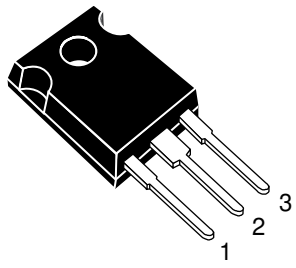
STW22N95K5

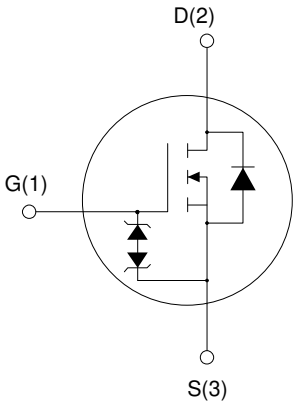
Automotive-grade N-channel 950 V, 0.280 Ω typ., 17.5 A MDmesh™ K5 Power MOSFET in a TO-247 package

Datasheet - production data



TO-247

Figure 1: Internal schematic diagram



Features

Order code	V_{DS}	$R_{DS(on)}$ max.	I_D	P_{TOT}
STW22N95K5	950 V	0.330 Ω	17.5 A	250 W

- AEC-Q101 qualified
- Industry's lowest $R_{DS(on)}$ x area
- Industry's best FoM (figure of merit)
- Ultra-low gate charge
- 100% avalanche tested
- Zener-protected

Applications

- Switching applications

Description

This very high voltage N-channel Power MOSFET is designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

Table 1: Device summary

Order code	Marking	Package	Packing
STW22N95K5	22N95K5	TO-247	Tube

Contents

1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{GS}	Gate-source voltage	±30	V
I_D	Drain current (continuous) at T_C = 25 °C	17.5	A
I_D	Drain current (continuous) at T_C = 100 °C	11	A
I_D (1)	Drain current (pulsed)	70	A
P_{TOT}	Total dissipation at T_C = 25 °C	250	W
ESD	Gate-source human body model (R= 1.5 kΩ, C = 100 pF)	2	kV
dv/dt (2)	Peak diode recovery voltage slope	4.5	V/ns
dv/dt (3)	MOSFET dv/dt ruggedness	50	
T_j	Operating junction temperature range	-55 to 150	°C
T_{stg}	Storage temperature range		

Notes:

(1)Pulse width limited by safe operating area.

(2)I_{SD} ≤ 17.5 A, di/dt ≤ 100 A/µs; V_{DS} peak ≤ $V_{(BR)DSS}$

(3)V_{DS} ≤ 760 V

Table 3: Thermal data

Symbol	Parameter	Value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case	0.5	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient	50	°C/W

Table 4: Avalanche characteristics

Symbol	Parameter	Value	Unit
I_{AR}	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax.}$)	6	A
E_{AS}	Single pulse avalanche energy (starting T_j = 25 °C, I_D = I_{AR}, V_{DD} = 50 V)	182	mJ

2 Electrical characteristics

T_C = 25 °C unless otherwise specified

Table 5: On/off-state

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	V_{GS} = 0 V, I_D = 1 mA	950			V
I_{DSS}	Zero-gate voltage drain current	V_{GS} = 0 V, V_{DS} = 950 V			1	µA
		V_{GS} = 0 V, V_{DS} = 950 V T_C = 125 °C(1)			50	µA
I_{GSS}	Gate body leakage current	V_{DS} = 0 V, V_{GS} = ±20 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS} = V_{GS}, I_D = 100 µA	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	V_{GS} = 10 V, I_D = 9 A		0.280	0.330	Ω

Notes:

(1)Defined by design, not subject to production test.

