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STGBL6NC60DI, STGDL6NC60DI STGFL6NC60DI, STGPL6NC60DI

6 A, 600 V hyper fast IGBT

Features

- Low C_{RES} / C_{IES} ratio (no cross-conduction susceptibility)
- Very high frequency operation
- Very soft ultrafast recovery antiparallel diode

Applications

- High frequency inverters
- SMPS and PFC (hard switching too)
- High frequency motor drive

Description

Thanks to a new lifetime control system, this new PowerMESH™ technology-based series of devices exhibits very low turn-off energy, representing the best trade-off between on-state voltage and switching losses and thus allowing very high operating frequencies.

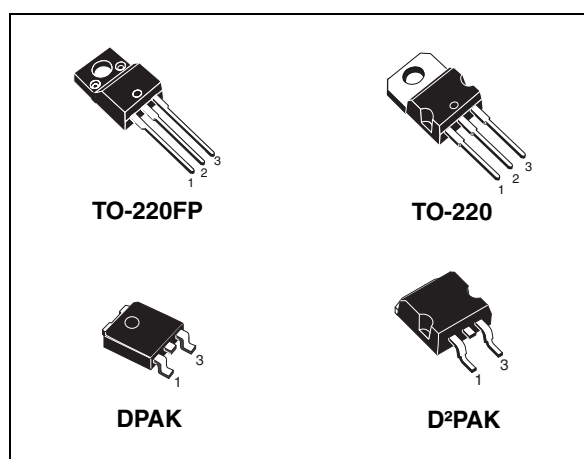


Figure 1. Internal schematic diagram

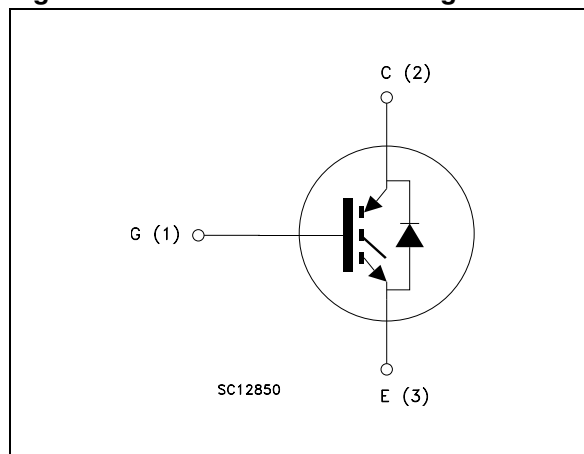


Table 1. Device summary

Order codes	Marking	Package	Packaging
STGBL6NC60DIT4	GBL6NC60DI	D ² PAK	Tape and reel
STGDL6NC60DIT4	GDL6NC60DI	DPAK	Tape and reel
STGPL6NC60DI	GPL6NC60DI	TO-220	Tube
STGFL6NC60DI	GFL6NC60DI	TO-220FP	Tube

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STGBL6NC60DI, STGDL6NC60DI, STGPL6NC60DI, STGFL6NC60DI

Electrical ratings

1 Electrical ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value			Unit
		DPAK	TO-220 D ² PAK	TO-220FP	
V _{CES}	Collector-emitter voltage (V _{GE} = 0)	600			V
I _C ⁽¹⁾	Collector current (continuous) at T _C = 25 °C	13	14	7	A
I _C ⁽¹⁾	Collector current (continuous) at T _C = 100 °C	5	6	3	A
I _{CL} ⁽²⁾	Turn-off latching current	18			A
I _{CP} ⁽³⁾	Pulsed collector current	18			A
V _{GE}	Gate-emitter voltage	±20			V
I _F	Diode RMS forward current at T _C = 25 °C	10			A
I _{FSM}	Surge non repetitive forward current t _p =10ms sinusoidal	25			A
P _{TOT}	Total dissipation at T _C = 25 °C	50	56	22	W
V _{ISO}	Isolation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T _C =25 °C)	--	--	2500	V
T _j	Operating junction temperature	– 55 to 150			°C

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. V_{clamp} = 80%, (V_{CES}), T_j = 150°C, R_G = 10 Ω, V_{GE} = 15 V

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

Table 3. Thermal data

Symbol	Parameter	Value			Unit
		DPAK	TO-220 D ² PAK	TO-220FP	
R _{thj-case}	Thermal resistance junction-case IGBT max.	2.5	2.2	5.6	°C/W
	Thermal resistance junction-case diode max.	4.5	4	7	°C/W
R _{thj-amb}	Thermal resistance junction-ambient max.	100	62.5		°C/W

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2 Electrical characteristics

($T_j=25\text{ }^{\circ}\text{C}$ unless otherwise specified)

Table 4. Static electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage ($V_{GE} = 0$)	$I_C = 1\text{ mA}$	600			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}, I_C = 1.5\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 3\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 3\text{ A}, T_j = 125^{\circ}\text{C}$		1.9 2.2 2	2.9	V V V
$V_{GE(th)}$	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 ($V_{GE} = 0$)	$V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_j = 125\text{ }^{\circ}\text{C}$			50 5	μA mA
I_{GES}	Gate-emitter leakage current ($V_{CE} = 0$)	$V_{GE} = \pm 20\text{ V}$			± 100	nA
g_{fs}	Forward transconductance	$V_{CE} = 15\text{ V}, I_C = 3\text{ A}$		3		S

Table 5. Dynamic electrical characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies} C_{oes} C_{res}	Input capacitance Output capacitance Reverse transfer capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$	-	208 32.5 5.4	-	pF pF pF
Q_g Q_{ge} Q_{gc}	Total gate charge Gate-emitter charge Gate-collector charge	$V_{CE} = 390\text{ V}, I_C = 3\text{ A},$ $V_{GE} = 15\text{ V}$ (see Figure 17)	-	12 2.6 4.9	-	nC nC nC

