DATA SHEET

BF904A; BF904AR; BF904AWR
N-channel dual gate MOS-FETs

Product specification
Supersedes data of 1999 Feb 01

1999 May 14

Philips Semiconductors

PHILIPS

N-channel dual gate MOS-FETs BF904A; BF904AR; BF904AWR

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

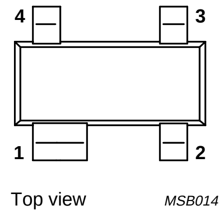
- VHF and UHF applications with 3 to 7 V supply voltage such as television tuners and professional communications equipment.

DESCRIPTION

Enhancement type field-effect transistors. The transistors consist of an amplifier MOS-FET with source and substrate interconnected and an internal bias circuit to ensure good cross-modulation performance during AGC.
The BF904A, BF904AR and BF904AWR are encapsulated in the SOT143B, SOT143R and SOT343R plastic packages respectively.

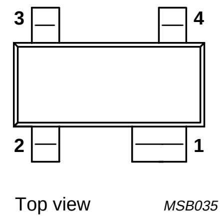
PINNING

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



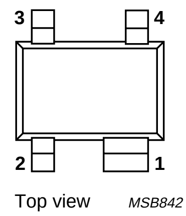
BF904A marking code: M41.

Fig.1 Simplified outline (SOT143B).



BF904AR marking code: M42.

Fig.2 Simplified outline (SOT143R).



BF904AWR marking code: MH.

Fig.3 Simplified outline (SOT343R).

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	$T_s \leq 110$ °C	–	–	200	mW
$\lvert y_{fs} \rvert$	forward transfer admittance		22	25	30	mS
C_{ig1-ss}	input capacitance at gate 1		–	2.2	2.6	pF
C_{rss}	reverse transfer capacitance	f = 1 MHz	–	25	35	fF
F	noise figure	f = 800 MHz	–	2	–	dB
T_j	operating junction temperature		–	–	150	°C

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		–	30	mA
I_{G1}	gate 1 current		–	±10	mA
I_{G2}	gate 2 current		–	±10	mA
P_{tot}	total power dissipation	$T_s \leq 110$ °C; note 1; see Fig.4	–	200	mW
T_{stg}	storage temperature		–65	+150	°C
T_j	operating junction temperature		–	150	°C

Note

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

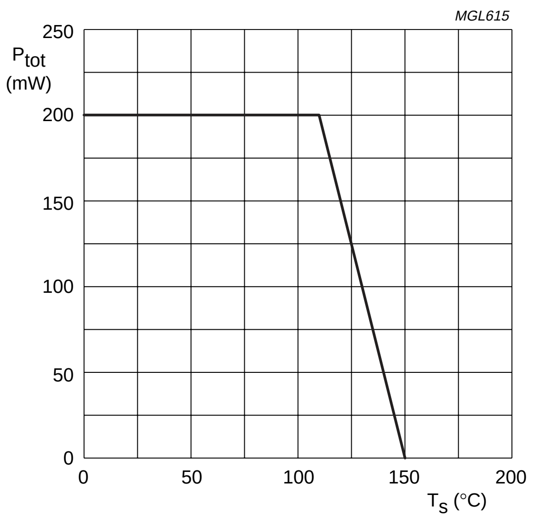


Fig.4 Power derating curve.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}s}$	thermal resistance from junction to soldering point	note 1	200	K/W

Note

1. 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	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_{G1} connects gate 1 to $V_{GG} = 5$ V; see Fig.21.

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	1.4	1.7	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

