



STW24NM65N-STI24NM65N-STF24NM65N STB24NM65N - STP24NM65N

N-channel 650 V - 0.16 Ω - 19 A - TO-220 - TO-220FP - D²PAK
I²PAK - TO-247 second generation MDmesh™ Power MOSFET

Features

Type	V _{DSS} (@T _J max)	R _{DS(on)} max	I _D
STB24NM65N	710 V	< 0.19 Ω	19 A
STI24NM65N	710 V	< 0.19 Ω	19 A
STF24NM65N	710 V	< 0.19 Ω	19 A ⁽¹⁾
STP24NM65N	710 V	< 0.19 Ω	19 A
STW24NM65N	710 V	< 0.19 Ω	19 A

1. Limited only by maximum temperature allowed

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

Application

- Switching applications

Description

This series of devices is designed using the second generation of MDmesh™ technology. This revolutionary Power MOSFET associates a new vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. It is therefore suitable for the most demanding high efficiency converters.

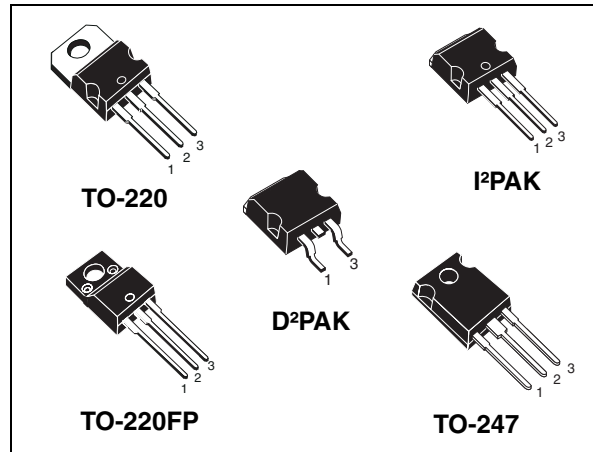


Figure 1. Internal schematic diagram

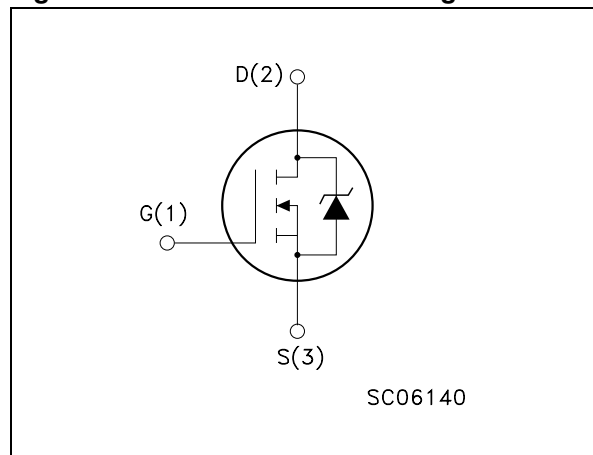


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB24NM65N	24NM65N	D ² PAK	Tape and reel
STI24NM65N	24NM65N	I ² PAK	Tube
STF24NM65N	24NM65N	TO-220FP	Tube
STP24NM65N	24NM65N	TO-220	Tube
STW24NM65N	24NM65N	TO-247	Tube

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1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220/I ² PAK TO-247/D 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	19	19 ⁽¹⁾	A
I _D	Drain current (continuous) at T _C = 100 °C	12	12 ⁽¹⁾	A
I _{DM} ⁽²⁾	Drain current (pulsed)	76	76 ⁽¹⁾	A
P _{TOT}	Total dissipation at T _C = 25 °C	160	40	W
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

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. I_{SD} ≤ 19 A, di/dt ≤ 400 A/μs, V_{DD} = 80% V_{(BR)DSS}

Table 3. Thermal data

Symbol	Parameter	TO-220	I ² PAK	TO-247	D ² PAK	TO-220FP	Unit
R _{thj-case}	Thermal resistance junction-case max	0.78				3.1	°C/W
R _{thj-amb}	Thermal resistance junction-amb max	62.5		50	--	62.5	°C/W
R _{thj-pcb}	Thermal resistance junction-pcb max	--	--	--	30	--	°C/W
T _l	Maximum lead temperature for soldering purposes	300					°C

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I_{AS}	Avalanche current, repetitive or not-repetitive (pulse width limited by T_J max)	6	A
E_{AS}	Single pulse avalanche energy (starting $T_J=25\text{ °C}$, $I_D=I_{AS}$, $V_{DD}=50\text{ V}$)	500	mJ

2 Electrical characteristics

($T_{CASE}=25\text{ }^{\circ}\text{C}$ 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
$dv/dt^{(1)}$	Drain source voltage slope	$V_{DD} = 520\text{ V}, I_D = 19\text{ A}, V_{GS} = 10\text{ V}$		35		V/ns
I_{DSS}	Zero gate voltage drain current ($V_{GS} = 0$)	$V_{DS} = \text{max rating}$ $V_{DS} = \text{max rating}, @125\text{ }^{\circ}\text{C}$			1 100	μA μA
I_{GSS}	Gate-body leakage current ($V_{DS} = 0$)	$V_{GS} = \pm 20\text{ V}$			± 100	nA
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	2	3	4	V
$R_{DS(on)}$	Static drain-source on resistance	$V_{GS} = 10\text{ V}, I_D = 9.5\text{ A}$		0.16	0.19	Ω

