STGB7NC60HD, STGF7NC60HD, STGP7NC60HD

N-channel 14 A, 600 V, very fast IGBT with Ultrafast diode

Datasheet — production data

Features

- Low on-voltage drop ($V_{CE(sat)}$)
- Off losses include tail current
- Losses include diode recovery energy
- High frequency operation up to 70 kHz
- Very soft ultra fast recovery anti parallel diode

Applications

- High frequency inverters
- SMPS and PFC in both hard switch and resonant topologies
- Motor drivers

Description

These devices are very fast IGBT developed using advanced PowerMESH™ technology. This process guarantees an excellent trade-off between switching performance and low on-state behavior. These devices are well-suited for resonant or soft-switching applications.

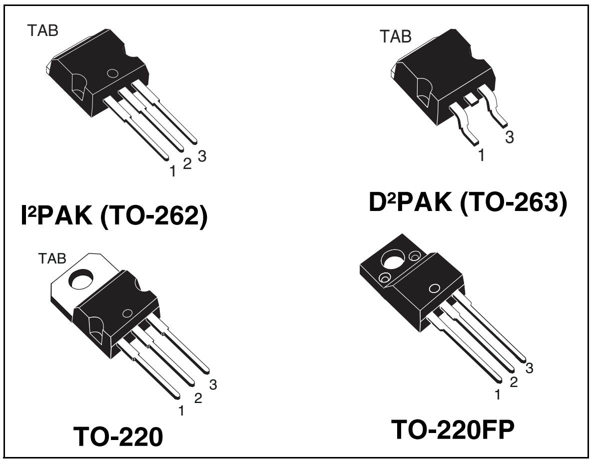


Figure 1. Internal schematic diagram

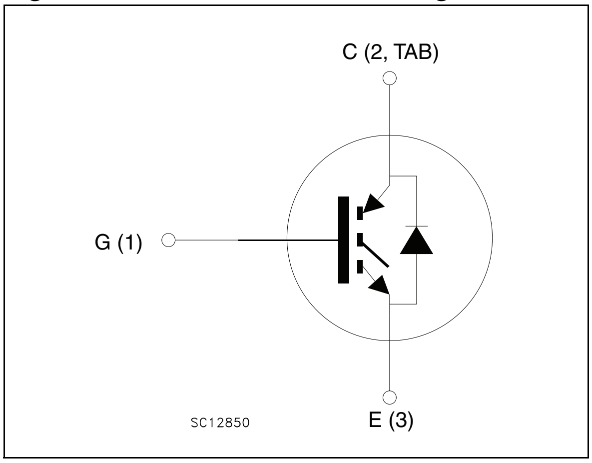


Table 1. Device summary

Order codes	Markings	Packages	Packaging
STGB7NC60HD-1	GB7NC60HD	I²PAK (TO-262)	Tube
STGB7NC60HDT4		D²PAK (TO-263)	Tape and reel
STGF7NC60HD	GF7NC60HD	TO-220FP	Tube
STGP7NC60HD	GP7NC60HD	TO-220	Tube

Contents

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		I^2PAK, D^2PAK, TO-220	TO-220FP	
V_{CES}	Collector-emitter voltage (V_{GS} = 0)	600		V
V_{ECR}	Emitter-collector voltage	20		V
V_{GE}	Gate-emitter voltage	±20		V
I_C	Collector current (continuous) at T_C = 25 °C (1)	25	10	A
I_C	Collector current (continuous) at T_C = 100 °C (1)	14	6	A
I_{CM} (2)	Collector current (pulsed)	50		A
I_F	Diode RMS forward current at T_C = 25°C	20		A
P_{TOT}	Total dissipation at T_C = 25°C	80	25	W
	Derating factor	0.64	0.20	W/°C
V_{ISO}	Insulation withstand voltage A.C. (t = 1 sec; T_C = 25°C)	--	2500	V
T_{stg}	Storage temperature	– 55 to 150		°C
T_j	Operating junction temperature			

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

2. Pulse width limited by maximum junction temperature and turn-off within RBSOA.

Table 3. Thermal data

Symbol	Parameter	Value		Unit
		I^2PAK, D^2PAK, TO-220	TO-220FP	
R_{thJC}	Thermal resistance junction-case	1.56	5.0	°C/W
R_{thJA}	Thermal resistance junction-ambient	62.5		°C/W

2 Electrical characteristics

T_{CASE} = 25°C unless otherwise specified.

Table 4. Electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	I_C = 1 mA, V_{GE} = 0	600			V
I_{CES}	Collector cut-off current (V_{GE} = 0)	V_{CE} = 600 V V_{CE} = 600 V, T_C = 125 °C			10 1	µA mA
I_{GES}	Gate-emitter leakage current (V_{CE} = 0)	V_{GE} = ± 20 V			±100	nA
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 250 µA	3.75		5.75	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15V, I_C = 7 A V_{GE} = 15V, I_C = 7 A, T_C= 125°C		1.85 1.7	2.5	V V

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{fs} (1)	Forward transconductance	V_{CE} = 15 V , I_C = 7 A		4.30		S
C_{ies} C_{oes} C_{res}	Input capacitance Output capacitance Reverse transfer capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0		720 81 17		pF pF pF
Q_g Q_{ge} Q_{gc}	Total gate charge Gate-emitter charge Gate-collector charge	V_{CE} = 390 V, I_C = 7 A, V_{GE} = 15 V		35 7 16	48	nC nC nC
I_{CL}	Turn-off SOA minimum current	V_{clamp} = 480 V , Tj =150°C R_G = 10 Ω, V_{GE} = 15 V	50			A

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

Table 6. Switching on

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$ t_r $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	V_{CC} = 390 V, I_C = 7 A R_G = 10 Ω, V_{GE} = 15V (see *Figure 21*)	-	18.5 8.5 1060	-	ns ns A/µs
$t_{d(on)}$ t_r $(di/dt)_{on}$	Turn-on delay time Current rise time Turn-on current slope	V_{CC} = 390 V, I_C = 7 A R_G = 10 Ω, V_{GE} = 15V, Tj = 125°C (see *Figure 21*)		18.5 7 1000		ns ns A/µs

Table 7. Switching off

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_r(V_{off})$	Off voltage rise time	V_{CC} = 390 V, I_C = 7 A, R_G = 10 Ω , V_{GE} = 15 V	-	27	-	ns
$t_d(_{off})$	Turn-off delay time			72		ns
t_f	Current fall time			60		ns
$t_r(V_{off})$	Off voltage rise time	V_{CC} = 390 V, I_C = 7 A, R_G = 10 Ω , V_{GE} = 15 V Tj = 125 °C		56		ns
$t_d(_{off})$	Turn-off delay time			116		ns
t_f	Current fall time			105		ns

Table 8. Switching energy

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
Eon (1) E_{off} (2) E_{ts}	Turn-on switching losses Turn-off switching loss Total switching loss	V_{CC} = 390 V, I_C = 7 A R_G = 10 Ω, V_{GE} = 15 V,	-	95 115 210	125 150 275	µJ µJ µJ
Eon (1) E_{off} (2) E_{ts}	Turn-on switching losses Turn-off switching loss Total switching loss	V_{CC} = 390 V, I_C = 7 A R_G = 10 Ω, V_{GE} = 15 V, Tj = 125°C		140 215 355		µJ µJ µJ

1. Eon is the turn-on losses when a typical diode is used in the test circuit. If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs and diode are at the same temperature (25°C and 125°C).
2. Turn-off losses include also the tail of the collector current.

