

BUK9907-40ATC

TrenchPLUS logic level FET

Rev. 01 — 28 January 2002

Product data

1. Description

N-channel enhancement mode field-effect power transistor in a plastic package using TrenchMOS™ technology, featuring very low on-state resistance and TrenchPLUS diodes for clamping, ElectroStatic Discharge (ESD) protection and temperature sensing.

Product availability:

BUK9907-40ATC in SOT263B.

2. Features

- Typical on-state resistance 5.8 mΩ
- Q101 compliant
- ESD and overvoltage protection
- Monolithically integrated temperature sensor for overload protection.

3. Applications

- Automotive and power switching:
 - ◆ 12 V and 24 V high power motor drives (e.g. Electrical Power Assisted Steering (EPAS))
 - ◆ Protected drive for lamps.

4. Pinning information

Table 1: Pinning - SOT263B simplified outline and symbol

Pin	Description	Simplified outline	Symbol
1	gate (g)		
2	anode (a)		
3	drain (d)		
4	cathode (k)		
5	source (s)		
mb	mounting base; connected to drain (d)	SOT263B	

5. Quick reference data

Table 2: Quick reference data

Symbol	Parameter	Conditions	Typ	Max	Unit
$V_{DSR(CL)}$	drain-source clamping voltage	$T_j = 25\text{ }^{\circ}\text{C}$; $I_{GS(CL)} = -2\text{ mA}$; $I_D = 1\text{ A}$	50	-	V
I_D	drain current (DC)	$T_{mb} = 25\text{ }^{\circ}\text{C}$; $V_{GS} = 5\text{ V}$	-	140	A
P_{tot}	total power dissipation	$T_{mb} = 25\text{ }^{\circ}\text{C}$	-	272	W
T_j	junction temperature		-	175	$^{\circ}\text{C}$
R_{DSon}	drain-source on-state resistance	$T_j = 25\text{ }^{\circ}\text{C}$; $V_{GS} = 5\text{ V}$; $I_D = 50\text{ A}$	5.8	7	$\text{m}\Omega$
		$T_j = 25\text{ }^{\circ}\text{C}$; $V_{GS} = 4.5\text{ V}$; $I_D = 50\text{ A}$	6	7.7	$\text{m}\Omega$
		$T_j = 25\text{ }^{\circ}\text{C}$; $V_{GS} = 10\text{ V}$; $I_D = 50\text{ A}$	5.2	6.2	$\text{m}\Omega$
V_F	temperature sense diode forward voltage	$T_j = 25\text{ }^{\circ}\text{C}$; $I_F = 250\text{ }\mu\text{A}$	658	668	mV
S_F	temperature sense diode temperature coefficient	$-55\text{ }^{\circ}\text{C} < T_j < 175\text{ }^{\circ}\text{C}$; $I_F = 250\text{ }\mu\text{A}$	-1.54	-1.68	mV/K

