

## Trench gate field-stop IGBT, H series 1200 V, 40 A high speed

Datasheet - production data

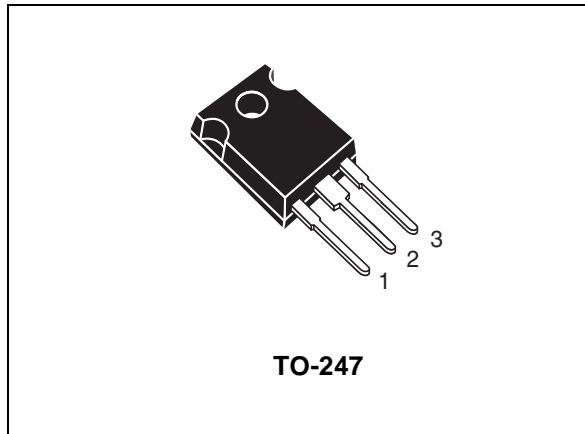
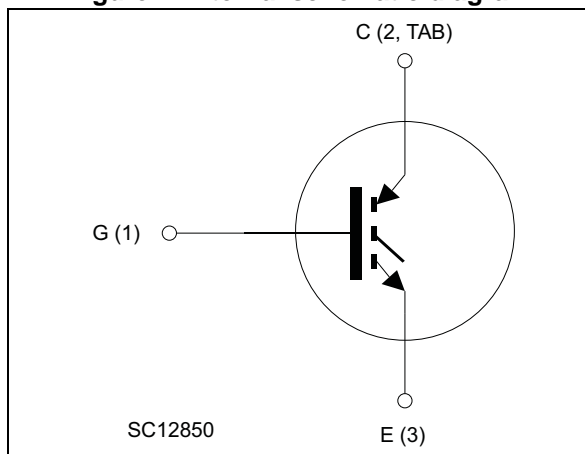


Figure 1. Internal schematic diagram



### Features

- Maximum junction temperature:  $T_J = 175\text{ }^{\circ}\text{C}$
- High speed switching series
- Minimized tail current
- $V_{CE(sat)} = 2.1\text{ V (typ.) @ } I_C = 40\text{ A}$
- $5\text{ }\mu\text{s}$  minimum short circuit withstand time at  $T_J = 150\text{ }^{\circ}\text{C}$
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Lead free package

### Applications

- Uninterruptible power supply
- Welding machines
- Photovoltaic inverters
- Power factor correction
- High frequency converters

### Description

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

Table 1. Device summary

Order codes	Marking	Package	Packaging
STGW40H120F2	GW40H120F2	TO-247	Tube

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{CES}$	Collector-emitter voltage ( $V_{GE} = 0$ )	1200	V
$I_C$	Continuous collector current at $T_C = 25\text{ °C}$	80	A
$I_C$	Continuous collector current at $T_C = 100\text{ °C}$	40	A
$I_{CP}^{(1)}$	Pulsed collector current	160	A
$V_{GE}$	Gate-emitter voltage	$\pm 20$	V
$P_{TOT}$	Total dissipation at $T_C = 25\text{ °C}$	468	W
$T_{STG}$	Storage temperature range	-55 to 150	°C
$T_J$	Operating junction temperature	-55 to 175	°C

1. Pulse width limited by maximum junction temperature

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{thJC}$	Thermal resistance junction-case	0.32	°C/W
$R_{thJA}$	Thermal resistance junction-ambient	50	°C/W

## 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 ( $V_{GE} = 0$ )	$I_C = 2\text{ mA}$	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$		2.1	2.6	V
		$V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$ $T_J = 125\text{ °C}$		2.4		
		$V_{GE} = 15\text{ V}$ , $I_C = 40\text{ A}$ $T_J = 175\text{ °C}$		2.5		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$ , $I_C = 2\text{ mA}$	5	6	7	V
$I_{CES}$	Collector cut-off current ( $V_{GE} = 0$ )	$V_{CE} = 1200\text{ V}$			25	$\mu\text{A}$
$I_{GES}$	Gate-emitter leakage current ( $V_{CE} = 0$ )	$V_{GE} = \pm 20\text{ V}$			250	nA

**Table 5. Dynamic characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{ies}$	Input capacitance	$V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ , $V_{GE} = 0$	-	3200	-	pF
$C_{oes}$	Output capacitance		-	202	-	pF
$C_{res}$	Reverse transfer capacitance		-	88	-	pF
$Q_g$	Total gate charge	$V_{CC} = 520\text{ V}$ , $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , see <a href="#">Figure 23</a>	-	187	-	nC
$Q_{ge}$	Gate-emitter charge		-	17	-	nC
$Q_{gc}$	Gate-collector charge		-	115	-	nC

