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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value			Unit
		TO-220	TO-247	TO-3PF	
$V_{DS}$	Drain-source voltage ( $V_{GS} = 0$ )	1500			V
$V_{GS}$	Gate- source voltage	$\pm 30$			V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^{\circ}\text{C}$	4	4	4 <sup>(1)</sup>	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^{\circ}\text{C}$	2.5	2.5	2.5 <sup>(1)</sup>	A
$I_{DM}^{(1)}$	Drain current (pulsed)	12	12	12 <sup>(1)</sup>	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	160		63	W
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t=1\text{ s}; T_C=25\text{ }^{\circ}\text{C}$ )			3500	V
$T_{stg}$	Storage temperature	-55 to 150			$^{\circ}\text{C}$
$T_j$	Max. operating junction temperature	150			$^{\circ}\text{C}$

1. Pulse width limited by safe operating area

**Table 3. Thermal data**

Symbol	Parameter	Value			Unit
		TO-220	TO-247	TO-3PF	
$R_{thj-case}$	Thermal resistance junction-case max	0.78		2	$^{\circ}\text{C}/\text{W}$
$R_{thj-amb}$	Thermal resistance junction-ambient max	62.5	50		$^{\circ}\text{C}/\text{W}$

**Table 4. Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not-repetitive (pulse width limited by $T_j$ max)	4	A
$E_{AS}$	Single pulse avalanche energy (starting $T_j = 25\text{ }^{\circ}\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	350	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	$I_D = 1\text{ mA}$ , $V_{GS} = 0$	1500			V
$I_{DSS}$	Zero gate voltage Drain current ( $V_{GS} = 0$ )	$V_{DS} = \text{Max rating}$ $V_{DS} = \text{Max rating}$ , $T_C = 125\text{ }^{\circ}\text{C}$			10 500	$\mu\text{A}$ $\mu\text{A}$
$I_{GSS}$	Gate-body leakage current ( $V_{DS} = 0$ )	$V_{GS} = \pm 30\text{ V}$			$\pm 100$	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	$V_{GS} = 10\text{ V}$ , $I_D = 2\text{ A}$		5	7	$\Omega$

**Table 6. Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$g_{fs}^{(1)}$	Forward transconductance	$V_{DS} = 30\text{ V}$ , $I_D = 2\text{ A}$	-	3.5		S
$C_{iss}$ $C_{oss}$ $C_{rss}$	Input capacitance Output capacitance Reverse transfer capacitance	$V_{DS} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GS} = 0$	-	1300 120 12		pF pF pF
$t_{d(on)}$ $T_r$ $t_{d(off)}$ $t_f$	Turn-on delay time Rise time Turn-off delay time Fall time	$V_{DD} = 750\text{ V}$ , $I_D = 2\text{ A}$ , $R_G = 4.7\text{ }\Omega$ , $V_{GS} = 10\text{ V}$ <a href="#">Figure 19</a>	-	35 30 45 45		ns ns ns ns
$Q_g$ $Q_{gs}$ $Q_{gd}$	Total gate charge Gate-source charge Gate-drain charge	$V_{DD} = 600\text{ V}$ , $I_D = 4\text{ A}$ , $V_{GS} = 10\text{ V}$ <a href="#">Figure 20</a>	-	30 10 9	50	nC nC nC

1. Pulsed: pulse duration=300  $\mu\text{s}$ , duty cycle 1.5%

**Table 7. Source drain diode**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_{SD}$	Source-drain current		-		4	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		12	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 4\text{ A}$ , $V_{GS} = 0$	-		2	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 4\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 45\text{ V}$ <a href="#">Figure 21</a>	-	510		ns
$Q_{rr}$	Reverse recovery charge			3		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			12		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 4\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ $V_{DD} = 45\text{ V}$ , $T_j = 150^\circ\text{C}$ <a href="#">Figure 21</a>	-	615		ns
$Q_{rr}$	Reverse recovery charge			4		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current			12.6		A

