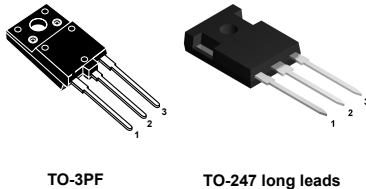


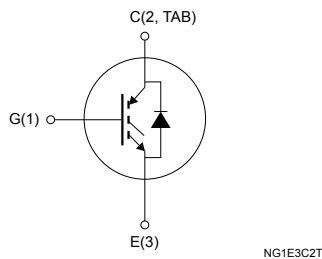


Trench gate field-stop, 650 V, 50 A, high-speed HB2 series IGBT in TO-3PF and TO-247 long leads packages



TO-3PF

TO-247 long leads



Features

- Maximum junction temperature: $T_J = 175\text{ }^{\circ}\text{C}$
- Low $V_{CE(sat)} = 1.55\text{ V (typ.) @ } I_C = 50\text{ A}$
- Co-packaged protection diode
- Minimized tail current
- Tight parameter distribution
- Low thermal resistance
- Positive $V_{CE(sat)}$ temperature coefficient

Applications

- Welding
- Power factor correction

Description

The newest IGBT 650 V HB2 series represents an evolution of the advanced proprietary trench gate field-stop structure. The performance of the HB2 series is optimized in terms of conduction, thanks to a better $V_{CE(sat)}$ behavior at low current values, as well as in terms of reduced switching energy. A diode used for protection purposes only is co-packaged in antiparallel with the IGBT. The result is a product specifically designed to maximize efficiency for a wide range of fast applications.

Product status links

[STGFW50HP65FB2](#)

[STGWA50HP65FB2](#)

Product summary

Order code	STGFW50HP65FB2
Marking	G50HP65FB2
Package	TO-3PF
Packing	Tube
Order code	STGWA50HP65FB2
Marking	G50HP65FB2
Package	TO-247 long leads
Packing	Tube

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value		Unit
		TO-3PF	TO-247 long leads	
V _{CES}	Collector-emitter voltage (V _{GE} = 0 V)	650		V
I _C	Continuous collector current at T _C = 25 °C	43	86	A
	Continuous collector current at T _C = 100 °C	25	53	
I _{CP} ⁽¹⁾	Pulsed collector current (t _p ≤1 μs, T _J < 175 °C)	150		A
V _{GE}	Gate-emitter voltage	±20		V
	Transient gate-emitter voltage (t _p ≤10 μs, D <0.01)	±30		
I _F	Continuous forward current at T _C = 25 °C	5		A
	Continuous forward current at T _C = 100 °C	5		
I _{FP} ⁽¹⁾	Pulsed forward current (t _p ≤1 μs, T _J <175 °C)	10		A
P _{TOT}	Total power dissipation at T _C = 25 °C	94	272	W
V _{ISO}	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s; T _C = 25 °C)	3.5		kV
T _{stg}	Storage temperature range	-55 to 150		°C
T _J	Operating junction temperature range	-55 to 175		°C

1. Defined by R_{thJC} and limited by maximum junction temperature, not tested in production.

Table 2. Thermal data

Symbol	Parameter	Value		Unit
		TO-3PF	TO-247 long leads	
R _{thJC}	Thermal resistance junction-case IGBT	1.59	0.55	°C/W
	Thermal resistance junction-case diode	5		
R _{thJA}	Thermal resistance junction-ambient	50		°C/W

2 Electrical characteristics

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

Table 3. Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}$, $I_C = 1\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$		1.55	2	V
		$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$, $T_J = 125\text{ °C}$		1.8		
		$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$, $T_J = 175\text{ °C}$		1.9		
V_F	Forward on-voltage	$I_F = 5\text{ A}$		2.6	3.5	V
		$I_F = 5\text{ A}$, $T_J = 125\text{ °C}$		2.3		
		$I_F = 5\text{ A}$, $T_J = 175\text{ °C}$		2.2		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$, $I_C = 1\text{ mA}$	5	6	7	V
I_{CES}	Collector cut-off current	$V_{GE} = 0\text{ V}$, $V_{CE} = 650\text{ V}$			25	μA
I_{GES}	Gate-emitter leakage current	$V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$			± 250	nA

Table 4. Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$	-	2928	-	pF
C_{oes}	Output capacitance		-	162	-	pF
C_{res}	Reverse transfer capacitance		-	78	-	pF
Q_g	Total gate charge	$V_{CC} = 520\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 30. Gate charge test circuit)	-	151	-	nC
Q_{ge}	Gate-emitter charge		-	30	-	nC
Q_{gc}	Gate-collector charge		-	63	-	nC

Table 5. Switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 400\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 4.7\text{ }\Omega$ (see Figure 29. Test circuit for inductive load switching)	-	115	-	ns
t_f	Current fall time		-	40	-	ns
$E_{off}^{(1)}$	Turn-off switching energy		-	580	-	μJ
$t_{d(off)}$	Turn-off delay time	$V_{CC} = 400\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 4.7\text{ }\Omega$, $T_J = 175\text{ °C}$ (see Figure 29. Test circuit for inductive load switching)	-	135	-	ns
t_f	Current fall time		-	90	-	ns
$E_{off}^{(1)}$	Turn-off switching energy		-	1090	-	μJ

