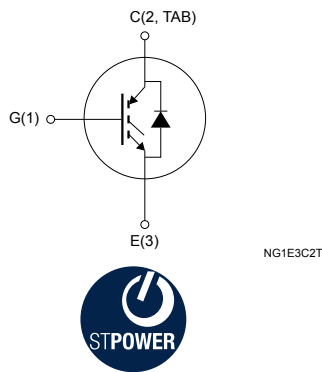
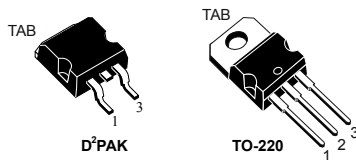


600 V, 14 A very fast IGBT



Features

- Low on voltage drop ($V_{CE(sat)}$)
- Low C_{res} / C_{ies} ratio (no cross-conduction susceptibility)
- Very soft ultra-fast recovery antiparallel diode

Applications

- High frequency motor controls
- SMPS and PFC in both hard switch and resonant topologies
- Motor drives

Description

These devices are very fast IGBTs developed using advanced PowerMESH technology. This process guarantees an excellent trade-off between switching performance and low on-state behavior.

Product status links

[STGB7NC60HDT4](#)

[STGP7NC60HD](#)

Product summary

Order code	STGB7NC60HDT4
Marking	GB7NC60HD
Package	D²PAK
Packing	Tape and reel
Order code	STGP7NC60HD
Marking	GP7NC60HD
Package	TO-220
Packing	Tube

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage ($V_{GE} = 0\text{ V}$)	600	V
V_{ECR}	Emitter-collector voltage	20	V
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	25	A
	Continuous collector current at $T_C = 100\text{ °C}$	14	
$I_{CP}^{(2)}$	Pulsed collector current	50	A
V_{GE}	Gate-emitter voltage	± 20	V
I_F	Diode RMS forward current at $T_C = 25\text{ °C}$	20	A
P_{TOT}	Total power dissipation at $T_C = 25\text{ °C}$	80	W
T_{stg}	Storage temperature range	-55 to 150	°C
T_J	Operating junction temperature range		°C

1. Calculated according to the iterative formula: $I_C(T_C) = \frac{T_{J(max)} - T_C}{R_{thJC} \times V_{CE(sat)(max)}(T_{J(max)}, I_C(T_C))}$
2. Pulse width limited by maximum junction temperature.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case	1.56	°C/W
R_{thJA}	Thermal resistance, junction-to-ambient	62.5	°C/W

2 Electrical characteristics

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

Table 3. Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}$, $I_C = 1\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$, $I_C = 7\text{ A}$		1.85	2.5	V
		$V_{GE} = 15\text{ V}$, $I_C = 7\text{ A}$, $T_J = 150\text{ °C}$		7		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$, $I_C = 250\text{ }\mu\text{A}$	3.75		5.75	V
I_{CES}	Collector cut-off current	$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$			10	mA
		$V_{GE} = 0\text{ V}$, $V_{CE} = 600\text{ V}$, $T_J = 125\text{ °C}$ ⁽¹⁾			1	
I_{GES}	Gate-emitter leakage current	$V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$			± 100	nA

1. Specified by design, not tested in production.

Table 4. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
g_{fs}	Forward transconductance	$V_{CE} = 15\text{ V}$, $I_C = 7\text{ A}$		4.30		S
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$		720		pF
C_{oes}	Output capacitance			81		pF
C_{res}	Reverse transfer capacitance			17		pF
Q_g	Total gate charge	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$, $V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 19. Gate charge test circuit)		35	48 ⁽¹⁾	nC
Q_{ge}	Gate-emitter charge			7		nC
Q_{gc}	Gate-collector charge			16		nC
I_{CL}	Turn-off SOA minimum current	$V_{clamp} = 480\text{ V}$, $T_J = 150\text{ °C}$, $R_G = 10\text{ }\Omega$, $V_{GE} = 15\text{ V}$	50			A

1. Specified by design, not tested in production.

Table 5. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform)	-	18.5	-	ns
t_r	Current rise time		-	8.5	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1060	-	A/ μ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$ (see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform)	-	18.5	-	ns
t_r	Current rise time		-	7	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1000	-	A/ μ s
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform)	-	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	$V_{CC} = 390\text{ V}$, $I_C = 7\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$ (see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform)	-	56	-	ns
$t_{d(off)}$	Turn-off delay time		-	116	-	ns
t_f	Current fall time		-	105	-	ns

Table 6. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CE} = 390\text{ V}$, $I_C = 7\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 17. Test circuit for inductive load switching)	-	95	125 ⁽²⁾	mJ
$E_{off}^{(3)}$	Turn-off switching energy		-	115	150 ⁽²⁾	mJ
E_{ts}	Total switching energy		-	210	275 ⁽²⁾	mJ
$E_{on}^{(1)}$	Turn-on switching energy	$V_{CE} = 390\text{ V}$, $I_C = 7\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ }^\circ\text{C}$ (see Figure 17. Test circuit for inductive load switching)	-	140		mJ
$E_{off}^{(3)}$	Turn-off switching energy		-	215		mJ
E_{ts}	Total switching energy		-	355		mJ

1. Including the reverse recovery of the diode.
2. Specified by design, not tested in production.
3. Including the tail of the collector current.

