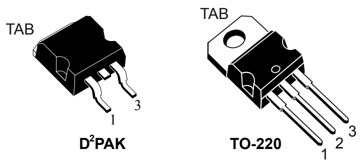
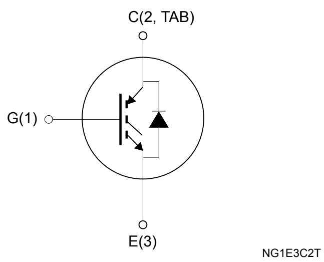
STGB7NC60HDT4, STGP7NC60HD

Datasheet

600 V, 14 A very fast IGBT





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

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.

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0 V)	600	V
V_{ECR}	Emitter-collector voltage	20	V
I_C(1)	Continuous collector current at T_C = 25 °C	25	A
	Continuous collector current at T_C = 100 °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 °C	20	A
P_{TOT}	Total power dissipation at T_C = 25 °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:* $I_C(T_C) = \dfrac{T_{J(\max)} - T_C}{R_{thJC} \times V_{CE(sat)(\max)}\left(T_{J(\max)}, I_C(T_C)\right)}$
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 °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 V, I_C = 1 mA	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 7 A		1.85	2.5	V
		V_{GE} = 15 V, I_C = 7 A, T_J = 150 °C		7		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 250 µA	3.75		5.75	V
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 600 V			10	mA
		V_{GE} = 0 V, V_{CE} = 600 V, T_J = 125 °C (1)			1	
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = ±20 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 V, I_C = 7 A		4.30		S
C_{ies}	Input capacitance	V_{CE} = 25 V, f = 1 MHz, V_{GE} = 0 V		720		pF
C_{oes}	Output capacitance			81		pF
C_{res}	Reverse transfer capacitance			17		pF
Q_g	Total gate charge	V_{CC} = 390 V, I_C = 7 A, V_{GE} = 0 to 15 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 V, T_J = 150 °C, R_G = 10 Ω, V_{GE} = 15 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 V, I_C = 7 A,	-	18.5	-	ns
t_r	Current rise time	R_G = 10 Ω, V_{GE} = 15 V	-	8.5	-	ns
$(di/dt)_{on}$	Turn-on current slope	(see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform)	-	1060	-	A/µs
$t_{d(on)}$	Turn-on delay time	V_{CC} = 390 V, I_C = 7 A,	-	18.5	-	ns
t_r	Current rise time	R_G = 10 Ω, V_{GE} = 15 V, T_J = 125 °C	-	7	-	ns
$(di/dt)_{on}$	Turn-on current slope	(see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform)	-	1000	-	A/µs
$t_r(V_{off})$	Off voltage rise time	V_{CC} = 390 V, I_C = 7 A,	-	27	-	ns
$t_{d(off)}$	Turn-off delay time	R_G = 10 Ω, V_{GE} = 15 V	-	72	-	ns
t_f	Current fall time	(see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform)	-	60	-	ns
$t_r(V_{off})$	Off voltage rise time	V_{CC} = 390 V, I_C = 7 A,	-	56	-	ns
$t_{d(off)}$	Turn-off delay time	R_G = 10 Ω, V_{GE} = 15 V, T_J = 125 °C	-	116	-	ns
t_f	Current fall time	(see Figure 17. Test circuit for inductive load switching and Figure 20. Switching waveform)	-	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 V, I_C = 7 A,	-	95	125 (2)	mJ
E_{off} (3)	Turn-off switching energy	R_G = 10 Ω, V_{GE} = 15 V	-	115	150 (2)	mJ
E_{ts}	Total switching energy	(see Figure 17. Test circuit for inductive load switching	-	210	275 (2)	mJ
E_{on} (1)	Turn-on switching energy	V_{CE} = 390 V, I_C = 7 A,	-	140		mJ
E_{off} (3)	Turn-off switching energy	R_G = 10 Ω, V_{GE} = 15 V, T_J = 125 °C	-	215		mJ
E_{ts}	Total switching energy	(see Figure 17. Test circuit for inductive load switching	-	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 A	-	1.3	1.9	V
		I_F = 3.5 A, T_J= 125 °C	-	1.1		
t_{rr}	Reverse recovery time	I_F = 7 A, V_R = 40 V, di/dt = 100 A/µs (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 A, V_R = 40 V, di/dt = 100 A/µs, T_J = 125 °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