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Electrical characteristics

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$		6.7		ns
t_r	Current rise time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$	-	3.7	-	ns
$(di/dt)_{on}$	Turn-on current slope	(see Figure 18)		930		A/ μ s
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$		6.5		ns
t_r	Current rise time	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	4	-	ns
$(di/dt)_{on}$	Turn-on current slope	$T_j = 125\text{ }^\circ\text{C}$ (see Figure 18)		820		A/ μ s
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$,		17		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 10\ \Omega$, $V_{GE} = 15\text{ V}$	-	46	-	ns
t_f	Current fall time	(see Figure 18)		47		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$,		35		ns
$t_{d(off)}$	Turn-off delay time	$R_{GE} = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	67	-	ns
t_f	Current fall time	$T_j = 125\text{ }^\circ\text{C}$ (see Figure 18)		55		ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$		32		μ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$	-	24	-	μ J
E_{ts}	Total switching losses	(see Figure 18)		56		μ J
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 390\text{ V}$, $I_C = 3\text{ A}$		51		μ J
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	46	-	μ J
E_{ts}	Total switching losses	$T_j = 125\text{ }^\circ\text{C}$ (see Figure 18)		97		μ J

1. E_{on} is the turn-on losses when a typical diode is used in the test circuit in (see Figure 19). If the IGBT is offered in a package with a co-pak diode, the co-pak 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 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on-voltage	$I_F = 1\text{ A}$ $I_F = 3\text{ A}$ $I_F = 3\text{ A}$, $T_j = 125\text{ }^\circ\text{C}$	-	1.8 1.3	1.7	V V V
t_{rr}	Reverse recovery time	$I_F = 3\text{ A}$, $V_R = 40\text{ V}$,		23		ns
Q_{rr}	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$	-	21		nC
I_{rrm}	Reverse recovery current	(see Figure 19)		1.5		A
t_{rr}	Reverse recovery time	$I_F = 3\text{ A}$, $V_R = 40\text{ V}$,		47		ns
Q_{rr}	Reverse recovery charge	$T_j = 125\text{ }^\circ\text{C}$, $di/dt = 100\text{ A}/\mu\text{s}$	-	51		nC
I_{rrm}	Reverse recovery current	(see Figure 19)		2		A

Electrical characteristics

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2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

