



STF16N65M5, STI16N65M5 STP16N65M5, STU16N65M5, STW16N65M5

N-channel 650 V, 0.270 Ω , 12 A MDmesh™ V Power MOSFET
in TO-220FP, TO-220, IPAK, I²PAK, TO-247

Features

Type	V _{DSS} @ T _{Jmax}	R _{DS(on)} max	I _D
STF16N65M5 STI16N65M5 STP16N65M5 STU16N65M5 STW16N65M5	710 V	< 0.299 Ω	12 A

- DPAK worldwide best R_{DS(on)}
- Higher V_{DSS} rating
- High dv/dt capability
- Excellent switching performance
- Easy to drive
- 100% avalanche tested

Application

- Switching applications

Description

MDmesh™ V is a revolutionary Power MOSFET technology based on an innovative proprietary vertical process, 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 efficiencies.

Table 1. Device summary

Order codes	Marking	Package	Packaging
STF16N65M5 STI16N65M5 STP16N65M5 STU16N65M5 STW16N65M5	16N65M5	TO-220FP I ² PAK TO-220 IPAK TO-247	Tube

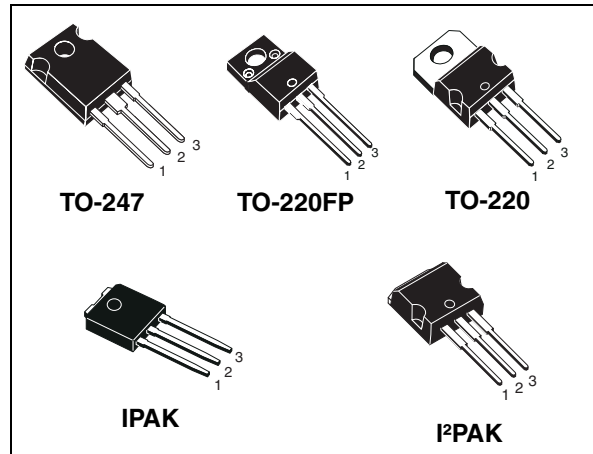
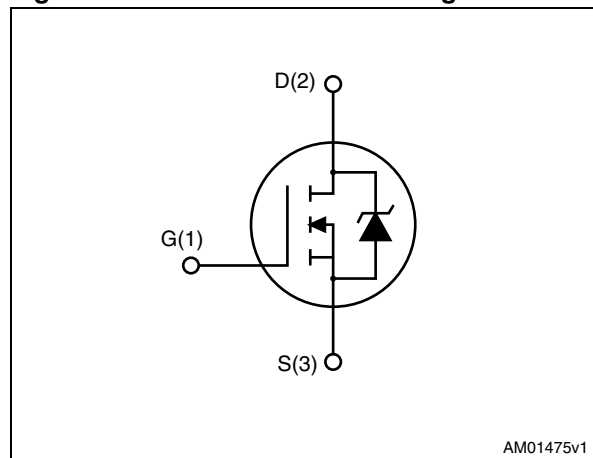


Figure 1. Internal schematic diagram



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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220, IPAK, TO-247, I ² PAK	TO-220FP	
V _{DS}	Drain-source voltage (V _{GS} = 0)	650		V
V _{GS}	Gate-source voltage	± 25		V
I _D	Drain current (continuous) at T _C = 25 °C	12	12 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	7.3	7.3 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	48	48 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	90	25	W
I _{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by T _j max)	4		A
E _{AS}	Single pulse avalanche energy (starting T _j = 25 °C, I _D = I _{AR} , V _{DD} = 50 V)	200		mJ
dv/dt ⁽³⁾	Peak diode recovery voltage slope	15		V/ns
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C)		2500	V
T _{stg}	Storage temperature	- 55 to 150		°C
T _j	Max. operating junction temperature	150		°C

- Limited only by maximum temperature allowed
- Pulse width limited by safe operating area
- I_{SD} ≤ 12 A, di/dt ≤ 400 A/μs, V_{DD} = 400 V, V_{Peak} < V_{(BR)DSS}

Table 3. Thermal data

Symbol	Parameter	Value					Unit
		TO-247	IPAK	I ² PAK	TO-220	TO-220FP	
R _{thj-case}	Thermal resistance junction-case max	1.38			5	°C/W	
R _{thj-amb}	Thermal resistance junction-ambient max	50	100	62.5		°C/W	
T _l	Maximum lead temperature for soldering purpose	300					°C

2 Electrical characteristics

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

Table 4. 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 ($V_{GS} = 0$)	$V_{DS} = \text{Max rating}$ $V_{DS} = \text{Max rating}$, $T_C = 125\text{ °C}$			1 100	μA 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	$V_{GS} = 10\text{ V}$, $I_D = 6\text{ A}$		0.270	0.299	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{DS} = 100\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$	-	1250	-	pF
C_{oss}	Output capacitance			30		pF
C_{rss}	Reverse transfer capacitance			3		pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{DS} = 0\text{ to }520\text{ V}$, $V_{GS} = 0$	-	100	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related			30		pF
R_G	Intrinsic gate resistance	$f = 1\text{ MHz}$ open drain	-	2	-	Ω
Q_g	Total gate charge	$V_{DD} = 520\text{ V}$, $I_D = 6\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 19)	-	31	-	nC
Q_{gs}	Gate-source charge			8		nC
Q_{gd}	Gate-drain charge			12		nC