1. Characteristic value at turn off on inductive load

Table 6. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 15\text{ V}, I_D = 9.5\text{ A}$		14		S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 50\text{ V}, f = 1\text{ MHz}, V_{GS} = 0$		2500 120 10		pF pF pF
$C_{oss\text{ eq}}^{(2)}$	Equivalent output capacitance	$V_{GS} = 0, V_{DS} = 0\text{ to }520\text{ V}$		310		pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 520\text{ V}, I_D = 19\text{ A}, V_{GS} = 10\text{ V},$ (see Figure 19)		70 10 40		nC nC nC
R_G	Gate input resistance	$f = 1\text{ MHz}$ gate DC bias = 0 Test signal level = 20 mV open drain		2.5		Ω

1. Pulsed: pulse duration = 300 μs , duty cycle 1.5%

2. $C_{oss\text{ eq}}$ 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}

Table 7. Switching times

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 325\text{ V}$, $I_D = 9.5\text{ A}$ $R_G = 4.7\ \Omega$, $V_{GS} = 10\text{ V}$ (see Figure 18)		25		ns
t_r	Rise time			10		ns
$t_{d(off)}$	Turn-off delay time			80		ns
t_f	Fall time			20		ns

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min	Typ	Max	Unit
I_{SD}	Source-drain current				19	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)				76	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 19\text{ A}$, $V_{GS} = 0$			1.3	V
t_{rr}	Reverse recovery time	$I_{SD} = 19\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$		460		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100\text{ V}$		7		μC
I_{RRM}	Reverse recovery current	(see Figure 20)		30		A
t_{rr}	Reverse recovery time	$I_{SD} = 19\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$		620		ns
Q_{rr}	Reverse recovery charge	$V_{DD} = 100\text{ V}$, $T_J = 150\text{ }^\circ\text{C}$		9		μC
I_{RRM}	Reverse recovery current	(see Figure 20)		29		A

