

## Trench gate field-stop IGBT, HB series 650 V, 20 A high speed

Datasheet - production data

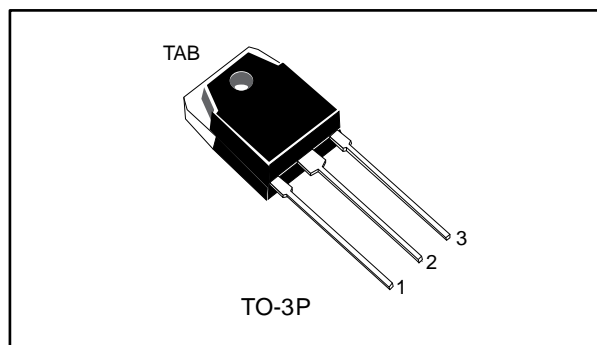
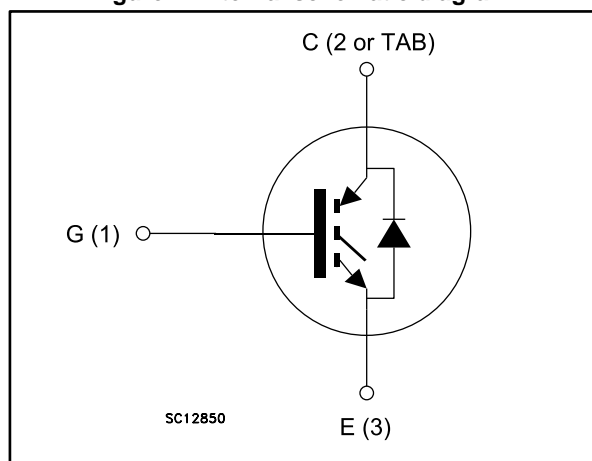


Figure 1: Internal schematic diagram



### Features

- Maximum junction temperature:  $T_J = 175\text{ }^\circ\text{C}$
- Minimized tail current
- $V_{CE(sat)} = 1.55\text{ V (typ.) @ } I_C = 20\text{ A}$
- Tight parameter distribution
- Co-packed diode for protection
- Safe paralleling
- Low thermal resistance

### Applications

- Power factor corrector (PFC)

### Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the new HB series of IGBTs, which represents an optimum compromise between conduction and switching loss to maximize the efficiency of any frequency converter. Furthermore, the slightly positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

Order code	Marking	Package	Packing
STGWT20HP65FB	GWT20HP65FB	TO-3P	Tube

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# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ V)	650	V
$I_C$	Continuous collector current at $T_C = 25$ °C	40	A
	Continuous collector current at $T_C = 100$ °C	20	
$I_{CP}^{(1)}$	Pulsed collector current	80	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F$	Continuous forward current at $T_C = 25$ °C <sup>(2)</sup>	5	A
	Continuous forward current at $T_C = 100$ °C	5	
$I_{FP}^{(3)}$	Pulsed forward current	10	A
$P_{TOT}$	Total dissipation at $T_C = 25$ °C	168	W
$T_{STG}$	Storage temperature range	-55 to 150	°C
$T_J$	Operating junction temperature range	-55 to 175	

**Notes:**

(1) Pulse width limited by maximum junction temperature

(2) Limited by wires

(3) Pulsed forward current

**Table 3: Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case IGBT	0.9	°C/W
$R_{thJC}$	Thermal resistance junction-case diode	5	
$R_{thJA}$	Thermal resistance junction-ambient	50	

## 2 Electrical characteristics

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

**Table 4: Static characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}$ , $I_C = 2\text{ mA}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$		1.55	2.0	V
		$V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$ , $T_J = 125\text{ °C}$		1.65		
		$V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$ , $T_J = 175\text{ °C}$		1.75		
$V_F$	Forward on-voltage	$I_F = 5\text{ A}$		2		V
		$I_F = 5\text{ A}$ , $T_J = 125\text{ °C}$		1.85		
		$I_F = 5\text{ A}$ , $T_J = 175\text{ °C}$		1.75		
$V_{GE(th)}$	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 5: Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$	-	2764	-	pF
$C_{oes}$	Output capacitance		-	80	-	
$C_{res}$	Reverse transfer capacitance		-	60	-	
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 27: "Gate charge test circuit"</a> )	-	120	-	nC
$Q_{ge}$	Gate-emitter charge		-	20	-	
$Q_{gc}$	Gate-collector charge		-	50	-	