Table 6: Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{DS} = 100 V, f = 1 MHz, V_{GS} = 0 V	-	1550	-	pF
C_{oss}	Output capacitance		-	140	-	pF
C_{rss}	Reverse transfer capacitance		-	1	-	pF
$C_{o(er)}$(1)	Equivalent capacitance energy related	V_{GS} = 0 V, V_{DS} = 0 to 760 V	-	65	-	pF
$C_{o(tr)}$(2)	Equivalent capacitance time related			178	-	pF
R_g	Intrinsic gate resistance	f = 1 MHz , I_D = 0 A	-	3.5	-	Ω
Q_g	Total gate charge	V_{DD} = 760 V, I_D = 17.5 A V_{GS}= 10 V (see *Figure 16: "Test circuit for gate charge behavior"*)	-	48	-	nC
Q_{gs}	Gate-source charge		-	9	-	nC
Q_{gd}	Gate-drain charge		-	32.5	-	nC

Notes:

(1)$C_{o(er)}$ is a constant capacitance value that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

(2)$C_{o(tr)}$ is a constant capacitance value that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

Table 7: Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{DD}= 475 V, I_D = 9 A, R_G = 4.7 Ω V_{GS} = 10 V (see *Figure 15: "Test circuit for resistive load switching times"* and *Figure 20: "Switching time waveform"*)	-	18	-	ns
t_r	Rise time		-	9	-	ns
$t_{d(off)}$	Turn-off delay time		-	65	-	ns
t_f	Fall time		-	18	-	ns

Table 8: Source-drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current		-		17.5	A
I_{SDM}(1)	Source-drain current (pulsed)		-		70	A
V_{SD}(2)	Forward on voltage	I_{SD} = 17.5 A, V_{GS} = 0 V	-		1.5	V
t_{rr}	Reverse recovery time	I_{SD} = 17.5 A, di/dt = 100 A/µs, V_{DD} = 60 V (see *Figure 17: "Test circuit for inductive load switching and diode recovery times"*)	-	513		ns
Q_{rr}	Reverse recovery charge		-	12		µC
I_{RRM}	Reverse recovery current		-	46		A
t_{rr}	Reverse recovery time	I_{SD} = 17.5 A, di/dt = 100 A/µs V_{DD} = 60 V, T_j = 150 °C (see *Figure 17: "Test circuit for inductive load switching and diode recovery times"*)	-	670		ns
Q_{rr}	Reverse recovery charge		-	15		µC
I_{RRM}	Reverse recovery current		-	44		A

Notes:

(1)Pulse width limited by safe operating area.

(2)Pulsed: pulse duration = 300 µs, duty cycle 1.5%.

Table 9: Gate-source Zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)\ GSO}$	Gate-source breakdown voltage	I_{GS} = ± 1 mA, I_D = 0 A	30	-	-	V

