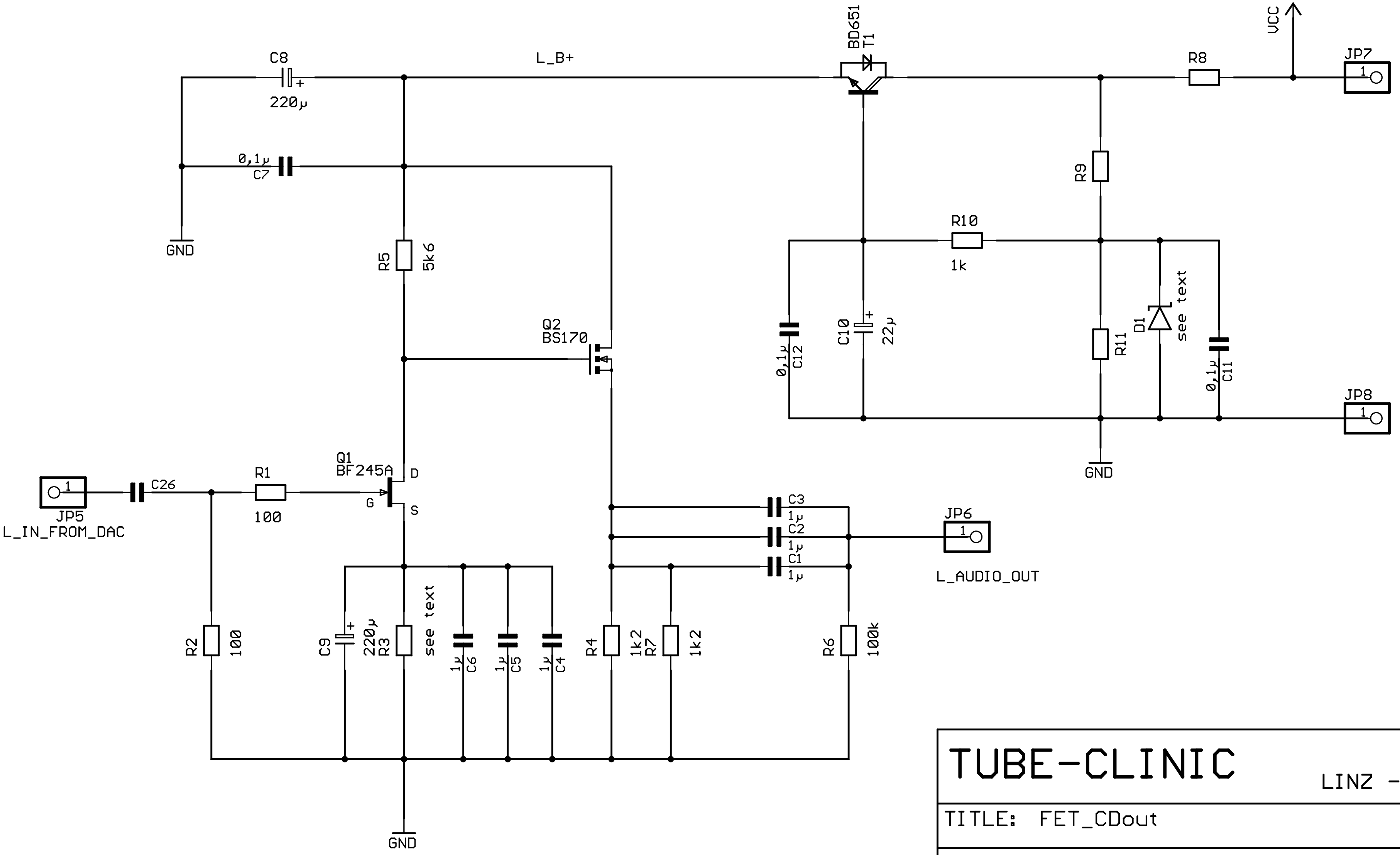

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TITLE: FET_CDout

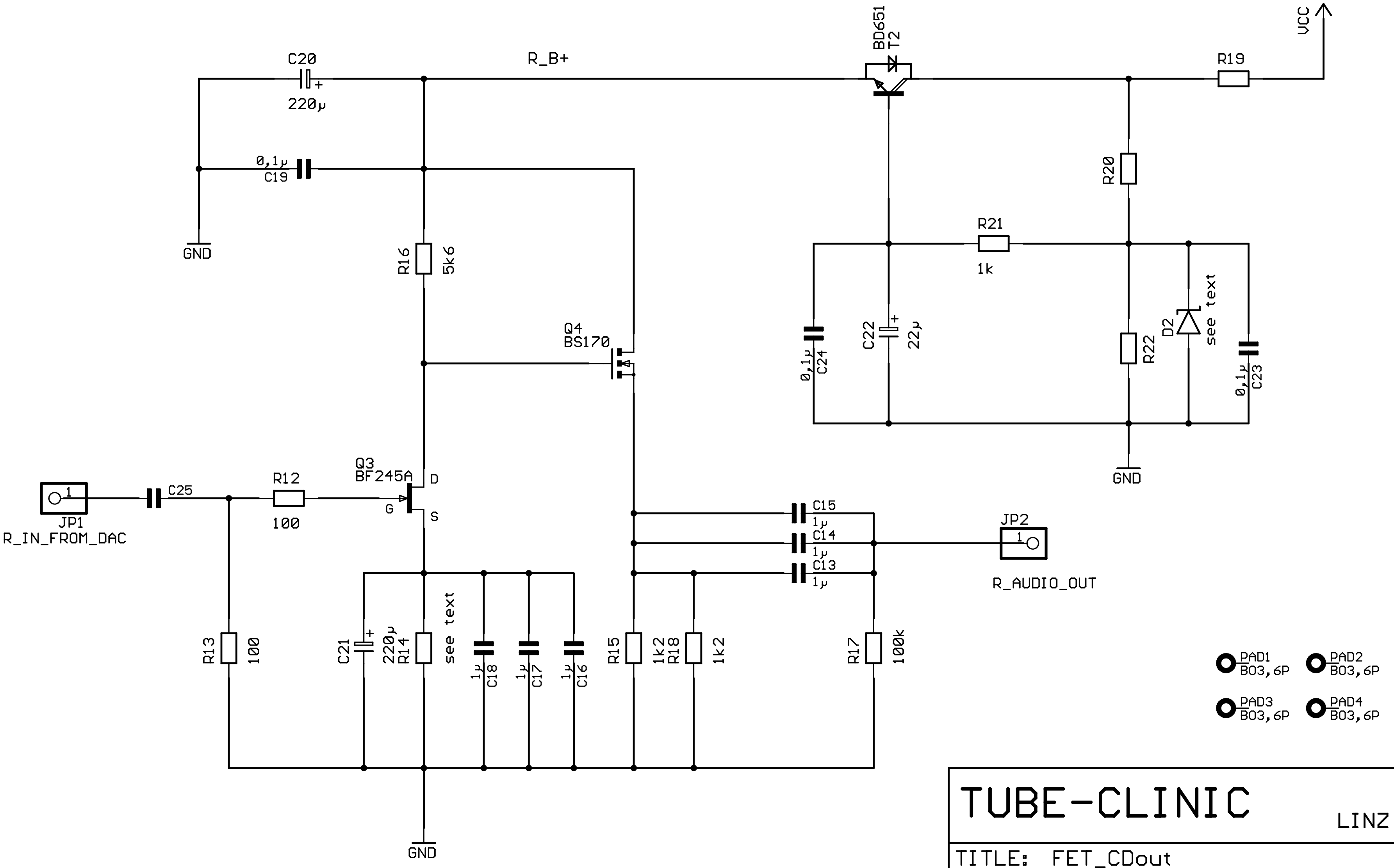
Document Number:
0808-030-1.2

Ⓒ by Barbara E. Gerhold

REV:
3.0

Date: 28.08.2012 18:43:56

Sheet: 1/2



TUBE-CLINIC

LINZ - AUSTRIA

TITLE: FET_CDout

Document Number:
0808-030-2.2

Ⓒ by Barbara E. Gerhold

REV:
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Date: 28.08.2012 18:43:56

