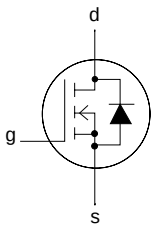
PowerMOS transistors Avalanche energy rated

PHB9N60E, PHW9N60E

FEATURES

- Repetitive Avalanche Rated
- Fast switching
- Stable off-state characteristics
- High thermal cycling performance
- Low thermal resistance

SYMBOL



QUICK REFERENCE DATA

V_{DSS} = 600 V

I_D = 8.7 A

$R_{DS(ON)} \leq 0.8\ \Omega$

GENERAL DESCRIPTION

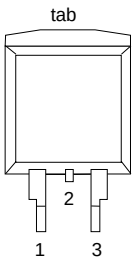
N-channel, enhancement mode field-effect power transistor, intended for use in off-line switched mode power supplies, T.V. and computer monitor power supplies, d.c. to d.c. converters, motor control circuits and general purpose switching applications.

The PHW9N60E is supplied in the SOT429 (TO247) conventional leaded package.
The PHB9N60E is supplied in the SOT404 surface mounting package.

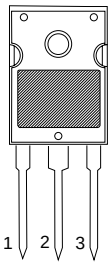
PINNING

PIN	DESCRIPTION
1	gate
2	drain[1]
3	source
tab	drain

SOT404



SOT429 (TO247)



LIMITING VALUES

Limiting values in accordance with the Absolute Maximum System (IEC 134)

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{DSS}	Drain-source voltage	T_j = 25 ˚C to 150˚C	-	600	V
V_{DGR}	Drain-gate voltage	T_j = 25 ˚C to 150˚C; R_{GS} = 20 kΩ	-	600	V
V_{GS}	Gate-source voltage		-	± 30	V
I_D	Continuous drain current	T_{mb} = 25 ˚C; V_{GS} = 10 V	-	9	A
		T_{mb} = 100 ˚C; V_{GS} = 10 V	-	5.7	A
I_{DM}	Pulsed drain current	T_{mb} = 25 ˚C	-	36	A
P_D	Total dissipation	T_{mb} = 25 ˚C	-	156	W
T_j, T_{stg}	Operating junction and storage temperature range		- 55	150	˚C

1 It is not possible to make connection to pin 2 of the SOT404 package.

AVALANCHE ENERGY LIMITING VALUES

Limiting values in accordance with the Absolute Maximum System (IEC 134)

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
E_{AS}	Non-repetitive avalanche energy	Unclamped inductive load, I_{AS} = 9 A; t_p = 0.2 ms; T_j prior to avalanche = 25˚C; $V_{DD} \leq 50$ V; R_{GS} = 50 Ω; V_{GS} = 10 V	-	700	mJ
E_{AR}	Repetitive avalanche energy[2]	I_{AR} = 9 A; t_p = 2.5 µs; T_j prior to avalanche = 25˚C; R_{GS} = 50 Ω; V_{GS} = 10 V	-	18	mJ
I_{AS}, I_{AR}	Repetitive and non-repetitive avalanche current		-	9	A

THERMAL RESISTANCES

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$R_{th\ j\text{-}mb}$	Thermal resistance junction to mounting base		-	-	0.8	K/W
$R_{th\ j\text{-}a$	Thermal resistance junction to ambient	SOT429 package, in free air	-	45	-	K/W
		SOT404 package, pcb mounted, minimum footprint	-	50	-	K/W