6. Limiting values

Table 3: Limiting values

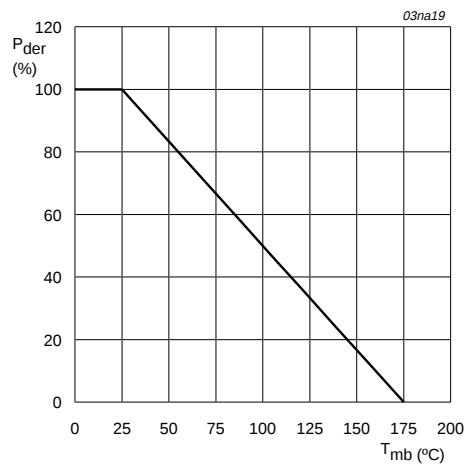
In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DS}	drain-source voltage (DC)		[1] -	40	V
V_{DGS}	drain-gate voltage (DC)	$I_{DG} = 250 \mu A$	[1] -	40	V
V_{GS}	gate-source voltage (DC)		[1] -	± 15	V
I_D	drain current (DC)	$T_{mb} = 25^\circ C$; $V_{GS} = 5 V$; Figure 2 and 3	[2] -	140	A
			[3] -	75	A
		$T_{mb} = 100^\circ C$; $V_{GS} = 5 V$; Figure 2	[3] -	75	A
I_{DM}	drain current (peak value)	$T_{mb} = 25^\circ C$; pulsed; $t_p \leq 10 \mu s$; Figure 3	-	560	A
P_{tot}	total power dissipation	$T_{mb} = 25^\circ C$; Figure 1	-	272	W
$I_{DG(CL)}$	drain-gate clamping current	$t_p = 5 ms$; $\delta = 0.01$	-	50	mA
$I_{GS(CL)}$	gate-source clamping current	continuous	-	10	mA
		$t_p = 5 ms$; $\delta = 0.01$	-	50	mA
$V_{isol(FET-TSD)}$	FET to temperature sense diode isolation voltage		-	± 100	V
T_{stg}	storage temperature		-55	+175	$^\circ C$
T_j	operating junction temperature		-55	+175	$^\circ C$
Source-drain diode					
I_{DR}	reverse drain current (DC)	$T_{mb} = 25^\circ C$	[2] -	140	A
			[3] -	75	A
I_{DRM}	pulsed reverse drain current	$T_{mb} = 25^\circ C$; pulsed; $t_p \leq 10 \mu s$	-	560	A
Clamping					
$E_{DS(CL)S}$	non-repetitive drain-source clamping energy	unclamped inductive load; $I_D = 75 A$; $V_{DS} \leq 40 V$; $V_{GS} = 5 V$; $R_{GS} = 10 k\Omega$; starting $T_j = 25^\circ C$	-	1.4	J
Electrostatic Discharge					
V_{esd}	electrostatic discharge voltage; pins 1,3,5	Human Body Model; $C = 100 pF$; $R = 1.5 k\Omega$	-	6	kV

[1] Voltage is limited by clamping

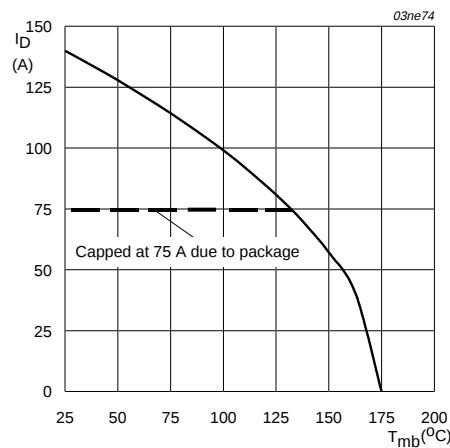
[2] Current is limited by power dissipation chip rating

[3] Continuous current is limited by package.



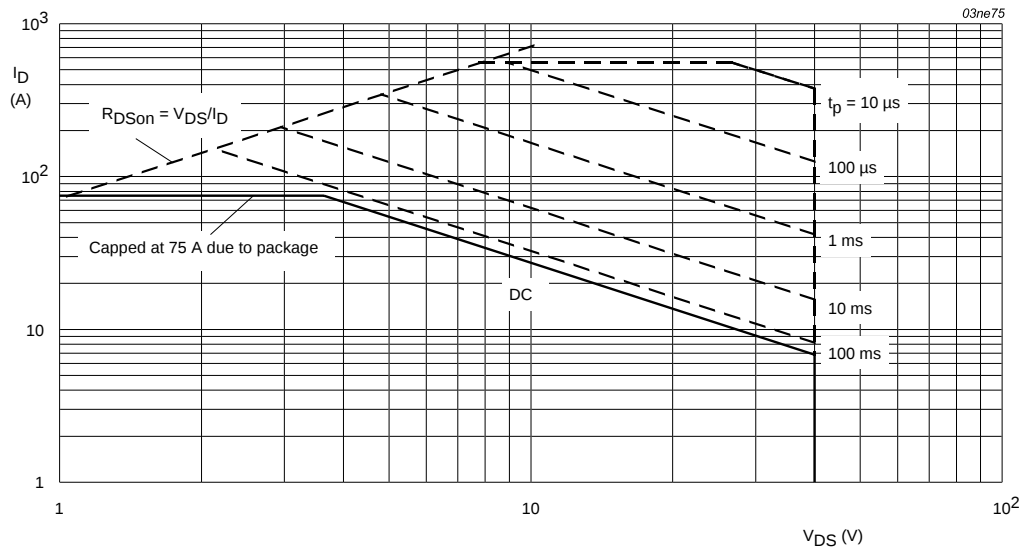
$$P_{der} = \frac{P_{tot}}{P_{tot(25^{\circ}C)}} \times 100\%$$