1. Including the tail of the collector current.

Table 6. Diode switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_{rr}	Reverse recovery time	$I_F = 5\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 32. Diode reverse recovery waveform)	-	140	-	ns
Q_{rr}	Reverse recovery charge		-	21	-	nC
I_{rrm}	Reverse recovery current		-	6.6	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	430	-	A/ μs
E_{rr}	Reverse recovery energy		-	1.6	-	μJ
t_{rr}	Reverse recovery time	$I_F = 5\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 32. Diode reverse recovery waveform)	-	200	-	ns
Q_{rr}	Reverse recovery charge		-	47.3	-	nC
I_{rrm}	Reverse recovery current		-	9.6	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	428	-	A/ μs
E_{rr}	Reverse recovery energy		-	3.2	-	μJ

2.1 Electrical characteristics (curves)

Figure 1. TO-3PF total power dissipation vs case temperature

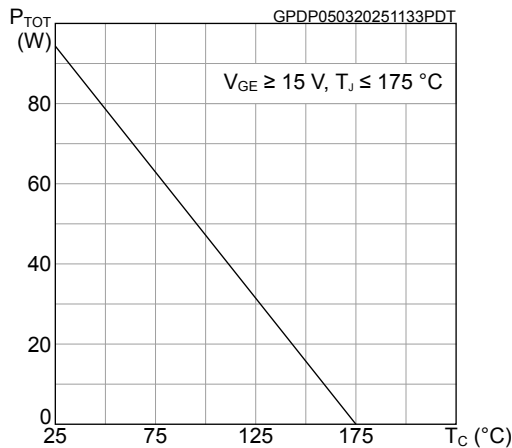


Figure 2. TO-3PF maximum continuous collector current vs case temperature

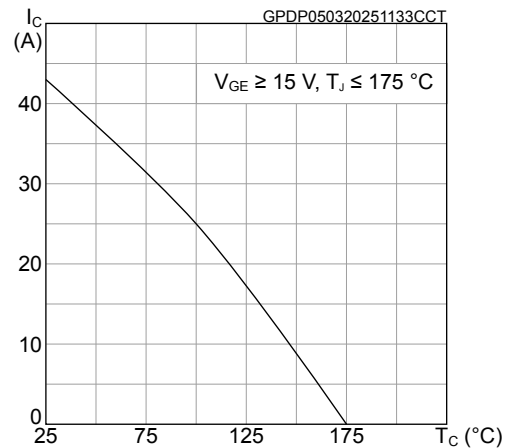


Figure 3. TO-247 long leads total power dissipation vs case temperature

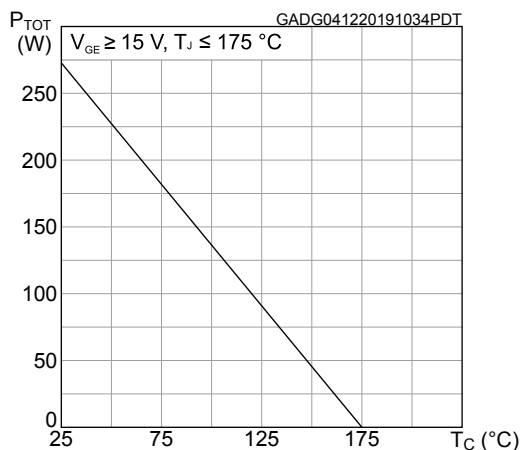


Figure 4. TO-247 long leads maximum continuous collector current vs case temperature

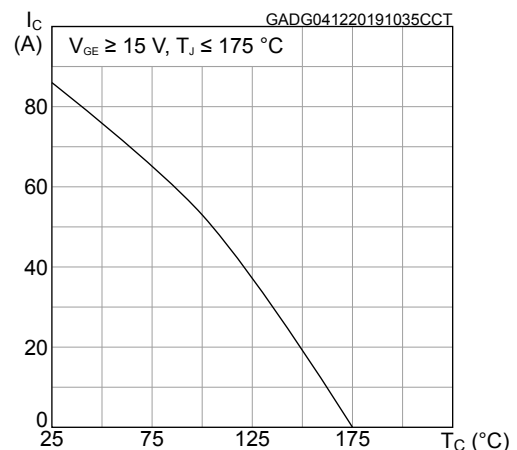


Figure 5. Typical output characteristics (T_J = 25 °C)

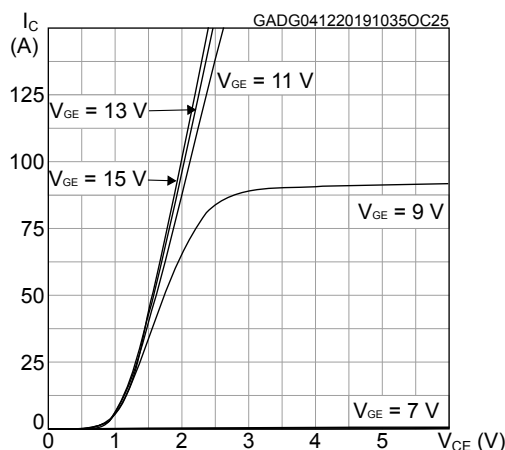


Figure 6. Typical output characteristics (T_J = 175 °C)