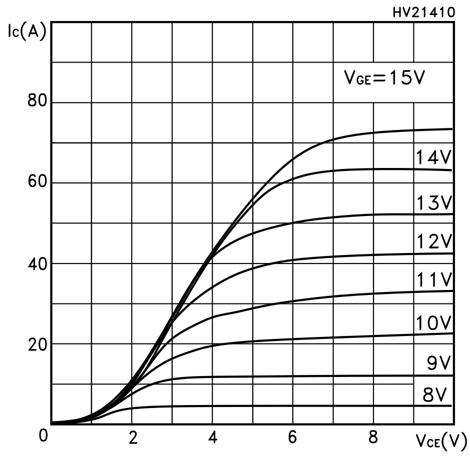


Figure 2. Typical transfer characteristics

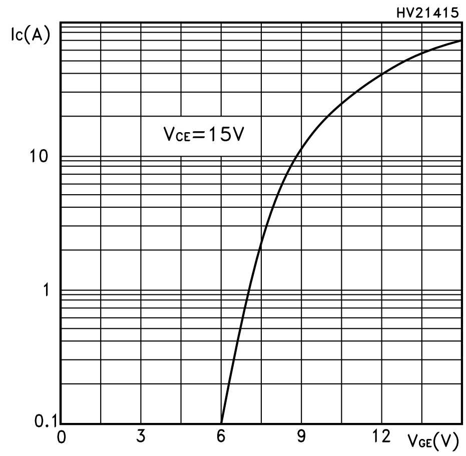


Figure 3. Typical transconductance characteristics

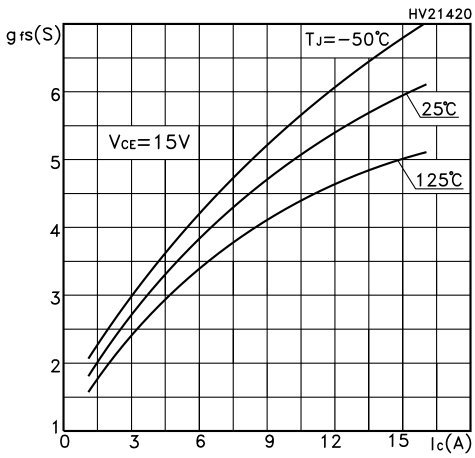


Figure 4. Typical collector-emitter on voltage vs temperature

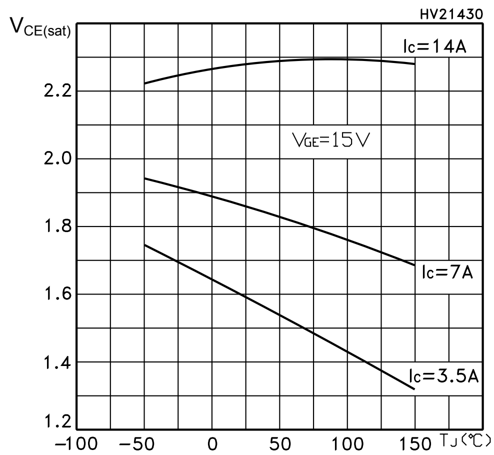


Figure 5. Typical gate charge characteristics

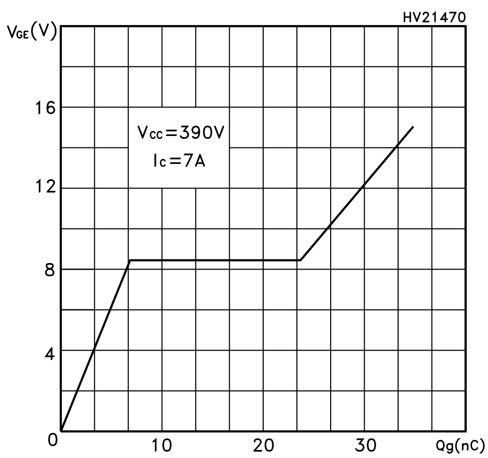


Figure 6. Typical capacitance characteristics

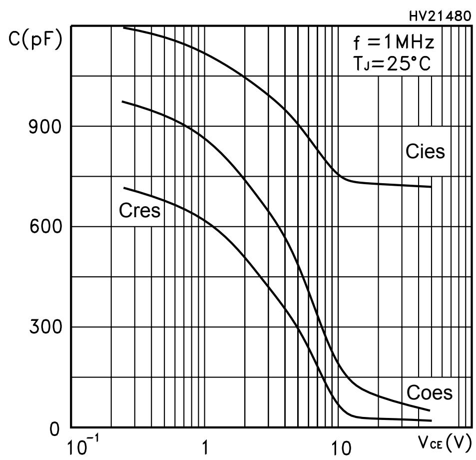


Figure 7. Normalized gate threshold vs temperature