**Table 6: IGBT switching characteristics (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(off)}$	Turn-off delay time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$ (see <a href="#">Figure 26: "Test circuit for inductive load switching"</a> )	-	139	-	ns
$t_f$	Current fall time		-	20	-	ns
$E_{off}^{(1)}$	Turn-off switching energy		-	170	-	$\mu\text{J}$
$t_{d(off)}$	Turn-off-delay time	$V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 10\ \Omega$ , $T_J = 175\text{ °C}$ (see <a href="#">Figure 26: "Test circuit for inductive load switching"</a> )	-	147	-	ns
$t_f$	Current fall time		-	38	-	ns
$E_{off}^{(1)}$	Turn-off switching energy		-	353	-	$\mu\text{J}$

**Notes:**

<sup>(1)</sup>Including the tail of the collector current

Table 7: 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 <a href="#">Figure 26: "Test circuit for inductive load switching"</a> )	-	140	-	ns
$Q_{rr}$	Reverse recovery charge		-	21	-	nC
$I_{rrm}$	Reverse recovery current		-	6.6	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	430	-	A/ $\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	1.6	-	$\mu\text{J}$
$t_{rr}$	Reverse recovery time	$I_F = 5\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ (see <a href="#">Figure 26: "Test circuit for inductive load switching"</a> )	-	200	-	ns
$Q_{rr}$	Reverse recovery charge		-	47.3	-	nC
$I_{rrm}$	Reverse recovery current		-	9.6	-	A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	428	-	A/ $\mu\text{s}$
$E_{rr}$	Reverse recovery energy		-	3.2	-	$\mu\text{J}$

## 2.1 Electrical characteristics (curves)

Figure 2: Output characteristics ( $T_J = 25\text{ }^\circ\text{C}$ )

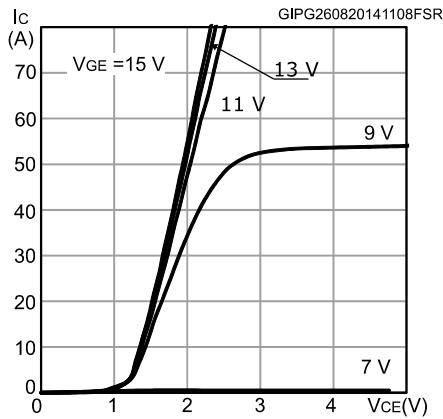


Figure 3: Output characteristics ( $T_J = 175\text{ }^\circ\text{C}$ )