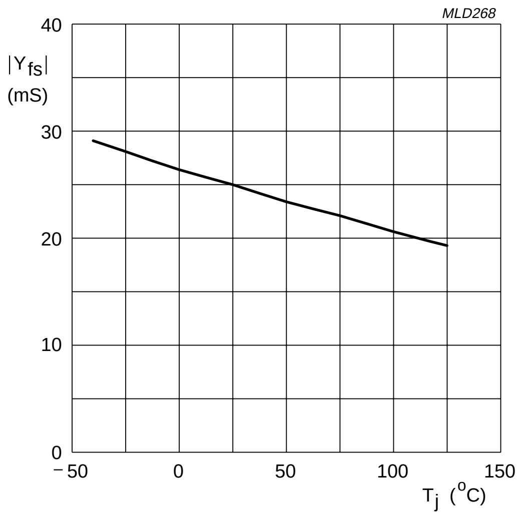
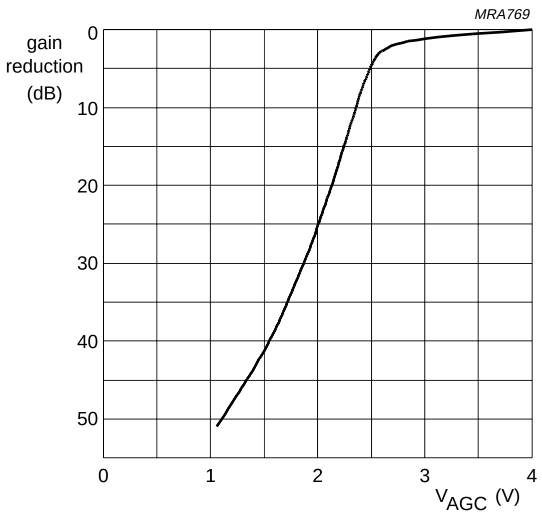
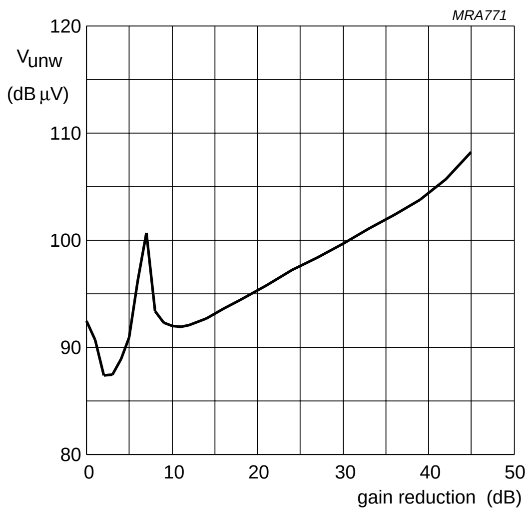


Fig.5 Transfer admittance as a function of the junction temperature; typical values.



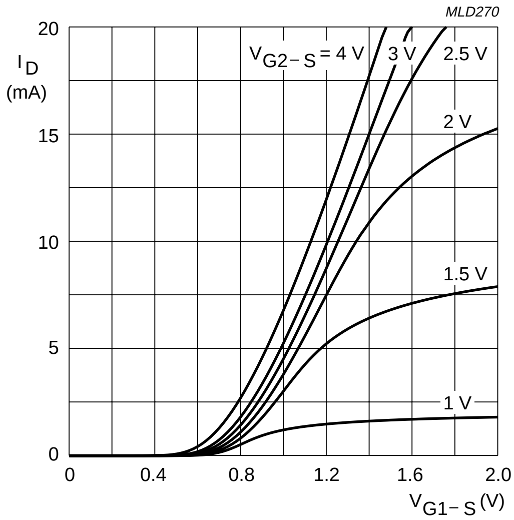
f = 50 MHz.

Fig.6 Typical gain reduction as a function of the AGC voltage; see Fig.21.



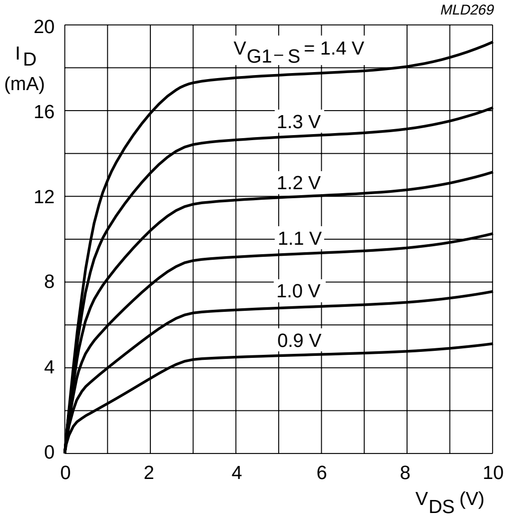
V_{DS} = 5 V; V_{GG} = 5 V; f_w = 50 MHz.
f_{unw} = 60 MHz; T_{amb} = 25 °C; R_{G1} = 120 kΩ.

Fig.7 Unwanted voltage for 1% cross-modulation as a function of gain reduction; typical values; see Fig.21.