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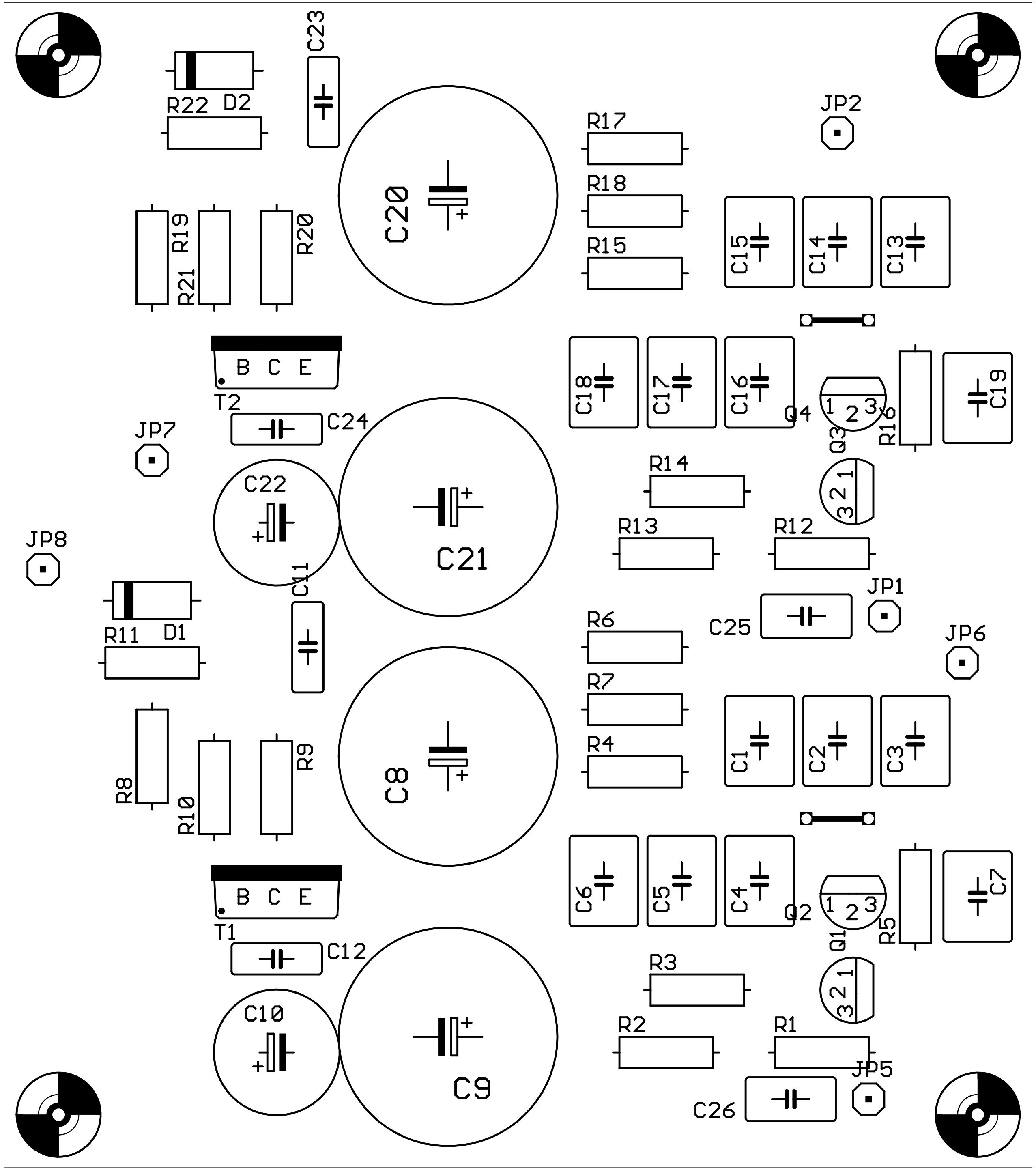
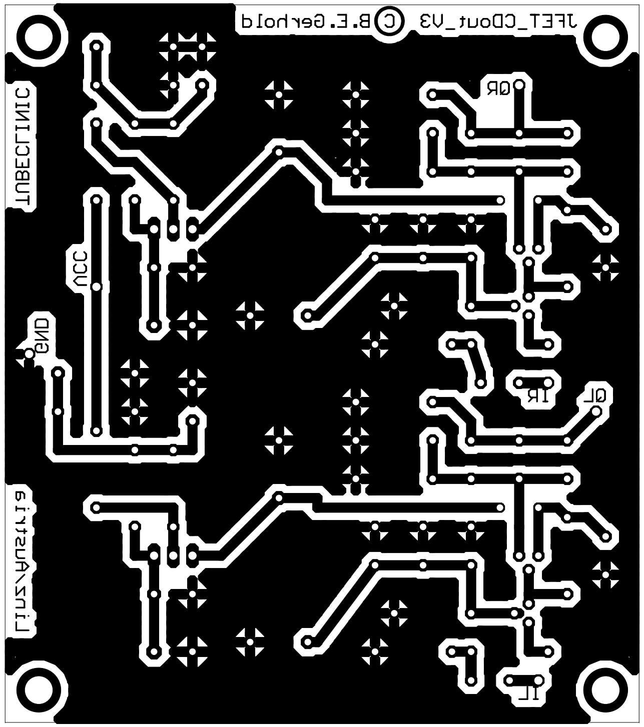
in case of mods pls. see text!




JFET_CDout_V3 © B.E.Gerhold
TUBECLINIC
VCC
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DATA SHEET

BF245A; BF245B; BF245C
N-channel silicon field-effect transistors

Product specification 1996 Jul 30
Supersedes data of April 1995
File under Discrete Semiconductors, SC07

Philips
Semiconductors

FEATURES

- Interchangeability of drain and source connections
- Frequencies up to 700 MHz.

APPLICATIONS

- LF, HF and DC amplifiers.

DESCRIPTION

General purpose N-channel symmetrical junction field-effect transistors in a plastic TO-92 variant package.

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	d	drain
2	s	source
3	g	gate

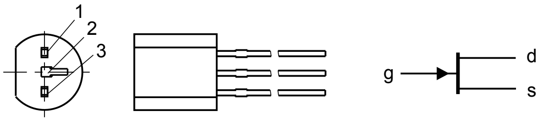


Fig.1 Simplified outline (TO-92 variant) and symbol.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{DS}	drain-source voltage		–	–	±30	V
V_{GSoff}	gate-source cut-off voltage	I_D = 10 nA; V_{DS} = 15 V	–0.25	–	–8	V
V_{GSO}	gate-source voltage	open drain	–	–	–30	V
I_{DSS}	drain current	V_{DS} = 15 V; V_{GS} = 0				
	BF245A		2	–	6.5	mA
	BF245B		6	–	15	mA
	BF245C		12	–	25	mA
P_{tot}	total power dissipation	T_{amb} = 75 °C	–	–	300	mW
$\lvert y_{fs} \rvert$	forward transfer admittance	V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz; T_{amb} = 25 °C	3	–	6.5	mS
C_{rs}	reverse transfer capacitance	V_{DS} = 20 V; V_{GS} = –1 V; f = 1 MHz; T_{amb} = 25 °C	–	1.1	–	pF

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{DS}	drain-source voltage		–	±30	V
V_{GDO}	gate-drain voltage	open source	–	–30	V
V_{GSO}	gate-source voltage	open drain	–	–30	V
I_D	drain current		–	25	mA
I_G	gate current		–	10	mA
P_{tot}	total power dissipation	up to T_{amb} = 75 °C;	–	300	mW
		up to T_{amb} = 90 °C; note 1	–	300	mW
T_{stg}	storage temperature		–65	+150	°C
T_j	operating junction temperature		–	150	°C

Note

1. Device mounted on a printed-circuit board, minimum lead length 3 mm, mounting pad for drain lead minimum 10 mm × 10 mm.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th\ j\text{-}a}$	thermal resistance from junction to ambient	in free air	250	K/W
	thermal resistance from junction to ambient		200	K/W

STATIC CHARACTERISTICS

T_j = 25 °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{(BR)GSS}$	gate-source breakdown voltage	I_G = –1 μA; V_{DS} = 0	–30	–	V
V_{GSoff}	gate-source cut-off voltage	I_D = 10 nA; V_{DS} = 15 V	–0.25	–8.0	V
V_{GS}	gate-source voltage	I_D = 200 μA; V_{DS} = 15 V			
	BF245A		–0.4	–2.2	V
	BF245B		–1.6	–3.8	V
	BF245C		–3.2	–7.5	V
I_{DSS}	drain current	V_{DS} = 15 V; V_{GS} = 0; note 1			
	BF245A		2	6.5	mA
	BF245B		6	15	mA
	BF245C		12	25	mA
I_{GSS}	gate cut-off current	V_{GS} = –20 V; V_{DS} = 0	–	–5	nA
		V_{GS} = –20 V; V_{DS} = 0; T_j = 125 °C	–	–0.5	μA

