BF904; BF904R
N-channel dual gate MOS-FETs

Product data sheet

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NXP Semiconductors

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

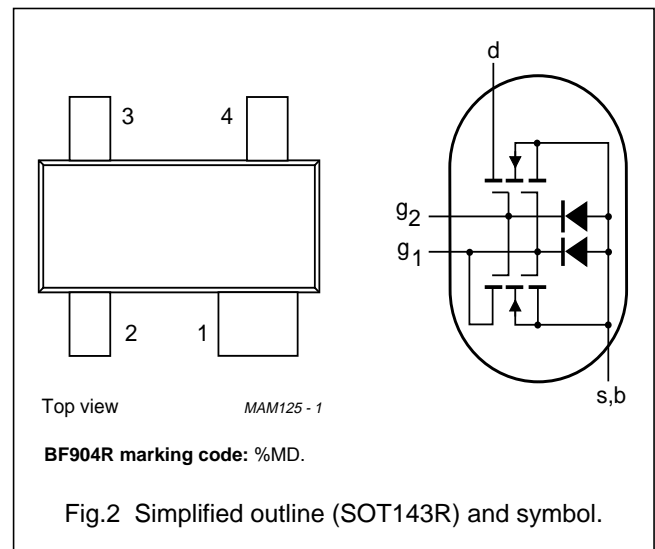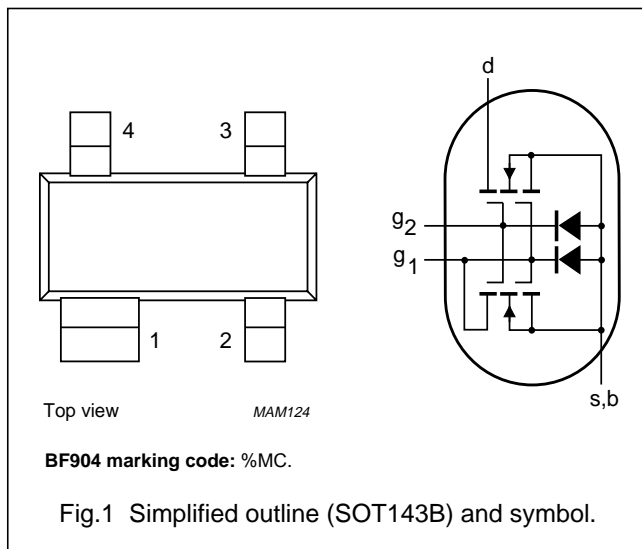Enhancement type field-effect transistor in a plastic microminiature SOT143B and SOT143R package. The transistor consists of an amplifier MOS-FET with source and substrate interconnected and an internal bias circuit to ensure good cross-modulation performance during AGC.

CAUTION
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.

PINNING

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

BF904 marking code: %MC.

Fig.1 Simplified outline (SOT143B) and symbol.

BF904R marking code: %MD.

Fig.2 Simplified outline (SOT143R) 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		–	–	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	see Fig.3			
	BF904	$T_{amb} \leq 50\ °C$; note 1	–	200	mW
	BF904R	$T_{amb} \leq 40\ °C$; note 1	–	200	mW
T_{stg}	storage temperature		–65	+150	°C
T_j	operating junction temperature		–	150	°C

Note

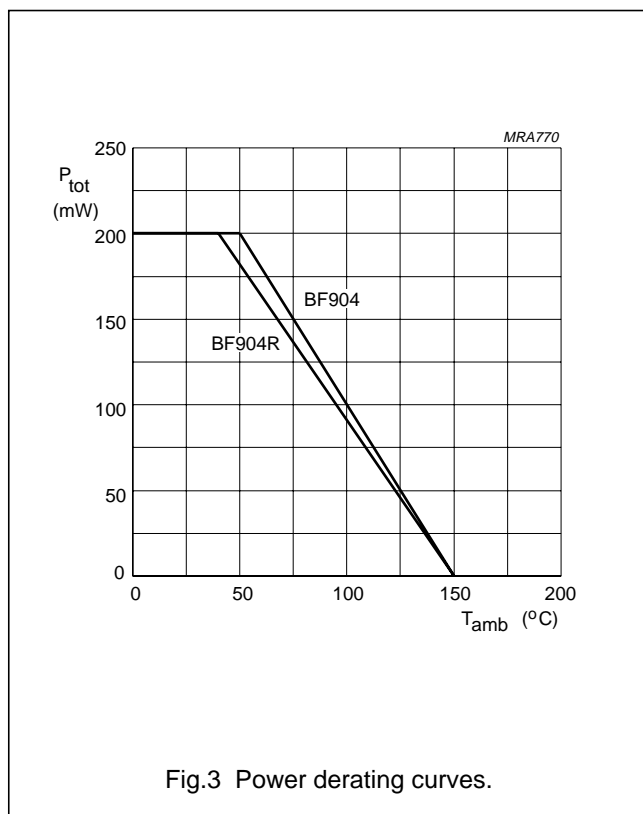1. Device mounted on a printed-circuit board.

Fig.3 Power derating curves.

N-channel dual gate MOS-FETs

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THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\,j-a}$	thermal resistance from junction to ambient	note 1		
	BF904		500	K/W
	BF904R		550	K/W
$R_{th\,j-s}$	thermal resistance from junction to soldering point	note 2		
	BF904	$T_s = 92\ °C$	290	K/W
	BF904R	$T_s = 78\ °C$	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

$T_j = 25\ °C$ unless otherwise specified.