Fig 1. Normalized total power dissipation as a function of mounting base temperature.



$$V_{GS} \geq 5 \text{ V}$$

Fig 2. Continuous drain current as a function of mounting base temperature.



$$T_{mb} = 25^{\circ}C; I_{DM} \text{ single pulse.}$$

Fig 3. Safe operating area; continuous and peak drain currents as a function of drain-source voltage.

7. Thermal characteristics

Table 4: Thermal characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	vertical in still air	-	-	60	K/W
$R_{th(j-mb)}$	thermal resistance from junction to mounting base	Figure 4	-	-	0.55	K/W

7.1 Transient thermal impedance

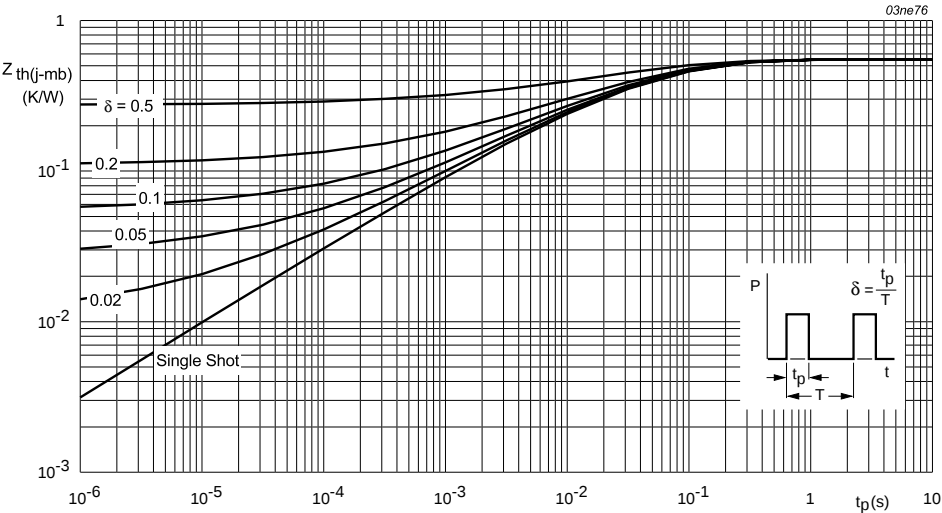


Fig 4. Transient thermal impedance from junction to mounting base as a function of pulse duration.

