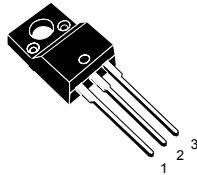
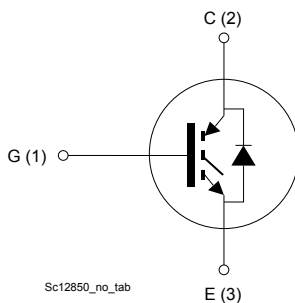


## Trench gate field-stop, 650 V, 20 A, high-speed HB2 series IGBT in a TO-220FP package



TO-220FP



### Features

- Maximum junction temperature :  $T_J = 175\text{ }^\circ\text{C}$
- Low  $V_{CE(sat)} = 1.65\text{ V (typ.) @ } I_C = 20\text{ A}$
- Very fast and soft recovery co-packaged diode
- Minimized tail current
- Tight parameter distribution
- Low thermal resistance
- Positive  $V_{CE(sat)}$  temperature coefficient

### Applications

- Welding
- Power factor correction
- UPS
- Solar inverters
- Chargers

### 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 very fast soft recovery diode 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 link

[STGF20H65DFB2](#)

#### Product summary

<b>Order code</b>	STGF20H65DFB2
<b>Marking</b>	G20H65DFB2
<b>Package</b>	TO-220FP
<b>Packing</b>	Tube

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ V)	650	V
$I_C^{(1)}$	Continuous collector current at $T_C = 25$ °C	40	A
	Continuous collector current at $T_C = 100$ °C	25	A
$I_{CP}^{(2)(3)}$	Pulsed collector current	60	A
$V_{GE}$	Gate-emitter voltage	±20	V
	Transient gate-emitter voltage ( $t_p \leq 10$ μs)	±30	
$I_F^{(1)}$	Continuous forward current at $T_C = 25$ °C	40	A
	Continuous forward current at $T_C = 100$ °C	23	
$I_{FP}^{(2)(3)}$	Pulsed forward current	60	A
$V_{ISO}$	Insulation withstand voltage (RMS) from all three leads to external heat sink ( $t = 1$ s, $T_C = 25$ °C)	2.5	kV
$P_{TOT}$	Total power dissipation at $T_C = 25$ °C	45	W
$T_{STG}$	Storage temperature range	-55 to 150	°C
$T_J$	Operating junction temperature range	-55 to 175	°C

1. Limited by maximum junction temperature.
2. Pulse width is limited by maximum junction temperature.
3. Defined by design, not subject to production test.

**Table 2. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	3.3	°C/W
	Thermal resistance junction-case diode	5.8	
$R_{thJA}$	Thermal resistance junction-ambient	62.5	

## 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	$V_{GE} = 15\text{ V}, I_C = 20\text{ A}$		1.65	2.1	V
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}, T_J = 125\text{ °C}$		1.95		
		$V_{GE} = 15\text{ V}, I_C = 20\text{ A}, T_J = 175\text{ °C}$		2.1		
$V_F$	Forward on-voltage	$I_F = 20\text{ A}$		1.65	2.55	V
		$I_F = 20\text{ A}, T_J = 125\text{ °C}$		1.4		
		$I_F = 20\text{ A}, T_J = 175\text{ °C}$		1.3		
$V_{GE(th)}$	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	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current	$V_{CE} = 0\text{ V}, V_{GE} = \pm 20\text{ V}$			$\pm 250$	nA

**Table 4. Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}, f = 1\text{ MHz}, V_{GE} = 0\text{ V}$	-	1010	-	pF
$C_{oes}$	Output capacitance		-	81	-	
$C_{res}$	Reverse transfer capacitance		-	26	-	
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}, I_C = 20\text{ A}, V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 28. Gate charge test circuit)	-	56	-	nC
$Q_{ge}$	Gate-emitter charge		-	9.4	-	
$Q_{gc}$	Gate-collector charge		-	27.8	-	

**Table 5. Switching characteristics (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$ (see Figure 27. Test circuit for inductive load switching)	-	16	-	ns
$t_r$	Current rise time		-	8	-	ns
$E_{on(1)}$	Turn-on switching energy		-	265	-	$\mu\text{J}$
$t_{d(off)}$	Turn-off delay time		-	78.8	-	ns
$t_f$	Current fall time		-	35	-	ns
$E_{off(2)}$	Turn-off switching energy		-	214	-	$\mu\text{J}$
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 27. Test circuit for inductive load switching)	-	17	-	ns
$t_r$	Current rise time		-	9	-	ns
$E_{on(1)}$	Turn-on switching energy		-	556	-	$\mu\text{J}$
$t_{d(off)}$	Turn-off delay time		-	98	-	ns
$t_f$	Current fall time		-	80	-	ns
$E_{off(2)}$	Turn-off switching energy		-	378	-	$\mu\text{J}$

