

## N-channel 950 V, 0.275 $\Omega$ typ., 17.5 A MDmesh™ K5 Power MOSFET in a TO-247 long leads package

Datasheet - production data

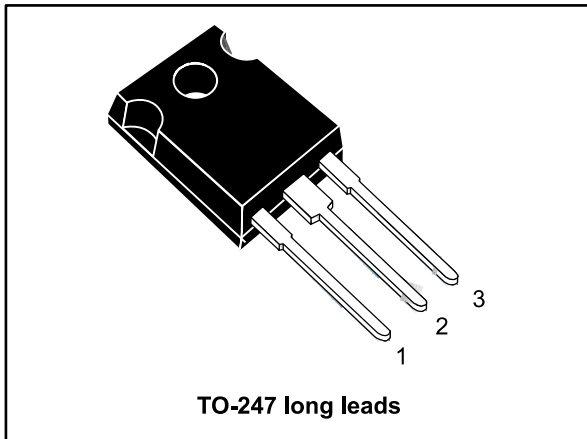
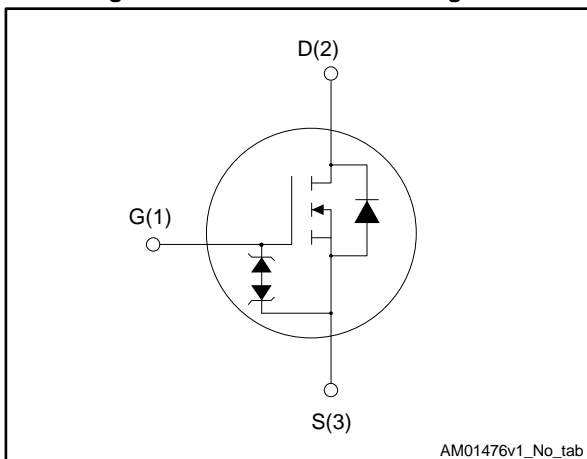


Figure 1: Internal schematic diagram



### Features

Order code	$V_{DS}$	$R_{DS(on)}$ max.	$I_D$	$P_{TOT}$
STWA20N95K5	950 V	0.330 $\Omega$	17.5 A	250 W

- 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
STWA20N95K5	20N95K5	TO-247 long leads	Tube

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# 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 $T_C = 25\text{ °C}$	17.5	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ °C}$	11	A
$I_D^{(1)}$	Drain current (pulsed)	70	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	250	W
ESD	Gate-source human body model ( $R = 1.5\text{ k}\Omega$ , $C = 100\text{ pF}$ )	2	kV
$dv/dt^{(2)}$	Peak diode recovery voltage slope	6	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)  $I_{SD} \leq 17.5\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ;  $V_{DS\text{ peak}} \leq V_{(BR)DSS}$

(3)  $V_{DS} \leq 760\text{ V}$

**Table 3: Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case	0.5	°C/W
$R_{thj-amb}$	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 $T_j = 25\text{ °C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	200	mJ

## 2 Electrical characteristics

$T_C = 25\text{ °C}$  unless otherwise specified

**Table 5: On/off-state**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	950			V
$I_{DSS}$	Zero-gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 950\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 950\text{ V}$ $T_C = 125\text{ °C}^{(1)}$			50	$\mu\text{A}$
$I_{GSS}$	Gate body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 9\text{ A}$		0.275	0.330	$\Omega$

**Notes:**

<sup>(1)</sup>Defined by design, not subject to production test

**Table 6: Dynamic**

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

**Notes:**

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

<sup>(2)</sup> $C_{o(tr)}$  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	$V_{DD} = 475 \text{ V}$ , $I_D = 9 \text{ A}$ , $R_G = 4.7 \Omega$ $V_{GS} = 10 \text{ V}$ (see <i>Figure 15: "Test circuit for resistive load switching times"</i> and <i>Figure 20: "Switching time waveform"</i> )	-	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	$I_{SD} = 17.5 \text{ A}$ , $V_{GS} = 0 \text{ V}$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 17.5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ , $V_{DD} = 60 \text{ V}$ (see <i>Figure 17: "Test circuit for inductive load switching and diode recovery times"</i> )	-	513		ns
$Q_{rr}$	Reverse recovery charge		-	12		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	46		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 17.5 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ , $T_j = 150 \text{ }^\circ\text{C}$ (see <i>Figure 17: "Test circuit for inductive load switching and diode recovery times"</i> )	-	670		ns
$Q_{rr}$	Reverse recovery charge		-	15		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	44		A

