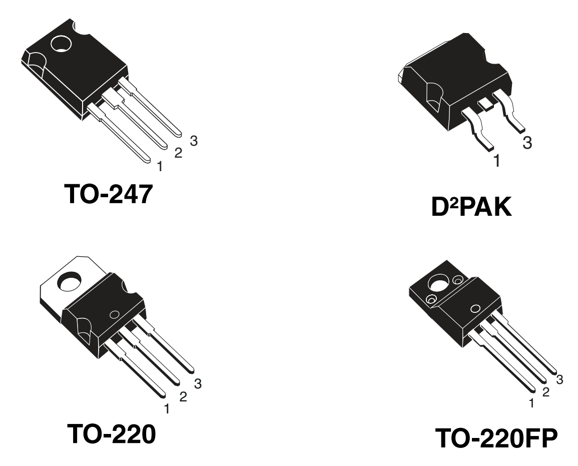
STB13NK60ZT4, STP13NK60Z
STP13NK60ZFP, STW13NK60Z

N-channel 600 V, 0.48 Ω, 13 A, TO-220, TO-220FP, D^2PAK TO-247 Zener-protected SuperMESH™ Power MOSFET

Features

Type	V_{DSS}	$R_{DS(on)}$ max	I_D	Pw
STB13NK60ZT4	600 V	<0.55 Ω	13 A	150 W
STP13NK60ZFP	600 V	<0.55 Ω	13 A	35 W
STP13NK60Z	600 V	<0.55 Ω	13 A	150 W
STW13NK60Z	600 V	<0.55 Ω	13 A	150 W

- Gate charge minimized
- Very low intrinsic capacitances
- Very good manufacturing repeatability



Application

- Switching applications

Description

The SuperMESH™ series is obtained through an extreme optimization of ST's well established strip-based PowerMESH™ layout. In addition to pushing on-resistance significantly down, special care is taken to ensure a very good dv/dt capability for the most demanding applications.

Figure 1. Internal schematic diagram

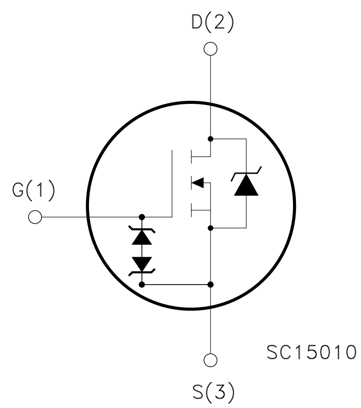


Table 1. Device summary

Order codes	Marking	Package	Packaging
STB13NK60ZT4	B13NK60Z	D^2PAK	Tape and reel
STP13NK60ZFP	P13NK60ZFP	TO-220FP	Tube
STP13NK60Z	P13NK60Z	TO-220	Tube
STW13NK60Z	W13NK60Z	TO-247	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-220 / TO-247 D²PAK	TO-220FP	
V_{DS}	Drain-source voltage (V_{GS} = 0)	600		V
V_{GS}	Gate-source voltage	± 30		V
I_D	Drain current (continuous) at T_C = 25 °C	13	13 (1)	A
I_D	Drain current (continuous) at T_C = 100 °C	8.2	8.2 (1)	A
I_{DM} (2)	Drain current (pulsed)	52	52(1)	A
P_{TOT}	Total dissipation at T_C = 25 °C	150	35	W
	Derating factor	1.20	0.27	W/°C
Vesd(G-S)	G-S ESD (HBM C=100pF, R=1.5 kΩ)	4000		V
dv/dt (3)	Peak diode recovery voltage slope	4.5		V/ns
V_{ISO}	Insulation withstand voltage (AC)	--	2500	V
T_j T_{stg}	Operating junction temperature Storage temperature	-55 to 150		°C

1. Limited only by maximum temperature allowed
2. Pulse width limited by safe operating area
3. $I_{SD} \leq 13$ A, di/dt ≤ 200 A/µs, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq T_{JMAX}$

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		TO-220 TO-247	D²PAK	TO-220FP	
$R_{thj-case}$	Thermal resistance junction-case max	0.83		3.6	°C/W
$R_{thj-pcb}$ (1)	Thermal resistance junction-pcb max	--	60	--	°C/W
$R_{thj-amb}$	Thermal resistance junction-amb max	62.5			°C/W
T_l	Maximum lead temperature for soldering purpose	300			°C

1. When mounted on minimum footprint

Table 4. Avalanche characteristics

Symbol	Parameter	Max value	Unit
I_{AR}	Avalanche current, repetitive or not-repetitive (pulse width limited by Tj max)	10	A
E_{AS}	Single pulse avalanche energy (starting Tj=25 °C, I_D=I_{AR}, V_{DD}= 50 V)	400	mJ

2 Electrical characteristics

(T_{CASE} = 25 °C unless otherwise specified)