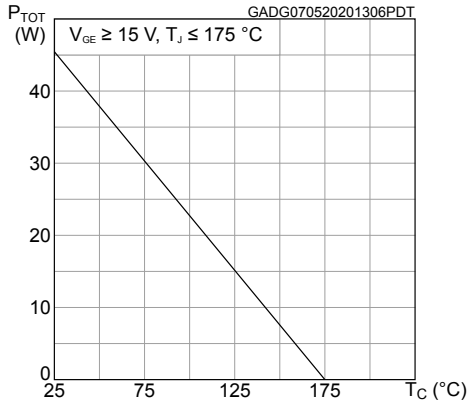
1. Including the reverse recovery of the diode.
2. Including the tail of the collector current.

**Table 6. Diode switching characteristics (inductive load)**

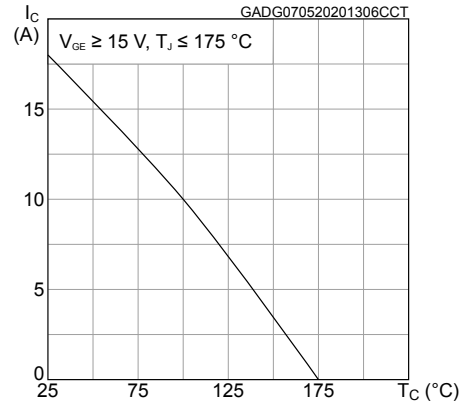
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{rr}$	Reverse recovery time	$I_F = 20\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 30. Diode reverse recovery waveform)	-	215	-	ns
$Q_{rr}$	Reverse recovery charge		-	970	-	nC
$I_{rrm}$	Reverse recovery current		-	17	-	A
$dI_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	303	-	$\text{A}/\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	293	-	$\mu\text{J}$
$t_{rr}$	Reverse recovery time	$I_F = 20\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ , $T_J = 175\text{ }^\circ\text{C}$ (see Figure 30. Diode reverse recovery waveform)	-	330	-	ns
$Q_{rr}$	Reverse recovery charge		-	2772	-	nC
$I_{rrm}$	Reverse recovery current		-	30	-	A
$dI_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	244	-	$\text{A}/\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	866	-	$\mu\text{J}$

## 2.1 Electrical characteristics (curves)

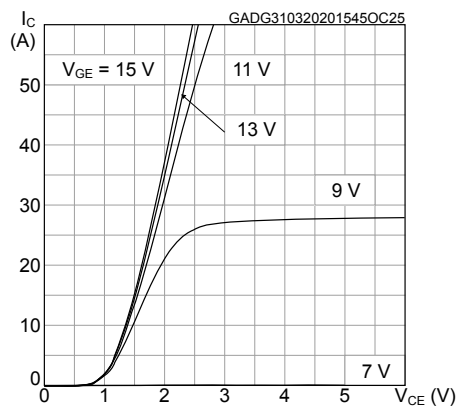
**Figure 1. Power dissipation vs case temperature**



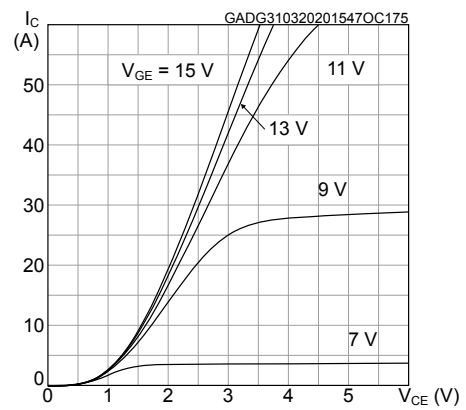
**Figure 2. Collector current vs case temperature**



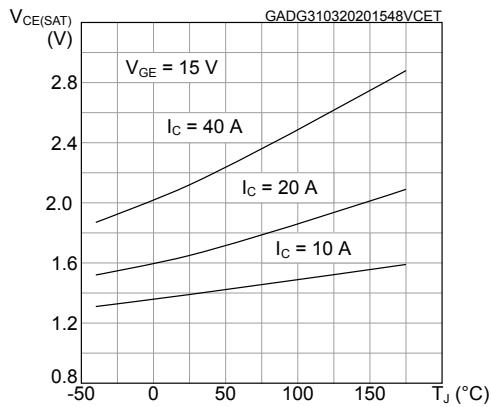
**Figure 3. Output characteristics (T<sub>J</sub> = 25 °C)**