1. Pulse width limited by safe operating area

2. Pulsed: pulse duration=300 $\mu\text{s}$ , duty cycle 1.5%

## 2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for TO-220

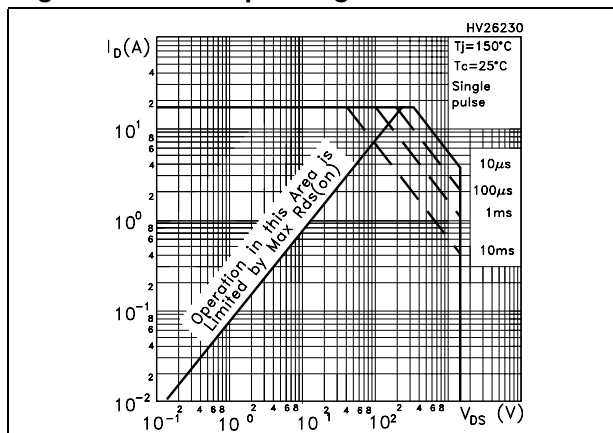


Figure 3. Thermal impedance for TO-220

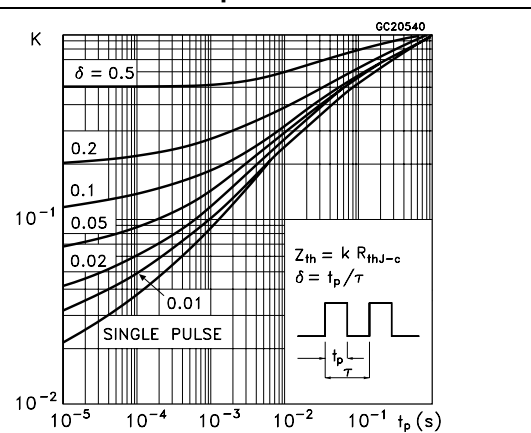


Figure 4. Safe operating area for TO-3PF

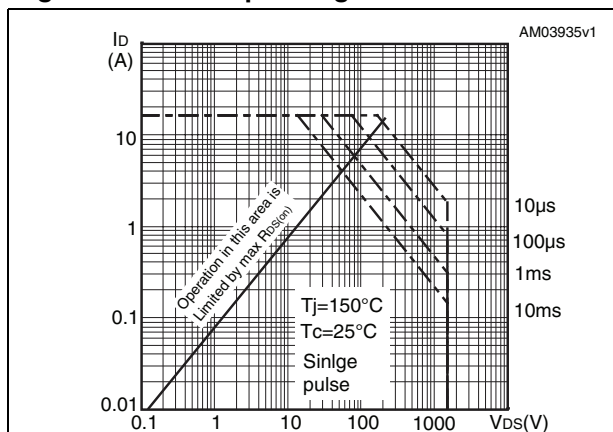


