PHP7NQ60E; PHX7NQ60E

N-channel enhancement mode field-effect transistor

Rev. 01 — 20 August 2002 **Product data**

1. Description

N-channel, enhancement mode field-effect power transistor.

Product availability:

PHP7NQ60E in TO-220AB (SOT78)

PHX7NQ60E in isolated TO-220AB.

2. Features

- Very fast switching
- Available in plastic and plastic full-pack package
- Low thermal resistance.

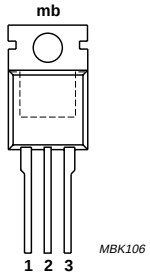
3. Applications

- DC to DC converters
- Switched mode power supplies
- Electronic lighting ballasts
- T.V. and computer monitor power supplies.

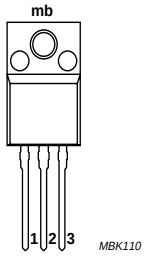
4. Pinning information

Table 1: Pinning - TO-220AB and isolated TO-220AB, simplified outline and symbol

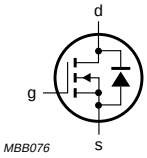
Pin	Description	Simplified outline	Symbol
1	gate (g)		
2	drain (d)		
3	source (s)		
mb (TO-220AB only)	mounting base, connected to drain (d)		



TO-220AB (SOT78)



isolated TO-220AB



5. Quick reference data

Table 2: Quick reference data

Symbol	Parameter	Conditions		Typ	Max	Unit
V_{DS}	drain-source voltage (DC)	25 °C ≤ T_j ≤ 150 °C		-	600	V
I_D	drain current (DC)	T_c = 25 °C; V_{GS} = 10 V	[1]	-	7	A
T_j	junction temperature			-	150	°C
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 3.5 A				
		T_j = 25 °C		0.94	1.2	Ω
		T_j = 150 °C		2.4	2.9	Ω

6. Limiting values

Table 3: Limiting values

Symbol	Parameter	Conditions		Min	Max	Unit
V_{DS}	drain-source voltage (DC)	25 °C ≤ T_j ≤ 150 °C		-	600	V
V_{DGR}	drain-gate voltage (DC)	25 °C ≤ T_j ≤ 150 °C; R_{GS} = 20 kΩ		-	600	V
V_{GS}	gate-source voltage (DC)			-	±30	V
I_D	drain current (DC)	T_c = 25 °C; V_{GS} = 10 V;	[1]	-	7	A
		T_c = 100 °C; V_{GS} = 10 V; Figure 3 and 4	[1]	-	4.5	A
I_{DM}	peak drain current	T_c = 25 °C; pulsed; t_p ≤ 10 µs; Figure 5 and 6		-	28	A
P_{tot}	total power dissipation (TO-220AB)	T_c = 25 °C; Figure 1		-	147	W
P_{tot}	total power dissipation (isolated TO-220AB)	T_c = 25 °C; Figure 2		-	37	W
T_{stg}	storage temperature			–55	+150	°C
T_j	junction temperature			–55	+150	°C
V_{isol}	R.M.S isolation voltage from all three terminals to external heatsink	f = 50 to 60 Hz; sinusoidal waveform; R.H. ≤ 65%; clean and dust-free; isolated TO-220AB only		-	2500	V
Source-drain diode						
I_S	source (diode forward) current (DC)	T_c = 25 °C		-	7	A
Avalanche ruggedness						
$E_{DS(AL)S}$	non-repetitive drain-source avalanche energy	unclamped inductive load, I_{AS} = 6.5 A; t_p = 2.3 ms; T_j prior to avalanche = 25 °C; V_{DD} ≤ 50 V; R_{GS} = 50 Ω; V_{GS} = 10 V		-	316	mJ
$E_{DS(AL)R}$	repetitive drain-source avalanche energy	I_{AR} = 7 A; t_p = 2.5 µs; T_j prior to avalanche = 25 °C; R_{GS} = 50 Ω; V_{GS} = 10 V		-	13	mJ
$I_{DS(AL)S}$	non-repetitive drain-source avalanche current			-	7	A

