

## Trench gate field-stop IGBT M series, 650 V, 15 A low-loss in a TO-220FP package

Datasheet - production data

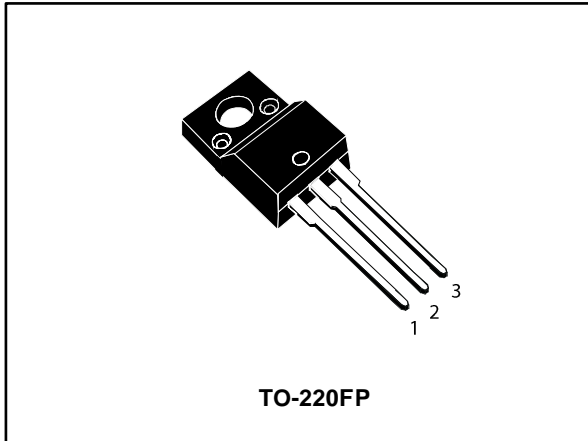
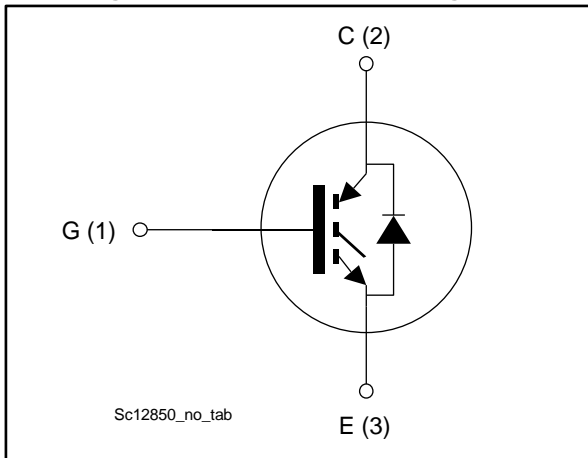


Figure 1: Internal schematic diagram



### Features

- 6  $\mu$ s of short-circuit withstand time
- $V_{CE(sat)} = 1.55$  V (typ.) @  $I_C = 15$  A
- Tight parameter distribution
- Safer paralleling
- Positive  $V_{CE(sat)}$  temperature coefficient
- Low thermal resistance
- Soft and very fast recovery antiparallel diode
- Maximum junction temperature:  $T_J = 175$  °C

### Applications

- Motor control
- UPS
- PFC
- General purpose inverter

### Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the M series IGBTs, which represent an optimal balance between inverter system performance and efficiency where low-loss and short-circuit functionality are essential. Furthermore, the positive  $V_{CE(sat)}$  temperature coefficient and tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

Order code	Marking	Package	Packing
STGF15M65DF2	G15M65DF2	TO-220FP	Tube

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## Contents

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# 1 Electrical ratings

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V <sub>CES</sub>	Collector-emitter voltage (V <sub>GE</sub> = 0 V)	650	V
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 25 °C	30	A
I <sub>C</sub> <sup>(1)</sup>	Continuous collector current at T <sub>C</sub> = 100 °C	15	A
I <sub>CP</sub> <sup>(2)</sup>	Pulsed collector current	60	A
V <sub>GE</sub>	Gate-emitter voltage	±20	V
I <sub>F</sub> <sup>(1)</sup>	Continuous forward current at T <sub>C</sub> = 25 °C	30	A
I <sub>F</sub> <sup>(1)</sup>	Continuous forward current at T <sub>C</sub> = 100 °C	15	A
I <sub>FP</sub> <sup>(2)</sup>	Pulsed forward current	60	A
V <sub>ISO</sub>	Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T <sub>C</sub> = 25 °C)	2.5	kV
P <sub>TOT</sub>	Total dissipation at T <sub>C</sub> = 25 °C	31	W
T <sub>STG</sub>	Storage temperature range	- 55 to 150	°C
T <sub>J</sub>	Operating junction temperature range	- 55 to 175	°C

**Notes:**

<sup>(1)</sup>Limited by maximum junction temperature.

<sup>(2)</sup>Pulse width limited by maximum junction temperature.

Table 3: Thermal data

Symbol	Parameter	Value	Unit
R <sub>thJC</sub>	Thermal resistance junction-case IGBT	4.8	°C/W
R <sub>thJC</sub>	Thermal resistance junction-case diode	6.25	°C/W
R <sub>thJA</sub>	Thermal resistance junction-ambient	62.5	°C/W

## 2 Electrical characteristics

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

**Table 4: Static characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}$ , $I_C = 250\text{ }\mu\text{A}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 15\text{ A}$		1.55	2.0	V
		$V_{GE} = 15\text{ V}$ , $I_C = 15\text{ A}$ , $T_J = 125\text{ °C}$		1.9		
		$V_{GE} = 15\text{ V}$ , $I_C = 15\text{ A}$ , $T_J = 175\text{ °C}$		2.1		
$V_F$	Forward on-voltage	$I_F = 15\text{ A}$		1.7	2.6	V
		$I_F = 15\text{ A}$ , $T_J = 125\text{ °C}$		1.5		
		$I_F = 15\text{ A}$ , $T_J = 175\text{ °C}$		1.4		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 500\text{ }\mu\text{A}$	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	$V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$			$\pm 250$	$\mu\text{A}$

**Table 5: Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0\text{ V}$	-	1250	-	pF
$C_{oes}$	Output capacitance		-	80	-	
$C_{res}$	Reverse transfer capacitance		-	25	-	
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}$ , $I_C = 15\text{ A}$ , $V_{GE} = 0\text{ to }15\text{ V}$ (see <a href="#">Figure 30: "Gate charge test circuit"</a> )	-	45	-	nC
$Q_{ge}$	Gate-emitter charge		-	11	-	
$Q_{gc}$	Gate-collector charge		-	15	-	