Figure 5. Thermal impedance for TO-3PF

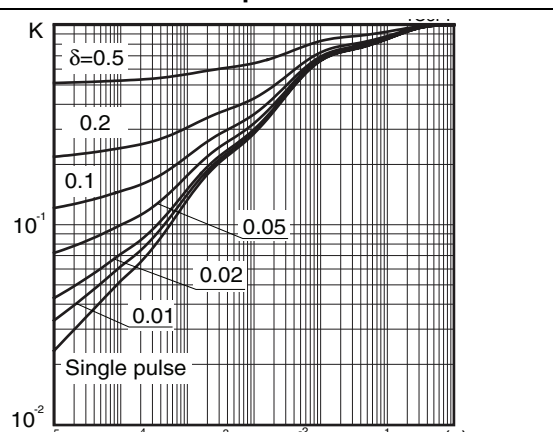


Figure 6. Safe operating area for TO-247

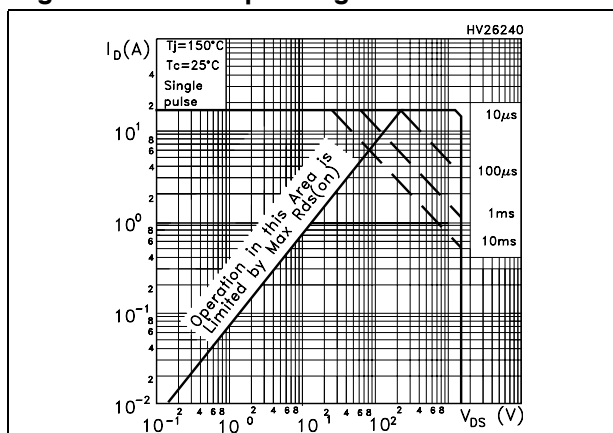


Figure 7. Thermal impedance for TO-247

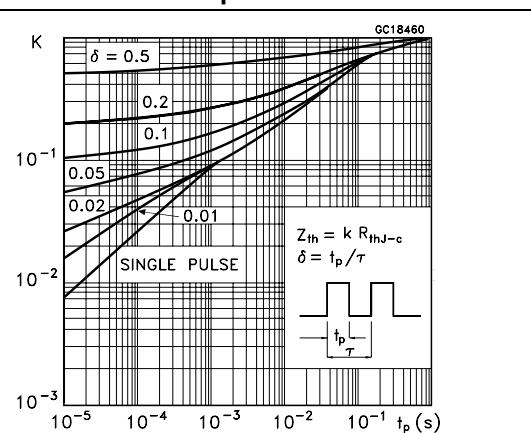


Figure 8. Output characteristics

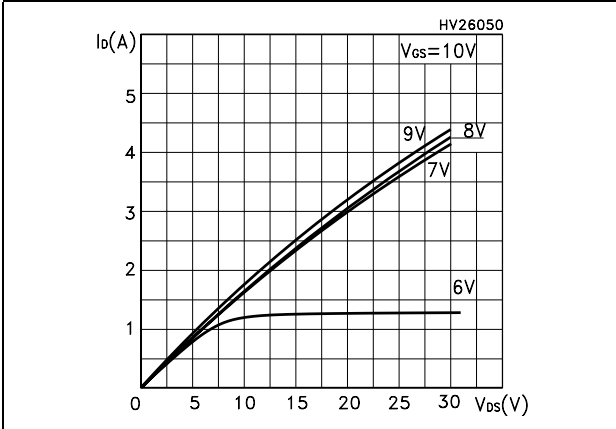


Figure 9. Transfer characteristics

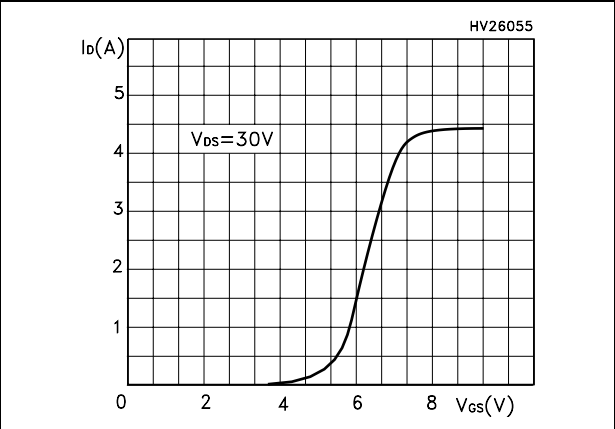