ELECTRICAL CHARACTERISTICS

T_j = 25 ˚C unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS} = 0 V; I_D = 0.25 mA	600	-	-	V
$\Delta V_{(BR)DSS}$ / ΔT_j	Drain-source breakdown voltage temperature coefficient	V_{DS} = V_{GS}; I_D = 0.25 mA	-	0.1	-	%/K
$R_{DS(ON)}$	Drain-source on resistance	V_{GS} = 10 V; I_D = 5 A	-	0.68	0.8	Ω
$V_{GS(TO)}$	Gate threshold voltage	V_{DS} = V_{GS}; I_D = 0.25 mA	2.0	3.0	4.0	V
g_{fs}	Forward transconductance	V_{DS} = 30 V; I_D = 5 A	4	6.5	-	S
I_{DSS}	Drain-source leakage current	V_{DS} = 600 V; V_{GS} = 0 V	-	2	100	µA
		V_{DS} = 480 V; V_{GS} = 0 V; T_j = 125 ˚C	-	80	1000	µA
I_{GSS}	Gate-source leakage current	V_{GS} = ±30 V; V_{DS} = 0 V	-	10	200	nA
$Q_{g(tot)}$	Total gate charge	I_D = 10 A; V_{DD} = 480 V; V_{GS} = 10 V	-	75	100	nC
Q_{gs}	Gate-source charge		-	6.8	12	nC
Q_{gd}	Gate-drain (Miller) charge		-	37	55	nC
$t_{d(on)}$	Turn-on delay time	V_{DD} = 300 V; R_D = 30 Ω;	-	11	-	ns
t_r	Turn-on rise time	R_G = 5.6 Ω	-	32	-	ns
$t_{d(off)}$	Turn-off delay time		-	98	-	ns
t_f	Turn-off fall time		-	37	-	ns
L_d	Internal drain inductance	Measured from tab to centre of die	-	3.5	-	nH
L_d	Internal drain inductance	Measured from drain lead to centre of die (SOT429 package only)	-	4.5	-	nH
L_s	Internal source inductance	Measured from source lead to source bond pad	-	7.5	-	nH
C_{iss}	Input capacitance	V_{GS} = 0 V; V_{DS} = 25 V; f = 1 MHz	-	1295	-	pF
C_{oss}	Output capacitance		-	163	-	pF
C_{rss}	Feedback capacitance		-	86	-	pF

2 pulse width and repetition rate limited by T_j max.

SOURCE-DRAIN DIODE RATINGS AND CHARACTERISTICS

T_j = 25 ˚C unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_S	Continuous source current (body diode)	T_{mb} = 25˚C	-	-	9	A
I_{SM}	Pulsed source current (body diode)	T_{mb} = 25˚C	-	-	36	A
V_{SD}	Diode forward voltage	I_S = 9 A; V_{GS} = 0 V	-	-	1.2	V
t_{rr}	Reverse recovery time	I_S = 9 A; V_{GS} = 0 V; dI/dt = 100 A/µs	-	740	-	ns
Q_{rr}	Reverse recovery charge		-	9	-	µC

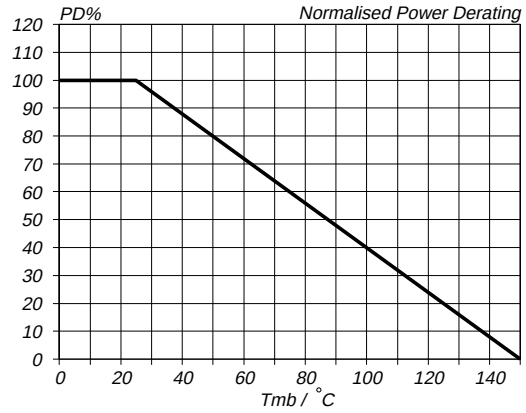


Fig.1. Normalised power dissipation.
PD% = 100·P_D/$P_{D\ 25\ °C}$ = f(T_{mb})

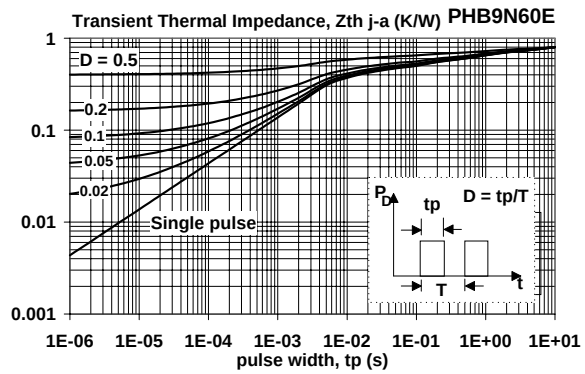


Fig.4. Transient thermal impedance.
$Z_{th\ j\text{-}mb}$ = f(t); parameter D = t_p/T