Table 7. Diode switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on-voltage	$I_F = 3.5\text{ A}$	-	1.3	1.9	V
		$I_F = 3.5\text{ A}, T_J = 125\text{ °C}$	-	1.1		
t_{rr}	Reverse recovery time	$I_F = 7\text{ A}, V_R = 40\text{ V}, di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 18. Diode reverse recovery waveform)	-	37		ns
Q_{rr}	Reverse recovery charge		-	40		nC
I_{rrm}	Reverse recovery current		-	2.1		A
t_{rr}	Reverse recovery time	$I_F = 5\text{ A}, V_R = 40\text{ V}, di/dt = 100\text{ A}/\mu\text{s}, T_J = 125\text{ °C}$ (see Figure 18. Diode reverse recovery waveform)	-	61		ns
Q_{rr}	Reverse recovery charge		-	98		nC
I_{rr}	Reverse recovery current		-	3.2		A

2.1 Electrical characteristics (curves)

Figure 1. Typical output characteristics

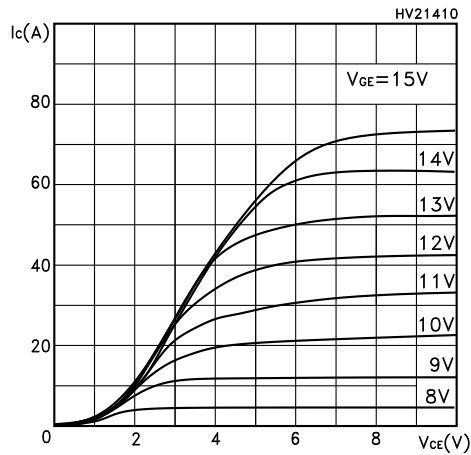


Figure 2. Typical transfer characteristics

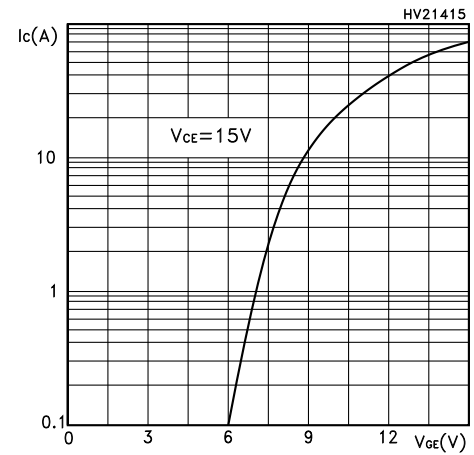


Figure 3. Typical transconductance characteristics

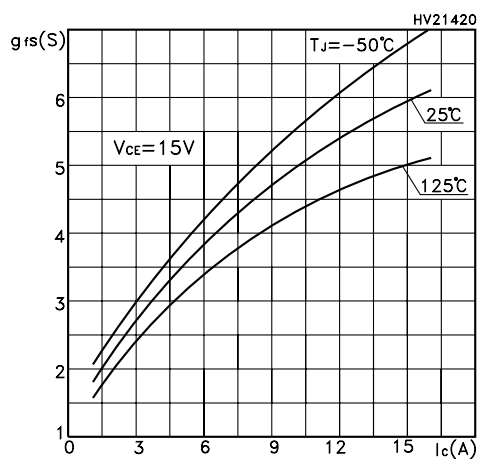


Figure 4. Typical collector-emitter on voltage vs temperature

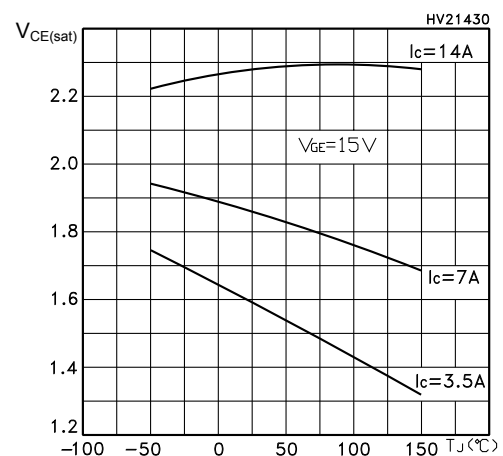


Figure 5. Typical gate charge characteristics

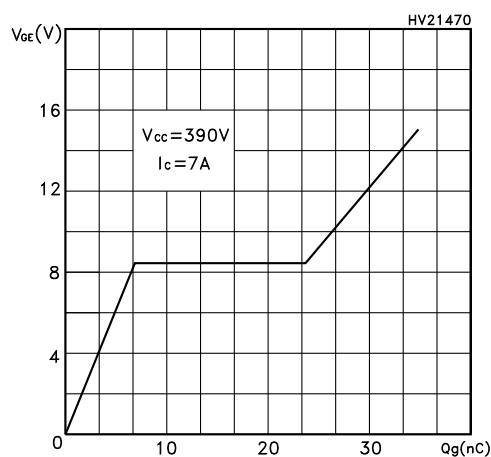


Figure 6. Typical capacitance characteristics

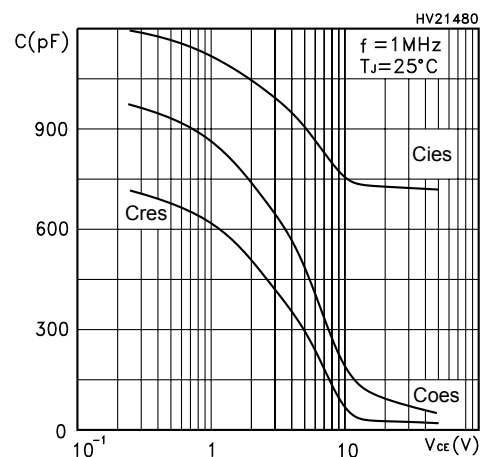


Figure 7. Normalized gate threshold vs temperature

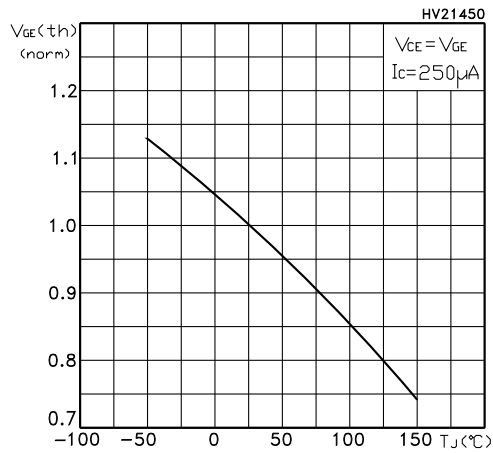


Figure 8. Typical collector-emitter on voltage vs collector current