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

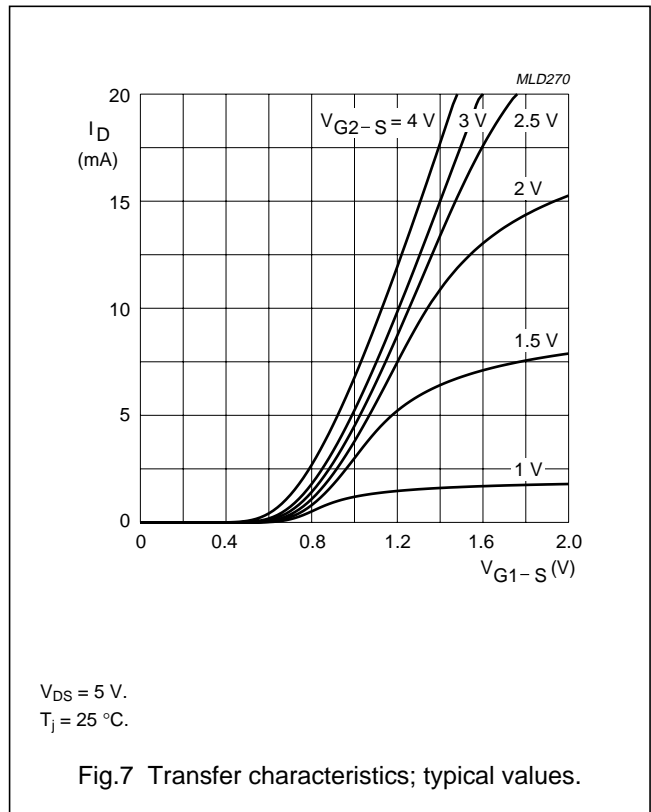**Note**

1. R_{G1} connects gate 1 to $V_{GG} = 5$ V; see Fig.20.

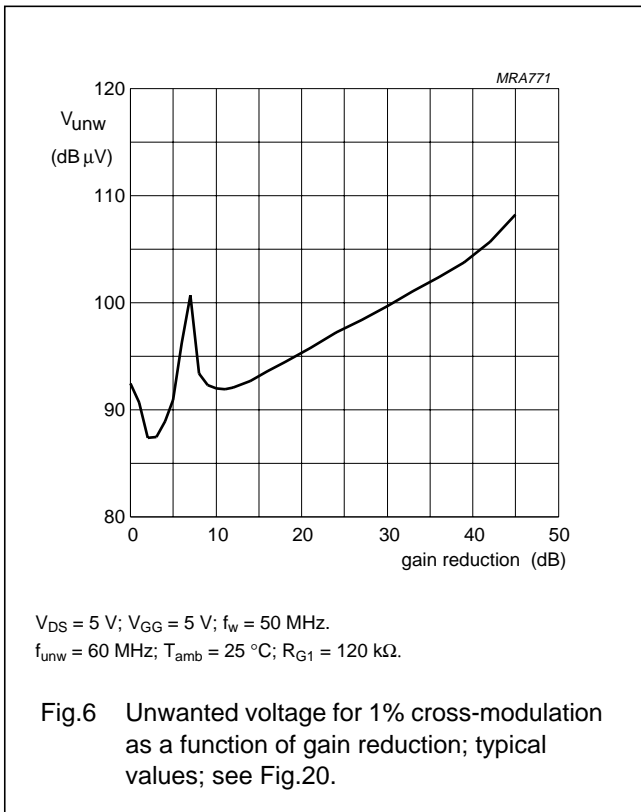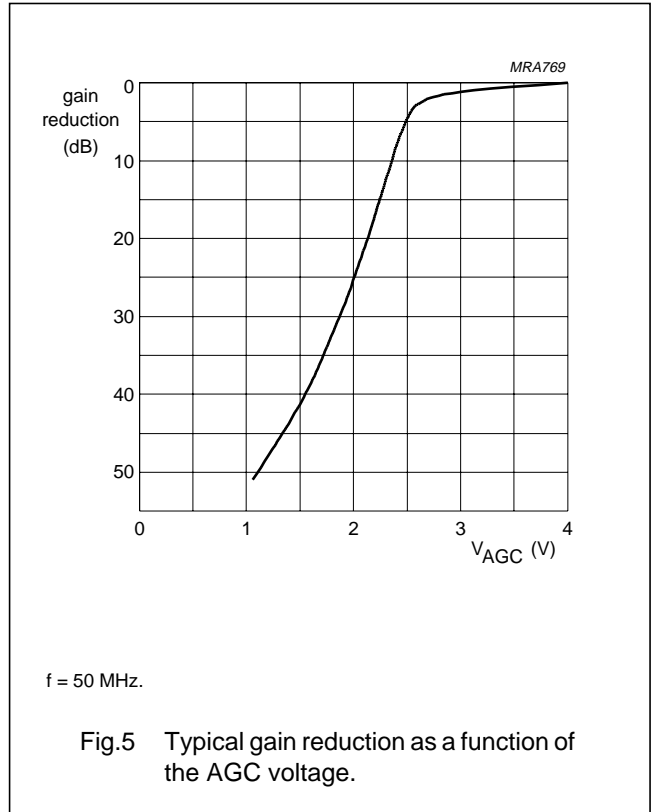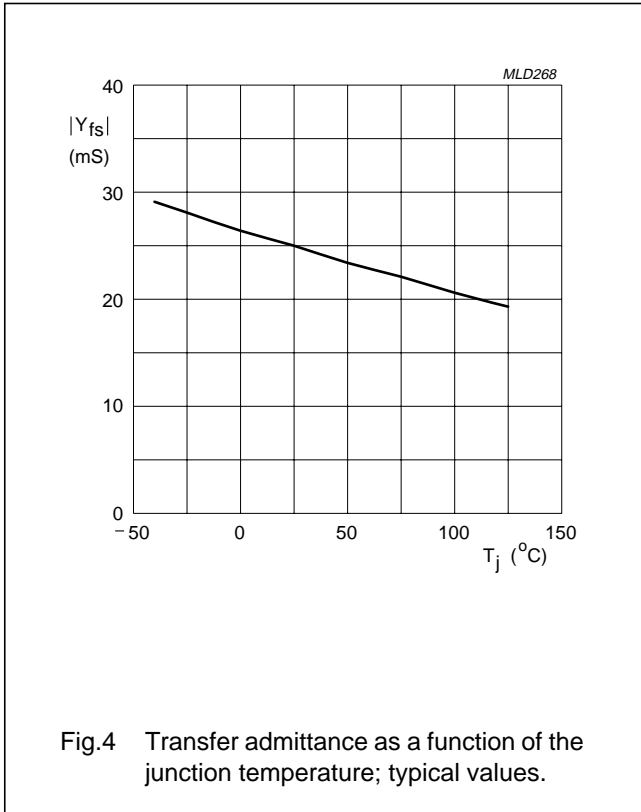### DYNAMIC CHARACTERISTICS