Table 6: IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 15\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 12\ \Omega$ (see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )	-	24	-	ns
$t_r$	Current rise time		-	7.8	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1570	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off-delay time		-	93	-	ns
$t_f$	Current fall time		-	106	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	0.09	-	mJ
$E_{off}^{(2)}$	Turn-off switching energy		-	0.45	-	mJ
$E_{ts}$	Total switching energy		-	0.54	-	mJ
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 400\text{ V}$ , $I_C = 15\text{ A}$ , $V_{GE} = 15\text{ V}$ , $R_G = 12\ \Omega$ $T_J = 175\text{ }^\circ\text{C}$ (see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )	-	24.8	-	ns
$t_r$	Current rise time		-	9.2	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1300	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off-delay time		-	96	-	ns
$t_f$	Current fall time		-	169	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	0.22	-	mJ
$E_{off}^{(2)}$	Turn-off switching energy		-	0.61	-	mJ
$E_{ts}$	Total switching energy		-	0.83	-	mJ
$t_{sc}$	Short-circuit withstand time	$V_{CC} \leq 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_{Jstart} = 150\text{ }^\circ\text{C}$	6		-	$\mu$ s
		$V_{CC} \leq 400\text{ V}$ , $V_{GE} = 13\text{ V}$ , $T_{Jstart} = 150\text{ }^\circ\text{C}$	10			

**Notes:**

(1)Including the reverse recovery of the diode.

(2)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	$I_F = 15\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ (see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )	-	142		ns
$Q_{rr}$	Reverse recovery charge		-	525		nC
$I_{rrm}$	Reverse recovery current		-	13.4		A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	790		A/ $\mu$ s
$E_{rr}$	Reverse recovery energy		-	64		$\mu$ J
$t_{rr}$	Reverse recovery time	$I_F = 15\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $di/dt = 1000\text{ A}/\mu\text{s}$ , $T_J = 175\text{ }^\circ\text{C}$ (see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> )	-	241		ns
$Q_{rr}$	Reverse recovery charge		-	1690		nC
$I_{rrm}$	Reverse recovery current		-	20		A
$dl_{rr}/dt$	Peak rate of fall of reverse recovery current during $t_b$		-	420		A/ $\mu$ s
$E_{rr}$	Reverse recovery energy		-	176		$\mu$ J

## 2.1 Electrical characteristics (curves)

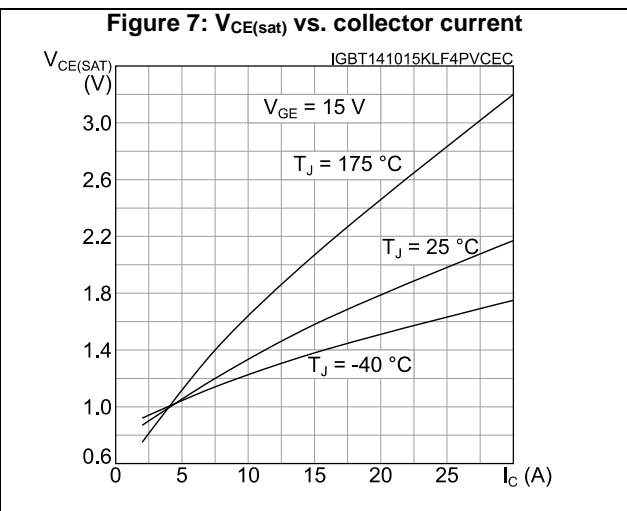
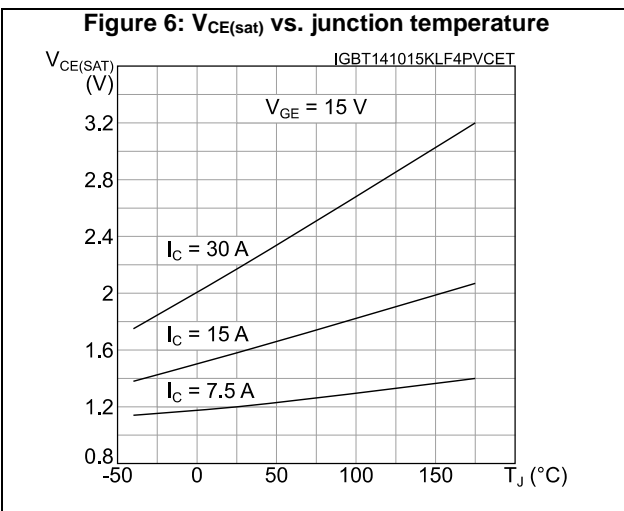
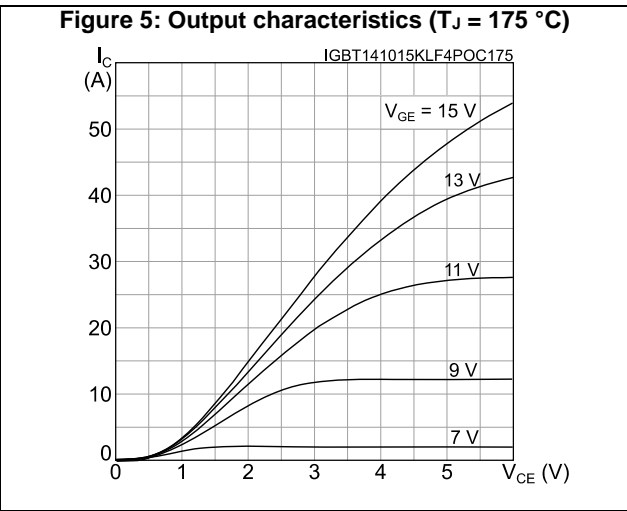
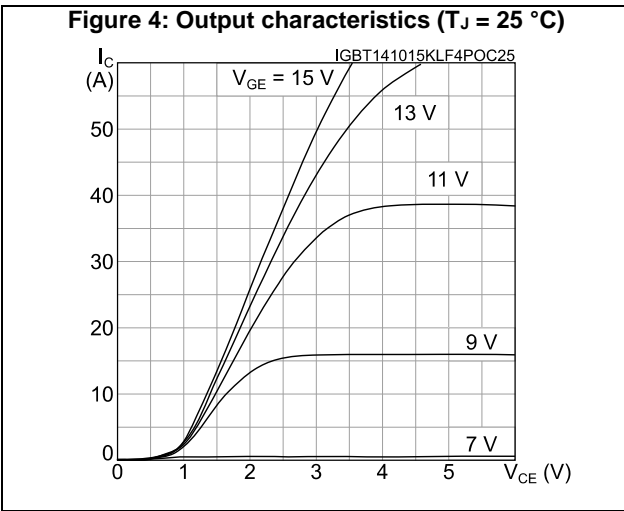
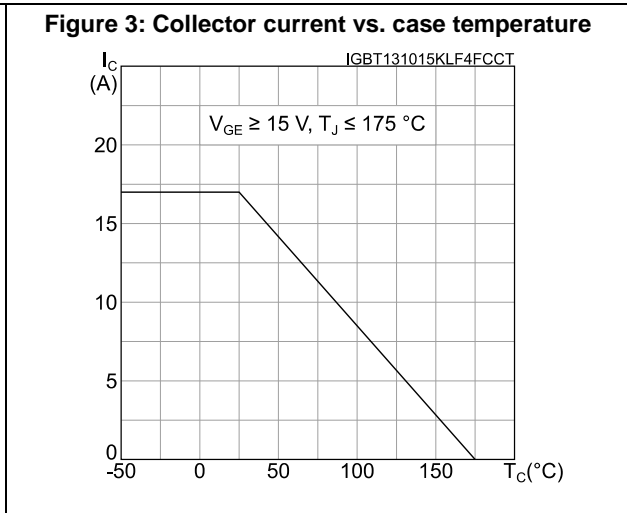
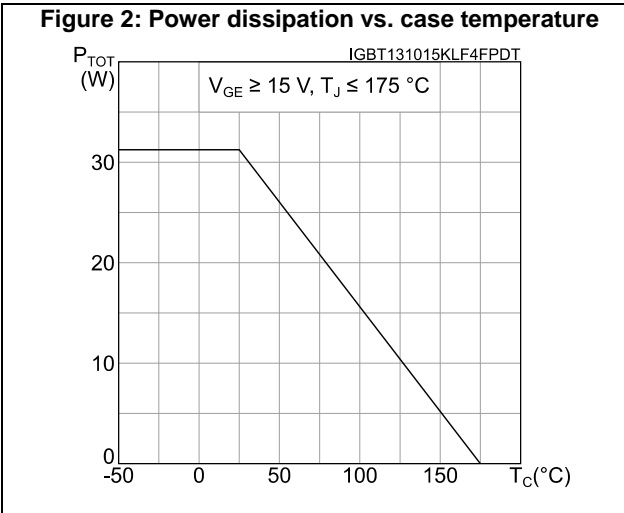


