

## Trench gate field-stop IGBT M series, 650 V 15 A low loss

Datasheet - preliminary data

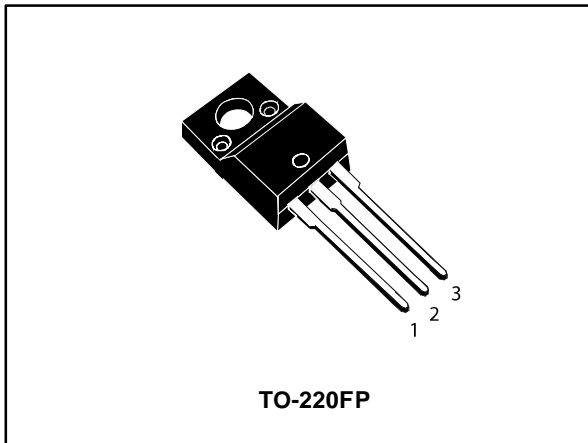
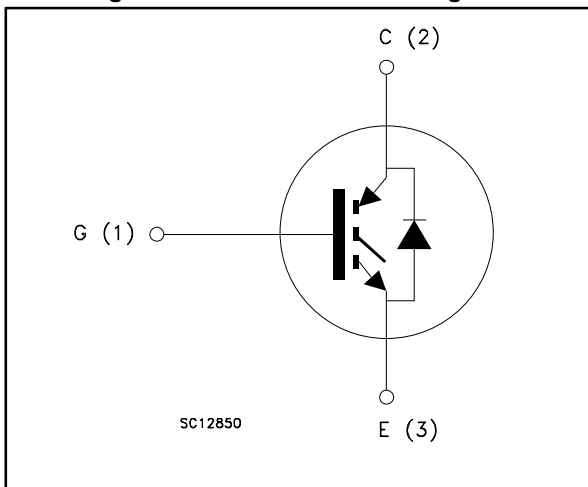


Figure 1: Internal schematic diagram



### 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
- Low thermal resistance
- Soft and very fast recovery antiparallel diode

### Applications

- Motor control
- UPS
- PFC

### Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the M series of IGBTs, which represents an optimum compromise in performance to maximize the efficiency of inverter systems where low loss and short-circuit capability are essential. Furthermore, a 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**

<b>1</b>	<b>Electrical ratings .....</b>	<b>3</b>
<b>2</b>	<b>Electrical characteristics .....</b>	<b>4</b>
	2.1 Electrical characteristics (curves).....	6
<b>3</b>	<b>Test circuits .....</b>	<b>11</b>
<b>4</b>	<b>Package information .....</b>	<b>12</b>
	4.1 TO-220FP package information .....	12
<b>5</b>	<b>Revision history .....</b>	<b>14</b>

# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ V)	650	V
$I_C^{(1)}$	Continuous collector current at $T_C = 25$ °C	30	A
	Continuous collector current at $T_C = 100$ °C	15	
$I_{CP}^{(2)}$	Pulsed collector current	60	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$I_F^{(1)}$	Continuous forward current at $T_C = 25$ °C	30	A
	Continuous forward current at $T_C = 100$ °C	15	
$I_{FP}^{(2)}$	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 dissipation at $T_C = 25$ °C	31	W
$T_{STG}$	Storage temperature range	- 55 to 150	°C
$T_J$	Operating junction temperature	- 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
$R_{thJC}$	Thermal resistance junction-case IGBT	4.8	°C/W
$R_{thJC}$	Thermal resistance junction-case diode	6.25	
$R_{thJA}$	Thermal resistance junction-ambient	62.5	

## 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	$V_{GE} = 0\text{ V}$ , $I_C = 2\text{ mA}$	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		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	$V_{CC} = 520\text{ V}$ , $I_C = 15\text{ A}$ , $V_{GE} = 15\text{ V}$ (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 losses			0.09	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses			0.45	-	mJ
$E_{ts}$	Total switching losses			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
$E_{on}$	Turn-on switching losses			0.22	-	mJ
$E_{off}$	Turn-off switching losses			0.61	-	mJ
$E_{ts}$	Total switching losses			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