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

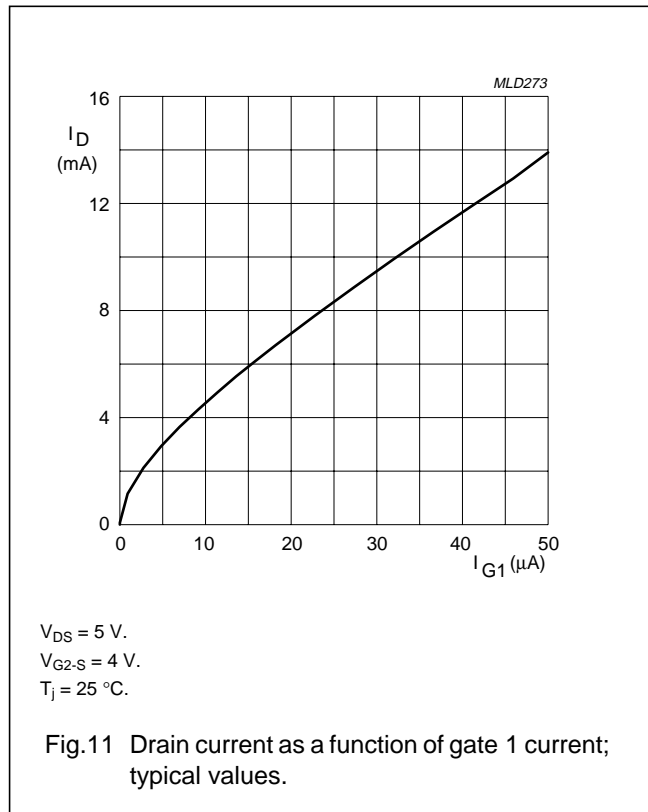| SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$|y_{fs}|$	forward transfer admittance	pulsed; $T_j = 25\ °C$	22	25	30	mS
C_{ig1-s}	input capacitance at gate 1	$f = 1$ MHz	−	2.2	2.6	pF
C_{ig2-s}	input capacitance at gate 2	$f = 1$ MHz	1	1.5	2	pF
C_{os}	drain-source capacitance	$f = 1$ MHz	1	1.3	1.6	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

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MLD268

Fig.4 Transfer admittance as a function of the junction temperature; typical values.

MRA769

f = 50 MHz.

Fig.5 Typical gain reduction as a function of the AGC voltage.

MRA771

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.6 Unwanted voltage for 1% cross-modulation as a function of gain reduction; typical values; see Fig.20.

MLD270

V_{DS} = 5 V.
T_j = 25 °C.

Fig.7 Transfer characteristics; typical values.

N-channel dual gate MOS-FETs

V_{G2-S} = 4 V.
T_j = 25 °C.

Fig.8   Output characteristics; typical values.

V_{DS} = 5 V.
T_j = 25 °C.

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

V_{DS} = 5 V.
T_j = 25 °C.

Fig.10   Forward transfer admittance as a
function of drain current; typical values.