Figure 8: Collector current vs. switching frequency

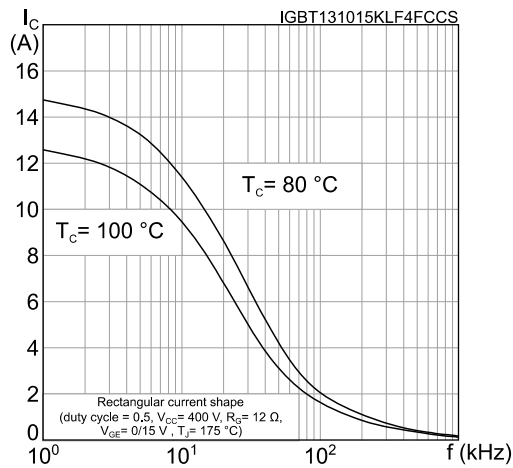


Figure 9: Forward bias safe operating area

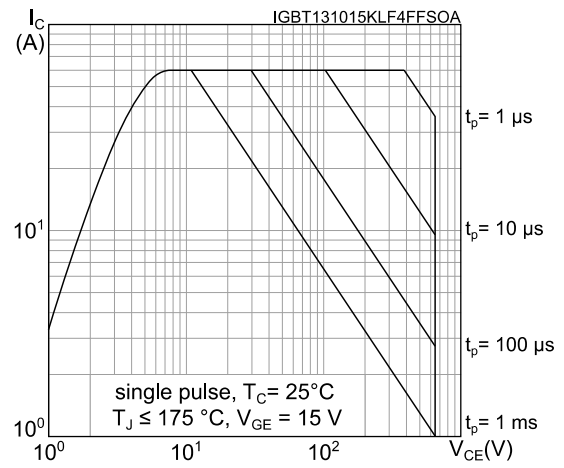


Figure 10: Transfer characteristics

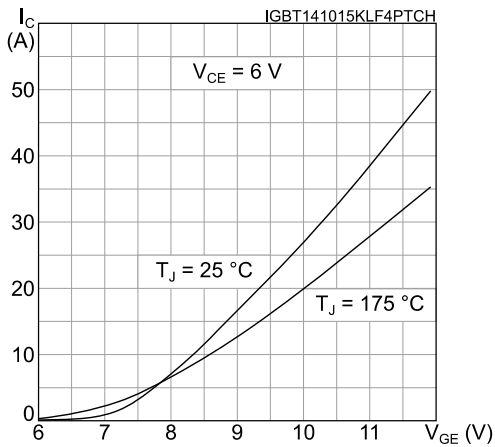


Figure 11: Diode Vf vs. forward current

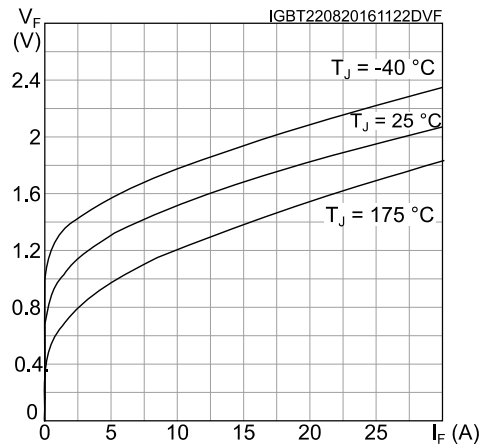


