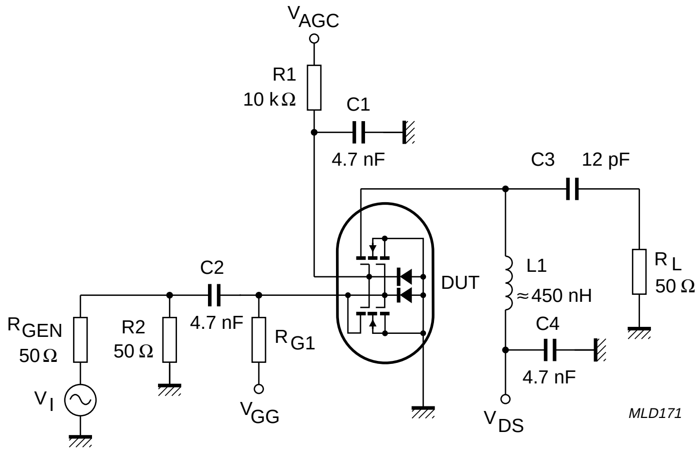


Fig.19 Cross-modulation test set-up.

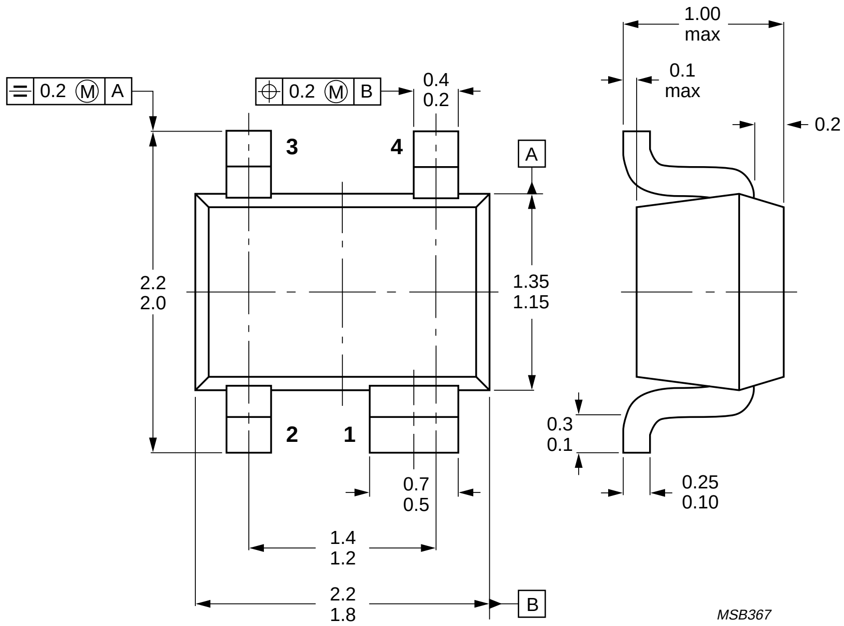
Table 1 Scattering parameters: V_{DS} =5 V; $V_{G2\text{-}S}$ = 4 V; I_D = 10 mA

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 V; $V_{G2\text{-}S}$ = 4 V; I_D = 10 mA

f (MHz)	F_{min} (dB)	Γ_{opt}		r_n
		(ratio)	(deg)	
800	2.00	.686	49.6	50.40

PACKAGE OUTLINE



Dimensions in mm.

Fig.20 SOT343R.

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.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.