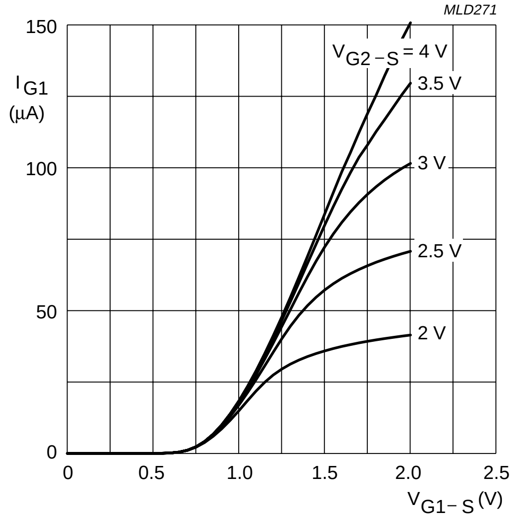
V_{DS} = 5 V.
T_j = 25 °C.

Fig.8 Transfer characteristics; typical values.



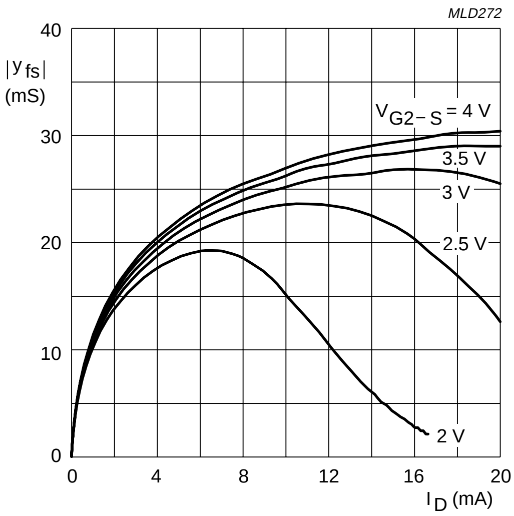
V_{G2-S} = 4 V.
T_j = 25 °C.

Fig.9 Output characteristics; typical values.



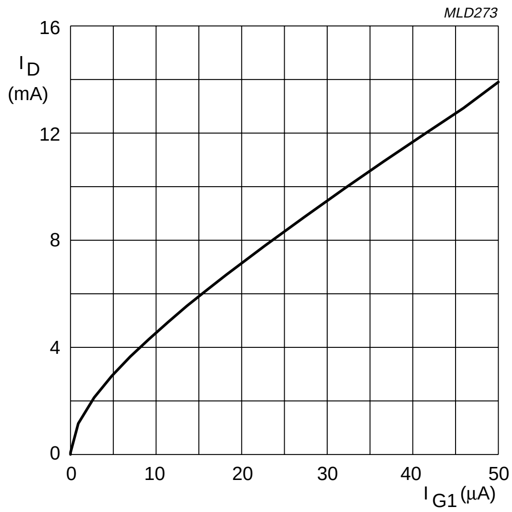
V_{DS} = 5 V.
T_j = 25 °C.

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



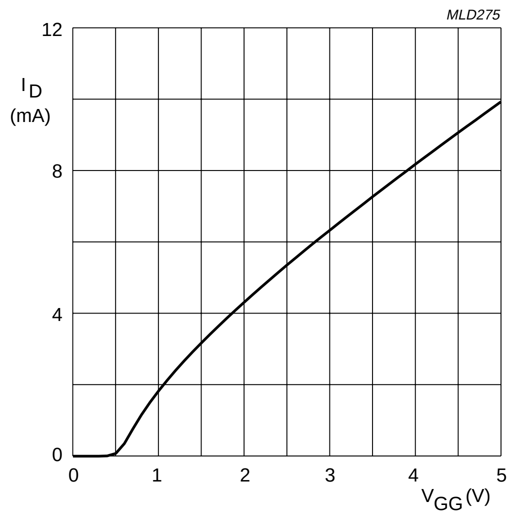
V_{DS} = 5 V.
T_j = 25 °C.

Fig.11 Forward transfer admittance as a function of drain current; typical values.



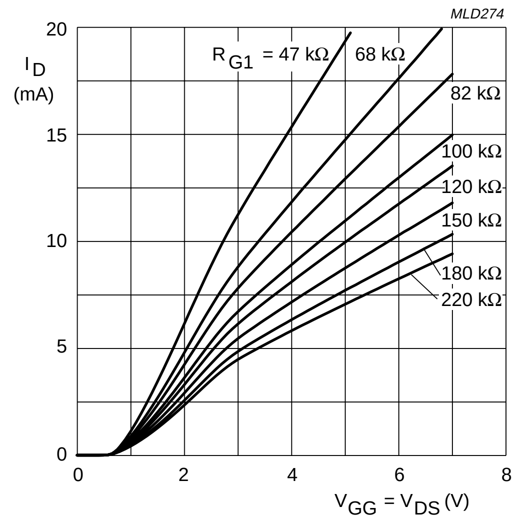
V_{DS} = 5 V.
V_{G2-S} = 4 V.
T_j = 25 °C.