**Notes:**

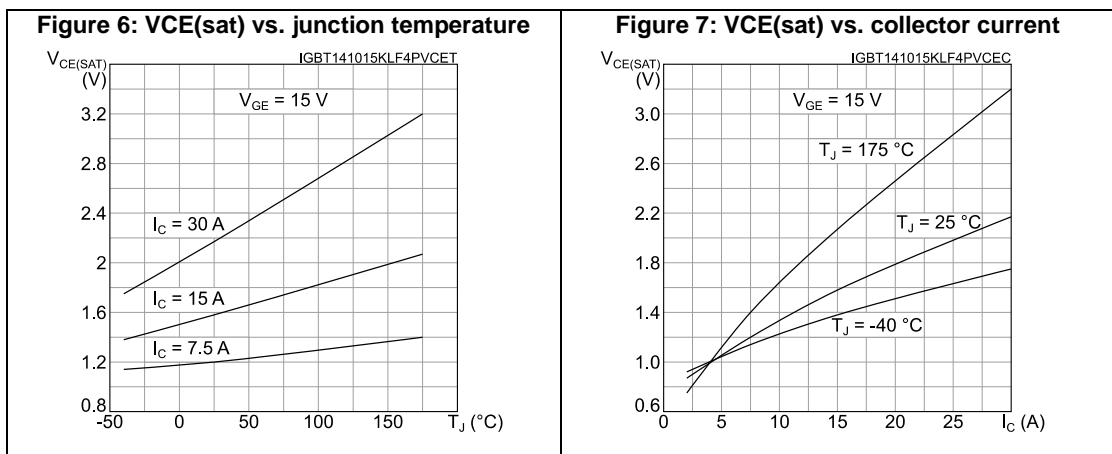
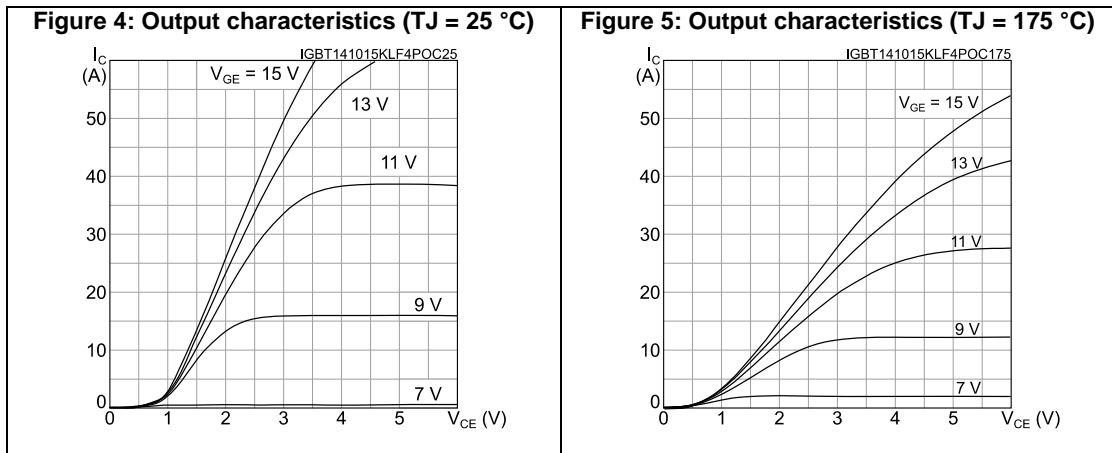
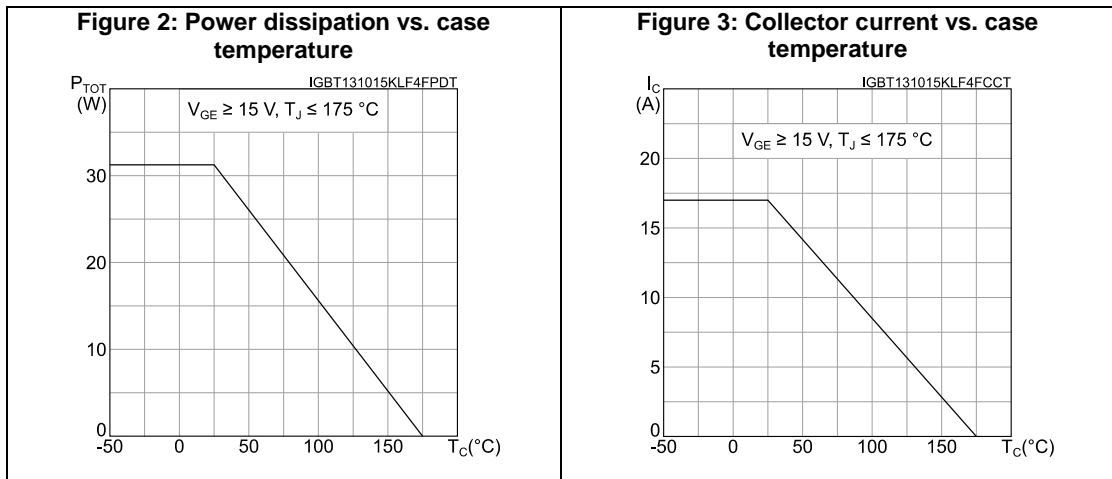
(1)Energy losses include reverse recovery of the diode.