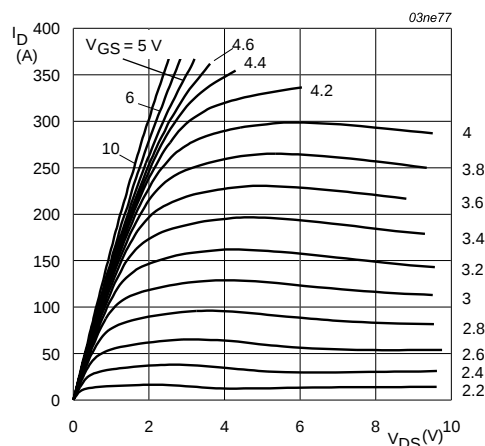
8. Characteristics

Table 5: Characteristics
 $T_j = 25\text{ °C}$ unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DG}$	drain-gate zener breakdown voltage	$I_D = 0.25\text{ mA}; V_{GS} = 0\text{ V}$	40	-	-	V
		$T_j = -55\text{ °C}$	40	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 1\text{ mA}; V_{DS} = V_{GS};$ Figure 9	1	1.5	2	V
		$T_j = 175\text{ °C}$	0.5	-	-	V
		$T_j = -55\text{ °C}$	-	-	2.3	V
I_{DSS}	drain-source leakage current	$V_{DS} = 40\text{ V}; V_{GS} = 0\text{ V}$	-	0.1	100	μA
		$T_j = 175\text{ °C}$	-	-	250	μA
$V_{(BR)GSS}$	gate-source breakdown voltage	$I_G = \pm 1\text{ mA};$ $-55\text{ °C} < T_j < 175\text{ °C}$	12	15	-	V
I_{GSS}	gate-source leakage current	$V_{GS} = \pm 5\text{ V}; V_{DS} = 0\text{ V}$	-	5	1000	nA
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 5\text{ V}; I_D = 50\text{ A};$ Figure 7 and 8	-	5.8	7	m Ω
		$T_j = 175\text{ °C}$	-	-	14	m Ω
		$V_{GS} = 4.5\text{ V}; I_D = 50\text{ A}$	-	6	7.7	m Ω
		$V_{GS} = 10\text{ V}; I_D = 50\text{ A}$	-	5.2	6.2	m Ω
V_F	temperature sense diode forward voltage	$I_F = 250\text{ }\mu\text{A}$	648	658	668	mV
S_F	temperature sense diode temperature coefficient	$I_F = 250\text{ }\mu\text{A};$ $-55\text{ °C} < T_j < 175\text{ °C}$	1.4	1.54	1.68	mV/K
V_{hys}	temperature sense diode forward voltage hysteresis	$125\text{ }\mu\text{A} < I_F < 250\text{ }\mu\text{A}$	25	32	50	mV
Dynamic characteristics						
C_{iss}	input capacitance	$V_{GS} = 0\text{ V}; V_{DS} = 25\text{ V};$ $f = 1\text{ MHz};$ Figure 12	-	5836	-	pF
C_{oss}	output capacitance		-	958	-	pF
C_{rss}	reverse transfer capacitance		-	595	-	pF
$t_{d(on)}$	turn-on delay time	$V_{DD} = 30\text{ V}; R_L = 1.2\text{ }\Omega;$ $V_{GS} = 5\text{ V}; R_G = 1\text{ k}\Omega$	-	3	-	μs
t_r	rise time		-	10	-	μs
$t_{d(off)}$	turn-off delay time		-	17	-	μs
t_f	fall time		-	11	-	μs
L_d	internal drain inductance	measured from upper edge of drain mounting base to centre of die	-	2.5	-	nH
L_s	internal source inductance	measured from source lead to source bond pad	-	7.5	-	nH

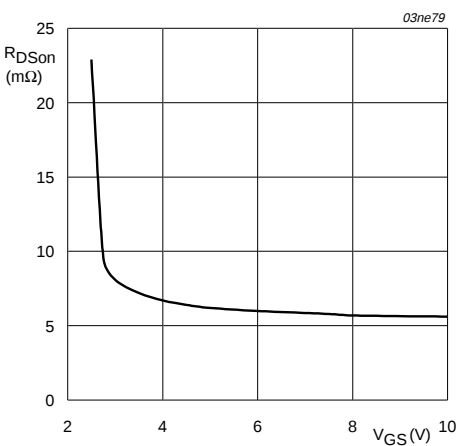
Table 5: Characteristics...continued $T_j = 25^\circ\text{C}$ unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Source-drain diode						
V_{SD}	source-drain (diode forward) voltage	$I_S = 25\text{ A}$; $V_{GS} = 0\text{ V}$; Figure 19	-	0.85	1.2	V
t_{rr}	reverse recovery time	$I_S = 20\text{ A}$; $dI_S/dt = -100\text{ A}/\mu\text{s}$	-	85	-	ns
Q_r	recovered charge	$V_{GS} = -10\text{ V}$; $V_{DS} = 30\text{ V}$	-	250	-	nC