1. Pulse width limited by safe operating area

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

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220 - D²PAK - I²PAK

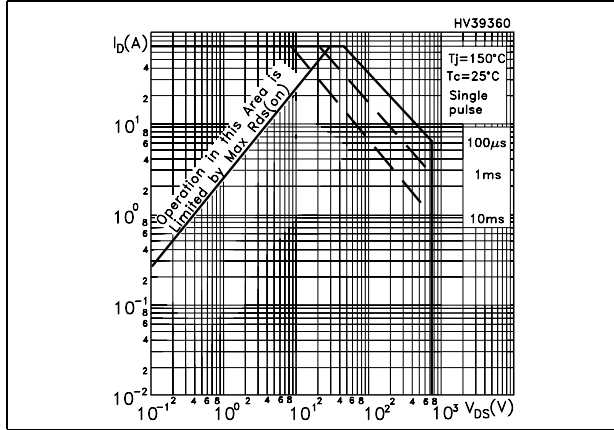


Figure 3. Thermal impedance for TO-220 - D²PAK - I²PAK

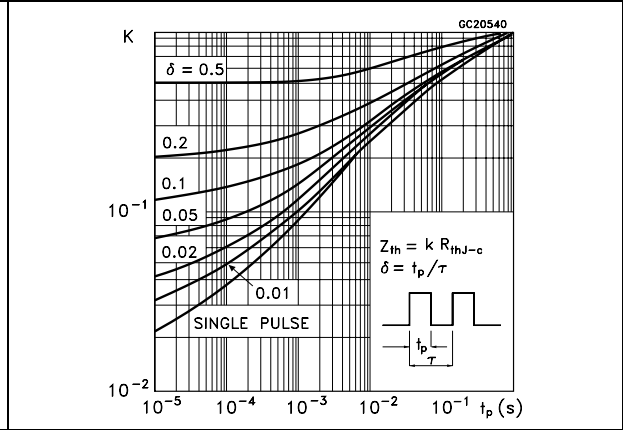


Figure 4. Safe operating area for TO-220FP

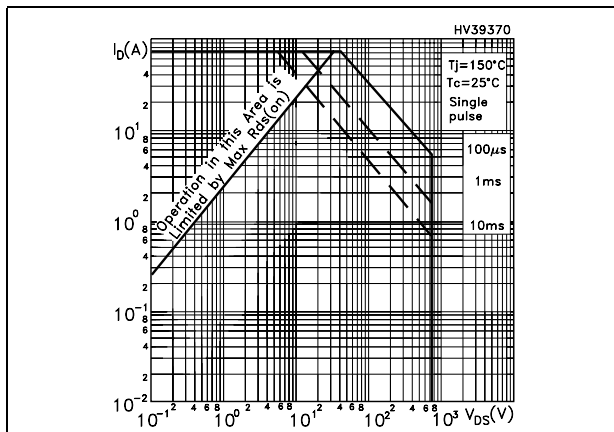


Figure 5. Thermal impedance for TO-220FP

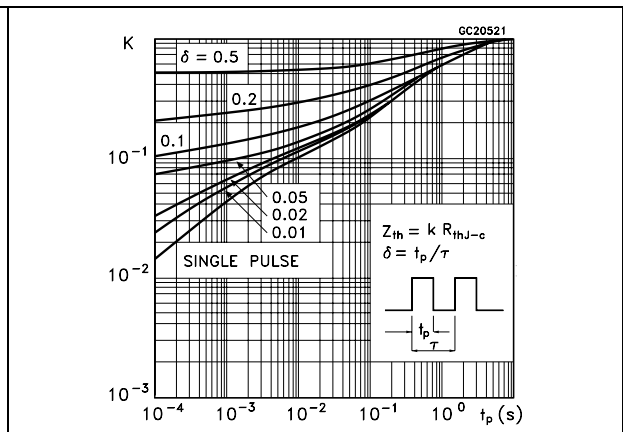


Figure 6. Safe operating area for TO-247

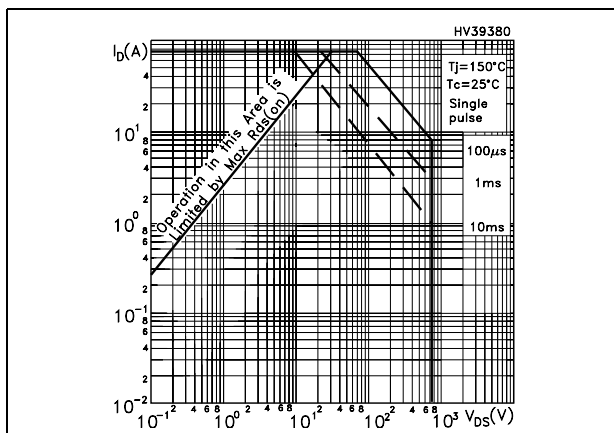


Figure 7. Thermal impedance for TO-247

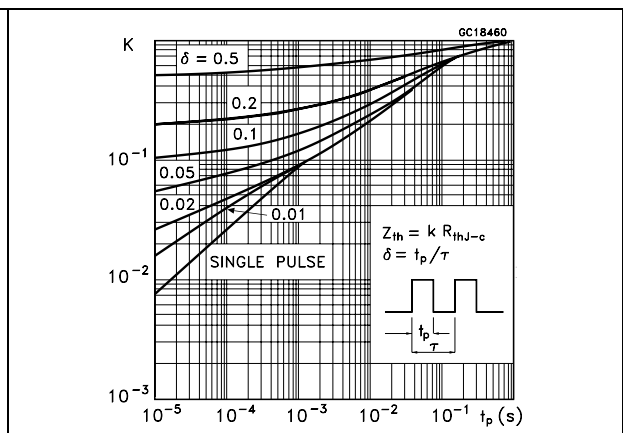


Figure 8. Output characteristics

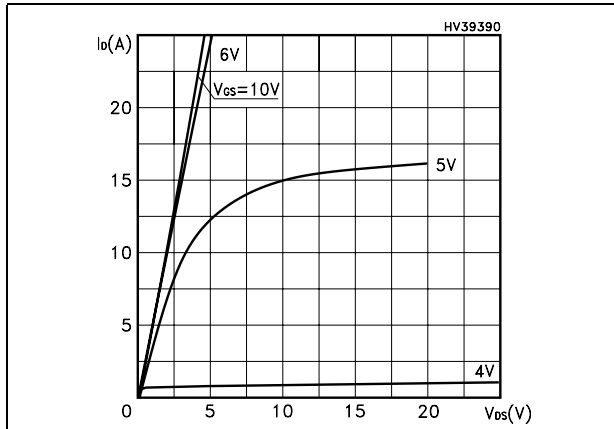