Table 9. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_f	Forward on-voltage	If = 3.5 A If = 3.5 A, Tj = 125 °C	-	1.3 1.1	1.9	V V
t_{rr} t_a Q_{rr} I_{rrm} S	Reverse recovery time Reverse recovery charge Reverse recovery current Softness factor of the diode	If = 7 A, V_R = 40 V, di/dt = 100 A/µs		37 22 40 2.1 0.68		ns ns nC A
t_{rr} t_a Q_{rr} I_{rrm} S	Reverse recovery time Reverse recovery charge Reverse recovery current Softness factor of the diode	If = 7 A, V_R = 40 V, T_j = 125 °C, di/dt = 100 A/µs		61 34 98 3.2 0.79		ns ns nC A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

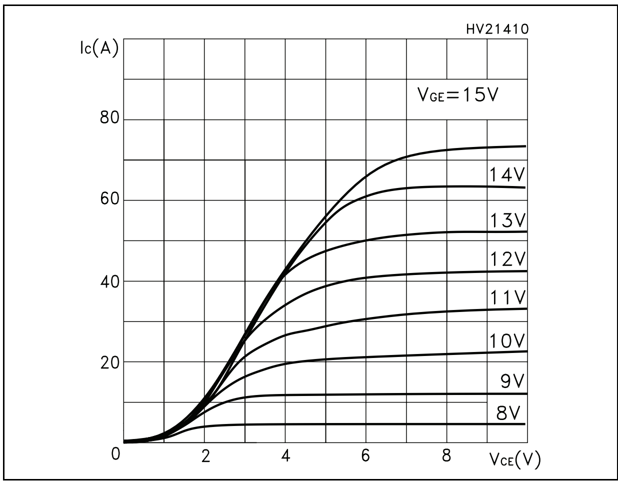


Figure 3. Transfer characteristics

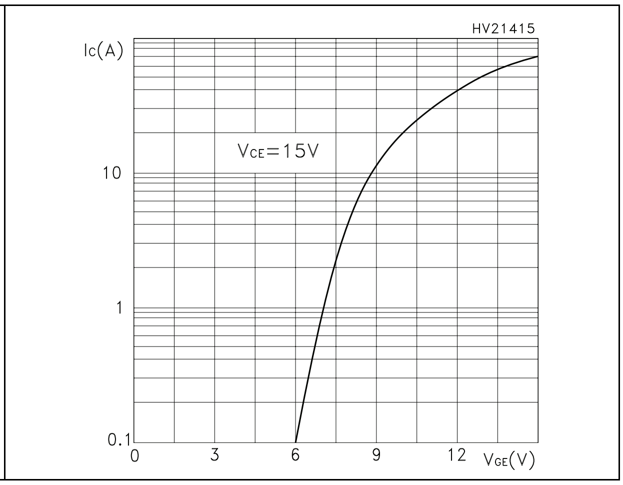


Figure 4. Transconductance

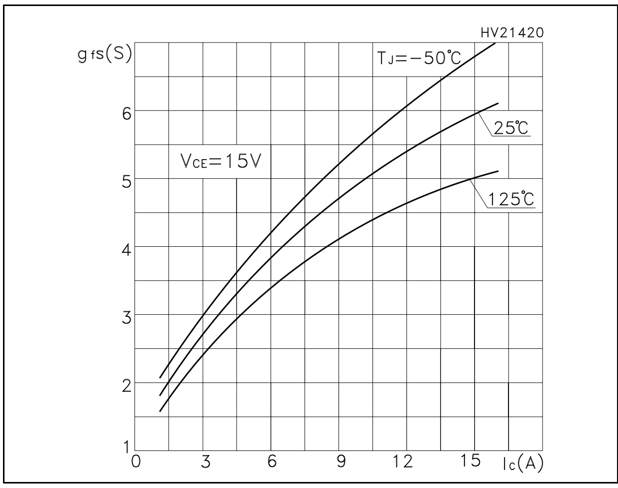


Figure 5. Collector-emitter on voltage vs. temperature

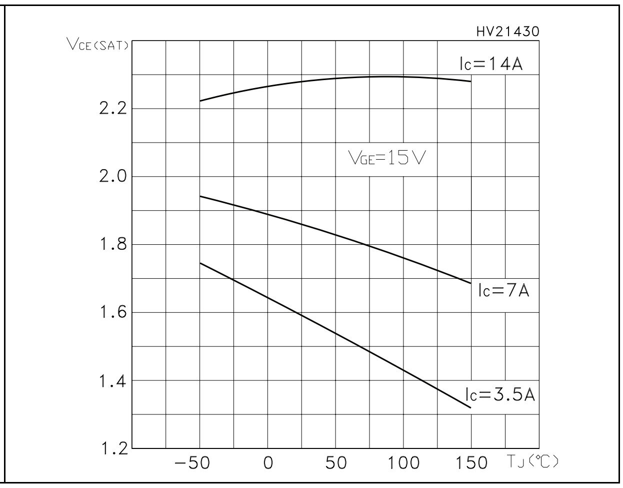


