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STFW45N65M5, STW45N65M5, STWA45N65M5

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

Datasheet - production data

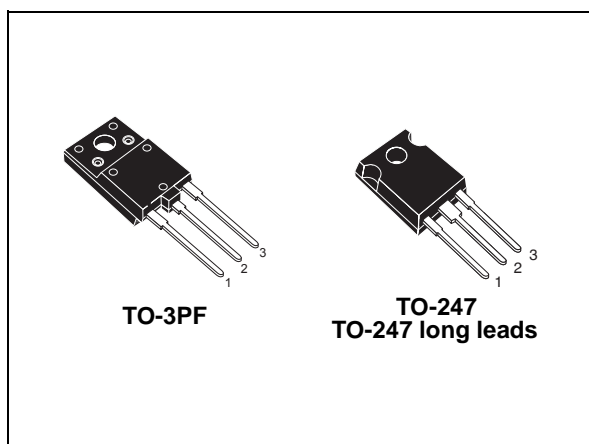
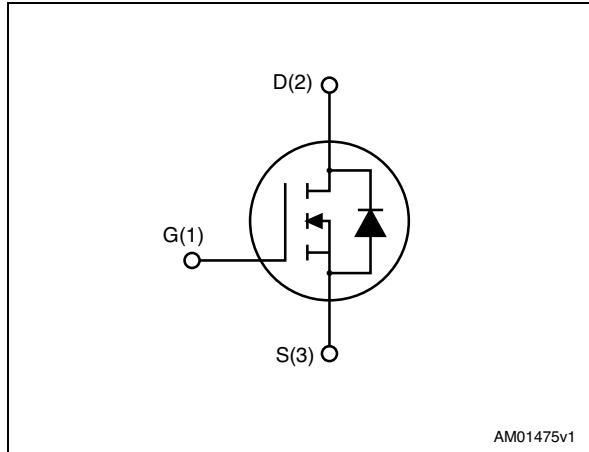


Figure 1. Internal schematic diagram



Features

Order codes	V _{DS} @ T _{Jmax}	R _{DS(on)} max	I _D
STFW45N65M5	710 V	0.078 Ω	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	

Contents

1	Electrical ratings	3
2	Electrical characteristics	4
2.1	Electrical characteristics (curves)	6
3	Test circuits	9
4	Package mechanical data	10
4.1	TO-3PF, STFW45N65M5	11
4.2	TO-247, STW45N65M5	13
4.3	TO-247 long leads, STWA45N65M5	15
5	Revision history	17

STFW45N65M5, STW45N65M5, STWA45N65M5

Electrical ratings

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 °C	35		A
I _D	Drain current (continuous) at T _C = 100 °C	22		A
I _{DM} ⁽¹⁾	Drain current (pulsed)	140		A
P _{TOT}	Total dissipation at T _C = 25 °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 s; T _c =25°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} ≤ 35 A, di/dt ≤ 400 A/μs, V_{DS(Peak)} < V_{(BR)DSS}, V_{DD} = 400 V
- V_{DS} < 520 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°C, I _d = I _{AR} ; V _{dd} =50)	810	mJ

Electrical characteristics

STFW45N65M5, STW45N65M5, STWA45N65M5

2 Electrical characteristics

($T_C = 25\text{ }^\circ\text{C}$ 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	μA
		$V_{DS} = 650\text{ V}, T_C = 125\text{ }^\circ\text{C}$			100	μA
I_{GSS}	Gate-body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 25\text{ V}$			± 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	Ω

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	-	Ω
Q_g	Total gate charge	$V_{DD} = 520\text{ V}, I_D = 17.5\text{ A}, V_{GS} = 10\text{ V}$ (see Figure 18)	-	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}

STFW45N65M5, STW45N65M5, STWA45N65M5
Electrical characteristics
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, $R_G = 4.7$ Ω , $V_{GS} = 10$ V (see Figure 19 and Figure 22)	-	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/ μ s $V_{DD} = 100$ V (see Figure 19)	-	392		ns
Q_{rr}	Reverse recovery charge		-	7.4		μ C
I_{RRM}	Reverse recovery current	$I_{SD} = 35$ A, $di/dt = 100$ A/ μ s $V_{DD} = 100$ V, $T_j = 150$ °C (see Figure 19)	-	38		A
t_{rr}	Reverse recovery time		-	468		ns
Q_{rr}	Reverse recovery charge		-	9.7		μ C
I_{RRM}	Reverse recovery current		-	42		A

