



STW20NK50Z

N-channel 500 V, 0.23 Ω , 20 A SuperMESH™ Power MOSFET
Zener-protected in TO-247 package

Datasheet — production data

Features

Order code	V _{DSS}	R _{DS(on) max}	I _D	P _W
STW20NK50Z	500 V	< 0.27 Ω	20 A	190 W

- Extremely high dv/dt capability
- 100% avalanche tested
- Gate charge minimized
- Very low intrinsic capacitance

Application

Switching applications

Description

This device is an N-channel Zener-protected Power MOSFET developed using STMicroelectronics' SuperMESH™ technology, achieved through optimization of ST's well established strip-based PowerMESH™ layout. In addition to a significant reduction in on-resistance, this device is designed to ensure a high level of dv/dt capability for the most demanding applications.

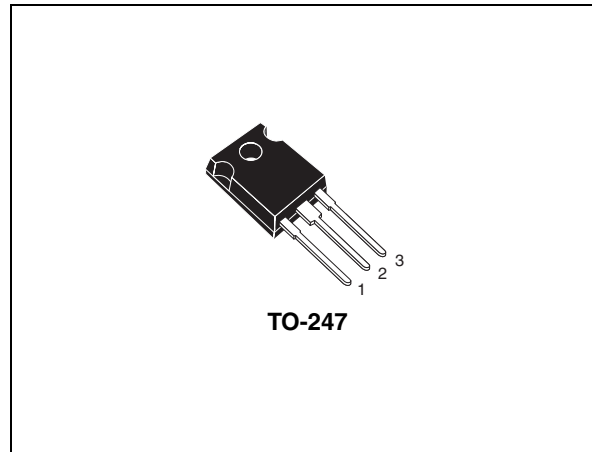


Figure 1. Internal schematic diagram

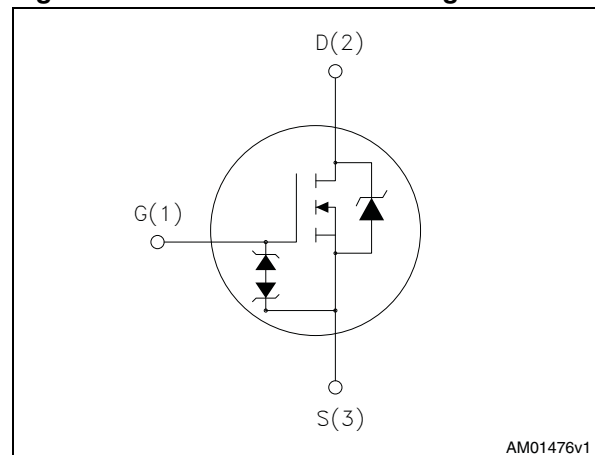


Table 1. Device summary

Order code	Marking	Package	Packaging
STW20NK50Z	W20NK50Z	TO-247	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{DS}	Drain-source voltage	500	V
V_{GS}	Gate-source voltage	± 30	V
I_D	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	20	A
I_D	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	12.6	A
$I_{DM}^{(1)}$	Drain current (pulsed)	68	A
P_{TOT}	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	190	W
	Derating factor	1.52	W/ $^\circ\text{C}$
ESD	Gate-source human body model ($R=1.5\text{ k}\Omega$, $C=100\text{ pF}$)	6	kV
$dv/dt^{(2)}$	Peak diode recovery voltage slope	4.5	V/ns
T_{stg}	Storage temperature	-55 to 150	$^\circ\text{C}$
T_j	Max operating junction temperature	150	$^\circ\text{C}$

1. Pulse width limited by safe operating area.

2. $I_{SD} \leq 17\text{ A}$, $di/dt \leq 200\text{ A}/\mu\text{s}$, $V_{DS\text{ peak}} \leq V_{(BR)DSS}$, $V_{DD} \leq V_{(BR)DSS}$, $T_j \leq T_{JMAX}$.