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

2.1 Electrical characteristics (curves)

Figure 2: Safe operating area

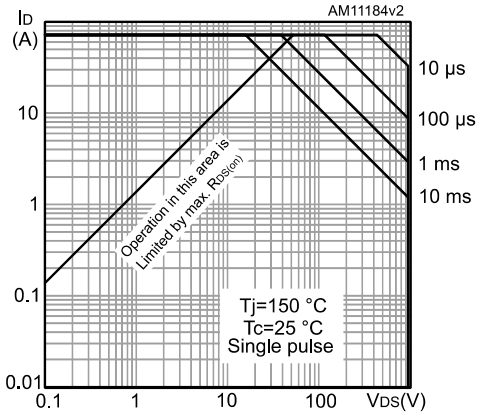


Figure 3: Thermal impedance

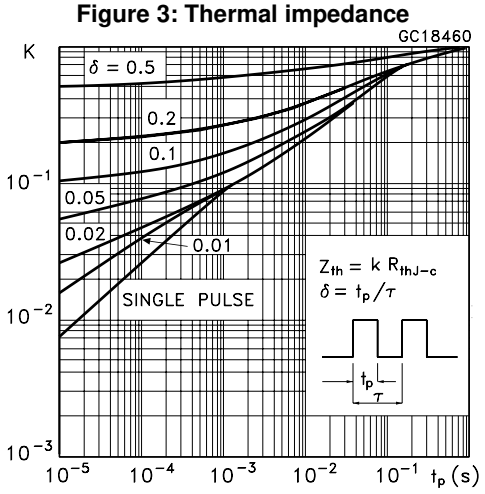


Figure 4: Output characteristics

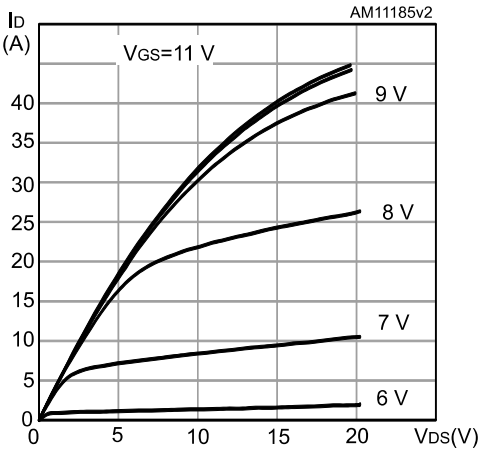


Figure 5: Transfer characteristics

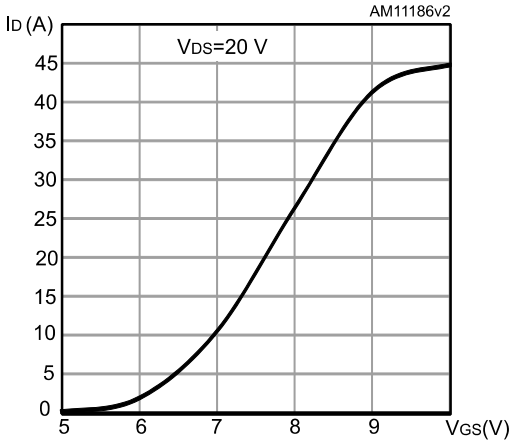


Figure 6: Gate charge vs gate-source voltage

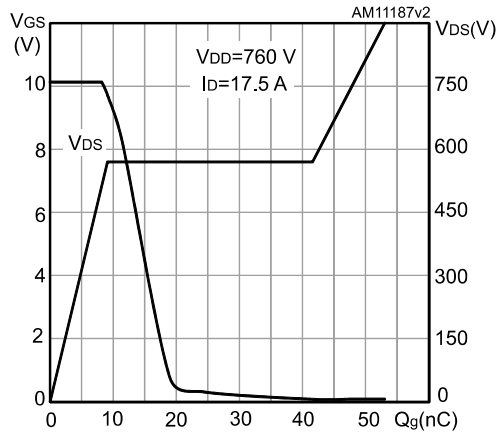


Figure 7: Static drain-source on-resistance

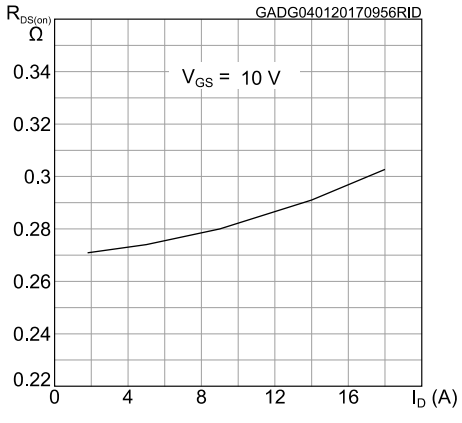