Figure 6. Collector-emitter on voltage vs. collector current

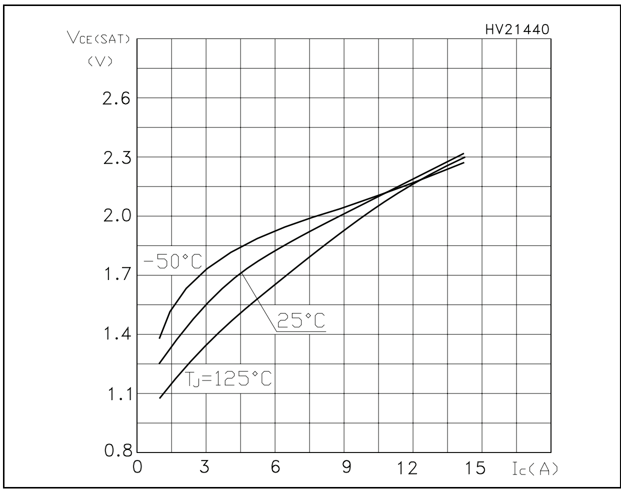


Figure 7. Normalized gate threshold vs. temperature

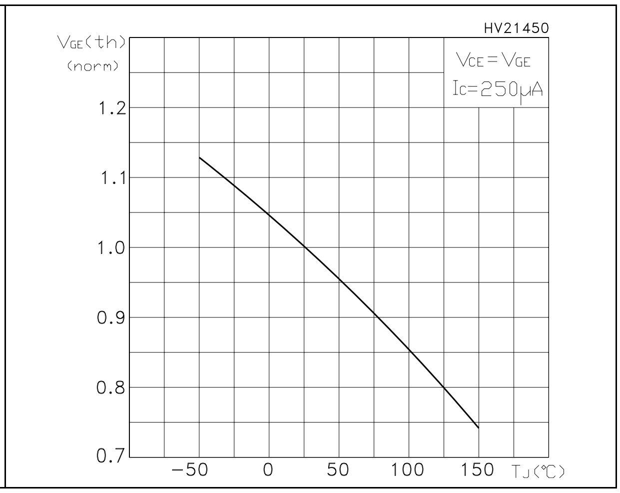


Figure 8. Normalized breakdown voltage vs temperature

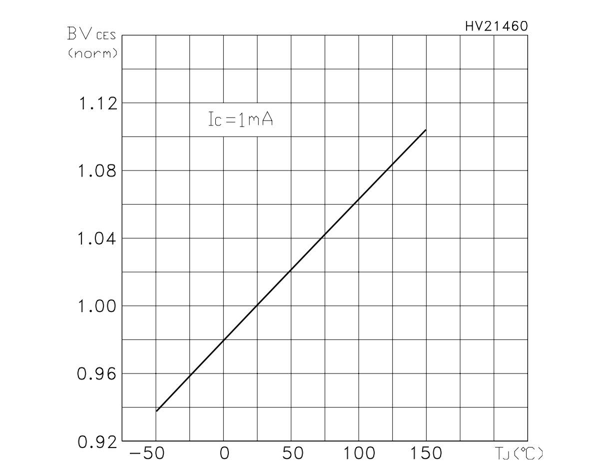


Figure 9. Gate charge vs. gate-emitter voltage

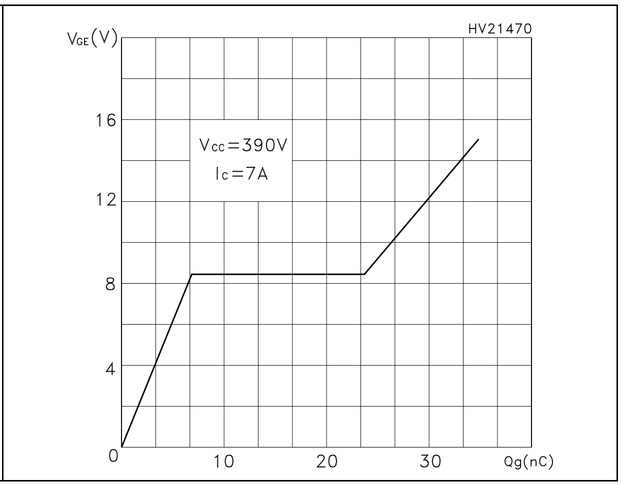


Figure 10. Capacitance variations

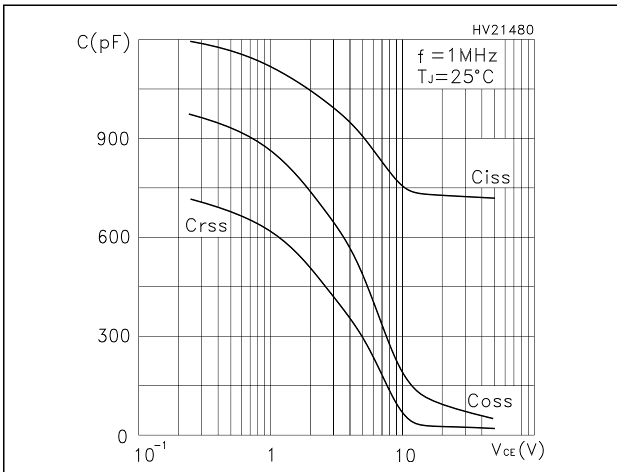


Figure 11. Total switching losses vs. temperature

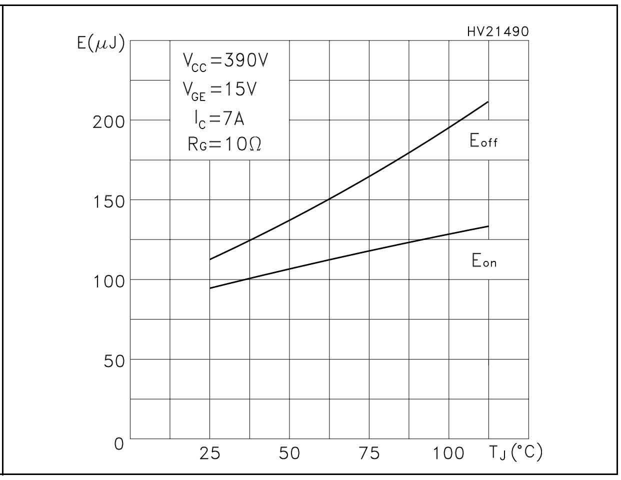


Figure 12. Total switching losses vs. gate resistance

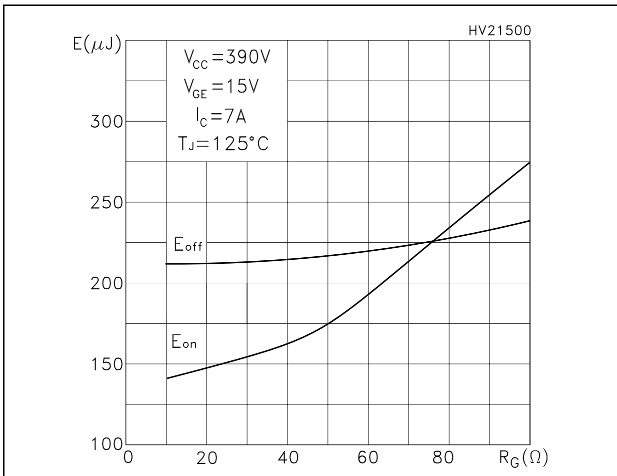


Figure 13. Total switching losses vs collector current

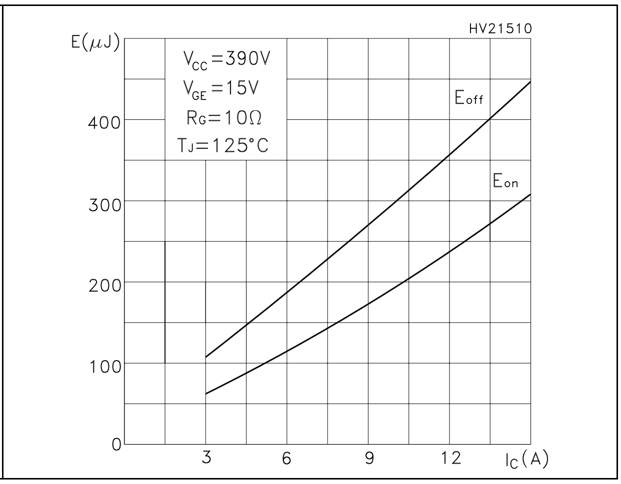


Figure 14. Emitter-collector diode characteristics

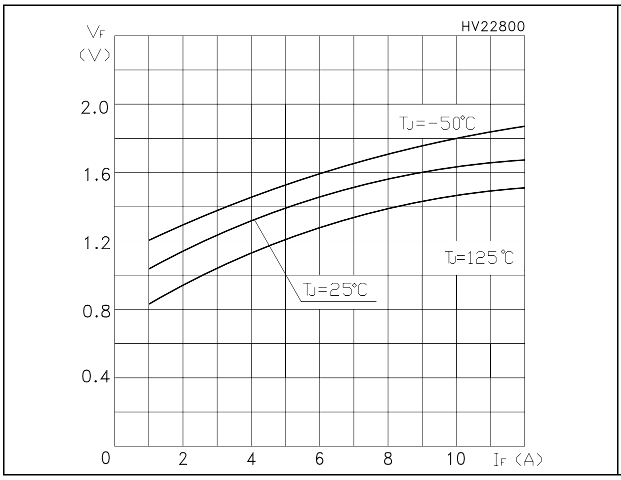


Figure 15. Turn-off SOA

