

N-channel 650 V, 35 A, 0.067  $\Omega$  typ., MDmesh™ V Power MOSFETs  
in TO-3PF, TO-247 and TO-247 long leads packages

Datasheet - production data

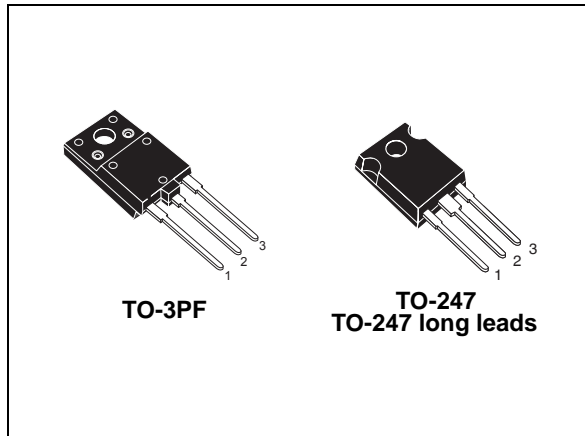
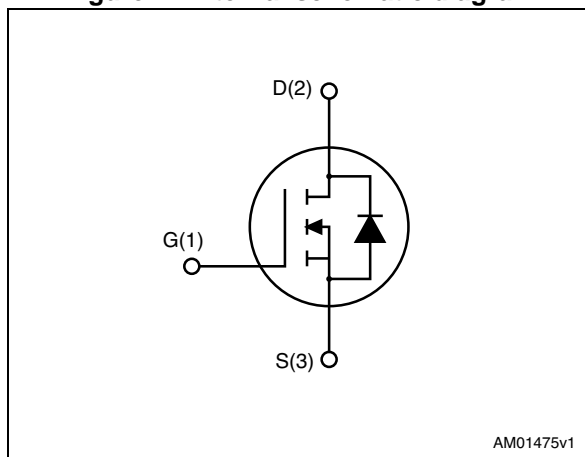


Figure 1. Internal schematic diagram



## Features

Order codes	$V_{DS} @ T_{Jmax}$	$R_{DS(on) max}$	$I_D$
STFW45N65M5	710 V	0.078 $\Omega$	35 A
STW45N65M5			
STWA45N65M5			

- Worldwide best  $R_{DS(on)}$  \* area
- Higher  $V_{DSS}$  rating and high dv/dt capability
- Excellent switching performance
- 100% avalanche tested

## Applications

- Switching applications

## Description

These devices are N-channel MDmesh™ V Power MOSFETs based on an innovative proprietary vertical process technology, which is combined with STMicroelectronics' well-known PowerMESH™ horizontal layout structure. The resulting product has extremely low on-resistance, which is unmatched among silicon-based Power MOSFETs, making it especially suitable for applications which require superior power density and outstanding efficiency.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STFW45N65M5	45N65M5	TO-3PF	Tube
STW45N65M5		TO-247	
STWA45N65M5		TO-247 long leads	

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value		Unit
		TO-3PF	TO-247, TO-247 long leads	
$V_{GS}$	Gate-source voltage	± 25		V
$I_D$	Drain current (continuous) at $T_C = 25\text{ °C}$	35		A
$I_D$	Drain current (continuous) at $T_C = 100\text{ °C}$	22		A
$I_{DM}^{(1)}$	Drain current (pulsed)	140		A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	57	210	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	15		V/ns
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	50		V/ns
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t=1\text{ s}$ ; $T_C=25\text{ °C}$ )	3500		V
$T_{stg}$	Storage temperature	- 55 to 150		°C
$T_j$	Max. operating junction temperature	150		°C

- Limited by maximum junction temperature
- $I_{SD} \leq 35\text{ A}$ ,  $di/dt \leq 400\text{ A}/\mu\text{s}$ ,  $V_{DS(Peak)} < V_{(BR)DSS}$ ,  $V_{DD} = 400\text{ V}$
- $V_{DS} < 520\text{ V}$

**Table 3. Thermal data**

Symbol	Parameter	Value		Unit
		TO-3PF	TO-247, TO-247 long leads	
$R_{thj-case}$	Thermal resistance junction-case max	2.2	0.6	°C/W
$R_{thj-amb}$	Thermal resistance junction-ambient max	50	50	°C/W

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{jmax}$ )	9	A
$E_{AS}$	Single pulse avalanche energy (starting $t_j=25\text{ °C}$ , $I_d=I_{AR}$ ; $V_{dd}=50$ )	810	mJ