[1] For isolated TO-220AB limited only by maximum temperature allowed

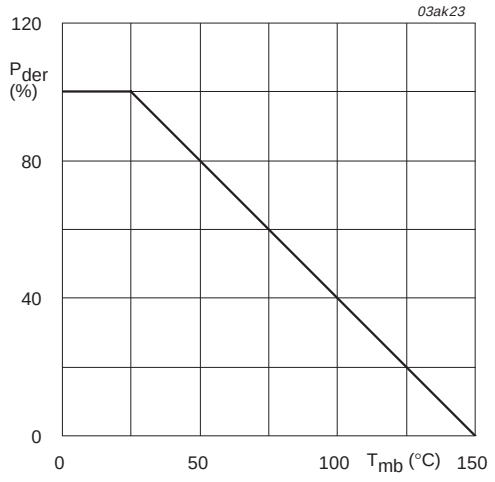


Fig 1. TO-220AB normalized total power dissipation as a function of mounting base temperature.

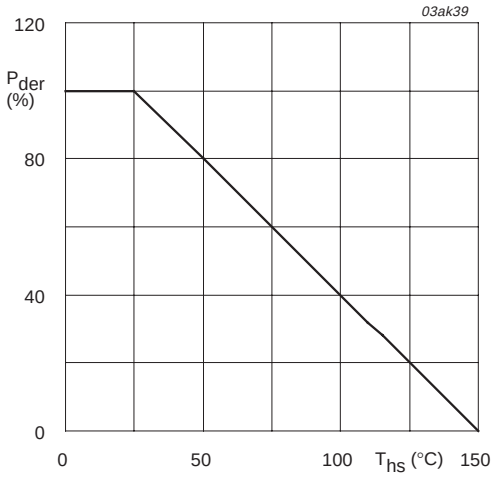


Fig 2. Isolated TO-220AB normalized total power dissipation as a function of heatsink temperature.

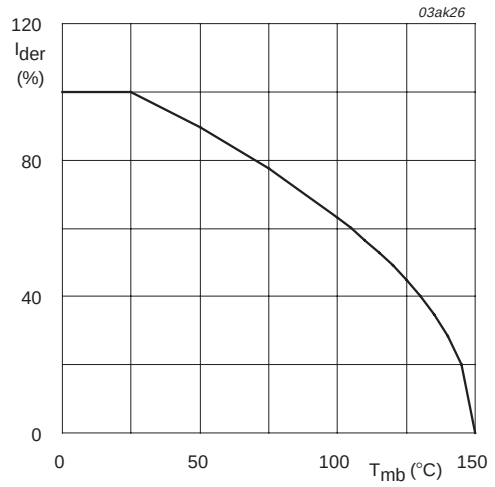


Fig 3. TO-220AB normalized continuous drain current as a function of mounting base temperature.

