DATA SHEET

BFR93
NPN 5 GHz wideband transistor

Product specification
1997 Oct 29
Supersedes data of September 1995
File under discrete semiconductors, SC14

Philips
Semiconductors

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NPN 5 GHz wideband transistor BFR93

FEATURES

- Very low intermodulation distortion
- High power gain
- Excellent wideband properties and low noise up to high frequencies due to its very high transition frequency.

APPLICATIONS

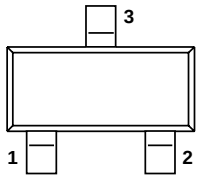
- RF wideband amplifiers and oscillators.

DESCRIPTION

NPN wideband transistor in a plastic SOT23 package.
PNP complement: BFT93.

PINNING

PIN	DESCRIPTION
1	base
2	emitter
3	collector



Marking code: R1p.

Fig.1 SOT23.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	TYP.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter	–	15	V
V_{CEO}	collector-emitter voltage	open base	–	12	V
I_C	collector current (DC)		–	35	mA
P_{tot}	total power dissipation	$T_s \leq 95$ °C	–	300	mW
C_{re}	feedback capacitance	I_C = 2 mA; V_{CE} = 5 V; f = 1 MHz	0.8	–	pF
f_T	transition frequency	I_C = 30 mA; V_{CE} = 5 V; f = 500 MHz; T_j = 25 °C	5	–	GHz
G_{UM}	maximum unilateral power gain	I_C = 30 mA; V_{CE} = 5 V; f = 500 MHz; T_{amb} = 25 °C	16.5	–	dB
F	noise figure	I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz; T_{amb} = 25 °C	1.9	–	dB
d_{im}	intermodulation distortion	I_C = 30 mA; V_{CE} = 5 V; R_L = 75 Ω; V_O = 300 mV; $f_p + f_q - f_r$ = 493.25 MHz; T_{amb} = 25 °C	–60	–	dB

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter	–	15	V
V_{CEO}	collector-emitter voltage	open base	–	12	V
V_{EBO}	emitter-base voltage	open collector	–	2	V
I_C	collector current (DC)		–	35	mA
P_{tot}	total power dissipation	$T_s \leq 95$ °C; note 1	–	300	mW
T_{stg}	storage temperature		–65	+150	°C
T_j	junction temperature		–	175	°C

Note

1. T_s is the temperature at the soldering point of the collector pin.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}s}$	thermal resistance from junction to soldering point	$T_s \leq 95$ °C; note 1	260	K/W

Note

1. T_s is the temperature at the soldering point of the collector pin.

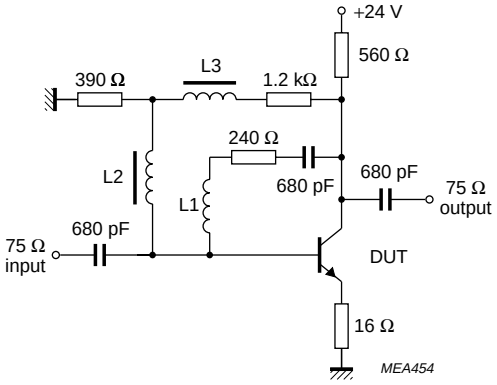
CHARACTERISTICS

T_j = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CBO}	collector cut-off current	$I_E = 0$; V_{CB} = 10 V	–	–	50	nA
h_{FE}	DC current gain	I_C = 30 mA; V_{CE} = 5 V	40	90	–	
C_c	collector capacitance	$I_E = i_e = 0$; V_{CB} = 10 V; f = 1 MHz	–	0.7	–	pF
C_e	emitter capacitance	$I_C = i_c = 0$; V_{EB} = 0.5 V; f = 1 MHz	–	1.8	–	pF
C_{re}	feedback capacitance	I_C = 2 mA; V_{CE} = 5 V; f = 1 MHz; T_{amb} = 25 °C	–	0.8	–	pF
f_T	transition frequency	I_C = 30 mA; V_{CE} = 5 V; f = 500 MHz	–	5	–	GHz
G_{UM}	maximum unilateral power gain (note 1)	I_C = 30 mA; V_{CE} = 5 V; f = 500 MHz; T_{amb} = 25 °C	–	16.5	–	dB
F	noise figure (note 2)	I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz; Z_S = opt.; T_{amb} = 25 °C	–	1.9	–	dB
d_{im}	intermodulation distortion	note 3	–	–60	–	dB