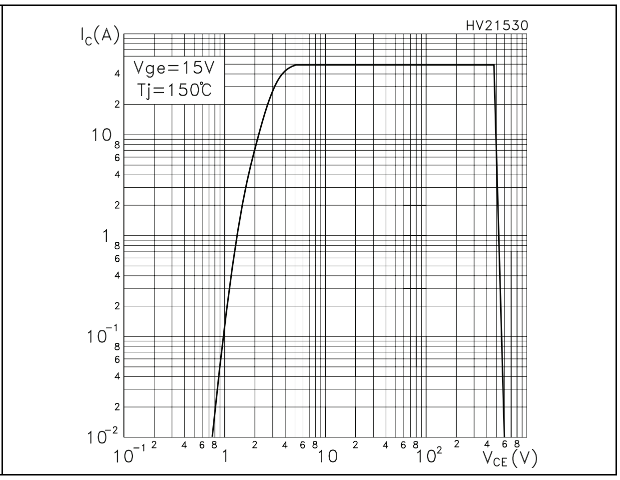


Figure 16. Thermal impedance for I^2PAK, D^2PAK and TO-220

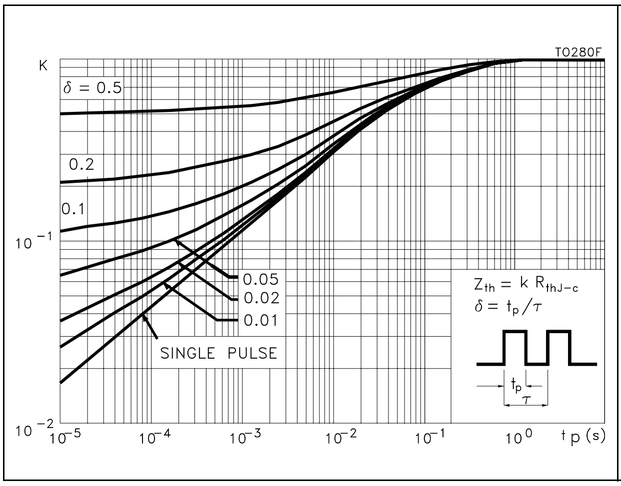
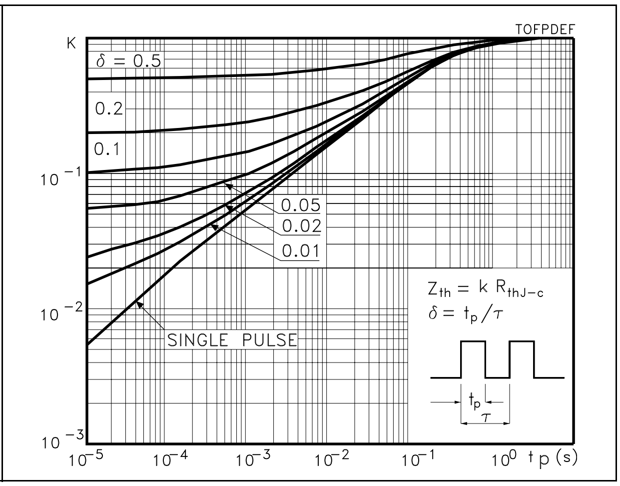
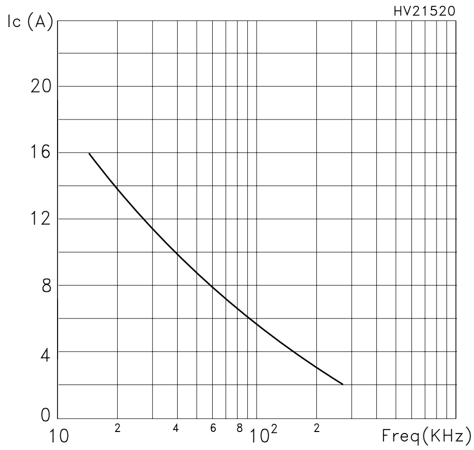


Figure 17. Thermal impedance for TO-220FP



2.2 Operating frequency

Figure 18. I_C vs. frequency



For a fast IGBT suitable for high frequency applications, the typical collector current vs. maximum operating frequency curve is reported. That frequency is defined as follows:

Equation 1

$$f_{MAX} = (P_D - P_C) / (E_{ON} + E_{OFF})$$

The maximum power dissipation is limited by maximum junction to case thermal resistance:

Equation 2

$$P_D = \Delta T / R_{THJ-C}$$

considering $\Delta T = T_J - T_C$ = 125 °C- 75 °C = 50°C

The conduction losses are:

Equation 3

$$P_C = I_C * V_{CE(SAT)} * \delta$$

with 50% of duty cycle, $V_{CE(sat)}$ typical value T_C = 125°C.