Figure 9. Transfer characteristics

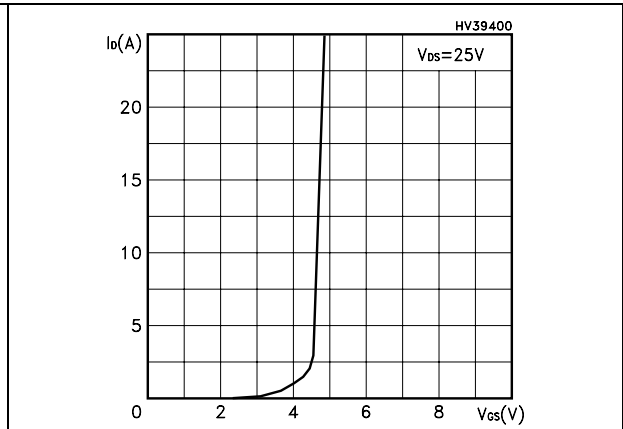


Figure 10. Transconductance

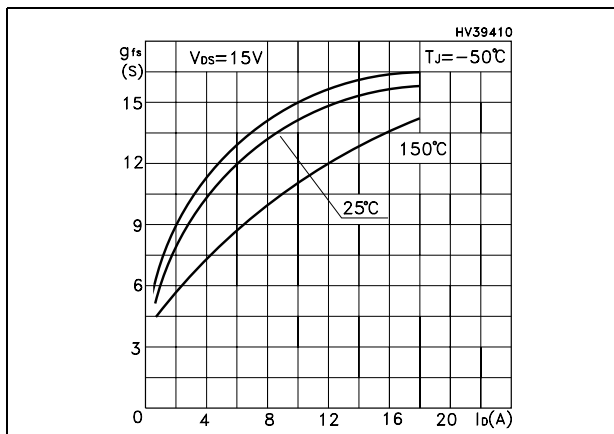


Figure 11. Static drain-source on resistance

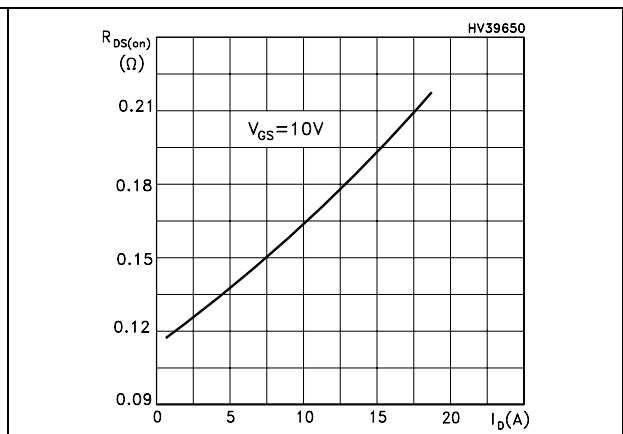


Figure 12. Gate charge vs gate-source voltage

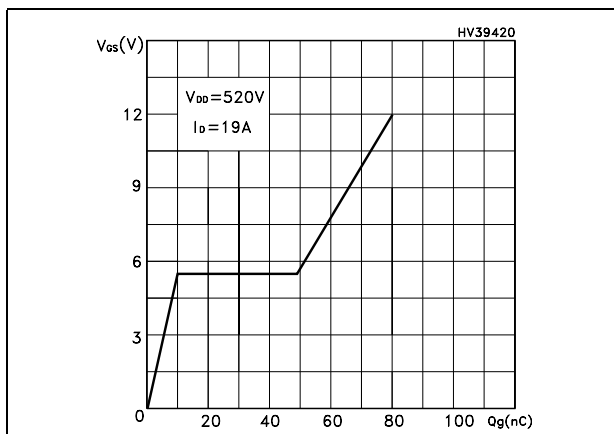


Figure 13. Capacitance variations

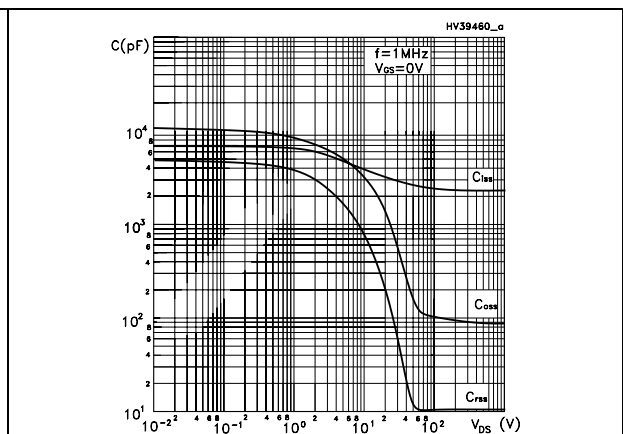


Figure 14. Normalized gate threshold voltage vs temperature

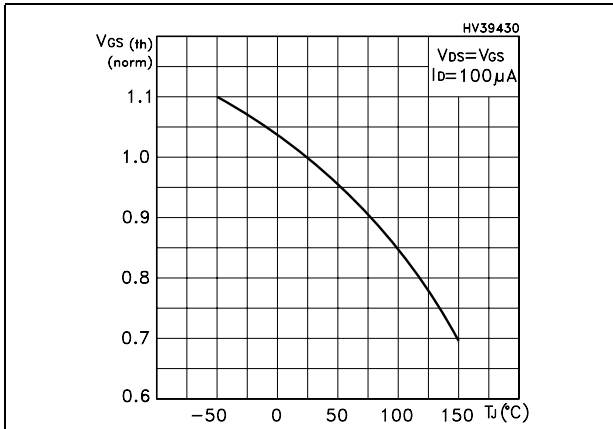


Figure 15. Normalized on resistance vs temperature

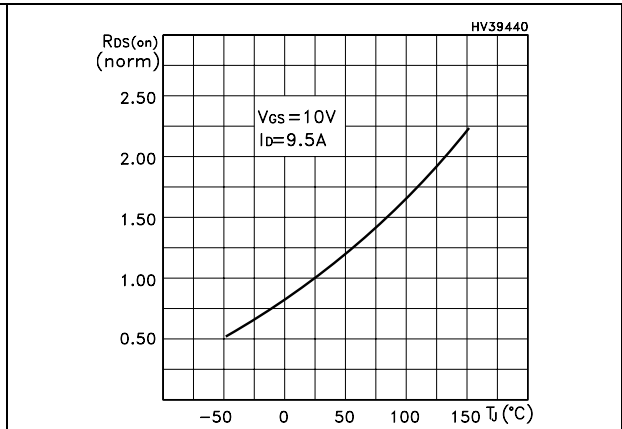


Figure 16. Source-drain diode forward characteristics

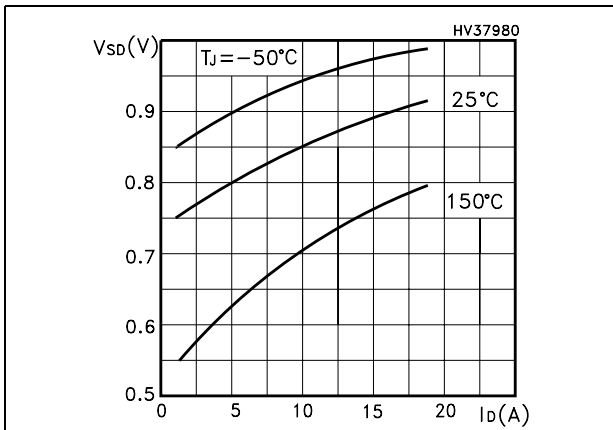
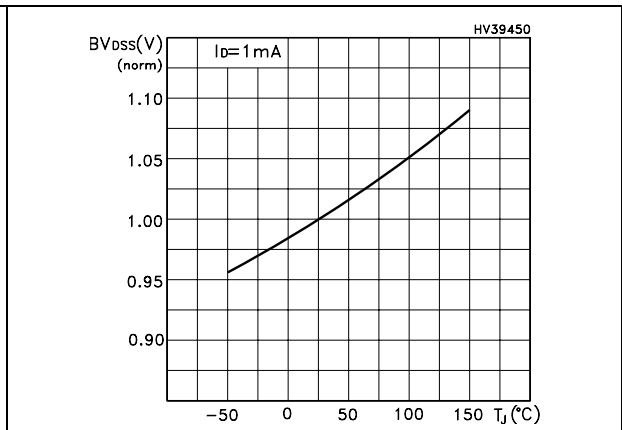