Notes

1. G_{UM} is the maximum unilateral power gain, assuming S_{12} is zero and $G_{UM} = 10 \log \frac{|S_{21}|^2}{\left(1-|S_{11}|^2\right)\left(1-|S_{22}|^2\right)}$ dB
2. Die mounted in a SOT37 package (BFR91).
3. I_C = 30 mA; V_{CE} = 5 V; R_L = 75 Ω; VSWR < 2; T_{amb} = 25 °C;
   $V_p = V_O$ = 300 mV at f_p = 495.25 MHz;
   $V_q = V_O$ –6 dB at f_q = 503.25 MHz;
   $V_r = V_O$ –6 dB at f_r = 505.25 MHz;
   measured at $f_p + f_q - f_r$ = 493.25 MHz.



L2 = L3 = 5 μH Ferroxcube choke, catalogue number 3122 108 20150.

L1 = 4 turns 0.35 mm copper wire; winding pitch 1 mm; internal diameter 4 mm.

Fig.2 Intermodulation distortion test circuit.

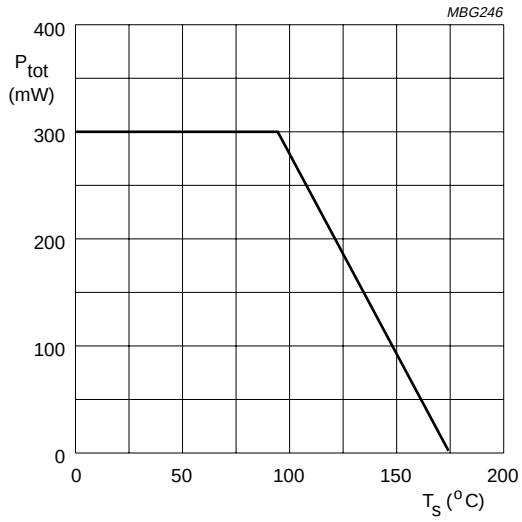
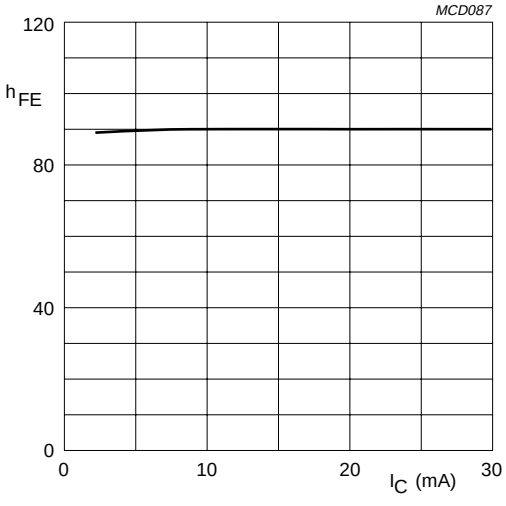
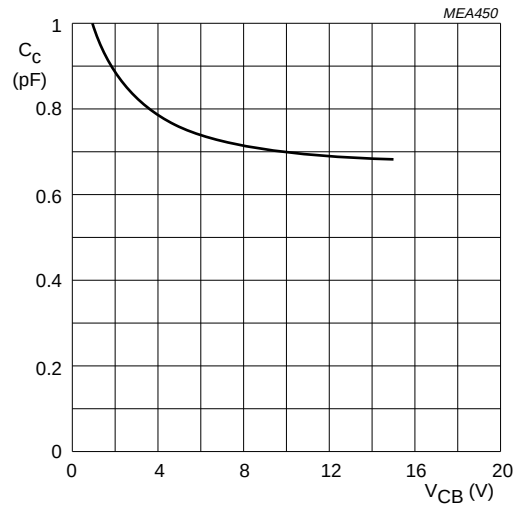


Fig.3 Power derating curve.