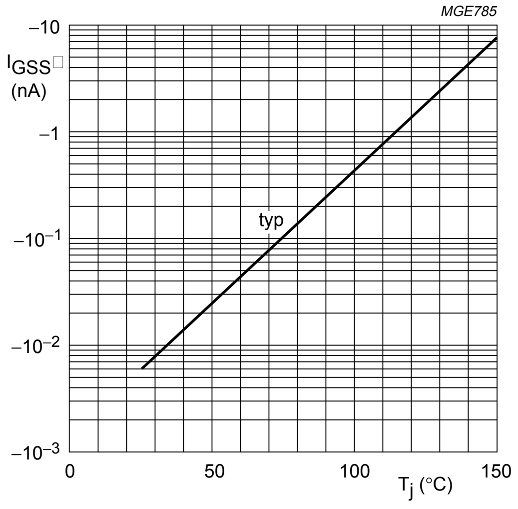
Note

1. Measured under pulse conditions: t_p = 300 μs; $\delta \leq 0.02$.

DYNAMIC CHARACTERISTICS

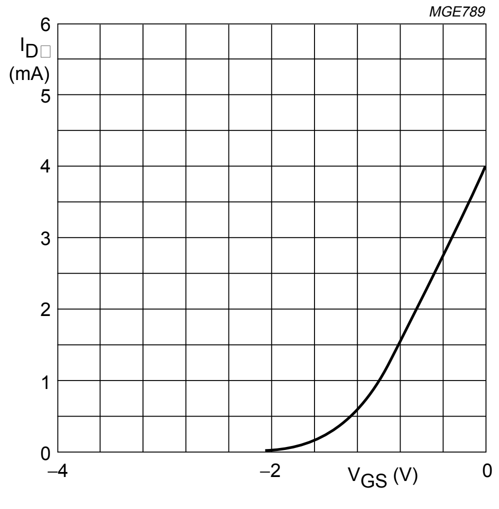
Common source; T_{amb} = 25 °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
C_{is}	input capacitance	V_{DS} = 20 V; V_{GS} = –1 V; f = 1 MHz	–	4	–	pF
C_{rs}	reverse transfer capacitance	V_{DS} = 20 V; V_{GS} = –1 V; f = 1 MHz	–	1.1	–	pF
C_{os}	output capacitance	V_{DS} = 20 V; V_{GS} = –1 V; f = 1 MHz	–	1.6	–	pF
g_{is}	input conductance	V_{DS} = 15 V; V_{GS} = 0; f = 200 MHz	–	250	–	μS
g_{os}	output conductance	V_{DS} = 15 V; V_{GS} = 0; f = 200 MHz	–	40	–	μS
$\lvert y_{fs} \rvert$	forward transfer admittance	V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz	3	–	6.5	mS
		V_{DS} = 15 V; V_{GS} = 0; f = 200 MHz	–	6	–	mS
$\lvert y_{rs} \rvert$	reverse transfer admittance	V_{DS} = 15 V; V_{GS} = 0; f = 200 MHz	–	1.4	–	mS
$\lvert y_{os} \rvert$	output admittance	V_{DS} = 15 V; V_{GS} = 0; f = 1 kHz	–	25	–	μS
f_{gfs}	cut-off frequency	V_{DS} = 15 V; V_{GS} = 0; g_{fs} = 0.7 of its value at 1 kHz	–	700	–	MHz
F	noise figure	V_{DS} = 15 V; V_{GS} = 0; f = 100 MHz; R_G = 1 kΩ (common source); input tuned to minimum noise	–	1.5	–	dB



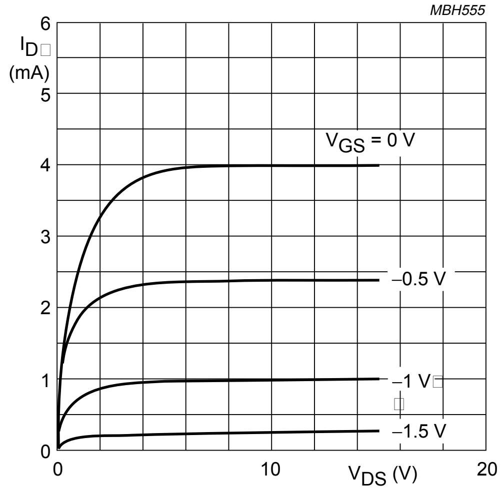
V_{DS} = 0; V_{GS} = −20 V.

Fig.2 Gate leakage current as a function of junction temperature; typical values.



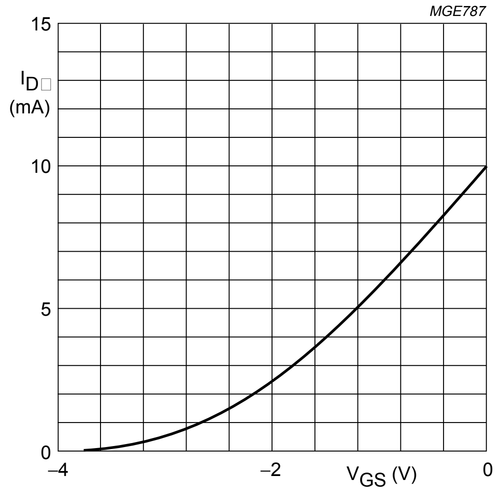
V_{DS} = 15 V; T_j = 25 °C.

Fig.3 Transfer characteristics for BF245A; typical values.



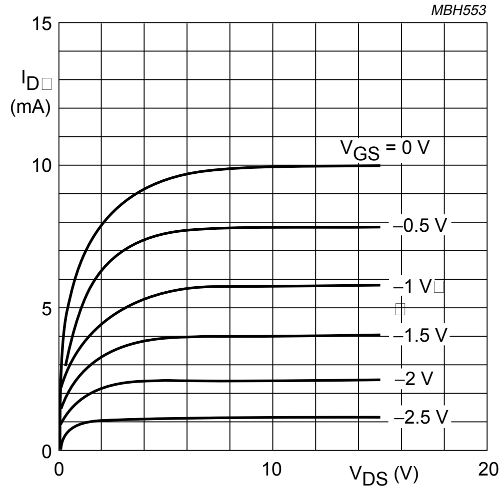
V_{DS} = 15 V; T_j = 25 °C.

Fig.4 Output characteristics for BF245A; typical values.



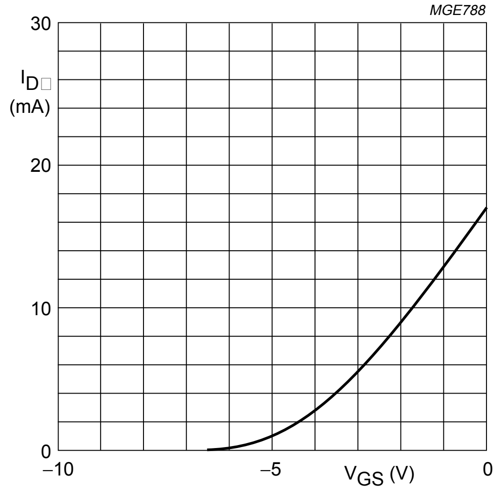
V_{DS} = 15 V; T_j = 25 °C.

Fig.5 Transfer characteristics for BF245B; typical values.



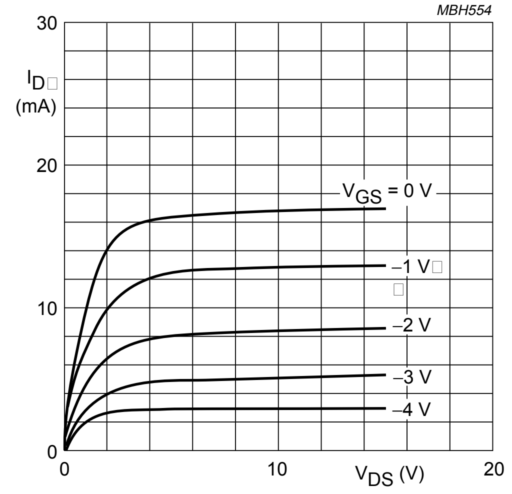
V_{DS} = 15 V; T_j = 25 °C.

Fig.6 Output characteristics for BF245B; typical values.



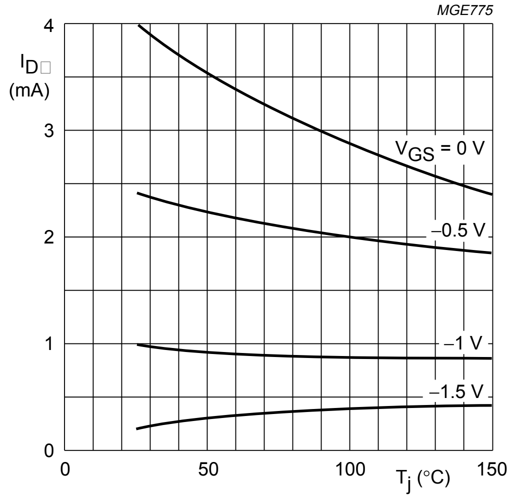
V_{DS} = 15 V; T_j = 25 °C.

Fig.7 Transfer characteristics for BF245C; typical values.



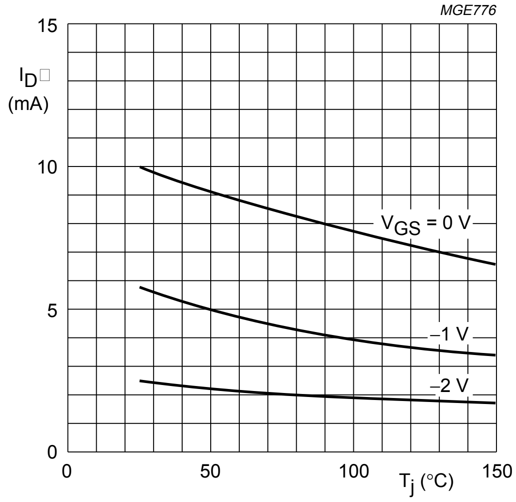
V_{DS} = 15 V; T_j = 25 °C.

Fig.8 Output characteristics for BF245C; typical values.



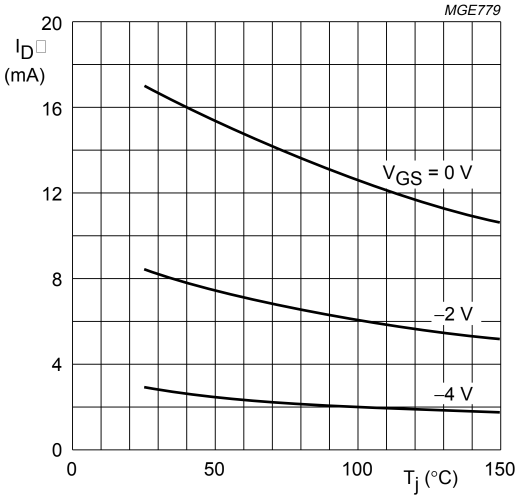
V_{DS} = 15 V.

Fig.9 Drain current as a function of junction temperature; typical values for BF245A.