Table 3. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case max	0.66	$^\circ\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	50	$^\circ\text{C}/\text{W}$

Table 4. Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_j Max)	17	A
E_{AS}	Single pulse avalanche energy (starting $T_j=25\text{ }^\circ\text{C}$, $I_D=I_{AR}$, $V_{DD}=50\text{ V}$)	850	mJ

2 Electrical characteristics

($T_{CASE} = 25\text{ °C}$ unless otherwise specified)

Table 5. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$, $V_{GS} = 0$	500			V
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = 500\text{ V}$ $V_{DS} = 500\text{ V}$, $T_C = 125\text{ °C}$			1 50	μA μA
I_{GSS}	Gate-body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 20\text{ V}$			± 10	μA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$, $I_D = 100\text{ }\mu\text{A}$	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$, $I_D = 8.5\text{ A}$		0.23	0.27	Ω

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit	
C_{ISS}	Input capacitance	$V_{DS} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$		2600		pF	
C_{OSS}	Output capacitance		-	328		pF	
C_{RSS}	Reverse transfer capacitance				72	pF	
$C_{OSS\text{ eq.}}$ (1)	Equivalent output capacitance	$V_{DS} = 0$, $V_{DS} = 0\text{ to }640\text{ V}$	-	187		pF	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 250\text{ V}$, $I_D = 8.5\text{ A}$, $R_G = 4.7\text{ }\Omega$, $V_{GS} = 10\text{ V}$ (see Figure 14)		28		ns	
t_r	Rise time		-	20		ns	
$t_{d(off)}$	Turn-off delay time				70		ns
t_f	Fall time				15		ns
Q_g	Total gate charge	$V_{DD} = 400\text{ V}$, $I_D = 17\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 15)		85	119	nC	
Q_{gs}	Gate-source charge		-	15.5		nC	
Q_{gd}	Gate-drain charge			42		nC	

1. $C_{OSS\text{ eq.}}$ is defined as a constant equivalent capacitance giving the same charging time as C_{OSS} when V_{DS} increases from 0 to 80% V_{DSS} .

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		20	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		68	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 17\text{ A}, V_{GS} = 0$	-		1.6	V
t_{rr}	Reverse recovery time	$I_{SD} = 17\text{ A},$ $di/dt = 100\text{ A}/\mu\text{s}$ $V_R = 100\text{ V}$ (see Figure 16)	-	355		ns
Q_{rr}	Reverse recovery charge			3.90		μC
I_{RRM}	Reverse recovery current			22		A
t_{rr}	Reverse recovery time	$I_{SD} = 17\text{ A},$ $di/dt = 100\text{ A}/\mu\text{s}$ $V_R = 100\text{ V}, T_j = 150\text{ }^\circ\text{C}$ (see Figure 16)	-	440		ns
Q_{rr}	Reverse recovery charge			5.72		μC
I_{RRM}	Reverse recovery current			26		A

1. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

2. Pulse width limited by safe operating area.

Table 8. Gate-source Zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
BV_{GSO}	Gate-source breakdown voltage	$I_{GS} = \pm 1\text{ mA}$ (open drain)	30	-		V