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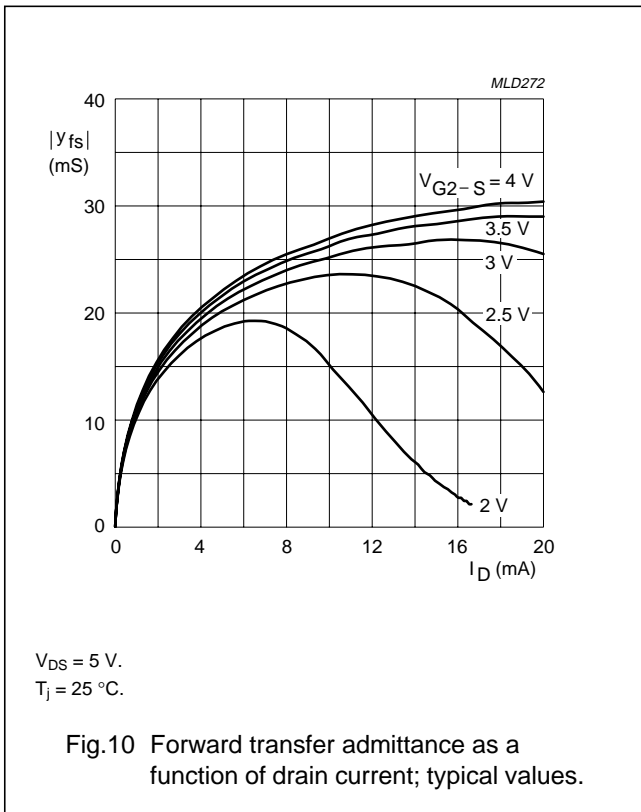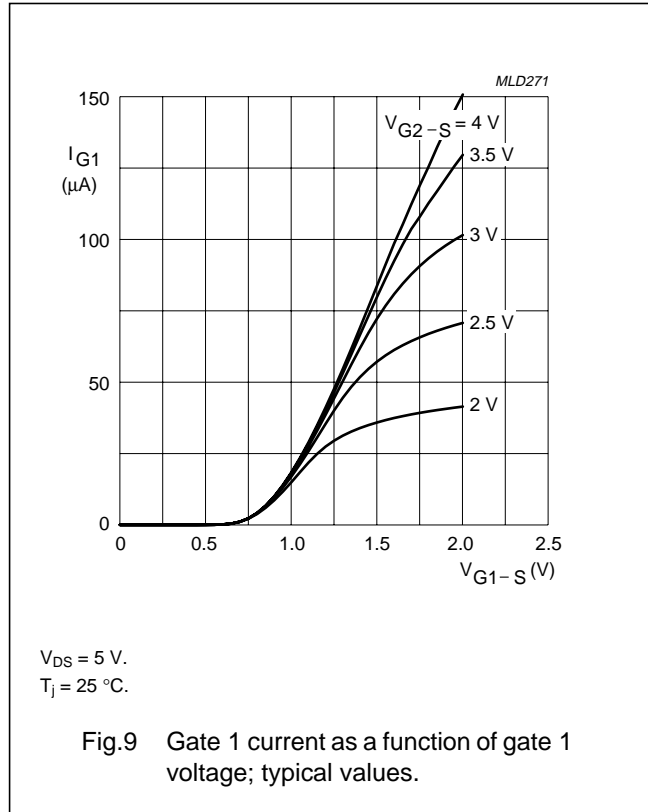T_j = 25 °C.

Fig.11   Drain current as a function of gate 1 current;
typical values.

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MLD275

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

Fig.12 Drain current as a function of gate 1
supply voltage (= V_{GG}); typical values;
see Fig.20.

MLD274

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

Fig.13 Drain current as a function of gate 1
(= V_{GG}) and drain supply voltage;
typical values; see Fig.20.

MLD276

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

Fig.14 Drain current as a function of gate 2 voltage;
typical values; see Fig.20.