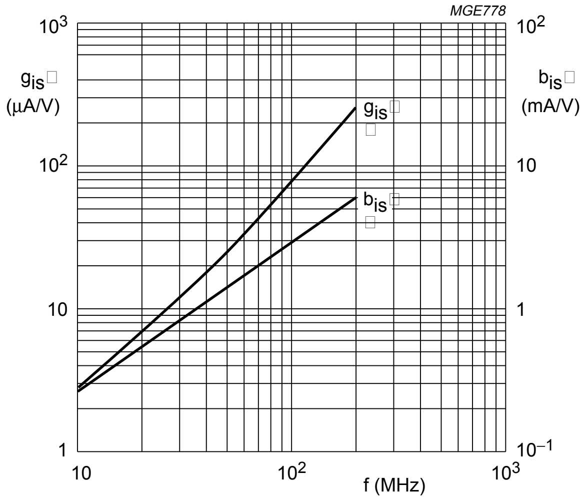
V_{DS} = 15 V.

Fig.10 Drain current as a function of junction temperature; typical values for BF245B.



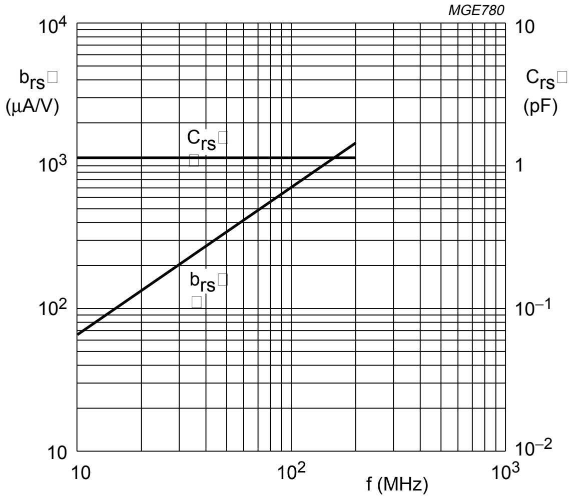
V_{DS} = 15 V.

Fig.11 Drain current as a function of junction temperature; typical values for BF245C.



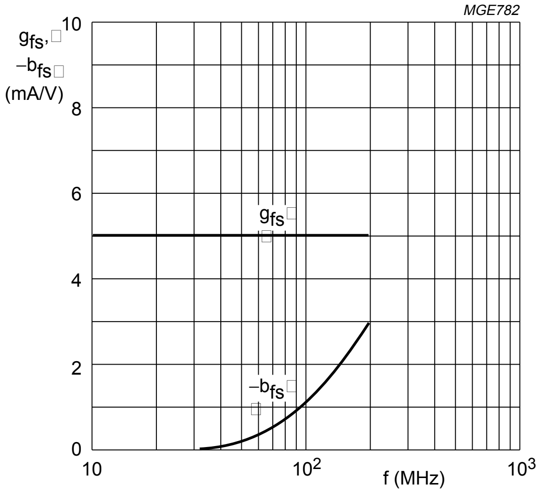
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C.

Fig.12 Input admittance; typical values.



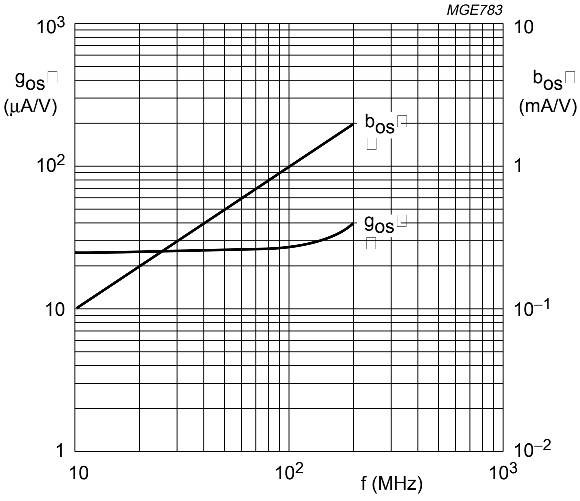
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C.

Fig.13 Common source reverse admittance as a function of frequency; typical values.



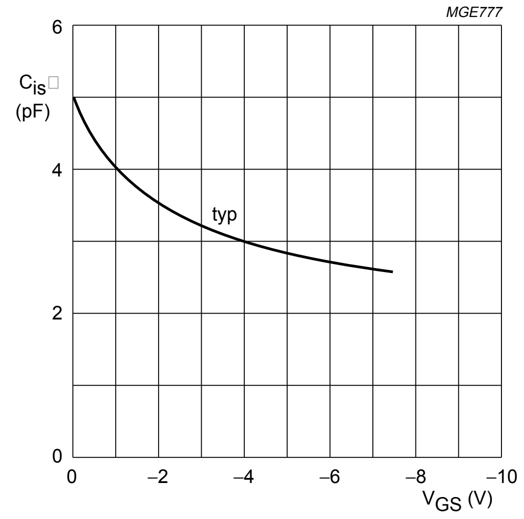
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C.

Fig.14 Common-source forward transfer admittance as a function of frequency; typical values.



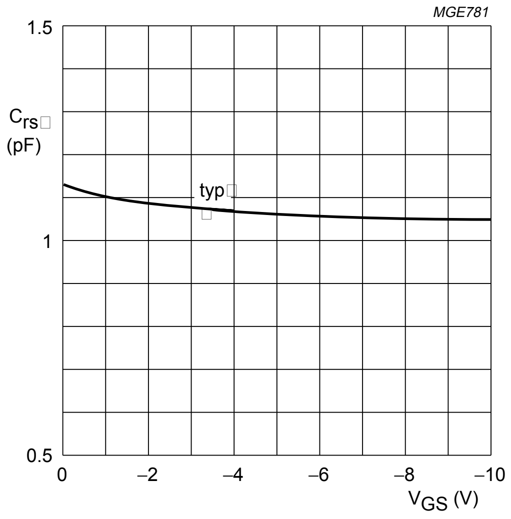
V_{DS} = 15 V; V_{GS} = 0; T_{amb} = 25 °C.

Fig.15 Common-source output admittance as a function of frequency; typical values.



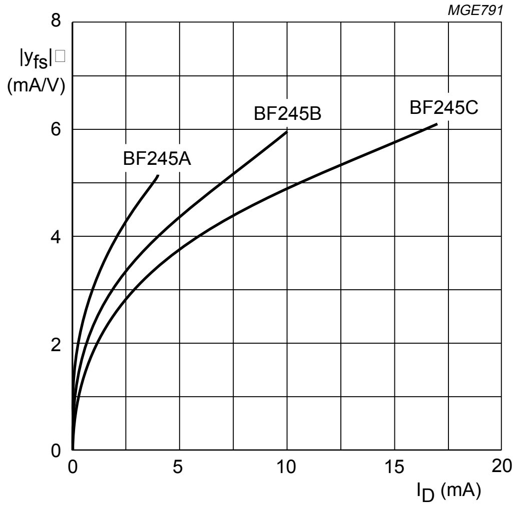
V_{DS} = 20 V; f = 1 MHz; T_{amb} = 25 °C.

Fig.16 Input capacitance as a function of gate-source voltage; typical values.



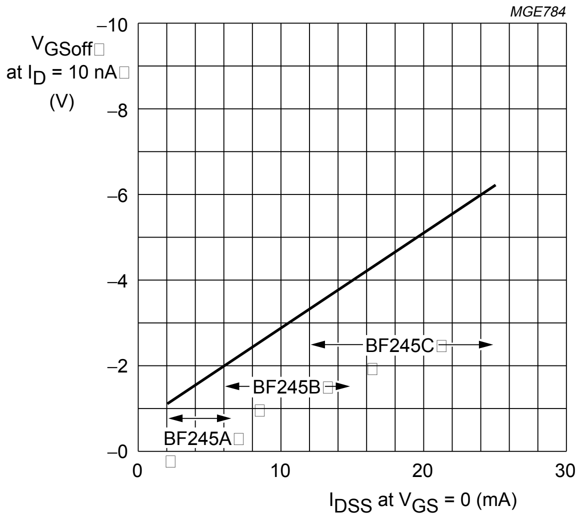
V_{DS} = 20 V; f = 1 MHz; T_{amb} = 25 °C.

Fig.17 Reverse transfer capacitance as a function of gate-source voltage; typical values.



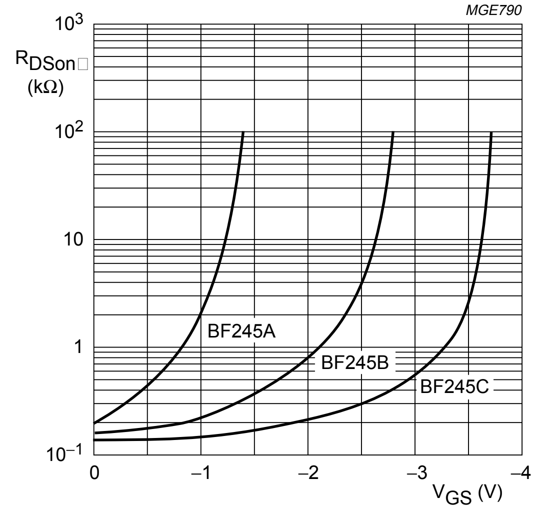
V_{DS} = 15 V; f = 1 kHz; T_{amb} = 25 °C.

Fig.18 Forward transfer admittance as a function of drain current; typical values.