Figure 12: Normalized VGE(th) vs. junction temperature

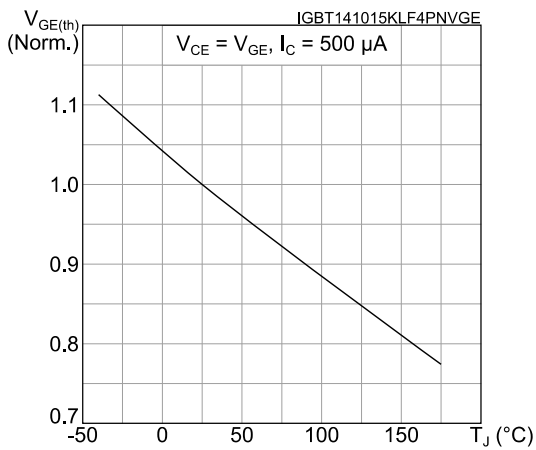
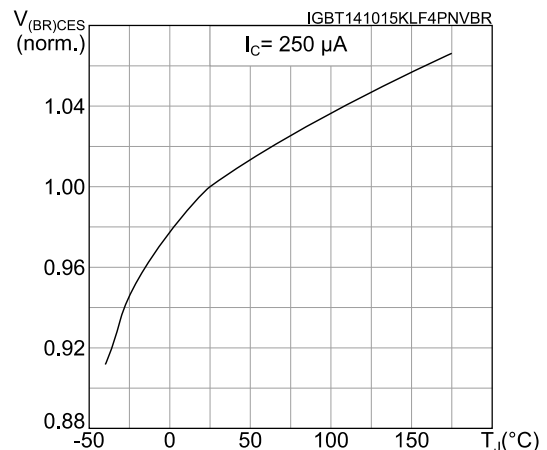
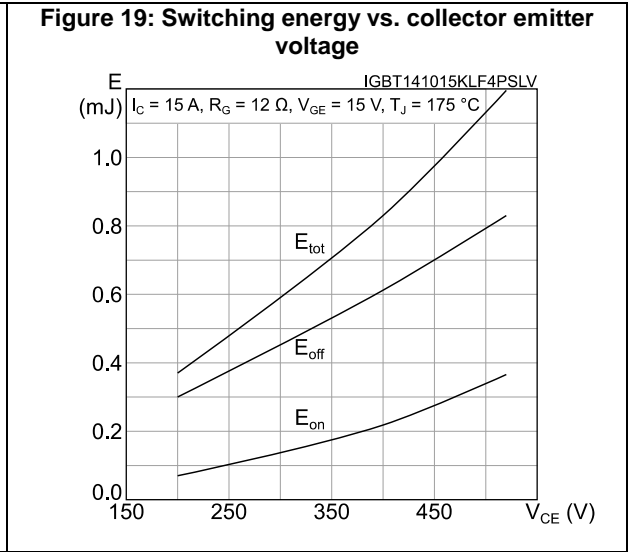
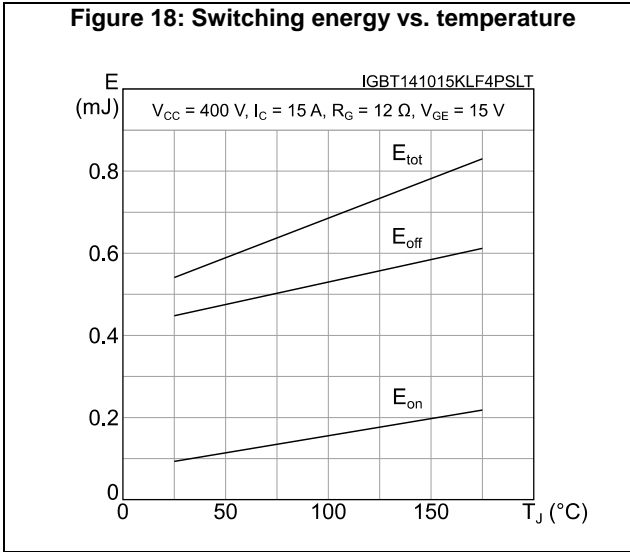
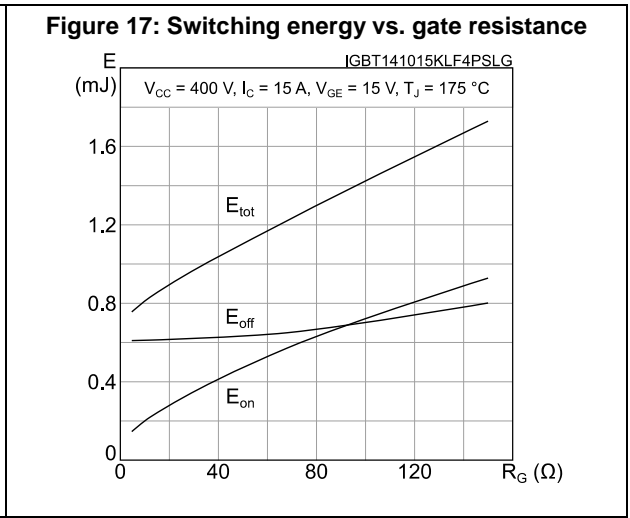
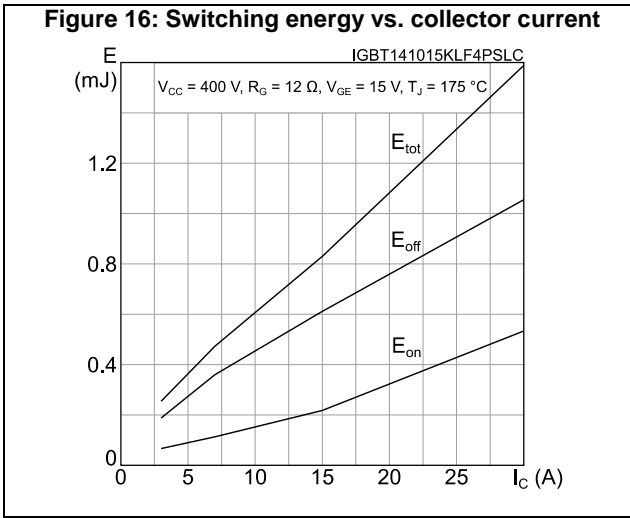
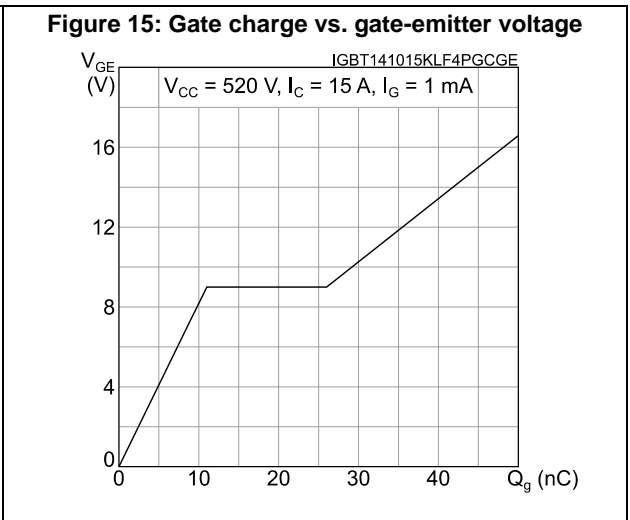
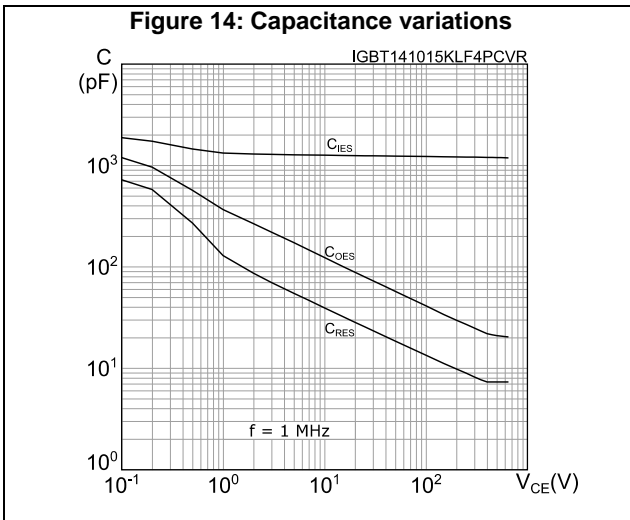