- $C_{oss\text{ eq.}}$ 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}
- $C_{oss\text{ eq.}}$ 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 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
t_d (v)	Voltage delay time	$V_{DD} = 400$ V, $I_D = 8$ A,		25		ns
t_r (v)	Voltage rise time	$R_G = 4.7$ Ω , $V_{GS} = 10$ V		9		ns
t_f (i)	Current fall time	(see Figure 20)	-	30	-	ns
t_c (off)	Crossing time	(see Figure 23)		7		ns

Table 7. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD}	Source-drain current				12	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		48	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 12$ A, $V_{GS} = 0$	-		1.5	V
t_{rr}	Reverse recovery time	$I_{SD} = 12$ A, $di/dt = 100$ A/ μ s		300		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100$ V (see Figure 23)	-	3.5		nC
I_{RRM}	Reverse recovery current			23		A
t_{rr}	Reverse recovery time	$I_{SD} = 12$ A, $di/dt = 100$ A/ μ s		350		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100$ V, $T_j = 150$ °C	-	4		nC
I_{RRM}	Reverse recovery current	(see Figure 23)		24		A

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for IPAK

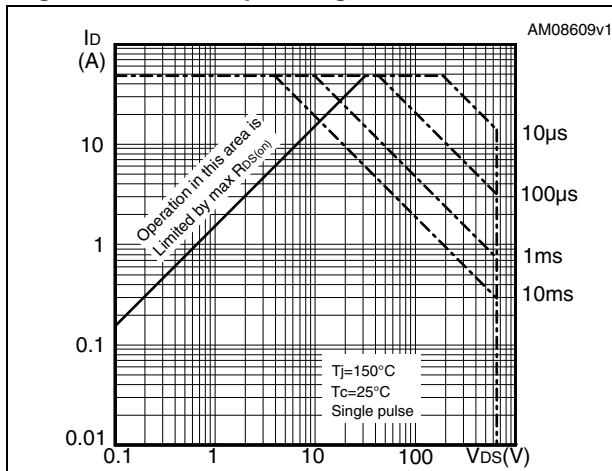


Figure 3. Thermal impedance for IPAK

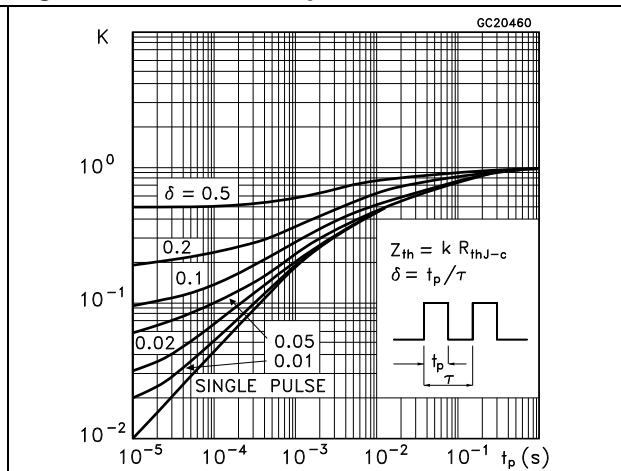


Figure 4. Safe operating area for TO-220, I²PAK, TO-247

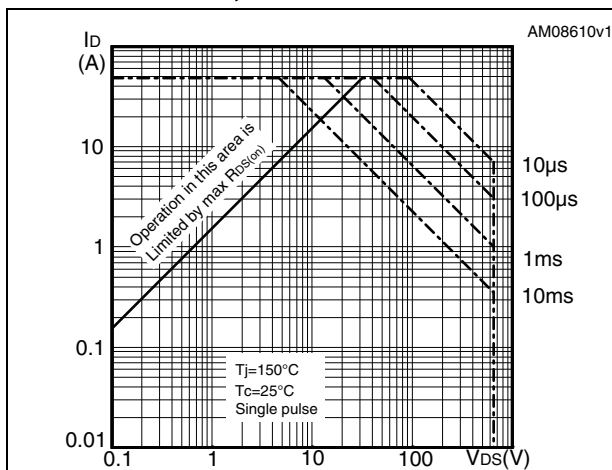


Figure 5. Thermal impedance for TO-220, I²PAK, TO-247

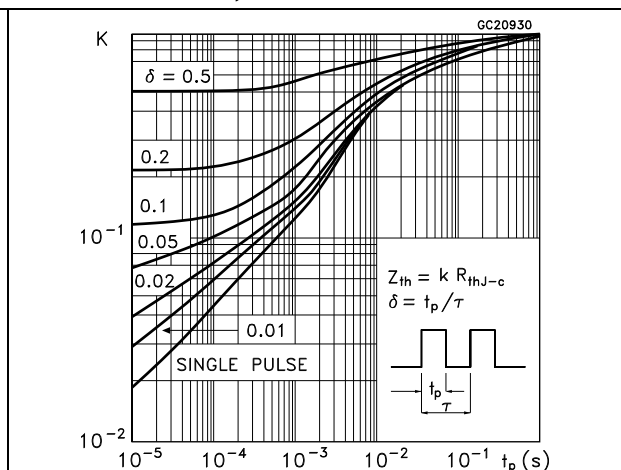


Figure 6. Safe operating area for TO-220FP

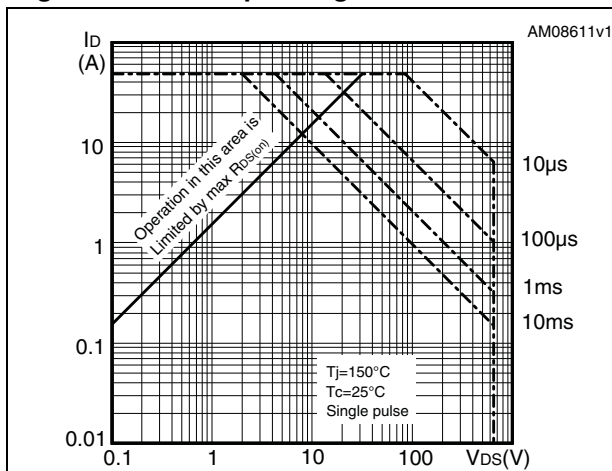


Figure 7. Thermal impedance for TO-220FP