Figure 2. On/off states

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	I_D = 1 mA, V_{GS}= 0	600			V
I_{DSS}	Zero gate voltage drain current (V_{GS} = 0)	V_{DS} = Max rating, V_{DS} = Max rating,Tc=125 °C			1 50	µA µA
I_{GSS}	Gate body leakage current (V_{DS} = 0)	V_{GS} = ±20 V			±10	µA
$V_{GS(th)}$	Gate threshold voltage	V_{DS}= V_{GS} , I_D = 100 µA	3	3.75	4.5	V
$R_{DS(on)}$	Static drain-source on resistance	V_{GS}= 10 V, I_D= 4.5 A		0.48	0.55	Ω

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{fs} (1)	Forward transconductance	V_{DS} =8 V, I_D = 5 A	-	11		S
C_{iss} C_{oss} C_{rss}	Input capacitance Output capacitance Reverse transfer capacitance	V_{DS} =25 V, f=1 MHz, V_{GS}=0	-	2030 210 48		pF pF pF
$C_{oss\ eq.}$ (2)	Equivalent output capacitance	V_{GS}=0, V_{DS} =0 to 480 V	-	125		pF
Q_g Q_{gs} Q_{gd}	Total gate charge Gate-source charge Gate-drain charge	V_{DD}=480 V, I_D = 10 A V_{GS} =10 V *(see Figure 21)*	-	66 11 33	92	nC nC nC

1. Pulsed: pulse duration = 300µs, duty cycle 1.5%
2. $C_{oss\ eq.}$ 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 6. Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r	Turn-on delay time Rise time	V_{DD}= 300 V, I_D= 5 A, R_G=4.7 Ω, V_{GS}=10 V (see Figure 20)	-	22 14	-	ns ns
$t_{d(off)}$ t_f	Turn-off delay time Fall time	V_{DD}=300 V, I_D= 5 A, R_G=4.7 Ω, V_{GS}=10 V (see Figure 20)	-	61 12	-	ns ns
$t_{r(Voff)}$ t_f t_c	Off-voltage rise time Fall time Cross-over time	V_{DD}=480 V, I_D= 10 A, R_G=4.7 Ω, V_{GS}=10 V (see Figure 20)	-	10 9 20	-	ns ns ns

Table 7. Gate-source Zener diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
BV_{GSO}	Gate-source breakdown voltage	Igs=±1mA (open drain)	30	-	-	V

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device's ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device's integrity. These integrated Zener diodes thus avoid the usage of external components.

Table 8. Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SD} I_{SDM}(1)	Source-drain current Source-drain current (pulsed)		-		10 40	A A
V_{SD} (2)	Forward on voltage	I_{SD} = 10 A, V_{GS}=0	-		1.6	V
t_{rr} Q_{rr} I_{RRM}	Reverse recovery time Reverse recovery charge Reverse recovery current	I_{SD}= 10 A, di/dt = 100 A/µs, V_{DD}=35 V, Tj=150 °C	-	570 4.5 16		ns µC A