MLB945

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

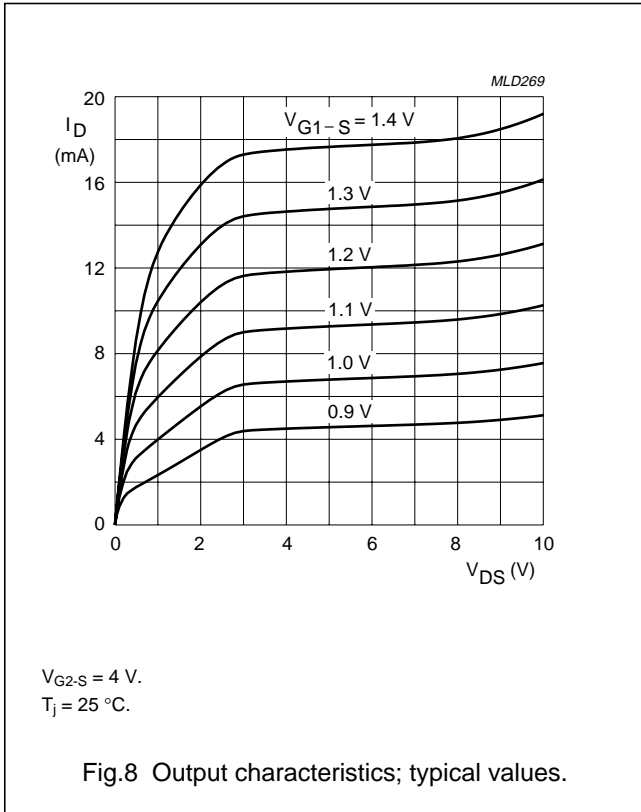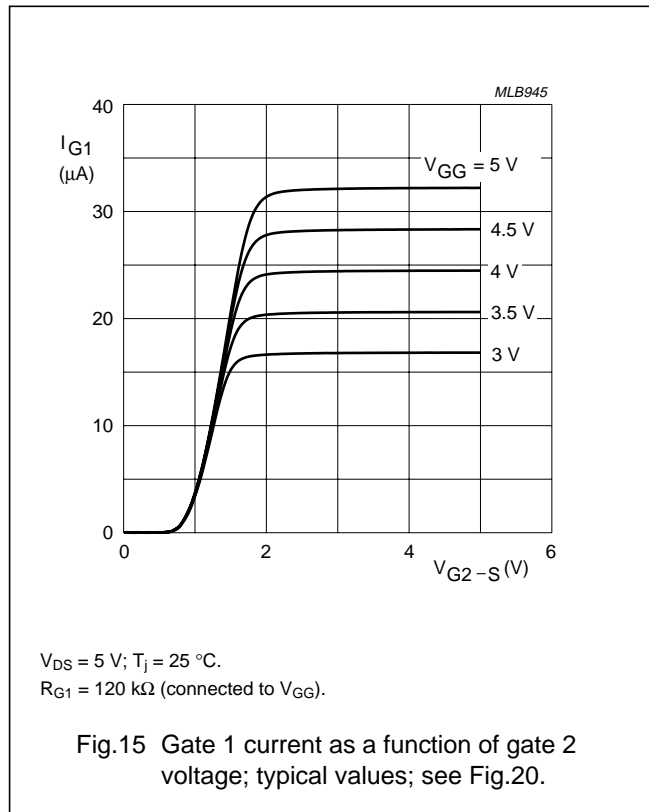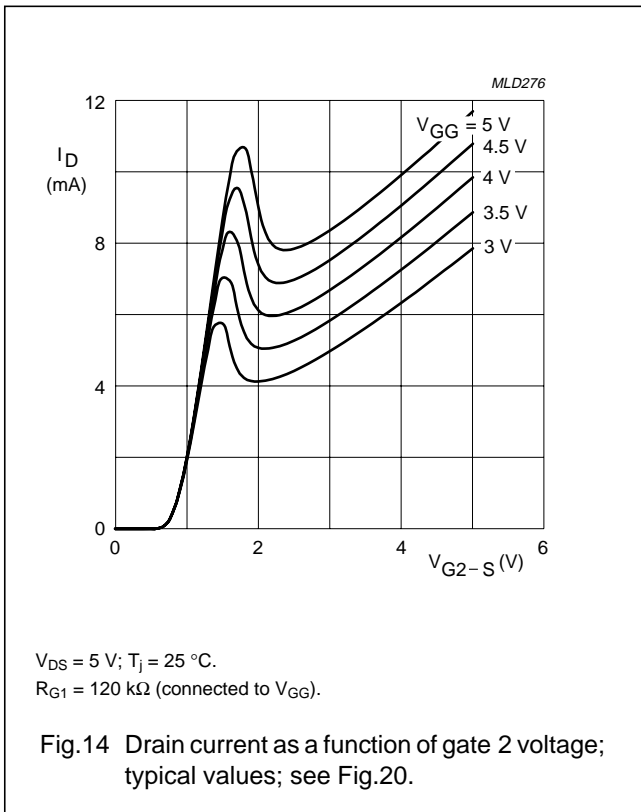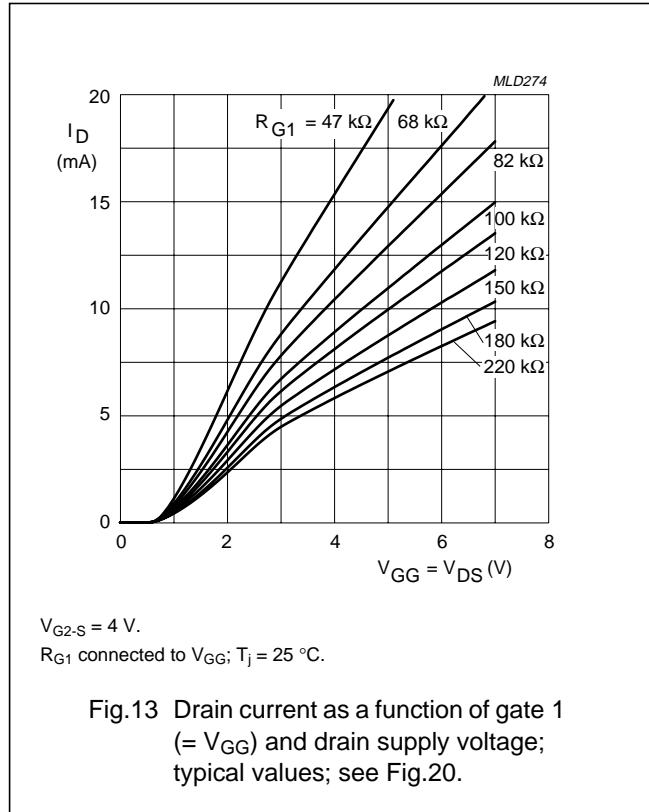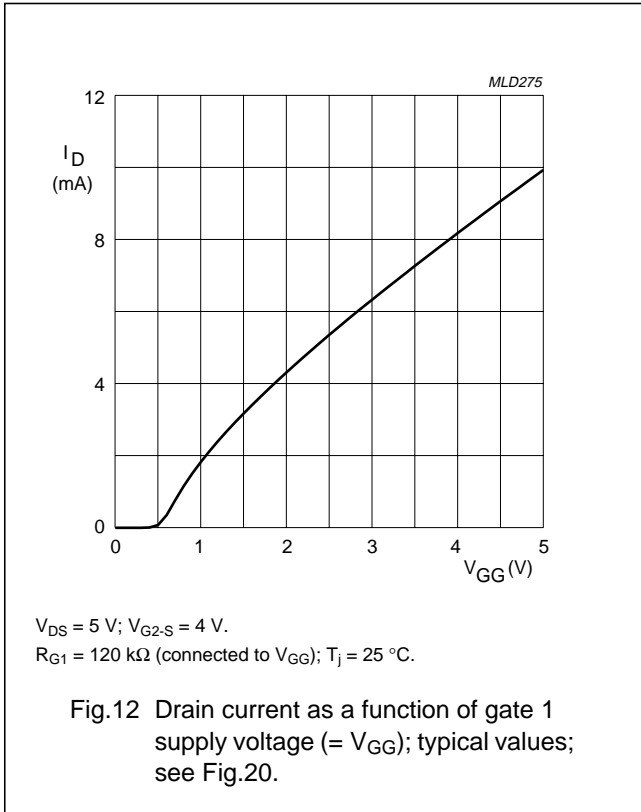Fig.15 Gate 1 current as a function of gate 2
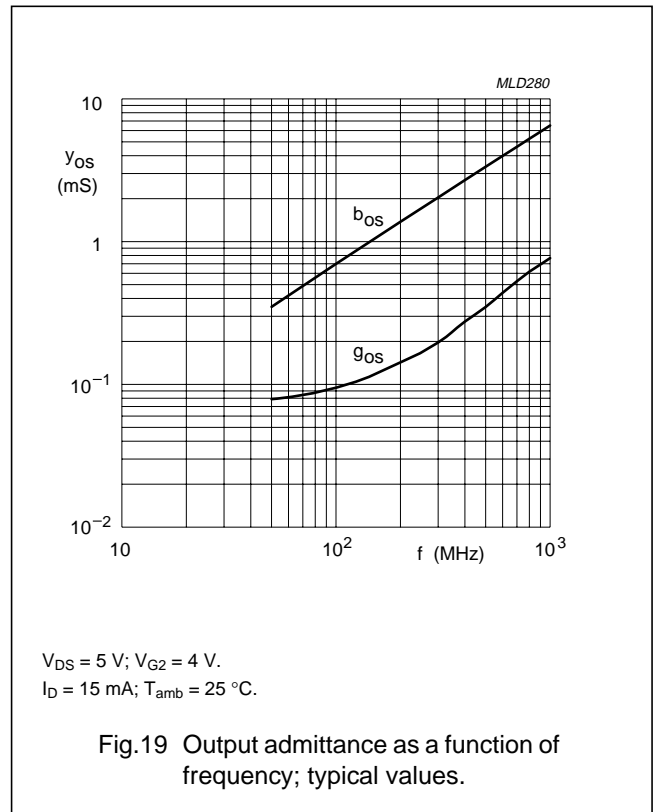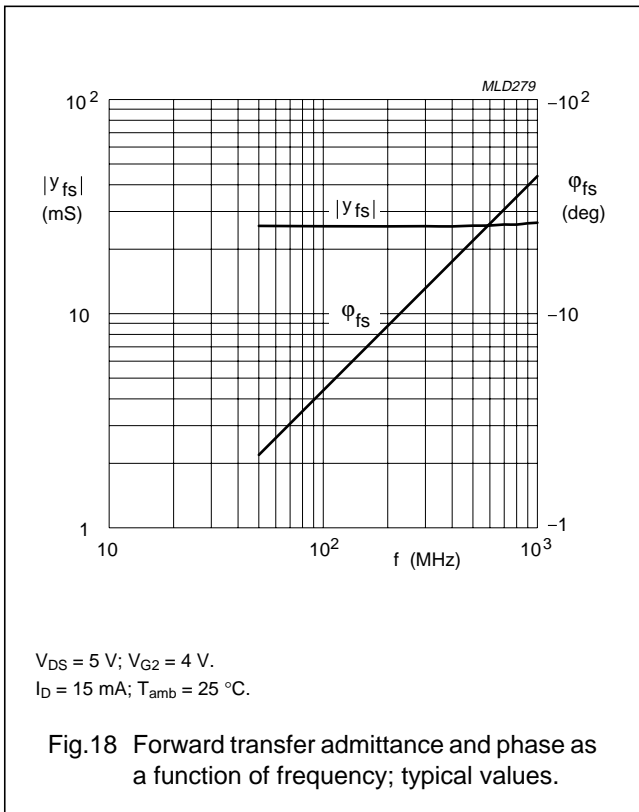voltage; typical values; see Fig.20.