Fig.12 Drain current as a function of gate 1 current; typical values.



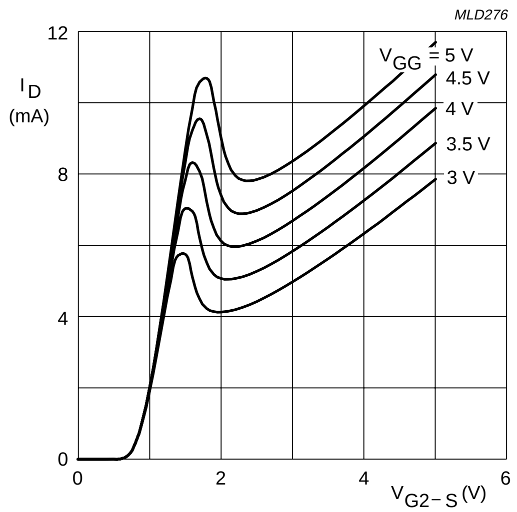
V_{DS} = 5 V; $V_{G2\text{-}S}$ = 4 V; T_j = 25 °C.
R_{G1} = 120 kΩ (connected to V_{GG}); see Fig.21.

Fig.13 Drain current as a function of gate 1 supply voltage (= V_{GG}); typical values.



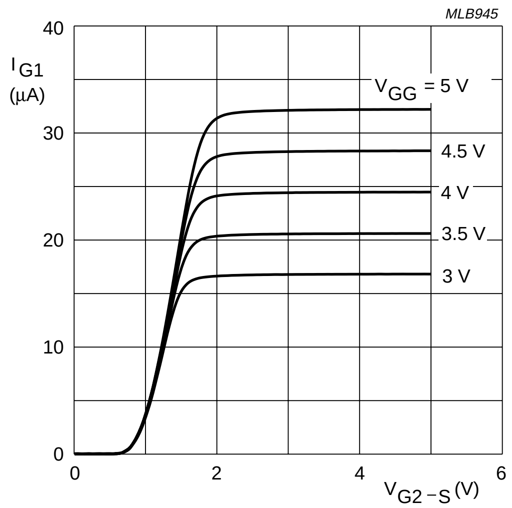
$V_{G2\text{-}S}$ = 4 V; T_j = 25 °C.
R_{G1} connected to V_{GG}; see Fig.21.

Fig.14 Drain current as a function of gate 1 (= V_{GG}) and drain supply voltage; typical values.



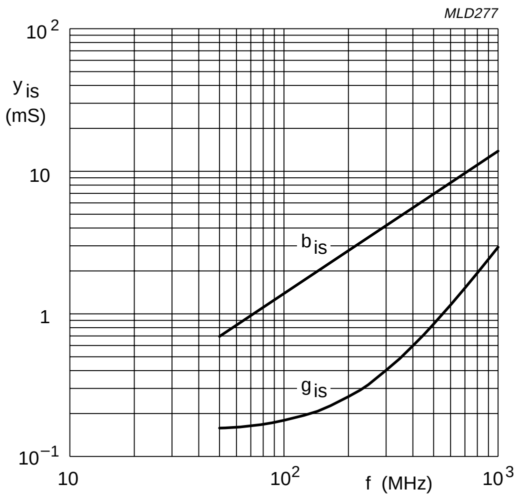
V_{DS} = 5 V; T_j = 25 °C.
R_{G1} = 120 kΩ (connected to V_{GG}); see Fig.21.

Fig.15 Drain current as a function of gate 2 voltage; typical values.



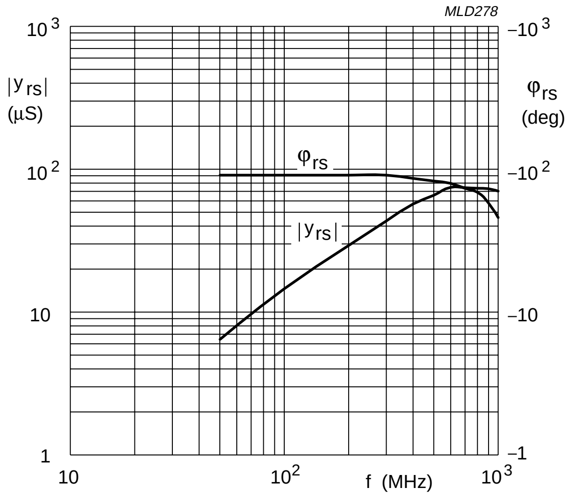
V_{DS} = 5 V; T_j = 25 °C.
R_{G1} = 120 kΩ (connected to V_{GG}); see Fig.21.