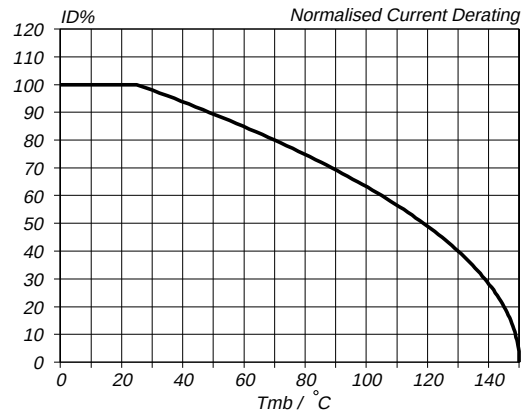


Fig.2. Normalised continuous drain current.
ID% = 100·I_D/$I_{D\ 25\ °C}$ = f(T_{mb}); conditions: V_{GS} ≥ 10 V

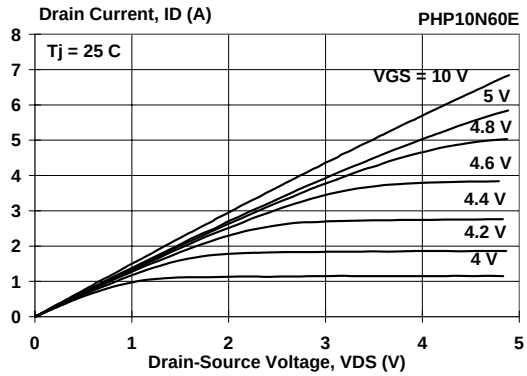


Fig.5. Typical output characteristics.
I_D = f(V_{DS}); parameter V_{GS}

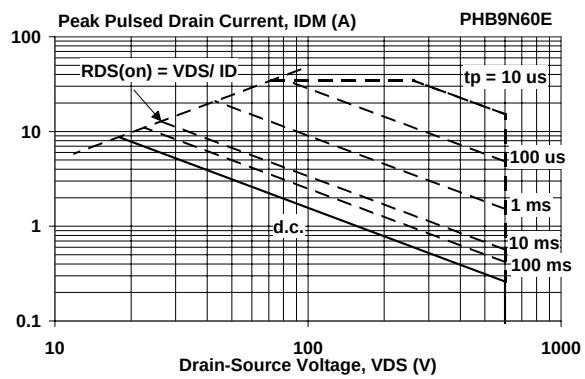


Fig.3. Safe operating area. T_{mb} = 25 ˚C
I_D & I_{DM} = f(V_{DS}); I_{DM} single pulse; parameter t_p