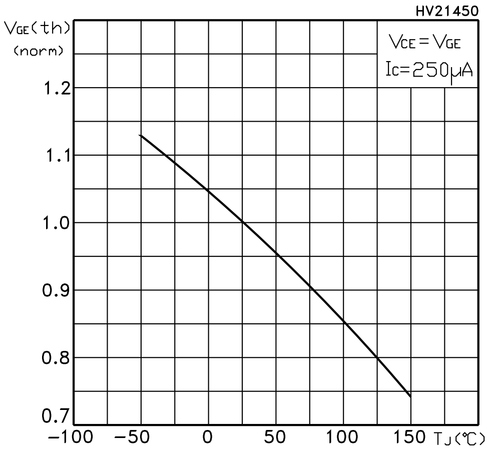


Figure 8. Typical collector-emitter on voltage vs collector current

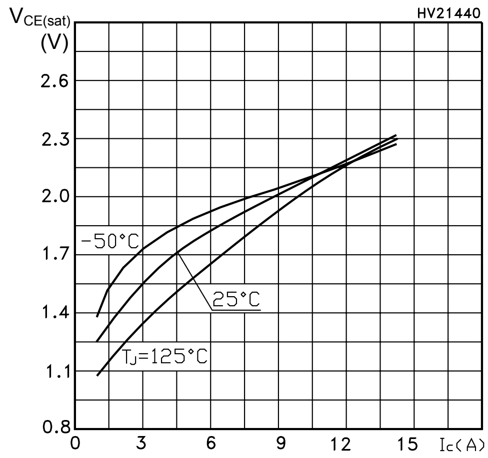


Figure 9. Typical emitter-collector diode characteristics

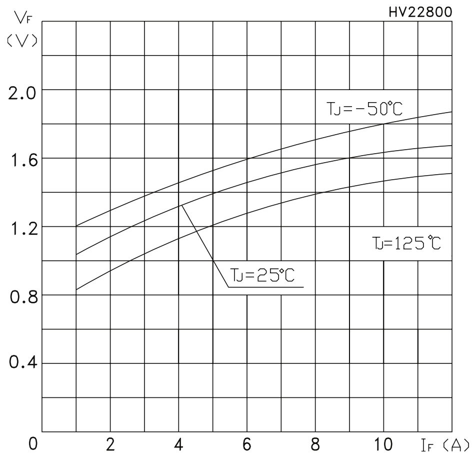


Figure 10. Normalized breakdown voltage vs temperature

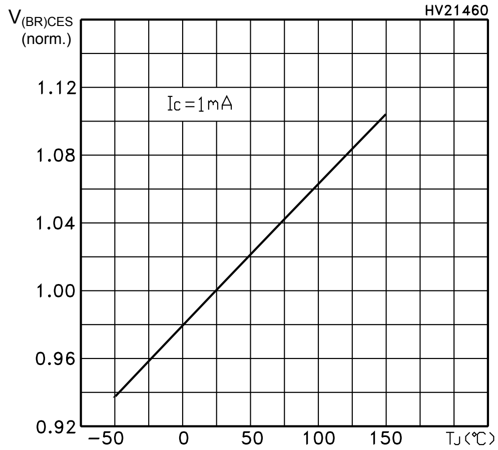


Figure 11. Typical switching energy vs temperature

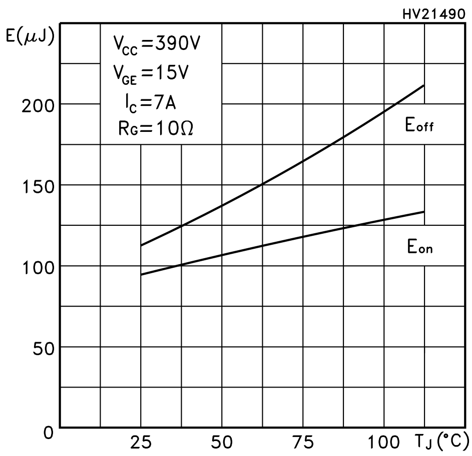


Figure 12. Typical switching energy vs gate resistance

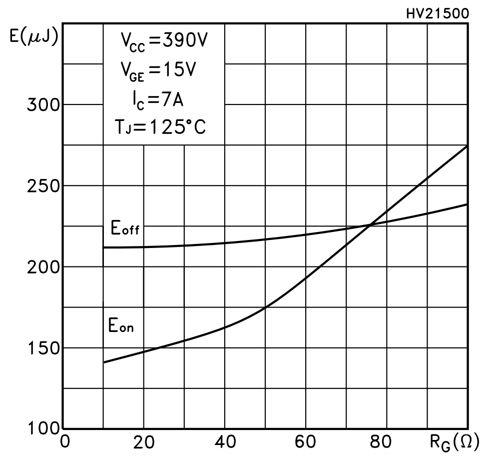


Figure 13. **Typical switching energy vs collector current**