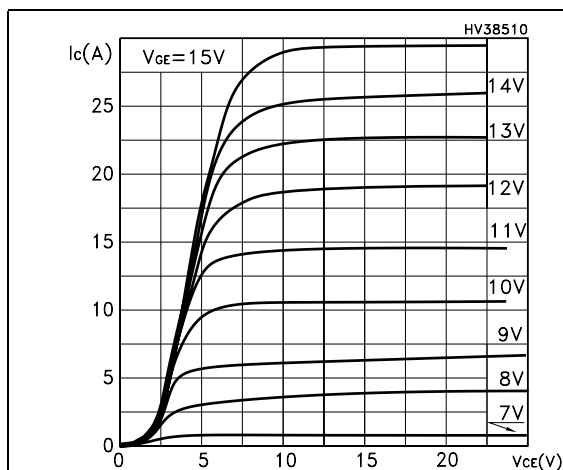


Figure 3. Transfer characteristics

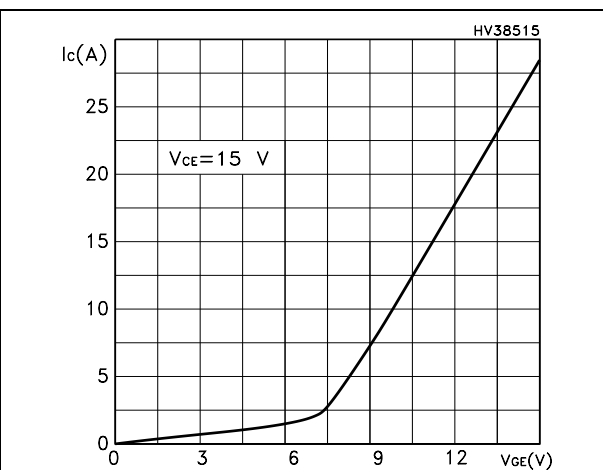


Figure 4. Transconductance

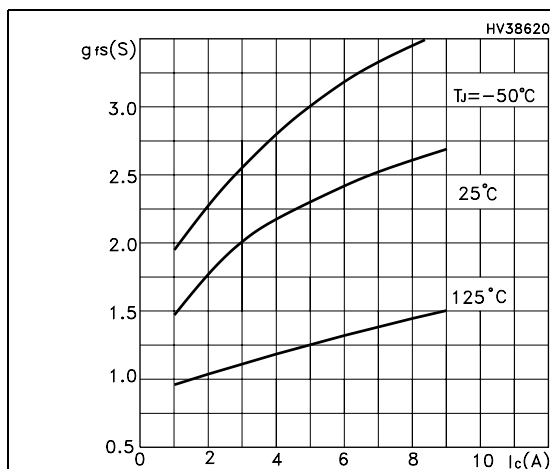


Figure 5. Collector-emitter on voltage vs temperature

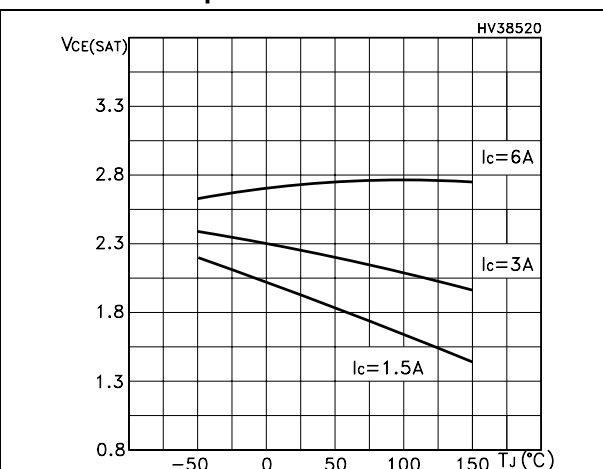


Figure 6. Gate charge vs gate-source voltage

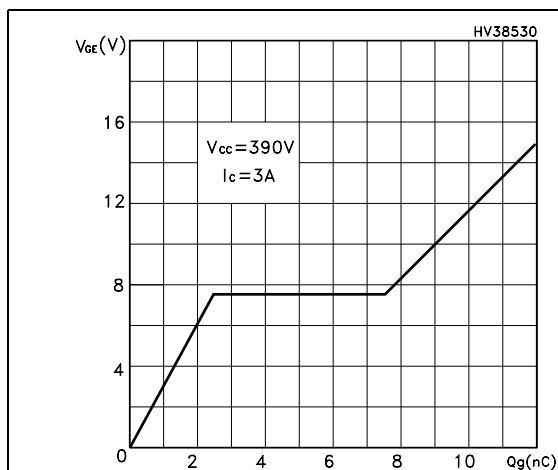
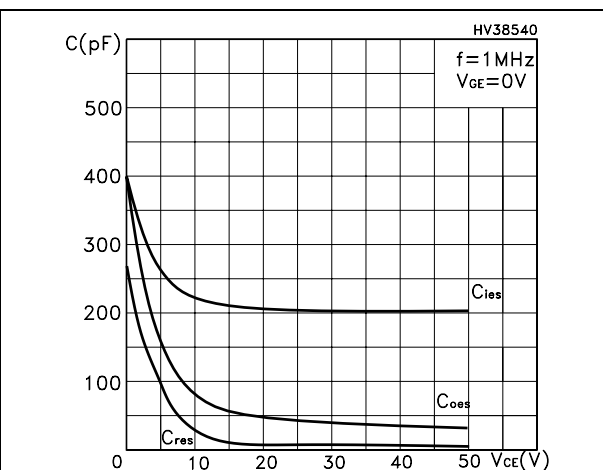