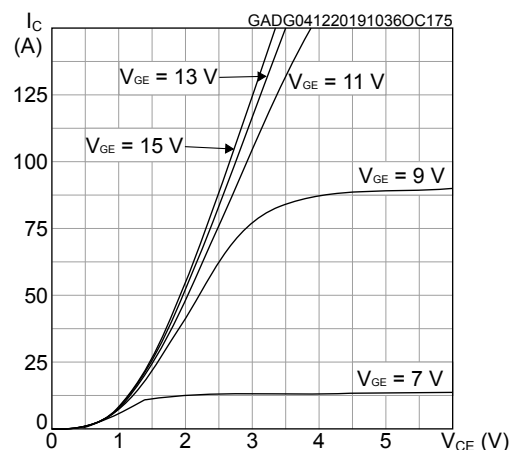


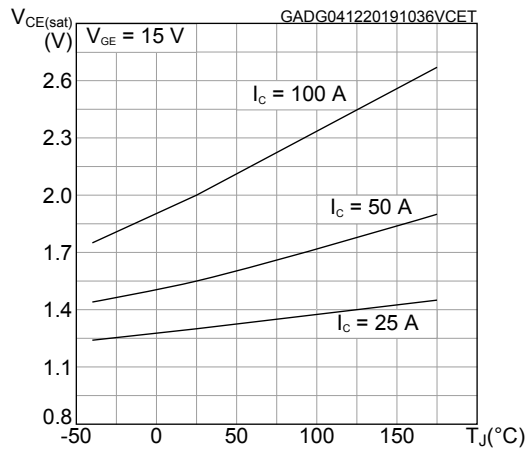
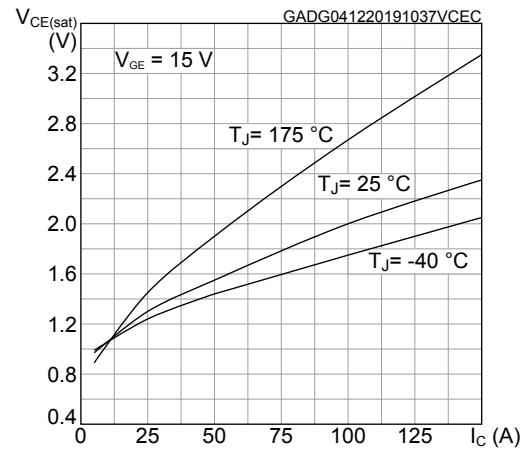
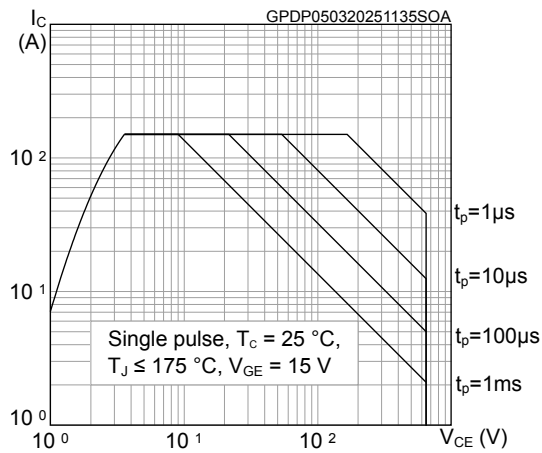
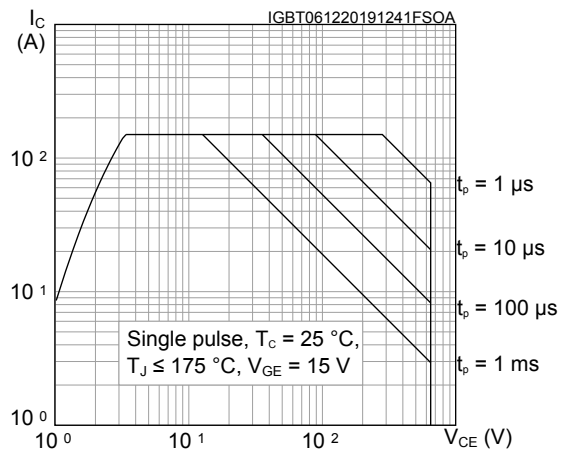
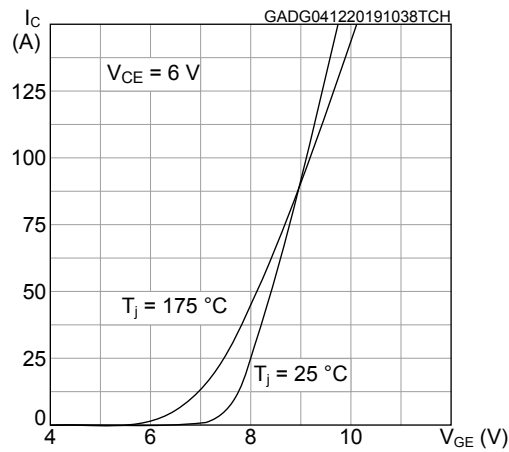
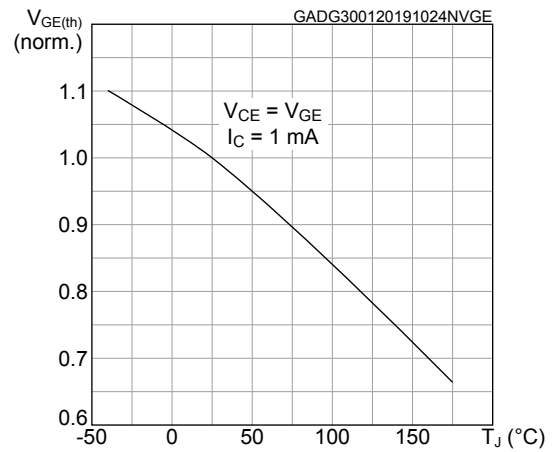
Figure 7. Typical $V_{CE(sat)}$ vs temperature