Table 6. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 600\text{ V}$ , $I_C = 40\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , see <a href="#">Figure 22</a>	-	18	-	ns
$t_r$	Current rise time		-	37	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1755	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time		-	152	-	ns
$t_f$	Current fall time		-	83	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	1.0	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses		-	1.32	-	mJ
$E_{ts}$	Total switching losses		-	2.32	-	mJ
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 600\text{ V}$ , $I_C = 40\text{ A}$ , $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$ , see <a href="#">Figure 22</a>	-	36	-	ns
$t_r$	Current rise time		-	20	-	ns
$(di/dt)_{on}$	Turn-on current slope		-	1580	-	A/ $\mu$ s
$t_{d(off)}$	Turn-off delay time		-	161	-	ns
$t_f$	Current fall time		-	190	-	ns
$E_{on}^{(1)}$	Turn-on switching losses		-	1.81	-	mJ
$E_{off}^{(2)}$	Turn-off switching losses		-	2.46	-	mJ
$E_{ts}$	Total switching losses		-	4.27	-	mJ
$t_{sc}$	Short-circuit withstand time	$V_{CE} = 600\text{ V}$ , $V_{GE} = 15\text{ V}$ , $T_J = 150\text{ }^\circ\text{C}$ ,	5		-	$\mu$ J

1. Energy losses include reverse recovery of the external diode. The diode is the same of the co-packed STGW40H120DF2

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

2.1 Electrical characteristics (curves)

Figure 2. Power dissipation vs. case temperature

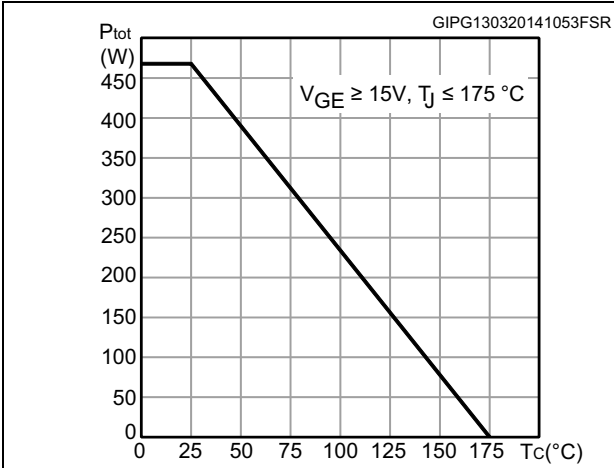


Figure 3. Collector current vs. case temperature

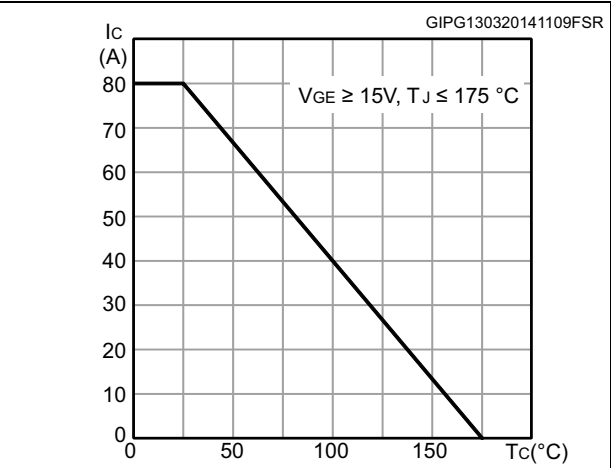


Figure 4. Output characteristics ( $T_J = 25^\circ C$ )

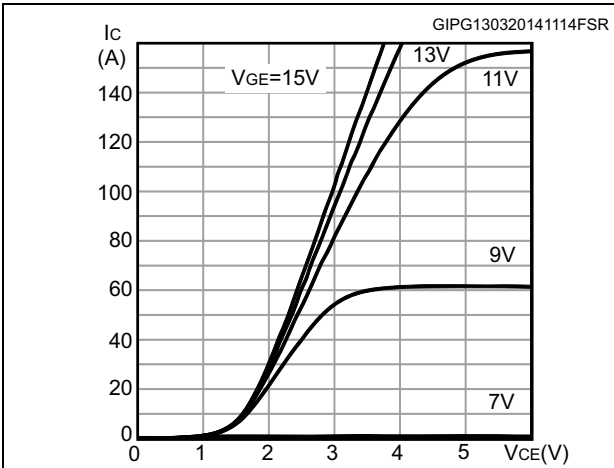


Figure 5. Output characteristics ( $T_J = 175^\circ C$ )