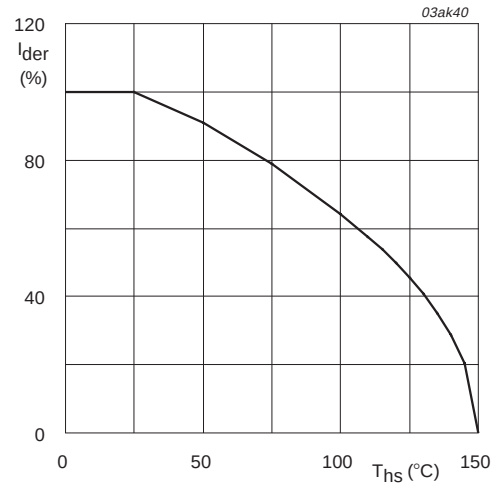
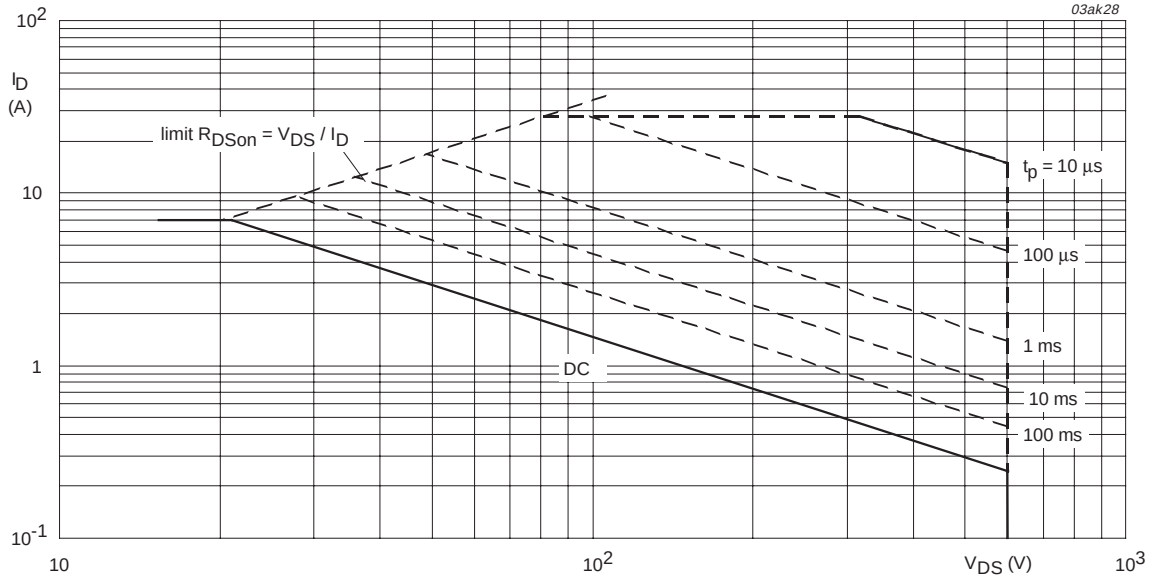
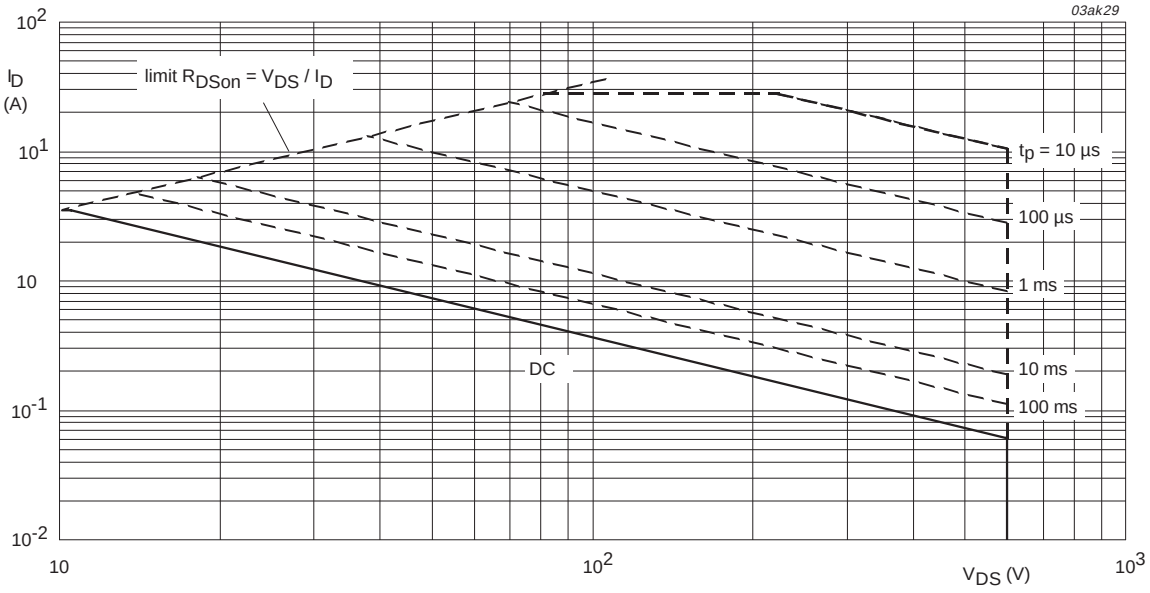


Fig 4. Isolated TO-220AB normalized continuous drain current as a function of heatsink temperature.



T_{mb} = 25 °C; I_{DM} is single pulse.

Fig 5. TO-220AB safe operating area; continuous and peak drain currents as a function of drain-source voltage.



T_{hs} = 25 °C; I_{DM} is single pulse.