**Notes:**

(1)Pulse width limited by safe operating area

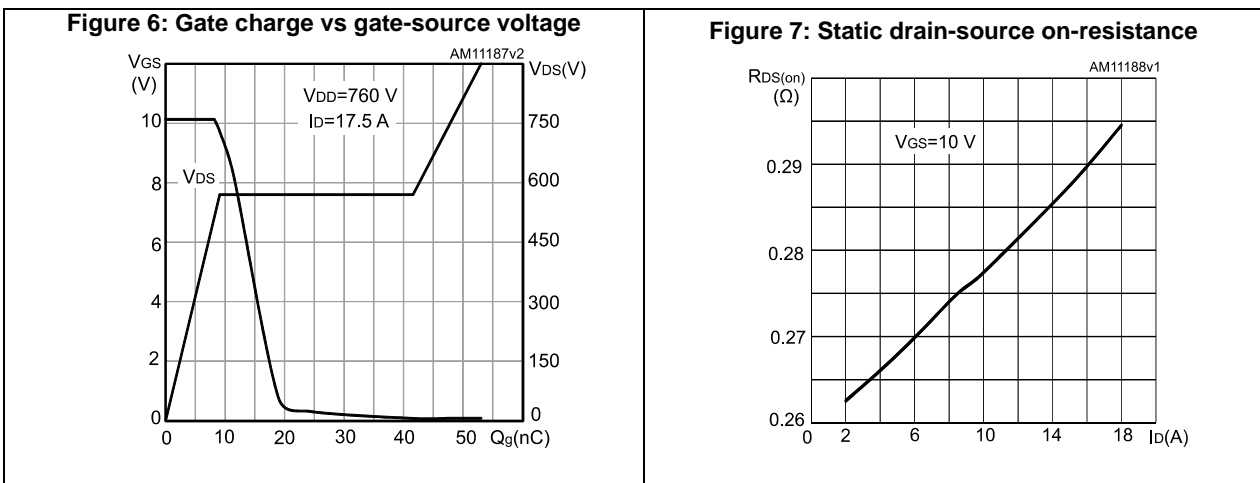
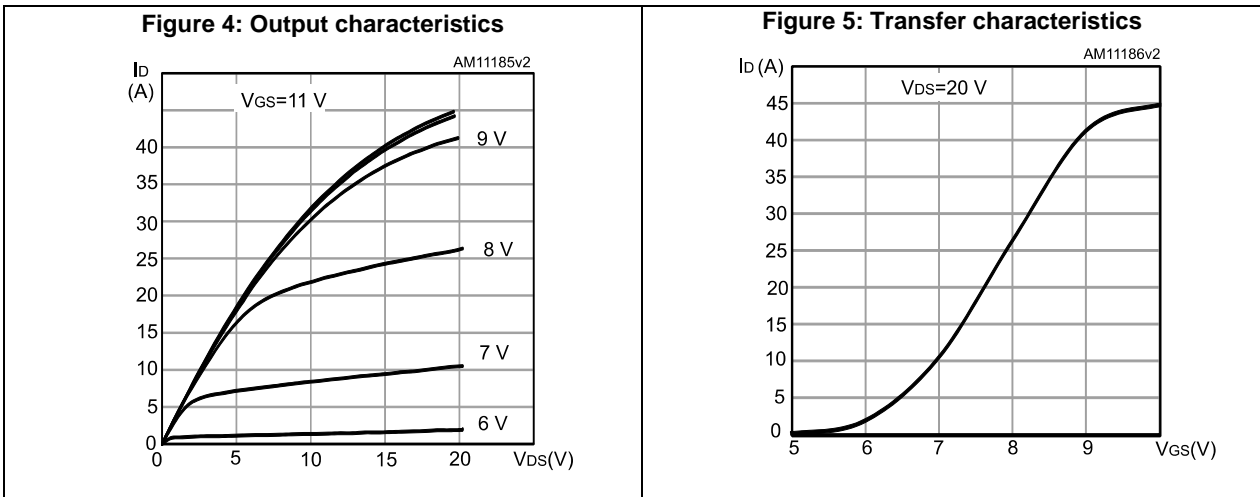
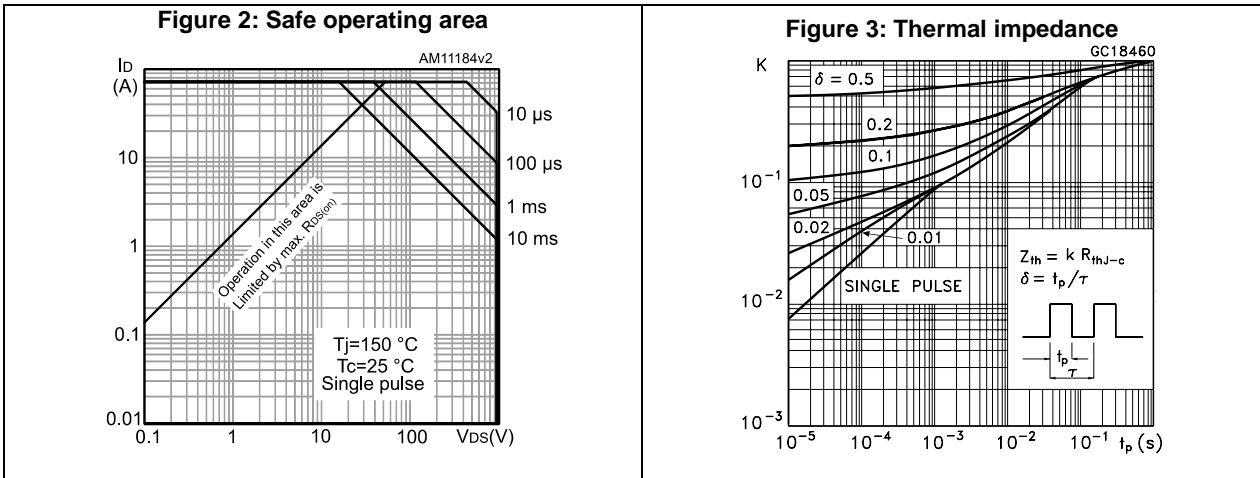
(2)Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