Figure 17. Normalized B_{VDSS} vs temperature



3 Test circuit

Figure 18. Switching times test circuit for resistive load

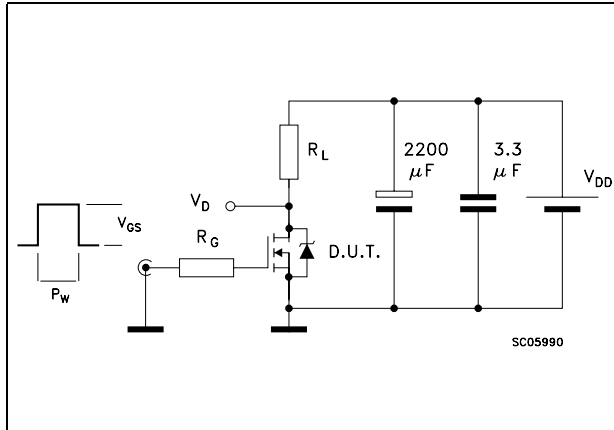


Figure 19. Gate charge test circuit

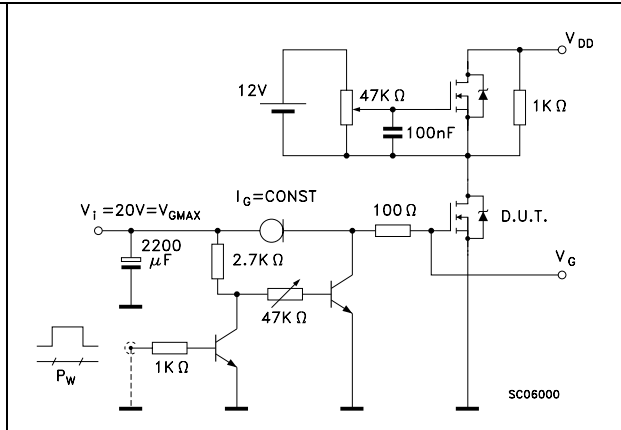


Figure 20. Test circuit for inductive load switching and diode recovery times

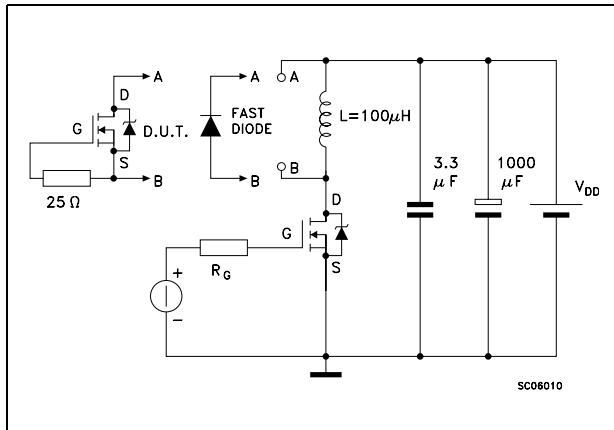


Figure 21. Unclamped Inductive load test circuit

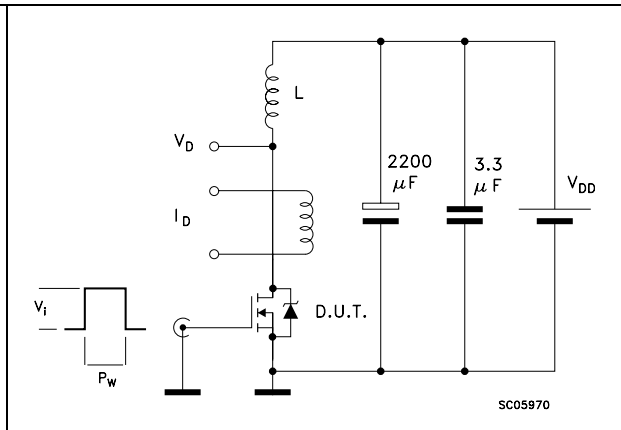


Figure 22. Unclamped inductive waveform

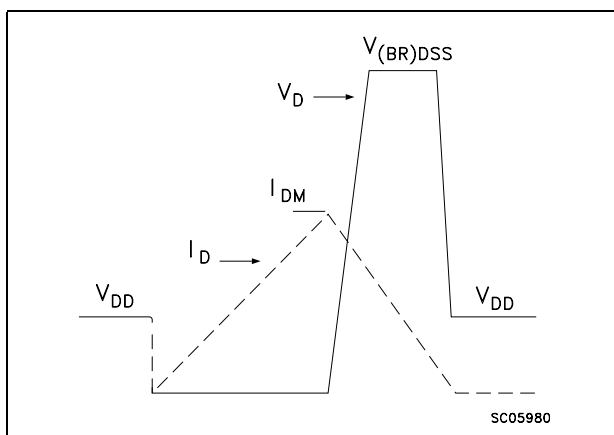
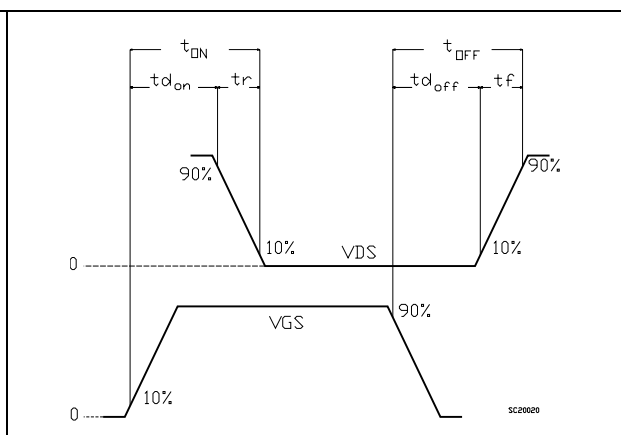