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

2.1 Electrical characteristics (curves)

Figure 3. Safe operating area for TO-220/ D²PAK

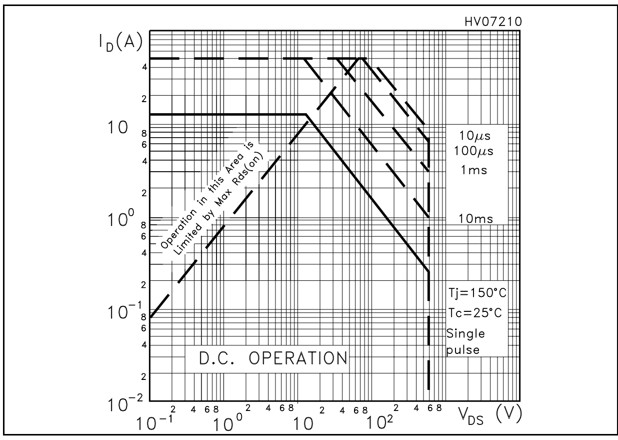


Figure 4. Thermal impedance for TO-220/ D²PAK

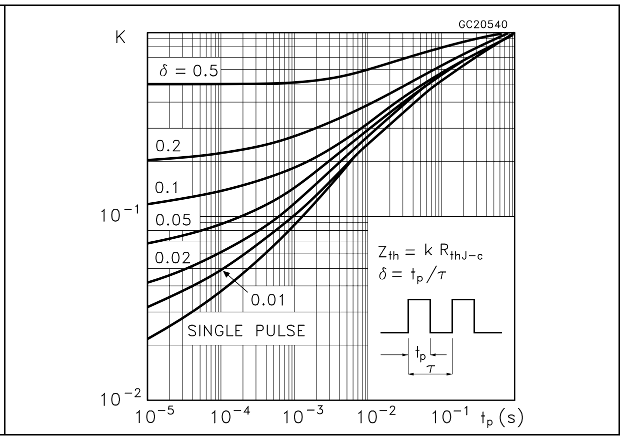


Figure 5. Safe operating area for TO-220FP

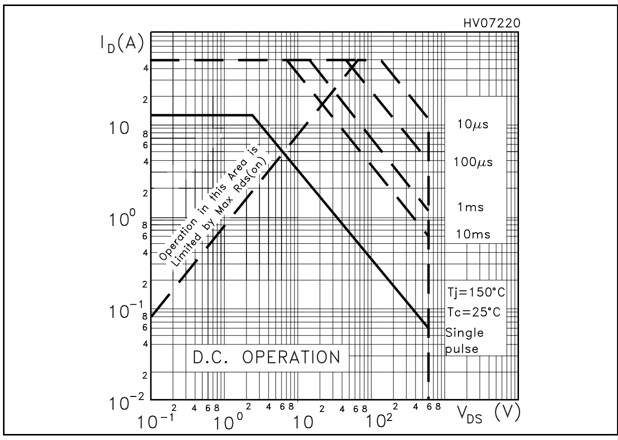


Figure 6. Thermal impedance for TO-220FP

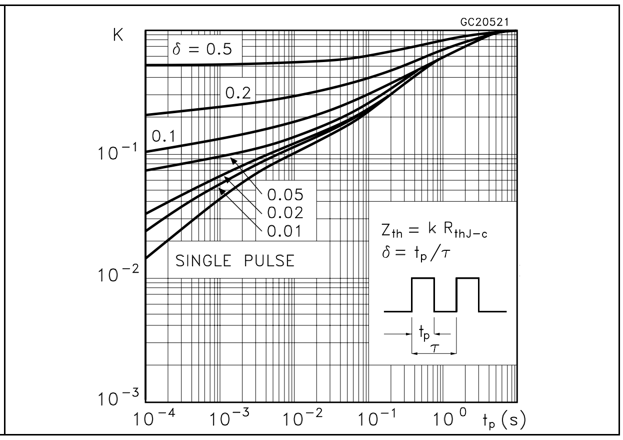


Figure 7. Safe operating area for TO-247