(2)Turn-off losses also include the tail of the collector current.

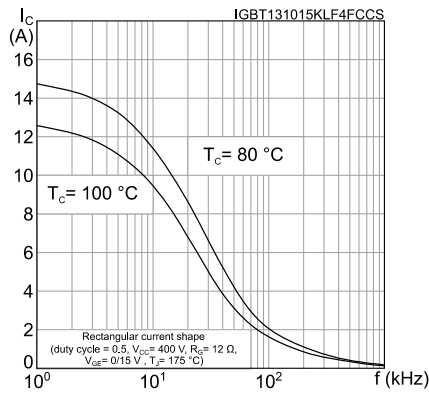
Table 7: Diode switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{rr}$	Reverse recovery time	$I_F = 15\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ (see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> ) $di/dt = 1000\text{ A}/\mu\text{s}$	-	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	$I_F = 15\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ (see <a href="#">Figure 29: "Test circuit for inductive load switching"</a> ) $di/dt = 1000\text{ A}/\mu\text{s}$	-	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

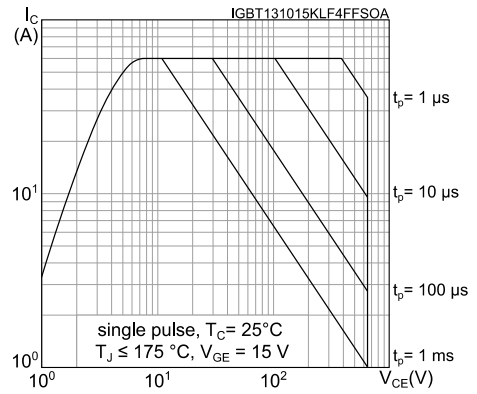
## 2.1 Electrical characteristics (curves)



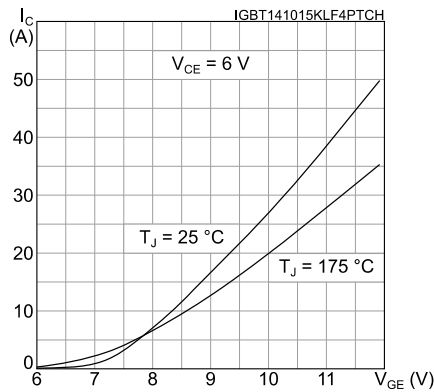
**Figure 8: Collector current vs. switching frequency**



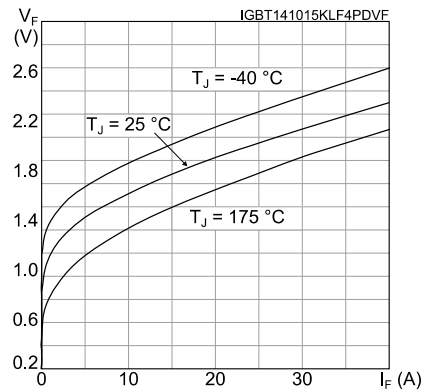
**Figure 9: Forward bias safe operating area**



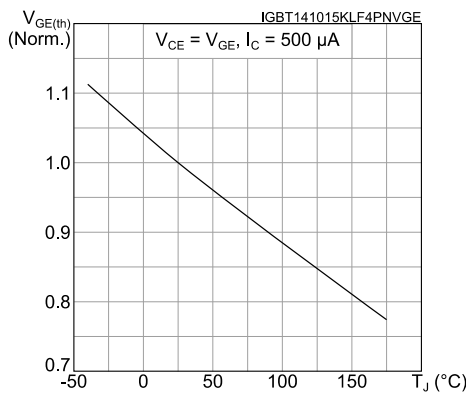
**Figure 10: Transfer characteristics**



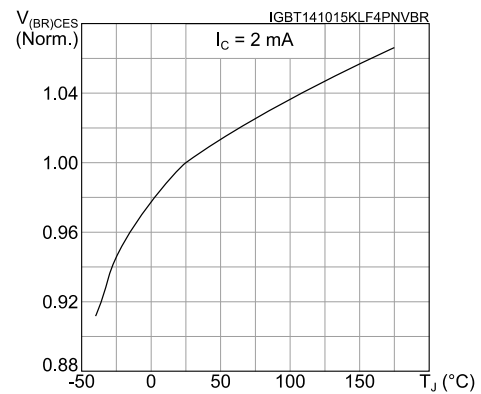
**Figure 11: Diode VF vs. forward current**