Power dissipation during ON & OFF commutations is due to the switching frequency:

Equation 4

$$P_{SW} = (E_{ON} + E_{OFF}) * freq.$$

Typical values T_C = 125°C for switching losses are used (test conditions: V_{CE} = 390 V, V_{GE} = 15 V, R_G = 3.3 Ω). Furthermore, diode recovery energy is included in the E_{ON}, while the tail of the collector current is included in the E_{OFF} measurements.

3 Test circuits

Figure 19. Test circuit for inductive load switching

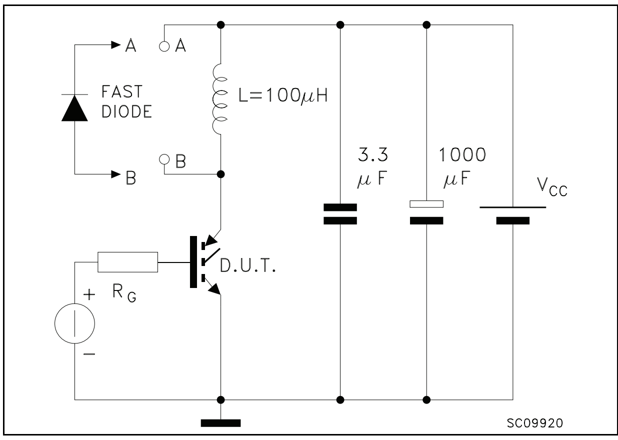


Figure 20. Gate charge test circuit

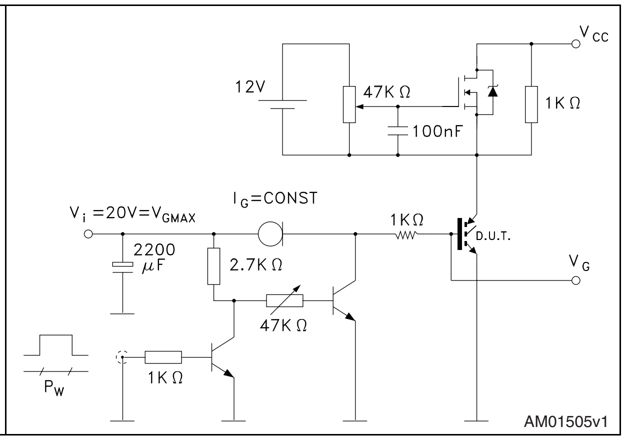


Figure 21. Switching waveform

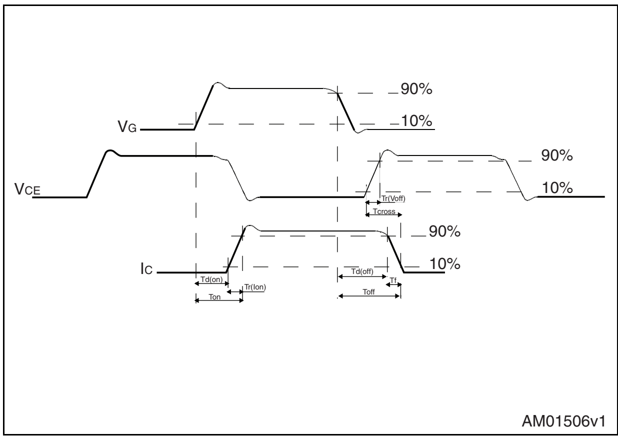
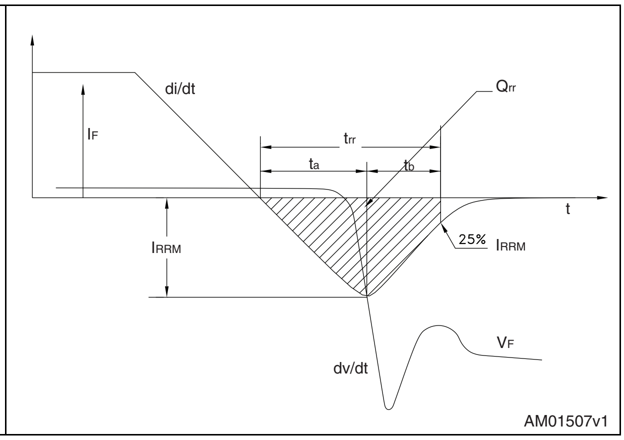


Figure 22. Diode recovery time waveform



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.

Table 10. I²PAK (TO-262) mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.40		4.60
A1	2.40		2.72
b	0.61		0.88
b1	1.14		1.70
c	0.49		0.70
c2	1.23		1.32
D	8.95		9.35
e	2.40		2.70
e1	4.95		5.15
E	10		10.40
L	13		14
L1	3.50		3.93
L2	1.27		1.40