1. Pulse width limited by safe operating area.

 2. Pulsed: pulse duration = 300 μ s, duty cycle 1.5%

Electrical characteristics

STFW45N65M5, STW45N65M5, STWA45N65M5

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-3PF

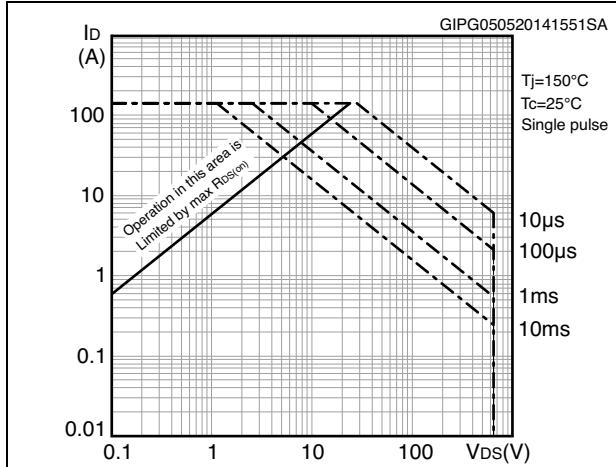


Figure 3. Thermal impedance for TO-3PF

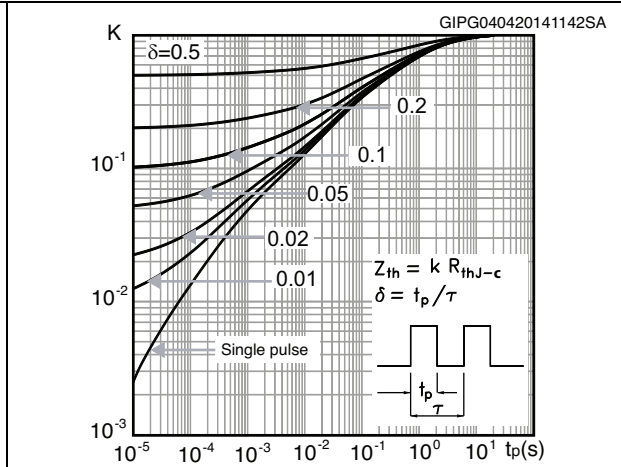


Figure 4. Safe operating area for TO-247 and TO-247LL

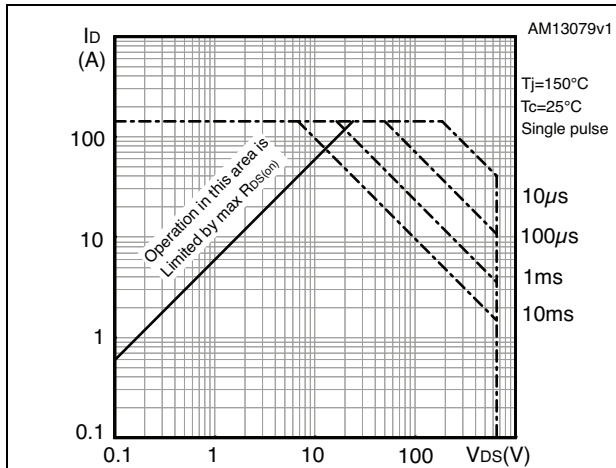


Figure 5. Thermal impedance for TO-247 and TO-247LL

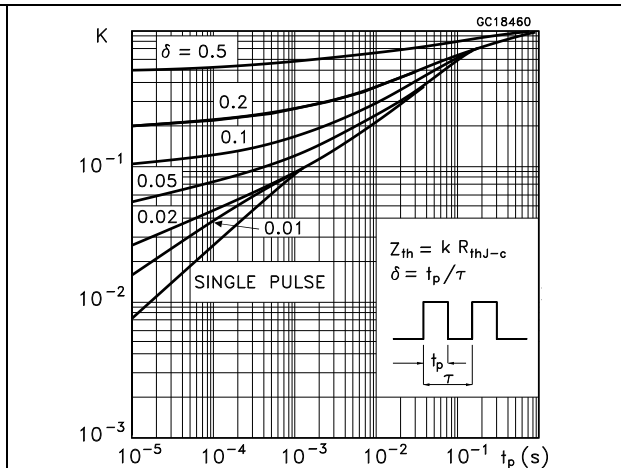


Figure 6. Output characteristics

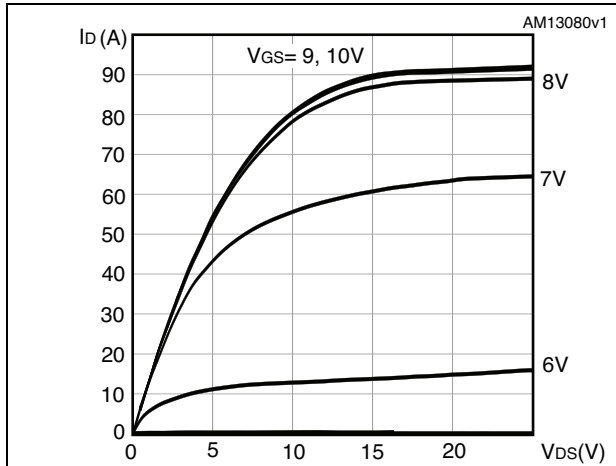
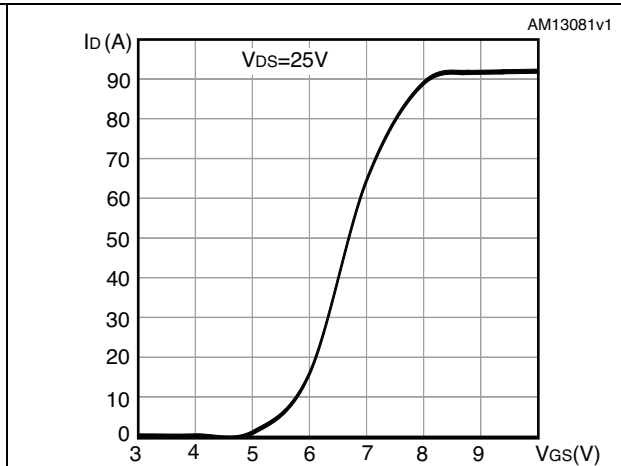