Figure 23. Switching time waveform

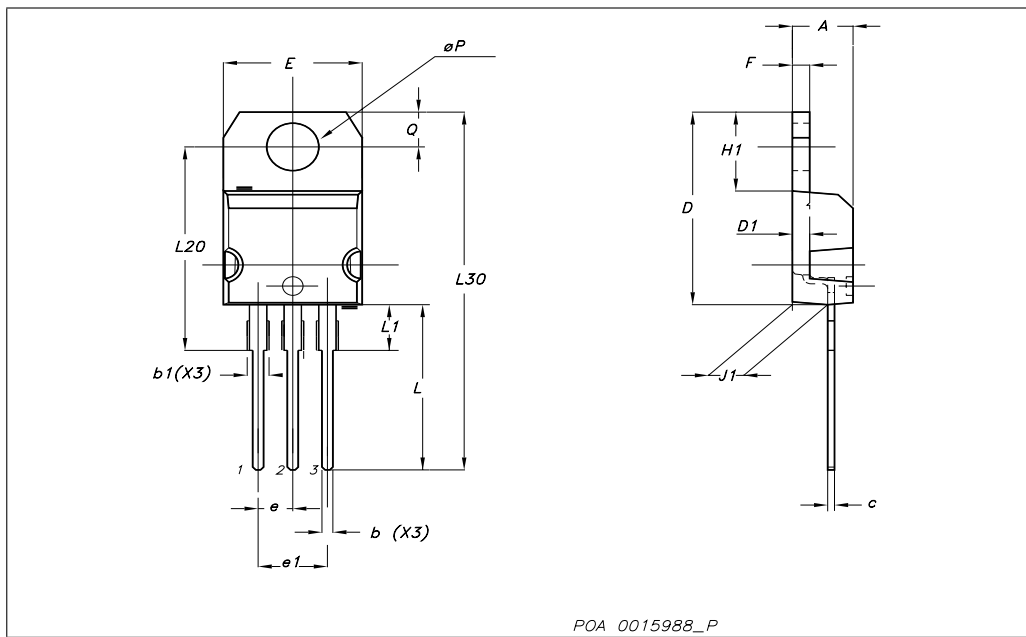


4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com

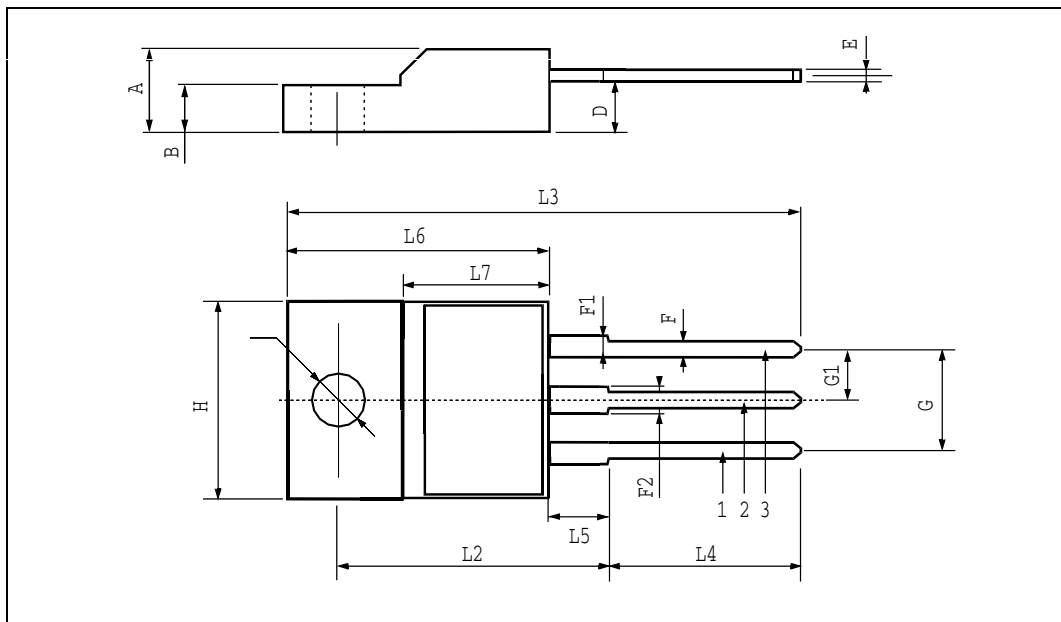
TO-220 mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
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
D	15.25		15.75	0.6		0.62
D1		1.27			0.050	
E	10		10.40	0.393		0.409
e	2.40		2.70	0.094		0.106
e1	4.95		5.15	0.194		0.202
F	1.23		1.32	0.048		0.051
H1	6.20		6.60	0.244		0.256
J1	2.40		2.72	0.094		0.107
L	13		14	0.511		0.551
L1	3.50		3.93	0.137		0.154
L20		16.40			0.645	
L30		28.90			1.137	
∅P	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