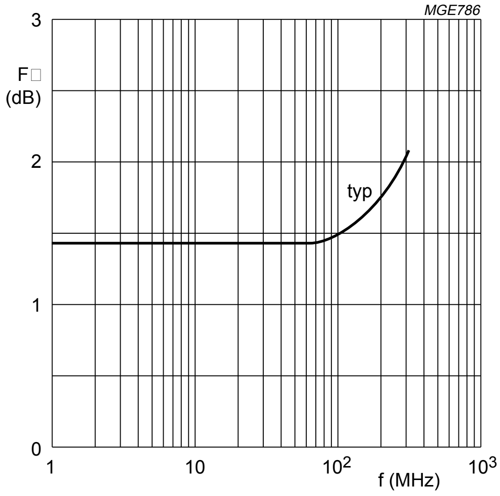
V_{DS} = 15 V; T_j = 25 °C.

Fig.19 Gate-source cut-off voltage as a function of drain current; typical values.



$V_{DS} = 0$; f = 1 kHz; $T_{amb} = 25$ °C.

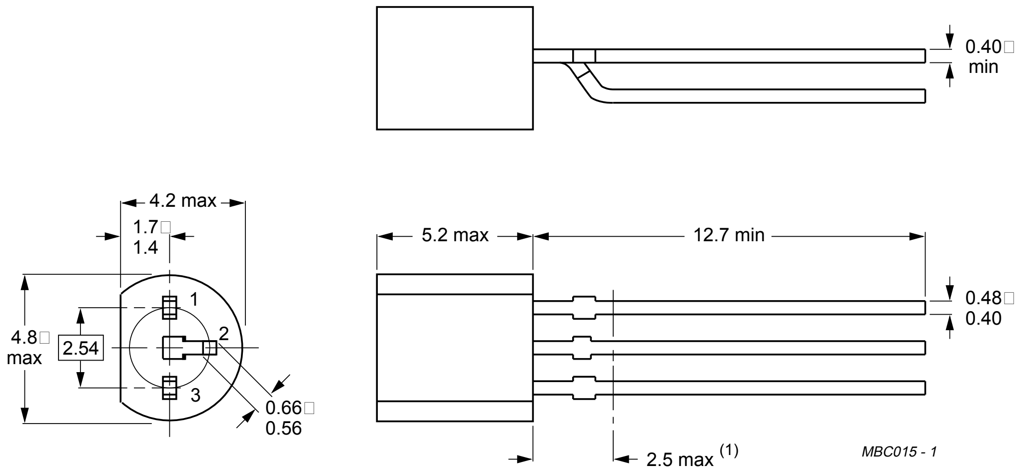
Fig.20 Drain-source on-state resistance as a function of gate-source voltage; typical values.



$V_{DS} = 15$ V; $V_{GS} = 0$; $R_G = 1$ kΩ; $T_{amb} = 25$ °C.
Input tuned to minimum noise.

Fig.21 Noise figure as a function of frequency; typical values.

PACKAGE OUTLINE



Dimensions in mm.

(1) Terminal dimensions within this zone are uncontrolled.

Fig.22 TO-92 variant.

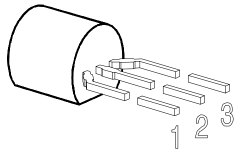
DEFINITIONS

<table>
<tr><th colspan="2">Data Sheet Status</th></tr>
<tr><td>Objective specification</td><td>This data sheet contains target or goal specifications for product development.</td></tr>
<tr><td>Preliminary specification</td><td>This data sheet contains preliminary data; supplementary data may be published later.</td></tr>
<tr><td>Product specification</td><td>This data sheet contains final product specifications.</td></tr>
<tr><th colspan="2">Limiting values</th></tr>
<tr><td colspan="2">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.</td></tr>
<tr><th colspan="2">Application information</th></tr>
<tr><td colspan="2">Where application information is given, it is advisory and does not form part of the specification.</td></tr>
</table>

LIFE SUPPORT APPLICATIONS

SIPMOS ® Small-Signal Transistor

- N channel
- Enhancement mode
- Logic Level
- $V_{GS(th)}$ = 0.8...2.0V



Pin 1	Pin 2	Pin 3
S	G	D

Type	V_{DS}	I_D	$R_{DS(on)}$	Package	Marking
BS 170	60 V	0.3 A	5 Ω	TO-92	BS 170

Type	Ordering Code	Tape and Reel Information
BS 170	Q67000-S076	E6288

Maximum Ratings

Parameter	Symbol	Values	Unit
Drain source voltage	V_{DS}	60	V
Drain-gate voltage R_{GS} = 20 kΩ	V_{DGR}	60	
Gate source voltage	V_{GS}	± 14	
Gate-source peak voltage,aperiodic	V_{gs}	± 20	
Continuous drain current T_A = 25 °C	I_D	0.3	A
DC drain current, pulsed T_A = 25 °C	I_{Dpuls}	1.2	
Power dissipation T_A = 25 °C	P_{tot}	0.63	W

Maximum Ratings

Parameter	Symbol	Values	Unit
Chip or operating temperature	T_j	-55 ... + 150	°C
Storage temperature	T_{stg}	-55 ... + 150	
Thermal resistance, chip to ambient air [1)	R_{thJA}	$\leq$ 200	K/W
DIN humidity category, DIN 40 040		E	
IEC climatic category, DIN IEC 68-1		55 / 150 / 56	

Electrical Characteristics, at T_j = 25°C, unless otherwise specified

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Static Characteristics					
Drain- source breakdown voltage V_{GS} = 0 V, I_D = 0.25 mA, T_j = 25 °C	$V_{(BR)DSS}$	60	-	-	V
Gate threshold voltage V_{GS}=$V_{DS,}$ I_D = 1 mA	$V_{GS(th)}$	0.8	1.4	2	
Zero gate voltage drain current	I_{DSS}				µA
V_{DS} = 60 V, V_{GS} = 0 V, T_j = 25 °C		-	0.05	0.5	
V_{DS} = 60 V, V_{GS} = 0 V, T_j = 125 °C		-	-	5	
Gate-source leakage current V_{GS} = 20 V, V_{DS} = 0 V	I_{GSS}	-	1	10	nA
Drain-Source on-state resistance V_{GS} = 10 V, I_D = 0.2 A	$R_{DS(on)}$	-	2.5	5	Ω

Electrical Characteristics, at T_j = 25°C, unless otherwise specified

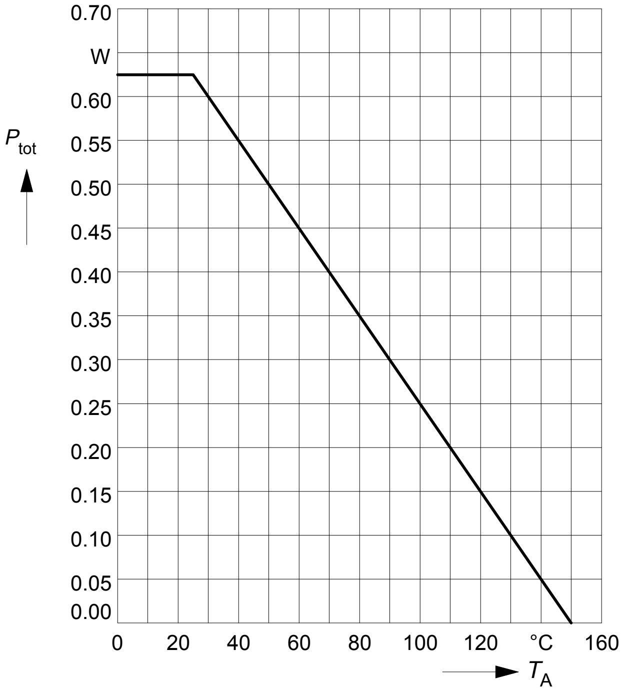
Parameter	**Symbol**	**Values**			**Unit**
		min.	**typ.**	**max.**	
Dynamic Characteristics					
Transconductance $V_{DS} \geq 2 * I_D * R_{DS(on)max}$, I_D = 0.2 A	g_{fs}	0.12	0.18	-	S
Input capacitance V_{GS} = 0 V, V_{DS} = 25 V, f = 1 MHz	C_{iss}	-	40	60	pF
Output capacitance V_{GS} = 0 V, V_{DS} = 25 V, f = 1 MHz	C_{oss}	-	15	25	
Reverse transfer capacitance V_{GS} = 0 V, V_{DS} = 25 V, f = 1 MHz	C_{rss}	-	5	10	
Turn-on delay time V_{DD} = 30 V, V_{GS} = 10 V, I_D = 0.29 A R_G = 50 Ω	$t_{d(on)}$	-	5	8	ns
Rise time V_{DD} = 30 V, V_{GS} = 10 V, I_D = 0.29 A R_G = 50 Ω	t_r	-	8	12	
Turn-off delay time V_{DD} = 30 V, V_{GS} = 10 V, I_D = 0.29 A R_G = 50 Ω	$t_{d(off)}$	-	12	16	
Fall time V_{DD} = 30 V, V_{GS} = 10 V, I_D = 0.29 A R_G = 50 Ω	t_f	-	17	22	

Electrical Characteristics, at T_j = 25°C, unless otherwise specified

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Reverse Diode					
Inverse diode continuous forward current T_A = 25 °C	I_S	-	-	0.3	A
Inverse diode direct current,pulsed T_A = 25 °C	I_{SM}	-	-	1.2	
Inverse diode forward voltage V_{GS} = 0 V, I_F = 0.5 A	V_{SD}	-	0.9	1.2	V