Figure 8. Typical $V_{CE(sat)}$ vs collector current

Figure 9. TO-3PF forward bias safe operating area

Figure 10. TO-247 long leads forward bias safe operating area

Figure 11. Typical transfer characteristics

Figure 12. Normalized gate threshold vs temperature


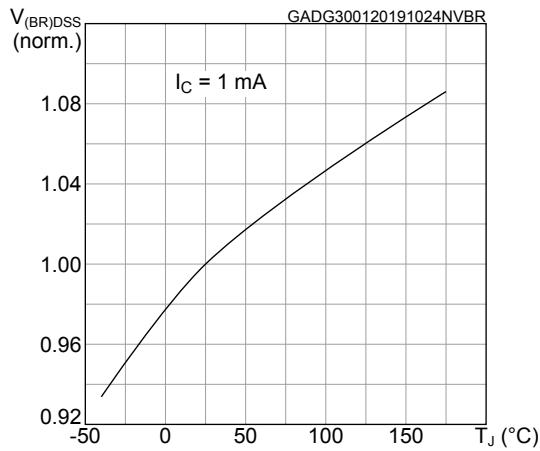
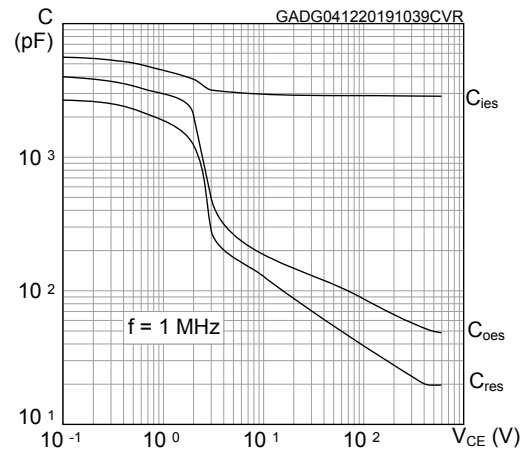
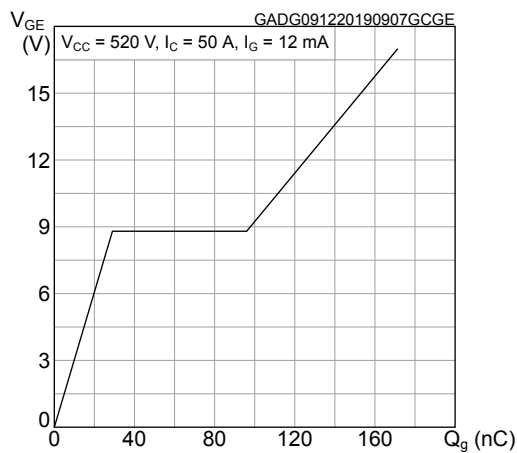
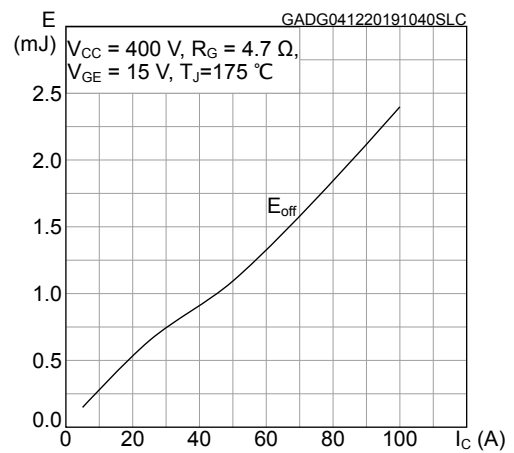
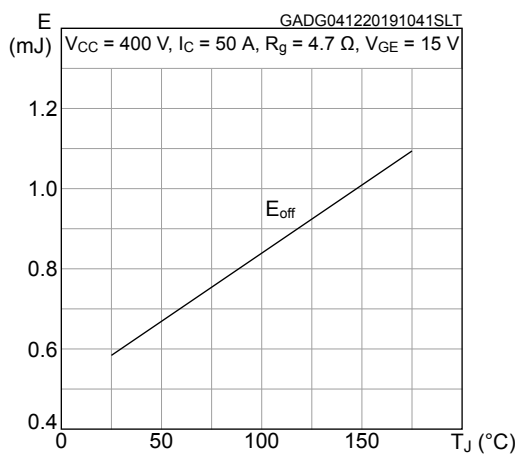
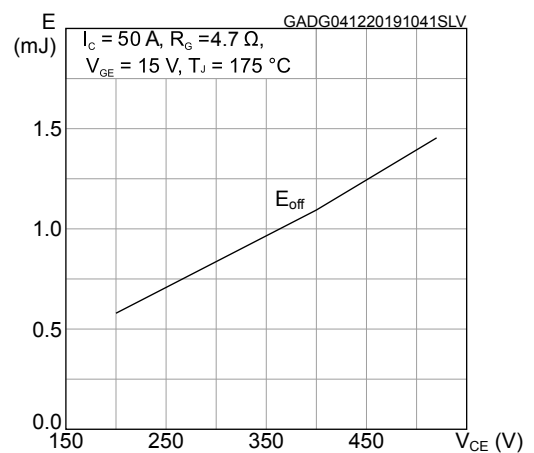
Figure 13. Normalized breakdown voltage vs temperature