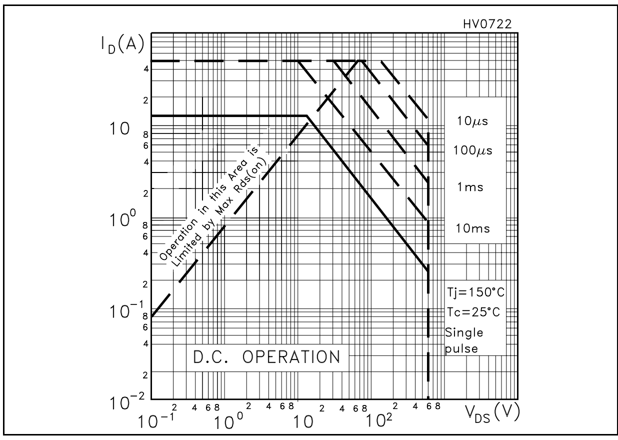


Figure 8. Thermal impedance for TO-247

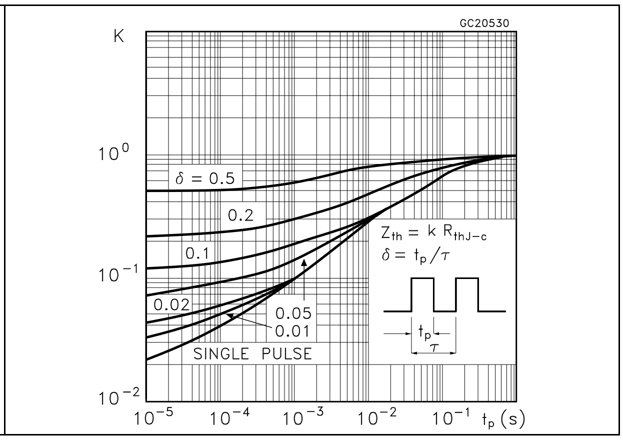


Figure 9. Output characteristics

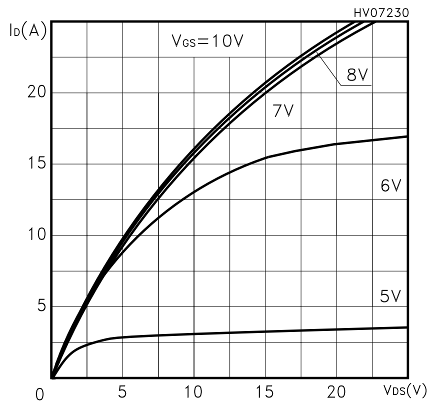


Figure 10. Transfer characteristics

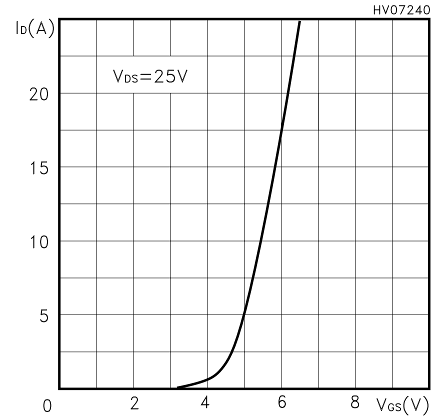


Figure 11. Transconductance

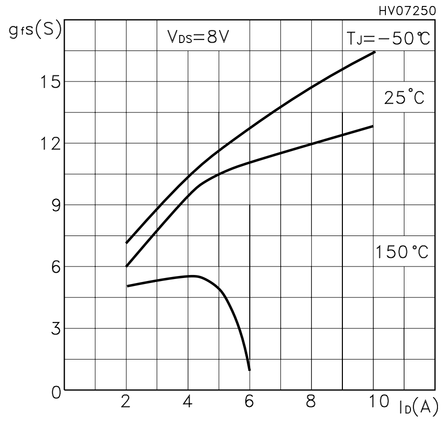


Figure 12. Static drain-source on resistance

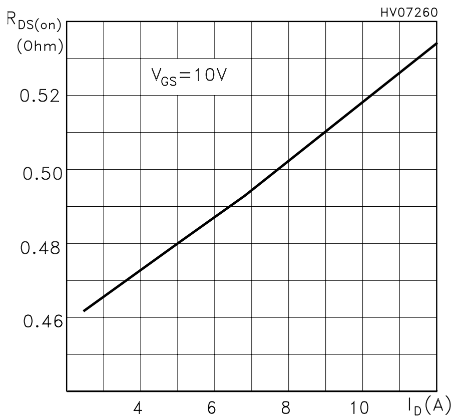


Figure 13. Gate charge vs gate-source voltage

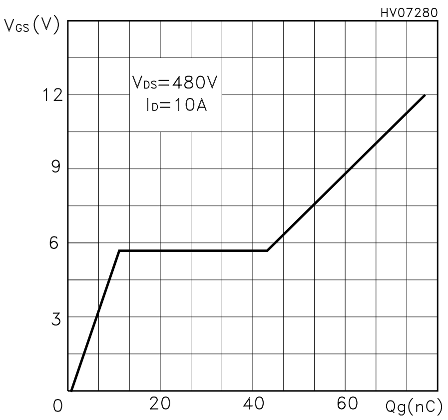