Figure 7. Transfer characteristics



STFW45N65M5, STW45N65M5, STWA45N65M5

Electrical characteristics

Figure 8. Gate charge vs gate-source voltage

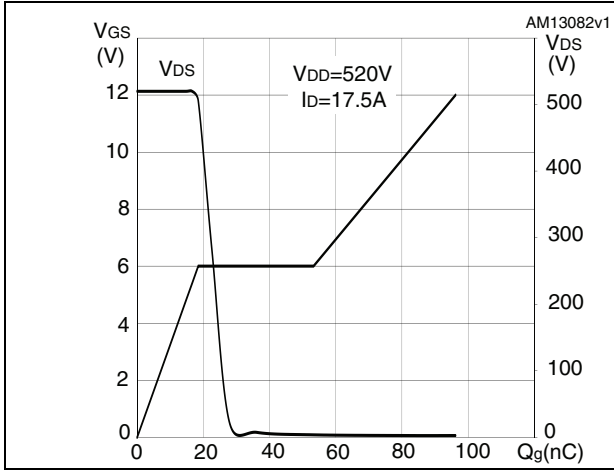


Figure 9. Static drain-source on-resistance

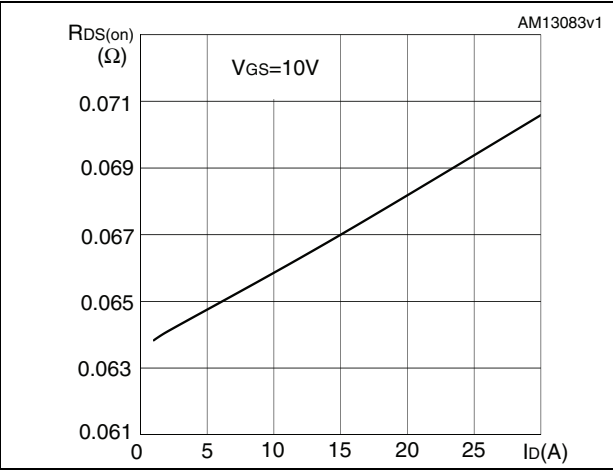


Figure 10. Capacitance variations

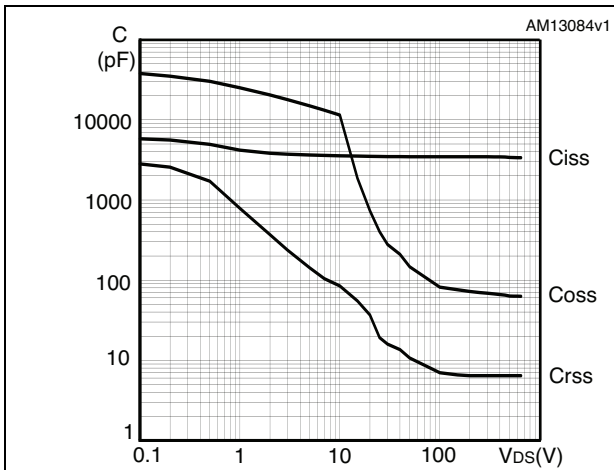


Figure 11. Output capacitance stored energy

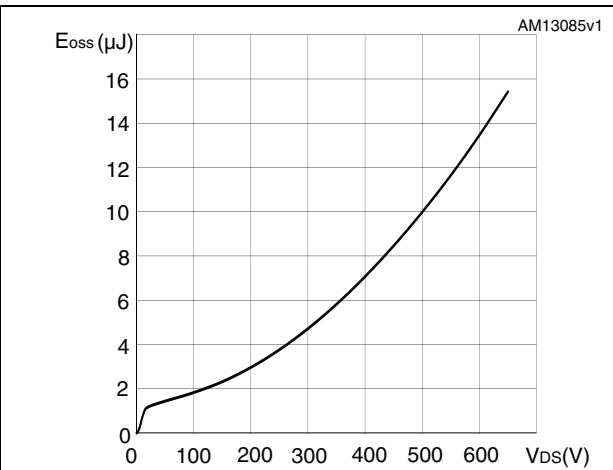