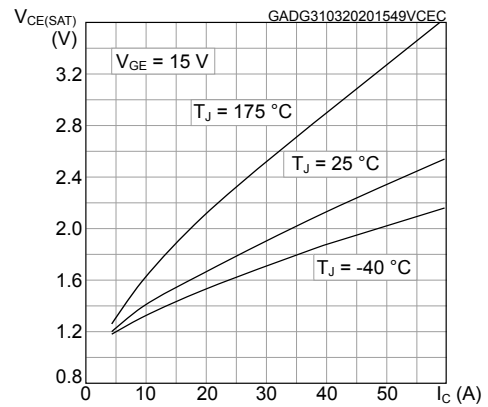
**Figure 4. Output characteristics (T<sub>J</sub> = 175 °C)**



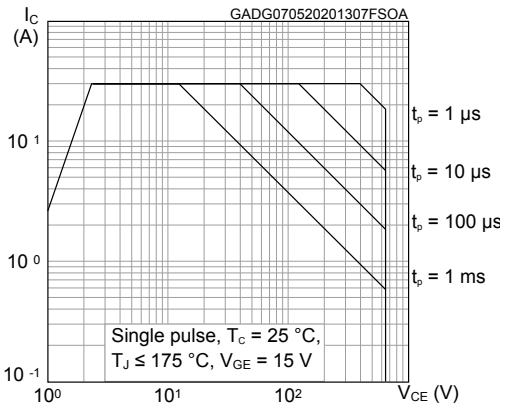
**Figure 5. V<sub>CE(sat)</sub> vs junction temperature**



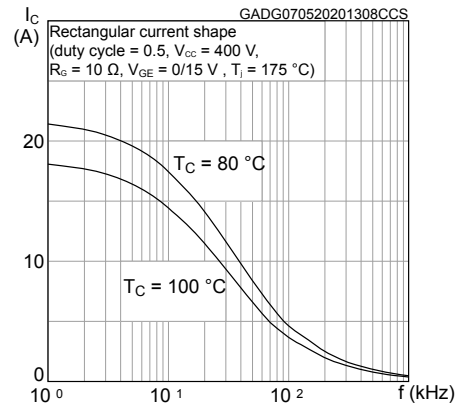
**Figure 6. V<sub>CE(sat)</sub> vs collector current**



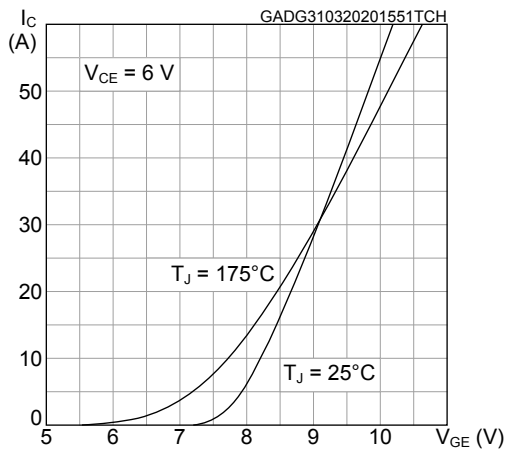
**Figure 7. Forward bias safe operating area**



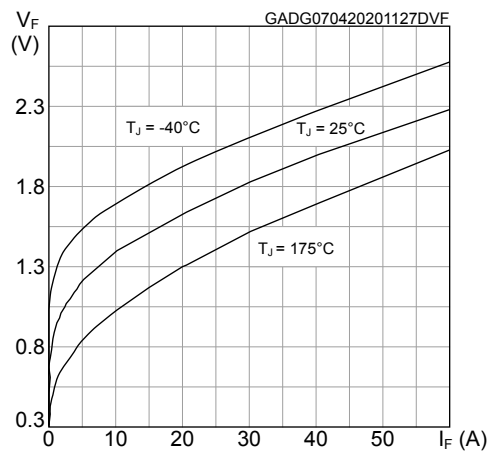
**Figure 8. Collector current vs switching frequency**