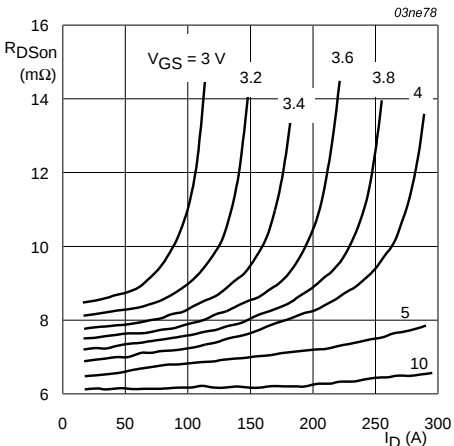
$T_j = 25\text{ }^{\circ}\text{C}$; $t_p = 300\text{ }\mu\text{s}$

Fig 5. Output characteristics: drain current as a function of drain-source voltage; typical values.



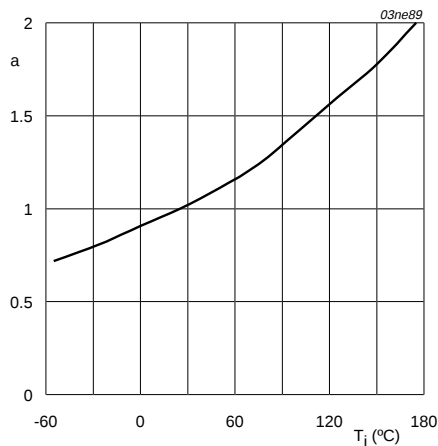
$T_j = 25\text{ }^{\circ}\text{C}$; $I_D = 50\text{ A}$

Fig 6. Drain-source on-state resistance as a function of gate-source voltage; typical values.



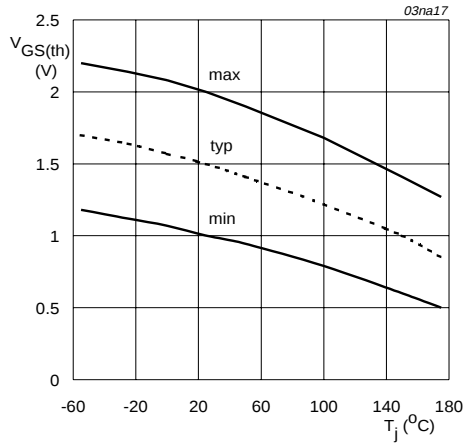
$T_j = 25\text{ }^{\circ}\text{C}$; $t_p = 300\mu\text{s}$

Fig 7. Drain-source on-state resistance as a function of drain current; typical values.



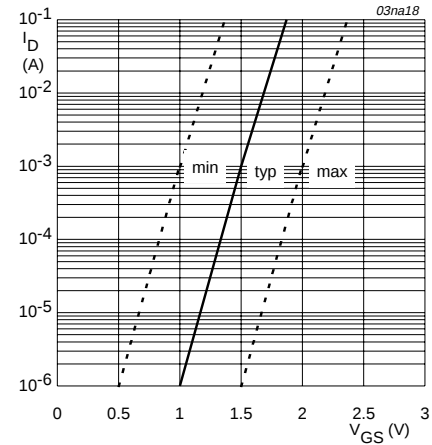
$$a = \frac{R_{DSon}}{R_{DSon}(25\text{ }^{\circ}\text{C})}$$

Fig 8. Normalized drain-source on-state resistance factor as a function of junction temperature.