## 2 Electrical characteristics

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

**Table 5. On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	650			V
$I_{DSS}$	Zero gate voltage drain current ( $V_{GS} = 0$ )	$V_{DS} = 650\text{ V}$			1	$\mu\text{A}$
		$V_{DS} = 650\text{ V}$ , $T_C = 125\text{ °C}$			100	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 25\text{ V}$			$\pm 100$	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 250\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 17.5\text{ A}$		0.067	0.078	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	3470	-	pF
$C_{oss}$	Output capacitance		-	82	-	pF
$C_{riss}$	Reverse transfer capacitance		-	7	-	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}$ , $V_{GS} = 0$	-	280	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	79	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	2	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 520\text{ V}$ , $I_D = 17.5\text{ A}$ , $V_{GS} = 10\text{ V}$ (see <a href="#">Figure 18</a> )	-	82	-	nC
$Q_{gs}$	Gate-source charge		-	18.5	-	nC
$Q_{gd}$	Gate-drain charge		-	35	-	nC

1. Time related is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$
2. Energy related is defined as a constant equivalent capacitance giving the same stored energy as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

Table 7. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$t_d$ (v)	Voltage delay time	$V_{DD} = 400$ V, $I_D = 23$ A, $R_G = 4.7$ $\Omega$ , $V_{GS} = 10$ V (see <a href="#">Figure 19</a> and <a href="#">Figure 22</a> )	-	79.5	-	ns
$t_r$ (v)	Voltage rise time		-	11	-	ns
$t_f$ (i)	Current fall time		-	9.3	-	ns
$t_c$ (off)	Crossing time		-	16	-	ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		35	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		140	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 35$ A, $V_{GS} = 0$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 35$ A, $di/dt = 100$ A/ $\mu$ s $V_{DD} = 100$ V (see <a href="#">Figure 19</a> )	-	392		ns
$Q_{rr}$	Reverse recovery charge		-	7.4		$\mu$ C
$I_{RRM}$	Reverse recovery current		-	38		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 35$ A, $di/dt = 100$ A/ $\mu$ s $V_{DD} = 100$ V, $T_j = 150$ °C (see <a href="#">Figure 19</a> )	-	468		ns
$Q_{rr}$	Reverse recovery charge		-	9.7		$\mu$ C
$I_{RRM}$	Reverse recovery current		-	42		A

1. Pulse width limited by safe operating area.
2. Pulsed: pulse duration = 300  $\mu$ s, duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-3PF