Figure 7. Capacitance variations



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Electrical characteristics

Figure 8. Normalized gate threshold voltage vs temperature

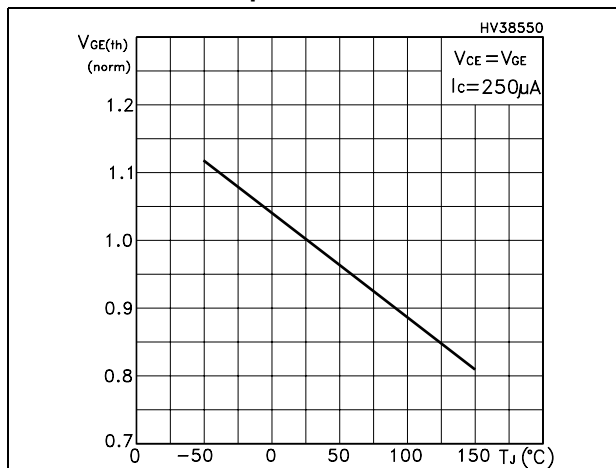


Figure 9. Collector-emitter on voltage vs collector current

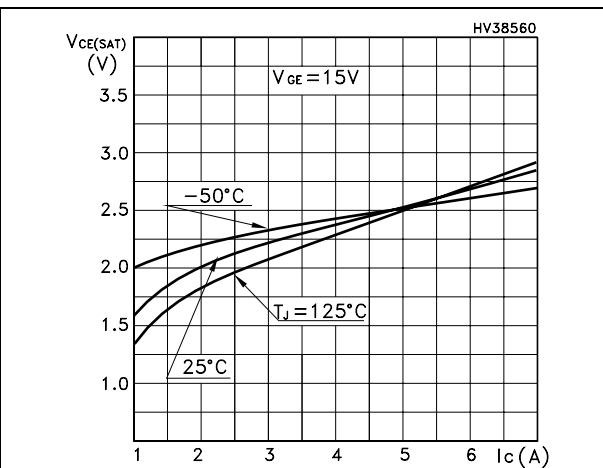


Figure 10. Normalized breakdown voltage vs temperature

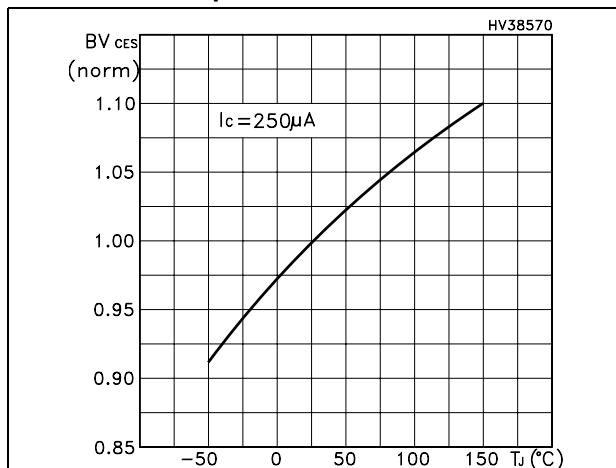


Figure 11. Switching losses vs temperature

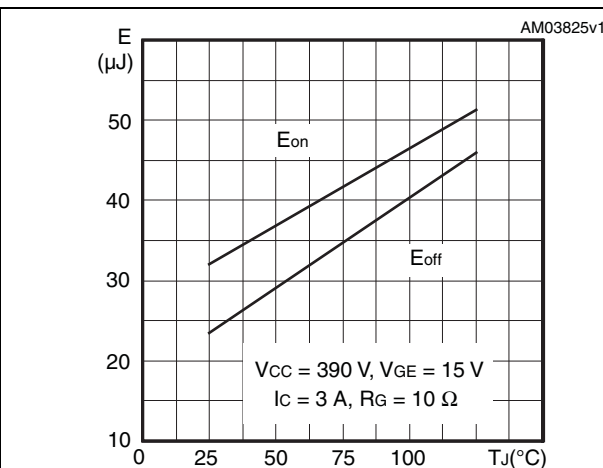


Figure 12. Switching losses vs gate resistance

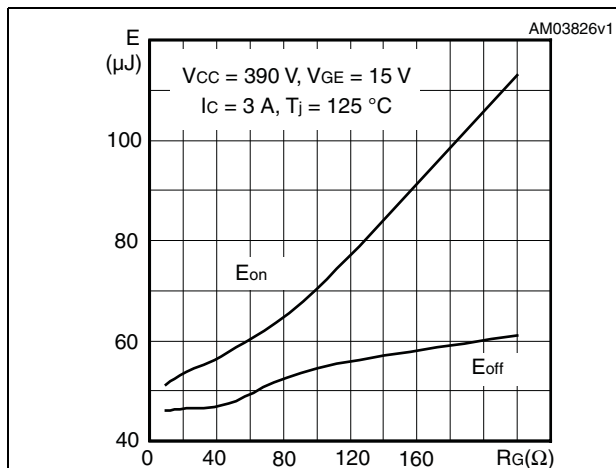
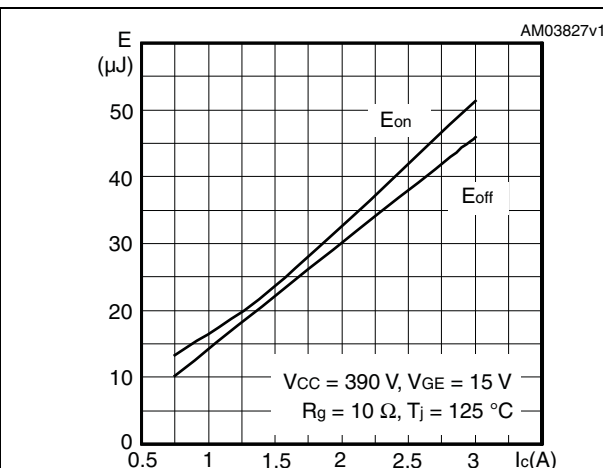


Figure 13. Switching losses vs collector current



Electrical characteristics

STGBL6NC60DI, STGDL6NC60DI, STGPL6NC60DI, STGFL6NC60DI

Figure 14. RBSOA

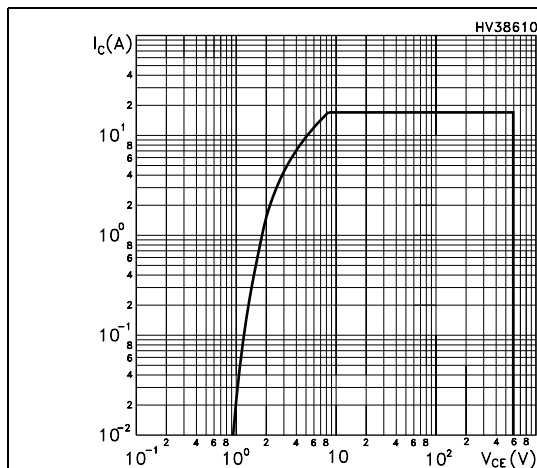
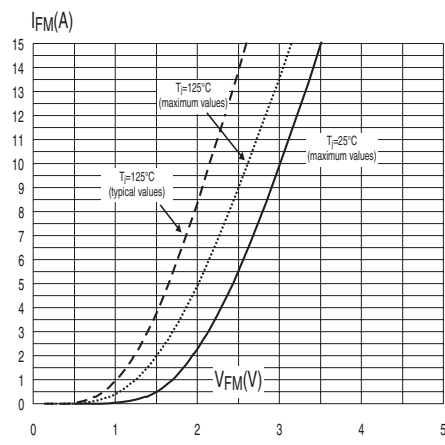