Fig 6. Isolated TO-220AB 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
$R_{th(j-mb)}$	thermal resistance from junction to mounting base					
	TO-220AB	Figure 7	-	-	0.85	K/W
$R_{th(j-hs)}$	thermal resistance from junction to heatsink					
	isolated TO-220AB	Figure 8	-	-	3.4	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient					
	isolated TO-220AB package	vertical in still air	-	55	-	K/W
	TO-220AB package	vertical in still air	-	60	-	K/W

7.1 Transient thermal impedance

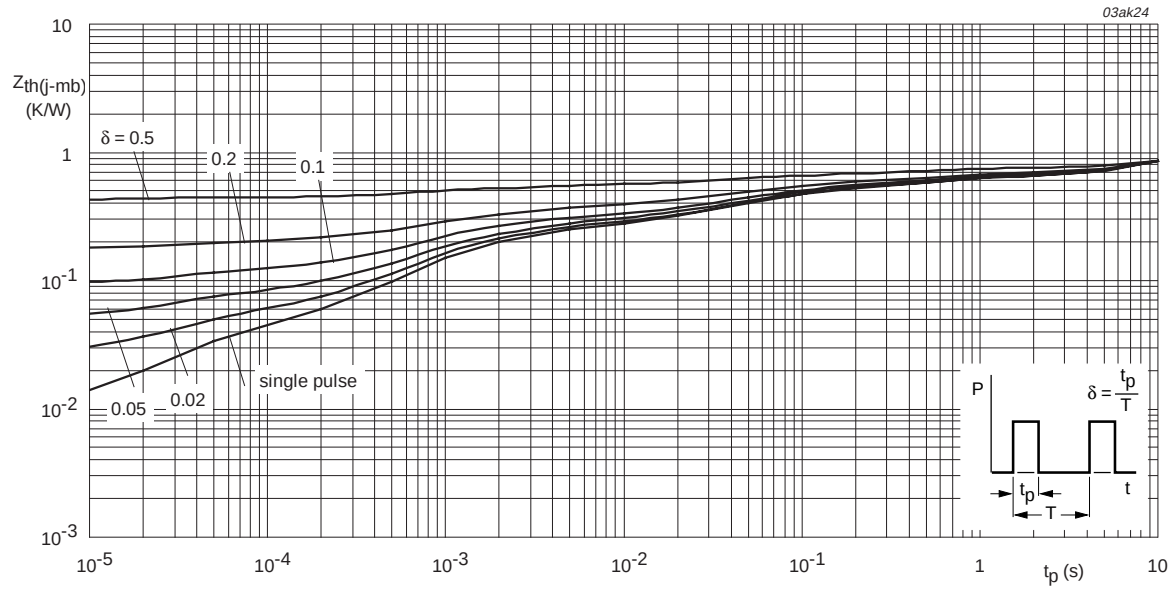


Fig 7. TO-220AB transient thermal impedance from junction to mounting base as a function of pulse duration.