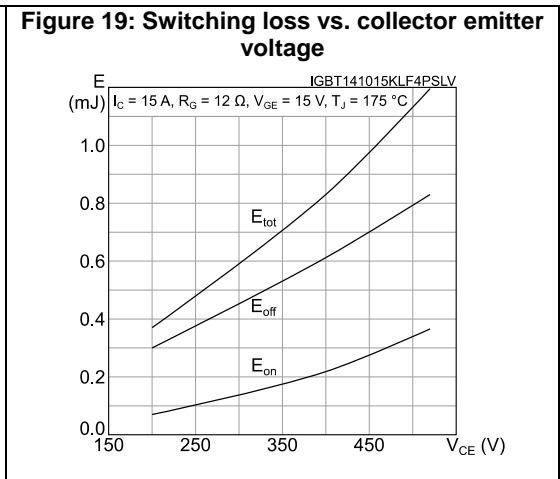
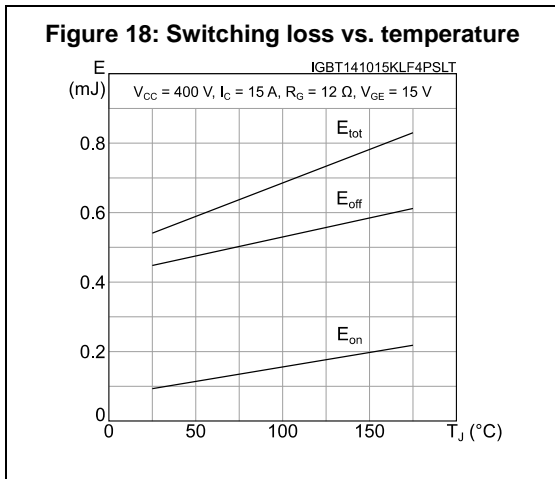
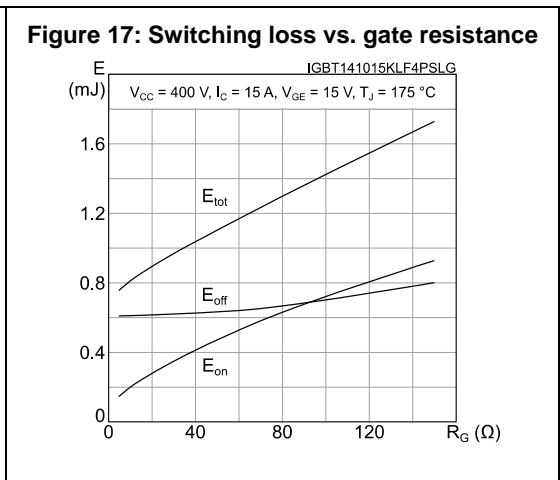
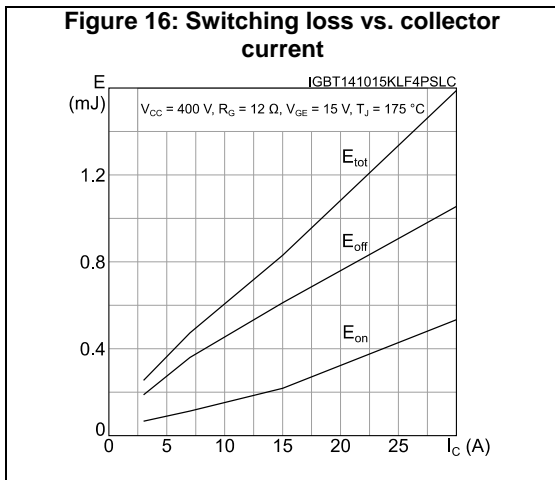
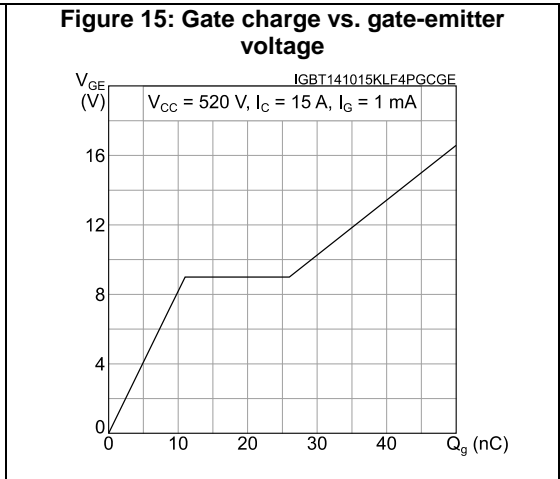
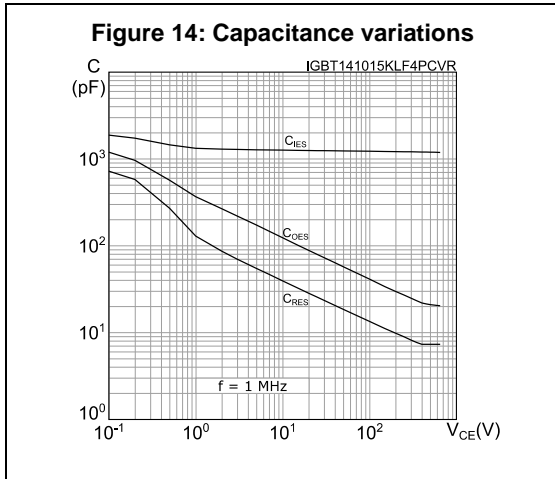