Figure 15. Forward voltage drop versus forward current



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Test circuits

3 Test circuits

Figure 16. Test circuit for inductive load switching

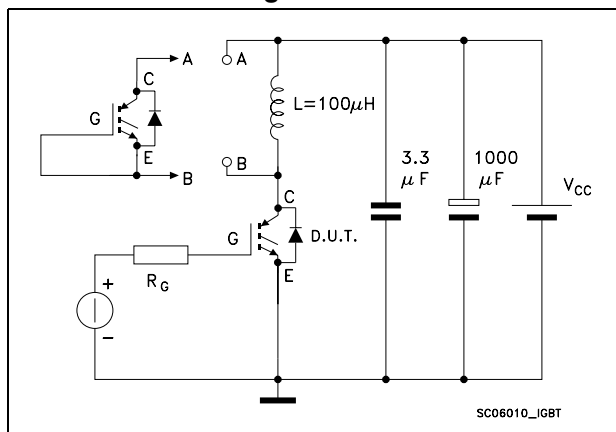


Figure 17. Gate charge test circuit

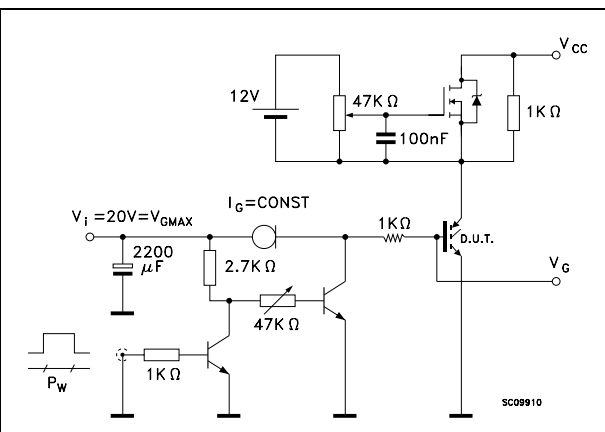


Figure 18. Switching waveform

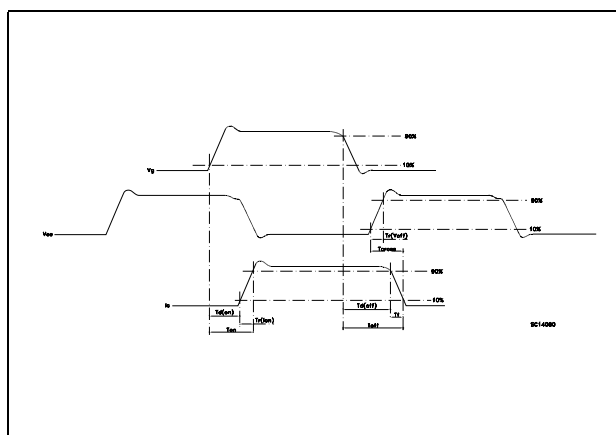
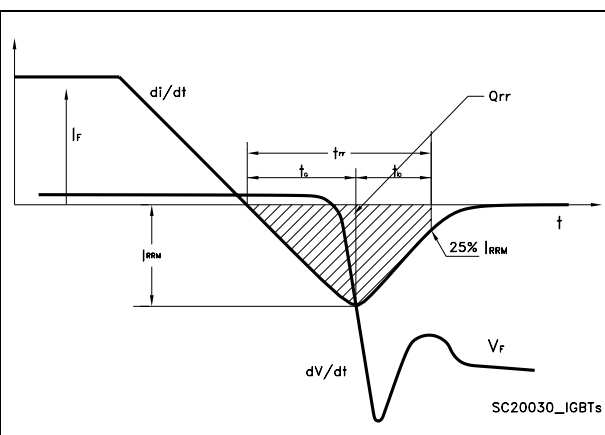


Figure 19. Diode recovery time waveform



Package mechanical data STGBL6NC60DI, STGDL6NC60DI, STGPL6NC60DI, STGFL6NC60DI

4 Package mechanical data

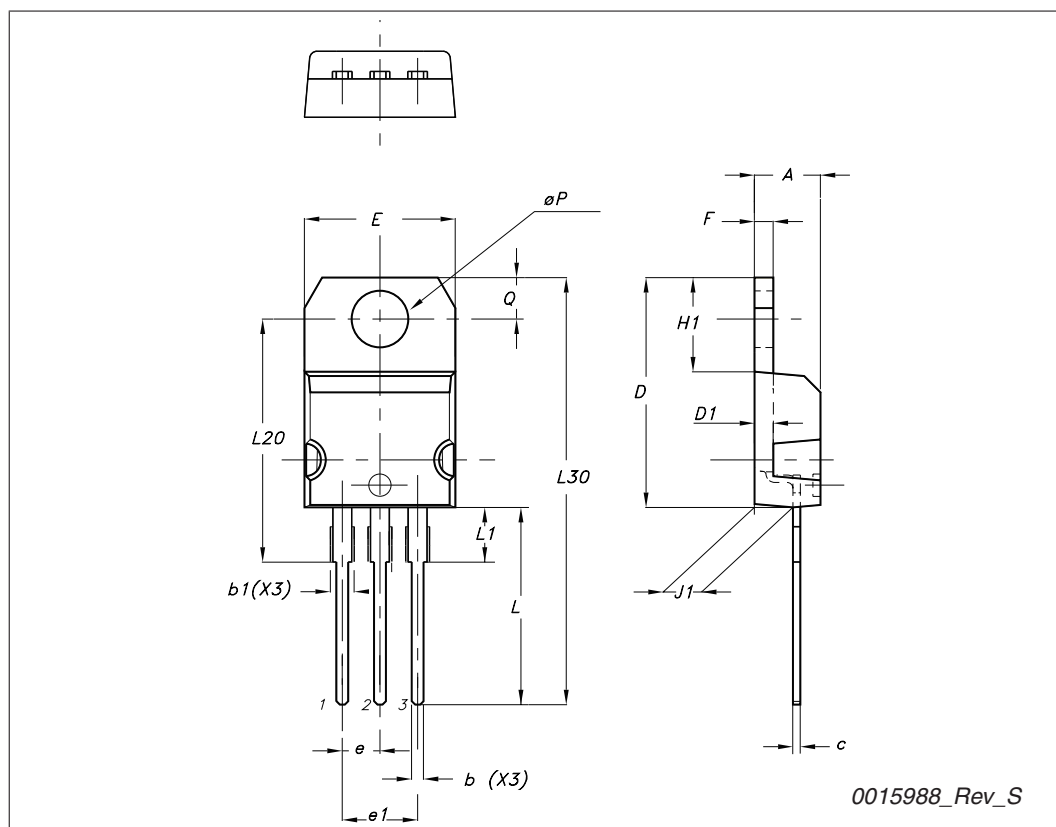
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Package mechanical data

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	
ØP	3.75		3.85
Q	2.65		2.95