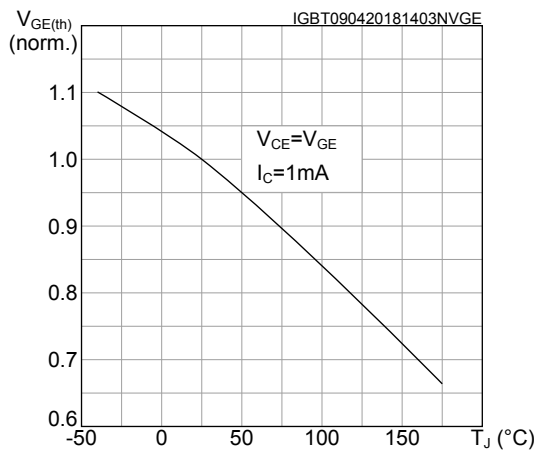
**Figure 9. Transfer characteristics**



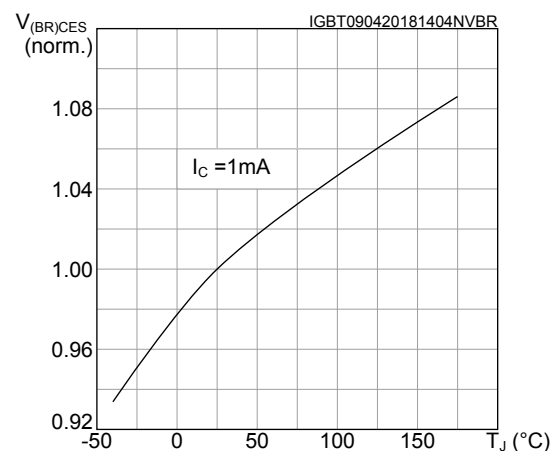
**Figure 10. Diode V\_F vs forward current**



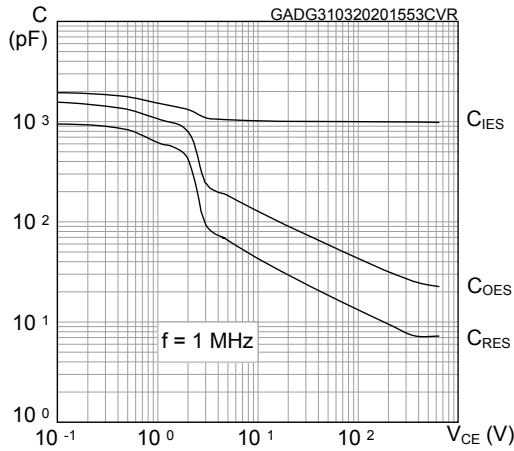
**Figure 11. Normalized V\_GE(th) vs junction temperature**



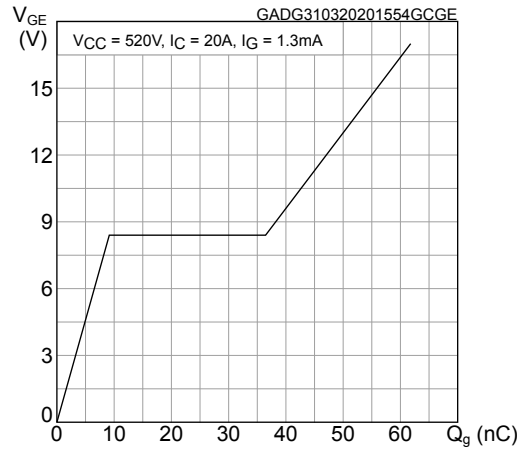
**Figure 12. Normalized V\_(BR)CES vs junction temperature**



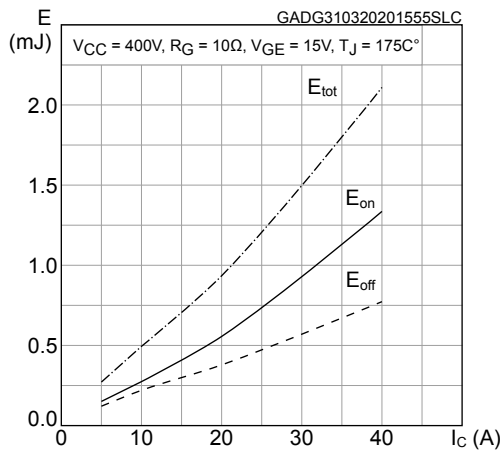
**Figure 13. Capacitance variations**



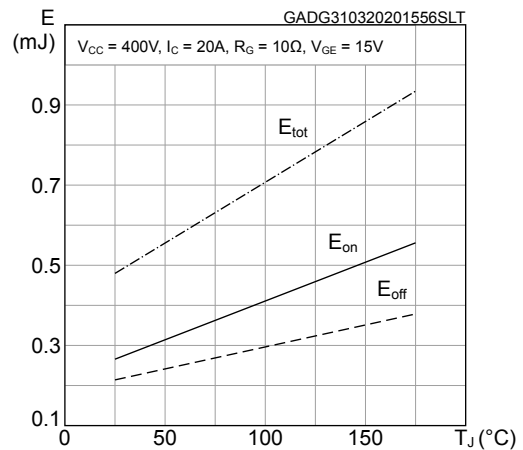
**Figure 14. Gate charge vs gate-emitter voltage**