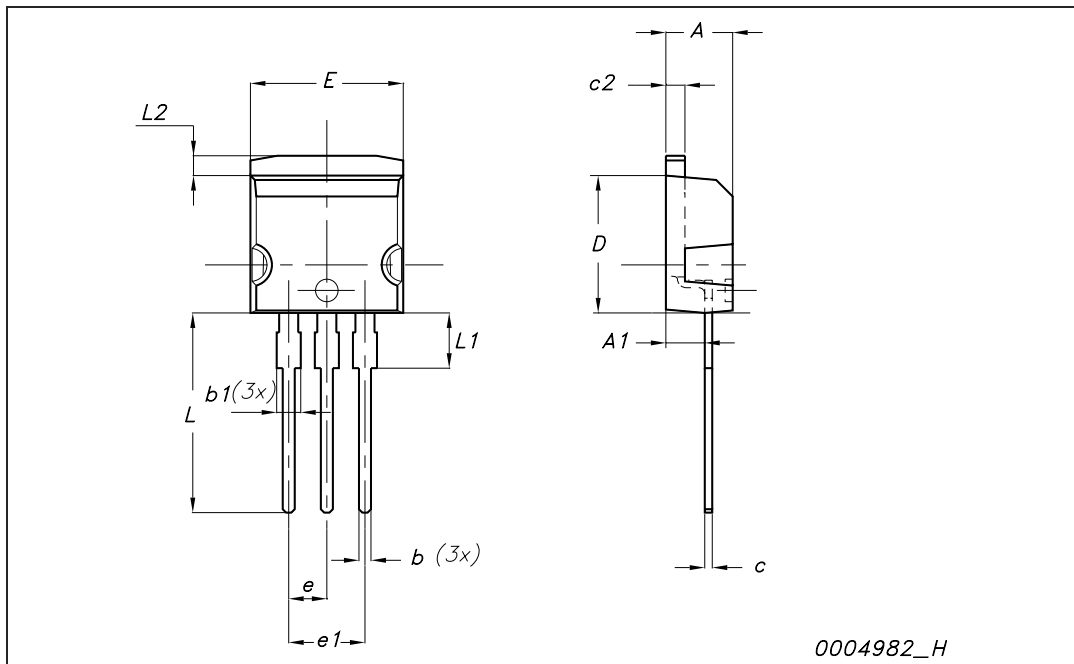
TO-220FP mechanical data

DIM.	mm.			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.4		4.6	0.173		0.181
B	2.5		2.7	0.098		0.106
D	2.5		2.75	0.098		0.108
E	0.45		0.7	0.017		0.027
F	0.75		1	0.030		0.039
F1	1.15		1.7	0.045		0.067
F2	1.15		1.7	0.045		0.067
G	4.95		5.2	0.195		0.204
G1	2.4		2.7	0.094		0.106
H	10		10.4	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.8		10.6	.0385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.9		16.4	0.626		0.645
L7	9		9.3	0.354		0.366
Ø	3		3.2	0.118		0.126