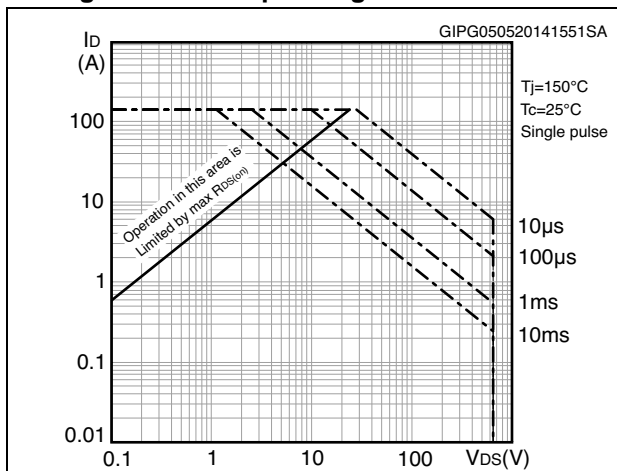


Figure 3. Thermal impedance for TO-3PF

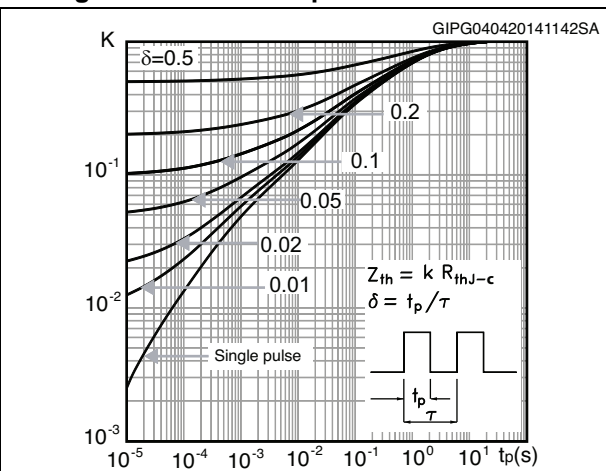


Figure 4. Safe operating area for TO-247 and TO-247LL

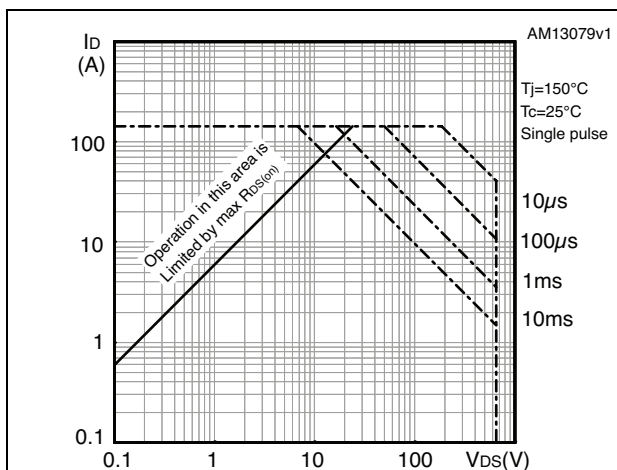


Figure 5. Thermal impedance for TO-247 and TO-247LL

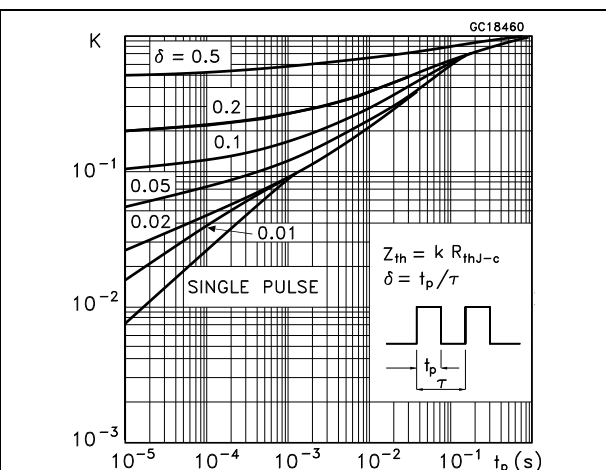


Figure 6. Output characteristics

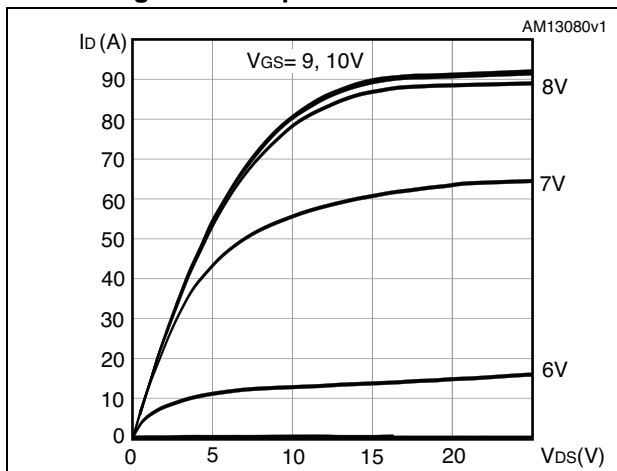


Figure 7. Transfer characteristics