Fig.16 Gate 1 current as a function of gate 2 voltage; typical values.



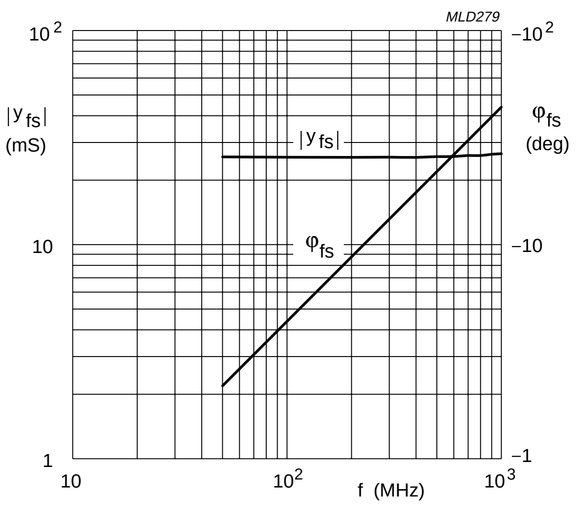
V_{DS} = 5 V; V_{G2} = 4 V.
I_D = 10 mA; T_{amb} = 25 °C.

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



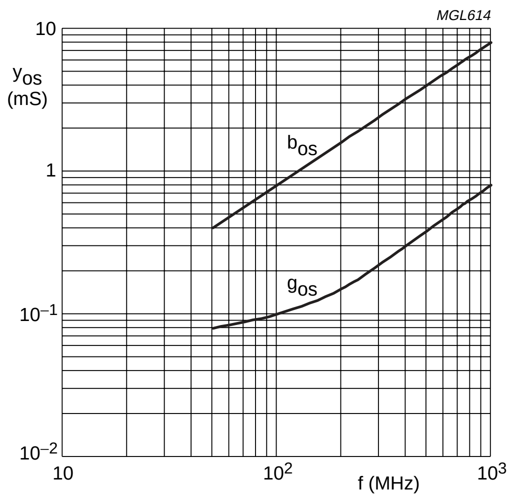
V_{DS} = 5 V; V_{G2} = 4 V.
I_D = 10 mA; T_{amb} = 25 °C.

Fig.18 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.19 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.20 Output admittance as a function of frequency; typical values.

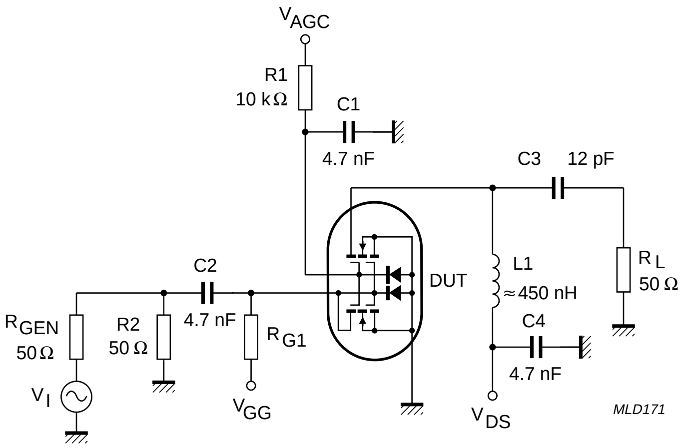


Fig.21 Cross-modulation test set-up.

Table 1 Scattering parameters: V_{DS} = 5 V; V_{G2-S} = 4 V; I_D = 10 mA; T_{amb} = 25 °C