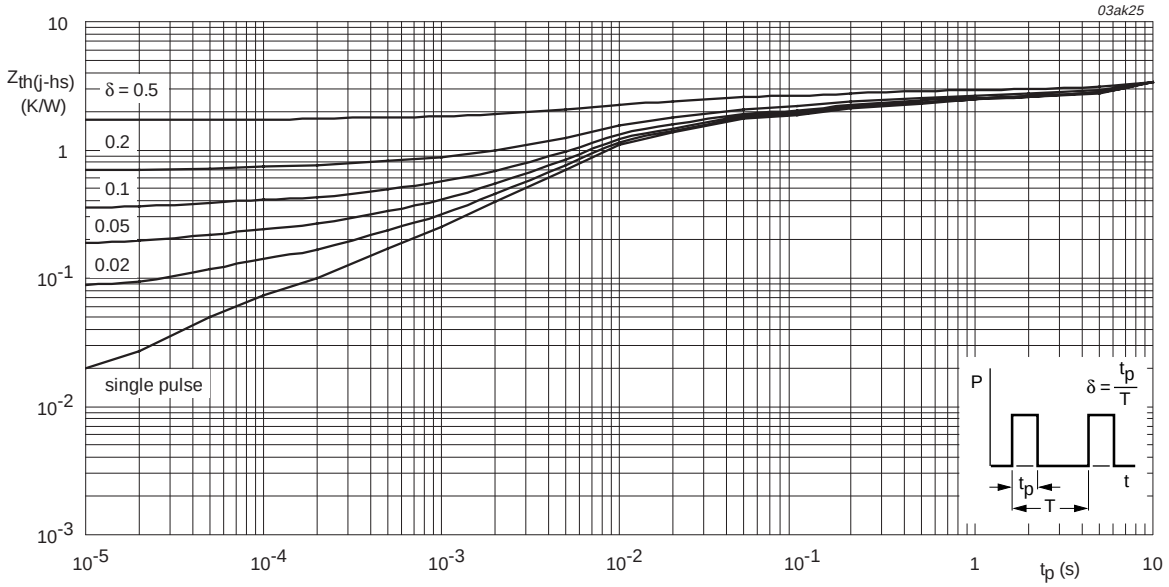


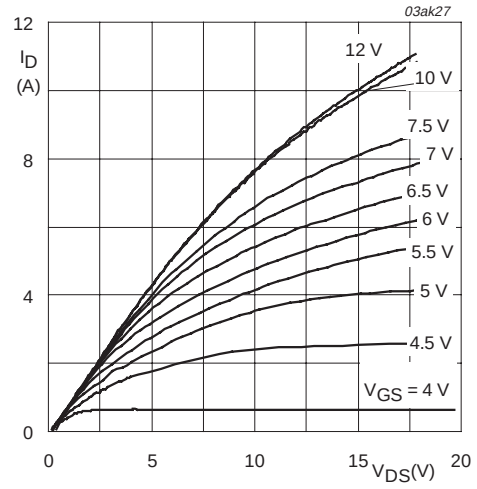
Fig 8. Isolated TO-220AB transient thermal impedance from junction to heatsink as a function of pulse duration.

8. Characteristics

Table 5: Characteristics

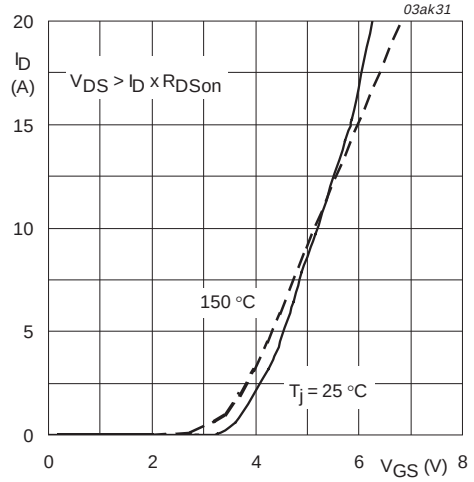
T_j = 25 °C unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Static characteristics						
$V_{(BR)DSS}$	drain-source breakdown voltage	I_D = 250 µA; V_{GS} = 0 V	600	-	-	V
		T_j = –55 °C	534	-	-	V
$V_{GS(th)}$	gate-source threshold voltage	I_D = 250 µA; V_{DS} = V_{GS}; Figure 13				
		T_j = 25 °C	2	2.9	4	V
		T_j = 150 °C	1	-	-	V
		T_j = –55 °C	-	3.2	4.5	V
I_{DSS}	drain-source leakage current	V_{GS} = 0 V; V_{DS} = 600 V				
		T_j = 25 °C	-	0.3	100	µA
		T_j = 125 °C; V_{DS} = 480V	-	150	500	µA
I_{GSS}	gate-source leakage current	V_{DS} = 0 V; V_{GS} = ±10 V	-	2	200	nA
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 3.5 A; Figure 11 and 12				
		T_j = 25 °C	-	0.94	1.2	Ω
		T_j = 150 °C	-	2.4	2.9	Ω
C_{isol}	Capacitance from pin 2 to external heatsink	f = 1 MHz; isolated TO-220AB only	-	10	-	pF
Dynamic characteristics						
$Q_{g(tot)}$	total gate charge	I_D = 7 A; V_{DD} = 480 V; V_{GS} = 10 V; Figure 17	-	27	-	nC
Q_{gs}	gate-source charge		-	3.6	-	nC
Q_{gd}	gate-drain (Miller) charge		-	10	-	nC
C_{iss}	input capacitance	V_{GS} = 0 V; V_{DS} = 25 V; f = 1 MHz; Figure 15	-	1130	-	pF
C_{oss}	output capacitance		-	105	-	pF
C_{rss}	reverse transfer capacitance		-	24	-	pF
$t_{d(on)}$	turn-on delay time	V_{DD} = 300 V; R_D = 39 Ω; R_G = 9.1 Ω	-	17	-	ns
t_r	rise time		-	20	-	ns
$t_{d(off)}$	turn-off delay time		-	40	-	ns
t_f	fall time		-	20	-	ns
Source-drain diode						
V_{SD}	source-drain (diode forward) voltage	I_S = 7 A; V_{GS} = 0 V; Figure 16	-	0.9	1.2	V
t_{rr}	reverse recovery time	I_S = 7 A; dI_S/dt = –100 A/µs; V_{GS} = 0 V	-	530	-	ns
Q_r	recovered charge		-	6.7	-	µC