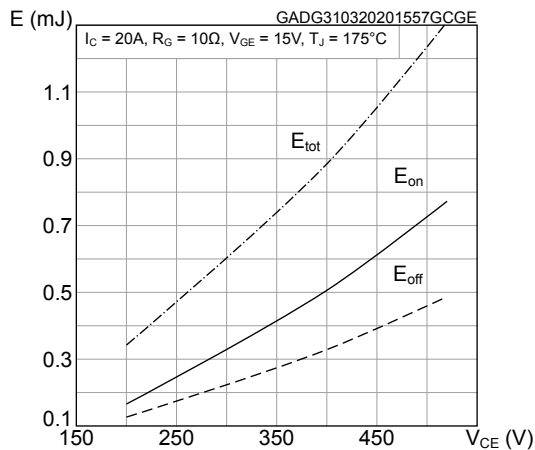
**Figure 15. Switching energy vs collector current**



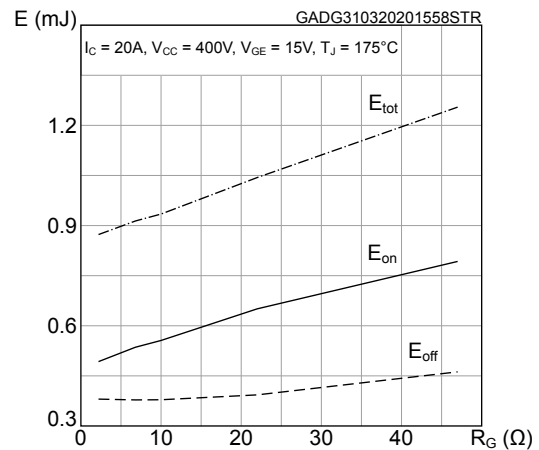
**Figure 16. Switching energy vs temperature**



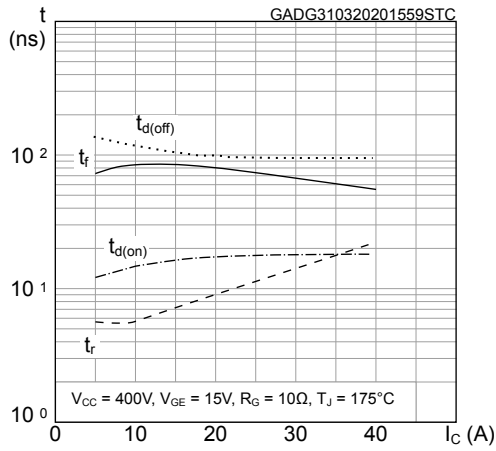
**Figure 17. Switching energy vs collector emitter voltage**



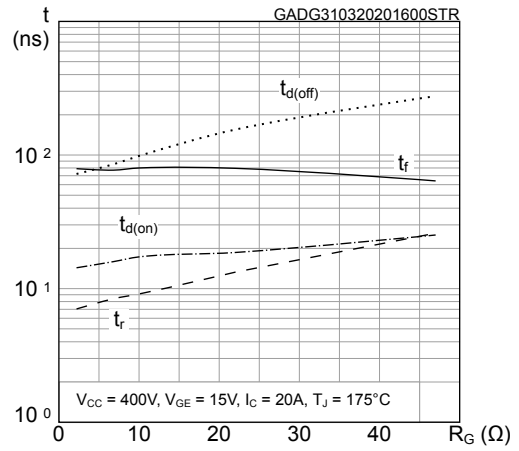
**Figure 18. Switching energy vs gate resistance**



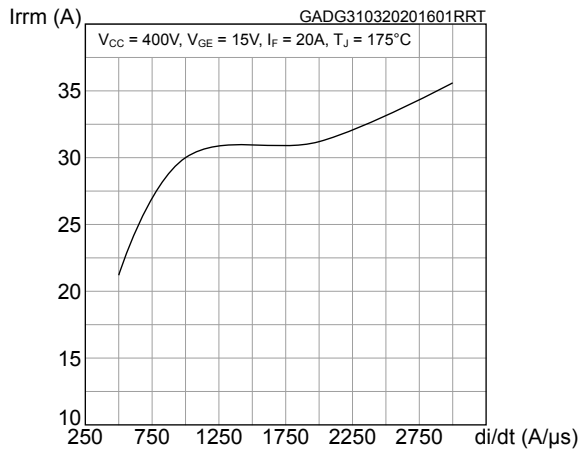
**Figure 19. Switching times vs collector current**