Figure 10. Transconductance

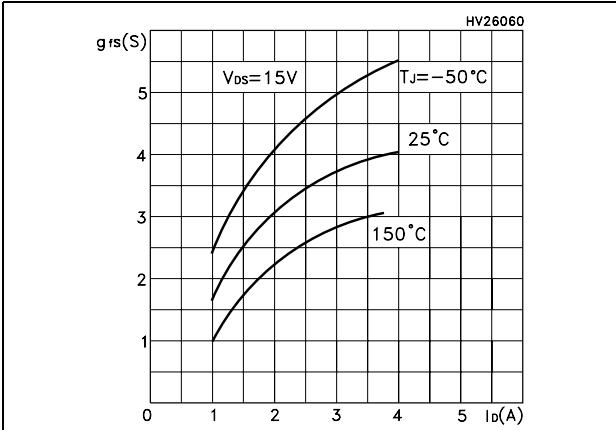


Figure 11. Static drain-source on resistance

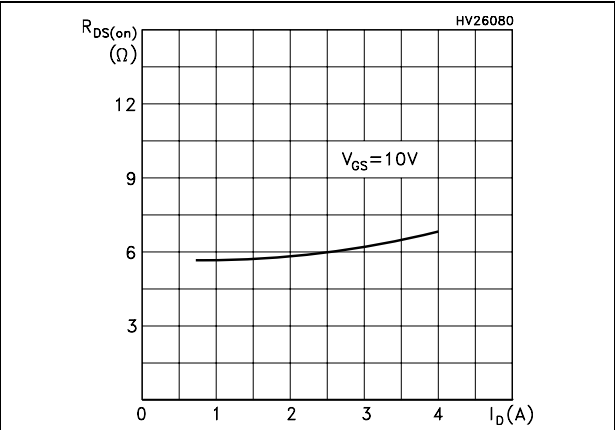


Figure 12. Gate charge vs gate-source voltage

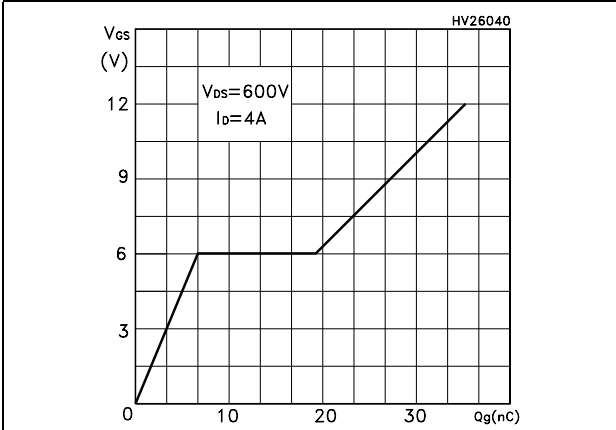


Figure 13. Capacitance variations

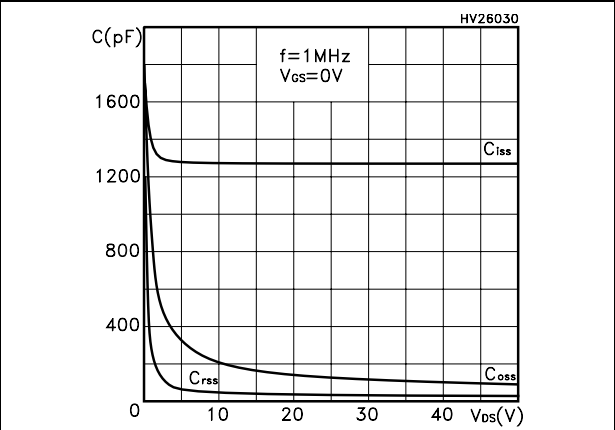


Figure 14. Normalized gate threshold voltage vs temperature