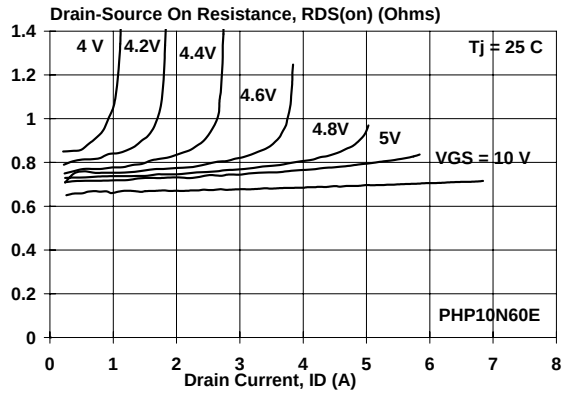


Fig.6. Typical on-state resistance.
$R_{DS(ON)}$ = f(I_D); parameter V_{GS}

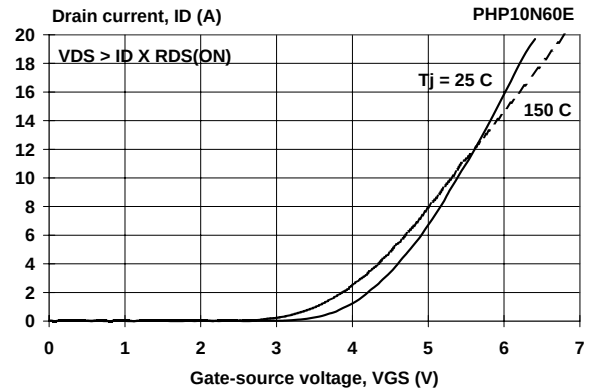


Fig.7. Typical transfer characteristics.
$I_D = f(V_{GS})$; parameter T_j

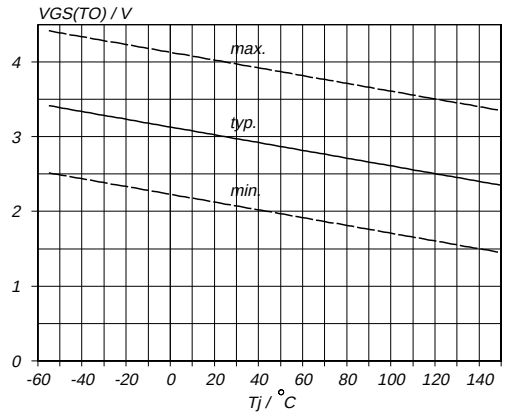


Fig.10. Gate threshold voltage.
$V_{GS(TO)} = f(T_j)$; conditions: I_D = 0.25 mA; $V_{DS} = V_{GS}$

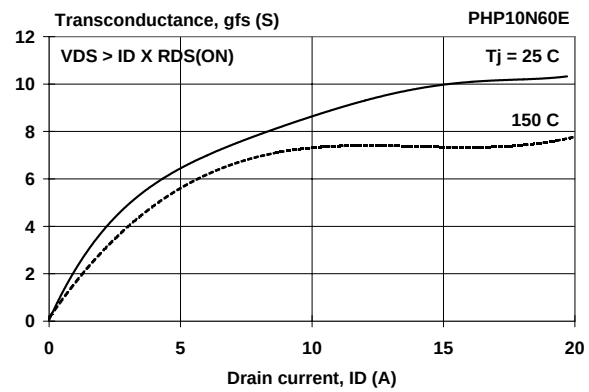


Fig.8. Typical transconductance.
$g_{fs} = f(I_D)$; parameter T_j

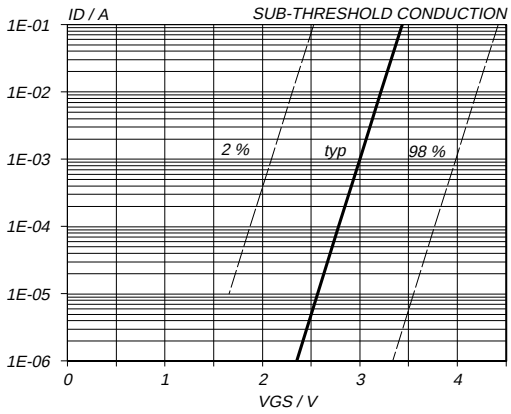


Fig.11. Sub-threshold drain current.
$I_D = f(V_{GS})$; conditions: T_j = 25 ˚C; $V_{DS} = V_{GS}$

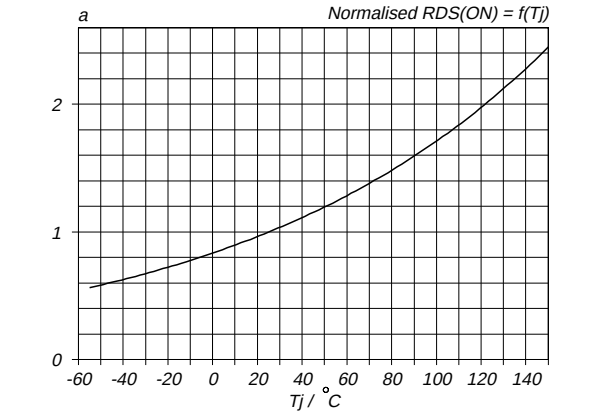


Fig.9. Normalised drain-source on-state resistance.
$a = R_{DS(ON)}/R_{DS(ON)25\,˚C} = f(T_j)$; I_D = 5 A; V_{GS} = 10 V