Figure 14. Capacitance variations

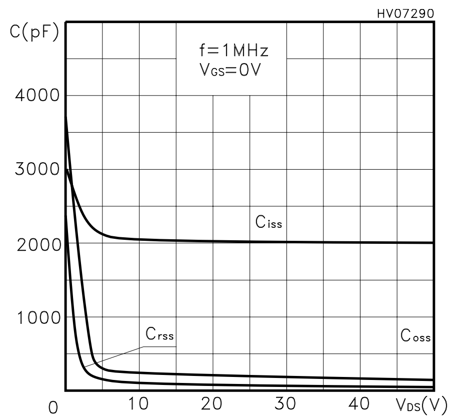


Figure 15. Normalized gate threshold voltage vs temperature

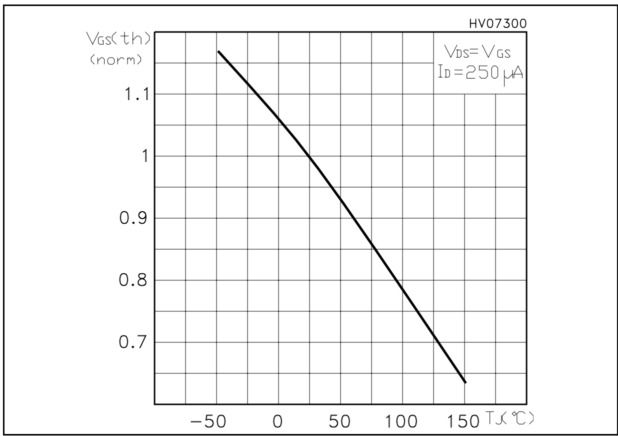


Figure 16. Normalized on resistance vs temperature

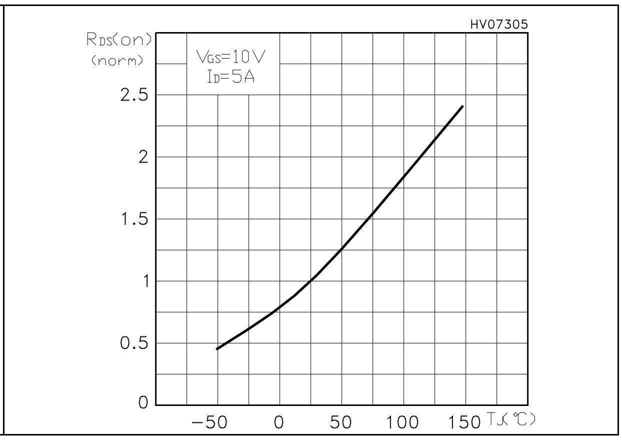


Figure 17. Source-drain diode forward characteristics

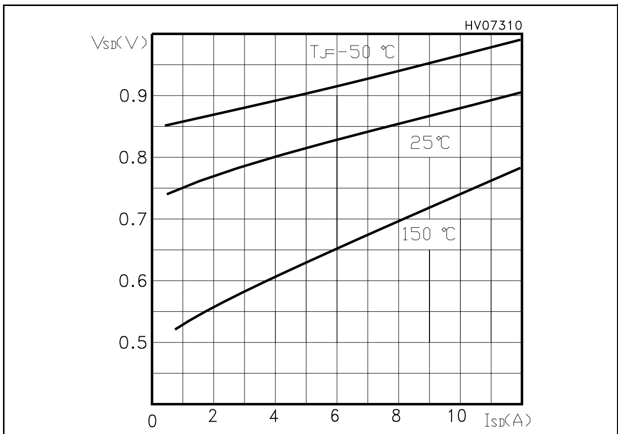


Figure 18. Normalized B_{VDSS} vs temperature

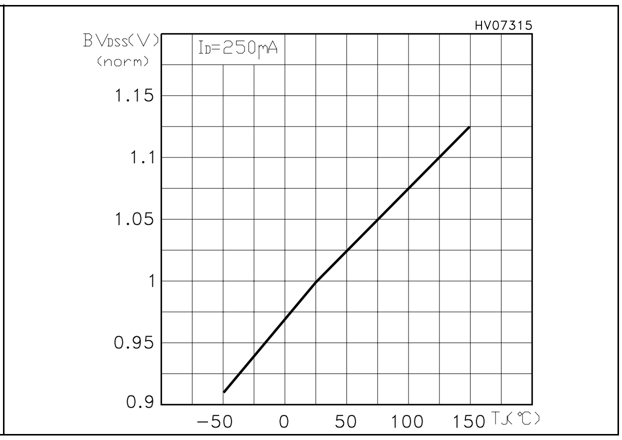
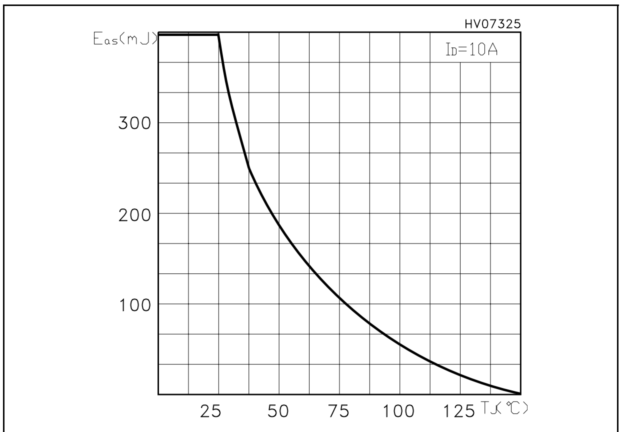