**Figure 12: Normalized V<sub>GE(th)</sub> vs. junction temperature**



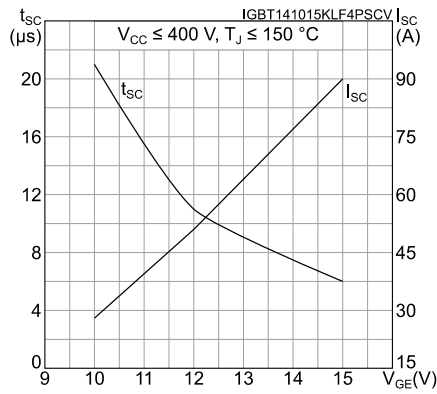
**Figure 13: Normalized V<sub>(BR)CES</sub> vs. junction temperature**



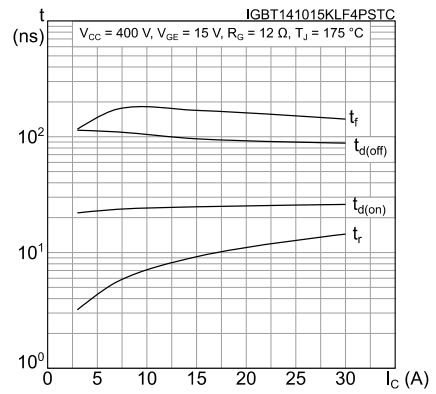




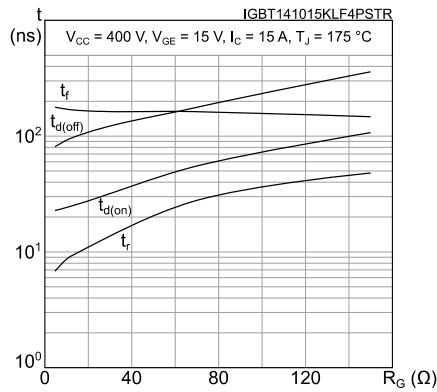
**Figure 20: Short-circuit time and current vs. V<sub>GE</sub>**



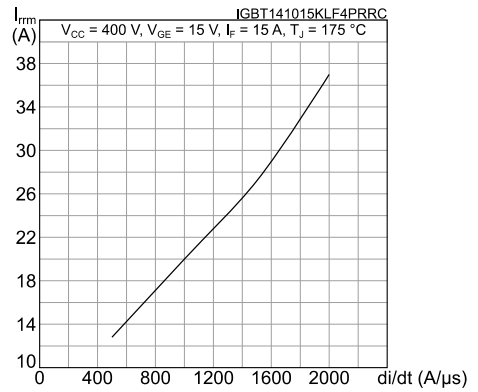
**Figure 21: Switching times vs. collector current**



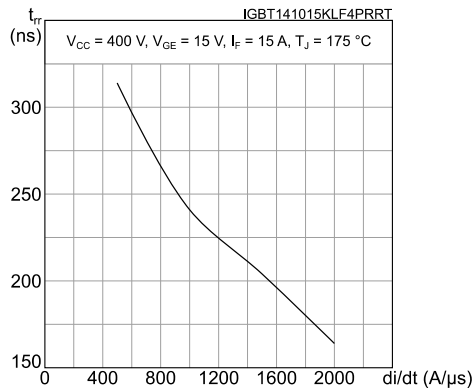
**Figure 22: Switching times vs. gate resistance**