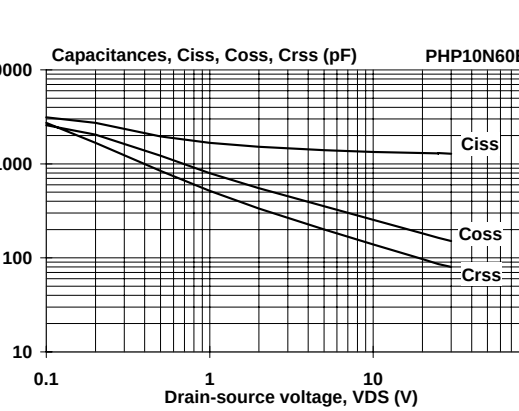


Fig.12. Typical capacitances, C_{iss}, C_{oss}, C_{rss}.
$C = f(V_{DS})$; conditions: V_{GS} = 0 V; f = 1 MHz

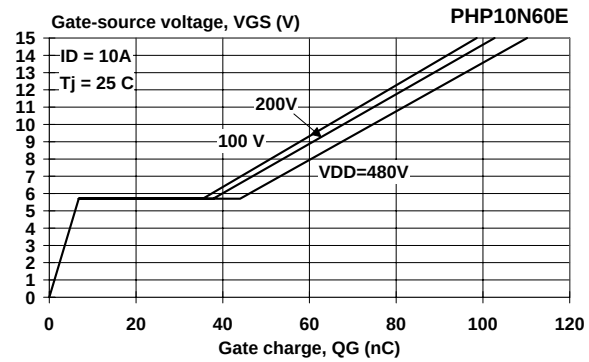


Fig.13. Typical turn-on gate-charge characteristics. $V_{GS} = f(Q_G)$; parameter V_{DS}