Figure 12. Normalized gate threshold voltage vs. temperature

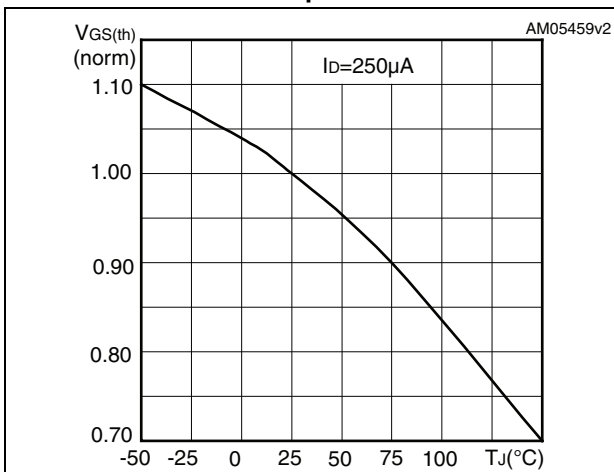
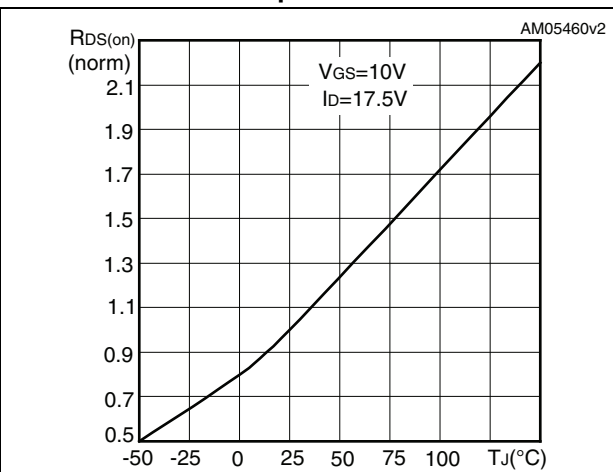


Figure 13. Normalized on-resistance vs. temperature



Electrical characteristics

STFW45N65M5, STW45N65M5, STWA45N65M5

Figure 14. Drain-source diode forward characteristics

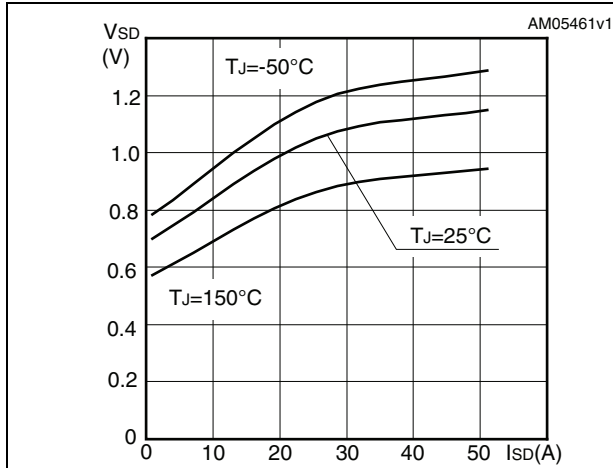


Figure 15. Normalized $V_{(BR)DSS}$ vs. temperature

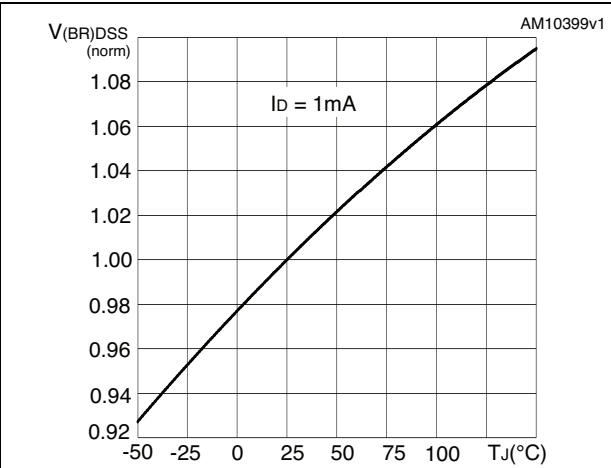
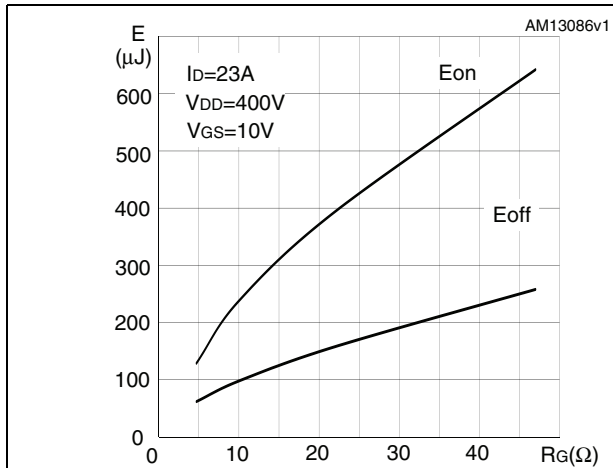