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



**Figure 24: Reverse recovery time vs. diode current slope**



**Figure 25: Reverse recovery charge vs. diode current slope**

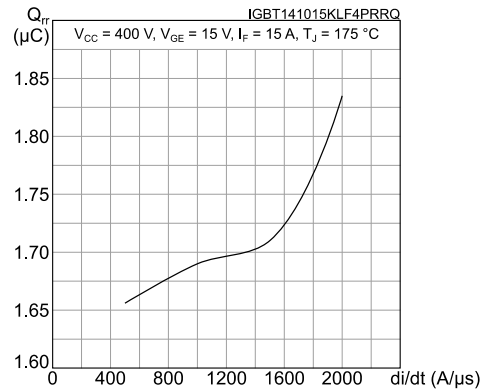


Figure 26: Reverse recovery energy vs. diode current slope

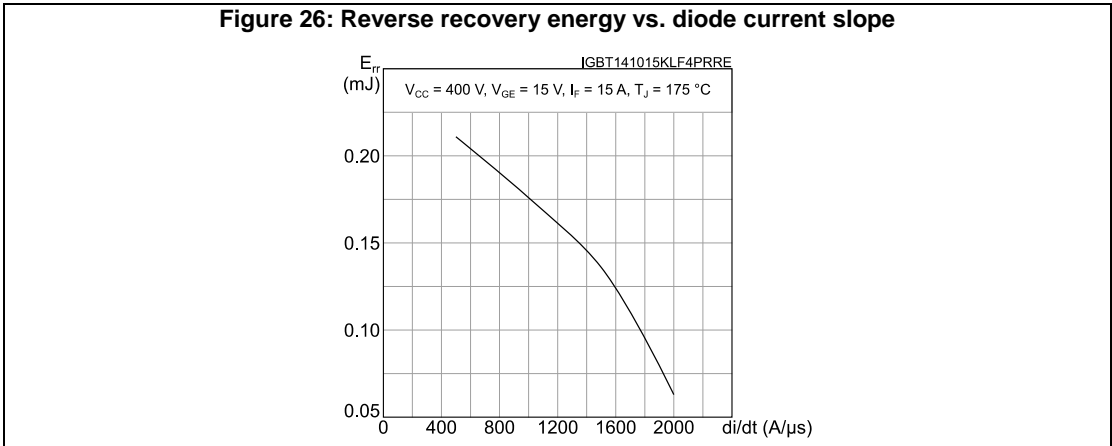


Figure 27: Thermal impedance for IGBT

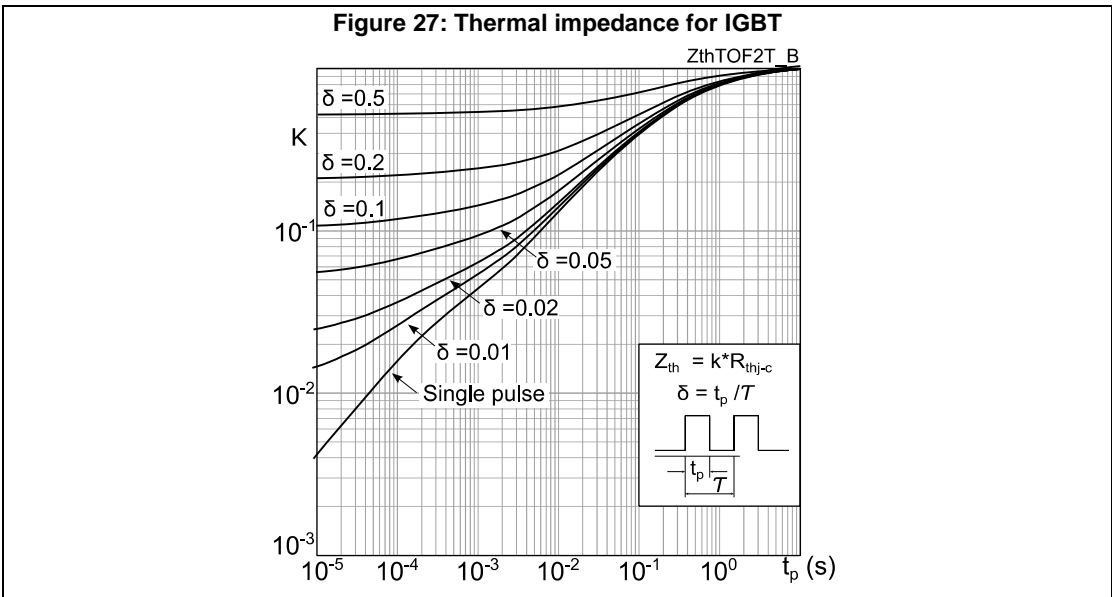
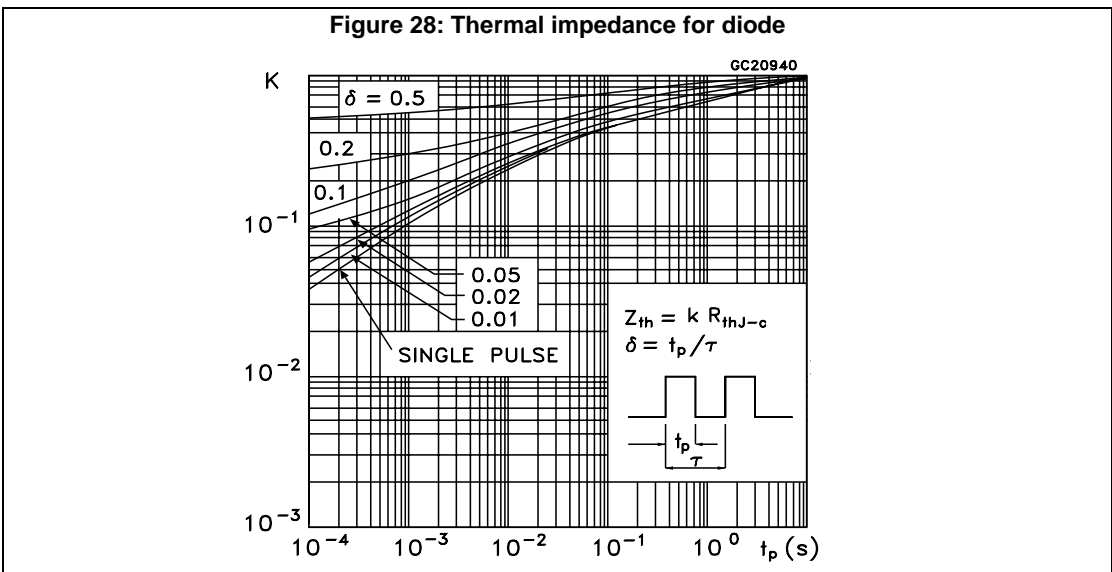
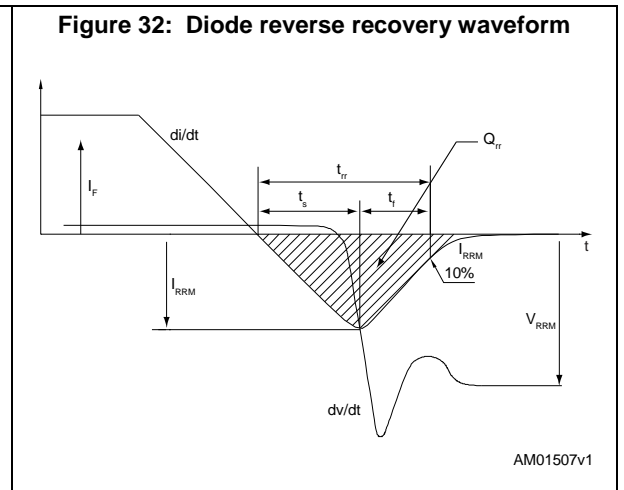
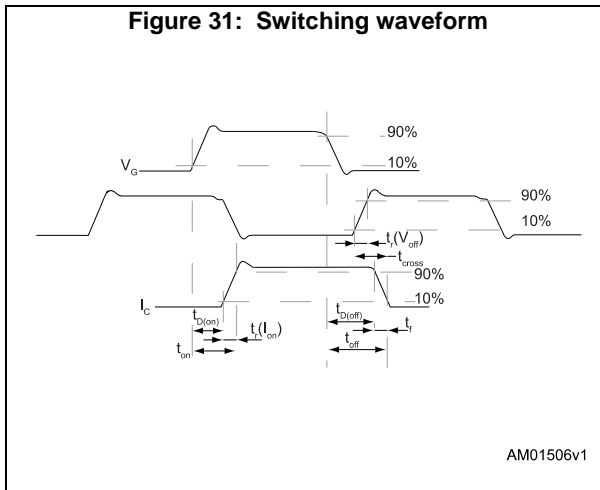
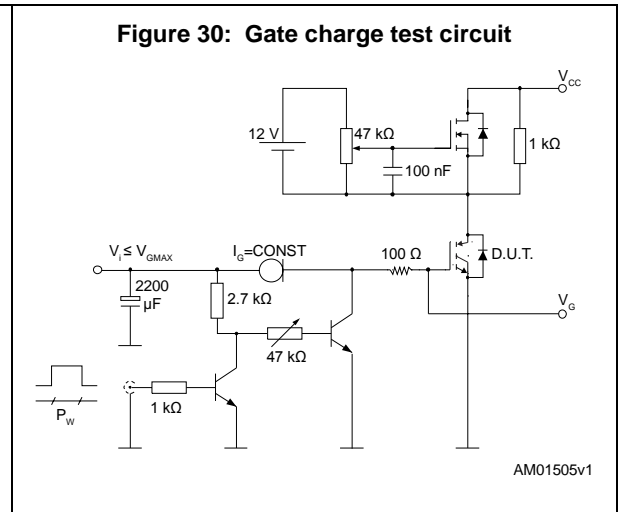
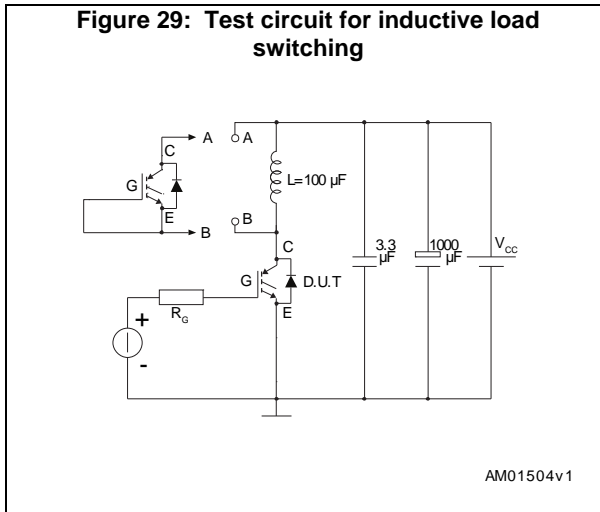