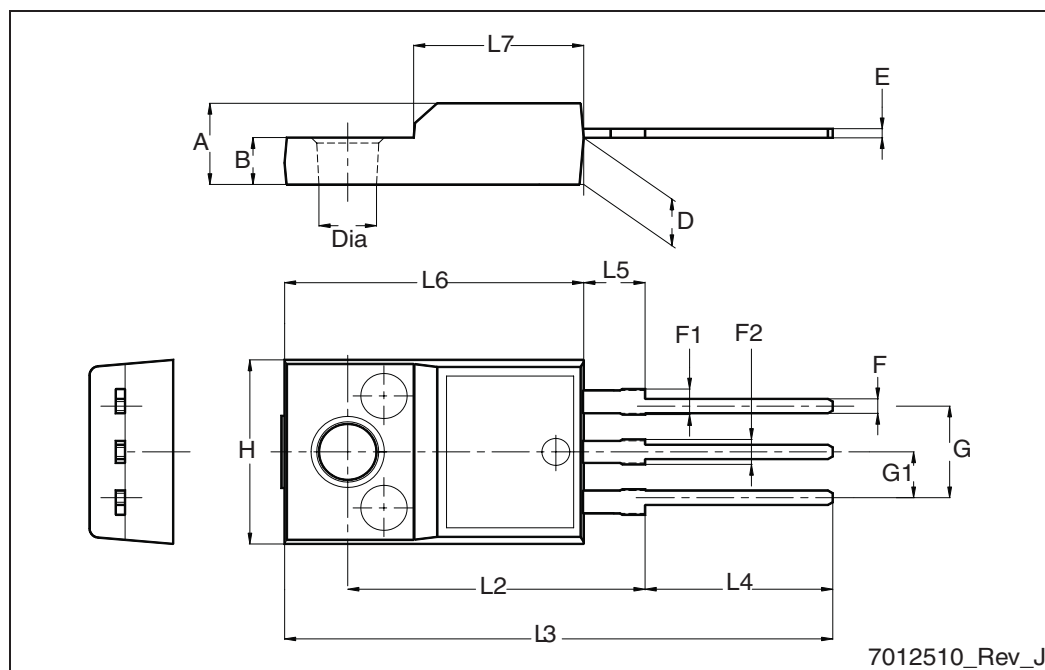


Package mechanical data

STGBL6NC60DI, STGDL6NC60DI, STGPL6NC60DI, STGFL6NC60DI

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		1.5
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



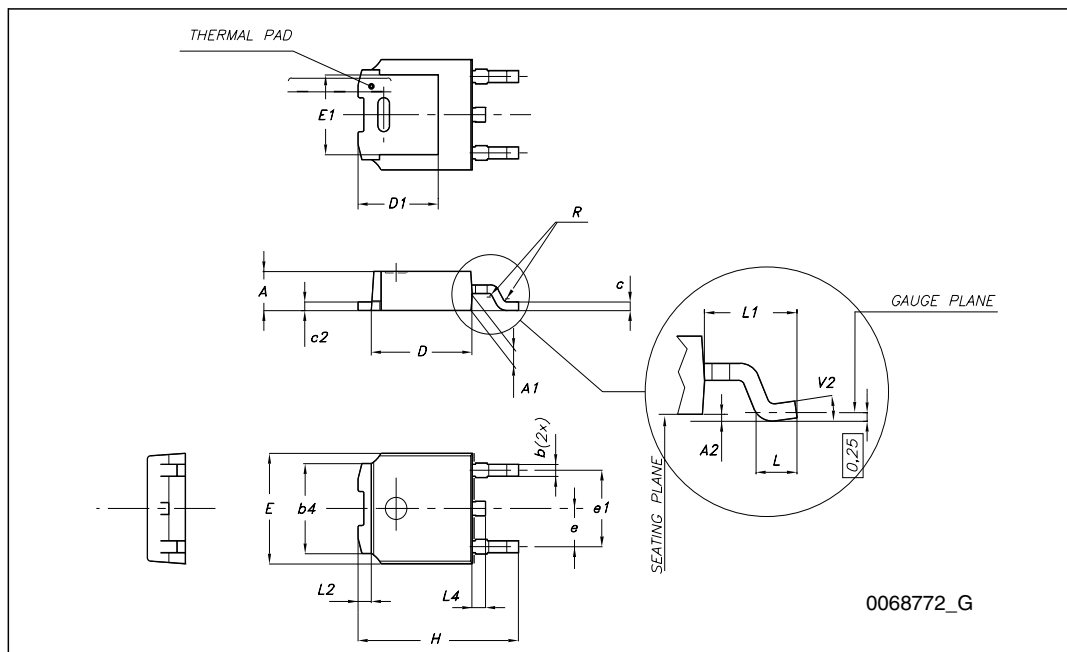
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Package mechanical data

TO-252 (DPAK) mechanical data

DIM.	mm.		
	min.	typ	max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1		
L1		2.80	
L2		0.80	
L4	0.60		1
R		0.20	
V2	0 °		8 °