Figure 16. Switching losses vs. gate resistance (1)



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

STFW45N65M5, STW45N65M5, STWA45N65M5

Test circuits

3 Test circuits

Figure 17. Switching times test circuit for resistive load

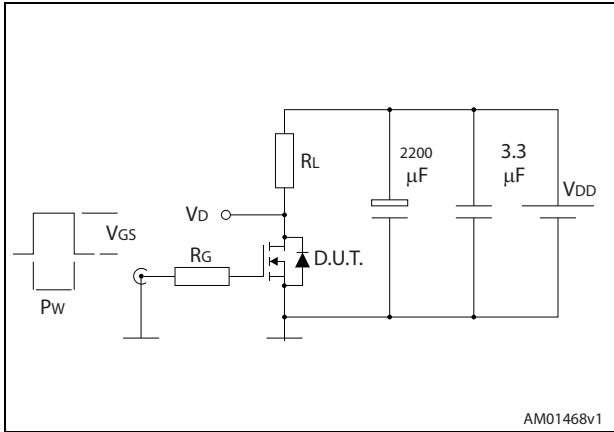


Figure 18. Gate charge test circuit

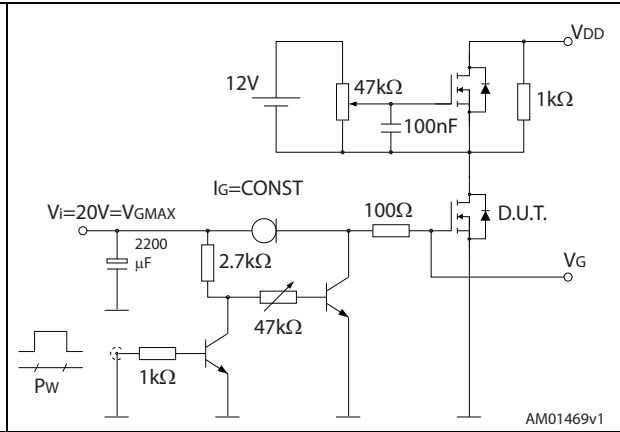


Figure 19. Test circuit for inductive load switching and diode recovery times