Figure 28: Thermal impedance for diode



### 3 Test circuits

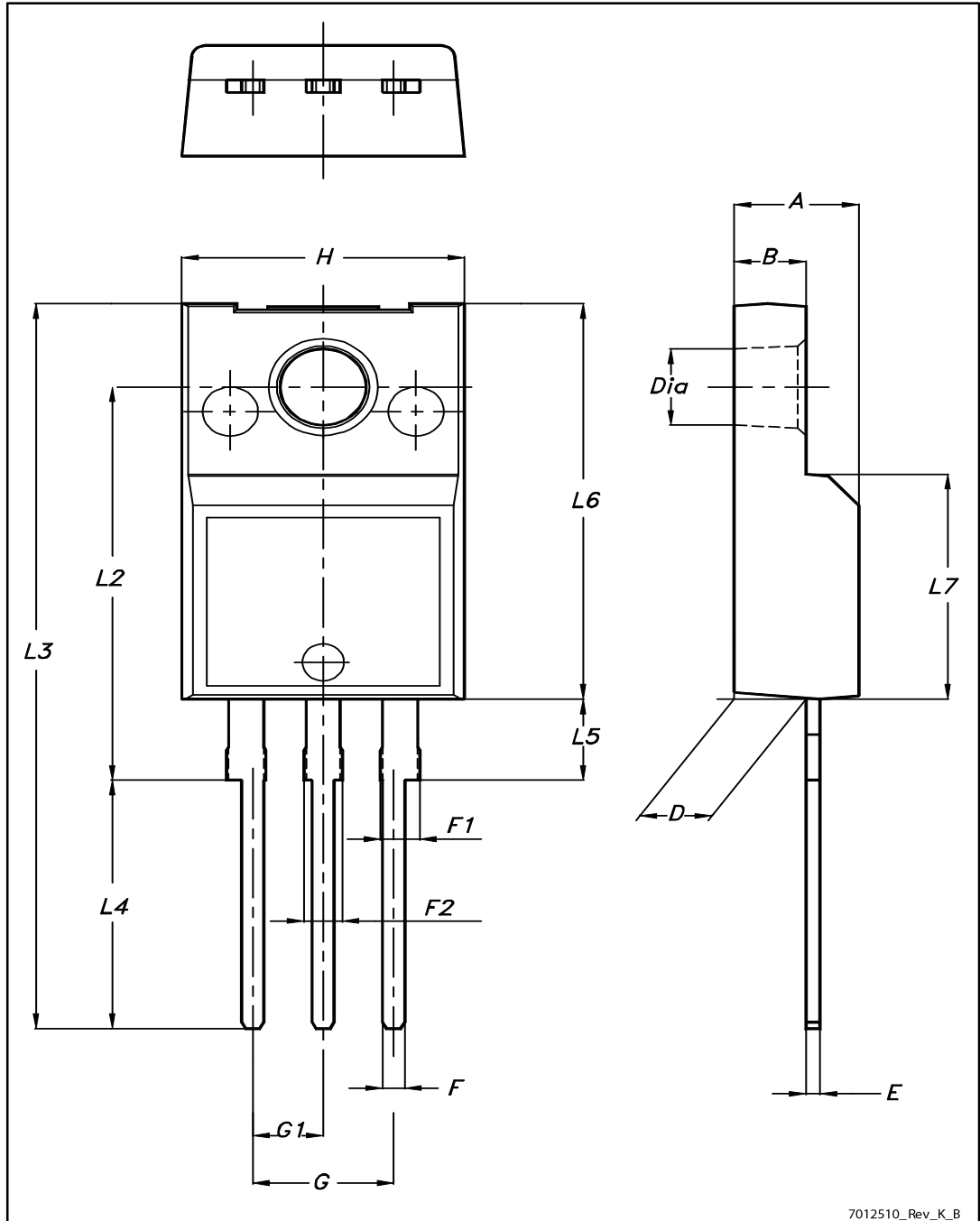


## 4 Package information

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\_K\_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.

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