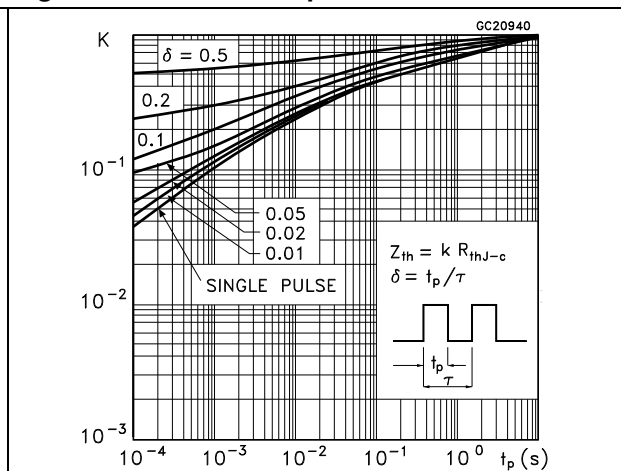


Figure 8. Output characteristics

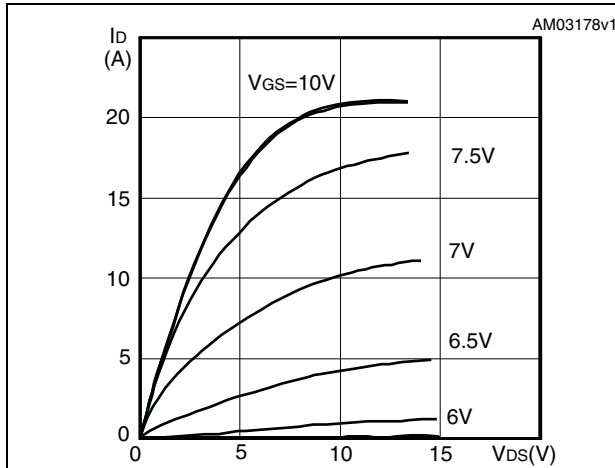


Figure 9. Transfer characteristics

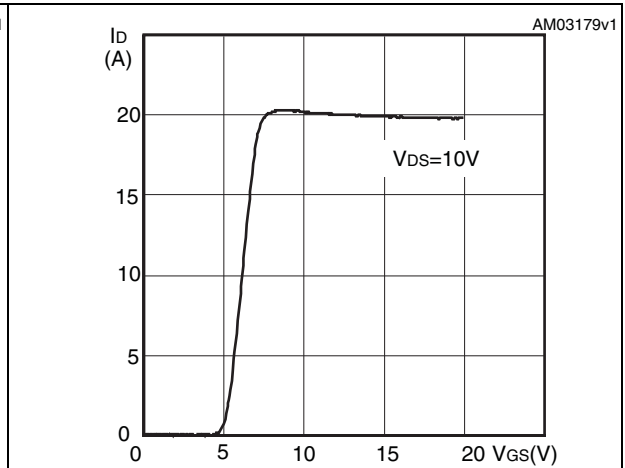


Figure 10. Normalized $B_{V_{DS}}$ vs temperature

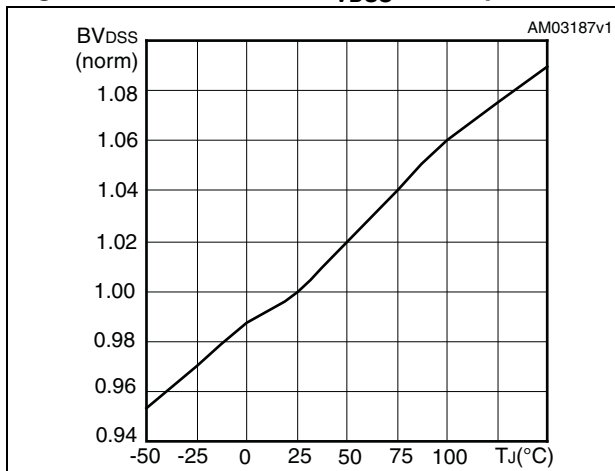


Figure 11. Static drain-source on resistance

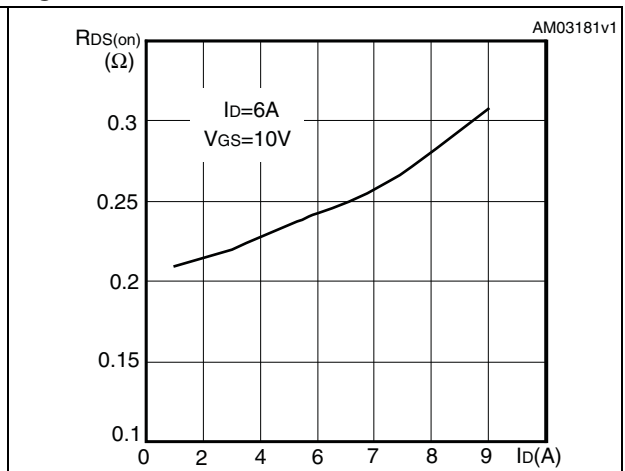


Figure 12. Output capacitance stored energy

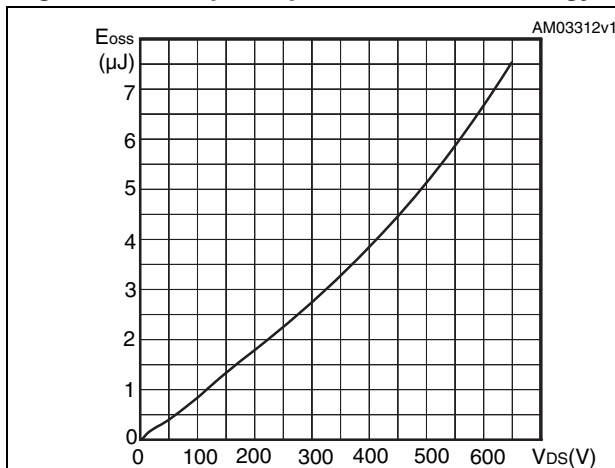


Figure 13. Capacitance variations

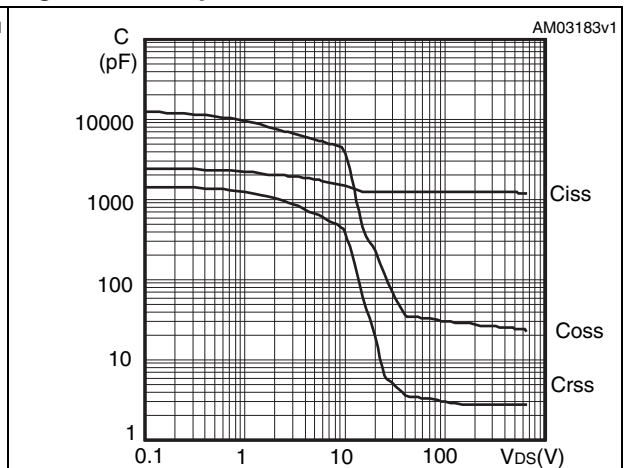


Figure 14. Gate charge vs gate-source voltage **Figure 15. Normalized on resistance vs temperature**

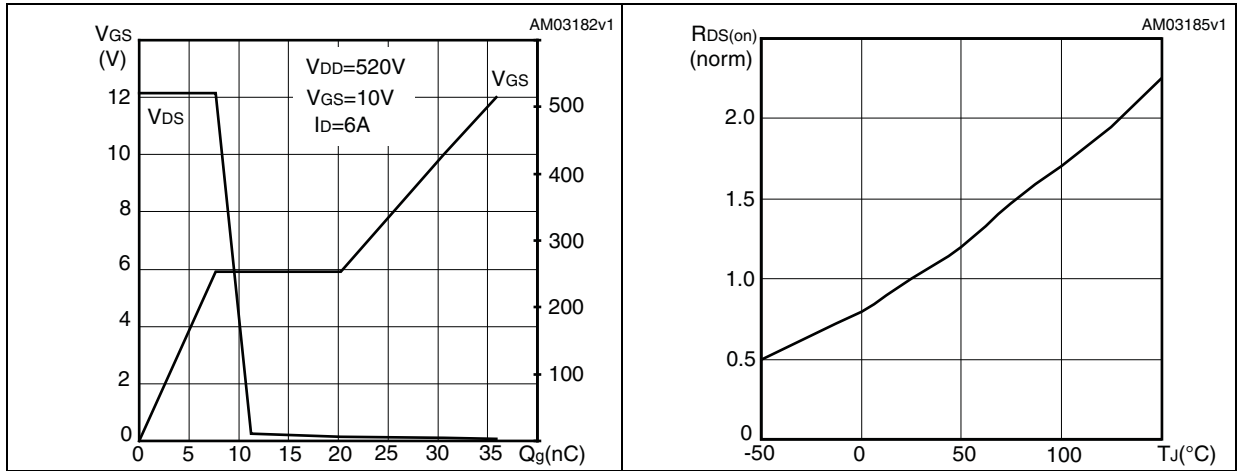
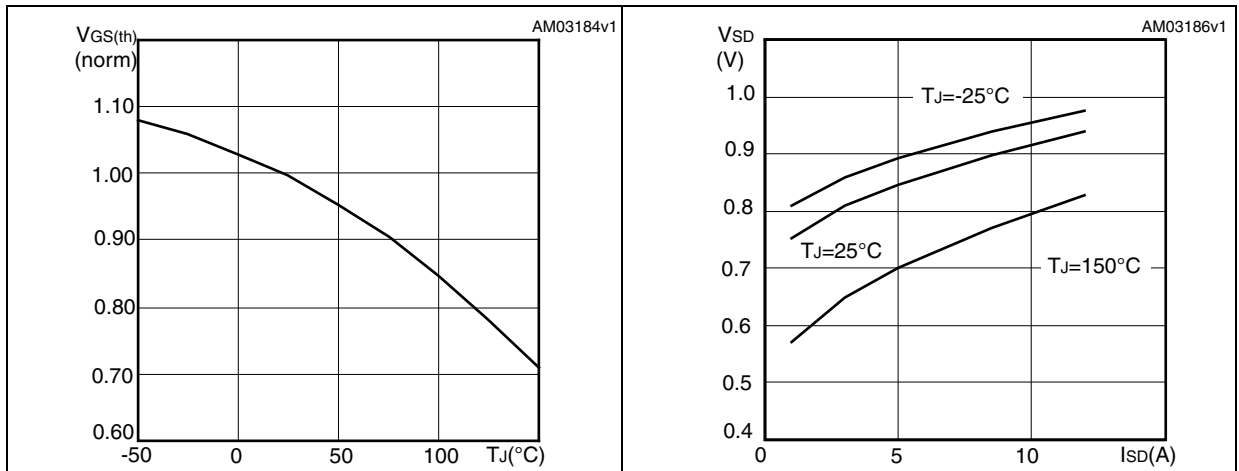
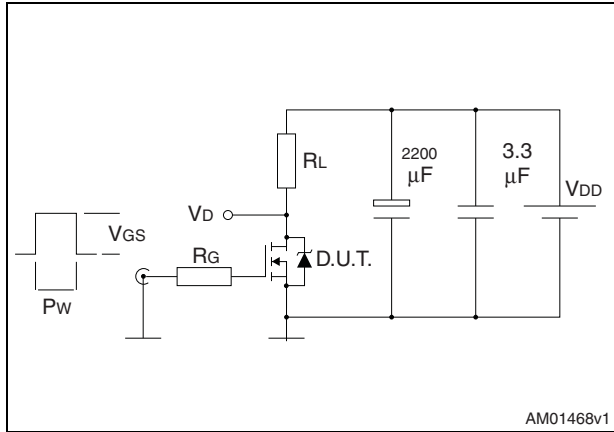