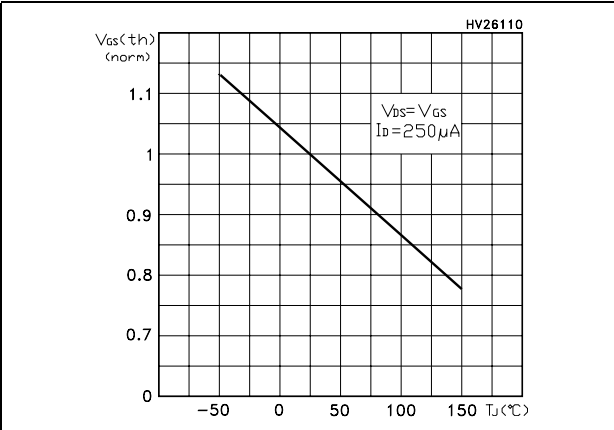


Figure 15. Normalized on resistance vs temperature

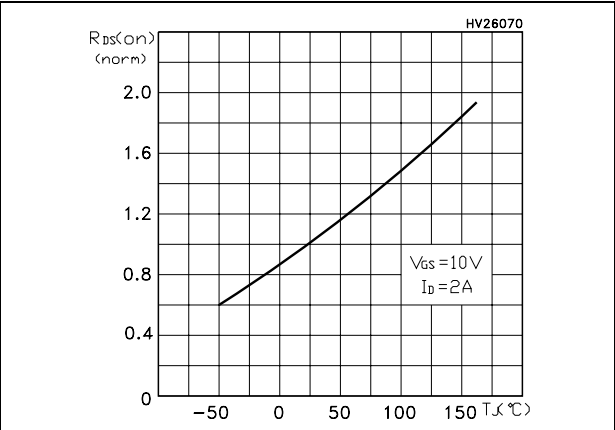


Figure 16. Source-drain diode forward characteristics

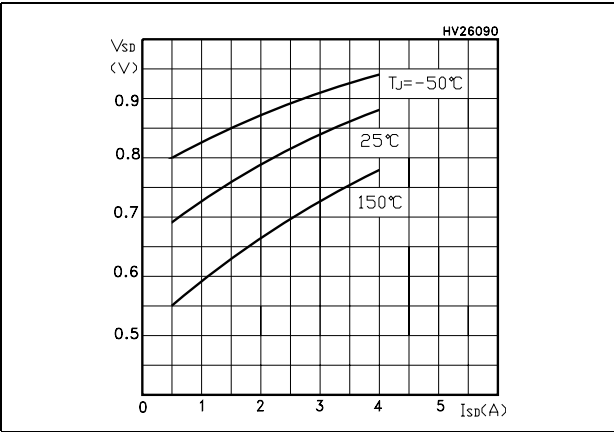


Figure 17. Normalized  $B_{VDS}$  vs temperature

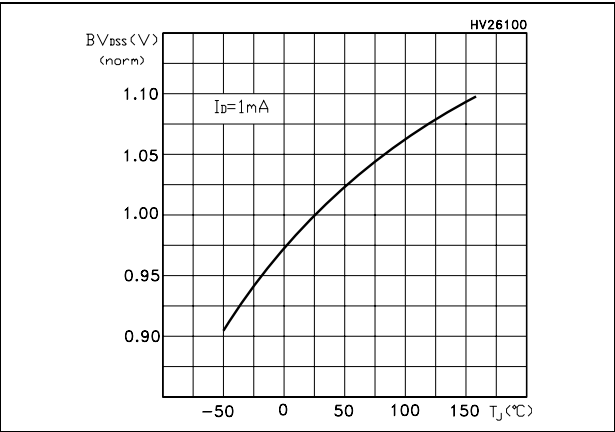
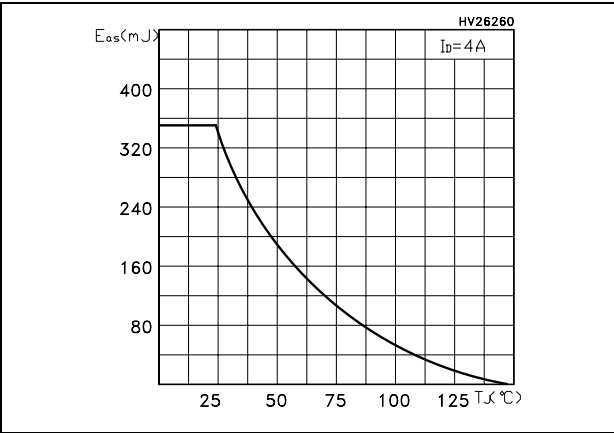
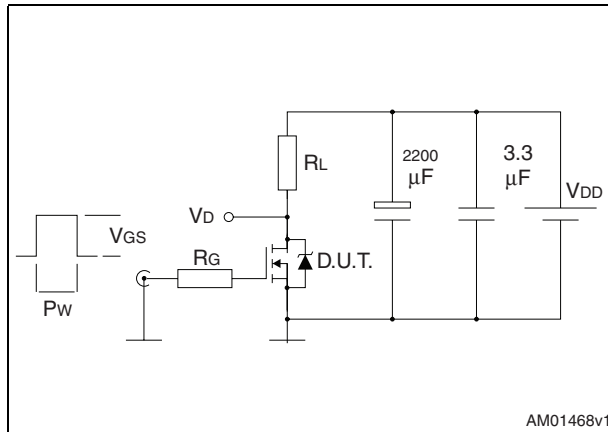