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MLD277

Fig.16 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.

MLD278

Fig.17 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.

MLD279

Fig.18 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.

MLD280

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

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

N-channel dual gate MOS-FETs

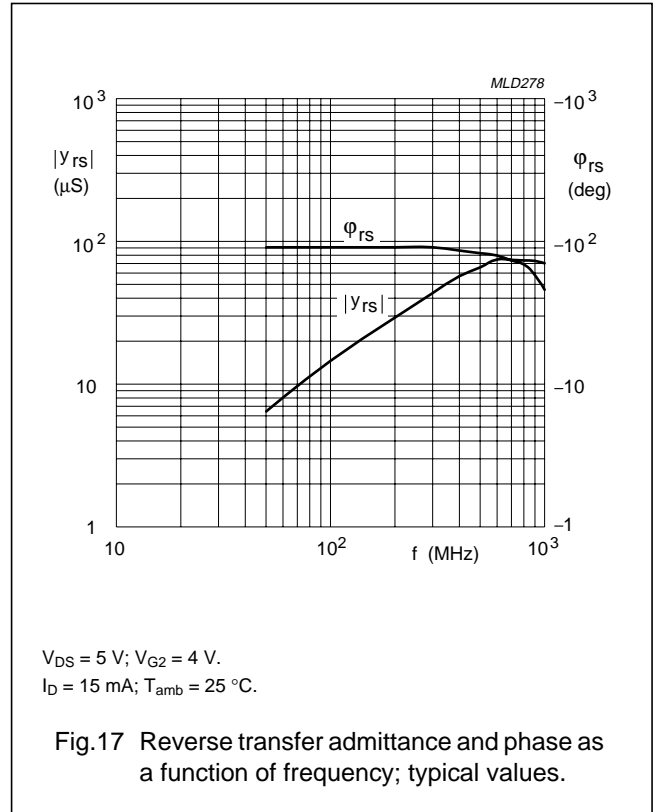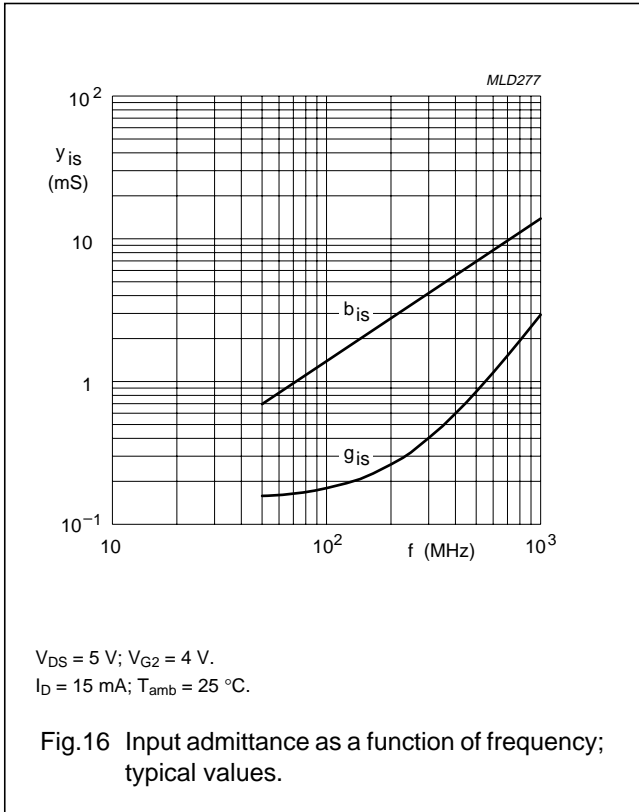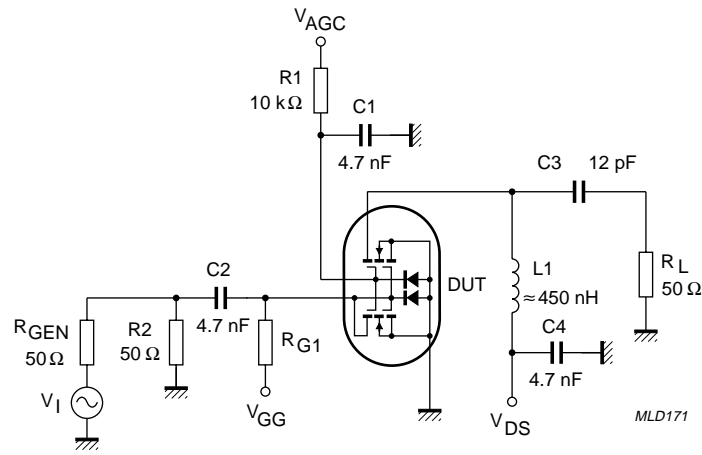Fig.20 Cross-modulation test set-up.