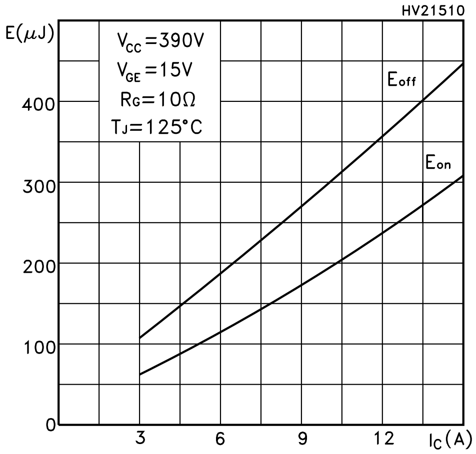


Figure 14. **Normalized transient thermal impedance**

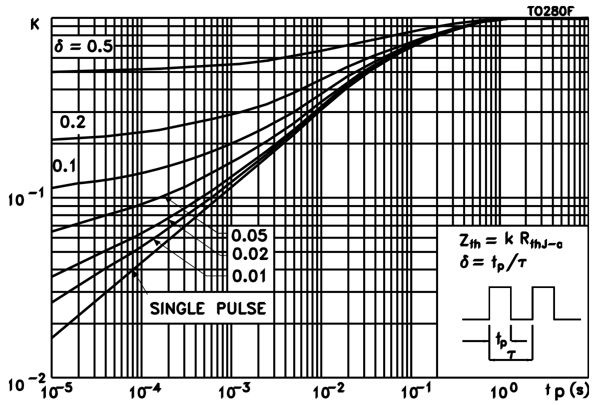
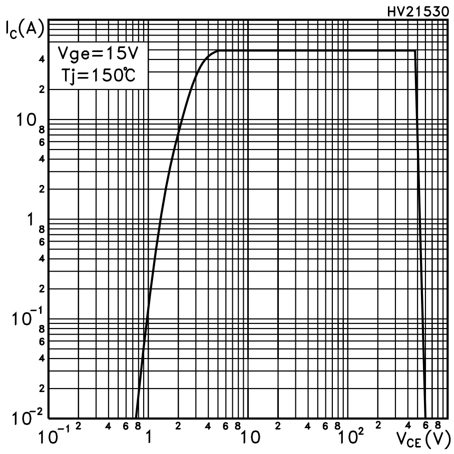
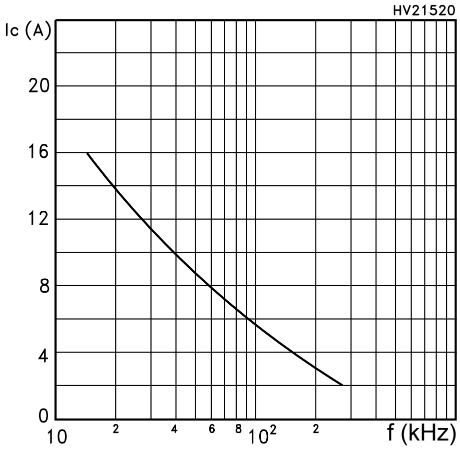


Figure 15. **Safe operating area**



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:

$$P_D = \frac{\Delta T}{Rth_{JC}}$$

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

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

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

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.