Figure 18. Maximum avalanche energy vs temperature

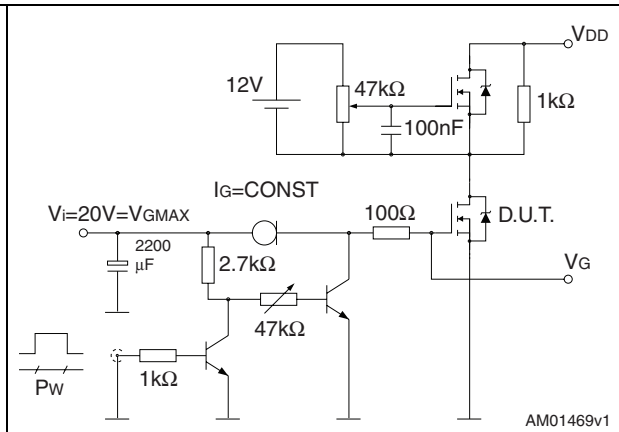


### 3 Test circuits

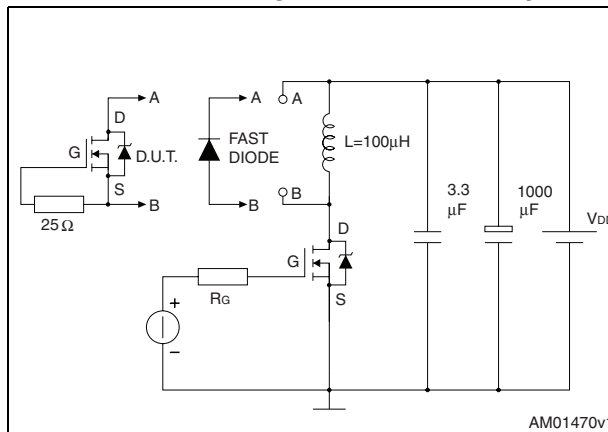
**Figure 19. Switching times test circuit for resistive load**



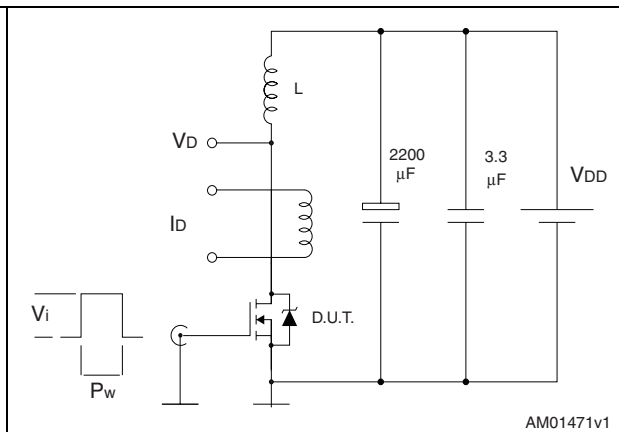
**Figure 20. Gate charge test circuit**



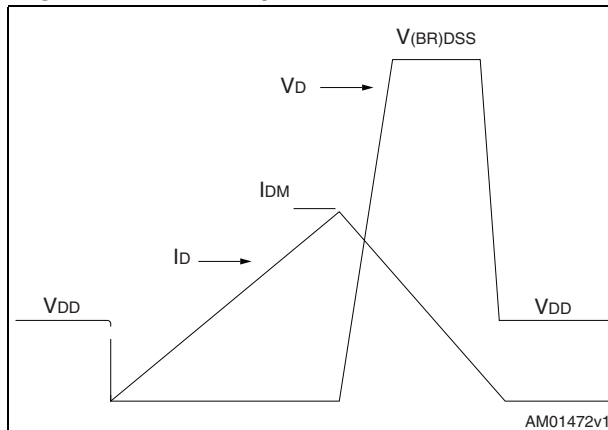
**Figure 21. Test circuit for inductive load switching and diode recovery times**



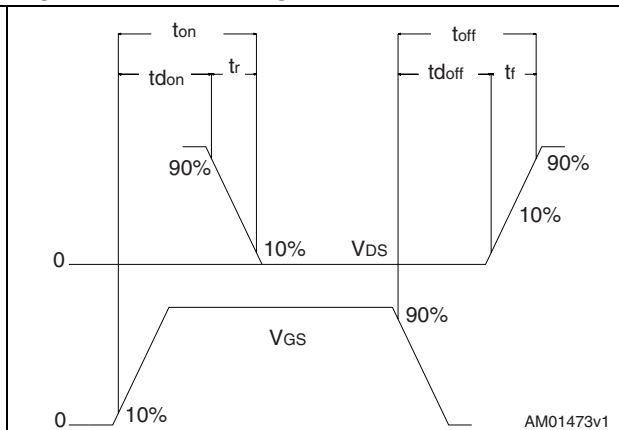
**Figure 22. Unclamped inductive load test circuit**