Figure 19. Maximum avalanche energy vs temperature



3 Test circuits

Figure 20. Switching times test circuit for resistive load

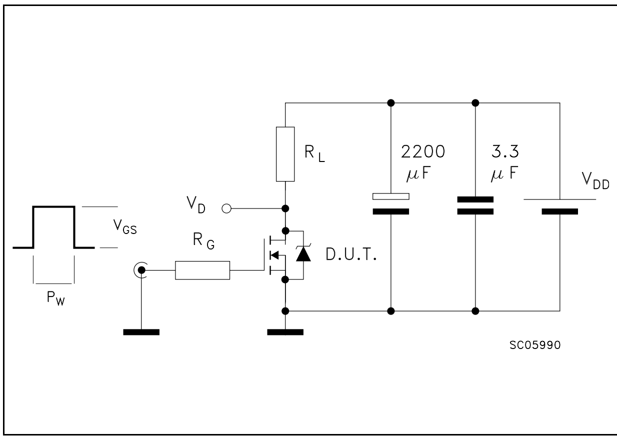


Figure 21. Gate charge test circuit

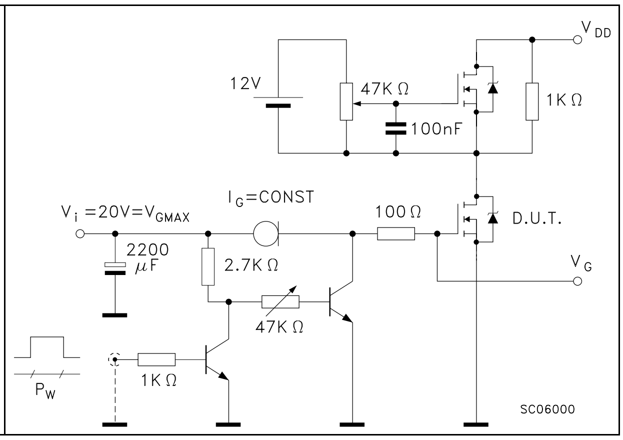


Figure 22. Test circuit for inductive load switching and diode recovery times

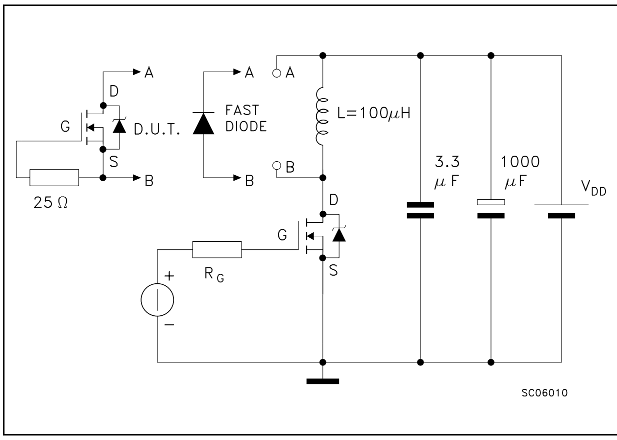


Figure 23. Unclamped inductive load test circuit

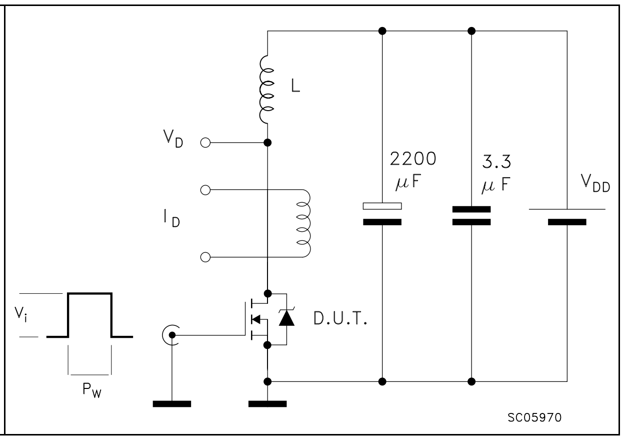


Figure 24. Unclamped inductive waveform

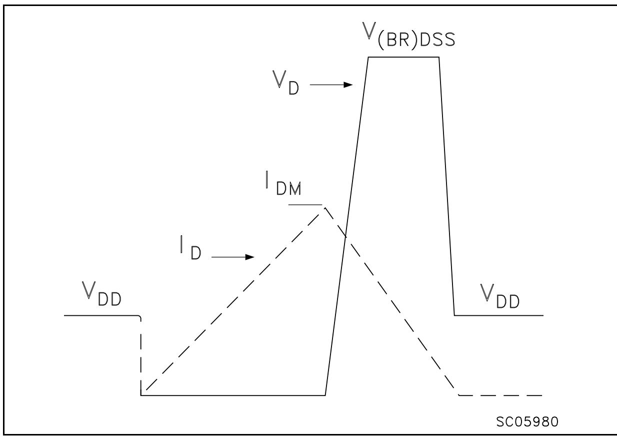
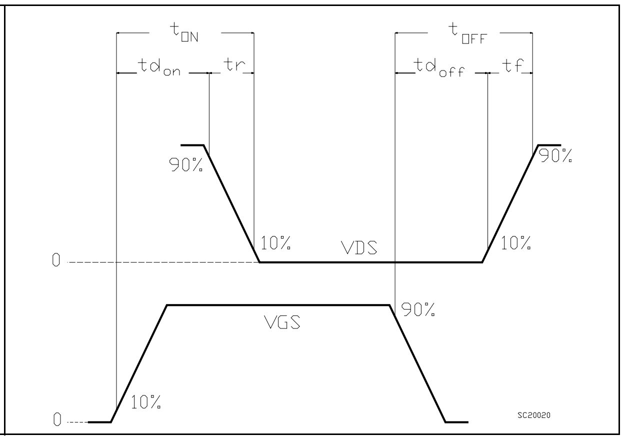