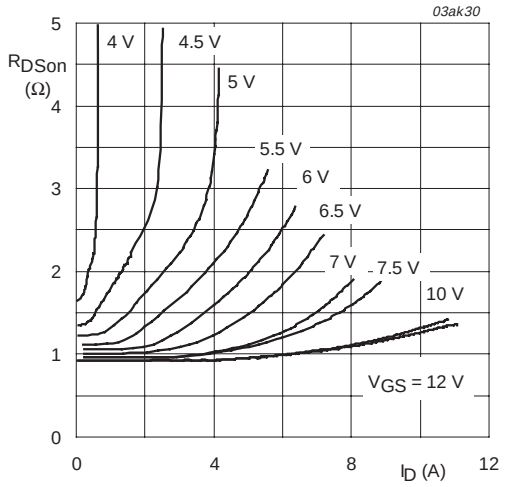
T_j = 25 °C

Fig 9. Output characteristics: drain current as a function of drain-source voltage; typical values.



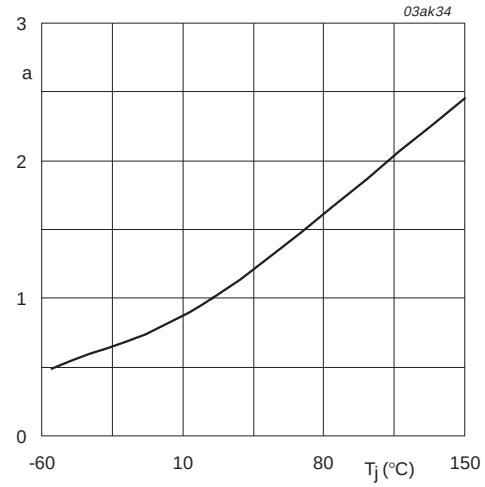
T_j = 25 °C and 150 °C; $V_{DS} > I_D \times R_{DSon}$

Fig 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values.



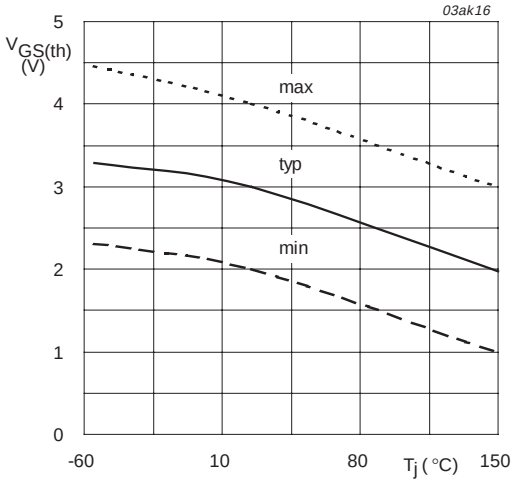
T_j = 25 °C

Fig 11. Drain-source on-state resistance as a function of drain current; typical values.



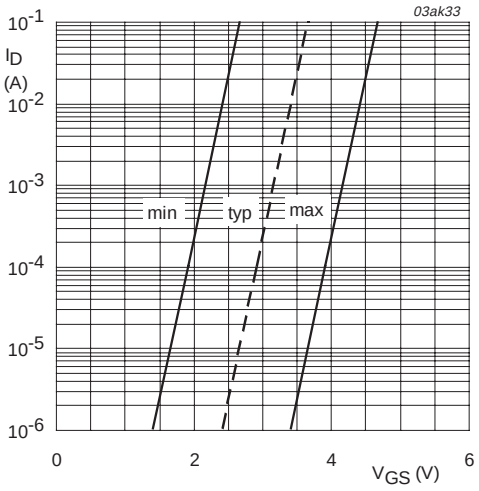
$$a = \frac{R_{DSon}}{R_{DSon(25°C)}}$$

Fig 12. Normalized drain-source on-state resistance factor as a function of junction temperature.