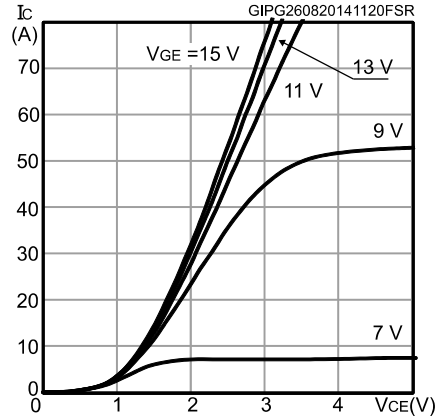


Figure 4: Transfer characteristics

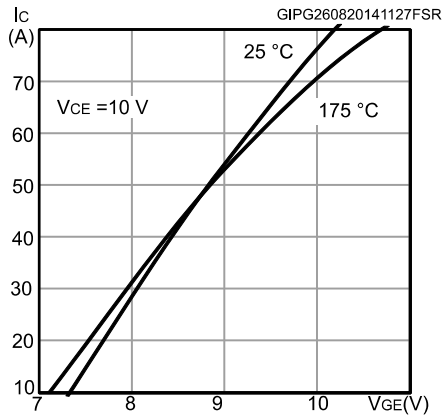


Figure 5: Collector current vs. case temperature

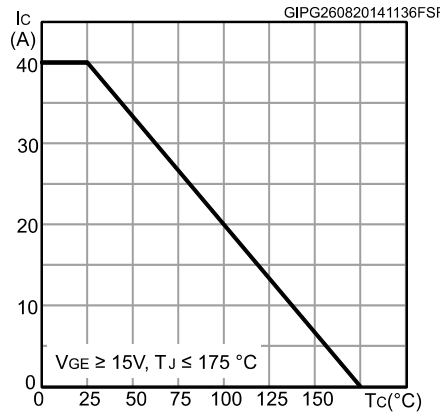


Figure 6:  $V_{CE(sat)}$  vs. junction temperature

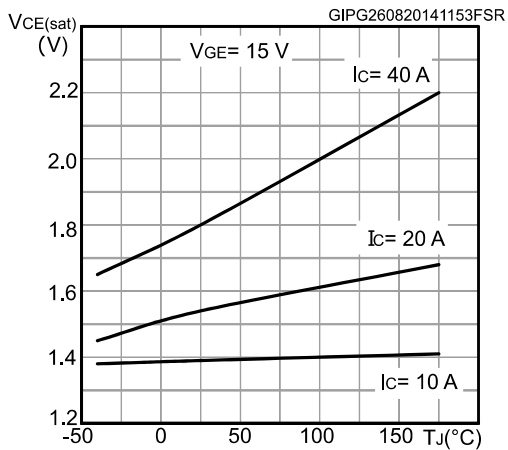


Figure 7: Power dissipation vs. case temperature

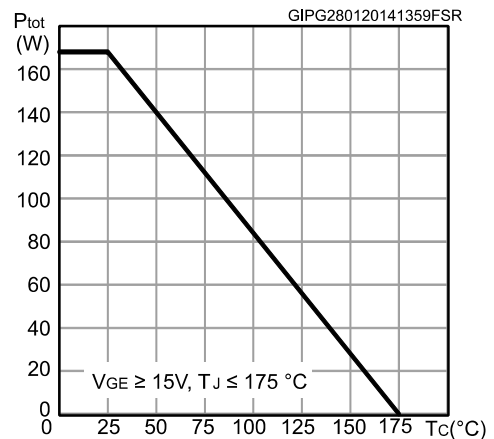


Figure 8: Forward bias safe operating area