Figure 16. Normalized gate threshold voltage vs temperature **Figure 17. Source-drain diode forward characteristics**



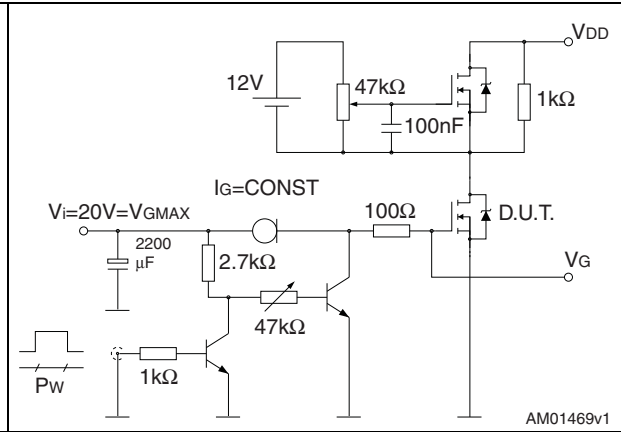
3 Test circuits

Figure 18. Switching times test circuit for resistive load



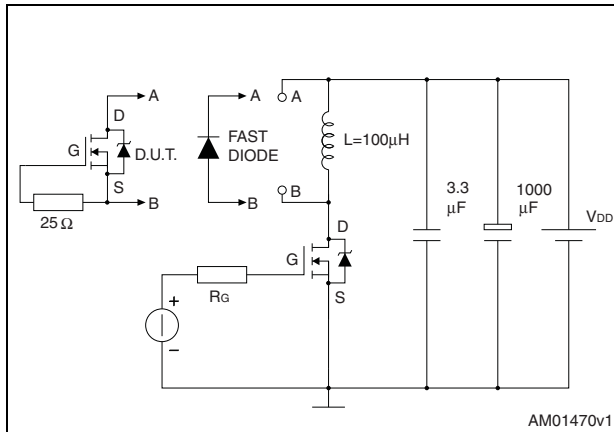
AM01468v1

Figure 19. Gate charge test circuit



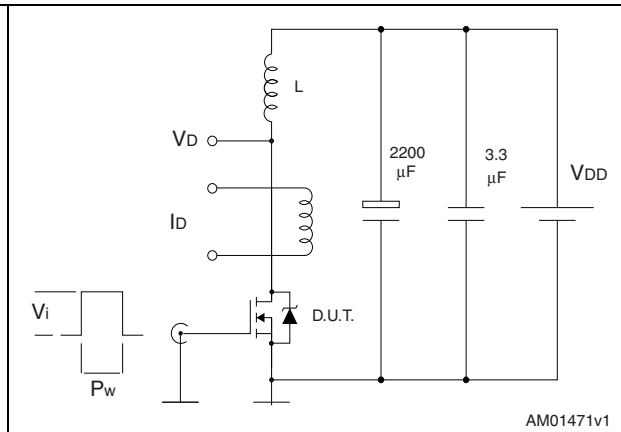
AM01469v1

Figure 20. Test circuit for inductive load switching and diode recovery times



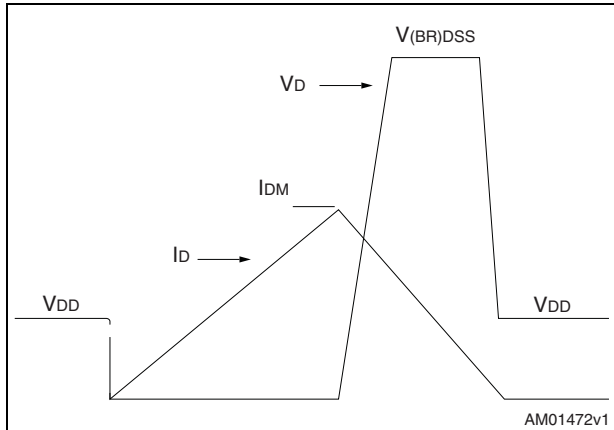
AM01470v1

Figure 21. Unclamped inductive load test circuit