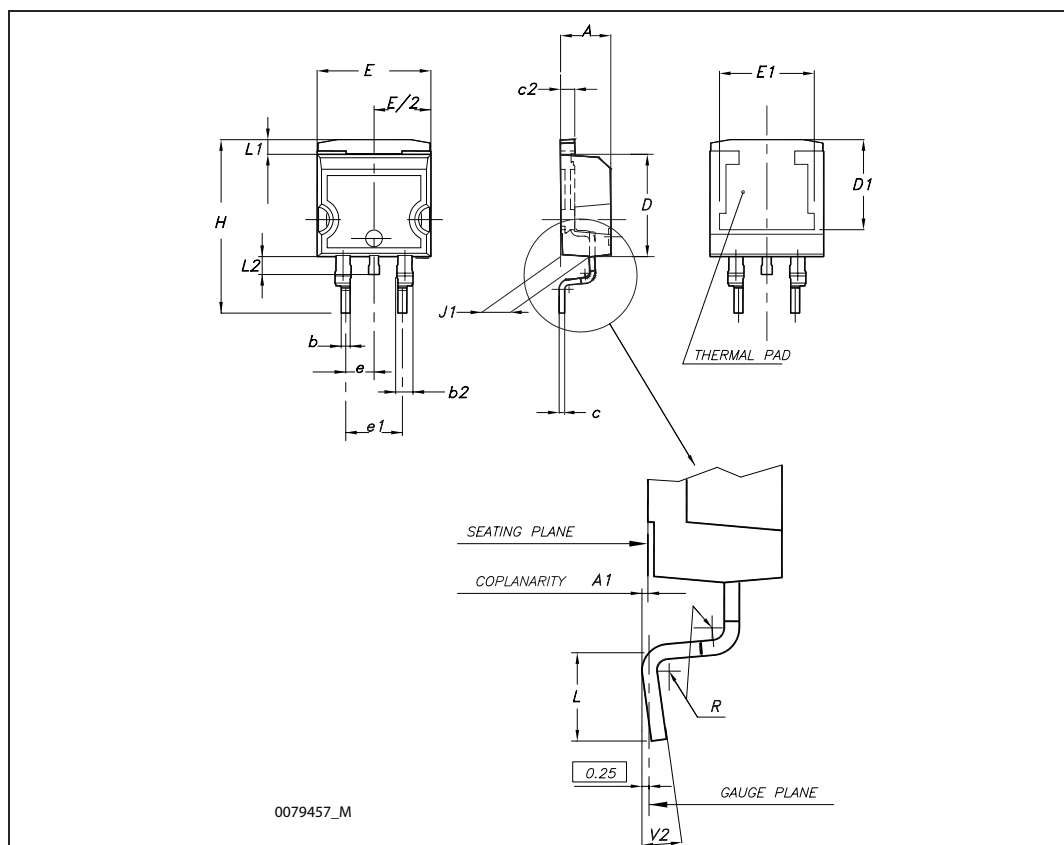


Package mechanical data

STGBL6NC60DI, STGDL6NC60DI, STGPL6NC60DI, STGFL6NC60DI

D²PAK (TO-263) mechanical data

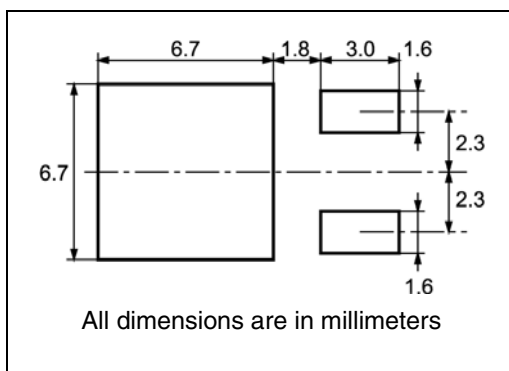
Dim	mm			inch		
	Min	Typ	Max	Min	Typ	Max
A	4.40		4.60	0.173		0.181
A1	0.03		0.23	0.001		0.009
b	0.70		0.93	0.027		0.037
b2	1.14		1.70	0.045		0.067
c	0.45		0.60	0.017		0.024
c2	1.23		1.36	0.048		0.053
D	8.95		9.35	0.352		0.368
D1	7.50			0.295		
E	10		10.40	0.394		0.409
E1	8.50			0.334		
e		2.54			0.1	
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°



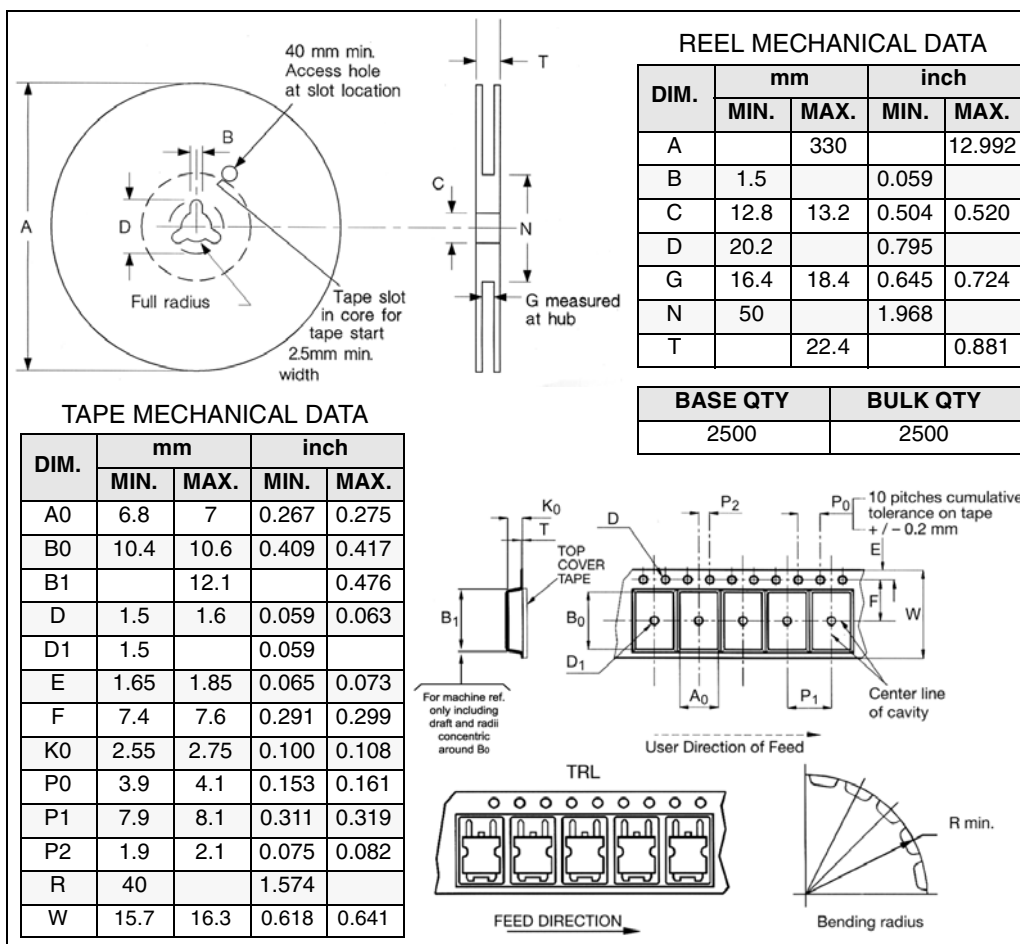
STGBL6NC60DI, STGDL6NC60DI, STGPL6NC60DI, STGFL6NC60DI Packaging mechanical data