Figure 23. I²PAK (TO-262) drawing

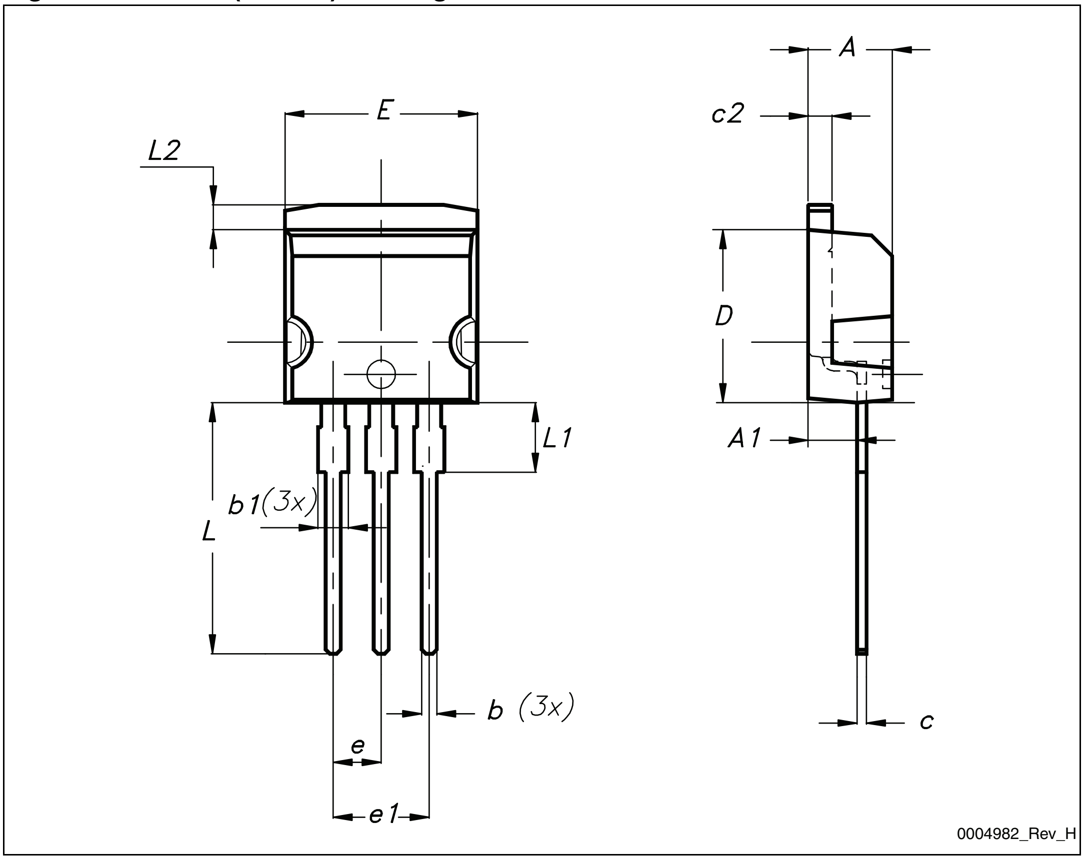


Table 11. D²PAK (TO-263) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
A1	0.03		0.23
b	0.70		0.93
b2	1.14		1.70
c	0.45		0.60
c2	1.23		1.36
D	8.95		9.35
D1	7.50		
E	10		10.40
E1	8.50		
e		2.54	
e1	4.88		5.28
H	15		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.4	
V2	0°		8°

Figure 24. D²PAK (TO-263) drawing

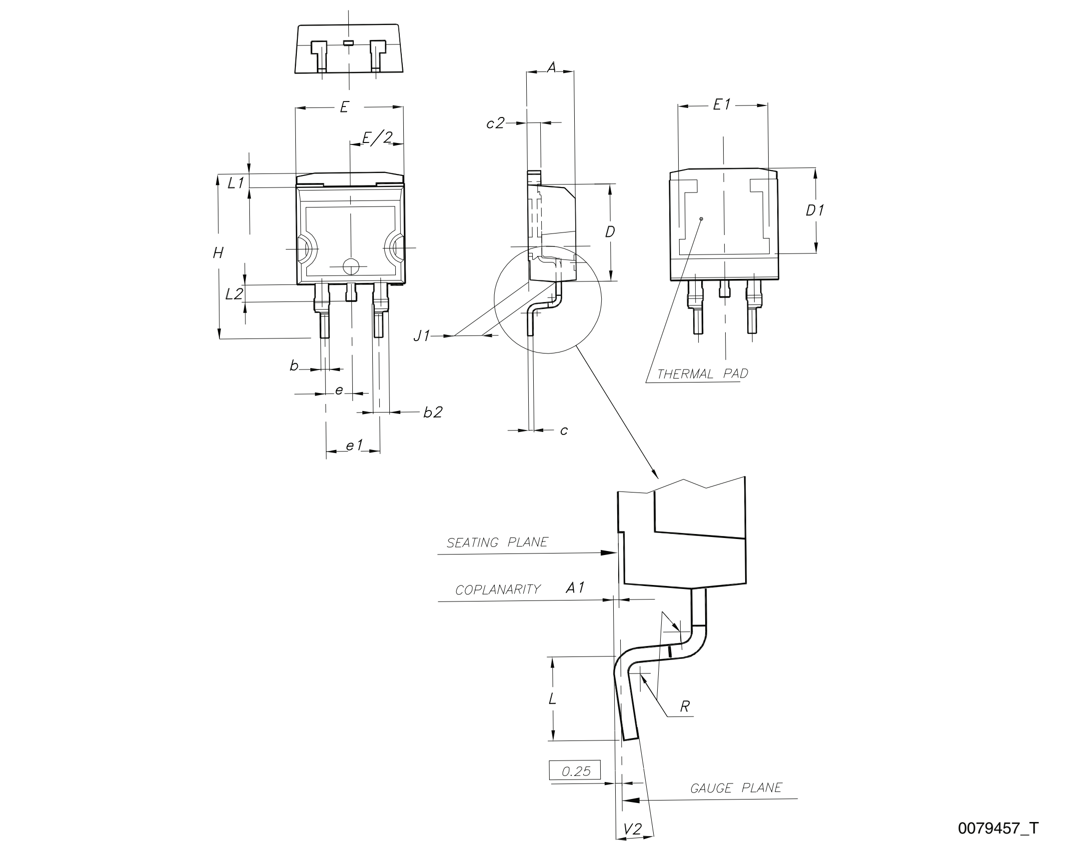
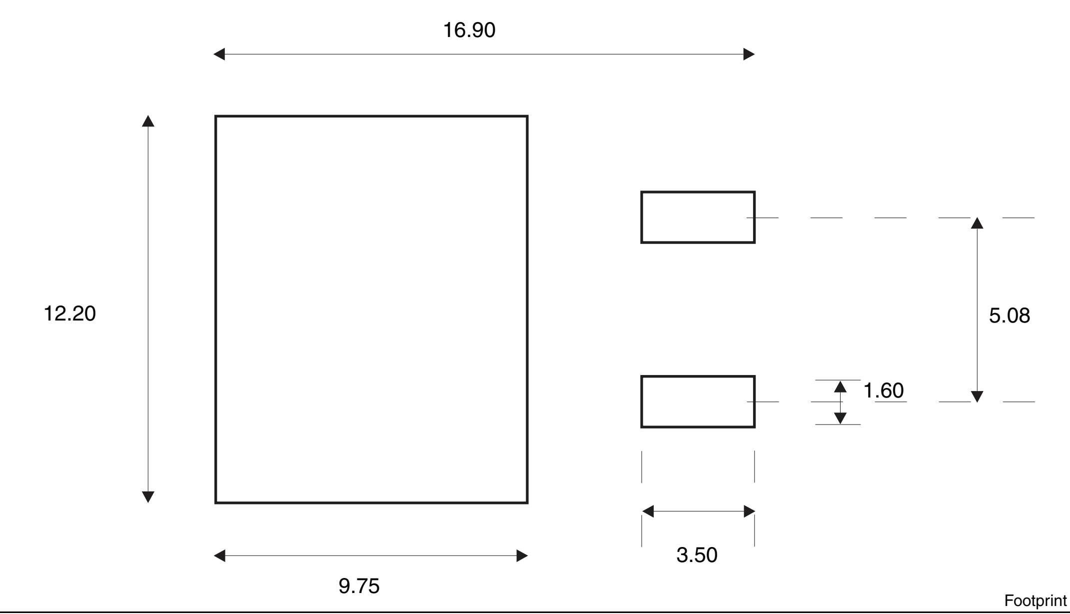


Figure 25. D²PAK footprint[(a)]



a. All dimensions are in millimeters

Table 12. 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 26. TO-220FP drawing