Figure 14. Typical capacitance characteristics

Figure 15. Typical gate charge vs gate-emitter voltage

Figure 16. Typical switching energy vs collector current

Figure 17. Typical switching energy vs temperature

Figure 18. Typical switching energy vs collector emitter voltage


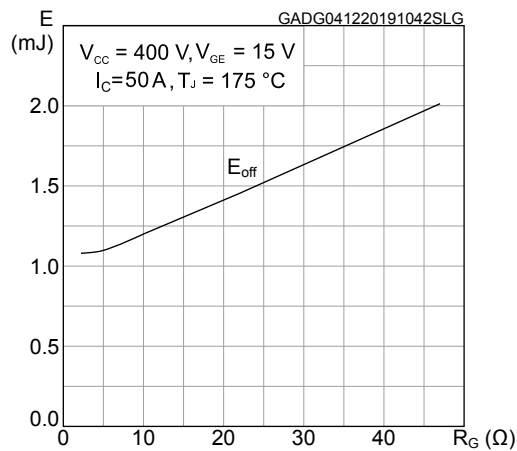
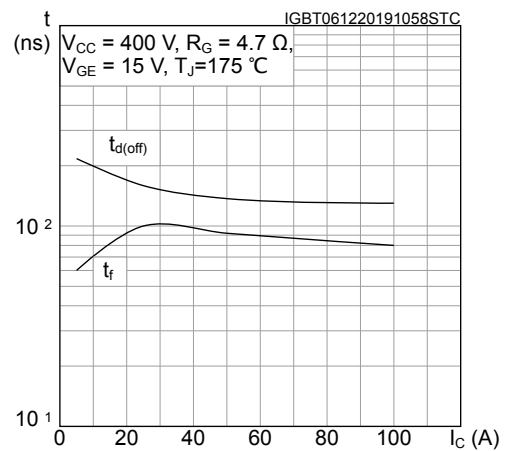
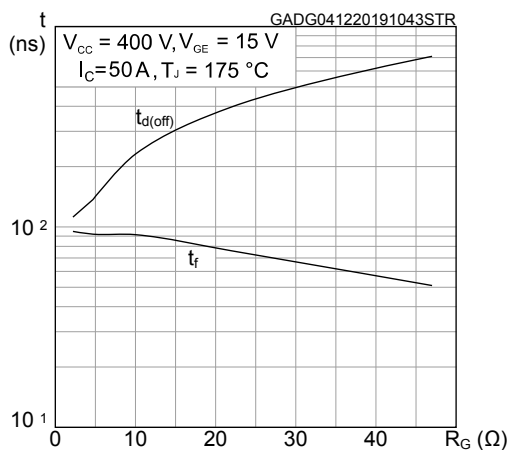
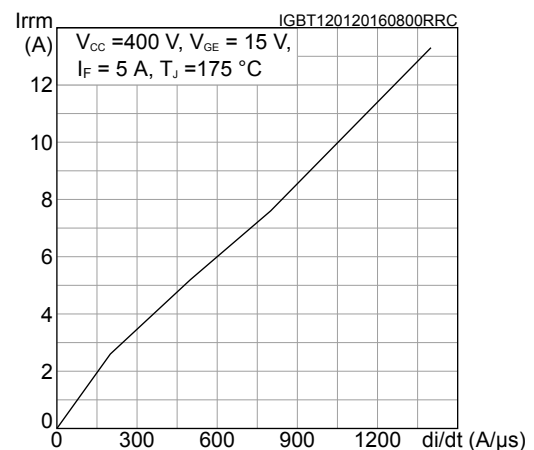