5 Packaging mechanical data

DPAK FOOTPRINT

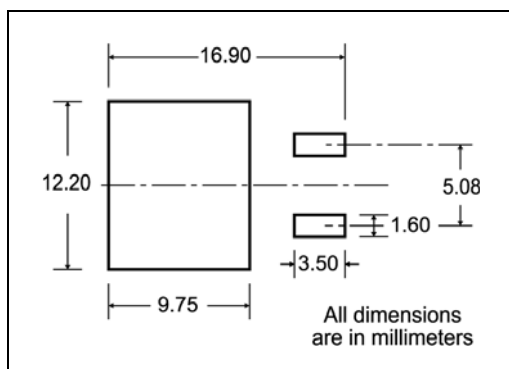


TAPE AND REEL SHIPMENT

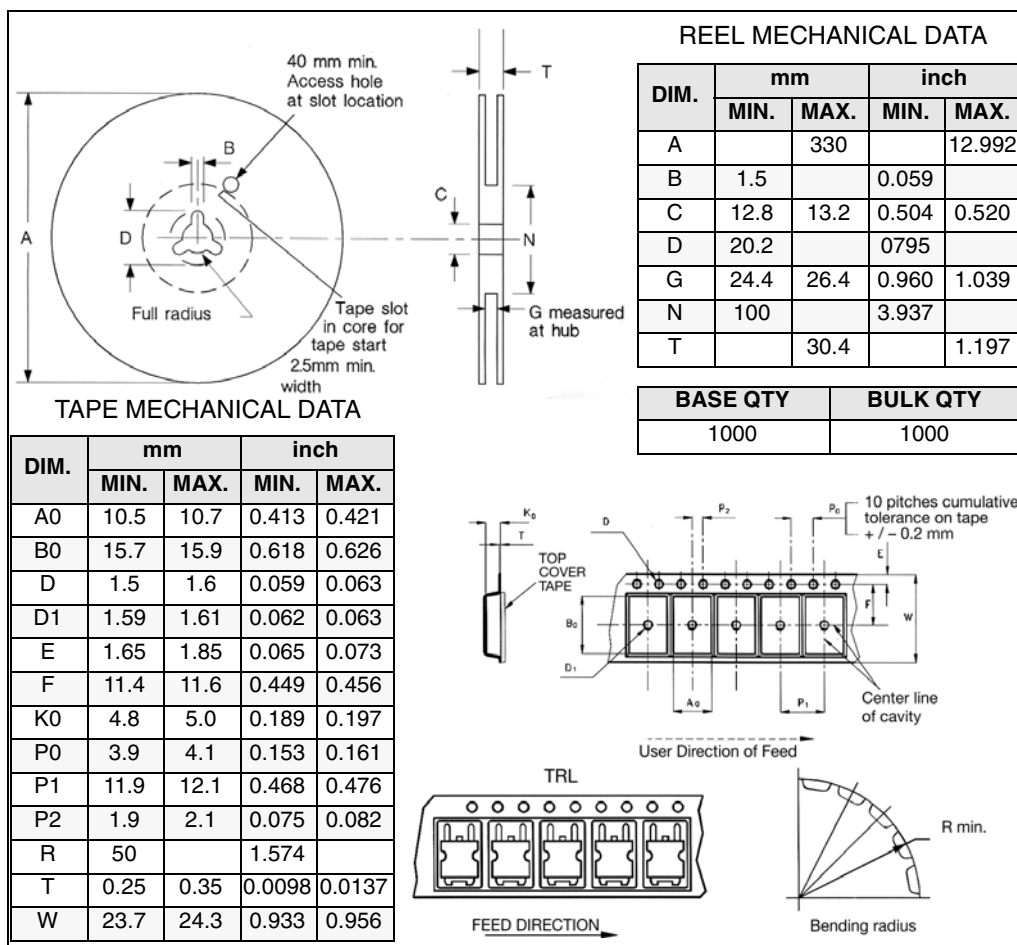


Packaging mechanical data STGBL6NC60DI, STGDL6NC60DI, STGPL6NC60DI, STGFL6NC60DI

D²PAK FOOTPRINT



TAPE AND REEL SHIPMENT



* on sales type

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
27-Mar-2009	1	First release
13-Aug-2009	2	Document status promoted from preliminary data to datasheet, inserted Section 2.1: Electrical characteristics (curves) , updated TO-220 and TO-220FP package mechanical data

STGBL6NC60DI, STGDL6NC60DI, STGPL6NC60DI, STGFL6NC60DI

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