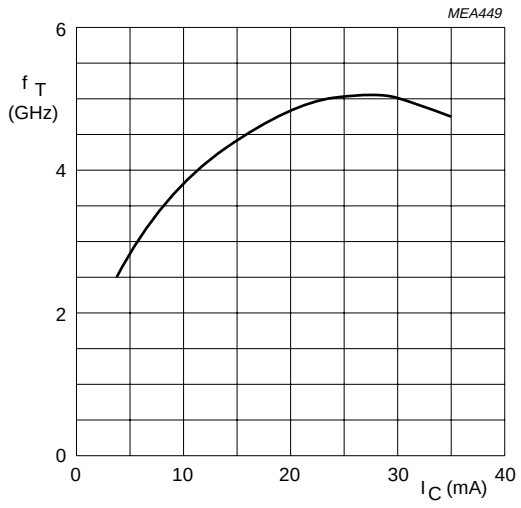
V_{CE} = 5 V; T_j = 25 °C.

Fig.4 DC current gain as a function of collector current; typical values.



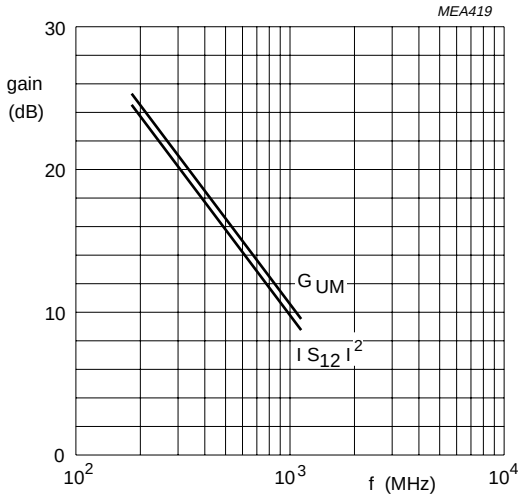
$I_E = i_e$ = 0; f = 1 MHz; T_j = 25 °C.

Fig.5 Collector capacitance as a function of collector-base voltage; typical values.



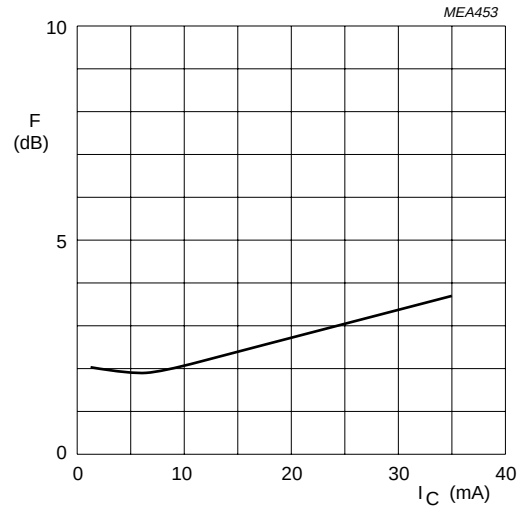
V_{CE} = 5 V; f = 500 MHz; T_j = 25 °C.

Fig.6 Transition frequency as a function of collector current; typical values.



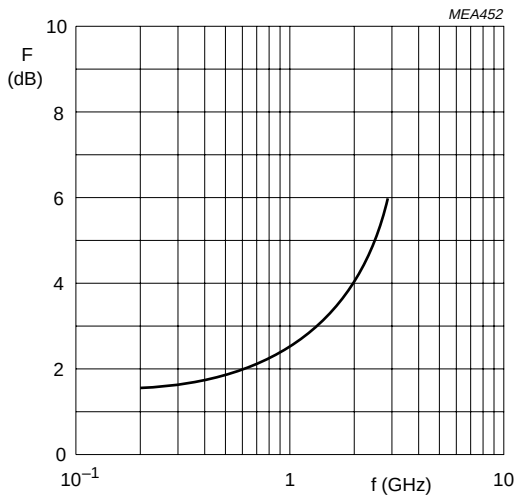
I_C = 30 mA; V_{CE} = 5 V; T_{amb} = 25 °C.