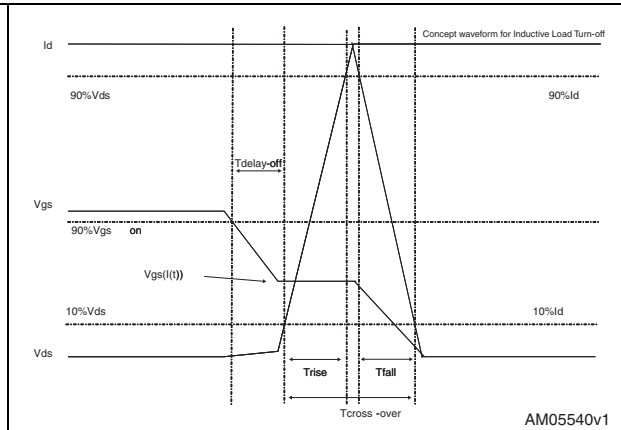
AM01471v1

Figure 22. Unclamped inductive waveform



AM01472v1

Figure 23. Switching time waveform



AM05540v1

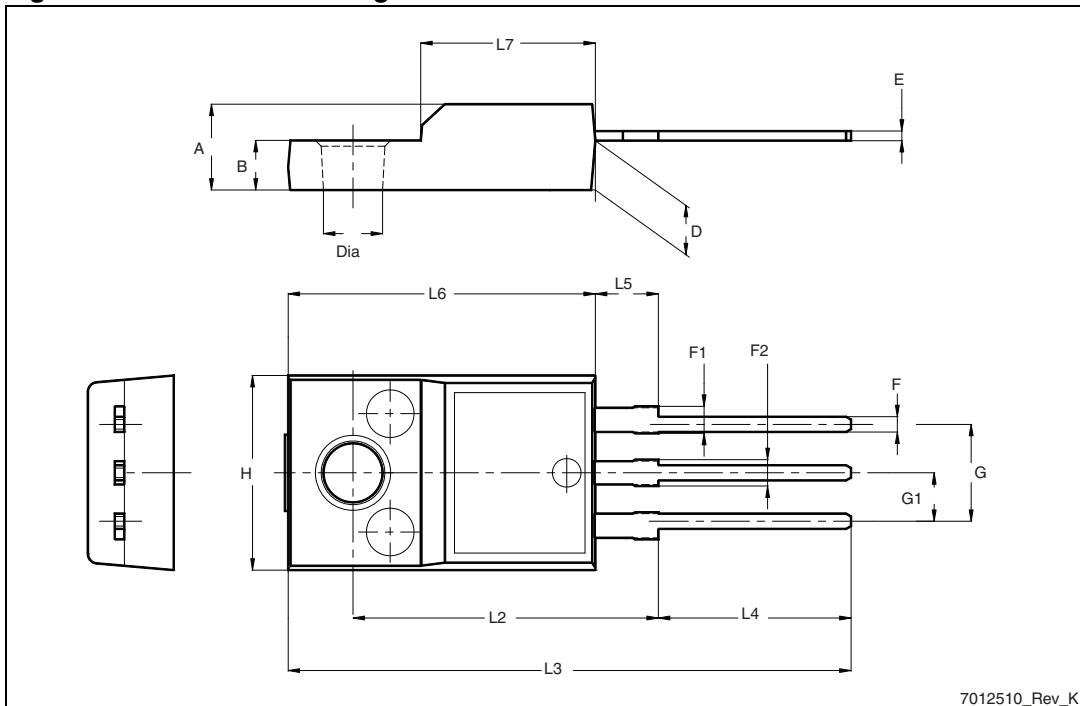
4 Package mechanical data

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 8. TO-220FP mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.4		4.6
B	2.5		2.7
D	2.5		2.75
E	0.45		0.7
F	0.75		1
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.2
G1	2.4		2.7
H	10		10.4
L2		16	
L3	28.6		30.6
L4	9.8		10.6
L5	2.9		3.6
L6	15.9		16.4
L7	9		9.3
Dia	3		3.2