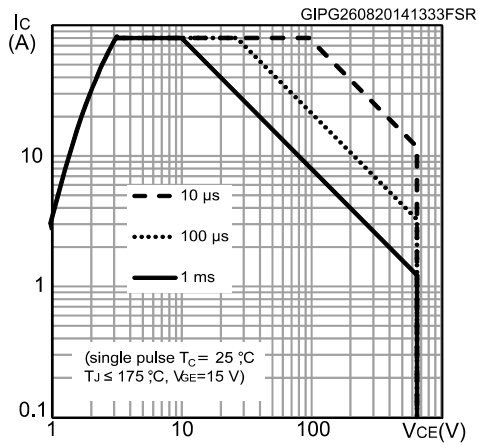


Figure 9: Collector current vs. switching frequency

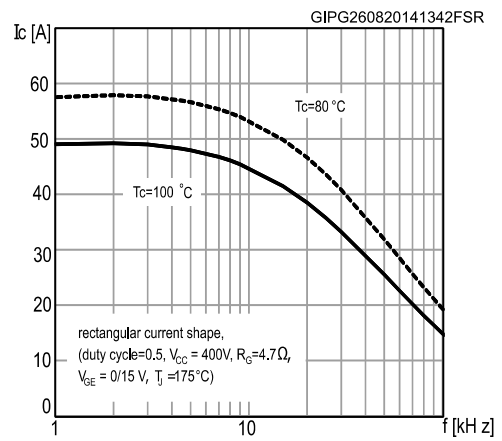


Figure 10: Normalized  $V_{GE(th)}$  vs. junction temperature

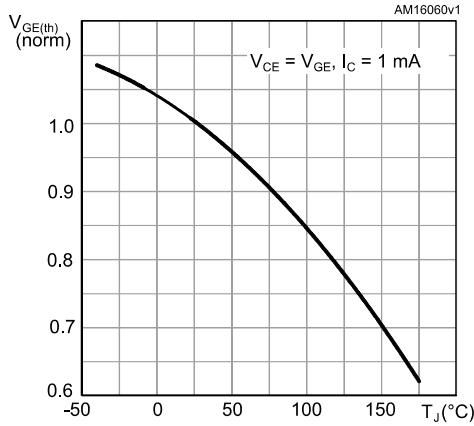


Figure 11: Normalized  $V_{(BR)CES}$  vs. junction temperature

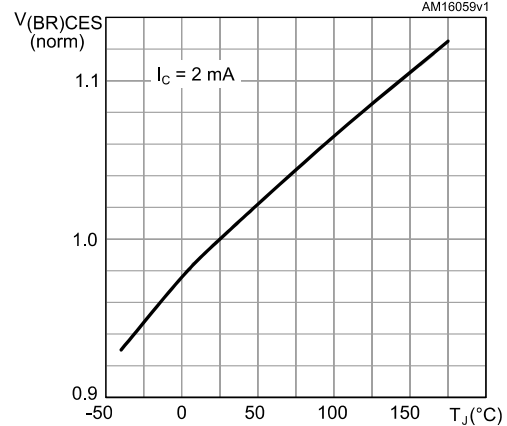


Figure 12: Switching energy vs. collector current