Figure 8: Capacitance variation

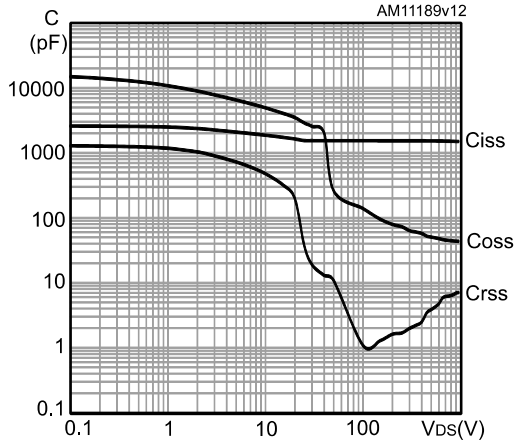


Figure 9: Output capacitance stored energy

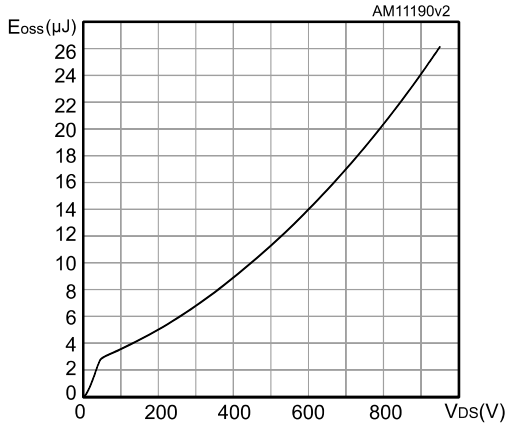


Figure 10: Normalized gate threshold voltage vs temperature

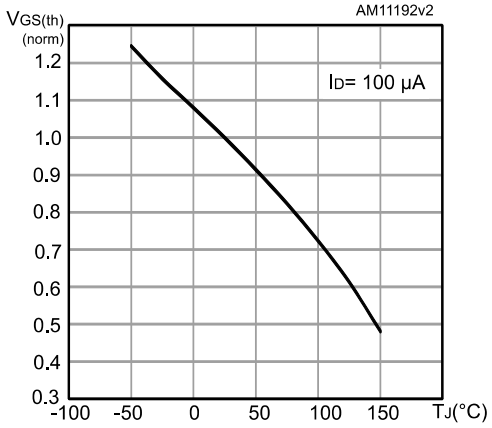


Figure 11: Normalized on-resistance vs temperature

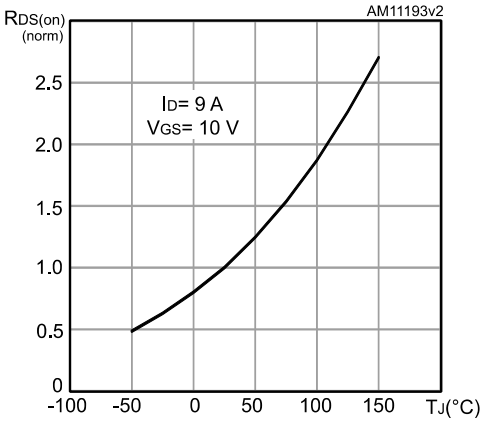


Figure 12: Maximum avalanche energy vs starting T_J

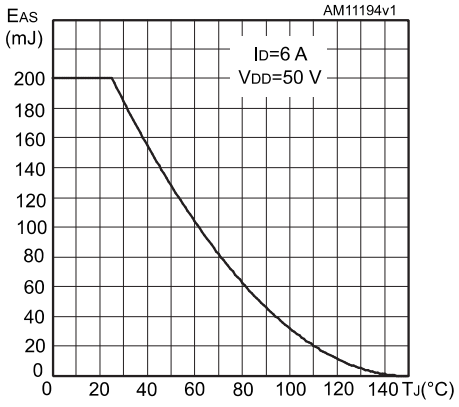


Figure 13: Normalized $V_{(BR)DSS}$ vs temperature

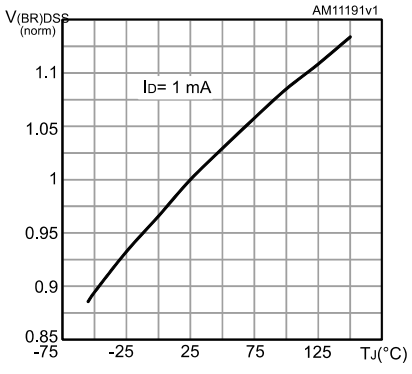
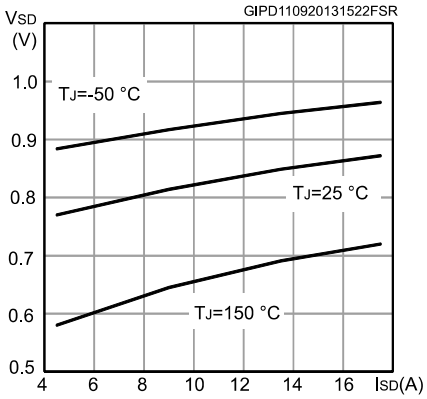