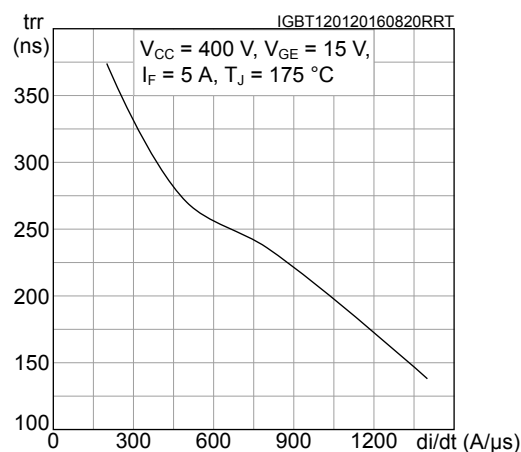
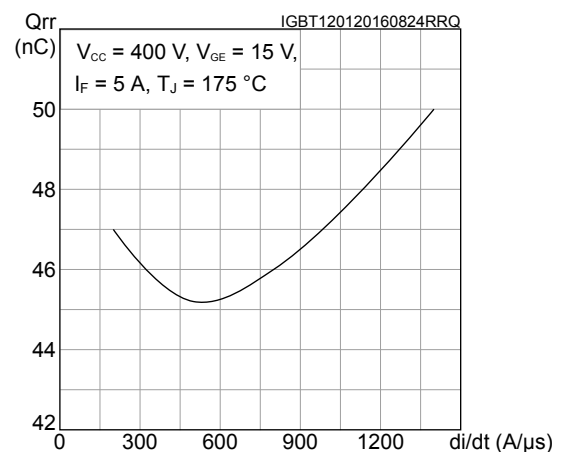
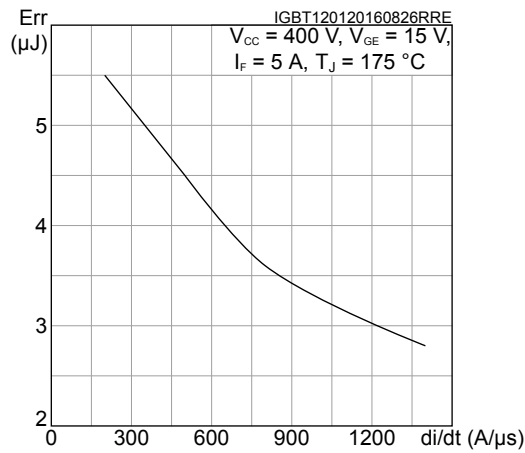
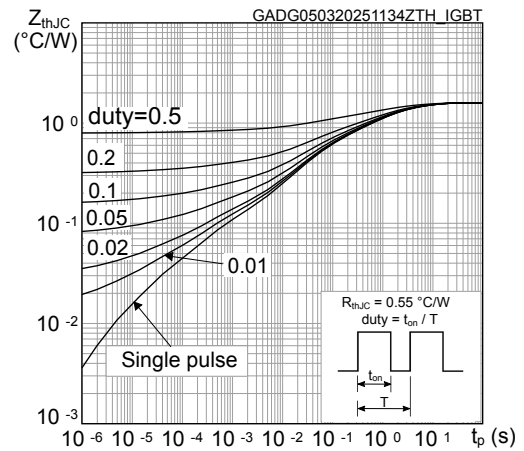
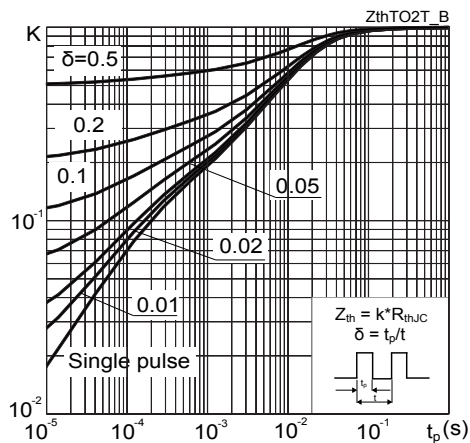
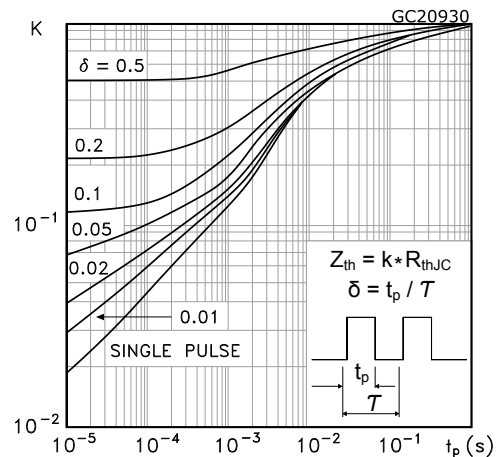
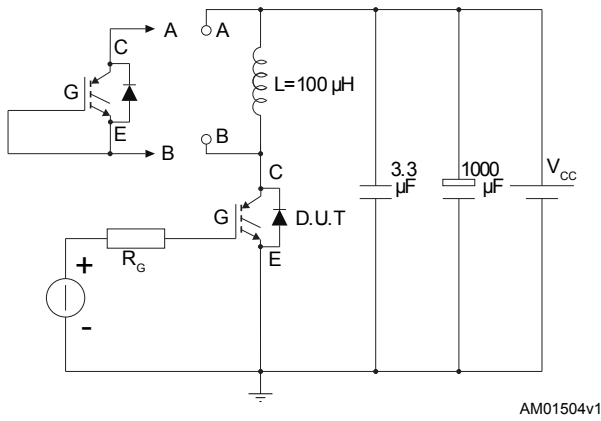
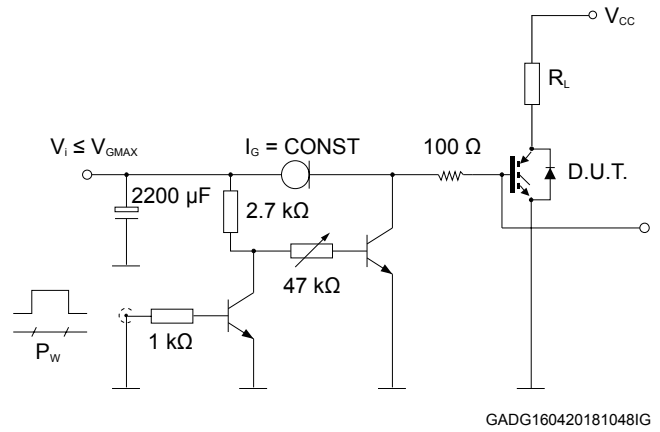
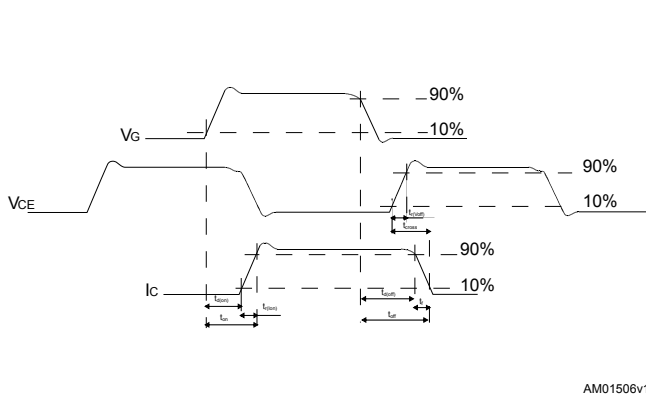
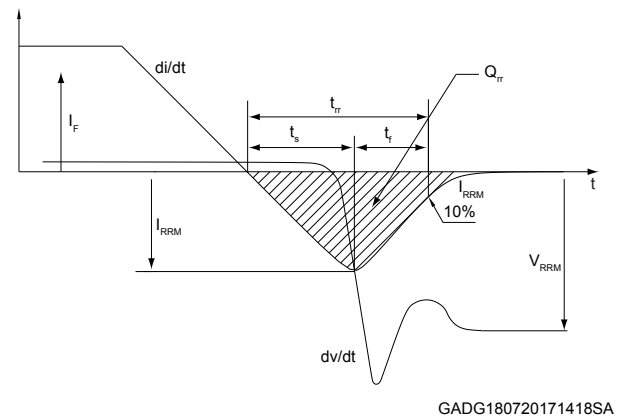
Figure 19. Typical switching energy vs gate resistance