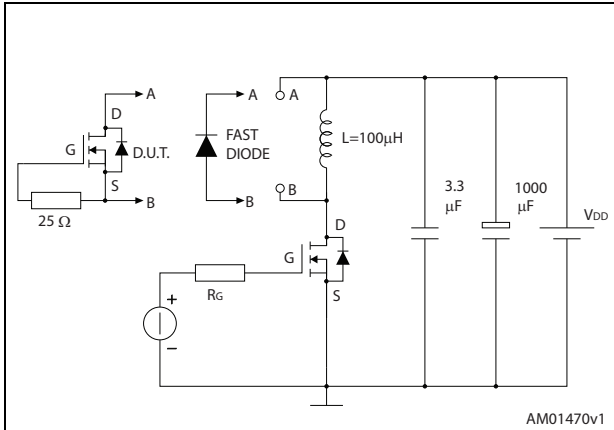


Figure 20. Unclamped inductive load test circuit

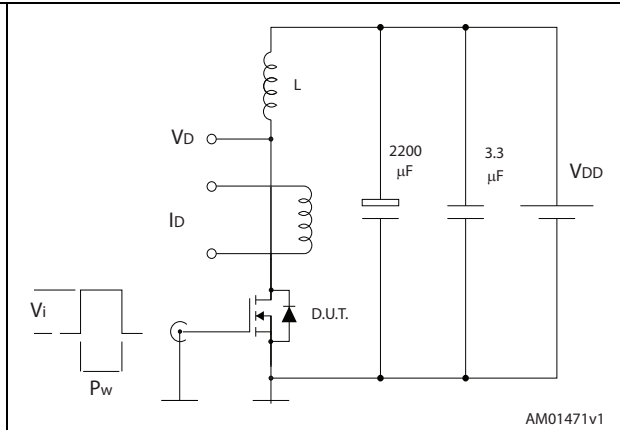


Figure 21. Unclamped inductive waveform

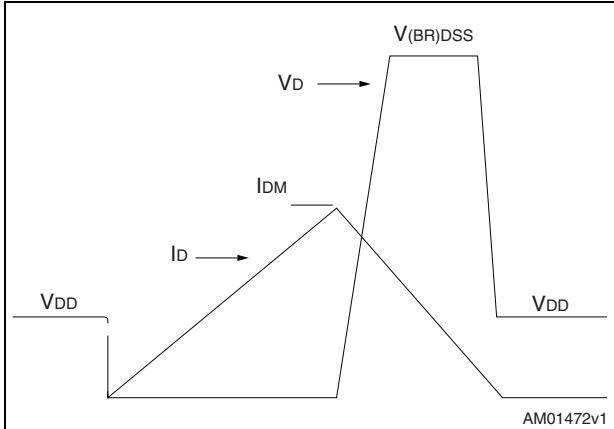
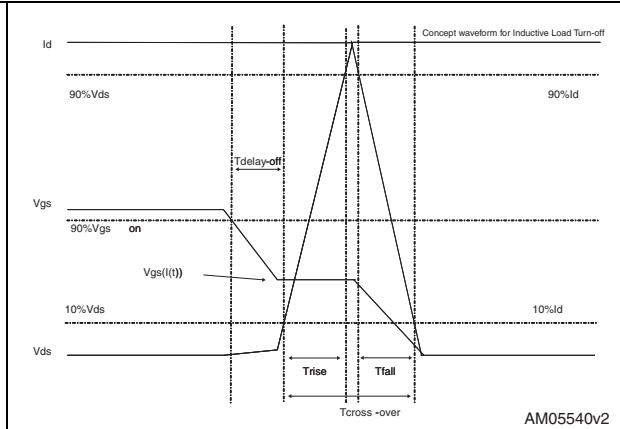


Figure 22. Switching time waveform



4 Package mechanical data

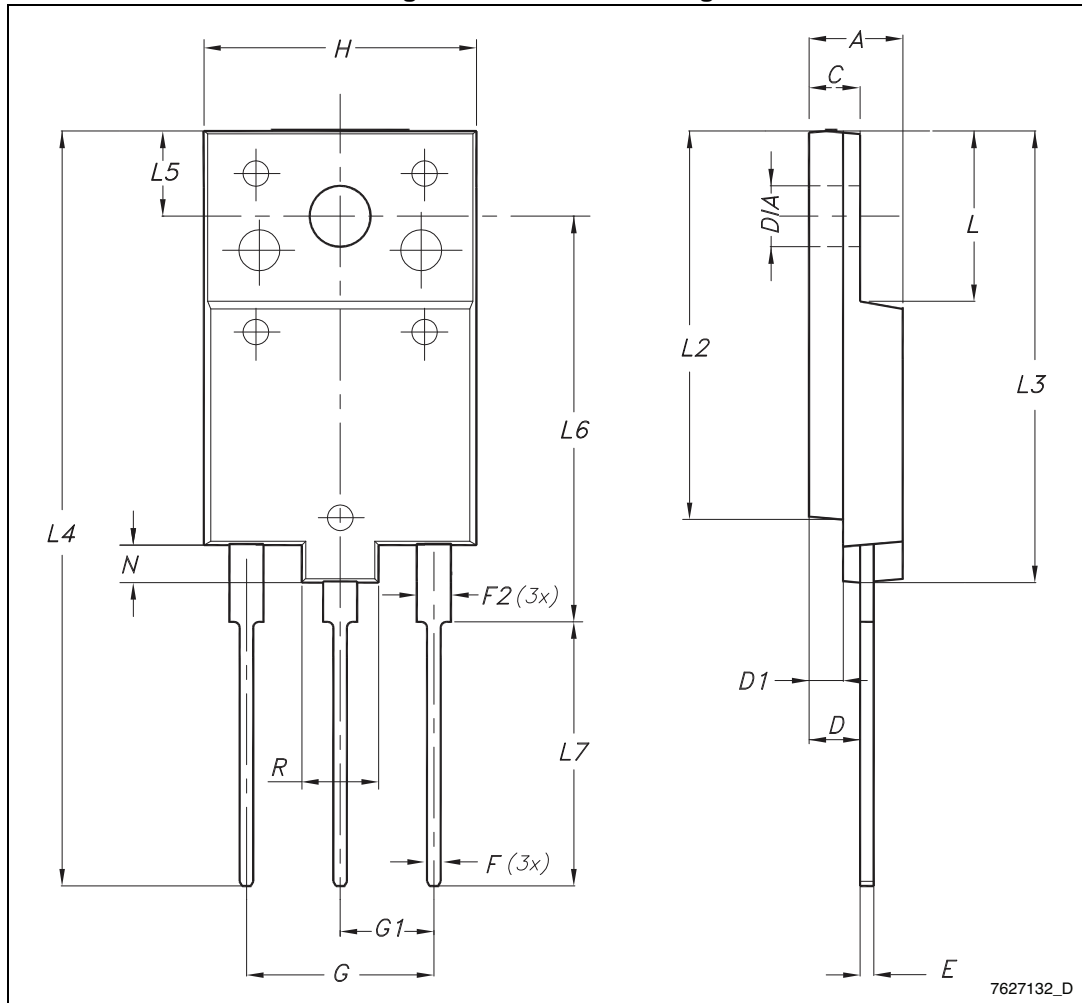
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STFW45N65M5, STW45N65M5, STWA45N65M5