Table 9: Gate-source Zener diode

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



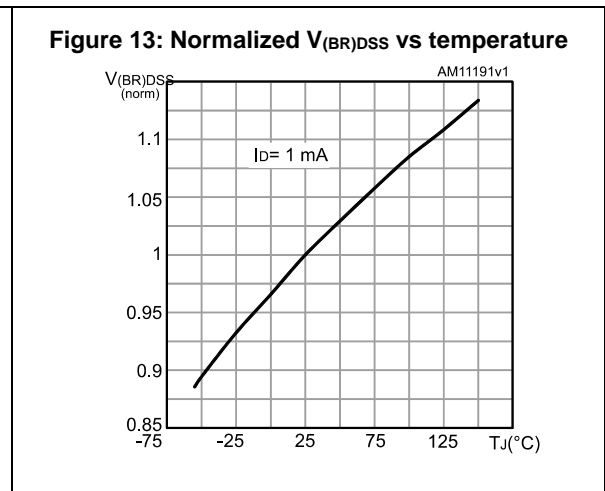
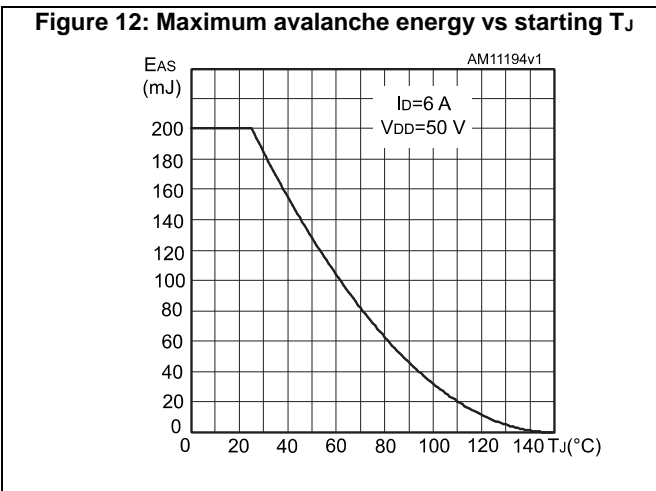