Power dissipation

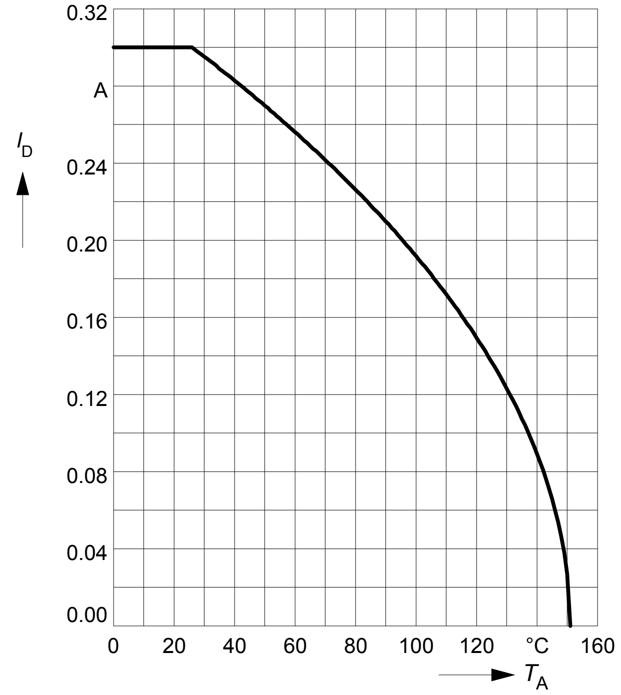
$P_{tot} = f(T_A)$



Drain current

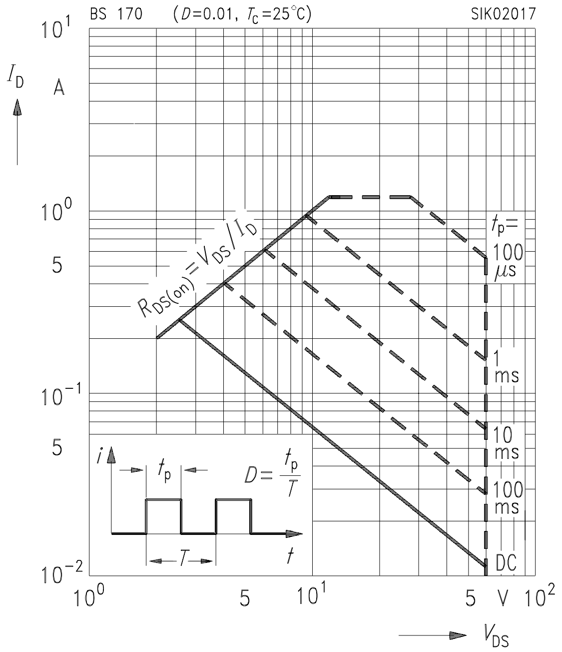
$I_D = f(T_A)$

parameter: $V_{GS} \geq 10$ V



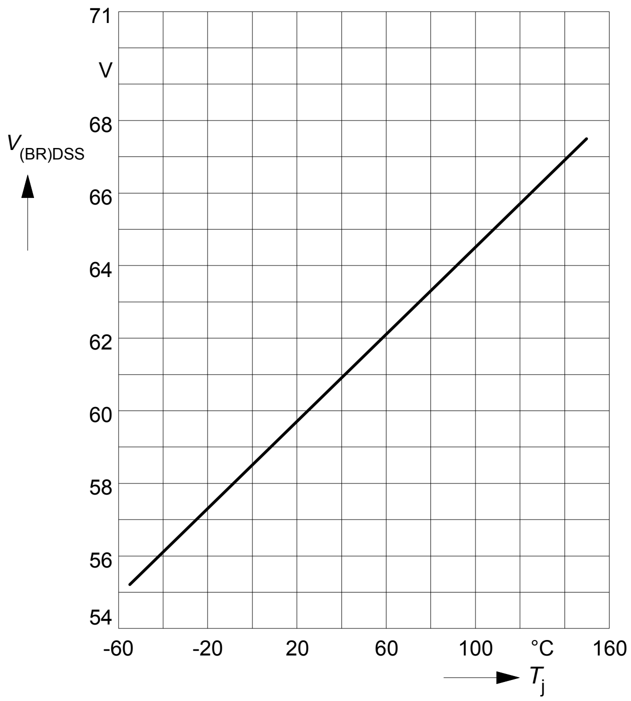
Safe operating area I_D=f(V_{DS})

parameter : D = 0.01, T_C=25°C



Drain-source breakdown voltage

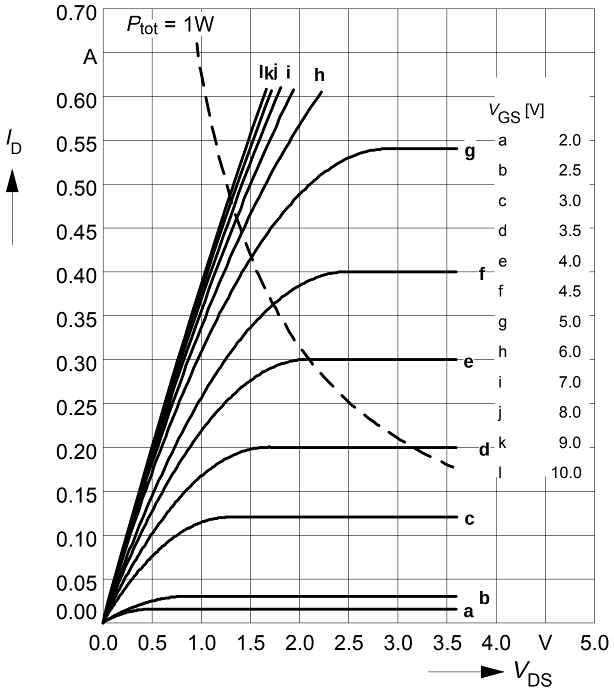
$V_{(BR)DSS} = f(T_j)$



Typ. output characteristics

$I_D = f(V_{DS})$

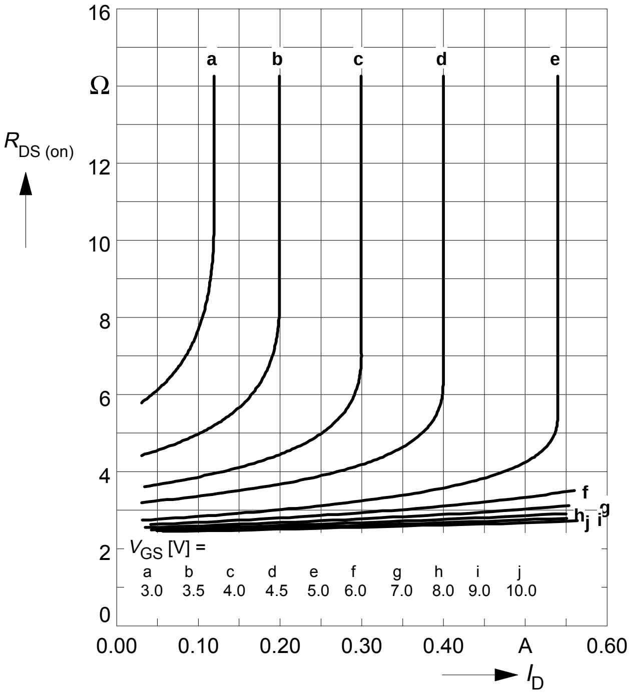
parameter: t_p = 80 µs , T_j = 25 °C



Typ. drain-source on-resistance

$R_{DS\ (on)} = f(I_D)$

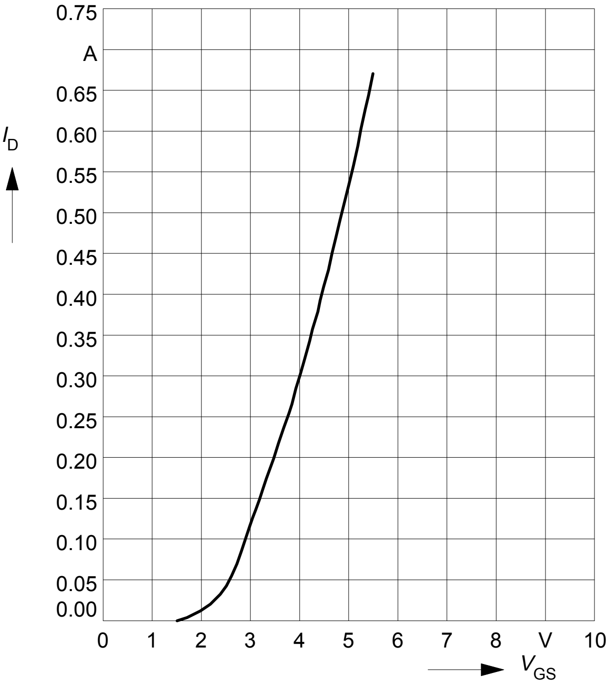
parameter: t_p = 80 µs, T_j = 25 °C



Typ. transfer characteristics $I_D = f(V_{GS})$

parameter: t_p = 80 µs

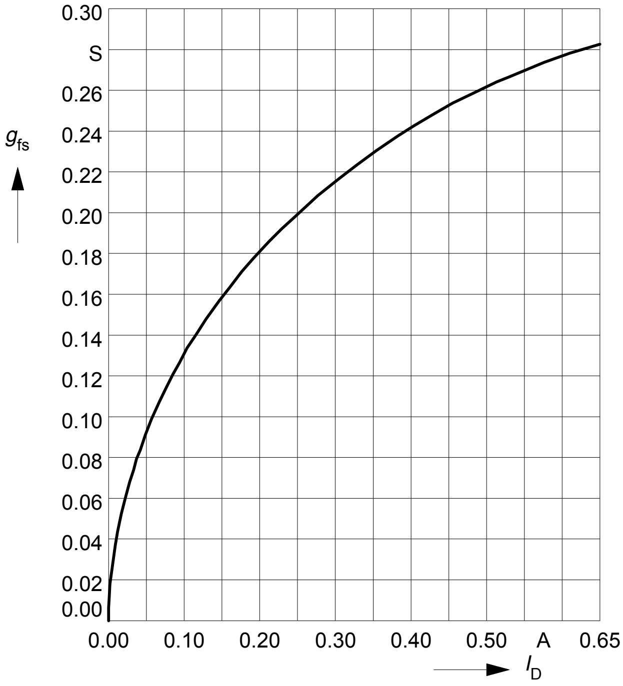
$V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$