Figure 14: Source-drain diode forward characteristics



3 Test circuits

Figure 15: Test circuit for resistive load switching times

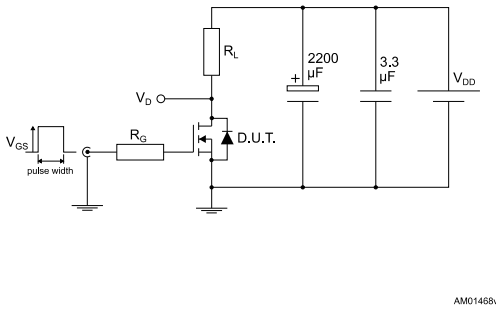


Figure 16: Test circuit for gate charge behavior

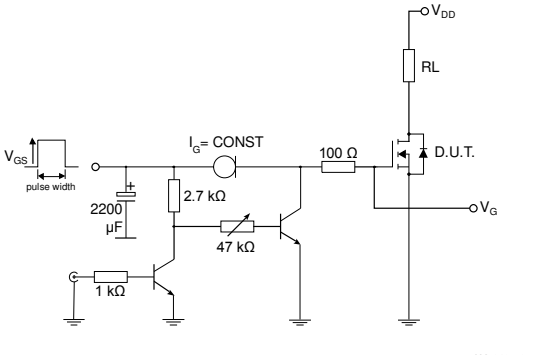


Figure 17: Test circuit for inductive load switching and diode recovery times

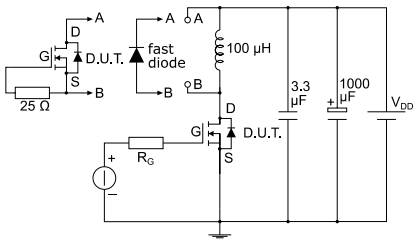


Figure 18: Unclamped inductive load test circuit

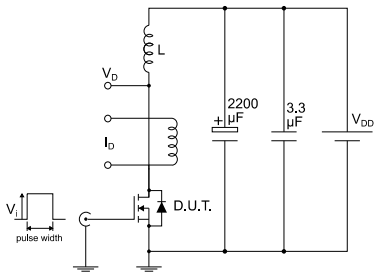


Figure 19: Unclamped inductive waveform

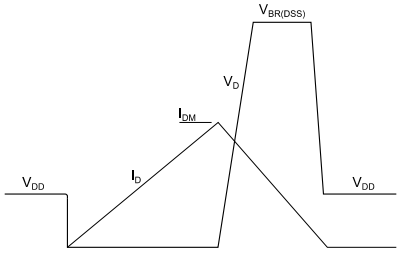
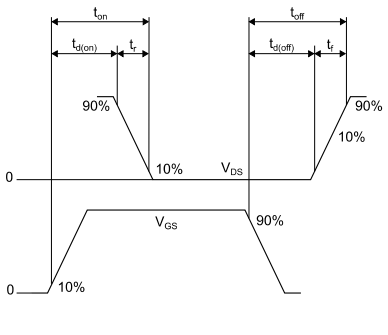


Figure 20: Switching time waveform



4 Package information

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.