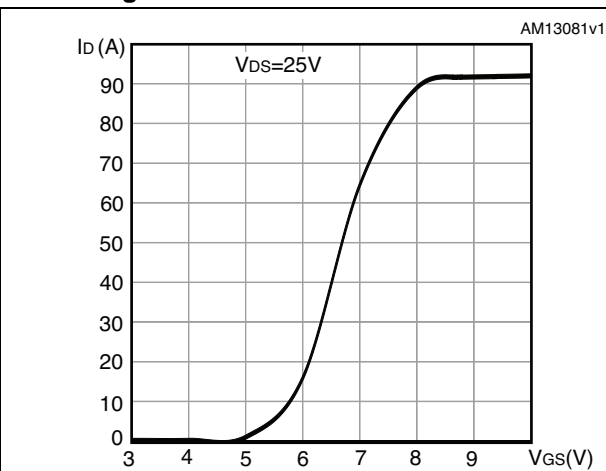


Figure 8. Gate charge vs gate-source voltage

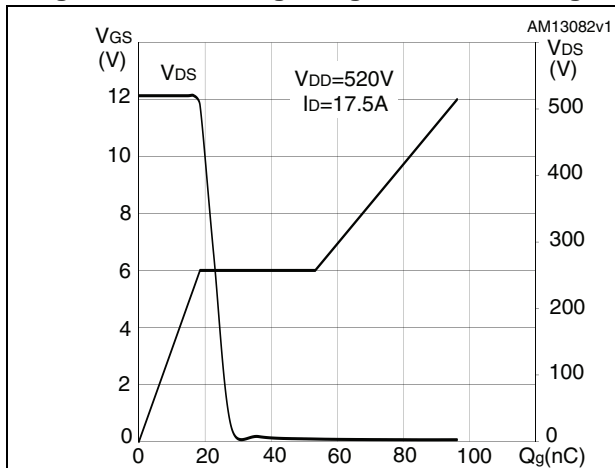


Figure 9. Static drain-source on-resistance

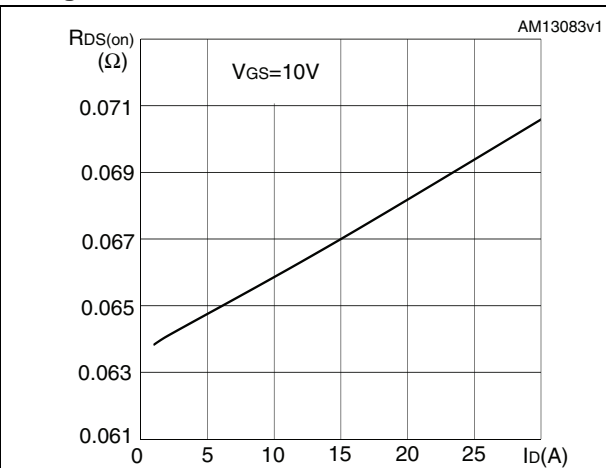


Figure 10. Capacitance variations

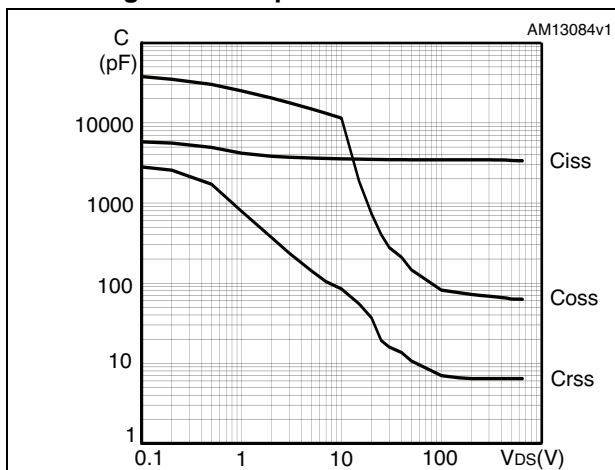


Figure 11. Output capacitance stored energy

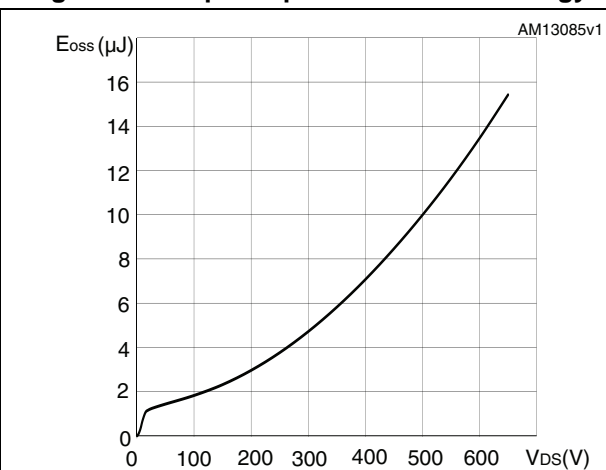


Figure 12. Normalized gate threshold voltage vs. temperature