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area

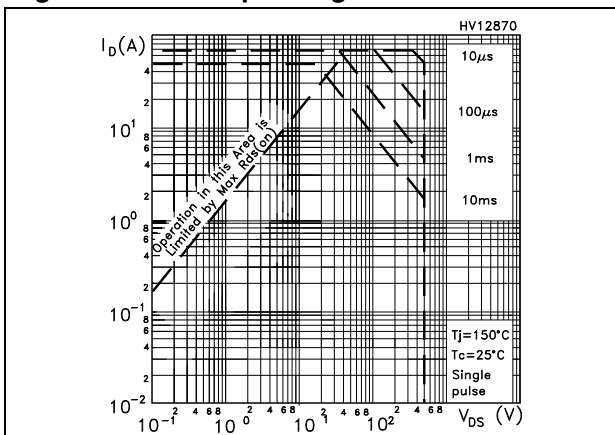


Figure 3. Thermal impedance

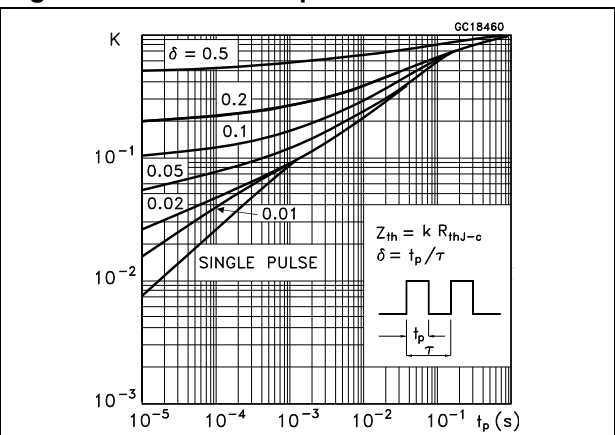


Figure 4. Output characteristics

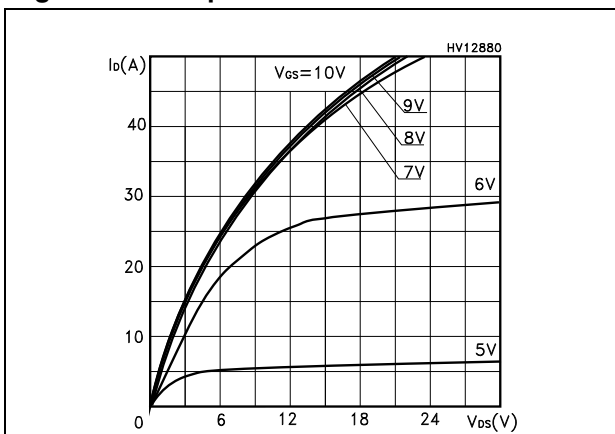


Figure 5. Transfer characteristics

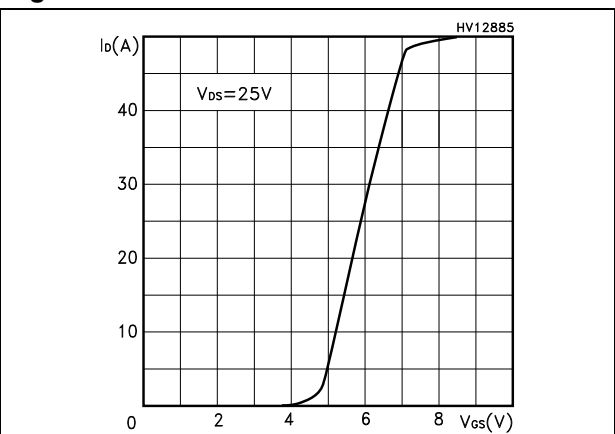


Figure 6. Normalized $B_{V_{DSS}}$ vs temperature