Fig.7 Gain as a function of frequency; typical values.



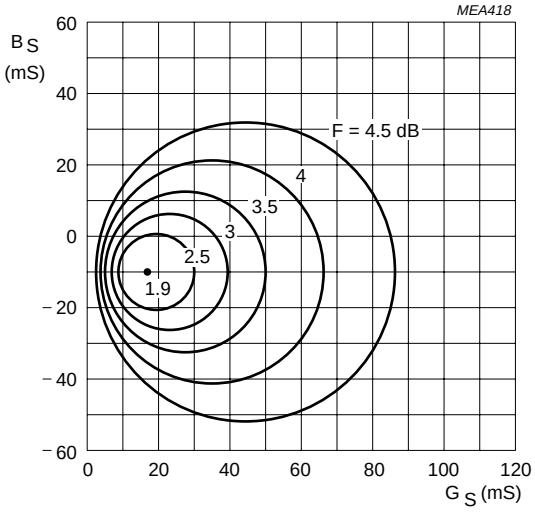
V_{CE} = 5 V; f = 500 MHz; Z_S = opt.; T_{amb} = 25 °C.

Fig.8 Minimum noise figure as a function of collector current; typical values.



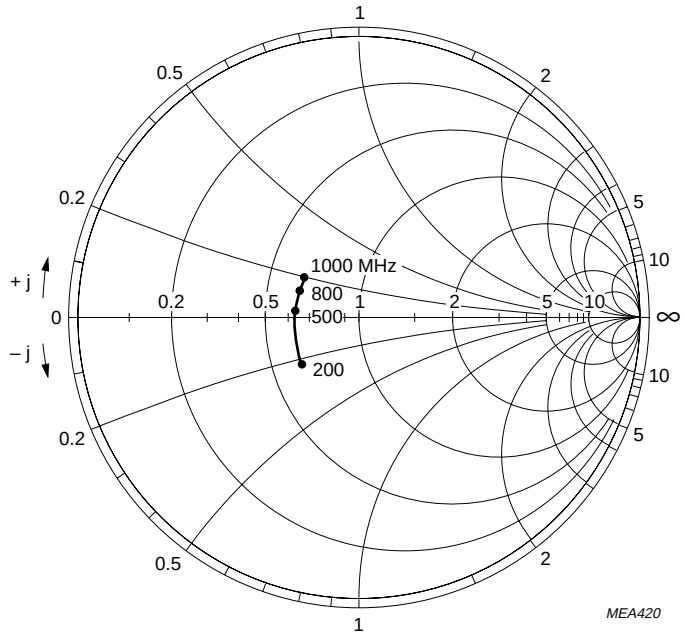
I_C = 2 mA; V_{CE} = 5 V; Z_S = opt.; T_{amb} = 25 °C.

Fig.9 Minimum noise figure as a function of frequency; typical values.



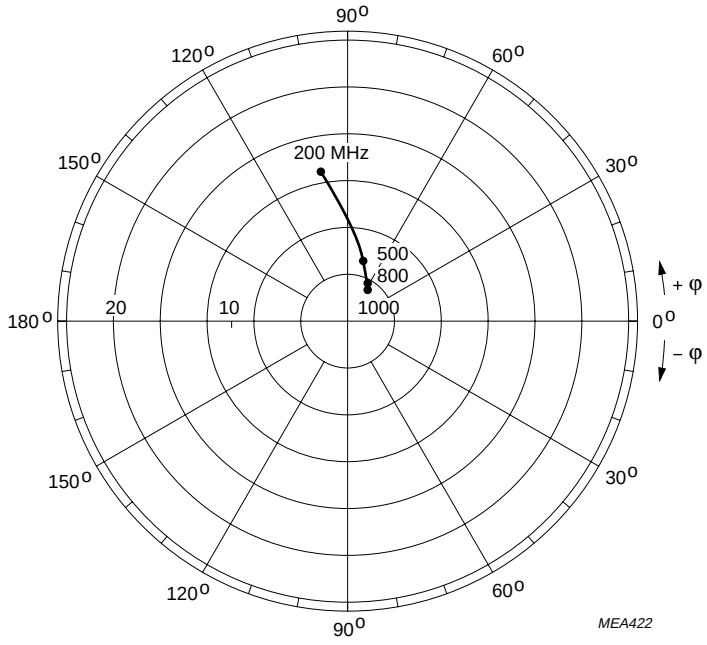
I_C = 2 mA; V_{CE} = 5 V; f = 500 MHz; T_{amb} = 25 °C.