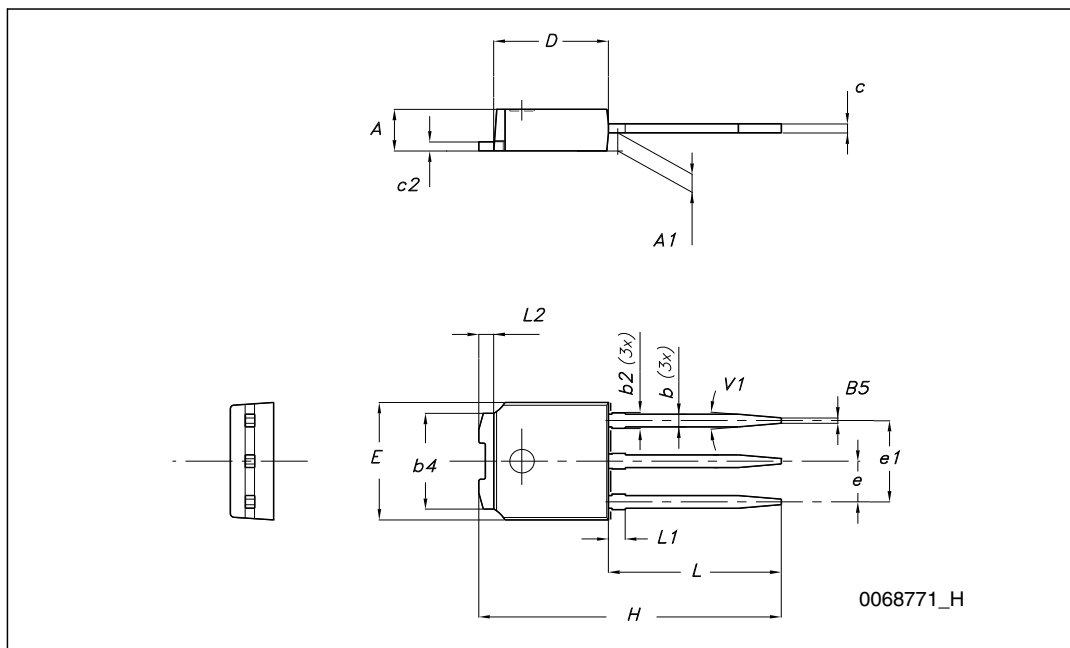
Figure 24. TO-220FP drawing



7012510_Rev_K

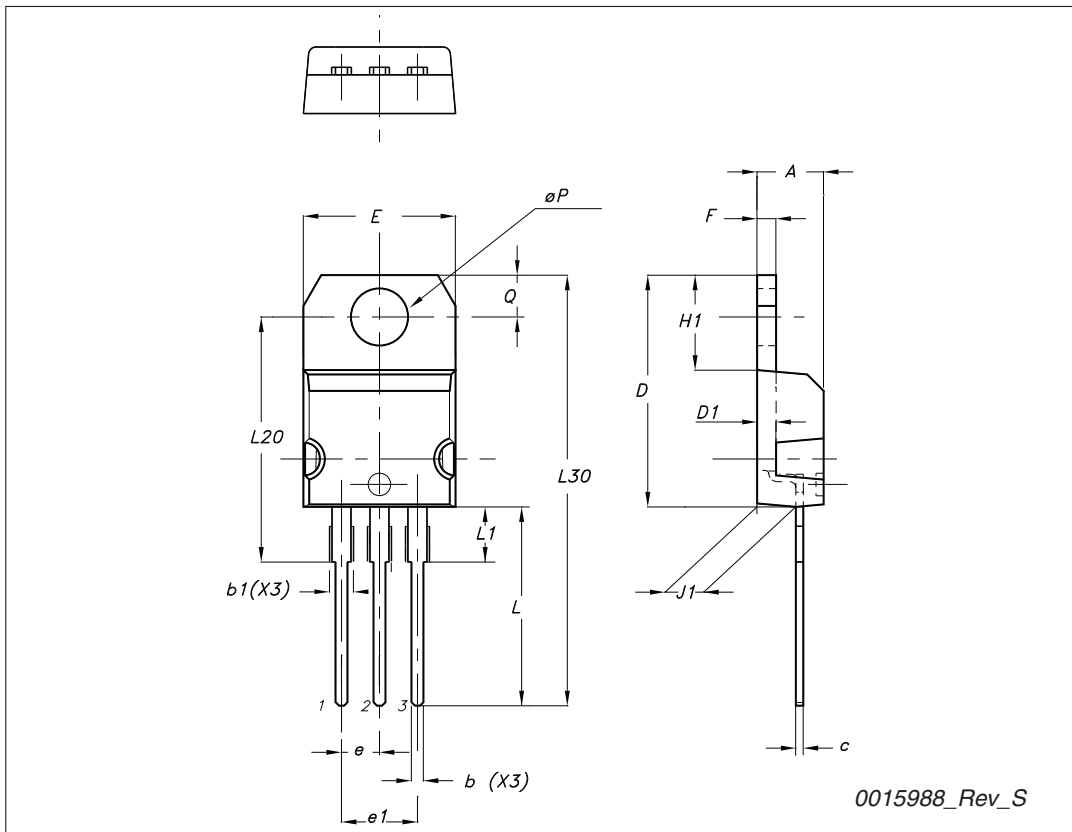
TO-251 (IPAK) mechanical data

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
b	0.64		0.90
b2			0.95
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
E	6.40		6.60
e		2.28	
e1	4.40		4.60
H		16.10	
L	9.00		9.40
(L1)	0.80		1.20
L2		0.80	
V1		10°	