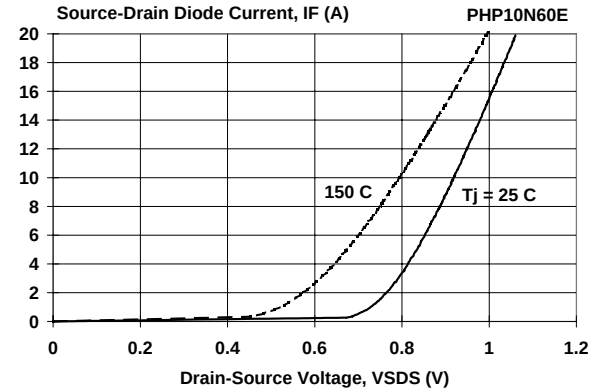


Fig.16. Source-Drain diode characteristic. $I_F = f(V_{SDS})$; parameter T_j

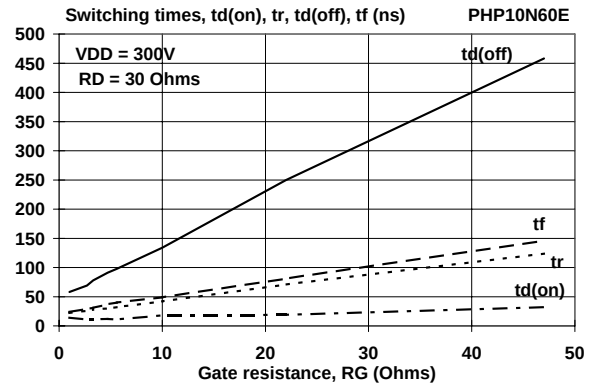


Fig.14. Typical switching times; $t_{d(on)}$, t_r, $t_{d(off)}$, $t_f = f(R_G)$

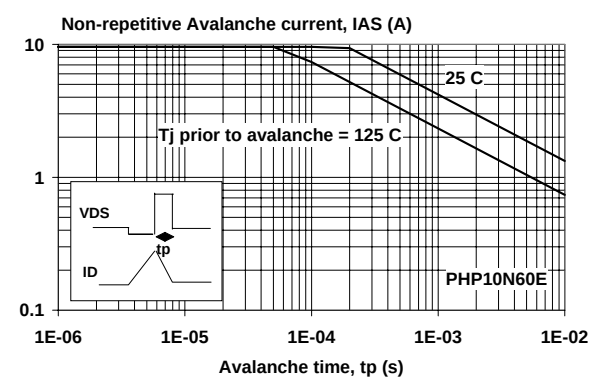


Fig.17. Maximum permissible non-repetitive avalanche current (I_{AS}) versus avalanche time (t_p); unclamped inductive load

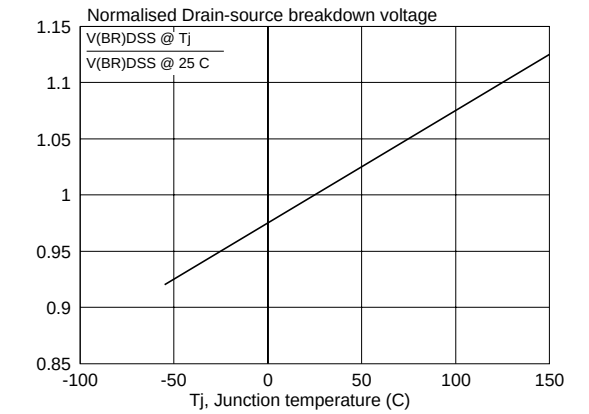


Fig.15. Normalised drain-source breakdown voltage; $V_{(BR)DSS}/V_{(BR)DSS\ 25\ ^\circ C} = f(T_j)$

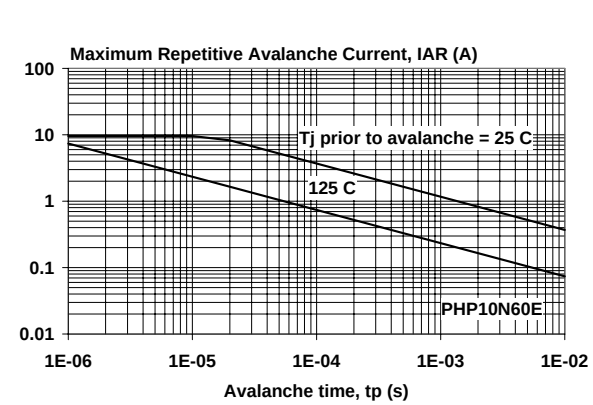


Fig.18. Maximum permissible repetitive avalanche current (I_{AR}) versus avalanche time (t_p)

MECHANICAL DATA

Dimensions in mm

Net Mass: 1.4 g

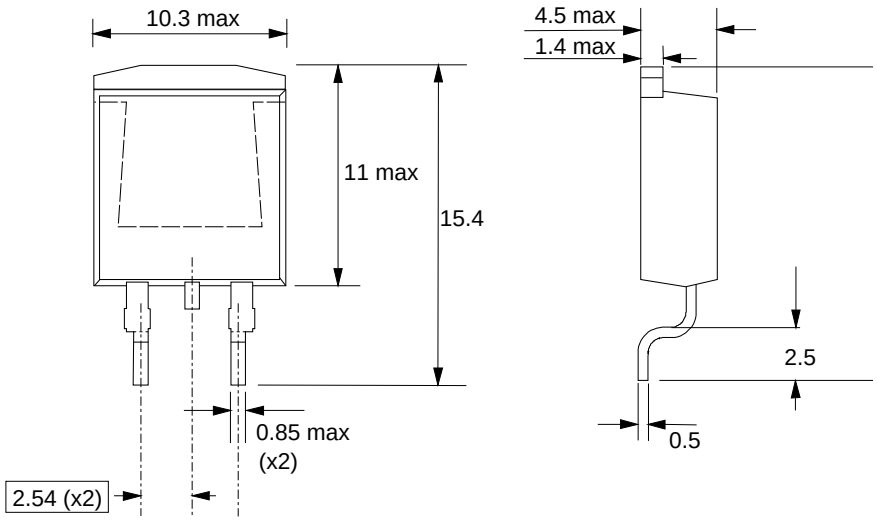


Fig.19. SOT404 : centre pin connected to mounting base.