Fig.10 Circles of constant noise figure; typical values.



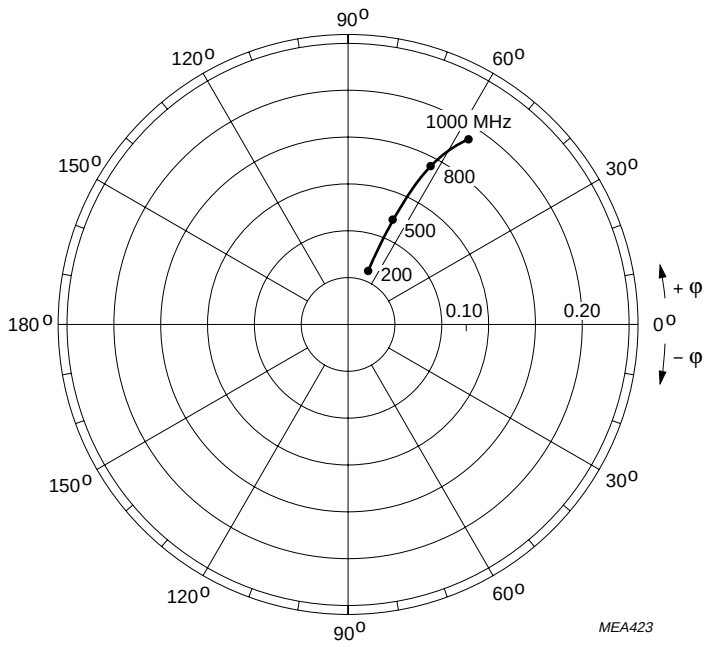
I_C = 30 mA; V_{CE} = 5 V; Z_o = 50 Ω; T_{amb} = 25 °C.

Fig.11 Common emitter input reflection coefficient (S_{11}); typical values.



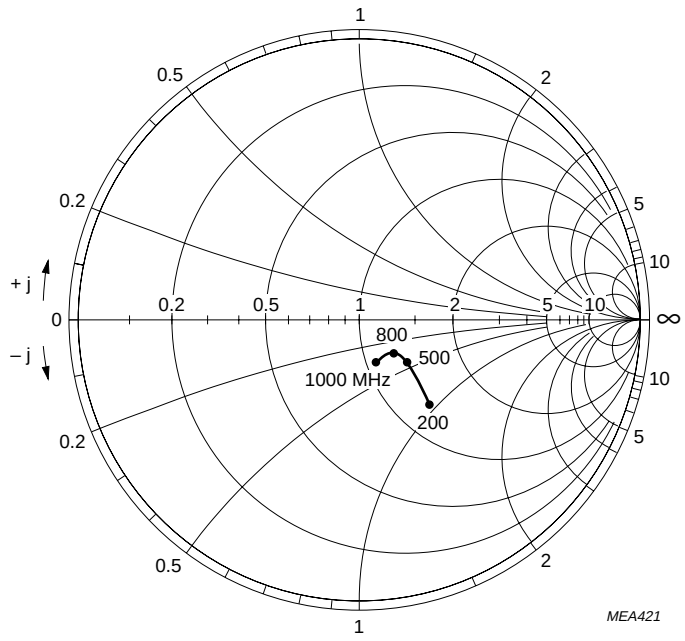
I_C = 30 mA; V_{CE} = 5 V; T_{amb} = 25 °C.

Fig.12 Common emitter forward transmission coefficient (S_{21}); typical values.



I_C = 30 mA; V_{CE} = 5 V; T_{amb} = 25 °C.