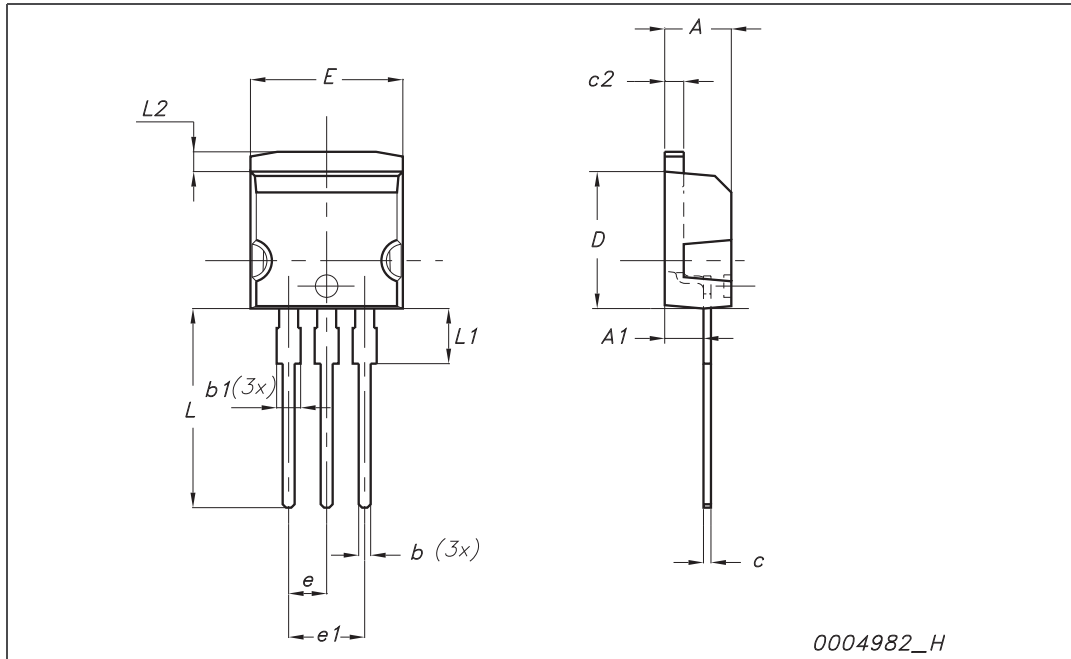
TO-220 type A mechanical data

Dim	mm		
	Min	Typ	Max
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.70
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10		10.40
e	2.40		2.70
e1	4.95		5.15
F	1.23		1.32
H1	6.20		6.60
J1	2.40		2.72
L	13		14
L1	3.50		3.93
L20		16.40	
L30		28.90	
∅P	3.75		3.85
Q	2.65		2.95



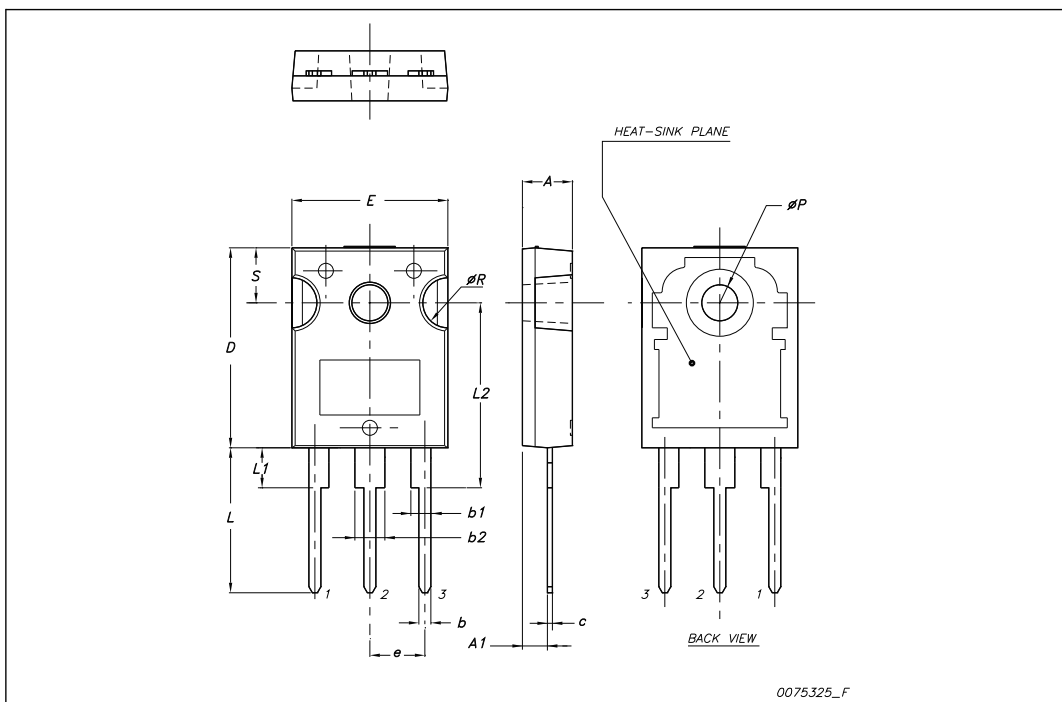
I²PAK (TO-262) mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	2.40		2.72	0.094		0.107
b	0.61		0.88	0.024		0.034
b1	1.14		1.70	0.044		0.066
c	0.49		0.70	0.019		0.027
c2	1.23		1.32	0.048		0.052
D	8.95		9.35	0.352		0.368
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
E	10		10.40	0.393		0.410
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L2	1.27		1.40	0.050		0.055



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	



5 Revision history

Table 9. Document revision history

Date	Revision	Changes
12-Feb-2009	1	First release.
21-Oct-2010	2	– Document status promoted from preliminary data to datasheet. – Added new package, mechanical data: I ² PAK. – Removed DPAK, D ² PAK packages and mechanical data.

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