Figure 20. Typical switching times vs collector current

Figure 21. Typical switching times vs gate resistance

Figure 22. Typical reverse recovery current vs diode current slope

Figure 23. Typical reverse recovery time vs diode current slope

Figure 24. Typical reverse recovery charge vs diode current slope


Figure 25. Typical reverse recovery energy vs diode current slope

Figure 26. TO-3PF maximum transient thermal impedance for IGBT

Figure 27. TO-247 long leads normalized transient thermal impedance for IGBT

Figure 28. Normalized transient thermal impedance for diode


3 Test circuits

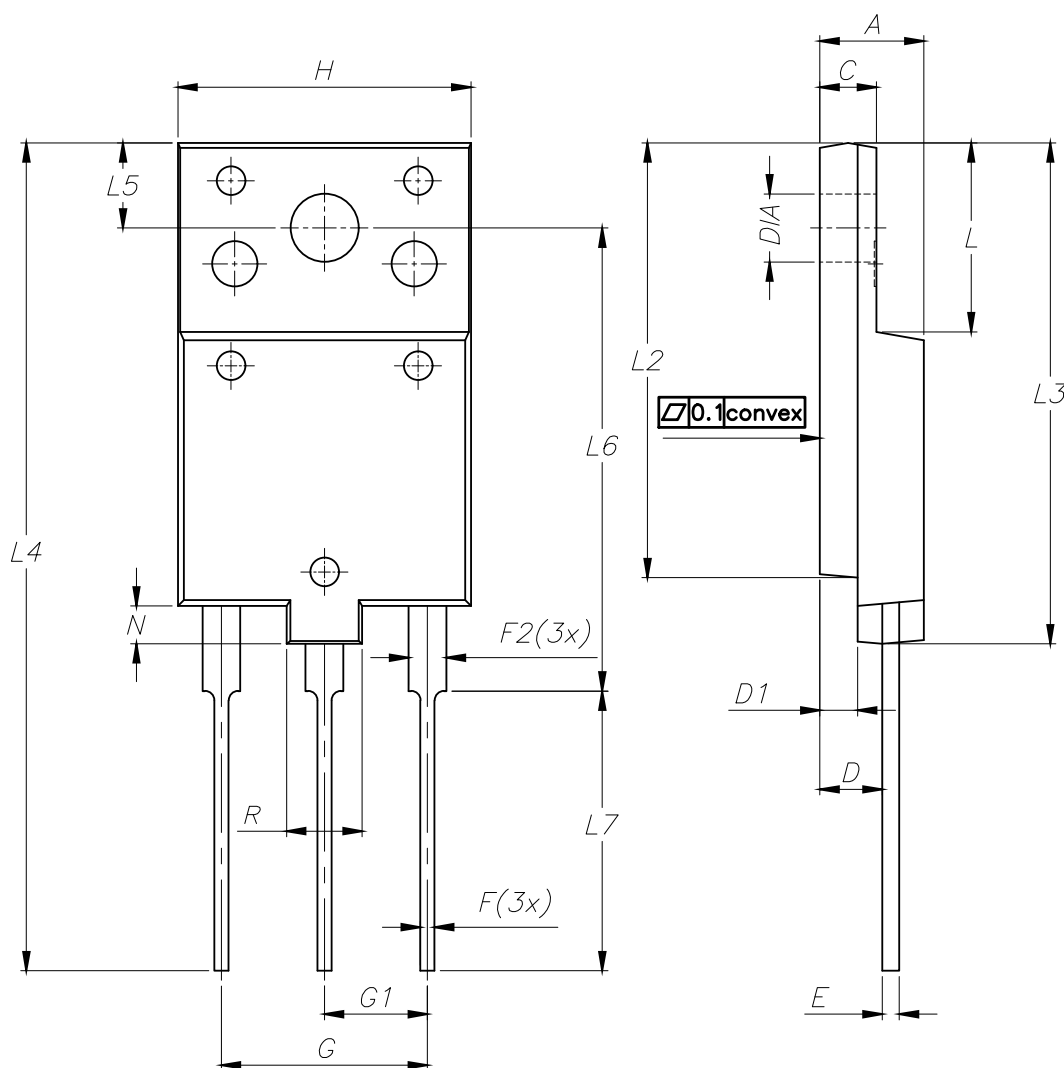
Figure 29. Test circuit for inductive load switching

Figure 30. Gate charge test circuit

Figure 31. Switching waveform

Figure 32. Diode reverse recovery waveform


4 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.