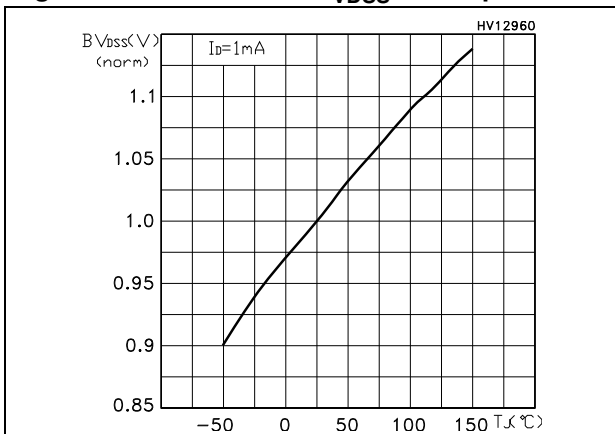


Figure 7. Static drain-source on-resistance

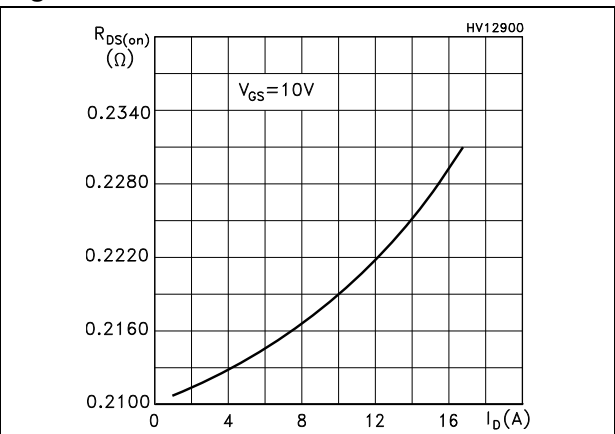


Figure 8. Gate charge vs gate-source voltage Figure 9. Capacitance variations

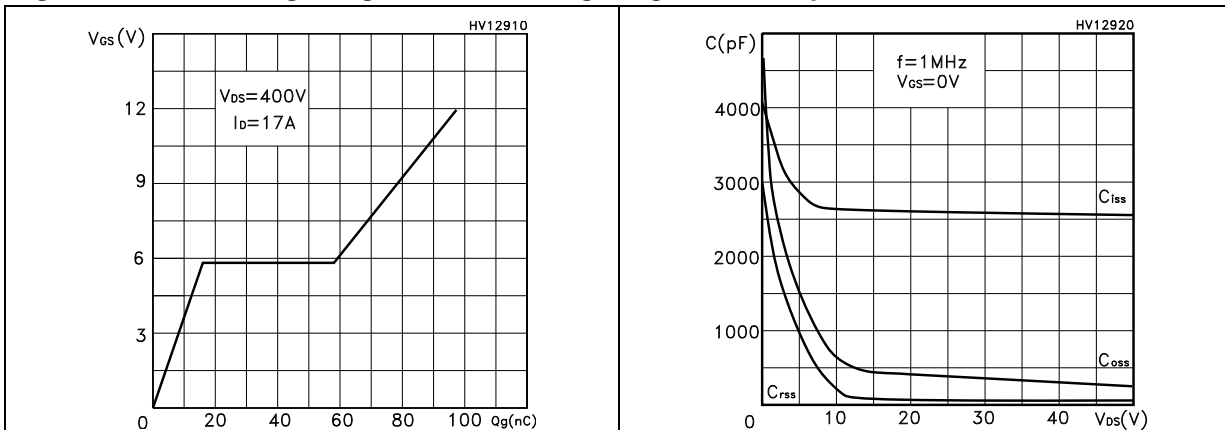


Figure 10. Normalized gate threshold voltage vs temperature Figure 11. Normalized on-resistance vs temperature