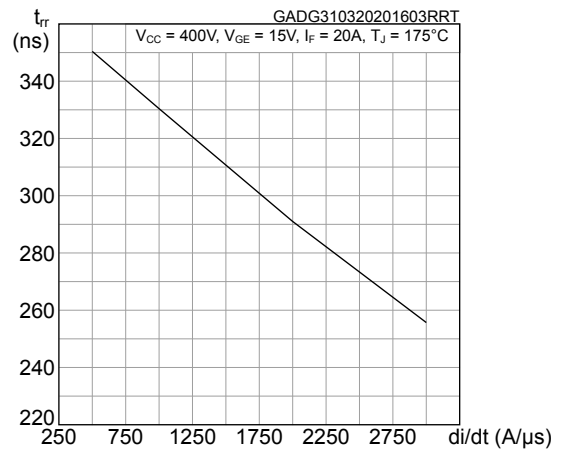
**Figure 20. Switching times vs gate resistance**



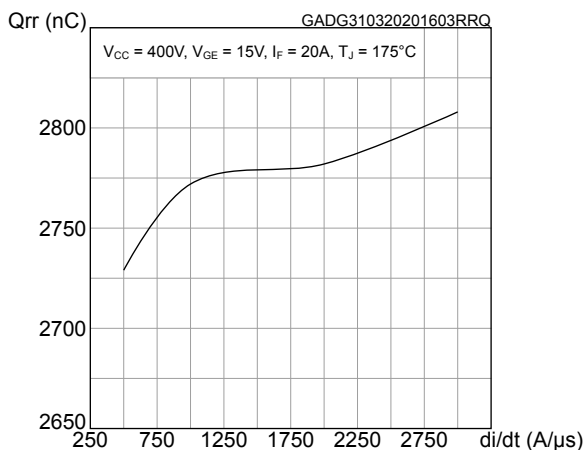
**Figure 21. Reverse recovery current vs diode current slope**



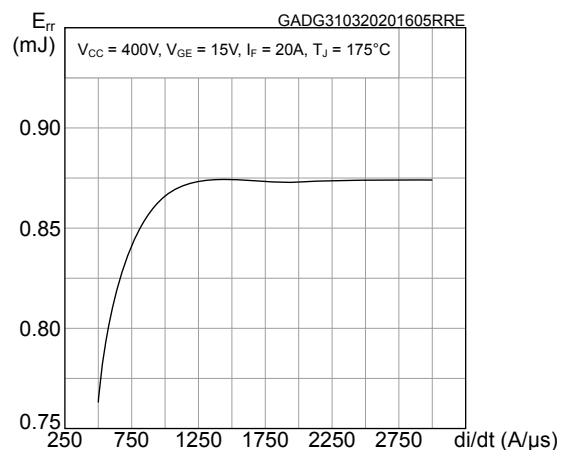
**Figure 22. Reverse recovery time vs diode current slope**