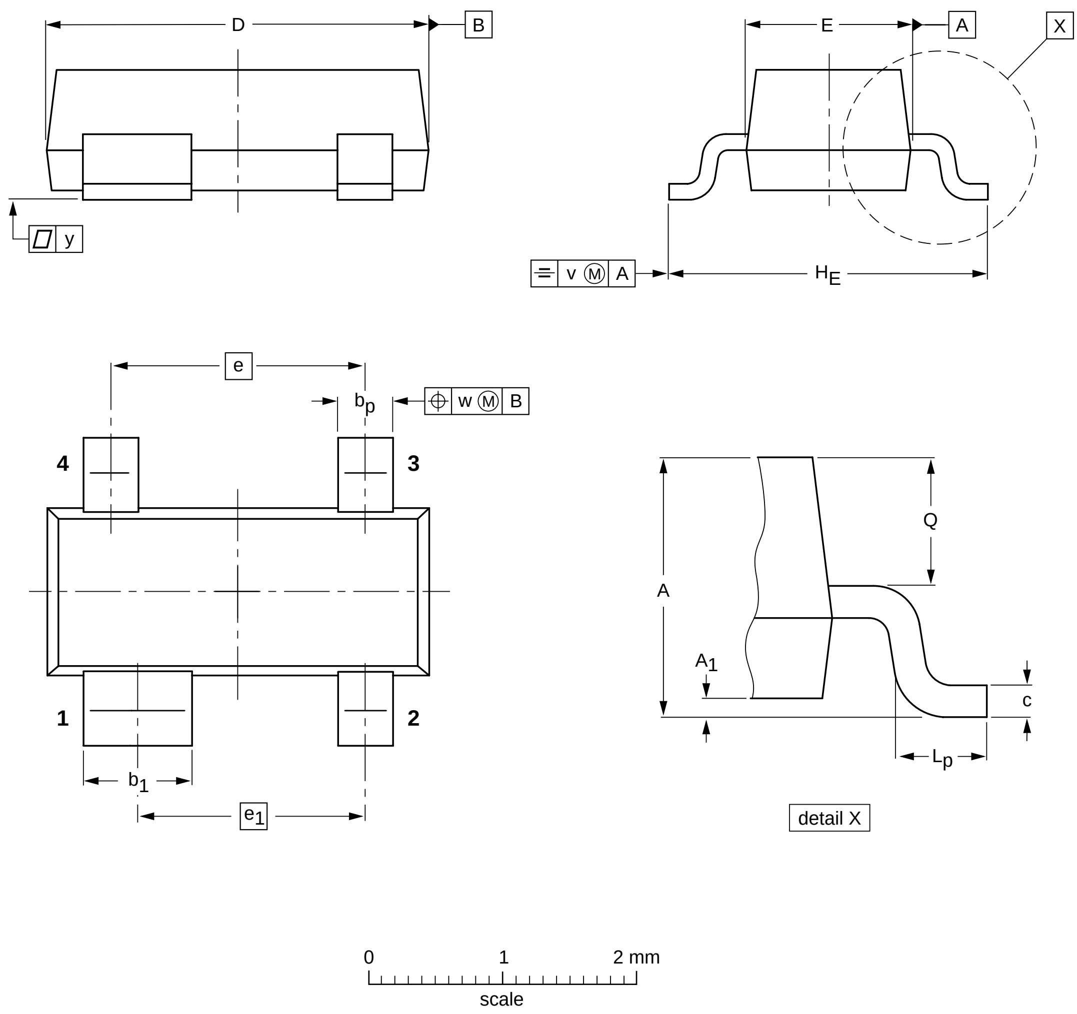
f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	MAGNITUDE (ratio)	**ANGLE (deg)**	**MAGNITUDE (ratio)**	**ANGLE (deg)**	**MAGNITUDE (ratio)**	**ANGLE (deg)**	**MAGNITUDE (ratio)**	**ANGLE (deg)**
40	0.989	–3.2	2.52	175.9	0.001	87.9	0.989	–1.7
100	0.987	–7.9	2.52	169.4	0.001	86.1	0.988	–4.3
200	0.976	–15.7	2.47	159.2	0.003	81.4	0.984	–8.6
300	0.972	–23.3	2.43	150.5	0.004	80.5	0.985	–12.7
400	0.947	–30.6	2.36	139.6	0.005	76.9	0.975	–16.9
500	0.925	–37.6	2.26	130.3	0.005	75.6	0.968	–20.8
600	0.905	–44.4	2.19	121.1	0.005	75.5	0.961	–24.7
700	0.883	–50.9	2.10	112.3	0.006	78.0	0.954	–28.4
800	0.861	–57.0	2.01	103.6	0.006	85.3	0.946	–32.0
900	0.841	–63.0	1.93	95.5	0.006	90.7	0.934	–35.6
1000	0.822	–68.4	1.85	87.8	0.006	102.6	0.931	–39.3
1200	0.787	–78.9	1.71	72.3	0.007	127.1	0.923	–46.7
1400	0.752	–88.1	1.59	57.3	0.011	143.7	0.926	–54.2
1600	0.723	–97.3	1.47	40.1	0.019	150.0	0.935	–62.2
1800	0.685	–106.3	1.36	25.0	0.021	149.4	0.931	–69.3
2000	0.665	–114.0	1.31	7.7	0.026	151.5	0.930	–77.7
2200	0.659	–119.8	1.30	–14.0	0.035	158.2	0.944	–89.1
2400	0.670	–124.2	1.26	–42.2	0.050	163.4	0.941	–103.5
2600	0.700	–129.3	1.10	–78.2	0.076	162.2	0.849	–119.7
2800	0.729	–138.7	0.82	–120.8	0.106	150.5	0.642	–130.9
3000	0.726	–150.1	0.52	–162.8	0.128	137.4	0.480	–130.6