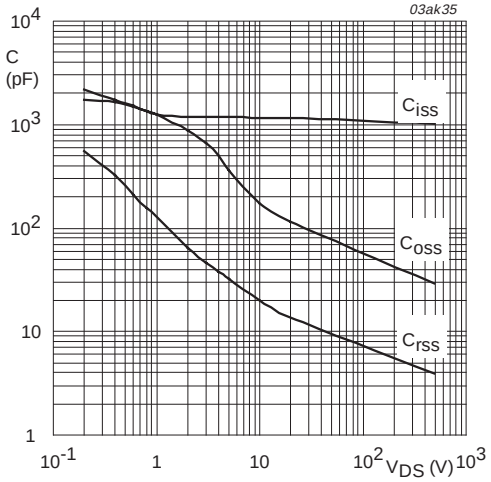
I_D = 1 mA; V_{DS} = V_{GS}

Fig 13. Gate-source threshold voltage as a function of junction temperature.



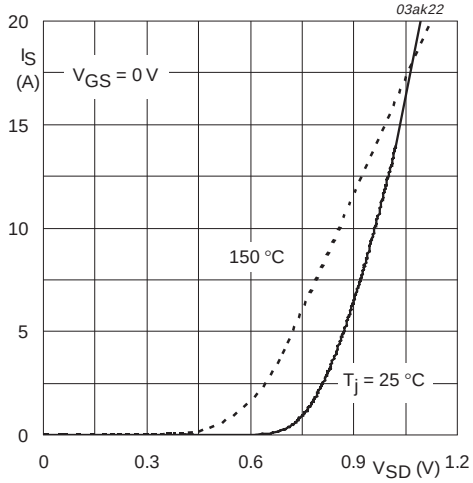
T_j = 25 °C; V_{DS} = 5 V

Fig 14. Sub-threshold drain current as a function of gate-source voltage.



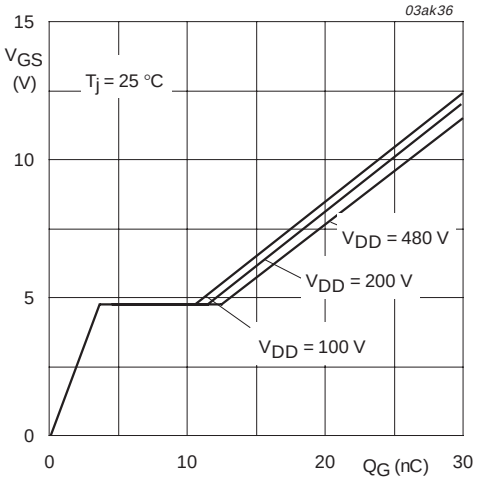
V_{GS} = 0 V; f = 1 MHz

Fig 15. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values.



T_j = 25 °C and 150 °C; V_{GS} = 0 V

Fig 16. Source (diode forward) current as a function of source-drain (diode forward) voltage; typical values.

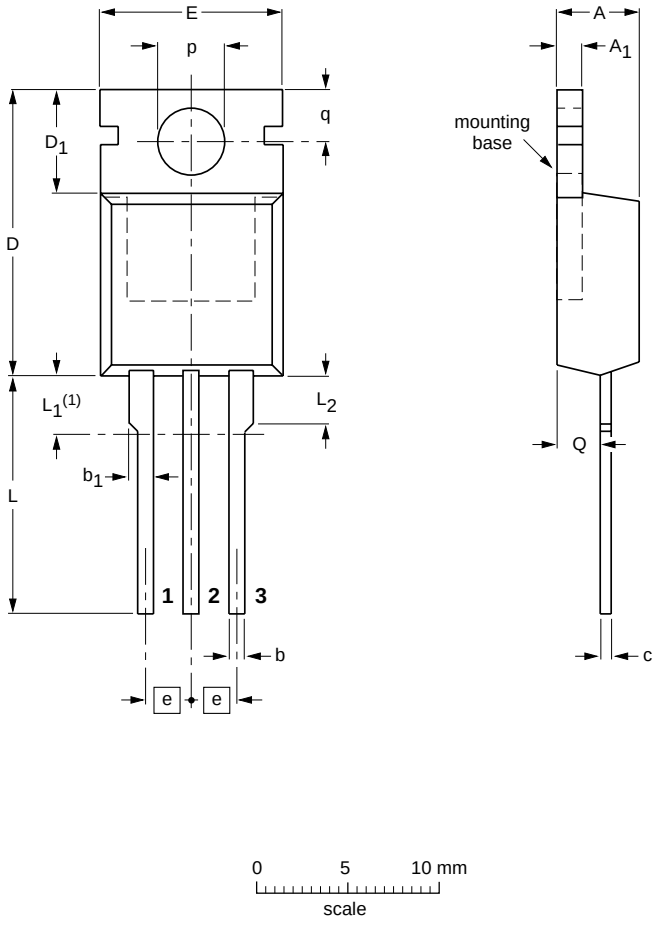


I_D = 7 A; V_{DD} = 100 V; 200 V; 480 V

Fig 17. Gate-source voltage as a function of gate charge; typical values.