**Figure 23. Reverse recovery charge vs diode current slope**

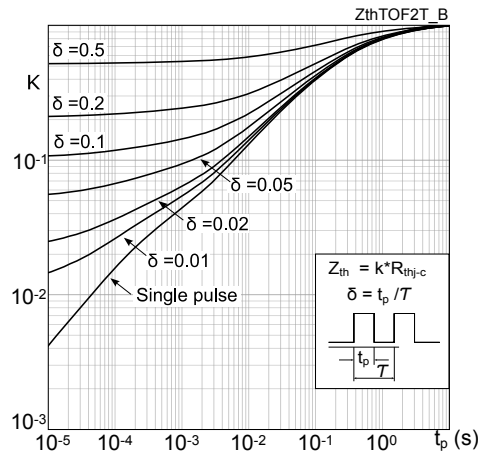


**Figure 24. Reverse recovery energy vs diode current slope**

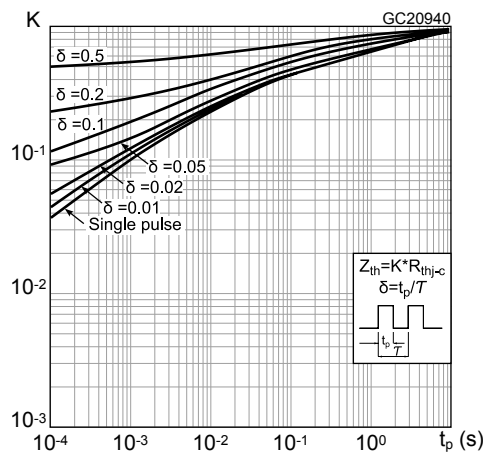




**Figure 25. Thermal impedance for IGBT**



**Figure 26. Thermal impedance for diode**



### 3 Test circuits

Figure 27. Test circuit for inductive load switching

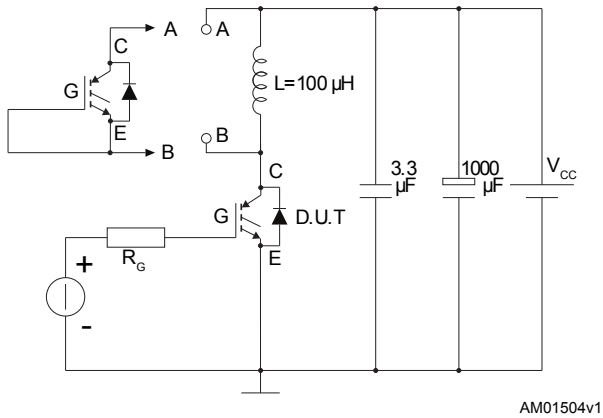


Figure 28. Gate charge test circuit

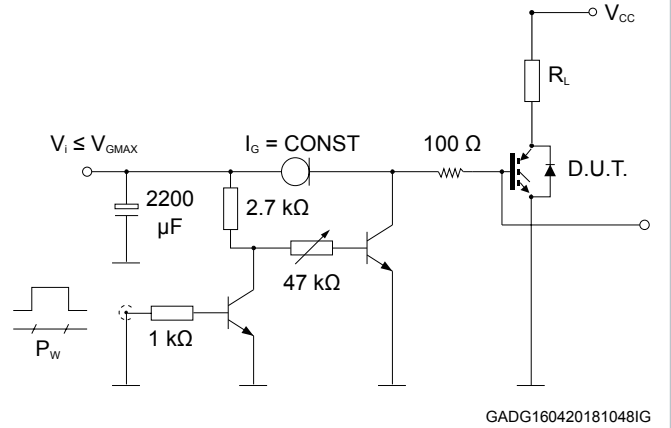


Figure 29. Switching waveform

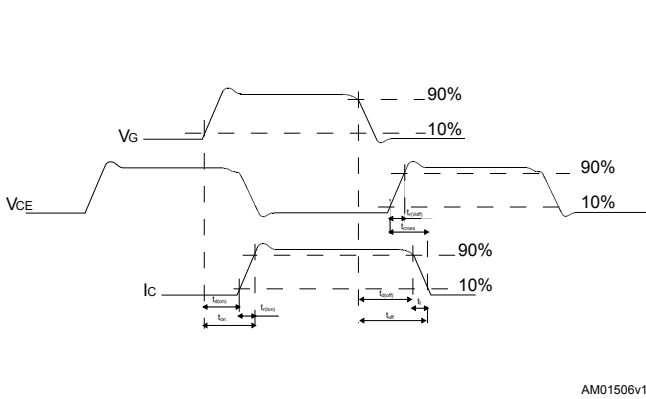
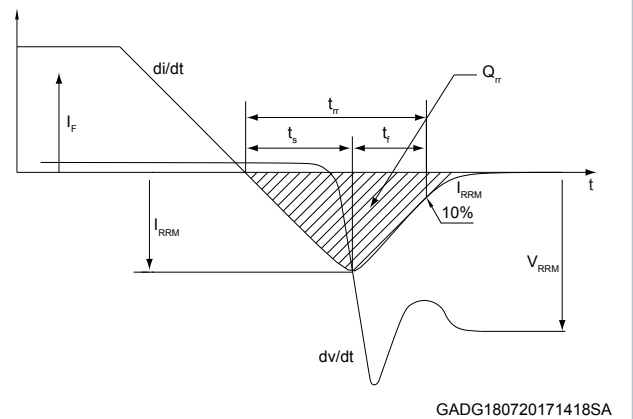