Figure 13: Normalized V(BR)CES vs. junction temperature







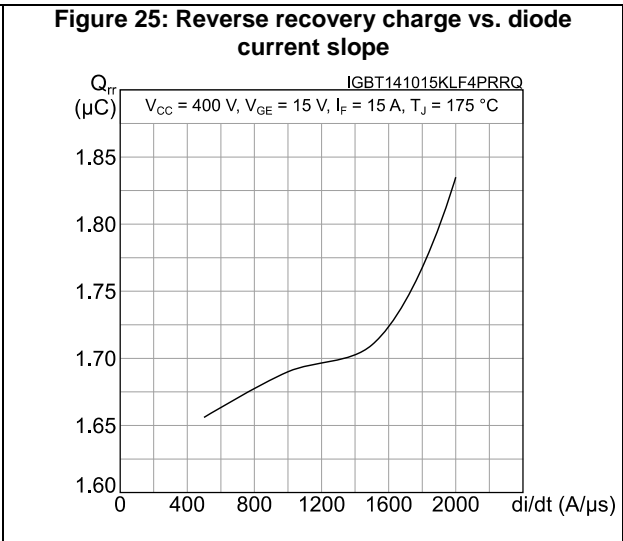
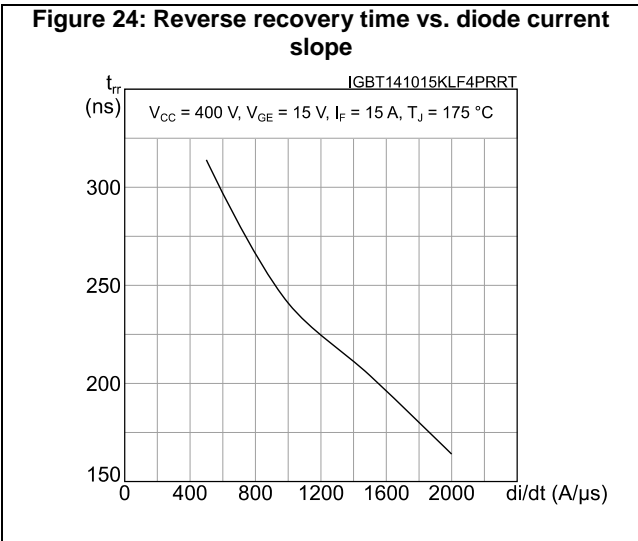
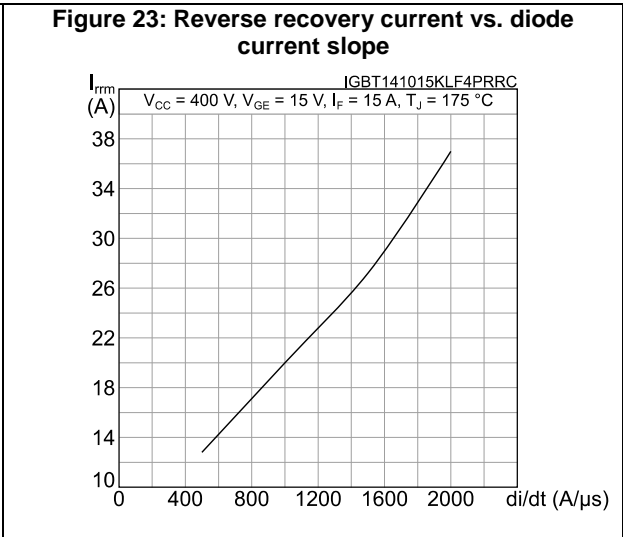
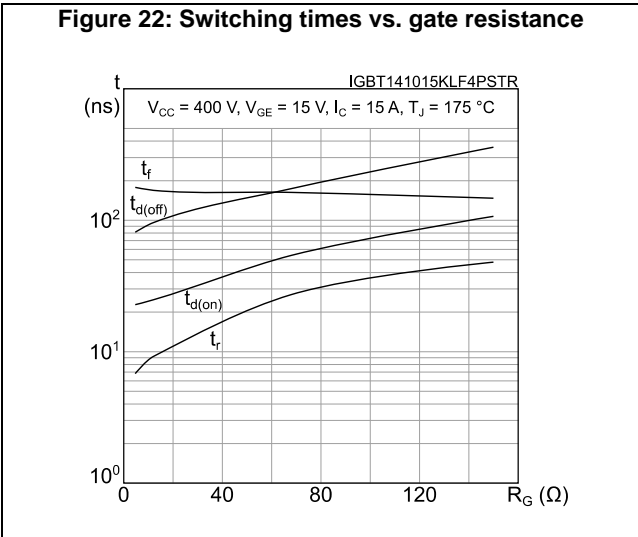
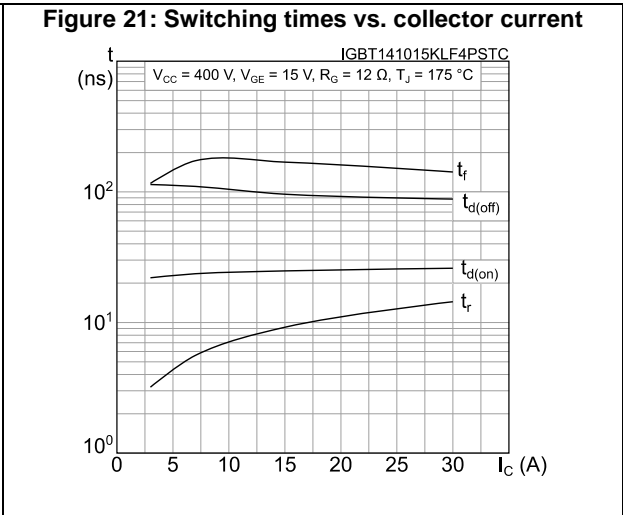
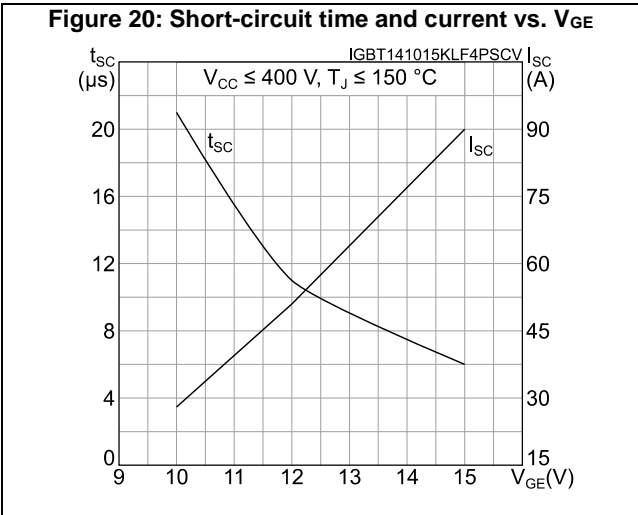