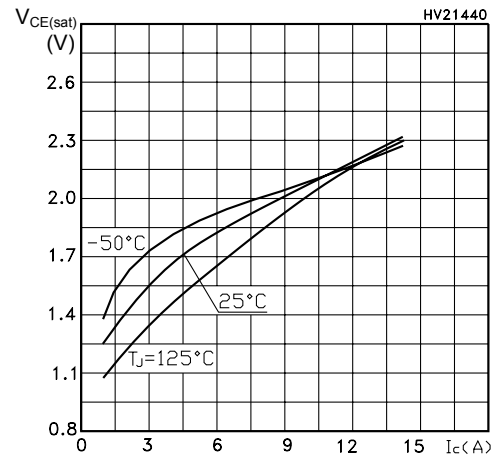


Figure 9. Typical emitter-collector diode characteristics

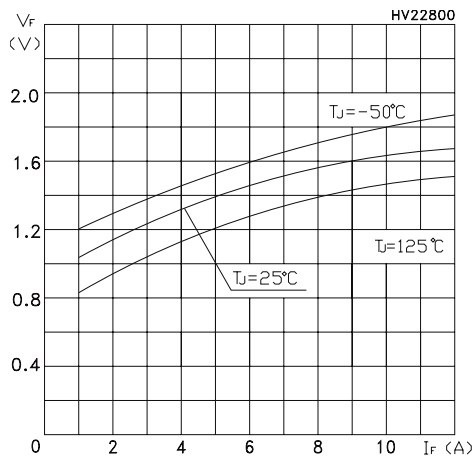


Figure 10. Normalized breakdown voltage vs temperature

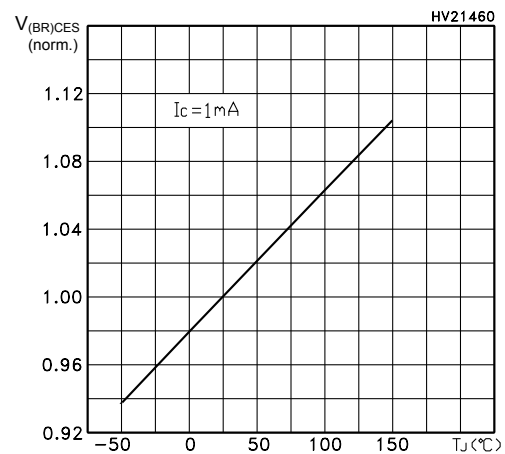


Figure 11. Typical switching energy vs temperature

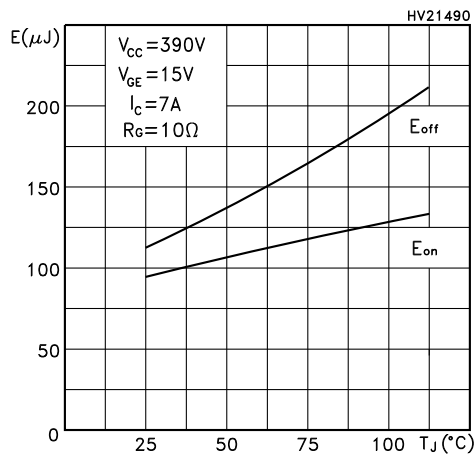


Figure 12. Typical switching energy vs gate resistance

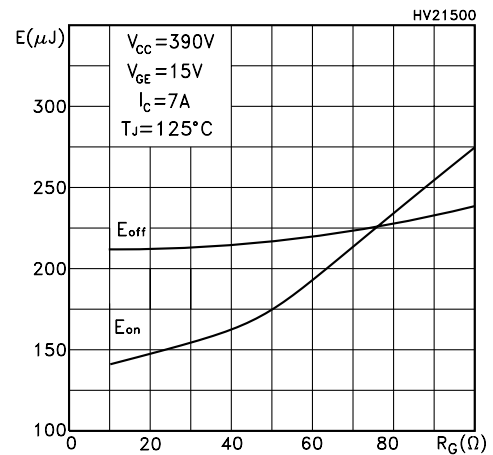


Figure 13. Typical switching energy vs collector current

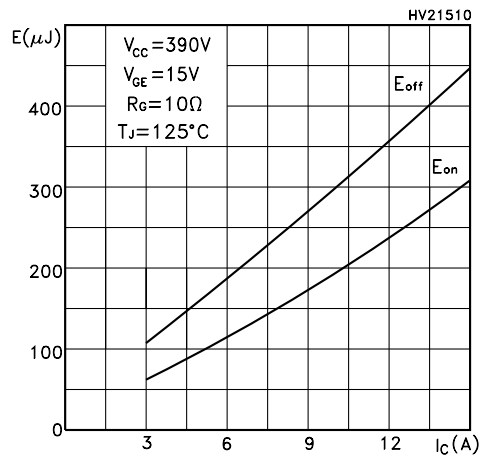


Figure 14. Normalized transient thermal impedance

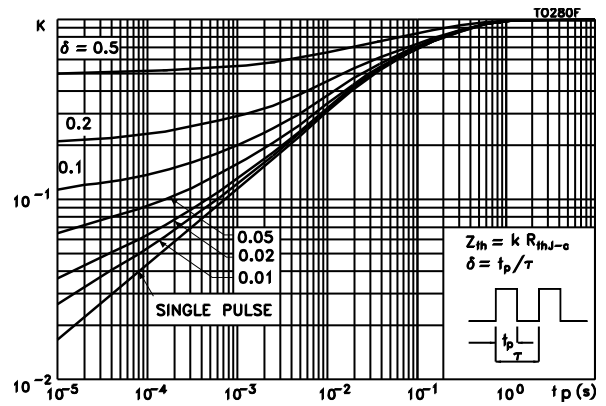
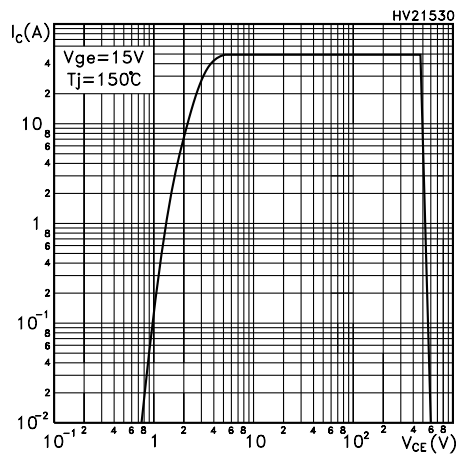
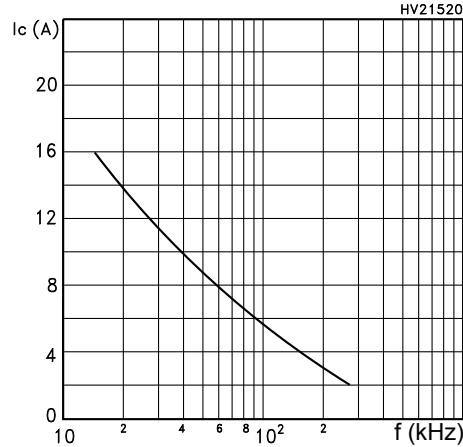