Figure 25. Switching time waveform

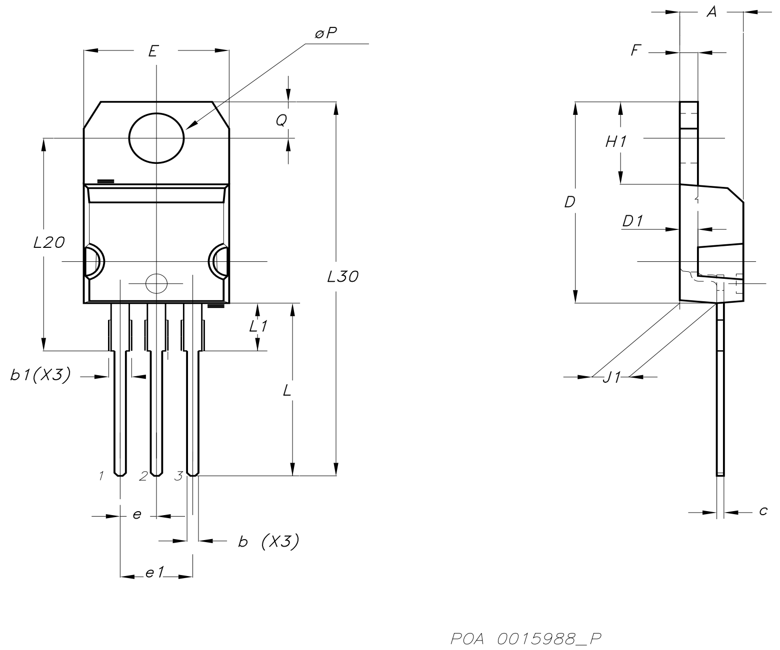


4 Package mechanical data

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.

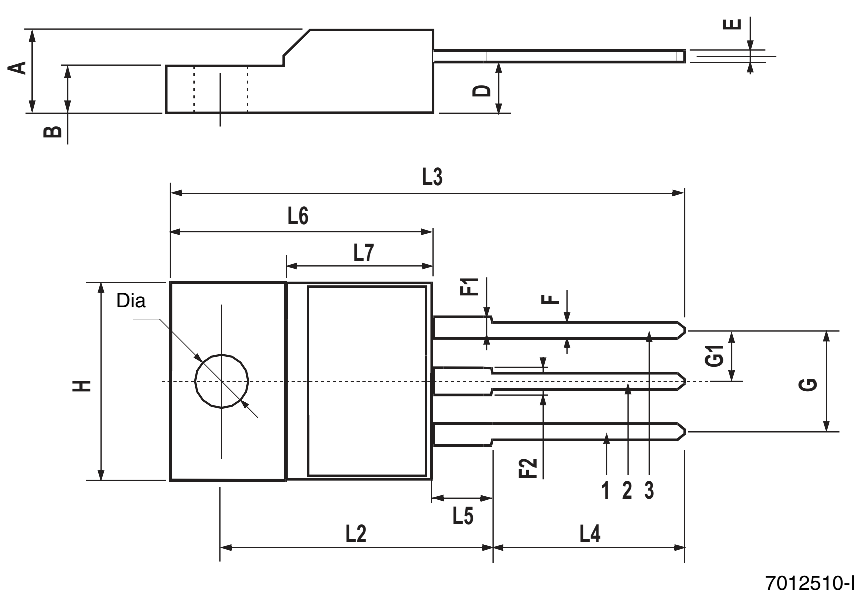
TO-220 mechanical data

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



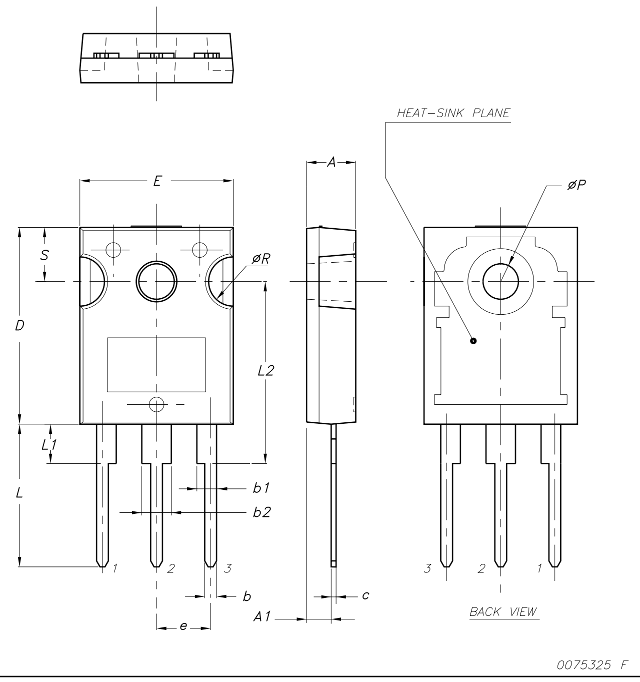
TO-220FP mechanical data

Dim.	mm.			inch		
	Min.	Typ	Max.	Min.	Typ.	Max.
A	4.40		4.60	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		0.70	0.017		0.027
F	0.75		1.00	0.030		0.039
F1	1.15		1.50	0.045		0.067
F2	1.15		1.50	0.045		0.067
G	4.95		5.20	0.195		0.204
G1	2.40		2.70	0.094		0.106
H	10		10.40	0.393		0.409
L2		16			0.630	
L3	28.6		30.6	1.126		1.204
L4	9.80		10.60	0.385		0.417
L5	2.9		3.6	0.114		0.141
L6	15.90		16.40	0.626		0.645
L7	9		9.30	0.354		0.366
Dia	3		3.2	0.118		0.126