Typ. forward transconductance $g_{fs} = f(I_D)$

parameter: t_p = 80 µs,

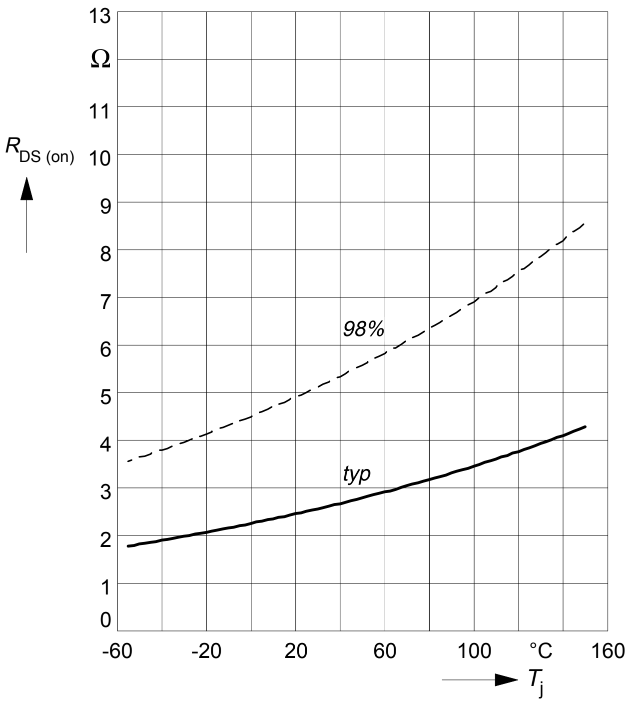
$V_{DS} \geq 2 \times I_D \times R_{DS(on)max}$



Drain-source on-resistance

$R_{DS\ (on)} = f(T_j)$

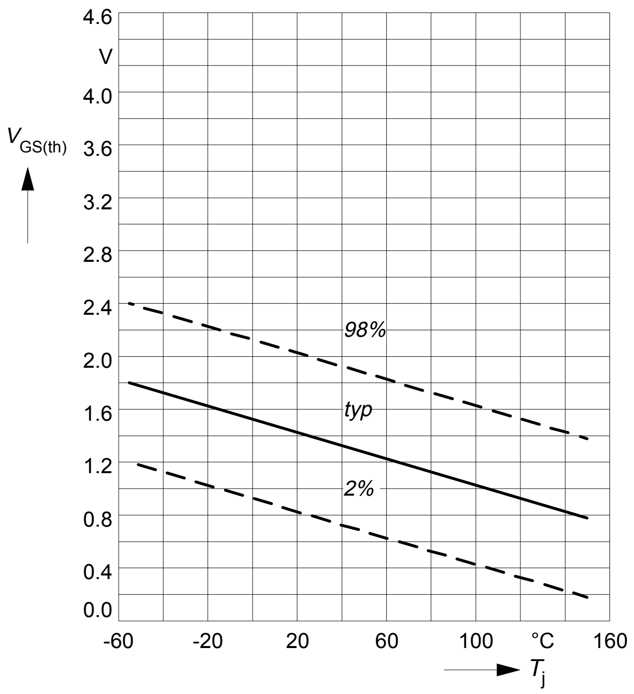
parameter: I_D = 0.2 A, V_{GS} = 10 V



Gate threshold voltage

$V_{GS\ (th)} = f(T_j)$

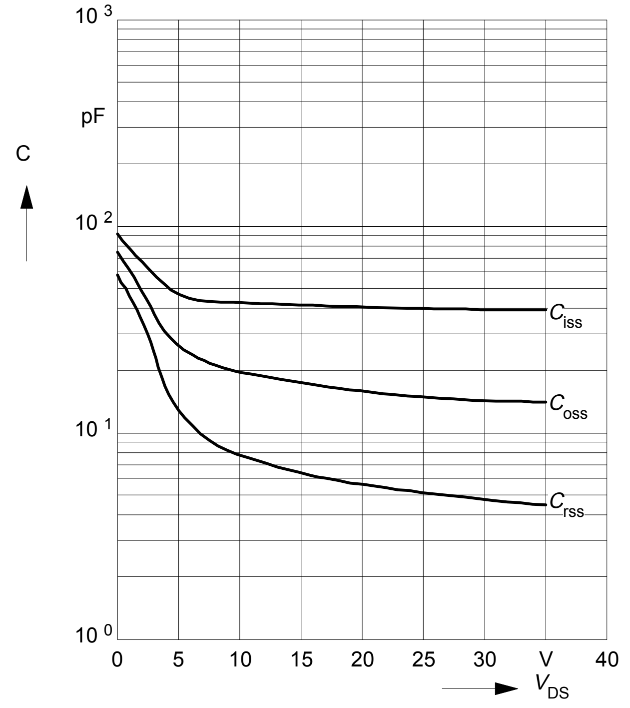
parameter: $V_{GS} = V_{DS}$, I_D = 1 mA



Typ. capacitances

$C = f\ (V_{DS})$

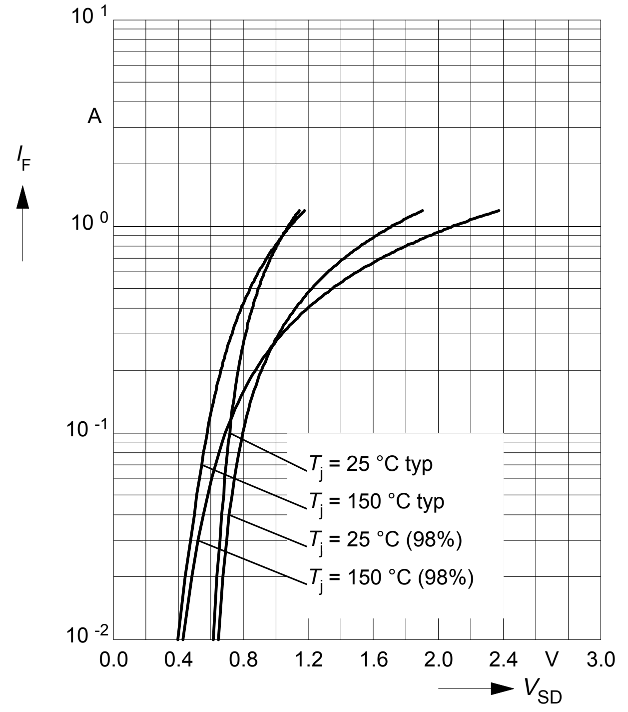
parameter: V_{GS}=0V, f = 1 MHz



Forward characteristics of reverse diode

$I_F = f(V_{SD})$

parameter: T_j, t_p = 80 µs

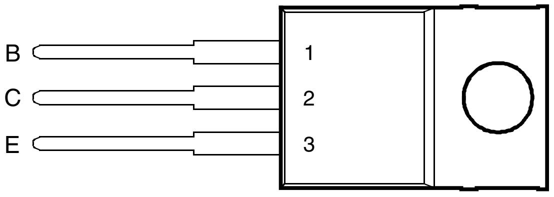


BD645, BD647, BD649, BD651
NPN SILICON POWER DARLINGTONS

BOURNS®

- **Designed for Complementary Use with BD646, BD648, BD650 and BD652**
- **62.5 W at 25°C Case Temperature**
- **8 A Continuous Collector Current**
- **Minimum h_{FE} of 750 at 3V, 3 A**

**TO-220 PACKAGE
(TOP VIEW)**



Pin 2 is in electrical contact with the mounting base.

MDTRACA

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Collector-base voltage ($I_E = 0$)	BD645	V_{CBO}	80	V
	BD647		100	
	BD649		120	
	BD651		140	
Collector-emitter voltage ($I_B = 0$)	BD645	V_{CEO}	60	V
	BD647		80	
	BD649		100	
	BD651		120	
Emitter-base voltage		V_{EBO}	5	V
Continuous collector current		I_C	8	A
Peak collector current (see Note 1)		I_{CM}	12	A
Continuous base current		I_B	0.3	A
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)		P_{tot}	62.5	W
Continuous device dissipation at (or below) 25°C free air temperature (see Note 3)		P_{tot}	2	W
Unclamped inductive load energy (see Note 4)		$½LI_C^2$	50	mJ
Operating junction temperature range		T_j	-65 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C
Lead temperature 3.2 mm from case for 10 seconds		T_L	260	°C

NOTES:
1. This value applies for $t_p \leq 0.3$ ms, duty cycle $\leq$ 10%.
2. Derate linearly to 150°C case temperature at the rate of 0.4 W/°C.
3. Derate linearly to 150°C free air temperature at the rate of 16 mW/°C.
4. This rating is based on the capability of the transistor to operate safely in a circuit of: L = 20 mH, $I_{B(on)} = 5$ mA, $R_{BE} = 100\ \Omega$, $V_{BE(off)} = 0$, $R_S = 0.1\ \Omega$, $V_{CC} = 20$ V.