Figure 15. Safe operating area



3 Operating frequency

Figure 16. 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:

$$f_{MAX} = \frac{P_D - P_C}{E_{on} + E_{off}}$$

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

$$P_D = \frac{\Delta T}{R_{thJC}}$$

considering $\Delta T = T_J - T_C = 125^\circ\text{C} - 75^\circ\text{C} = 50^\circ\text{C}$

The conduction losses are:

$$P_C = I_C \cdot V_{CE(sat)} \cdot \delta$$

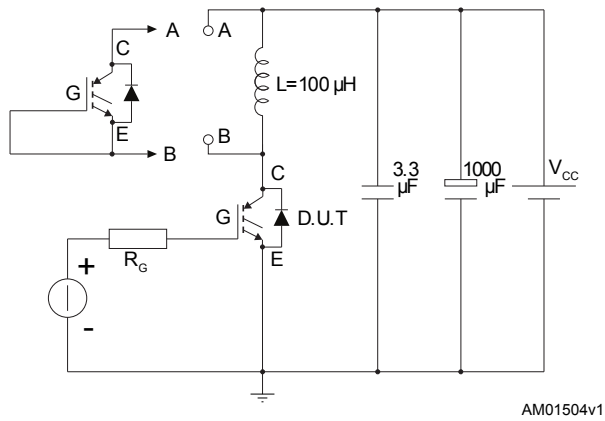
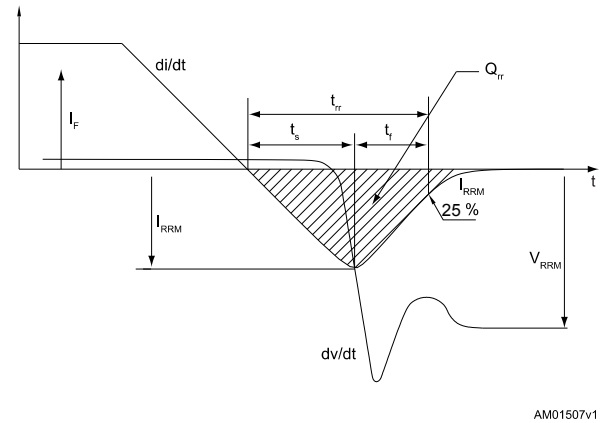
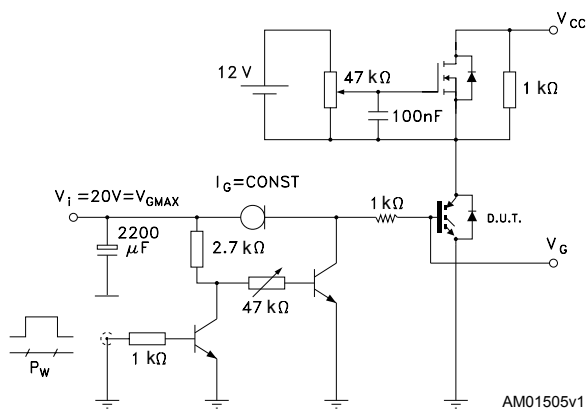
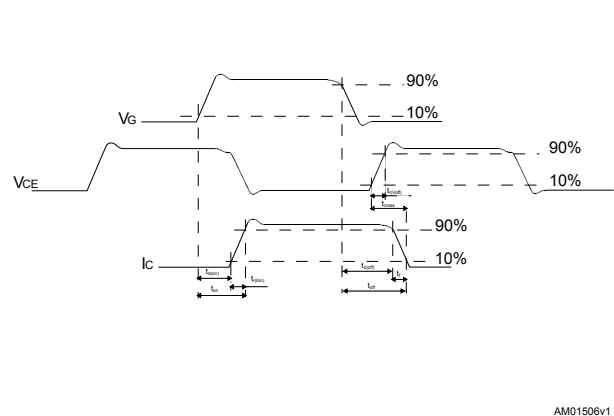
with 50% of duty cycle, $V_{CE(sat)}$ typical value $T_C = 125^\circ\text{C}$.