Package mechanical data

4.1 TO-3PF, STFW45N65M5

Figure 23. TO-3PF drawing



Package mechanical data

STFW45N65M5, STW45N65M5, STWA45N65M5

Table 9. TO-3PF mechanical data

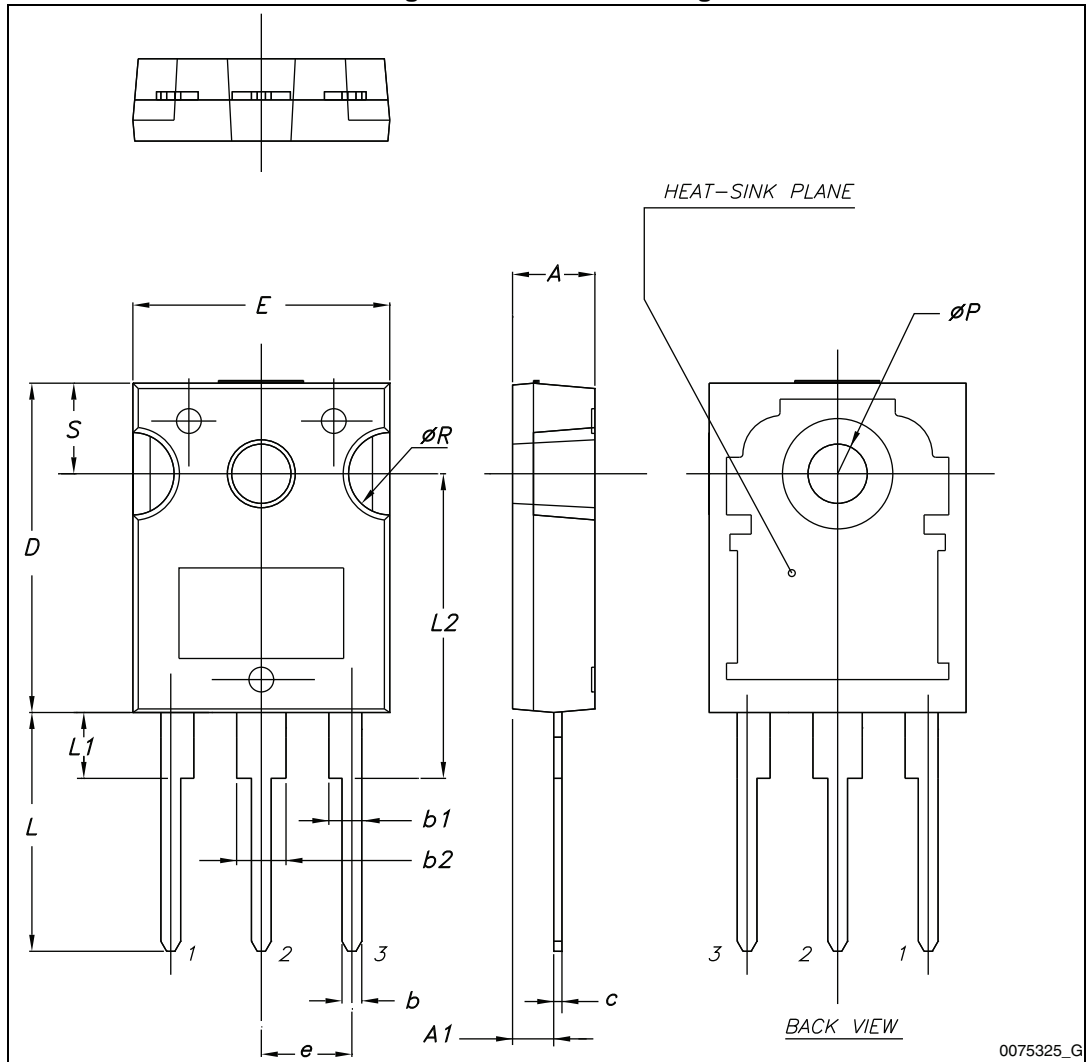
Dim.	mm		
	Min.	Typ.	Max.
A	5.30		5.70
C	2.80		3.20
D	3.10		3.50
D1	1.80		2.20
E	0.80		1.10
F	0.65		0.95
F2	1.80		2.20
G	10.30		11.50
G1		5.45	
H	15.30		15.70
L	9.80	10	10.20
L2	22.80		23.20
L3	26.30		26.70
L4	43.20		44.40
L5	4.30		4.70
L6	24.30		24.70
L7	14.60		15
N	1.80		2.20
R	3.80		4.20
∅	3.40		3.80