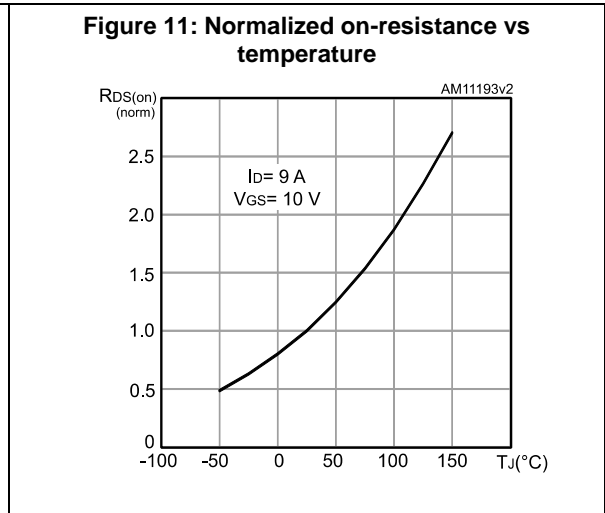
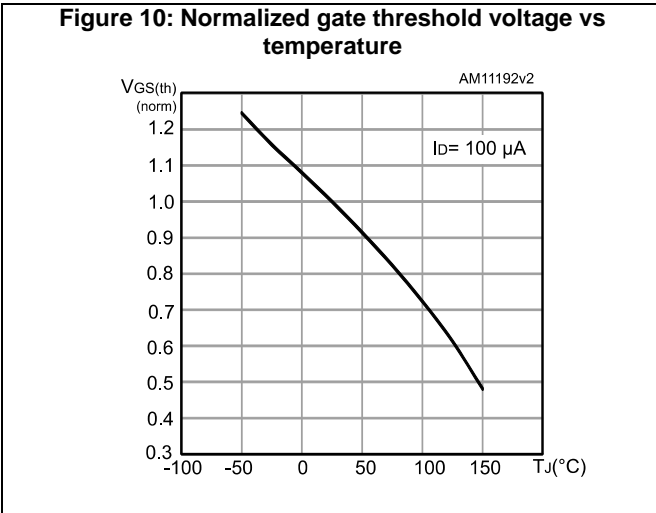
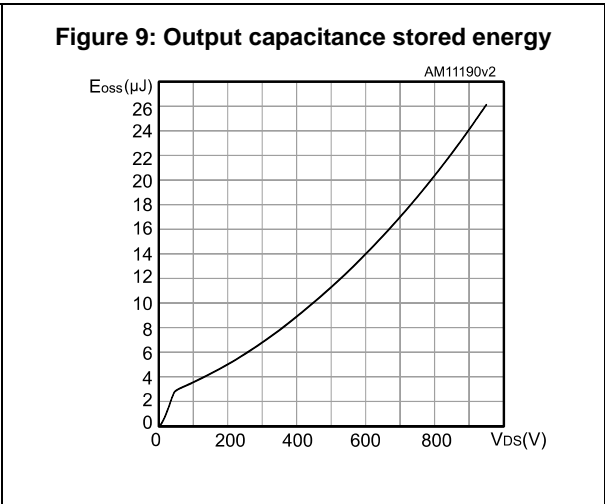
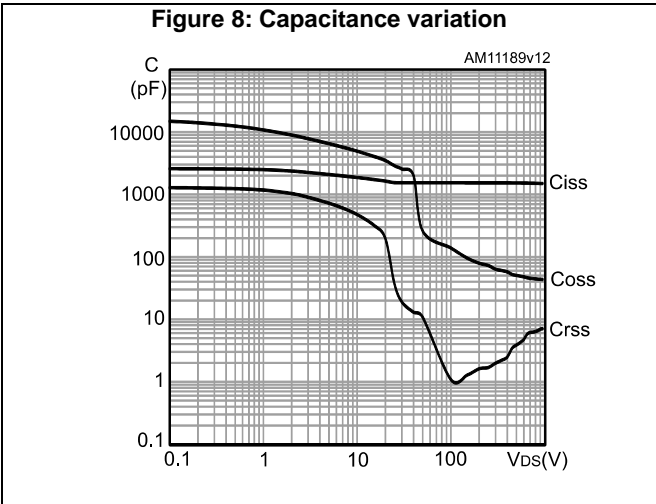
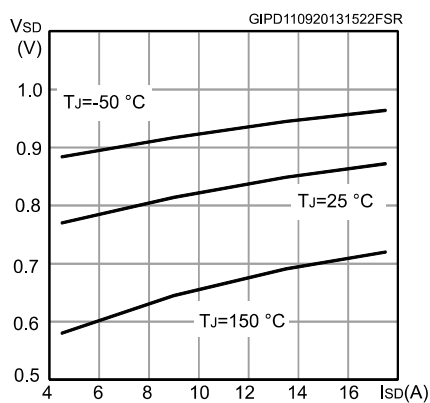