MAY 1993 - REVISED SEPTEMBER 2002

electrical characteristics at 25°C case temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS				MIN	TYP	MAX	UNIT
$V_{(BR)CEO}$	Collector-emitter breakdown voltage	I_C = 30 mA	I_B = 0	(see Note 5)	BD645	60			V
					BD647	80			
					BD649	100			
					BD651	120			
I_{CEO}	Collector-emitter cut-off current	V_{CE} = 30 V	I_B = 0		BD645			0.5	mA
		V_{CE} = 40 V	I_B = 0		BD647			0.5	
		V_{CE} = 50 V	I_B = 0		BD649			0.5	
		V_{CE} = 60 V	I_B = 0		BD651			0.5	
I_{CBO}	Collector cut-off current	V_{CB} = 60 V	I_E = 0		BD645			0.2	mA
		V_{CB} = 80 V	I_E = 0		BD647			0.2	
		V_{CB} = 100 V	I_E = 0		BD649			0.2	
		V_{CB} = 120 V	I_E = 0		BD651			0.2	
		V_{CB} = 40 V	I_E = 0	T_C = 150°C	BD645			2.0	
		V_{CB} = 50 V	I_E = 0	T_C = 150°C	BD647			2.0	
		V_{CB} = 60 V	I_E = 0	T_C = 150°C	BD649			2.0	
		V_{CB} = 70 V	I_E = 0	T_C = 150°C	BD651			2.0	
I_{EBO}	Emitter cut-off current	V_{EB} = 5 V	I_C = 0	(see Notes 5 and 6)				5	mA
h_{FE}	Forward current transfer ratio	V_{CE} = 3 V	I_C = 3 A	(see Notes 5 and 6)		750			
$V_{CE(sat)}$	Collector-emitter saturation voltage	I_B = 12 mA	I_C = 3 A	(see Notes 5 and 6)				2	V
		I_B = 50 mA	I_C = 5 A					2.5	
$V_{BE(sat)}$	Base-emitter saturation voltage	I_B = 50 mA	I_C = 5 A	(see Notes 5 and 6)				3	V
$V_{BE(on)}$	Base-emitter voltage	V_{CE} = 3 V	I_C = 3 A	(see Notes 5 and 6)				2.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_p = 300 µs, duty cycle ≤ 2%.
6. These parameters must be measured using voltage-sensing contacts, separate from the current carrying contacts.

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$	Junction to case thermal resistance			2.0	°C/W
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS

TYPICAL DC CURRENT GAIN vs COLLECTOR CURRENT

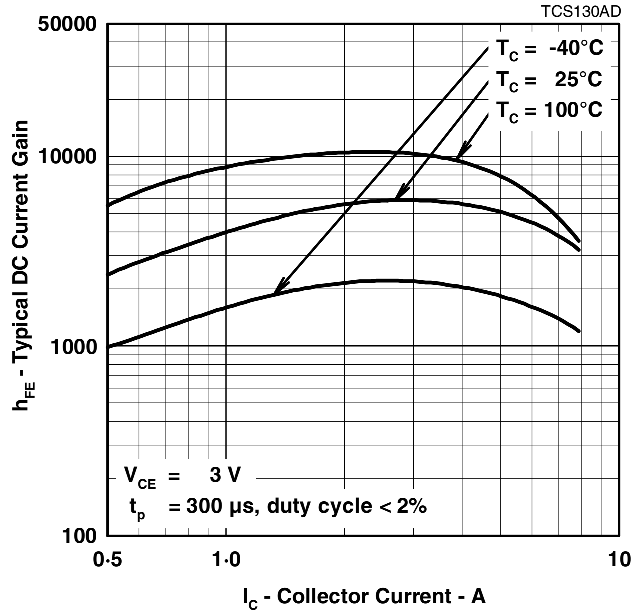


Figure 1.

COLLECTOR-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

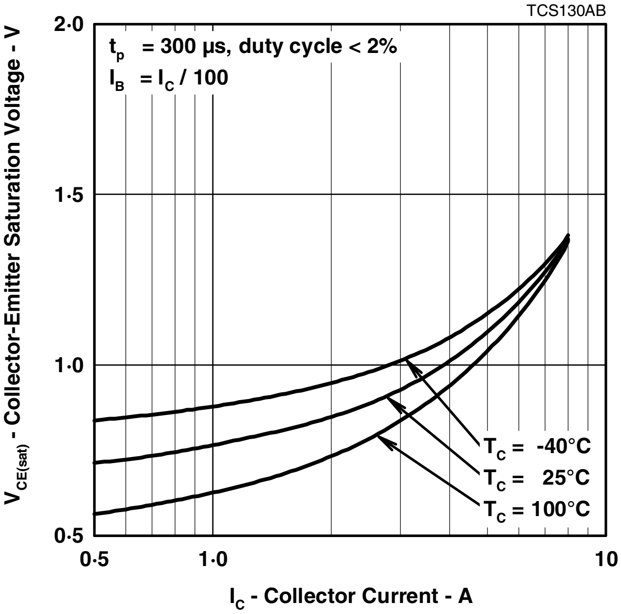


Figure 2.

BASE-EMITTER SATURATION VOLTAGE vs COLLECTOR CURRENT

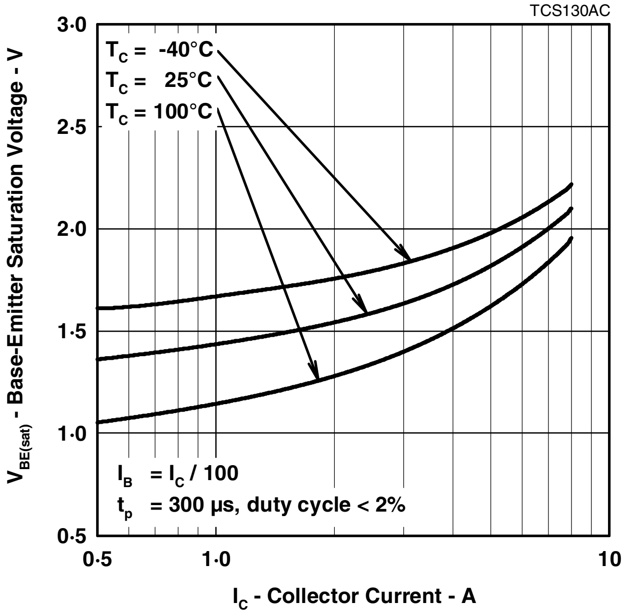


Figure 3.

MAXIMUM SAFE OPERATING REGIONS

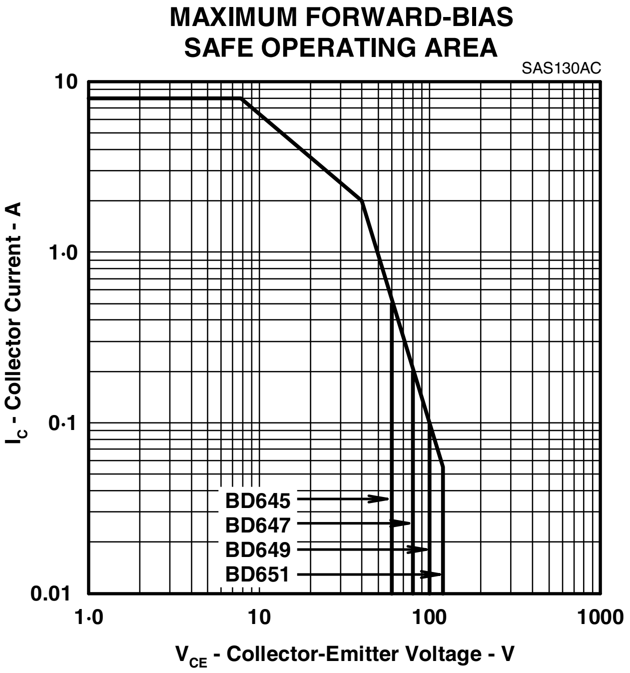


Figure 4.

THERMAL INFORMATION

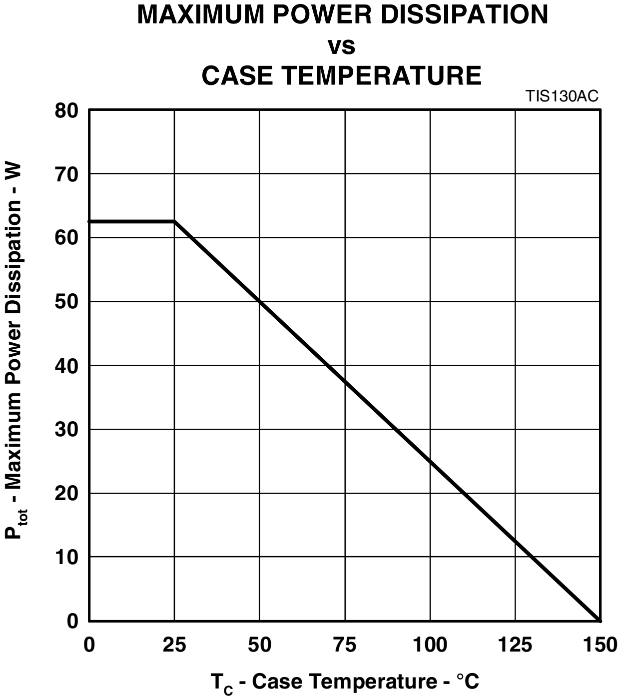


Figure 5.