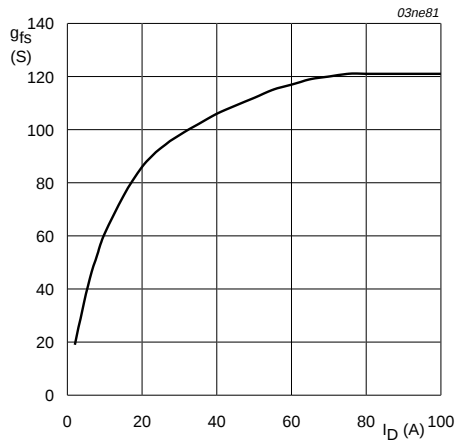
$I_D = 1 \text{ mA}$; $V_{DS} = V_{GS}$

Fig 9. Gate-source threshold voltage as a function of junction temperature.



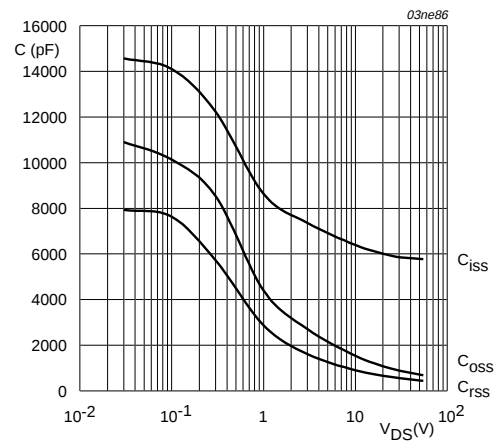
$T_j = 25 \text{ }^{\circ}C$; $V_{DS} = V_{GS}$

Fig 10. Sub-threshold drain current as a function of gate-source voltage.



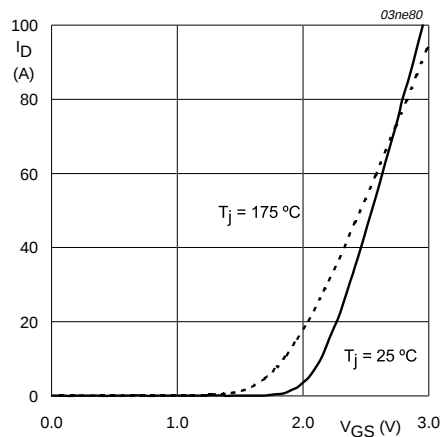
$T_j = 25 \text{ }^{\circ}C$; $V_{DS} = 25 \text{ V}$

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



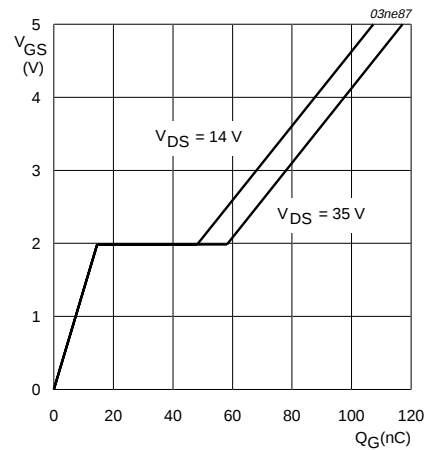
$V_{GS} = 0 \text{ V}$; $f = 1 \text{ MHz}$

Fig 12. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values.



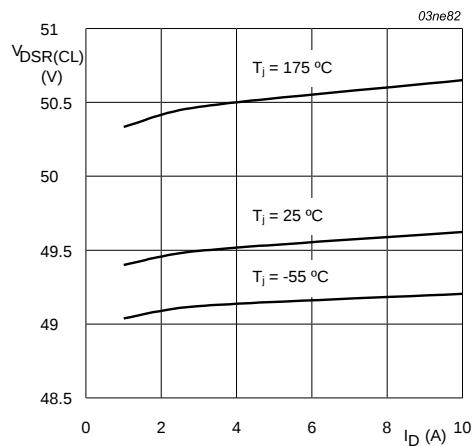
$V_{DS} = 25\text{ V}$

Fig 13. Transfer characteristics: drain current as a function of gate-source voltage; typical values.