Figure 26: Reverse recovery energy vs. diode current slope

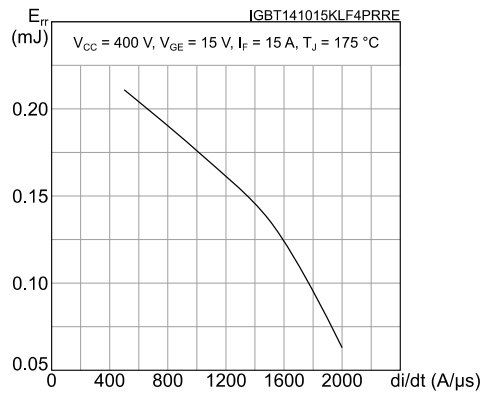
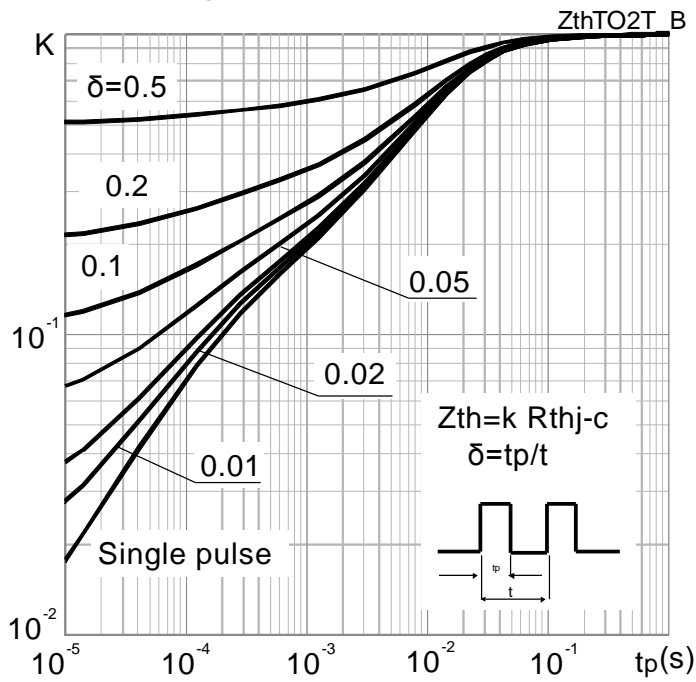
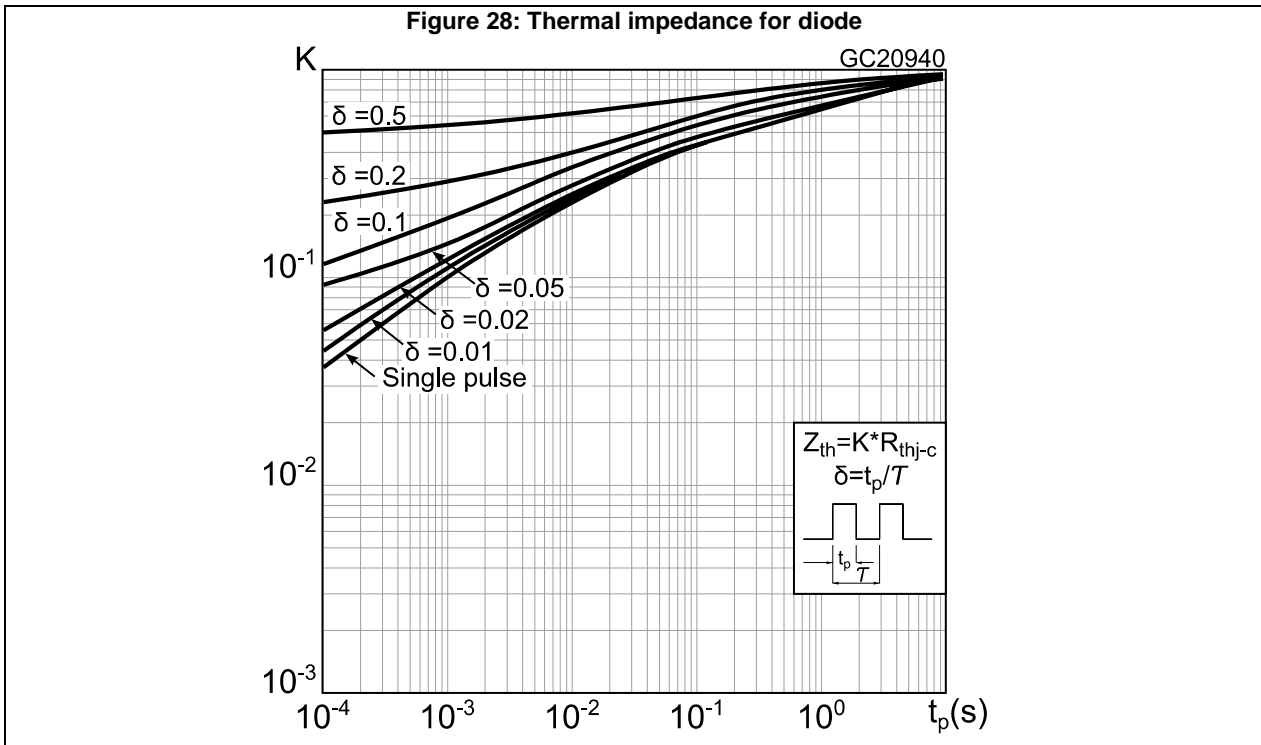


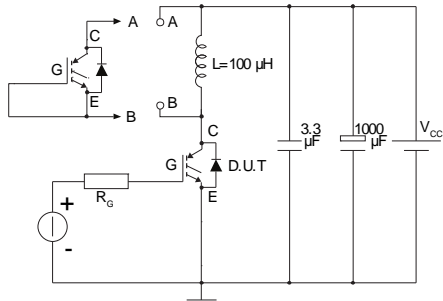
Figure 27: Thermal impedance for IGBT





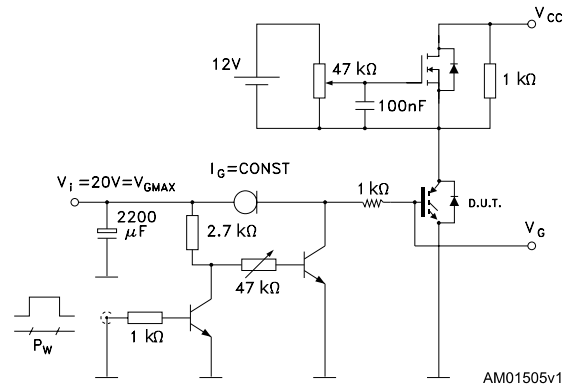
### 3 Test circuits

**Figure 29: Test circuit for inductive load switching**



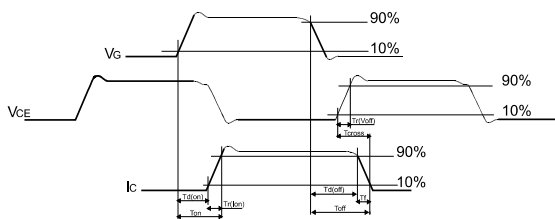
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**Figure 30: Gate charge test circuit**