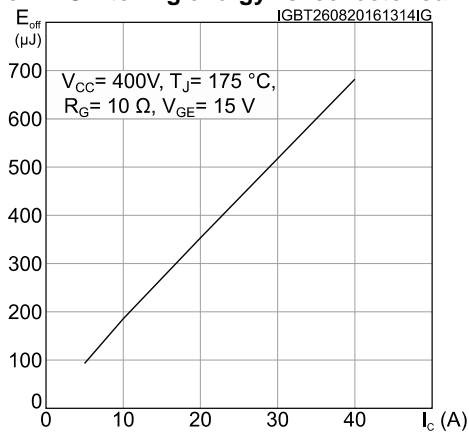


Figure 13: Switching energy vs. gate resistance

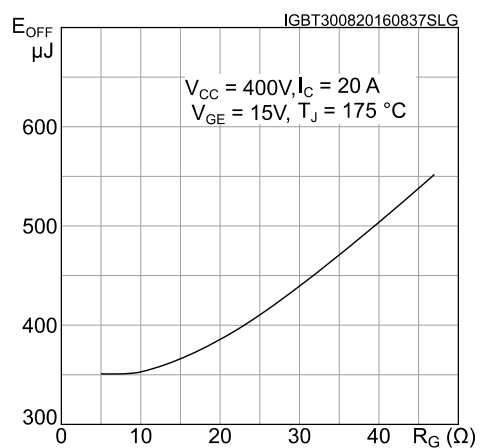


Figure 14: Switching energy vs. temperature

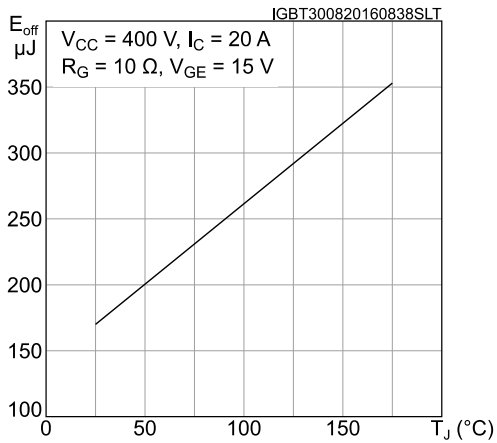


Figure 15: Switching energy vs. collector emitter voltage

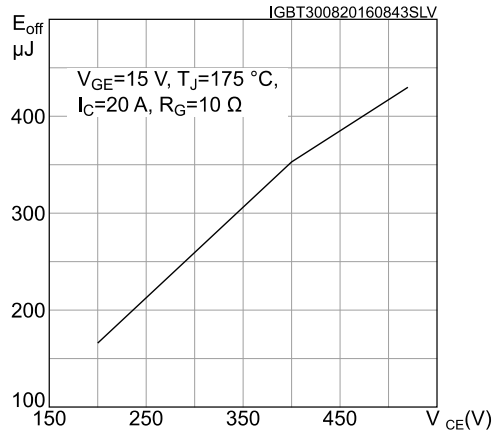


Figure 16: Switching times vs. collector current

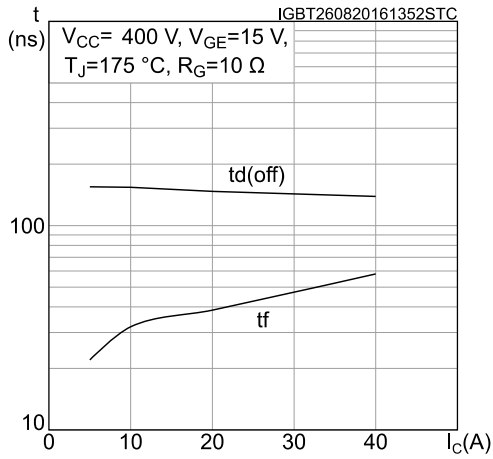


Figure 17: Switching time vs. gate resistance