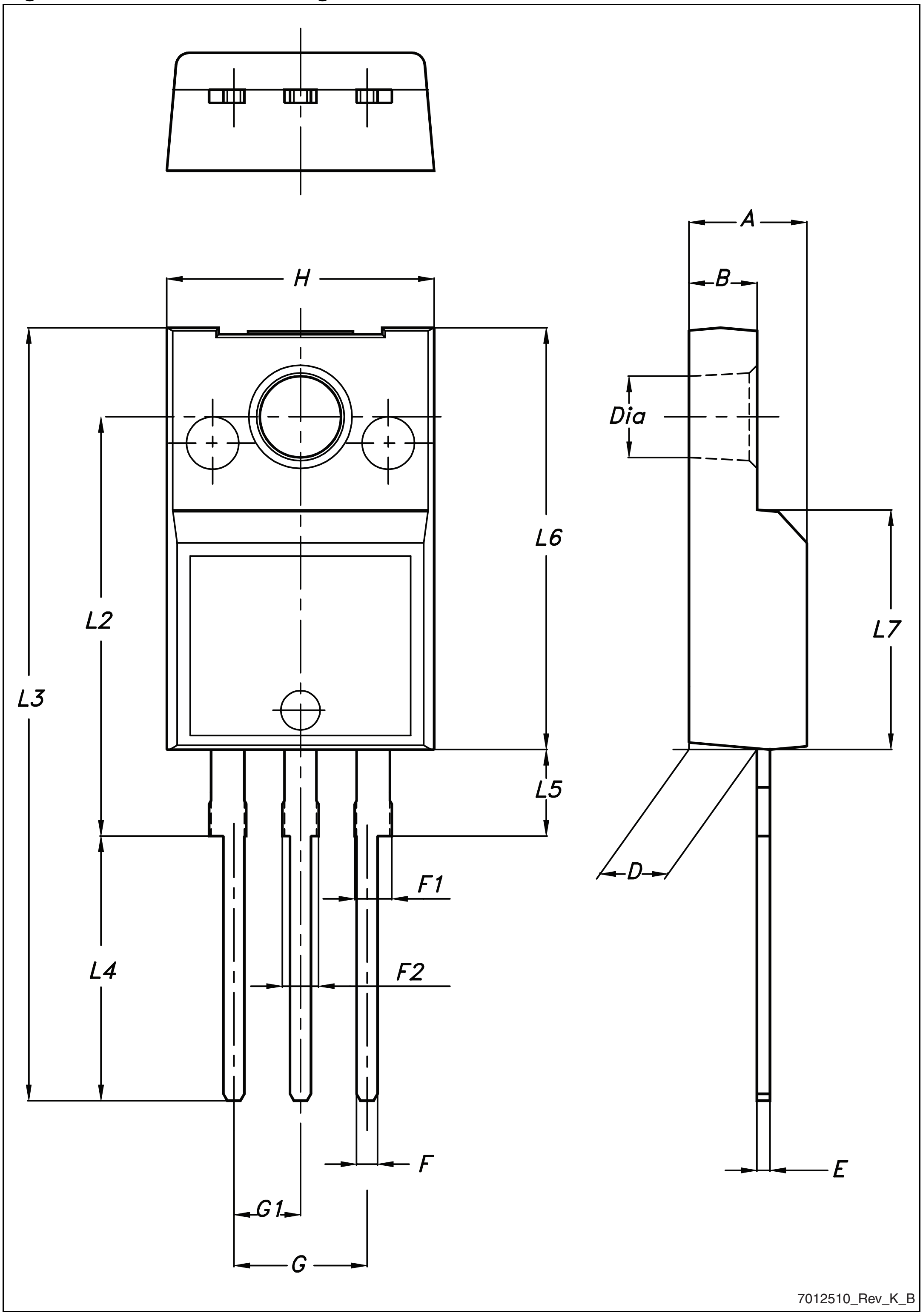
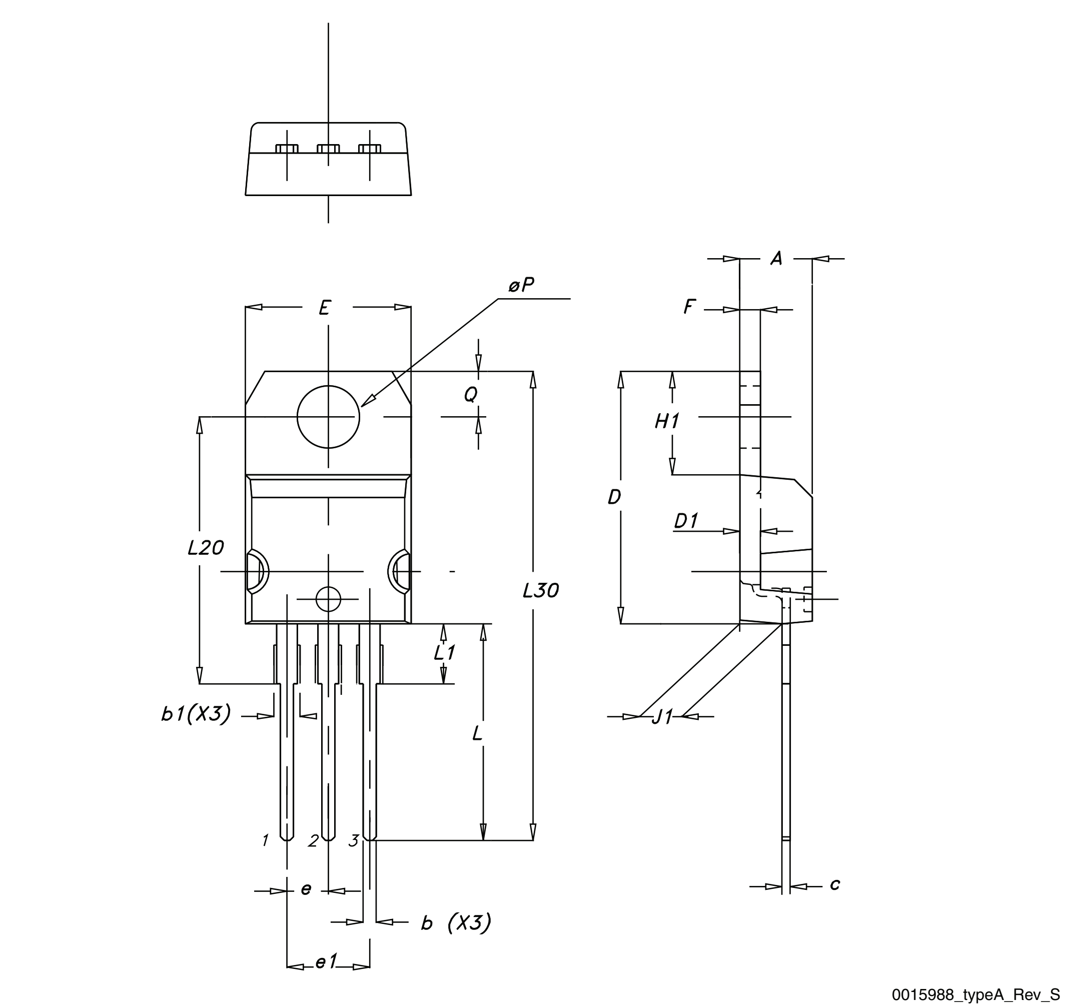