STFW45N65M5, STW45N65M5, STWA45N65M5

Package mechanical data

4.2 TO-247, STW45N65M5

Figure 24. TO-247 drawing



Package mechanical data

STFW45N65M5, STW45N65M5, STWA45N65M5

Table 10. TO-247 mechanical data

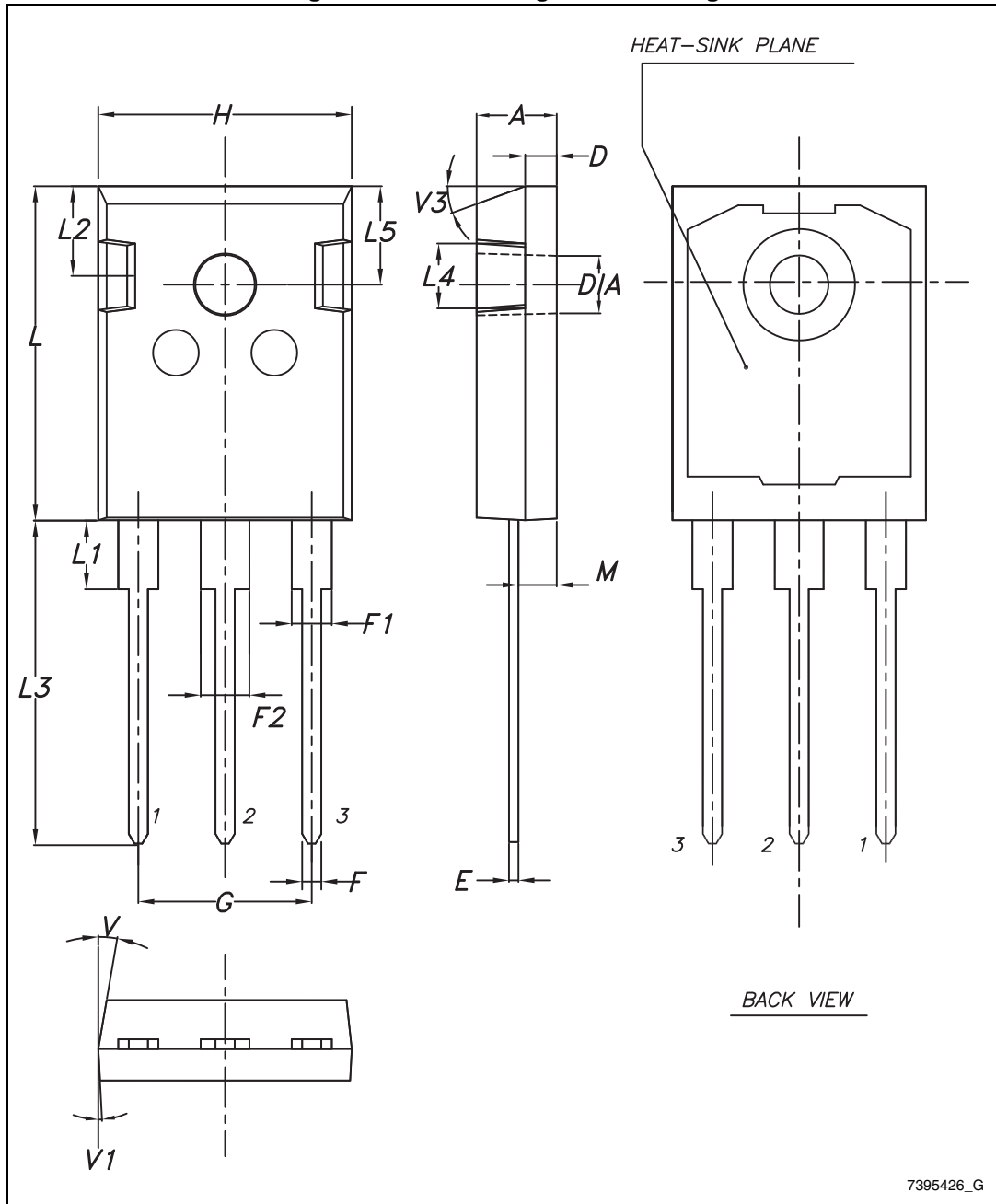
Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

STFW45N65M5, STW45N65M5, STWA45N65M5

Package mechanical data

4.3 TO-247 long leads, STWA45N65M5

Figure 25. TO-247 long leads drawing



Package mechanical data

STFW45N65M5, STW45N65M5, STWA45N65M5

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">– Added: TO-3PF package– Added: dv/dt (MOSFET dv/dt ruggedness) parameter and V_{ISO}– Modified: Figure 6 and 7– Minor text changes

STFW45N65M5, STW45N65M5, STWA45N65M5

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