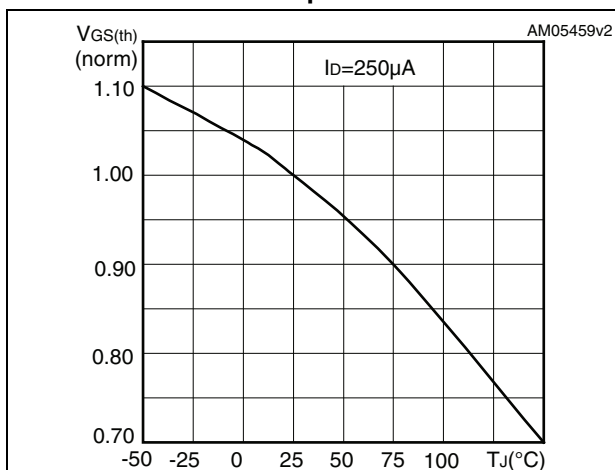


Figure 13. Normalized on-resistance vs. temperature

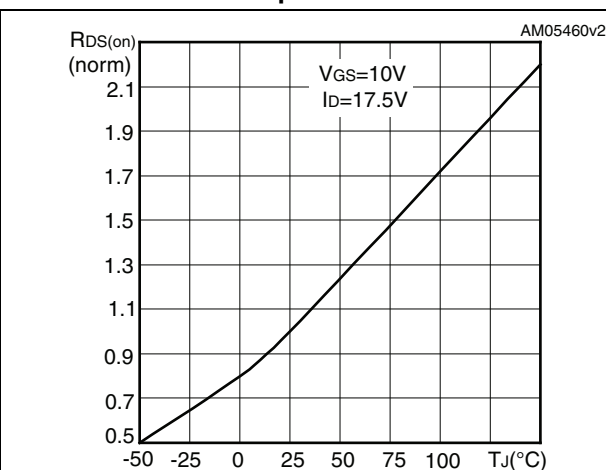


Figure 14. Drain-source diode forward characteristics

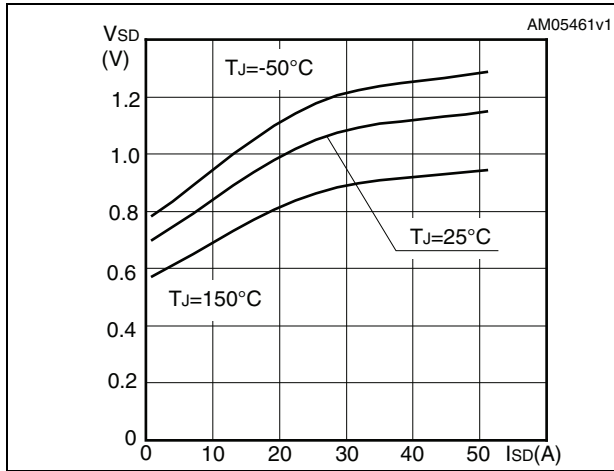


Figure 15. Normalized  $V_{(BR)DSS}$  vs. temperature

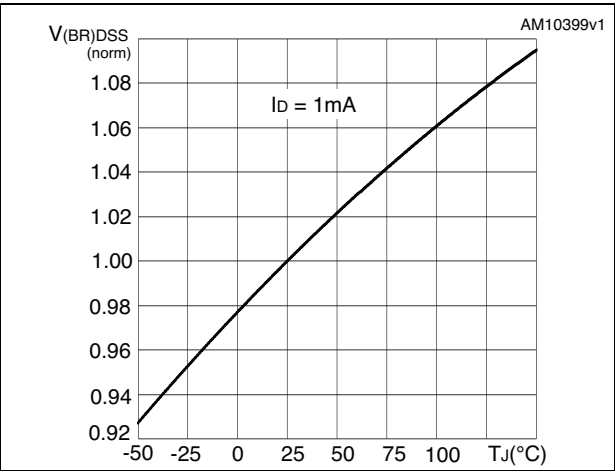
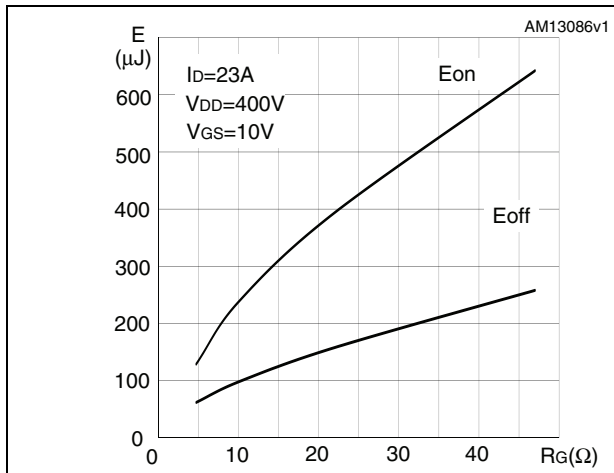


Figure 16. Switching losses vs. gate resistance (1)