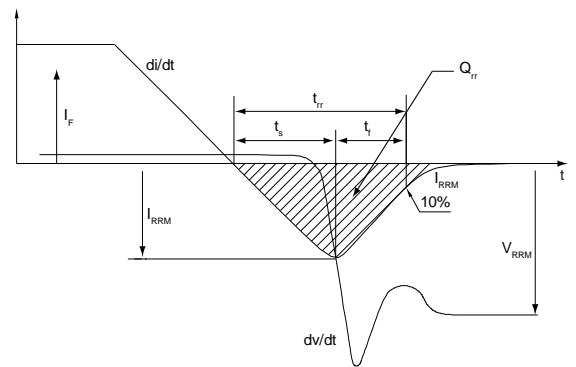
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**Figure 31: Switching waveform**



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**Figure 32: Diode reverse recovery waveform**



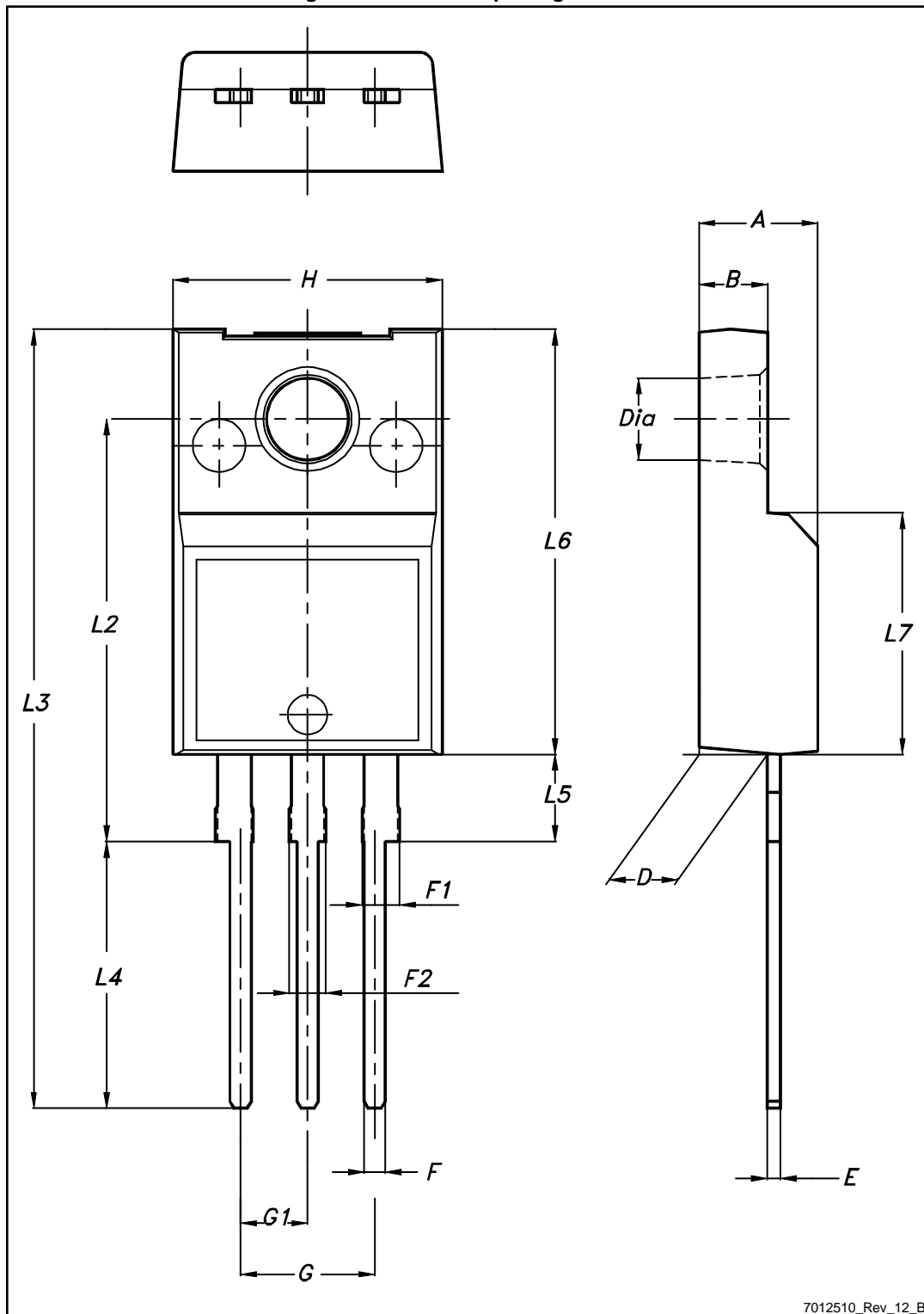
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## 4 Package information

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 33: TO-220FP package outline



7012510\_Rev\_12\_B

Table 8: TO-220FP package 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		1.70
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

## 5 Revision history

**Table 9: Document revision history**

Date	Revision	Changes
14-Oct-2015	1	First release.
22-Aug-2016	2	Datasheet promoted from preliminary data to production data. Changed <i>Figure 11: "Diode VF vs. forward current"</i> . Updated: <i>Table 2: "Absolute maximum ratings"</i> and <i>Table 6: "IGBT switching characteristics (inductive load)"</i> . Updated: <i>Figure 16: "Switching energy vs. collector current"</i> , <i>Figure 17: "Switching energy vs. gate resistance"</i> , <i>Figure 18: "Switching energy vs. temperature"</i> and <i>Figure 19: "Switching energy vs. collector emitter voltage"</i> .
04-May-2017	3	Modified: title, features and applications on cover page. Modified <i>Table 4: "Static characteristics"</i> , <i>Table 5: "Dynamic characteristics"</i> , <i>Table 7: "Diode switching characteristics (inductive load)"</i> Updated <i>Section 4: "Package information"</i> . Minor text changes.



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