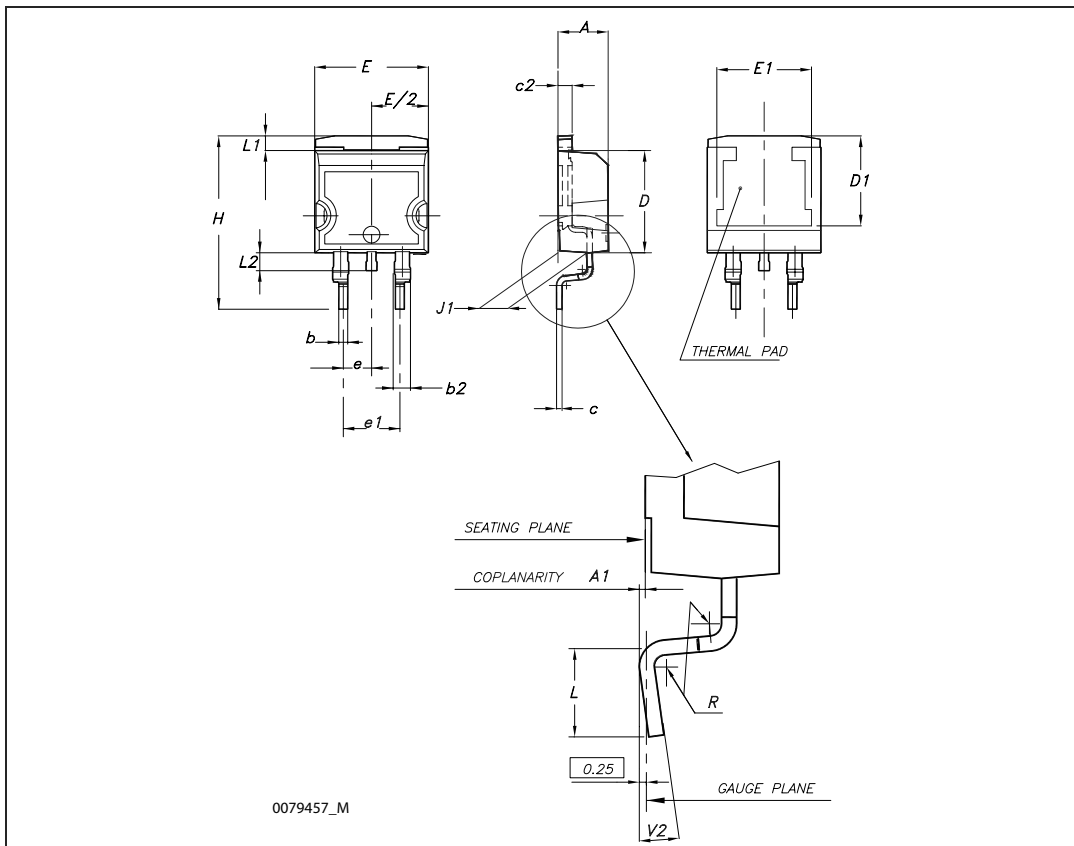
TO-262 mechanical data

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



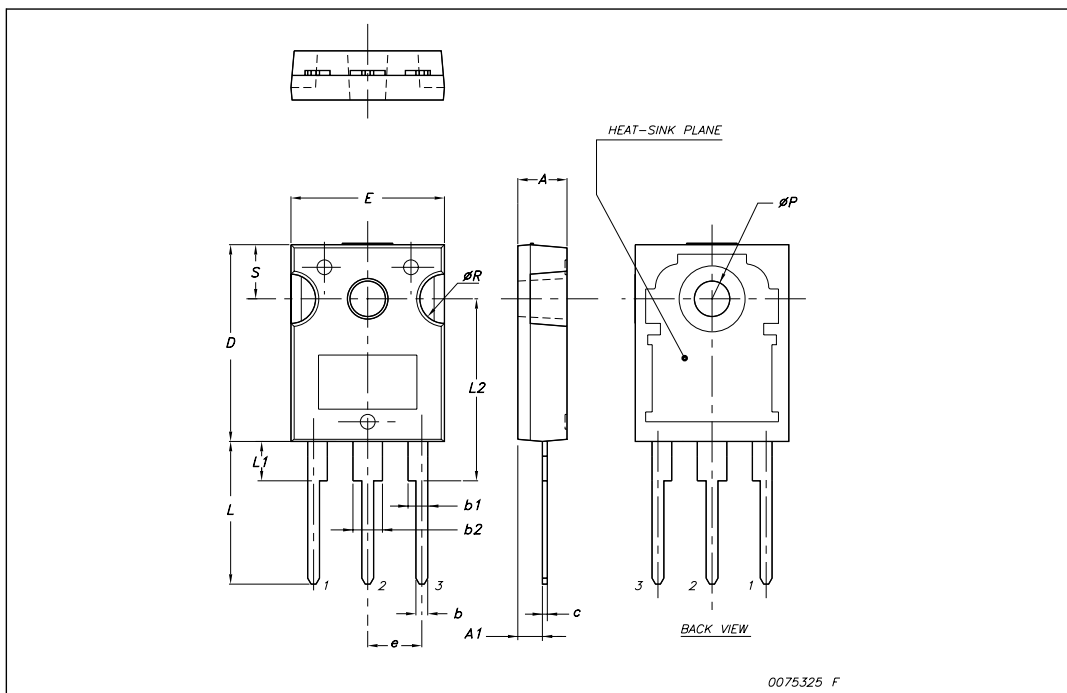
D²PAK (TO-263) mechanical data

Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	0.03		0.23	0.001		0.009
b	0.70		0.93	0.027		0.037
b2	1.14		1.70	0.045		0.067
c	0.45		0.60	0.017		0.024
c2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1	7.50			0.295		
E	10		10.40	0.394		0.409
E1	8.50			0.334		
e		2.54			0.1	
e1	4.88		5.28	0.192		0.208
H	15		15.85	0.590		0.624
J1	2.49		2.69	0.099		0.106
L	2.29		2.79	0.090		0.110
L1	1.27		1.40	0.05		0.055
L2	1.30		1.75	0.051		0.069
R		0.4			0.016	
V2	0°		8°	0°		8°



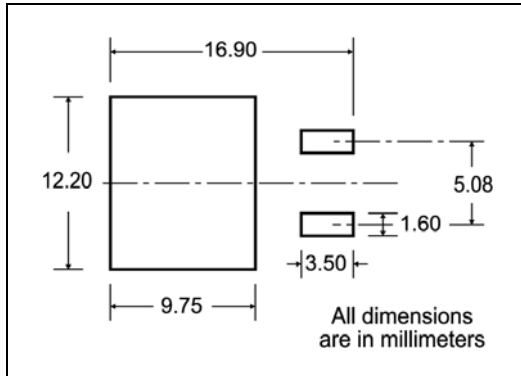
TO-247 Mechanical data

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 Packaging mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT

40 mm min. Access hole at slot location

Full radius

Tape slot in core for tape start 2.5mm min. width

G measured at hub

TAPE MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A0	10.5	10.7	0.413	0.421
B0	15.7	15.9	0.618	0.626
D	1.5	1.6	0.059	0.063
D1	1.59	1.61	0.062	0.063
E	1.65	1.85	0.065	0.073
F	11.4	11.6	0.449	0.456
K0	4.8	5.0	0.189	0.197
P0	3.9	4.1	0.153	0.161
P1	11.9	12.1	0.468	0.476
P2	1.9	2.1	0.075	0.082
R	50		1.574	
T	0.25	0.35	0.0098	0.0137
W	23.7	24.3	0.933	0.956

REEL MECHANICAL DATA

DIM.	mm		inch	
	MIN.	MAX.	MIN.	MAX.
A		330		12.992
B	1.5		0.059	
C	12.8	13.2	0.504	0.520
D	20.2		0.795	
G	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000

10 pitches cumulative tolerance on tape +/- 0.2 mm

Center line of cavity

User Direction of Feed

TRL

FEED DIRECTION

Bending radius R min.

* on sales type

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
14-Feb-2008	1	First release

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