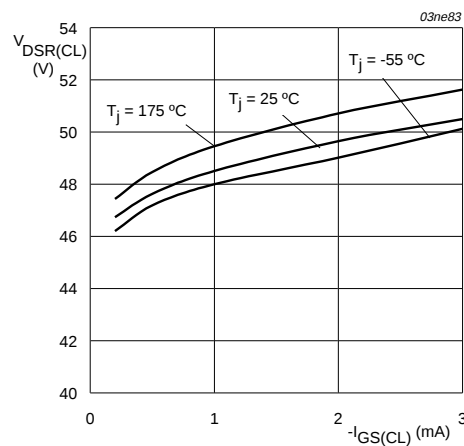
$T_J = 25\text{ }^{\circ}\text{C}; I_D = 50\text{ A}$

Fig 14. Gate-source voltage as a function of turn-on gate charge; typical values.



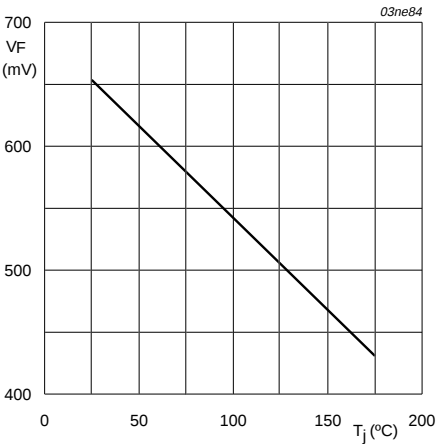
$I_{DG(CL)} = -2\text{ mA}$

Fig 15. Drain-source clamping voltage as a function of drain current; typical values.



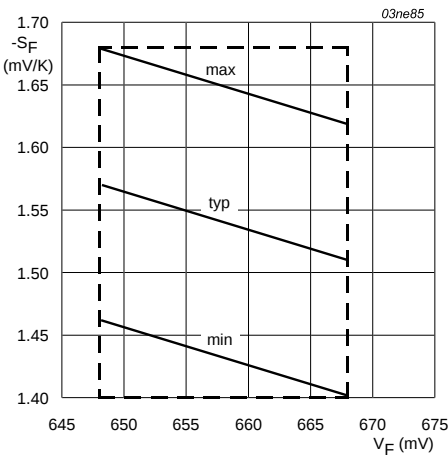
$I_D = 10\text{ A}$

Fig 16. Drain-source clamping voltage as a function of gate current; typical values.



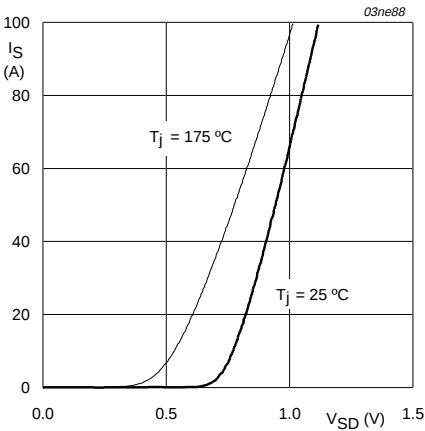
$I_F = 250 \mu A$

Fig 17. Forward voltage of temperature sense diode as a function of junction temperature; typical values.



V_F at $T_j = 25\text{ }^\circ\text{C}$; $I_F = 250 \mu A$

Fig 18. Temperature coefficient of temperature sense diode as a function of forward voltage; typical values.



$V_{GS} = 0\text{ V}$

Fig 19. Reverse diode current as a function of reverse diode voltage; typical values.