1.  $E_{on}$  including reverse recovery of a SiC diode



### 3 Test circuits

Figure 17. Switching times test circuit for resistive load



Figure 18. Gate charge test circuit

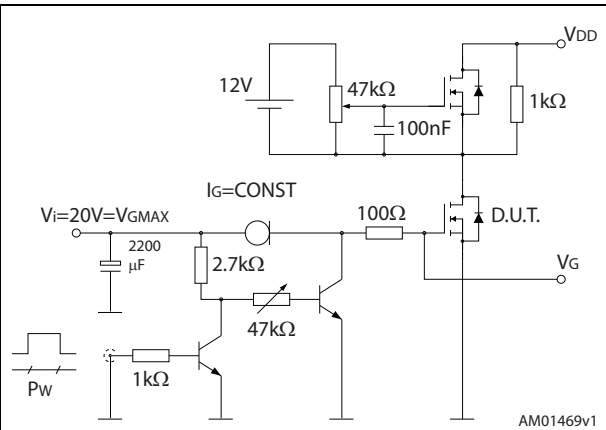


Figure 19. Test circuit for inductive load switching and diode recovery times

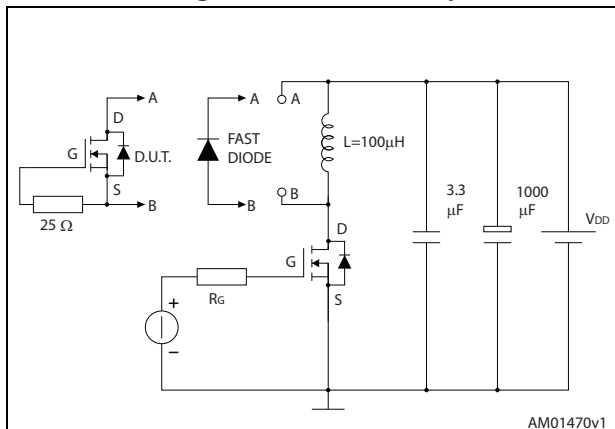


Figure 20. Unclamped inductive load test circuit

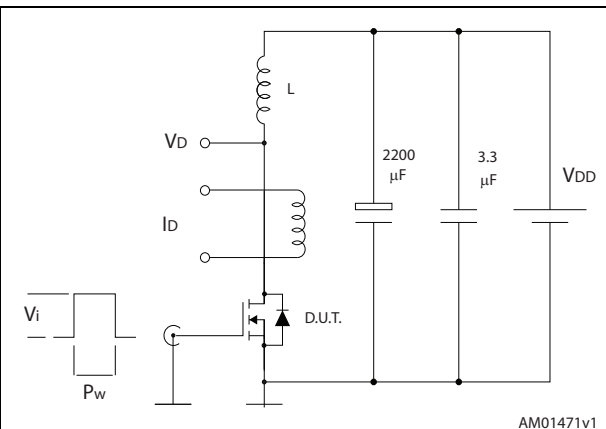


Figure 21. Unclamped inductive waveform

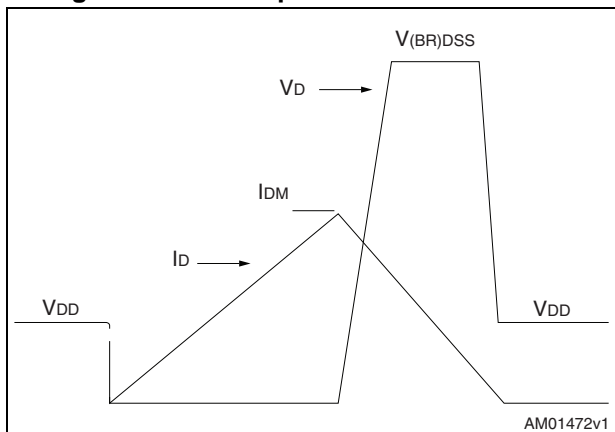
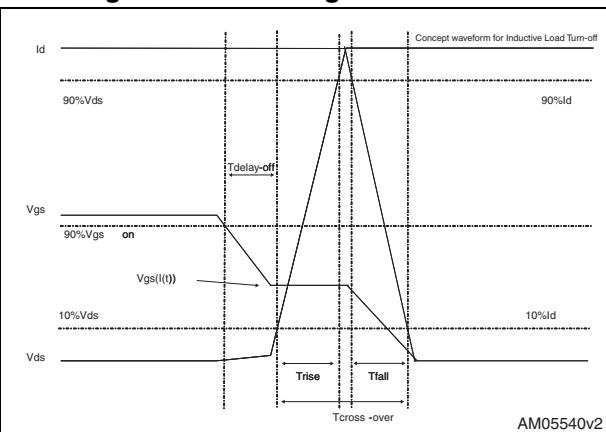