**Figure 23. Unclamped inductive waveform**



**Figure 24. Switching time waveform**



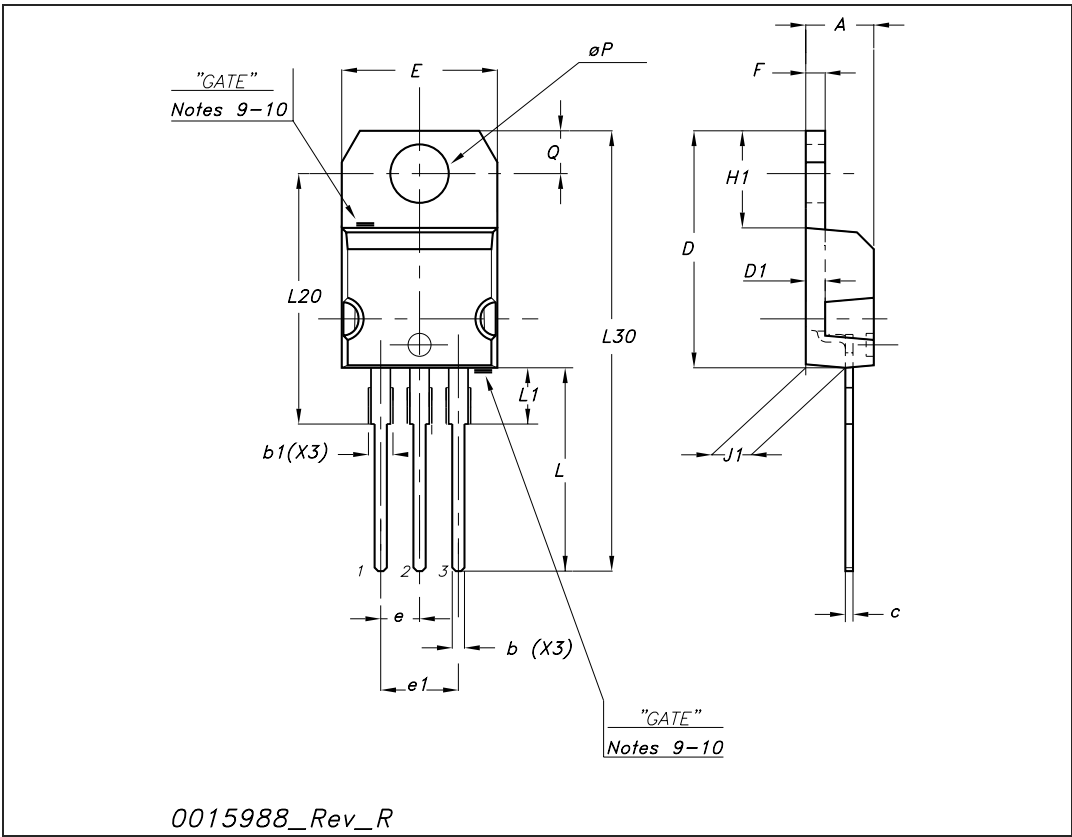


## 4 Package mechanical data

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](http://www.st.com). ECOPACK is an ST trademark.