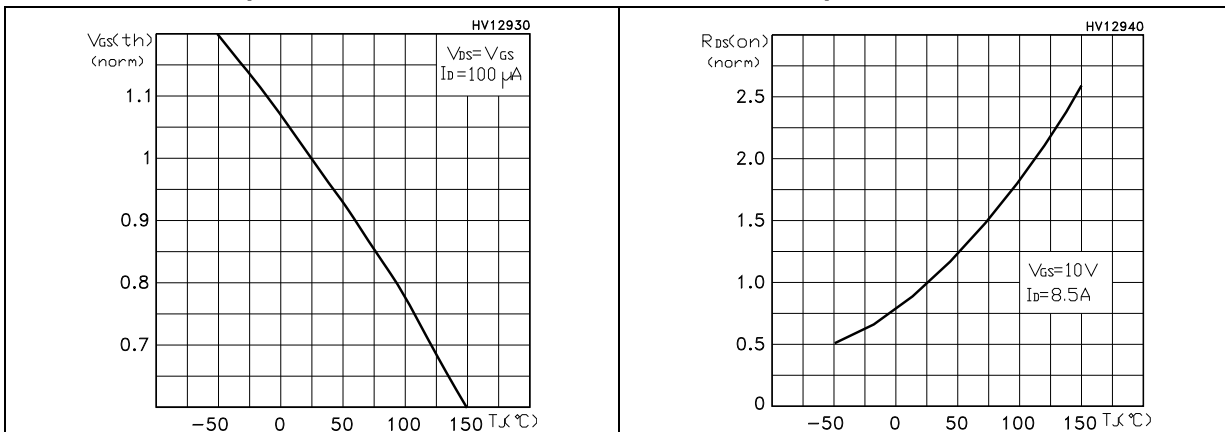
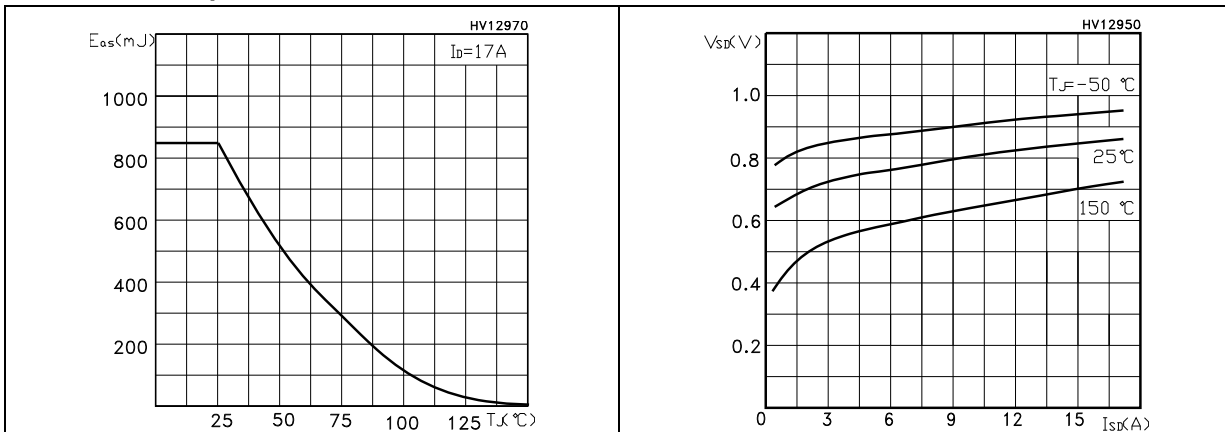


Figure 12. Maximum avalanche energy vs temperature Figure 13. Source-drain diode forward characteristic