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

$$P_{SW} = (E_{on} + E_{off}) \cdot f$$

Typical values $T_C = 125^\circ\text{C}$ for switching losses are used (test conditions: $V_{CE} = 390\text{ V}$, $V_{GE} = 15\text{ V}$, $R_G = 3.3\ \Omega$). Furthermore, diode recovery energy is included in the E_{on} , while the tail of the collector current is included in the E_{off} measurements.

4 Test circuits

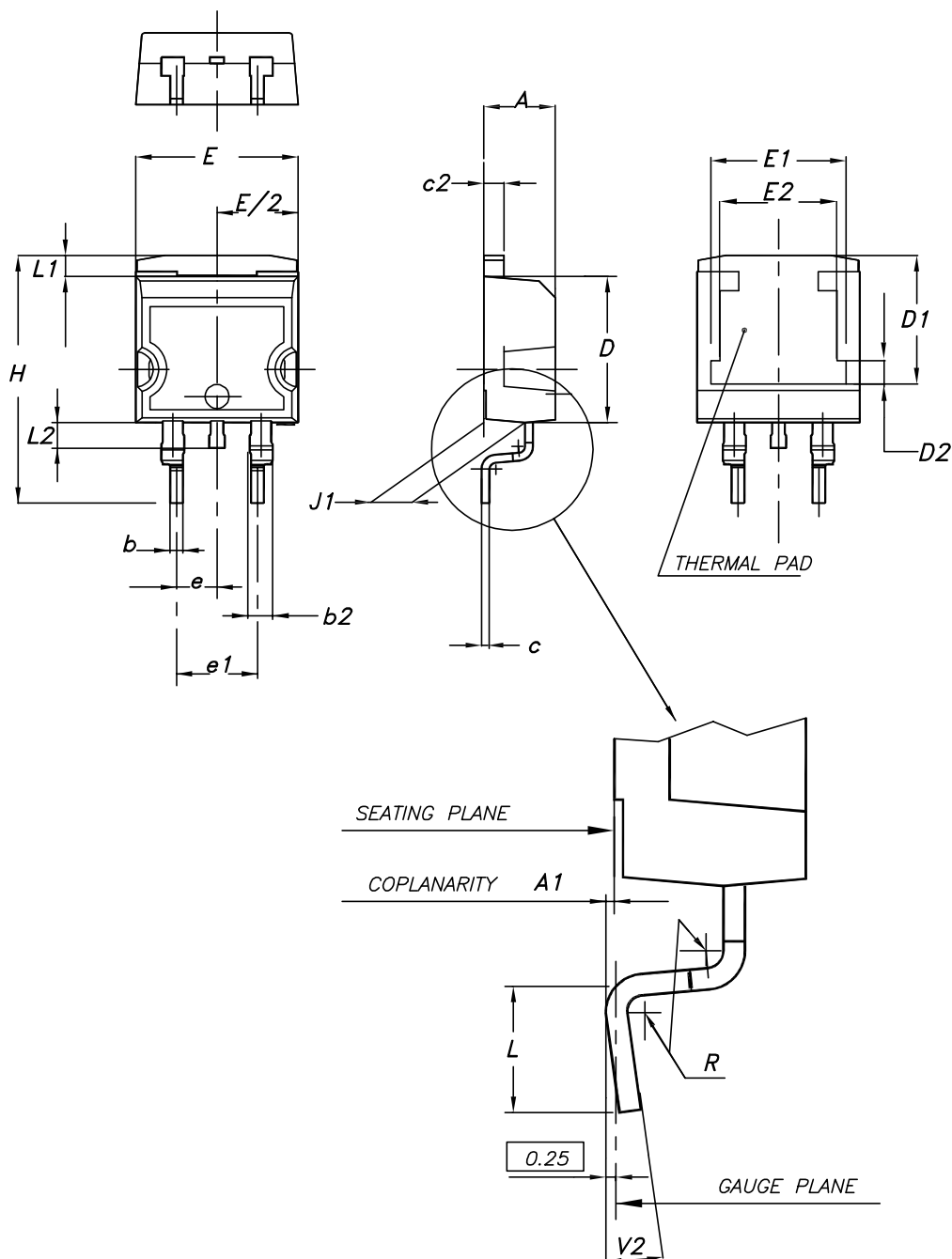
Figure 17. Test circuit for inductive load switching

Figure 18. Diode reverse recovery waveform

Figure 19. Gate charge test circuit

Figure 20. Switching waveform


5 Package information

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.