Table 2 Noise data: V_{DS} = 5 V; V_{G2-S} = 4 V; I_D = 10 mA; T_{amb} = 25 °C

f (MHz)	F_{min} (dB)	Γ_{opt}		R_n (Ω)
		(ratio)	**(deg)**	
800	2.0	0.686	49.6	50.4

PACKAGE OUTLINES

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

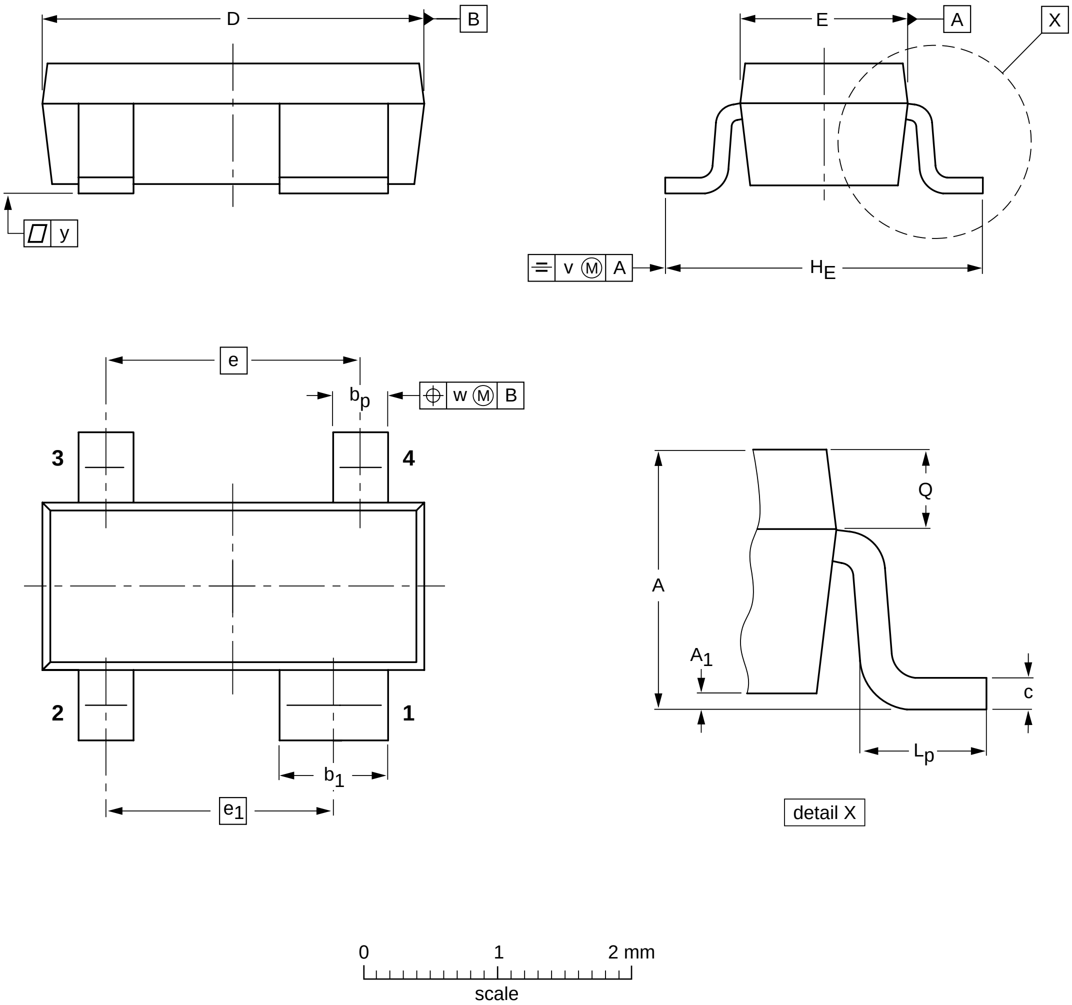


DIMENSIONS (mm are the original dimensions)