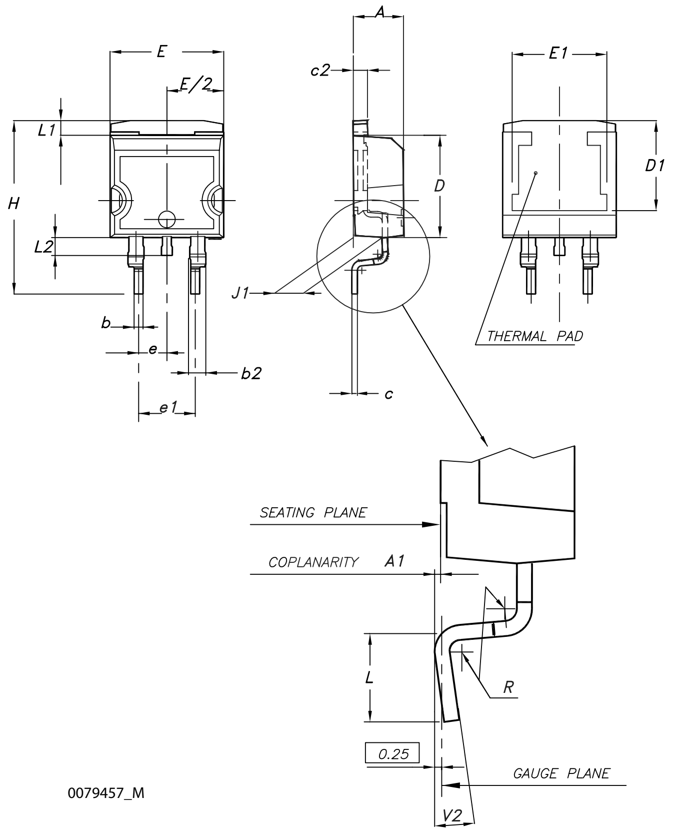
TO-247 Mechanical data

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	



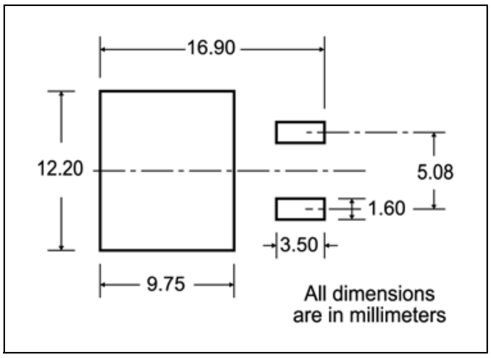
D²PAK (TO-263) mechanical data

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°

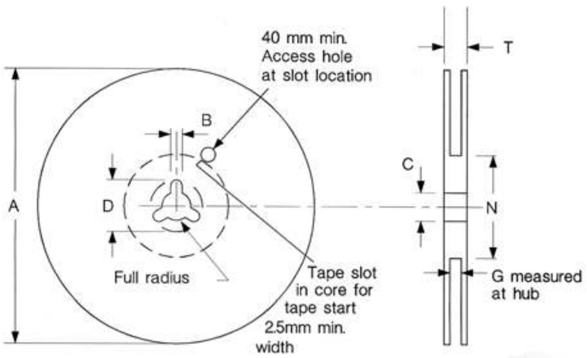


5 Packing mechanical data

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT



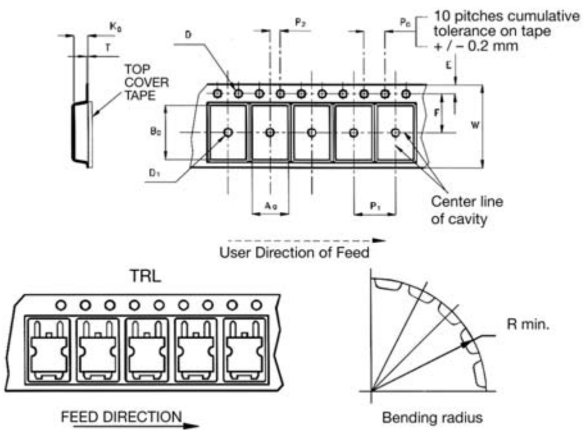
REEL MECHANICAL DATA

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		0795	
G	24.4	26.4	0.960	1.039
N	100		3.937	
T		30.4		1.197

BASE QTY	BULK QTY
1000	1000

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



* on sales type

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
20-Sep-2005	4	
05-Oct-2005	5	Inserted ECOPACK® indication
29-Feb-2008	6	V_{ISO} parameter on *Table* has been updated
15-Apr-2009	7	Order codes in *Table 1: Device summary* has been changed