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

Plastic surface mounted package; 4 leads

SOT143B
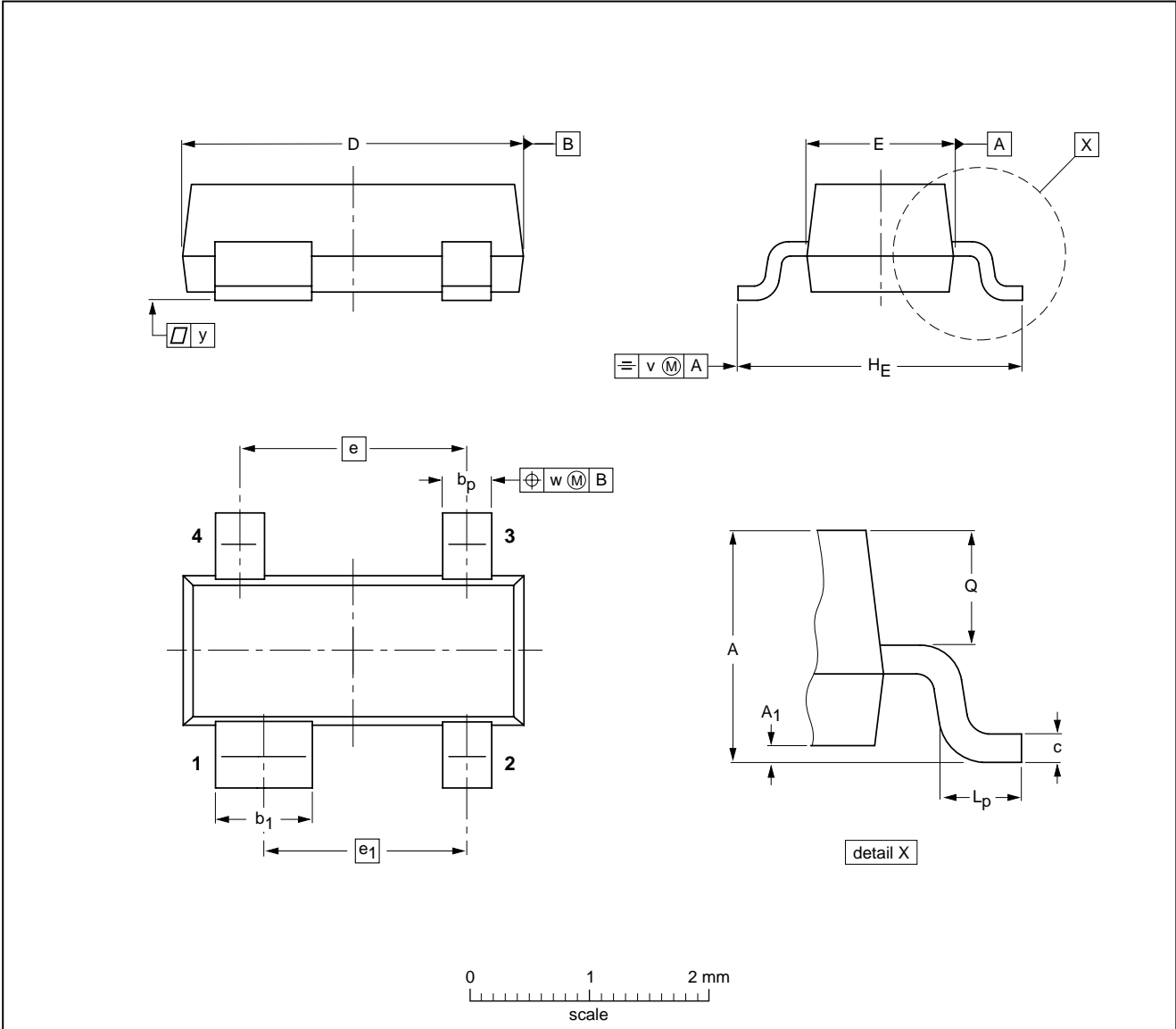
0   1   2 mm
scale

DIMENSIONS (mm are the original dimensions)