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 0.9	0.1	0.48 0.38	0.88 0.78	0.15 0.09	3.0 2.8	1.4 1.2	1.9	1.7	2.5 2.1	0.45 0.15	0.55 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**

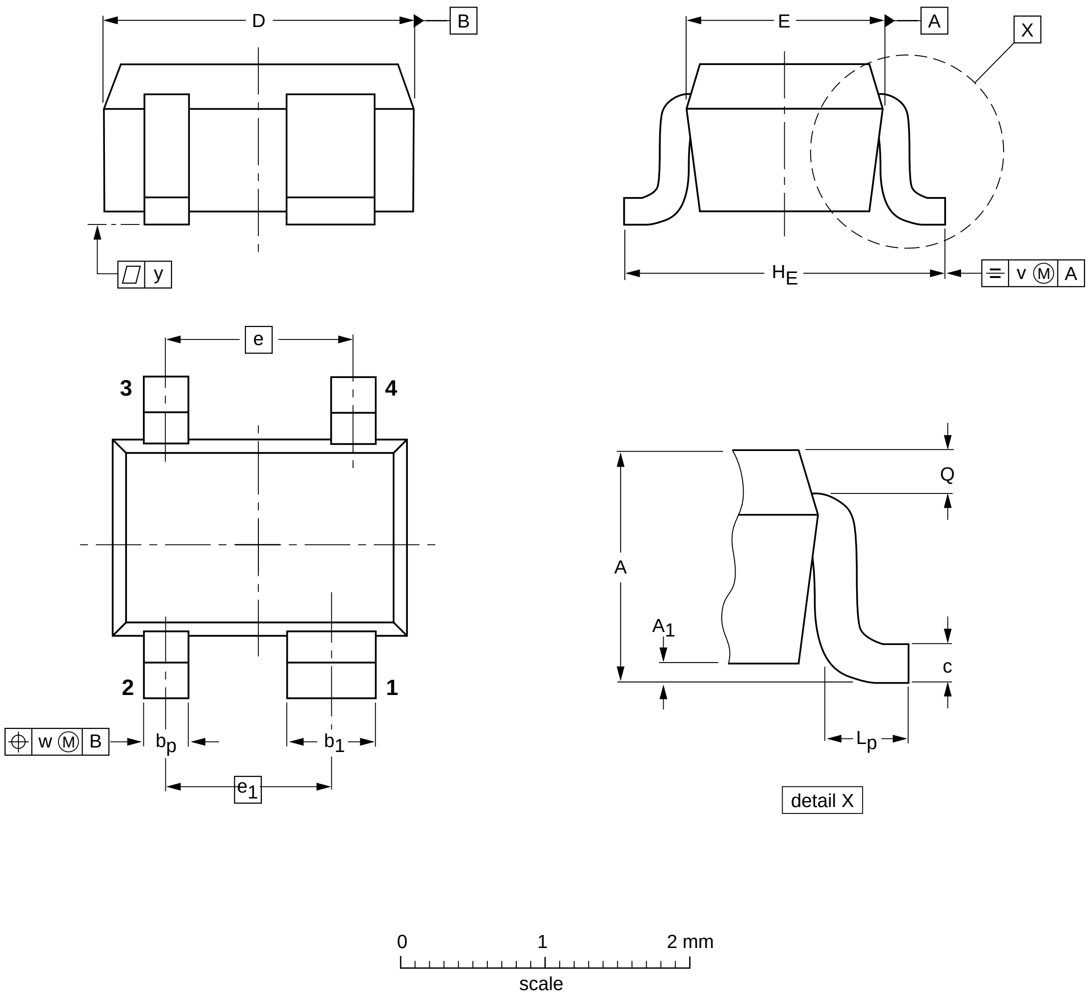


DIMENSIONS (mm are the original dimensions)

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 0.9	0.1	0.48 0.38	0.88 0.78	0.15 0.09	3.0 2.8	1.4 1.2	1.9	1.7	2.5 2.1	0.55 0.25	0.45 0.25	0.2	0.1	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT143R						97-03-10

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 0.8	0.1	0.4 0.3	0.7 0.5	0.25 0.10	2.2 1.8	1.35 1.15	1.3	1.15	2.2 2.0	0.45 0.15	0.23 0.13	0.2	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT343R						97-05-21

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.

NOTES

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