Figure 22. Switching time waveform

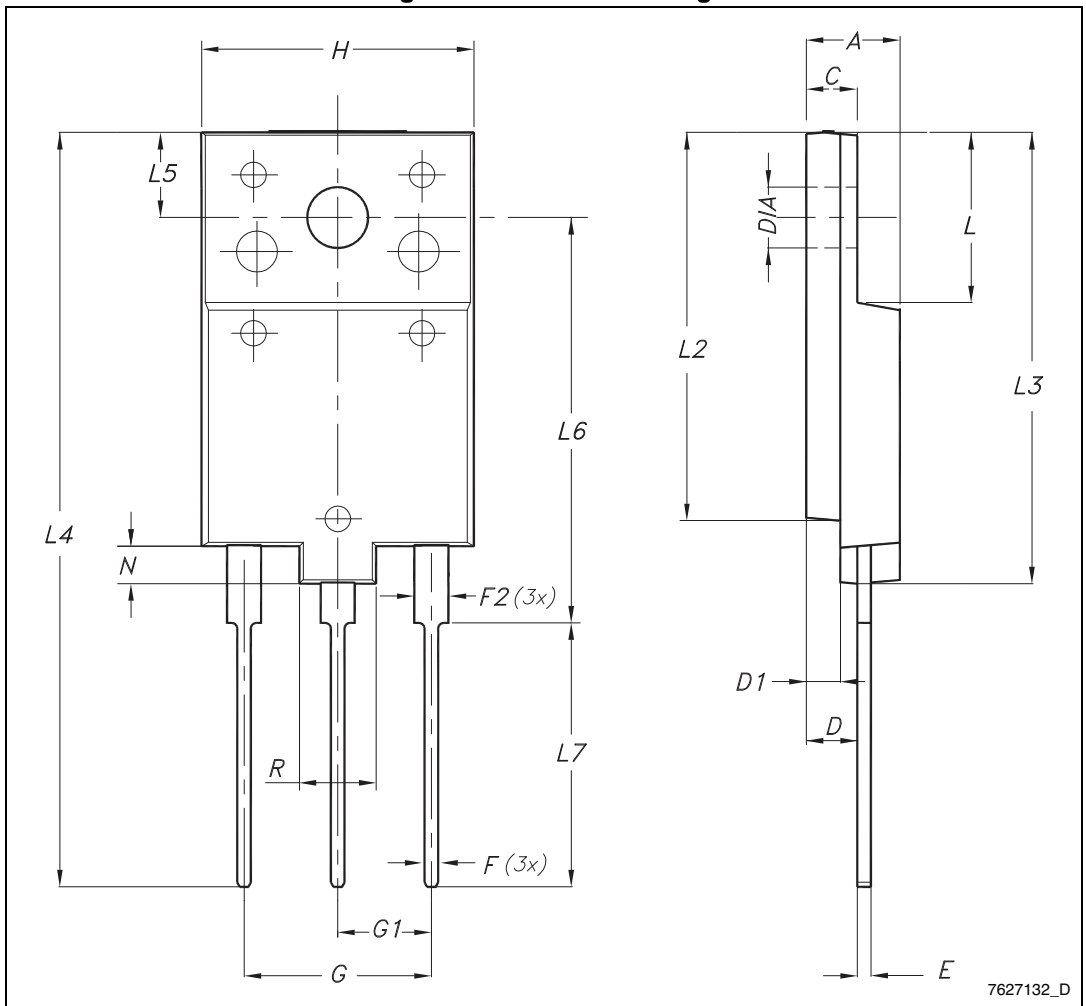


## 4 Package mechanical data

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

4.1 TO-3PF, STFW45N65M5

Figure 23. TO-3PF drawing



7627132\_D

Table 9. TO-3PF mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	5.30		5.70
C	2.80		3.20
D	3.10		3.50
D1	1.80		2.20
E	0.80		1.10
F	0.65		0.95
F2	1.80		2.20
G	10.30		11.50
G1		5.45	
H	15.30		15.70
L	9.80	10	10.20
L2	22.80		23.20
L3	26.30		26.70
L4	43.20		44.40
L5	4.30		4.70
L6	24.30		24.70
L7	14.60		15
N	1.80		2.20
R	3.80		4.20
∅	3.40		3.80