9. Package outline

Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB **SOT78**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1	b	b_1	c	D	D_1	E	e	L	L_1(1)	L_2 max.	p	q	Q
mm	4.5 4.1	1.39 1.27	0.9 0.7	1.3 1.0	0.7 0.4	15.8 15.2	6.4 5.9	10.3 9.7	2.54	15.0 13.5	3.30 2.79	3.0	3.8 3.6	3.0 2.7	2.6 2.2

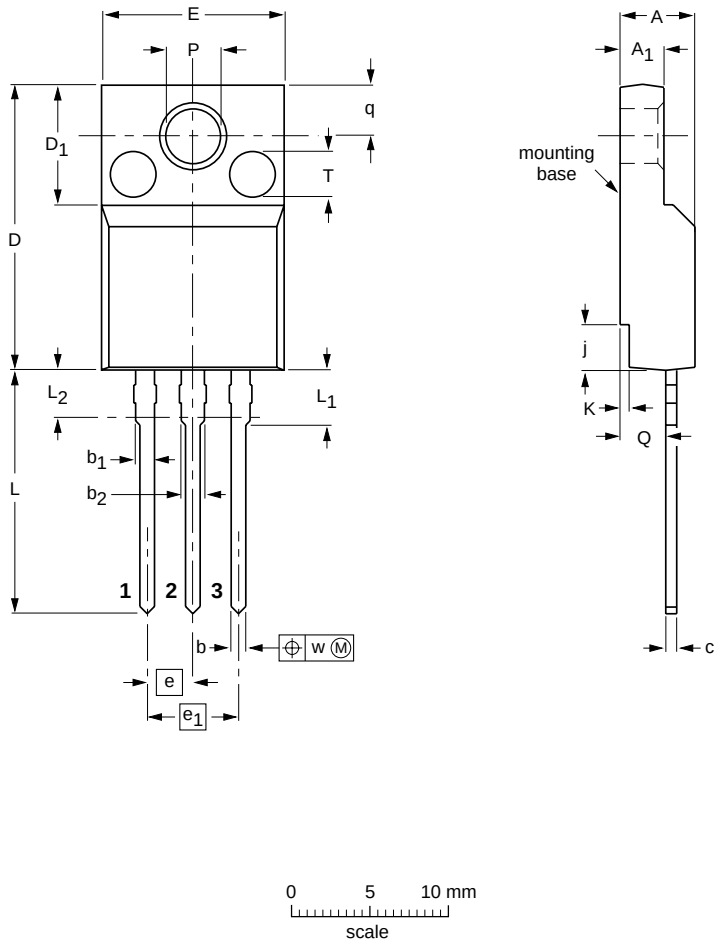
Note

1. Terminals in this zone are not tinned.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT78		3-lead TO-220AB	SC-46			~~00-09-07~~ 01-02-16

Fig 18. TO-220AB (SOT78)

Plastic single-ended package; isolated heatsink mounted;
1 mounting hole; 3 lead TO-220 'full pack' **SOT186A**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1	b	b_1	b_2	c	D	D_1	E	e	e_1	j	K	L	L_1	L_2 (1) max.	P	Q	q	T (2)	w
mm	4.6 4.0	2.9 2.5	0.9 0.7	1.1 0.9	1.4 1.0	0.7 0.4	15.8 15.2	6.5 6.3	10.3 9.7	2.54	5.08	2.7 1.7	0.6 0.4	14.4 13.5	3.30 2.79	3	3.2 3.0	2.6 2.3	3.0 2.6	2.5	0.4

Notes

1. Terminal dimensions within this zone are uncontrolled. Terminals in this zone are not tinned.
2. Both recesses are ∅ 2.5 × 0.8 max. depth

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT186A		3-lead TO-220F				~~02-03-12~~ 02-04-09

Fig 19. isolated TO-220AB

10. Revision history

Table 6: Revision history

Rev	Date	CPCN	Description
01	20020820		Product specification; 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.
Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Changes will be communicated according to the Customer Product/Process Change Notification (CPCN) procedure SNW-SQ-650A.

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

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL http://www.semiconductors.philips.com.

12. Definitions

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). 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 — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

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