5.1 D²PAK (TO-263) type A package information

Figure 21. D²PAK (TO-263) type A package outline

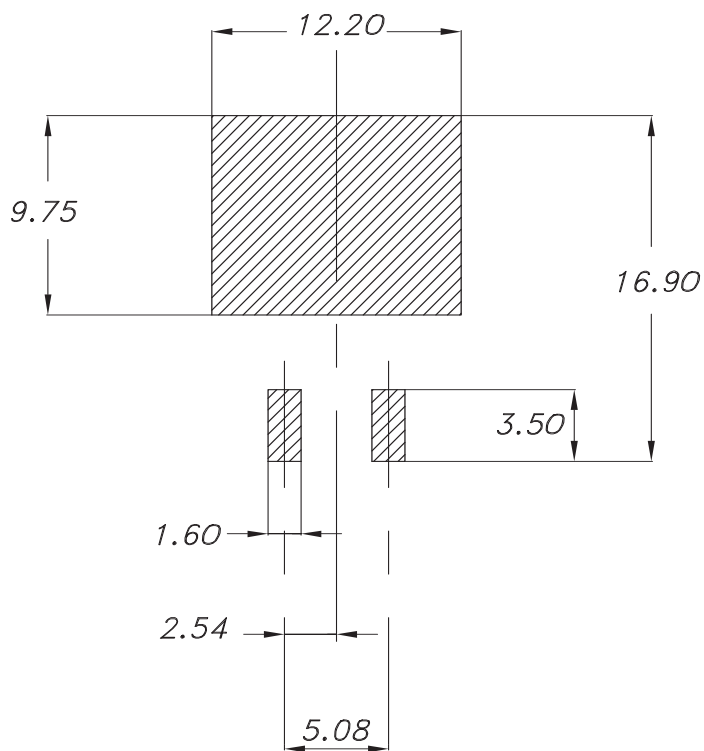


0079457_27

Table 8. D²PAK (TO-263) type A package 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	7.75	8.00
D2	1.10	1.30	1.50
E	10.00		10.40
E1	8.30	8.50	8.70
E2	6.85	7.05	7.25
e		2.54	
e1	4.88		5.28
H	15.00		15.85
J1	2.49		2.69
L	2.29		2.79
L1	1.27		1.40
L2	1.30		1.75
R		0.40	
V2	0°		8°

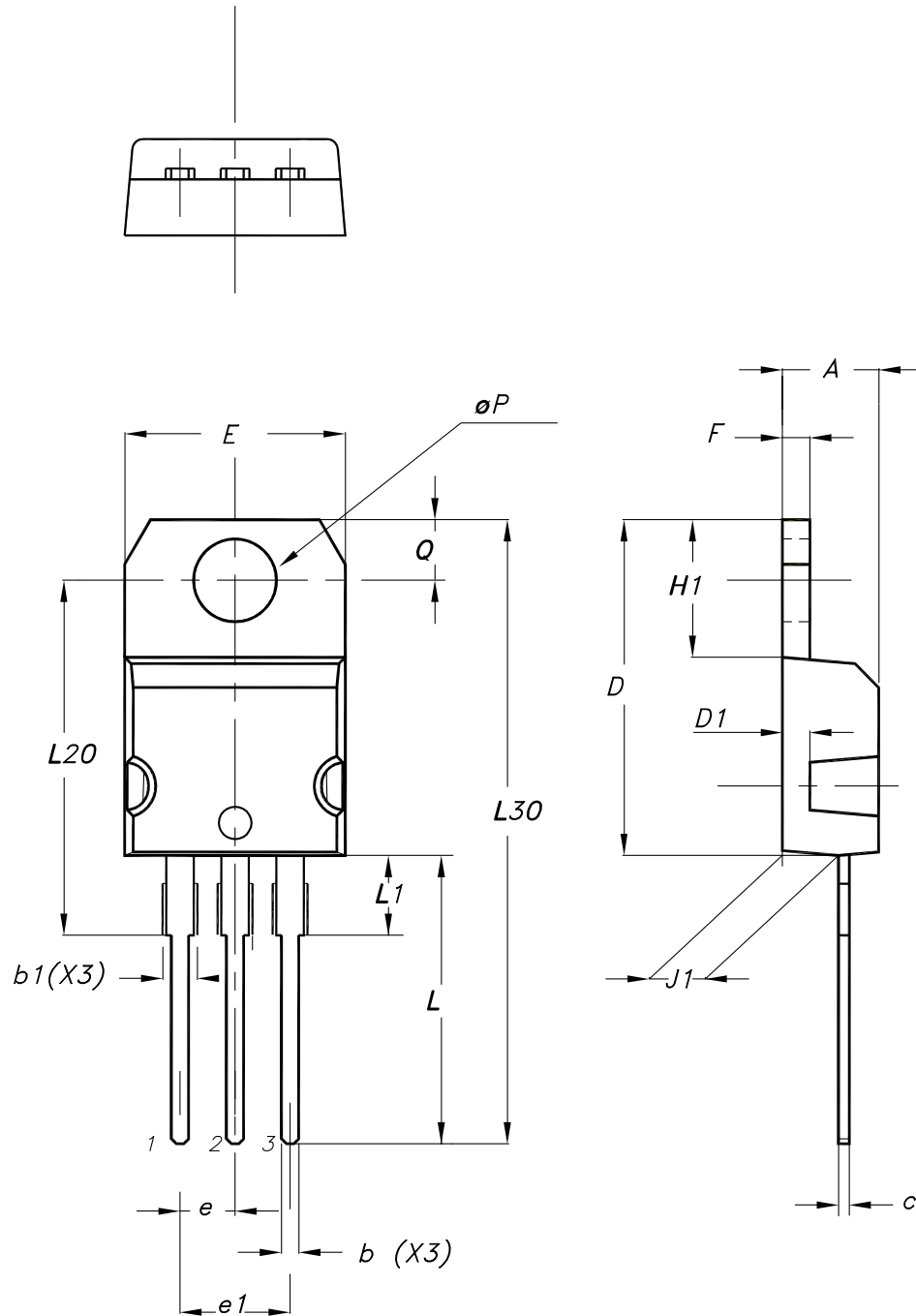
Figure 22. D²PAK (TO-263) recommended footprint (dimensions are in mm)