4 Test circuits

Figure 17. Test circuit for inductive load switching

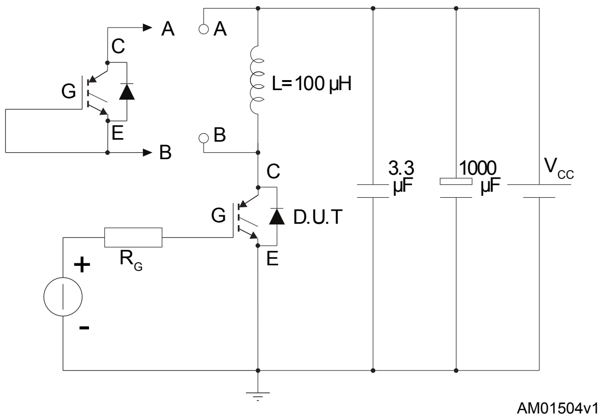


Figure 18. Diode reverse recovery waveform

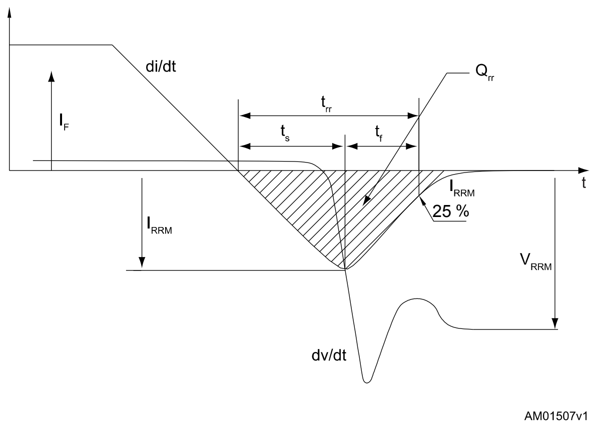


Figure 19. Gate charge test circuit

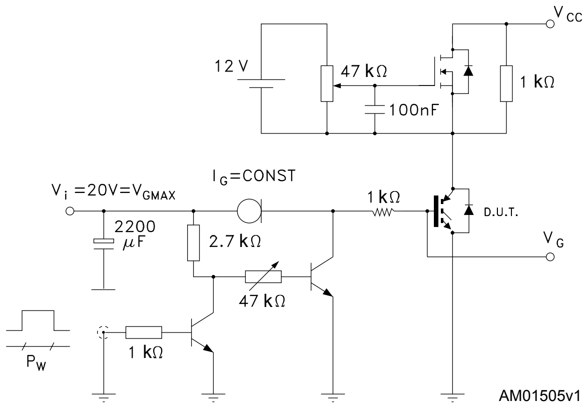
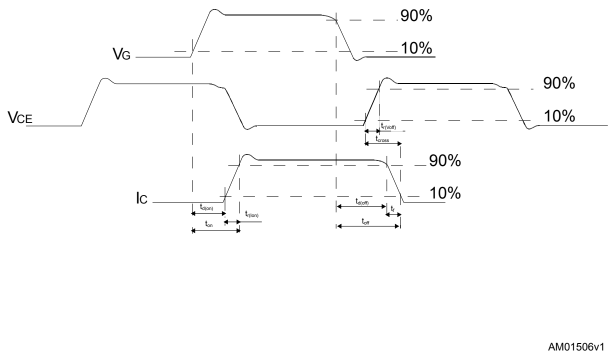