Figure 30. Diode reverse recovery waveform

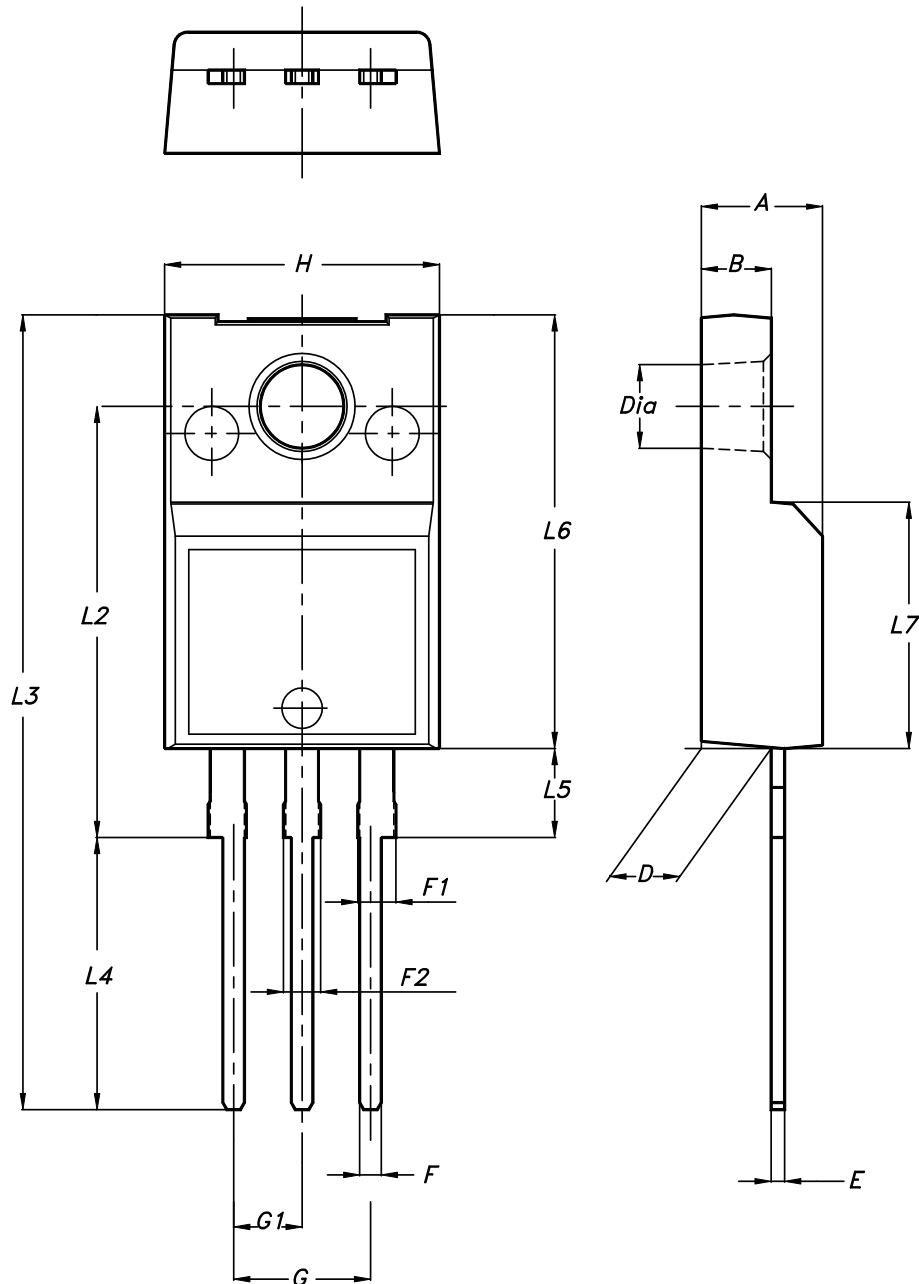


## 4 Package information

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](http://www.st.com). ECOPACK is an ST trademark.

### 4.1 TO-220FP package information

Figure 31. TO-220FP package outline



7012510\_Rev\_13\_B

**Table 7. TO-220FP package mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	4.40		4.60
B	2.50		2.70
D	2.50		2.75
E	0.45		0.70
F	0.75		1.00
F1	1.15		1.70
F2	1.15		1.70
G	4.95		5.20
G1	2.40		2.70
H	10.00		10.40
L2		16.00	
L3	28.60		30.60
L4	9.80		10.60
L5	2.90		3.60
L6	15.90		16.40
L7	9.00		9.30
Dia	3.00		3.20

## Revision history

**Table 8. Document revision history**

Date	Version	Changes
18-May-2020	1	First release.

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<b>2</b>	<b>Electrical characteristics</b> .....	<b>3</b>
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<b>3</b>	<b>Test circuits</b> .....	<b>10</b>
<b>4</b>	<b>Package information</b> .....	<b>11</b>
<b>4.1</b>	<b>TO-220FP package information</b> .....	<b>11</b>
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