Table 13. TO-220 type A mechanical data

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

Figure 27. TO-220 type A drawing



5 Packaging mechanical data

Table 14. D^2PAK (TO-263) tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base qty		1000
P2	1.9	2.1	Bulk qty		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Figure 28. Tape

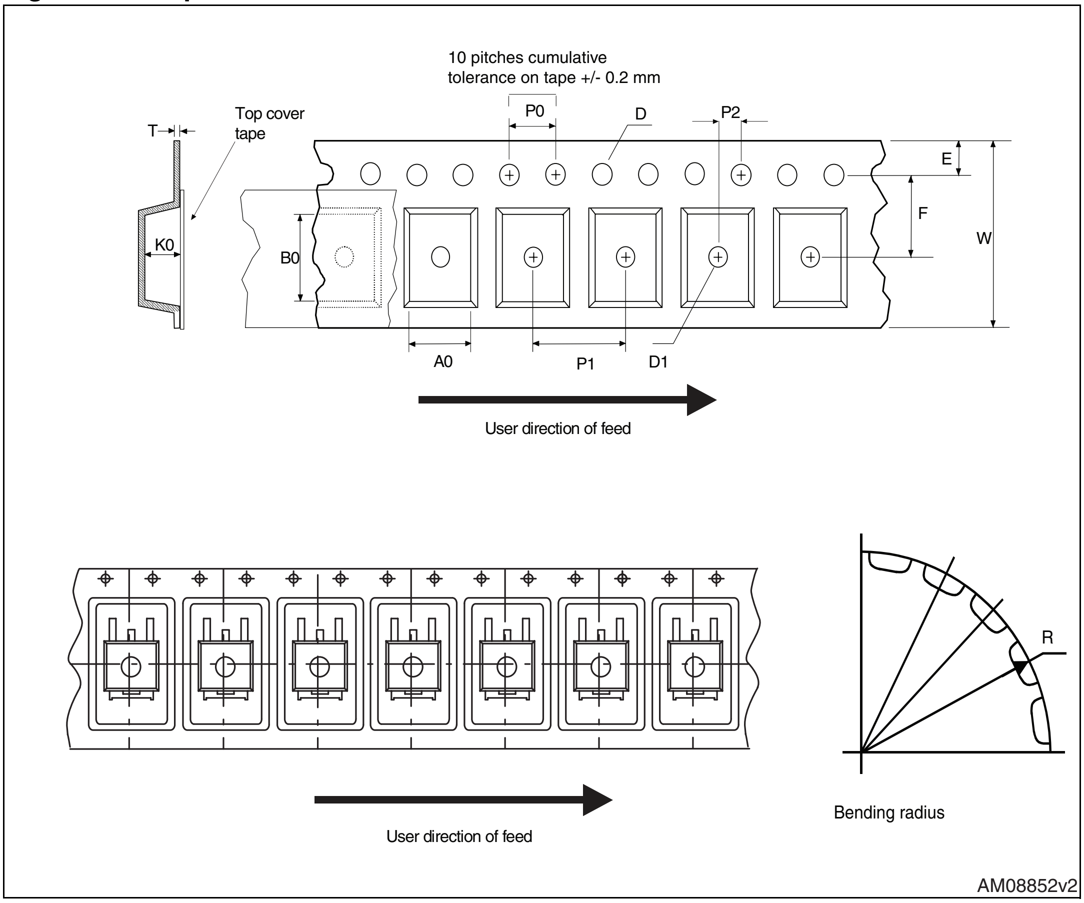
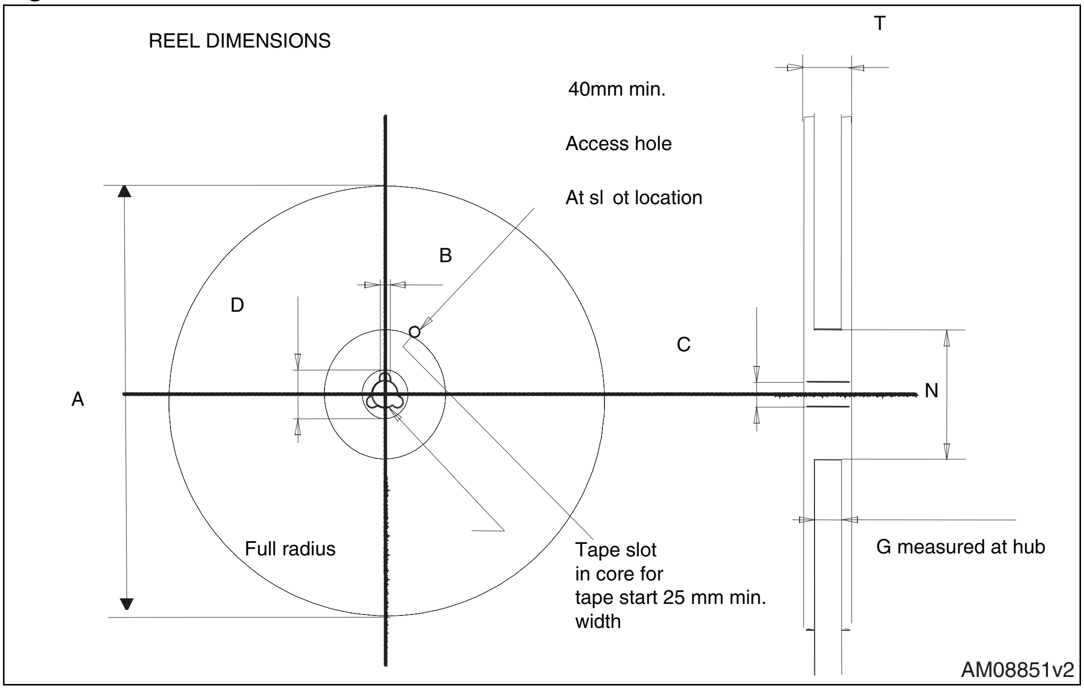


Figure 29. Reel



6 Revision history

Table 15. Document revision history

Date	Revision	Changes
07-Jun-2004	4	Stylesheet update. No content change.
19-Aug-2004	5	Complete version
17-Sep-2004	6	*Figure 14* has been added
09-Nov-2004	7	Final datasheet
19-Jan-2005	8	Datasheet updated
09-Jun-2005	9	Modified title
27-Jun-2012	10	Inserted commercial type STGB7NC60HD. Minor text changes.

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