3 Test circuits

Figure 14. Switching times test circuit for resistive load



AM01468v1

Figure 15. Gate charge test circuit



AM01469v1

Figure 16. Test circuit for inductive load switching and diode recovery times



AM01470v1

Figure 17. Unclamped inductive load test circuit



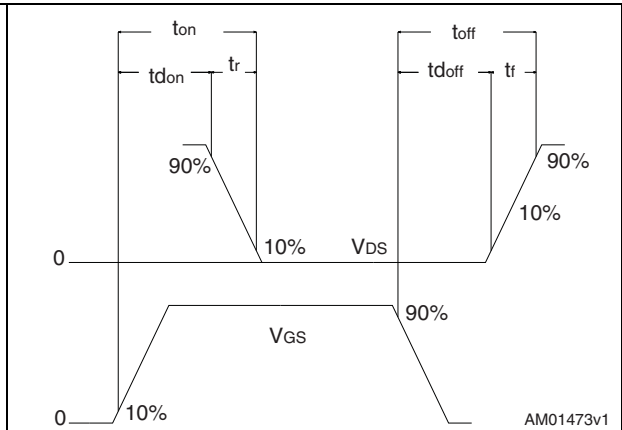
AM01471v1

Figure 18. Unclamped inductive waveform



AM01472v1

Figure 19. Switching time waveform



AM01473v1

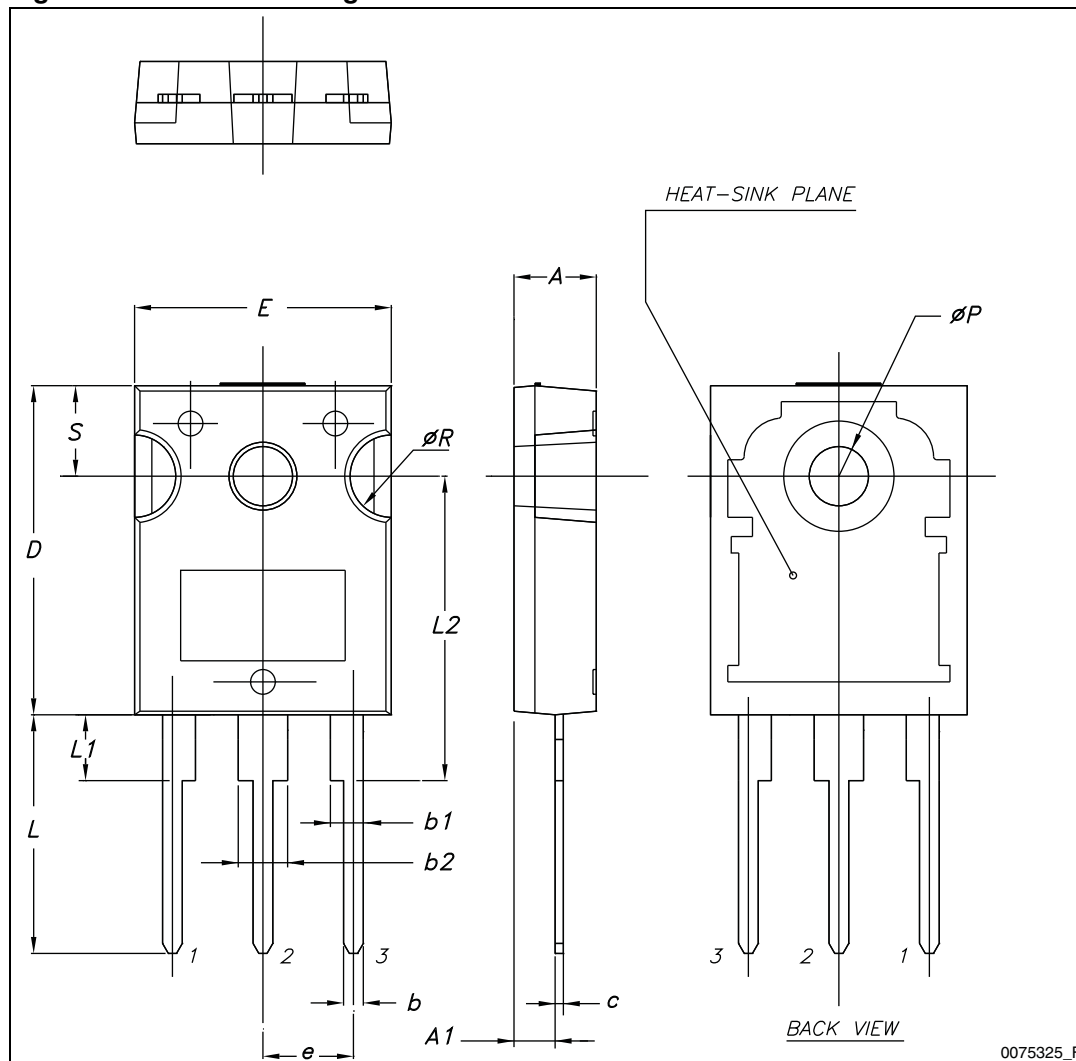
4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

Table 9. TO-247 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e		5.45	
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S		5.50	

Figure 20. TO-247 drawing



5 Revision history

Table 10. Document revision history

Date	Revision	Changes
05-Apr-2012	1	First release.

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