9. Package outline

Plastic single-ended package; heatsink mounted; 1 mounting hole; 5-lead TO-220

SOT263B

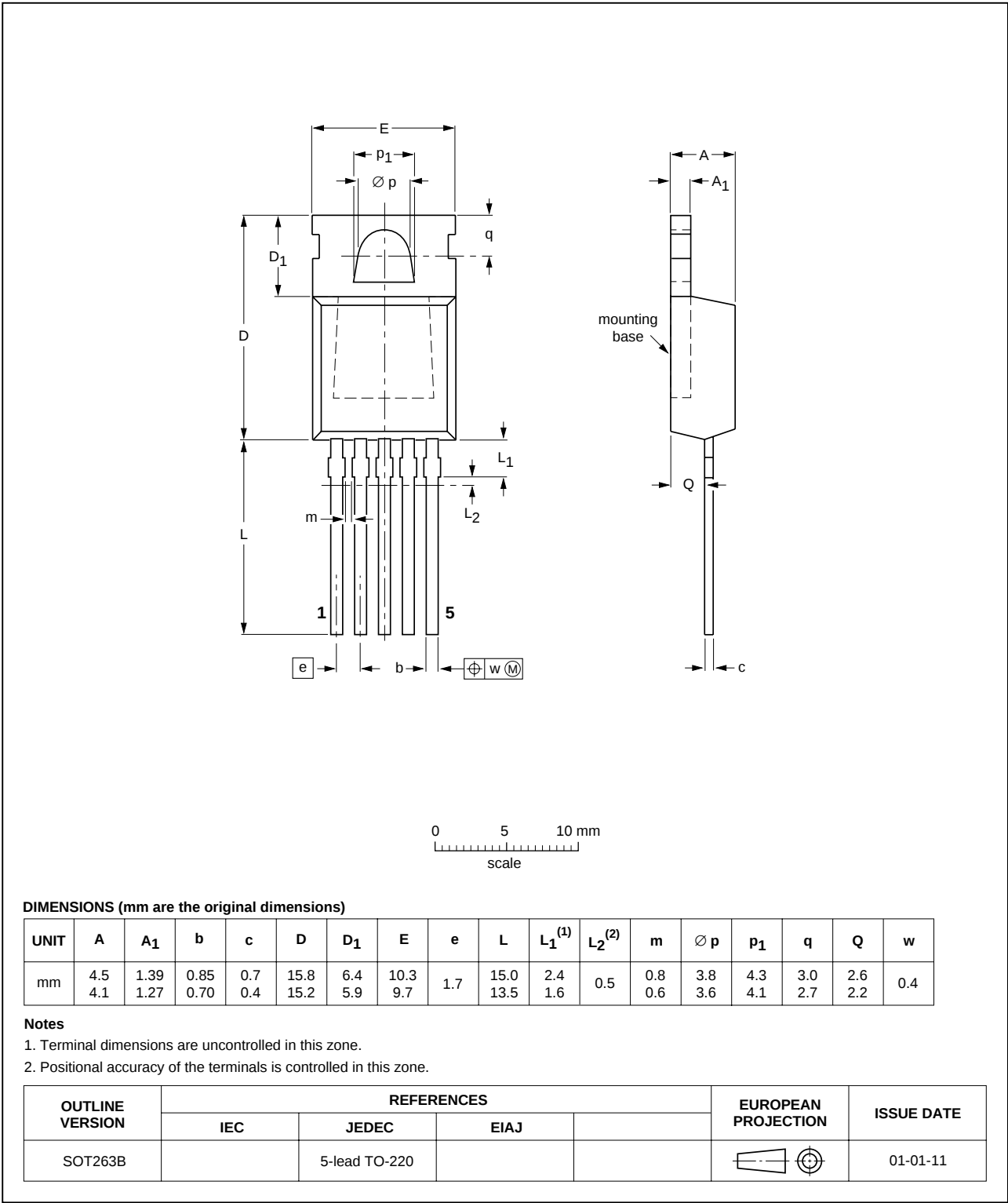


Fig 20. SOT263B.

10. Revision history

Table 6: Revision history

Rev	Date	CPCN	Description
01	20020128	-	Product data; initial version

11. Data sheet status

Data sheet status ^[1]	Product status ^[2]	Definition
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
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