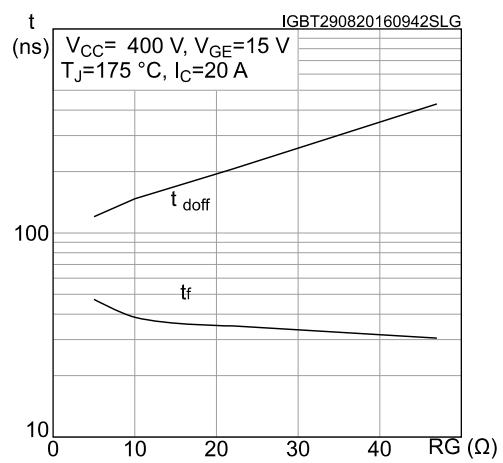


Figure 18: Capacitance variations

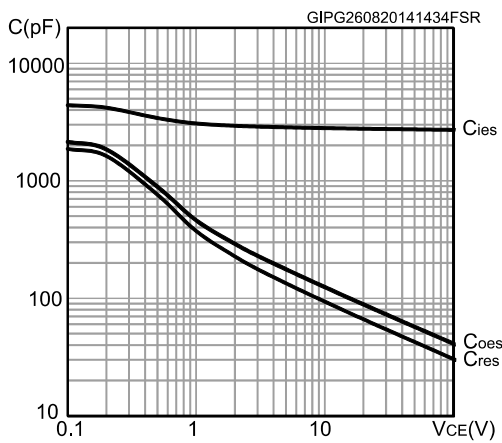
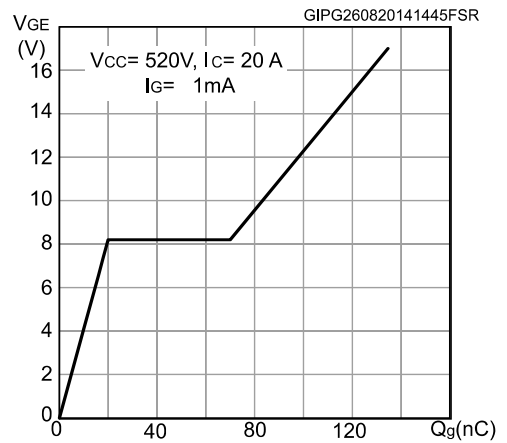
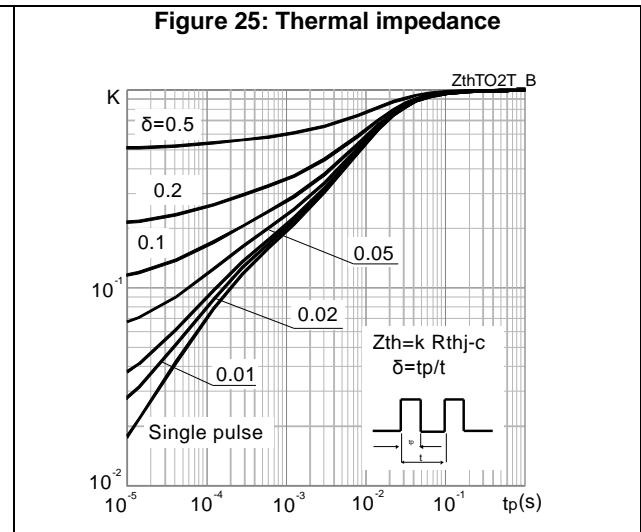
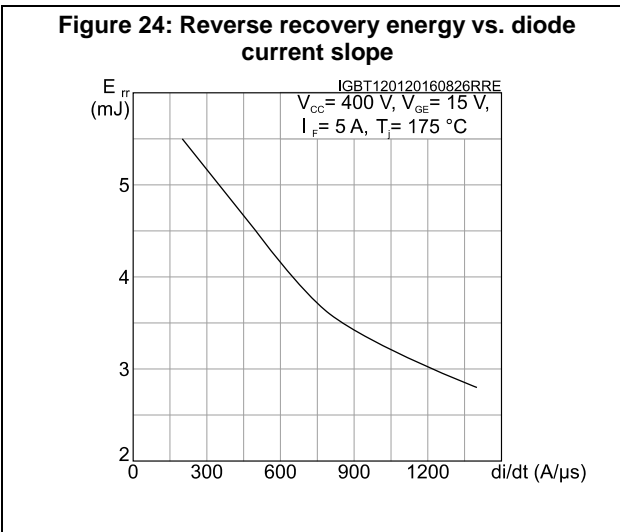
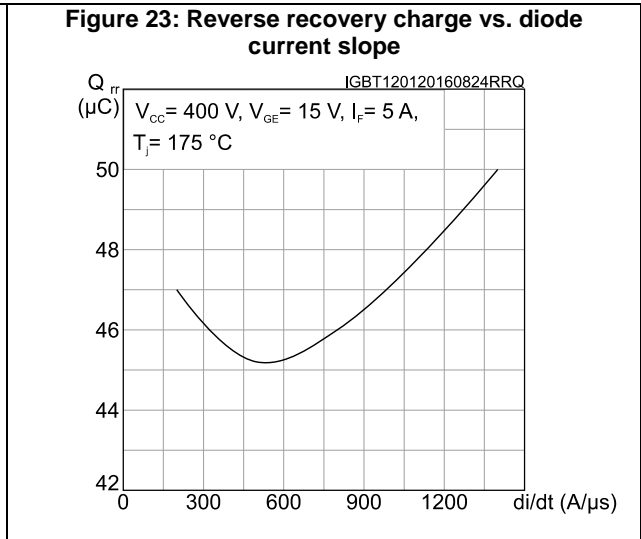
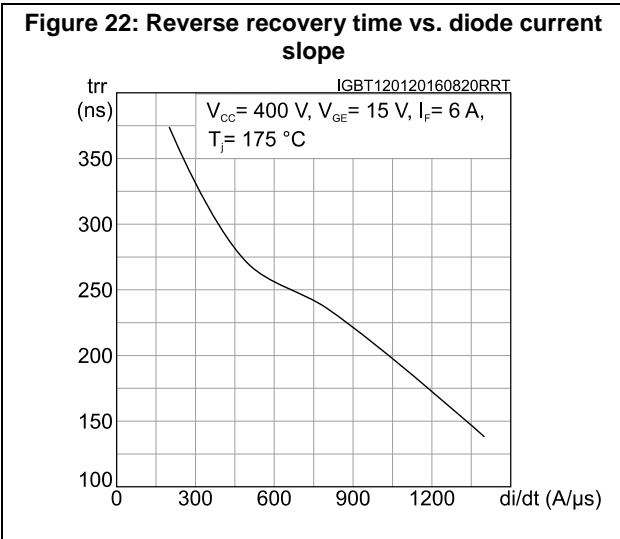
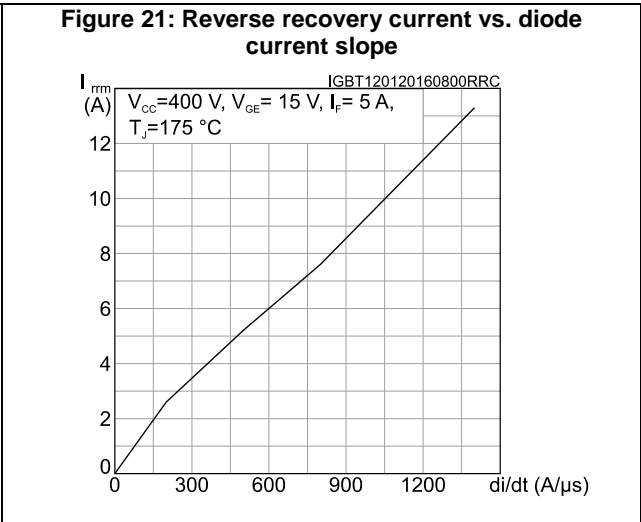
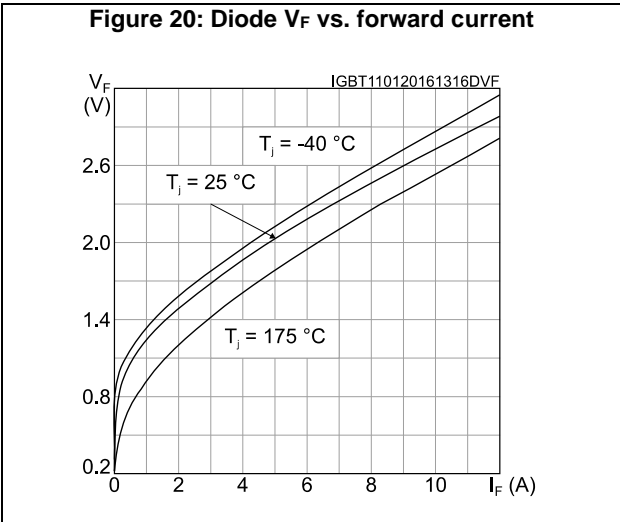