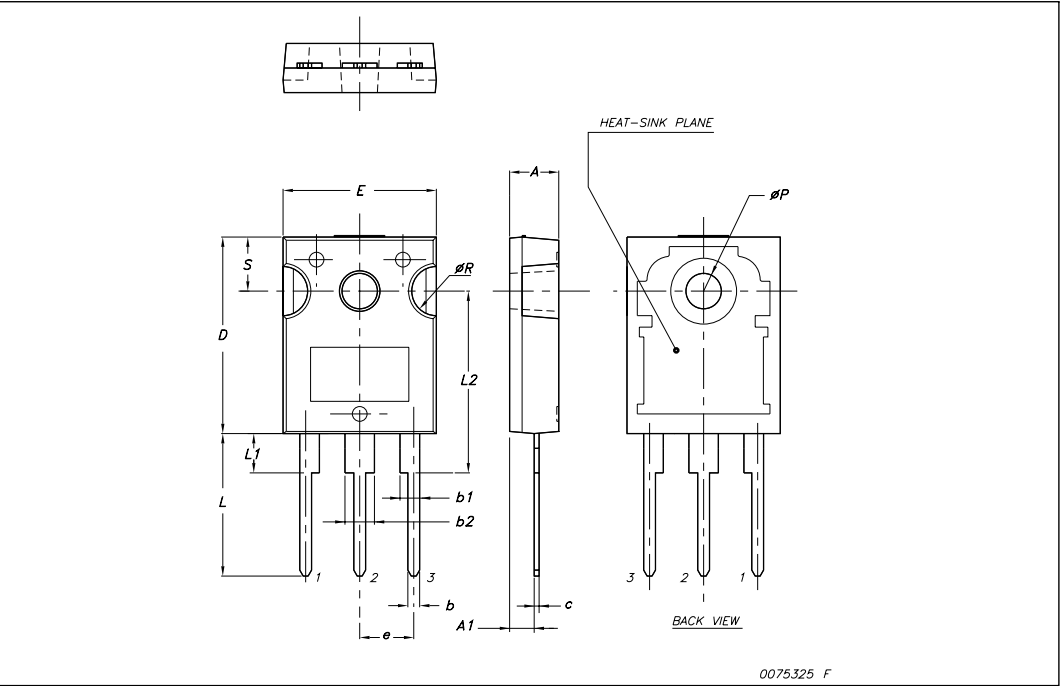
TO-220 mechanical data

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	0.48		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	
ØP	3.75		3.85	0.147		0.151
Q	2.65		2.95	0.104		0.116



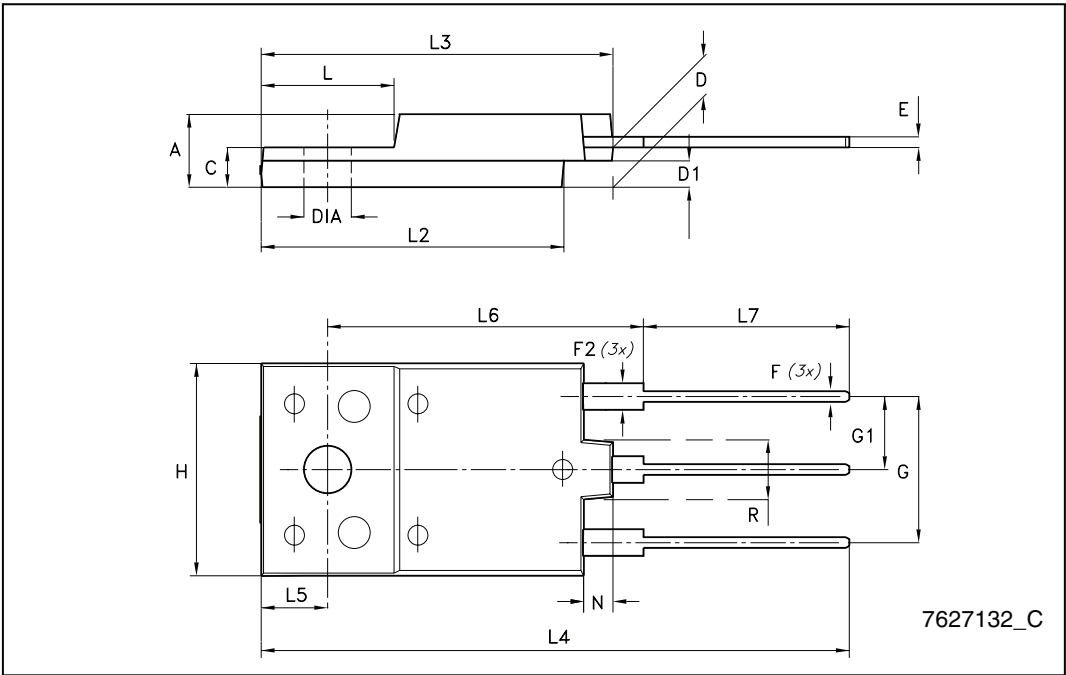
TO-247 Mechanical data

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	



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
Dia	3.40		3.80



## 5 Revision history

**Table 8. Document revision history**

Date	Revision	Changes
29-Mar-2005	1	Initial release
07-Jul-2005	2	Removed TO-220FP
07-Oct-2005	3	Document status promoted from preliminary data to datasheet
10-Aug-2006	4	Document reformatted, no content change
06-Nov-2007	5	Updated unit on <a href="#">Table 5: On/off states</a>
09-Apr-2008	6	Added new packages: TO-220FH, TO-3PF
21-Jan-2009	7	Remove package TO-220FH
23-Feb-2009	8	Added $P_{TOT}$ value for TO-3PF $P_{TOT}$ ( <a href="#">Table 2: Absolute maximum ratings</a> )
23-Jul-2009	9	Added new figures: <a href="#">Figure 4: Safe operating area for TO-3PF</a> and <a href="#">Figure 5: Thermal impedance for TO-3PF</a>

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