MOUNTING INSTRUCTIONS

Dimensions in mm

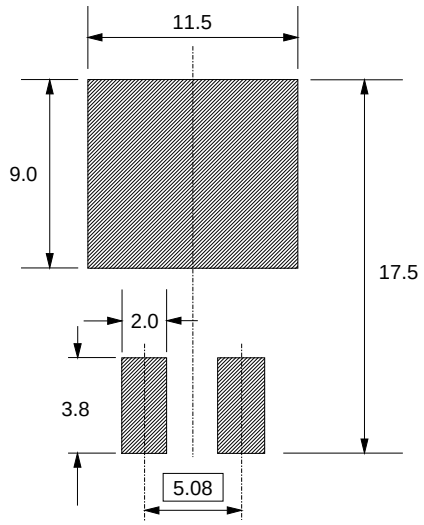


Fig.20. SOT404 : soldering pattern for surface mounting.

Notes

1. Observe the general handling precautions for electrostatic-discharge sensitive devices (ESDs) to prevent damage to MOS gate oxide.
2. Epoxy meets UL94 V0 at 1/8".

MECHANICAL DATA

Dimensions in mm

Net Mass: 5 g

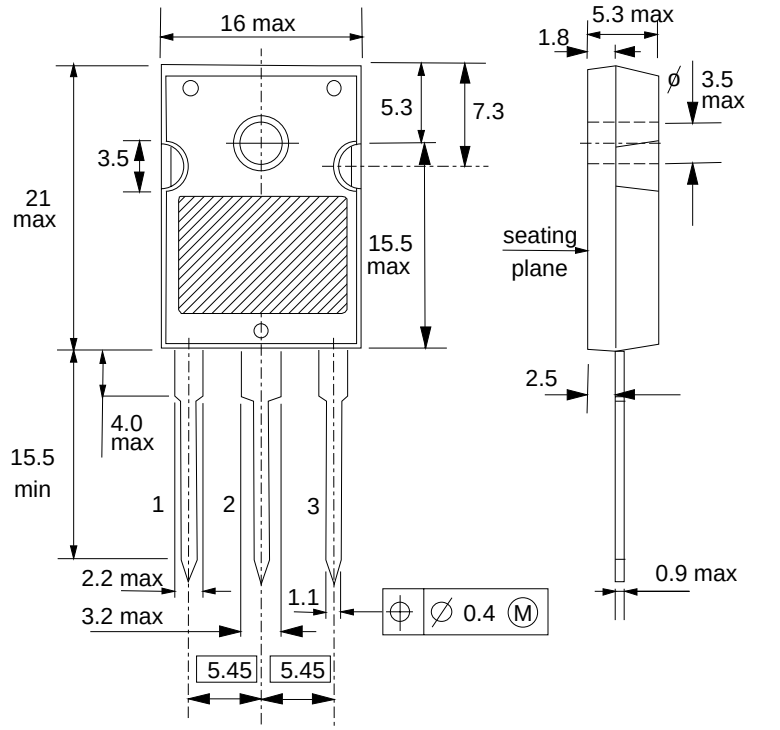


Fig.21. SOT429; pin 2 connected to mounting base.

Notes

1. Observe the general handling precautions for electrostatic-discharge sensitive devices (ESDs) to prevent damage to MOS gate oxide.
2. Refer to mounting instructions for SOT429 envelope.
3. Epoxy meets UL94 V0 at 1/8".

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 are given 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 this 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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