Figure 20. Switching waveform



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

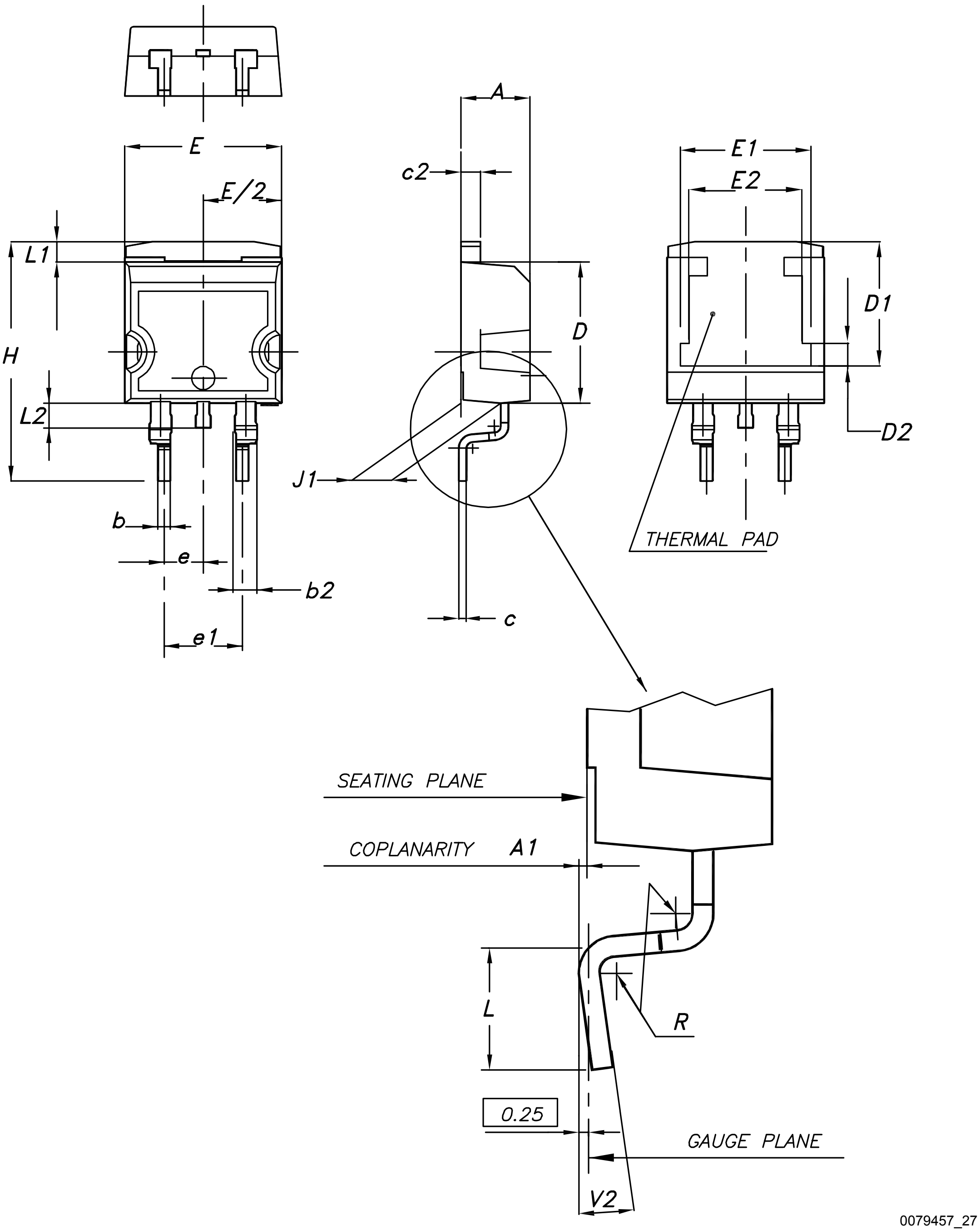
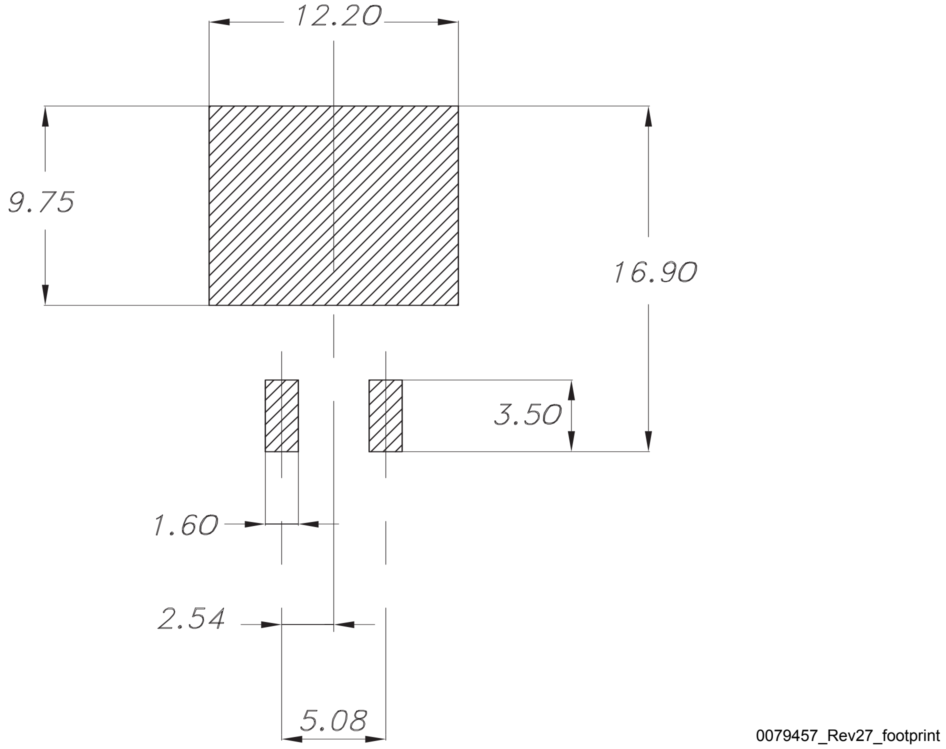