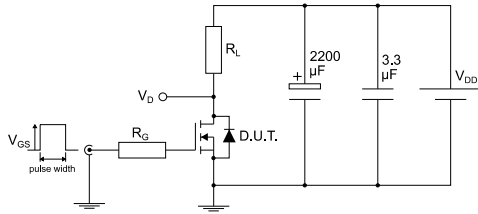
Figure 14: Source-drain diode forward characteristics





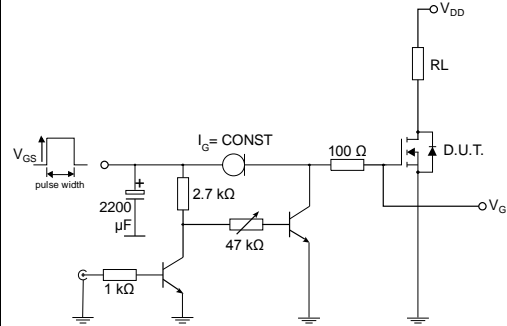
### 3 Test circuits

**Figure 15: Test circuit for resistive load switching times**



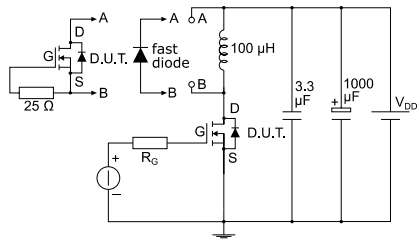
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**Figure 16: Test circuit for gate charge behavior**



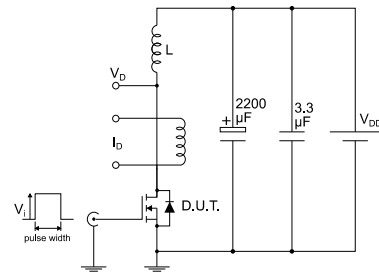
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**Figure 17: Test circuit for inductive load switching and diode recovery times**



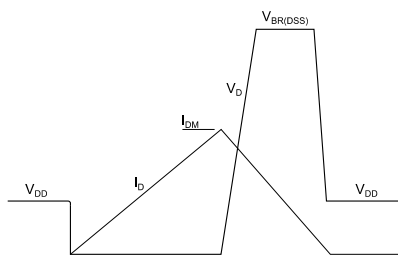
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**Figure 18: Unclamped inductive load test circuit**



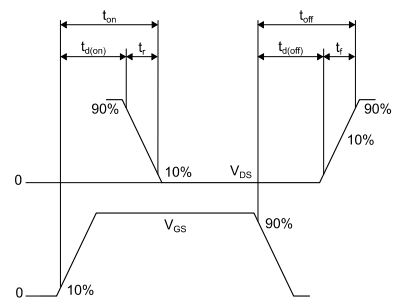
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**Figure 19: Unclamped inductive waveform**



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**Figure 20: Switching time waveform**



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## 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](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 TO-247 long leads package information