UNIT	A	A₁ max	bp	b₁	c	D	E	e	e₁	HE	Lp	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

N-channel dual gate MOS-FETs

BF904; BF904R

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
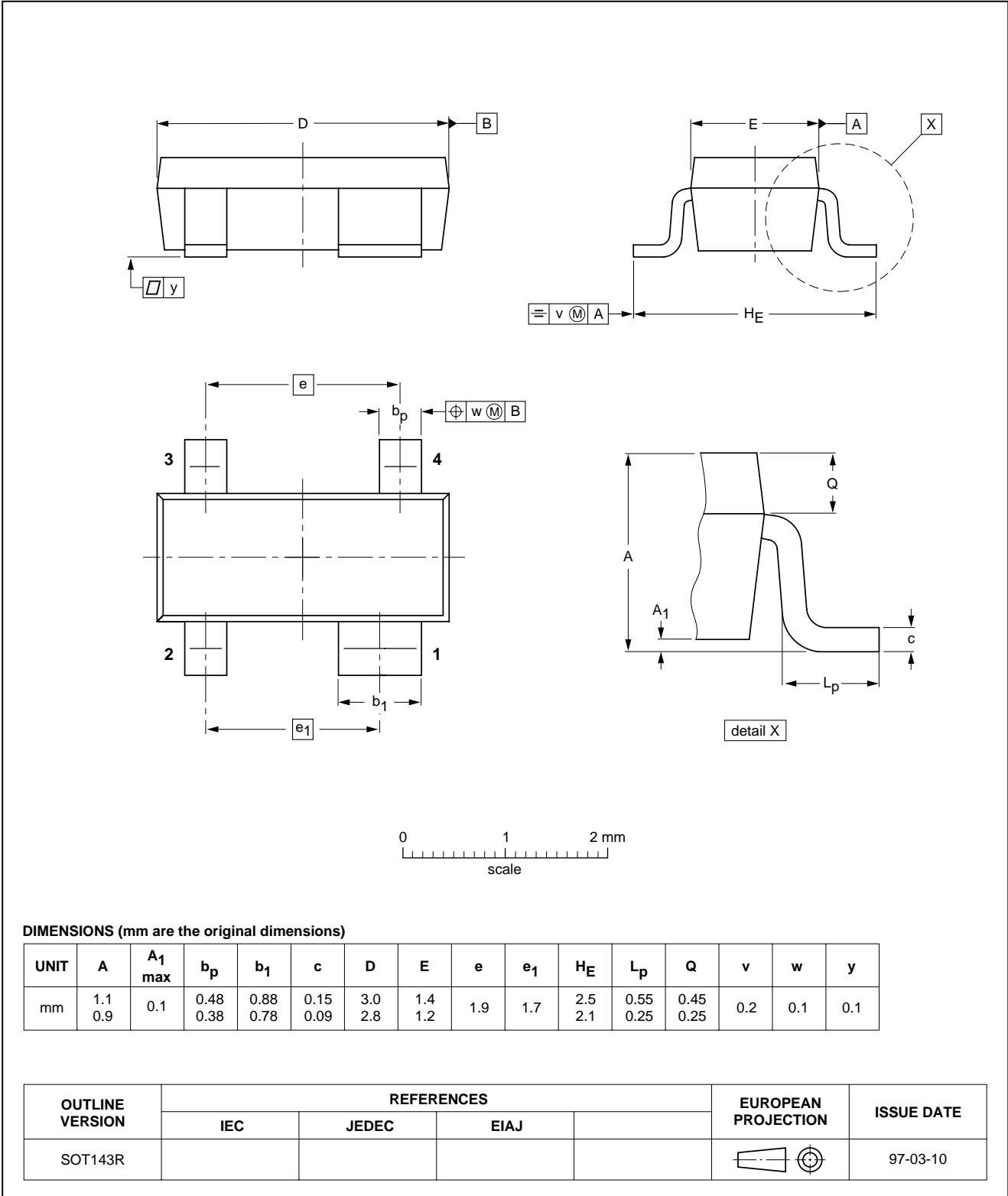
Legal information

Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

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Revision history

Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
BF904_904R_N_6	20071113	Product data sheet	-	BF904_904R_5
Modifications:	• Fig. 1 and 2 on page 2; Figure note changed			
BF904_904R_5 (9397 750 05898)	19990517	Product specification	-	BF904R_4
BF904R_4 (9397 750 02668)	19970905	Product specification	-	BF904R_3
BF904R_3	19950425	Product specification	-	BF904R_2
BF904R_2	-	-	-	BF904R_1
BF904R_1	-	-	-	-

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MRFE6VP5150GNR1 LET9060S MRF136Y BF999E6327HTSA1 SD2931-12MR BF998E6327HTSA1 MRF141 MRF171 MRF172
MRF174 SD2942 QPD1020SR BF 1005S E6327 MRF134 MRF136 MRF137 MRF141G MRF151A MRF151G MRF157 MRF158
MRF160 MRF166C MRF171A MRF177 UF2840G TGF3021-SM ARF1510 ARF448BG ARF449AG ARF466BG