0079457_Rev27_footprint

5.2 TO-220 type A package information

Figure 23. TO-220 type A package outline



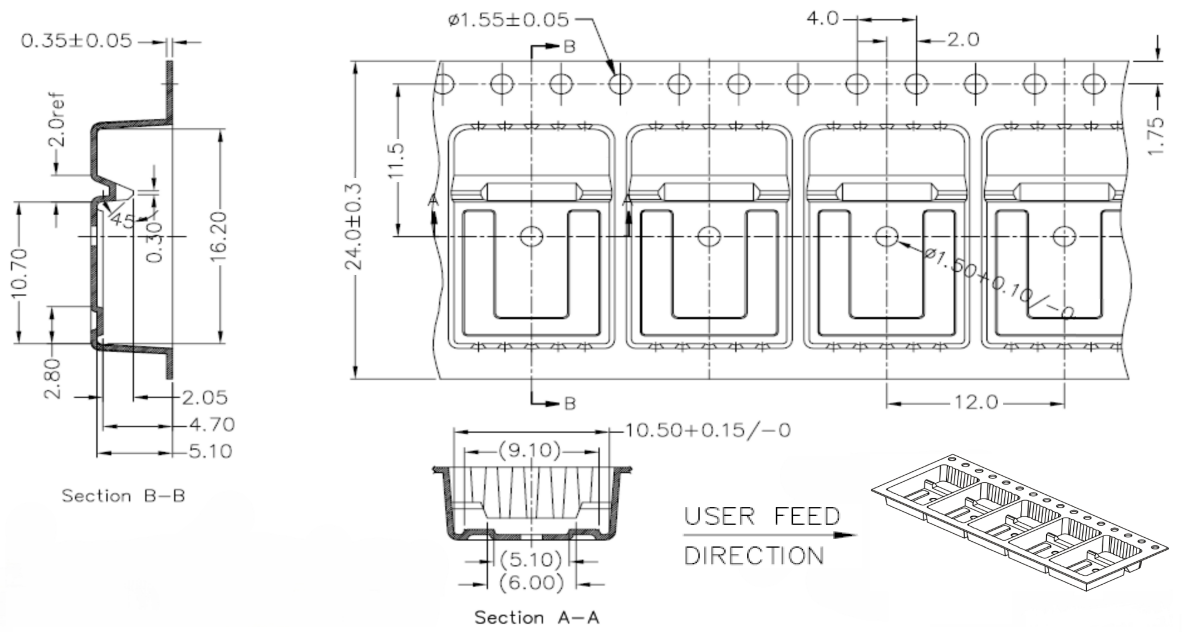
0015988_typeA_Rev_24

Table 9. TO-220 type A package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
b	0.61		0.88
b1	1.14		1.55
c	0.48		0.70
D	15.25		15.75
D1		1.27	
E	10.00		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	13.00		14.00
L1	3.50		3.93
L20		16.40	
L30		28.90	
øP	3.75		3.85
Q	2.65		2.95
Slug flatness		0.03	0.10

5.3 D²PAK packing information

Figure 24. D²PAK tape drawing (dimensions are in mm)



DM01095771_1

Revision history

Table 10. 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	<i>Figure 14</i> 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.
02-May-2025	11	The part number STGF7NC60HD has been removed and the document has been updated accordingly. Updated Section 5: Package information . Minor text changes.

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