4.1 TO-247 package information

Figure 21: TO-247 package outline

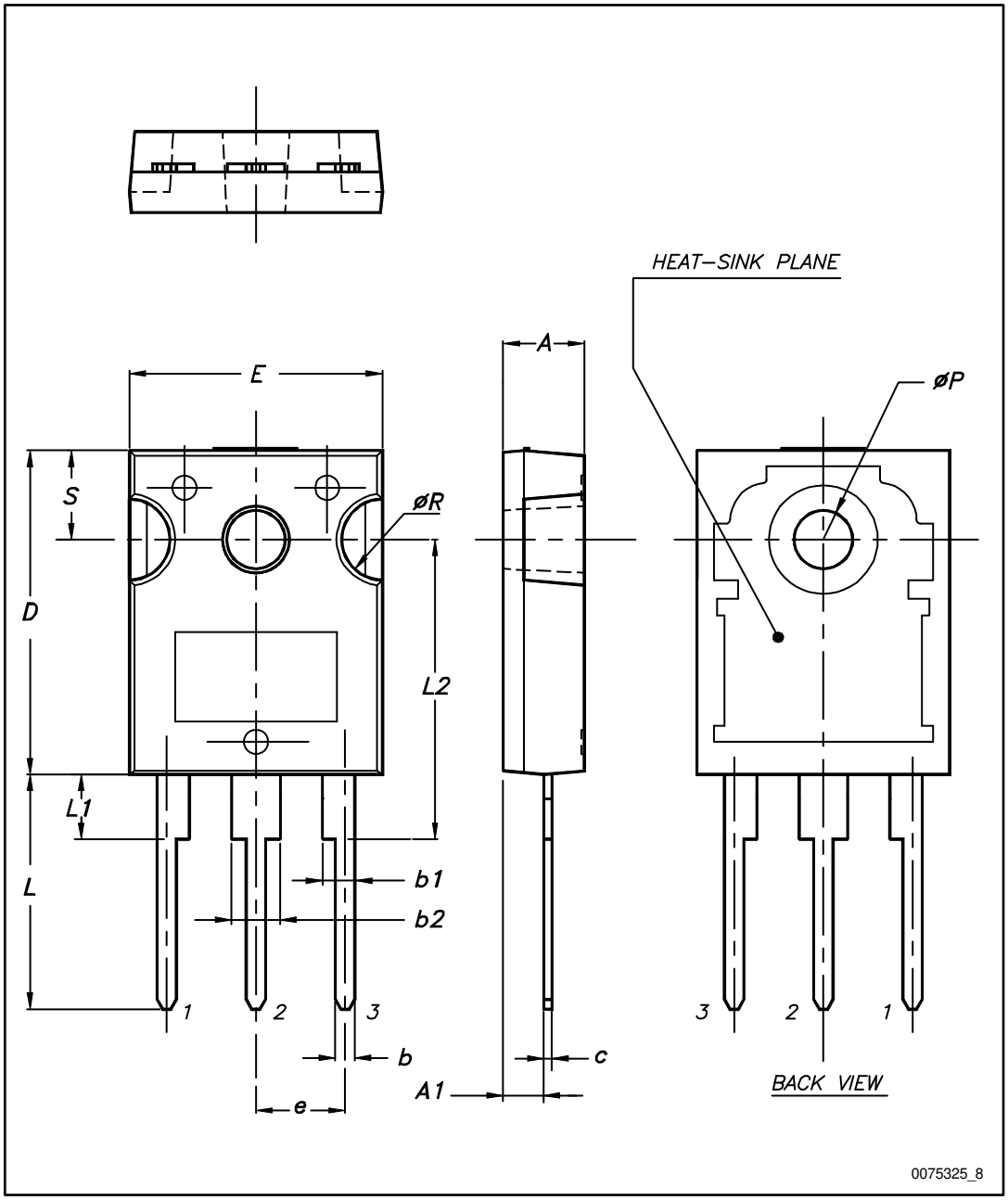


Table 10: TO-247 package mechanical data

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	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

5 Revision history

Table 11: Document revision history

Date	Revision	Changes
17-Oct-2013	1	First release.
19-Dec-2013	2	Datasheet promoted from preliminary to production data Modified: title and *Features* Minor text changes
20-Mar-2014	3	– Modified: note 3 in Table 2 – Modified: Q_{gs} and Q_{gd} typical values in *Table 5* – Modified: typical values in *Table 6* and *7* – Updated: *Figure 6* – Minor text changes
11-Jan-2017	4	Updated title, features and description in cover page. Minor text changes in *Section 1: "Electrical ratings"* and *Section 2: "Electrical characteristics"*. Changed *Figure 7: "Static drain-source on-resistance"*.

IMPORTANT NOTICE – PLEASE READ CAREFULLY

STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST’s terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers’ products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.