Table 8. D²PAK (TO-263) type A package mechanical data

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)**



5.2 TO-220 type A package information

Figure 23. TO-220 type A package outline

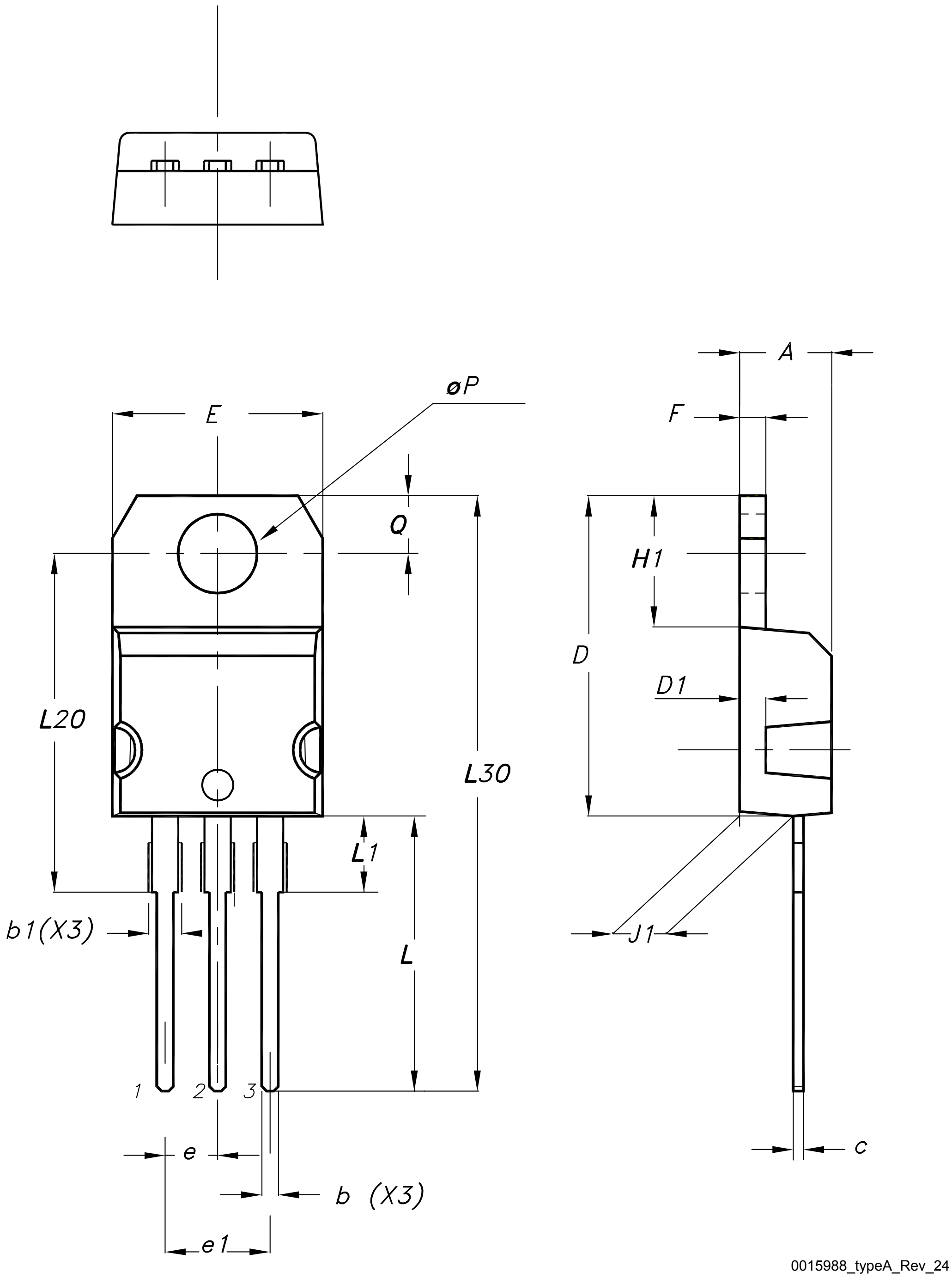
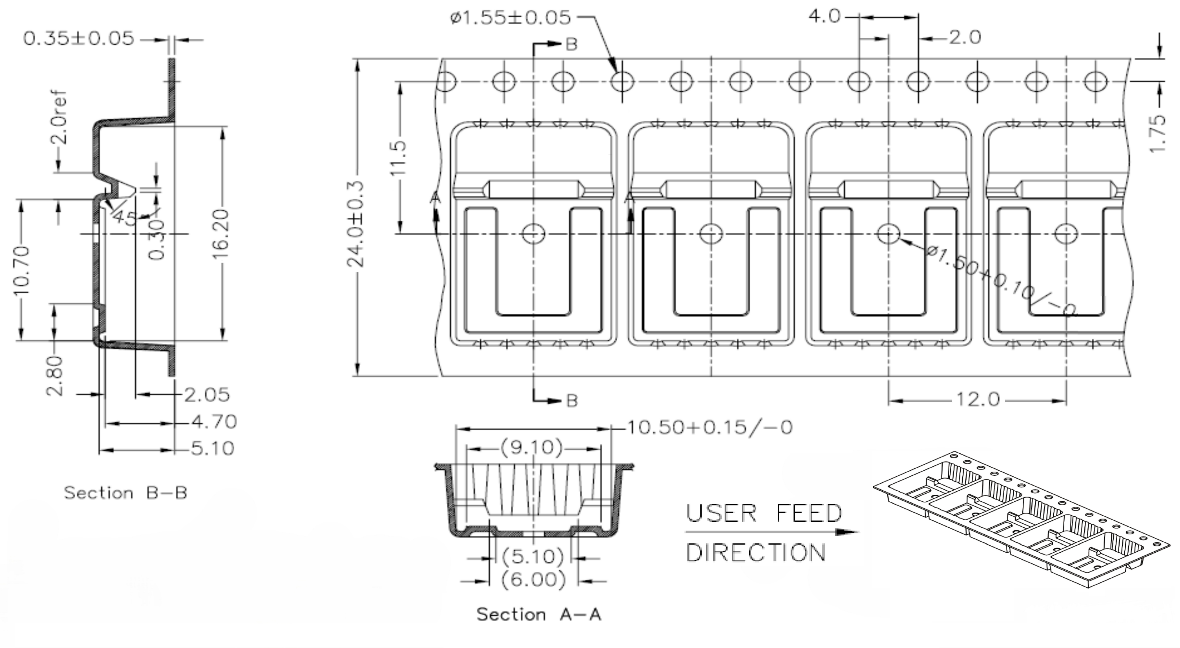


Table 9. **TO-220 type A package mechanical data**

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)



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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	*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.
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.

Contents