Figure 19: Gate charge vs. gate-emitter voltage

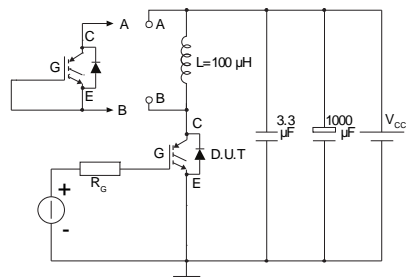






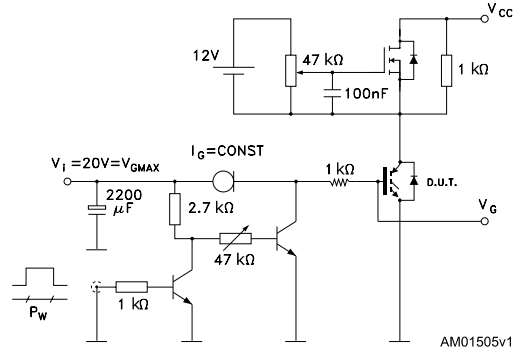
### 3 Test circuits

**Figure 26: Test circuit for inductive load switching**



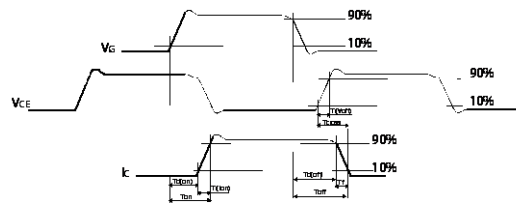
AM01504v1

**Figure 27: Gate charge test circuit**



AM01505v1

**Figure 28: Switching waveform**



AM01506v1

## 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-3P package information

Figure 29: TO-3P package outline

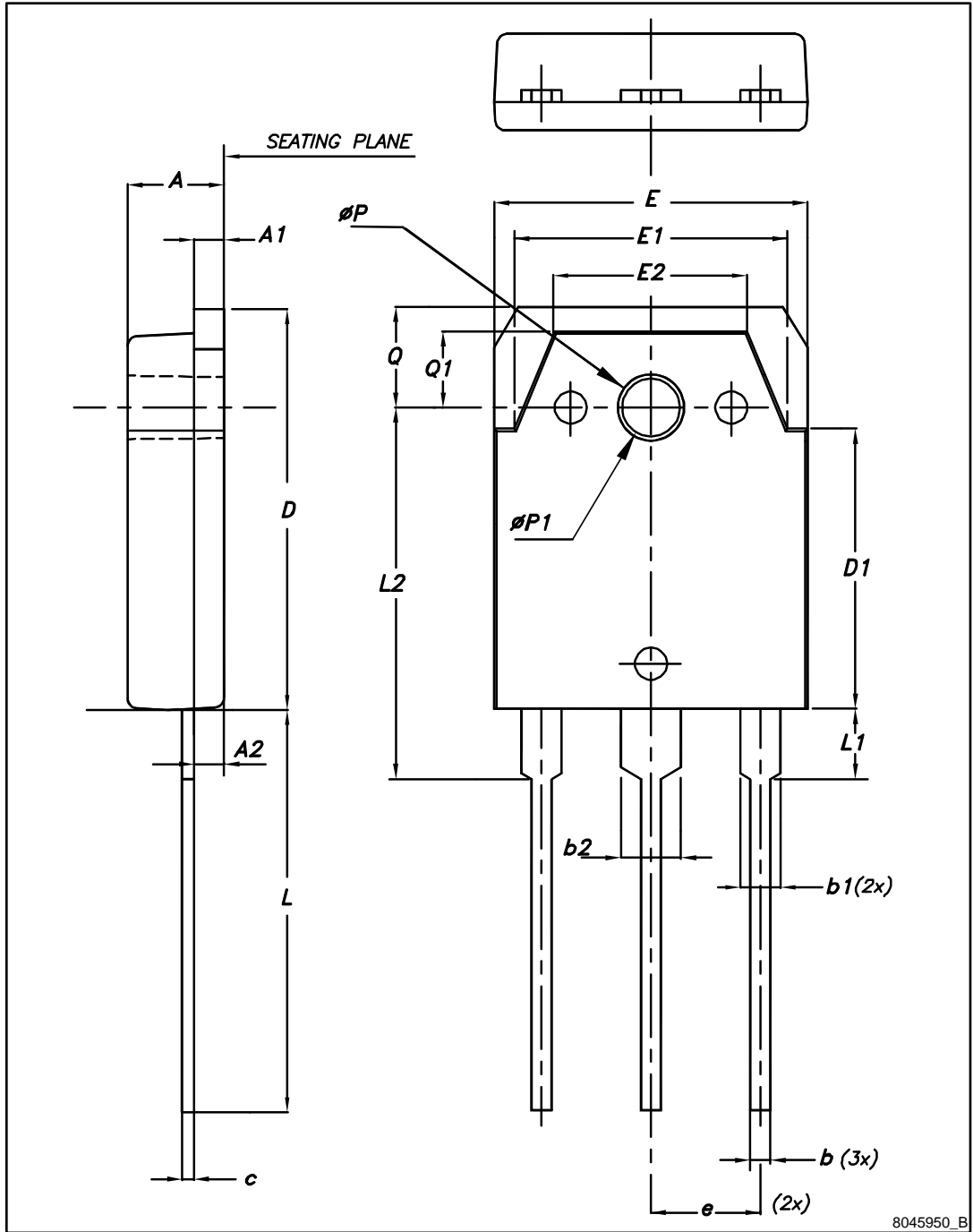


Table 8: TO-3P package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.60	4.80	5.00
A1	1.45	1.50	1.65
A2	1.20	1.40	1.60
b	0.80	1.00	1.20
b1	1.80	2.00	2.20
b2	2.80	3.00	3.20
c	0.55	0.60	0.75
D	19.70	19.90	20.10
D1	13.70	13.90	14.10
E	15.40	15.60	15.80
E1	13.40	13.60	13.80
E2	9.40	9.60	9.90
e	5.15	5.45	5.75
L	19.80	20.00	20.20
L1	3.30	3.50	3.70
L2	18.20	18.40	18.60
ØP	3.30	3.40	3.50
ØP1	3.10	3.20	3.30
Q	4.80	5.00	5.20
Q1	3.60	3.80	4

## 5 Revision history

Table 9: Document revision history

Date	Revision	Changes
31-Aug-2016	1	First release.
28-Sep-2016	2	Datasheet promoted from preliminary to production data.
13-Dec-2016	3	<p>Updated <a href="#">Figure 1: "Internal schematic diagram"</a>.</p> <p>Updated <a href="#">Table 4: "Static characteristics"</a> and <a href="#">Table 7: "Diode switching characteristics (inductive load)"</a>.</p> <p>Added <a href="#">Figure 20: "Diode VF vs. forward current"</a>, <a href="#">Figure 21: "Reverse recovery current vs. diode current slope"</a>, <a href="#">Figure 22: "Reverse recovery time vs. diode current slope"</a>, <a href="#">Figure 23: "Reverse recovery charge vs. diode current slope"</a> and <a href="#">Figure 24: "Reverse recovery energy vs. diode current slope"</a>.</p> <p>Updated <a href="#">Figure 2: "Output characteristics (TJ = 25 °C)"</a>, <a href="#">Figure 12: "Switching energy vs. collector current"</a> and <a href="#">Figure 17: "Switching time vs. gate resistance"</a>.</p> <p>Minor text changes</p>

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