Figure 21: TO-247 long leads package outline

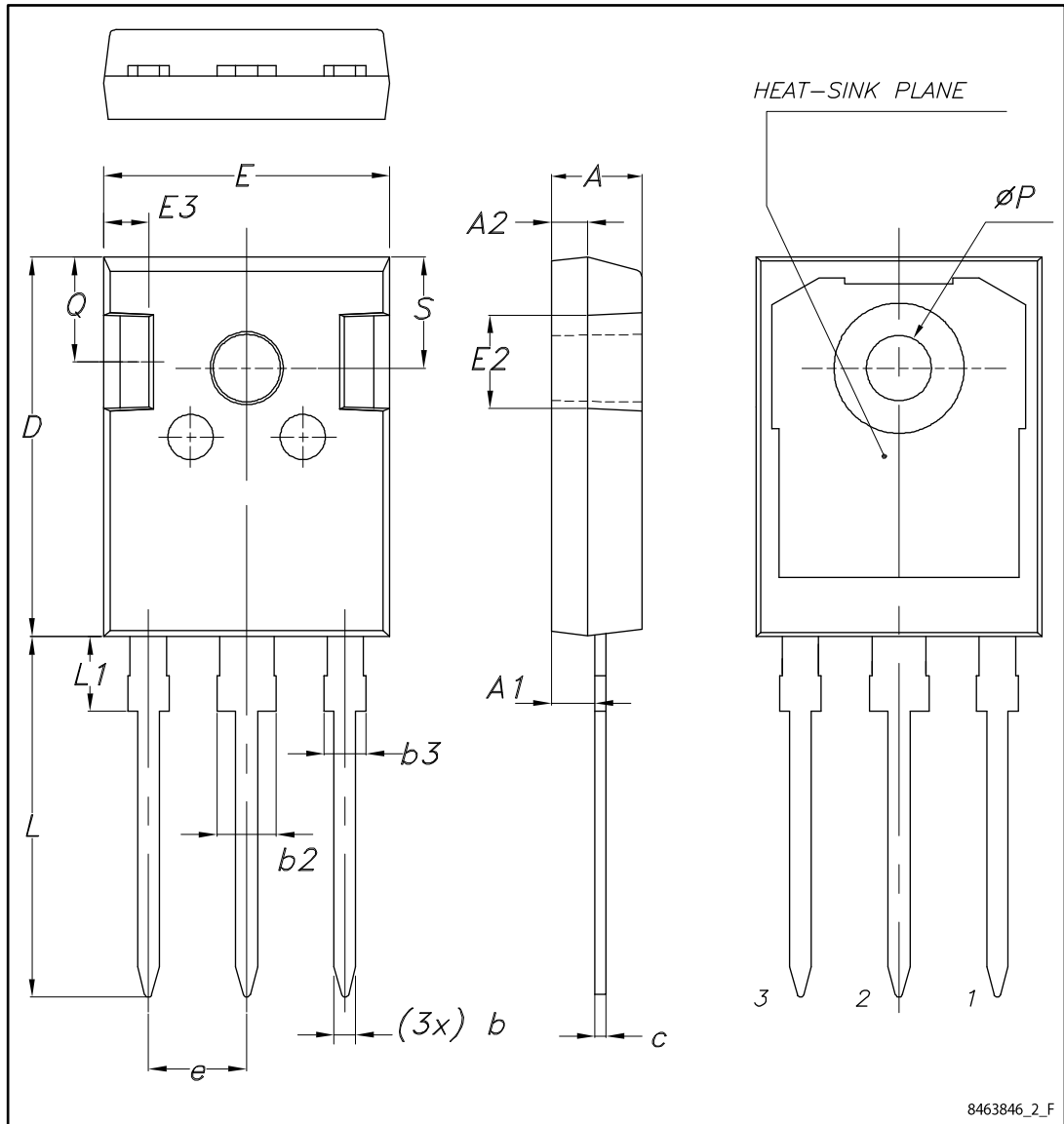


Table 10: TO-247 long leads package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.26
b2			3.25
b3			2.25
c	0.59		0.66
D	20.90	21.00	21.10
E	15.70	15.80	15.90
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25

## 5 Revision history

Table 11: Document revision history

Date	Revision	Changes
21-Nov-2013	1	First release.
16-Jan-2017	2	Datasheet promoted from preliminary to production data. Modified: title. Updated: features, applications and description in cover page. Minor text changes in <a href="#">Section 1: "Electrical ratings"</a> and <a href="#">Section 2: "Electrical characteristics"</a> . Updated <a href="#">Section 2.1: "Electrical characteristics (curves)"</a> . Updated <a href="#">Section 4.1: "TO-247 long leads package information"</a> .

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