### 4.2 TO-247, STW45N65M5

Figure 24. TO-247 drawing

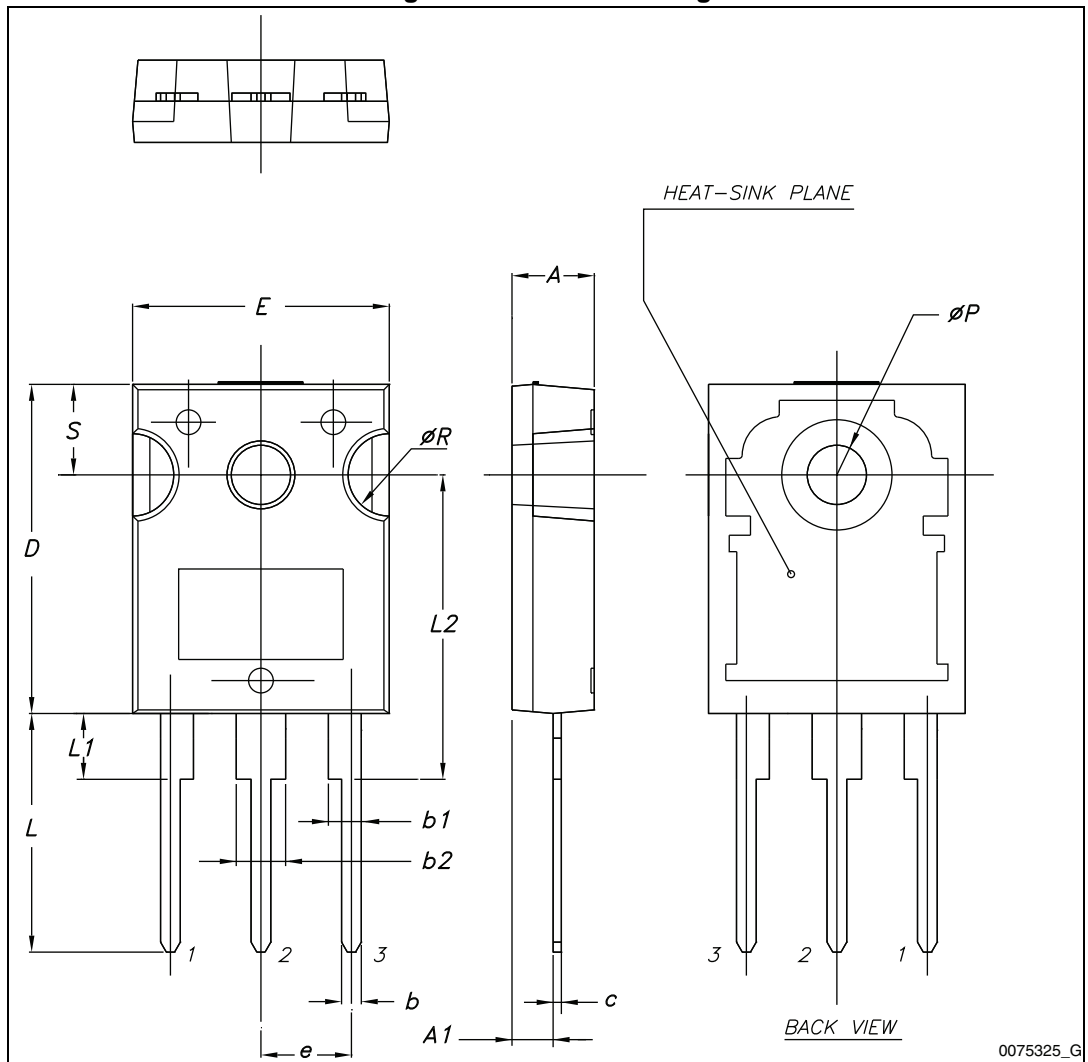
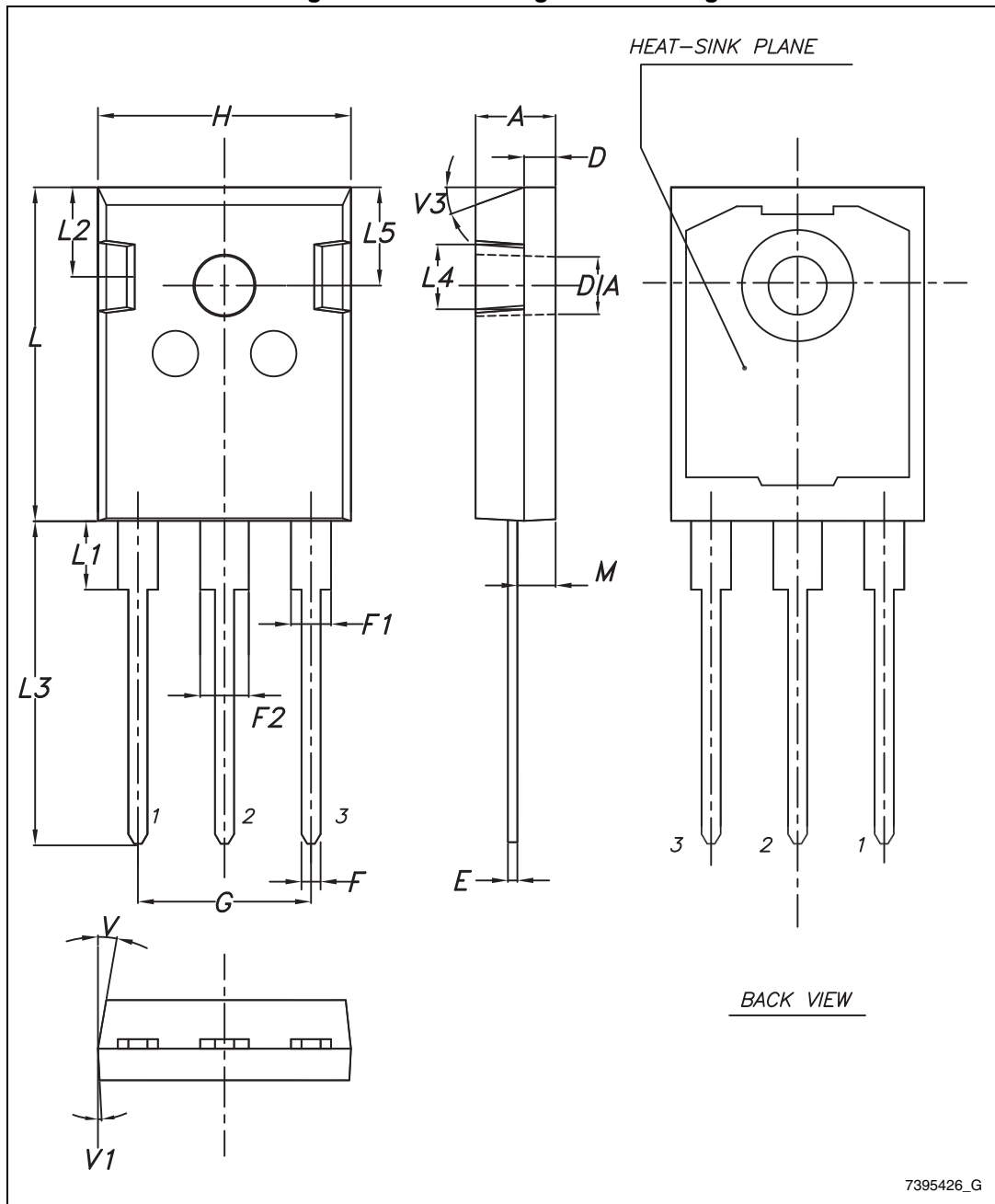


Table 10. TO-247 mechanical data

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	5.30	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

### 4.3 TO-247 long leads, STWA45N65M5

Figure 25. TO-247 long leads drawing



7395426\_G

Table 11. TO-247 long leads mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.90		5.15
D	1.85		2.10
E	0.55		0.67
F	1.07		1.32
F1	1.90		2.38
F2	2.87		3.38
G	10.90 BSC		
H	15.77		16.02
L	20.82		21.07
L1	4.16		4.47
L2	5.49		5.74
L3	20.05		20.30
L4	3.68		3.93
L5	6.04		6.29
M	2.25		2.55
V		10°	
V1		3°	
V3		20°	
Dia.	3.55		3.66



## 5 Revision history

Table 12. Document revision history

Date	Revision	Changes
11-Dec-2012	1	First release.
09-May-2014	2	<ul style="list-style-type: none"><li>– Added: TO-3PF package</li><li>– Added: dv/dt (MOSFET dv/dt ruggedness) parameter and <math>V_{ISO}</math></li><li>– Modified: <a href="#">Figure 6</a> and <a href="#">7</a></li><li>– Minor text changes</li></ul>

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