4.1 TO-3PF type A package information

Figure 33. TO-3PF type A package outline



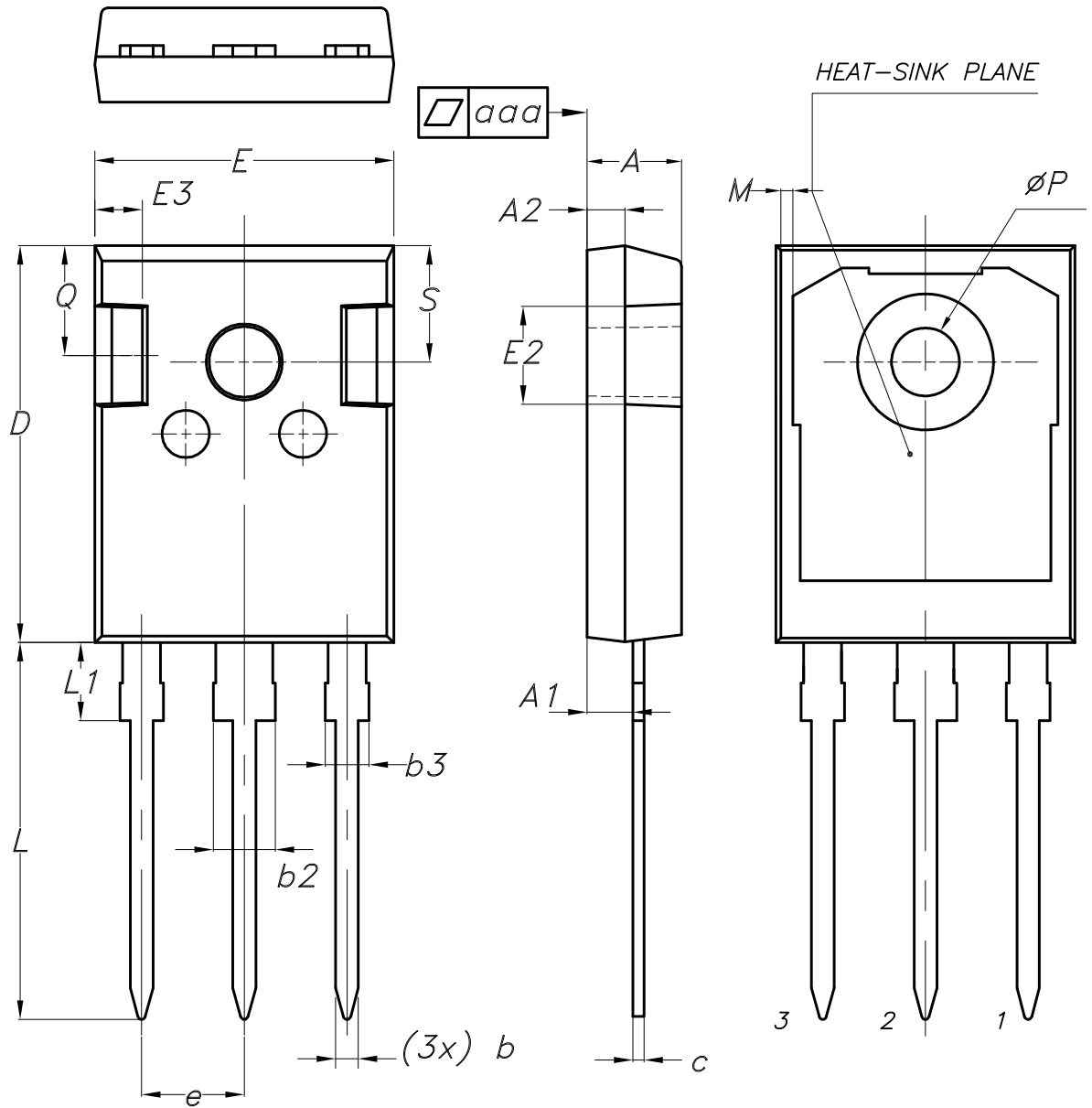
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Table 7. TO-3PF type A mechanical data

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		1.00
F	0.65		0.85
F2	1.80		2.20
G	10.80		11.00
G1	5.35	5.45	5.55
H	15.30		15.70
L	9.80	10.00	10.20
L2	22.80		23.20
L3	26.30		26.70
L4	43.60		44.00
L5	4.30		4.70
L6	24.30		24.70
L7	14.60		15.00
N	1.80		2.20
R	3.80		4.20
Dia	3.40		3.80

4.2 TO-247 long leads package information

Figure 34. TO-247 long leads package outline



BACK VIEW

8463846_6

Table 8. TO-247 long leads package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.26
b2			3.25
b3			2.25
c	0.59		0.66
D	20.90	21.00	21.10
E	15.70	15.80	15.90
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
M	0.35		0.95
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25
aaa		0.04	0.10

Revision history

Table 9. Document revision history

Date	Version	Changes
05-Dec-2019	1	First release.
03-Oct-2024	2	Updated <i>Section 4.1: TO-247 long leads package information</i> . Minor text changes
21-Nov-2024	3	Updated <i>Table 3. Static characteristics</i> . Removed figure <i>Diode V_F vs forward current</i>
05-Mar-2025	4	Added TO-3PF package on cover page and datasheet modified accordingly. Updated <i>Section 1: Electrical ratings</i> . Added <i>Figure 1. TO-3PF total power dissipation vs case temperature</i> , <i>Figure 2. TO-3PF maximum continuous collector current vs case temperature</i> , <i>Figure 9. TO-3PF forward bias safe operating area</i> and <i>Figure 26. TO-3PF maximum transient thermal impedance for IGBT</i> . Minor text changes.



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