Fig.13 Common emitter reverse transmission coefficient (S_{12}); typical values.

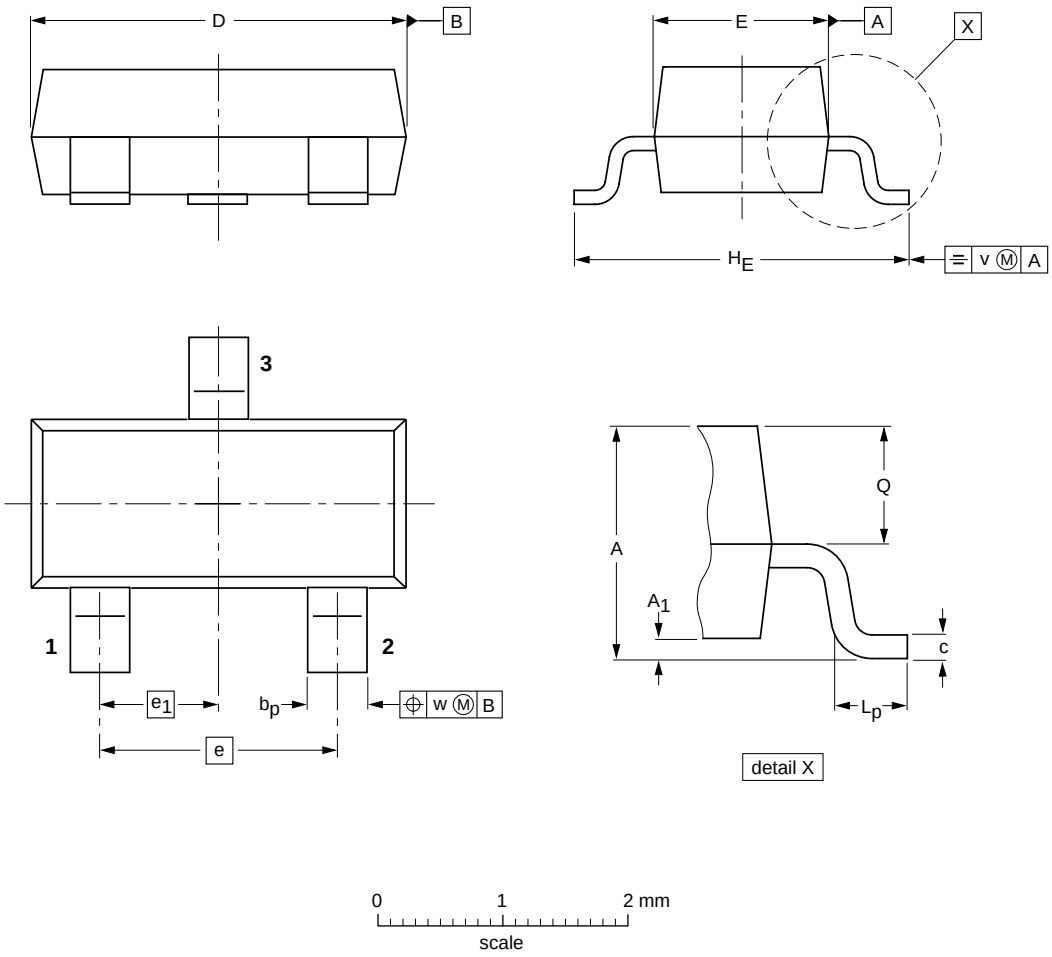


I_C = 30 mA; V_{CE} = 5 V; Z_o = 50 Ω; T_{amb} = 25 °C.

Fig.14 Common emitter output reflection coefficient (S_{22}); typical values.

PACKAGE OUTLINE

Plastic surface mounted package; 3 leads **SOT23**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1 max.	b_p	c	D	E	e	e_1	H_E	L_p	Q	v	w
mm	1.1 0.9	0.1	0.48 0.38	0.15 0.09	3.0 2.8	1.4 1.2	1.9	0.95	2.5 2.1	0.45 0.15	0.55 0.45	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT23						97-02-28

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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