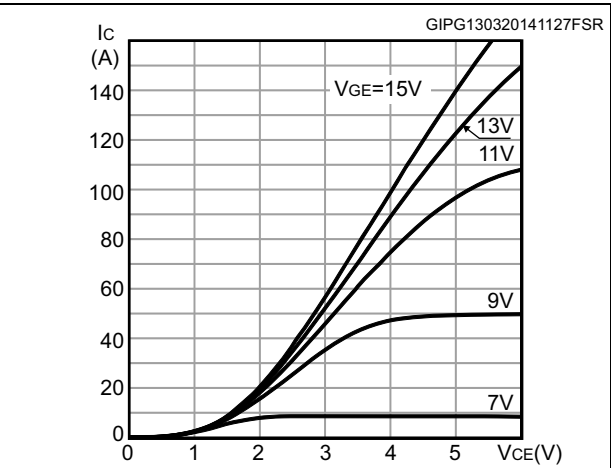


Figure 6.  $V_{CE(sat)}$  vs. junction temperature

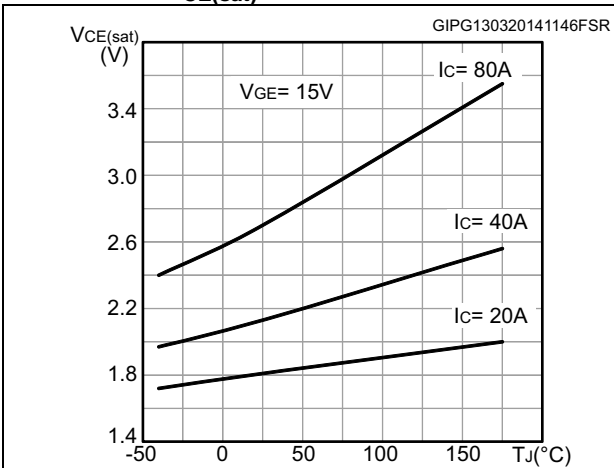


Figure 7.  $V_{CE(sat)}$  vs. collector current

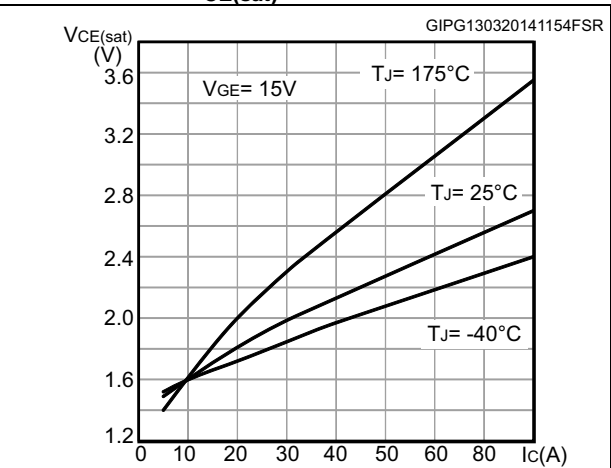


Figure 8. Collector current vs. switching frequency

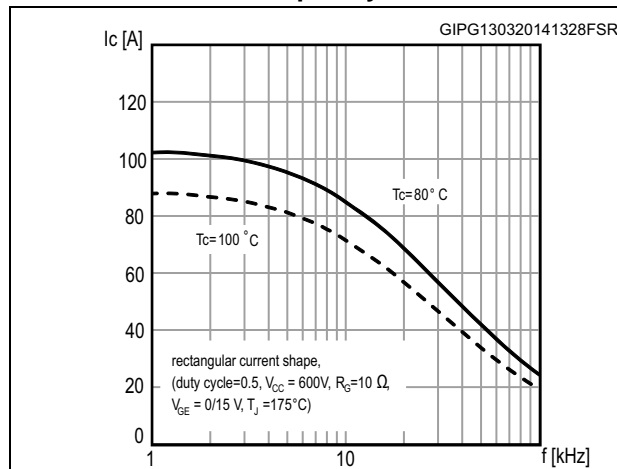


Figure 9. Forward bias safe operating area

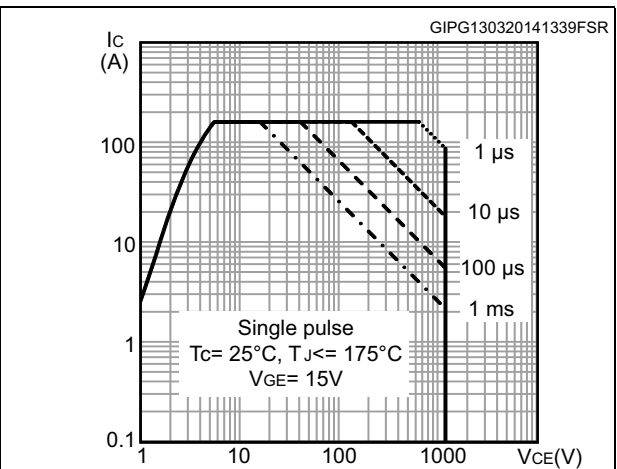


Figure 10. Transfer characteristics

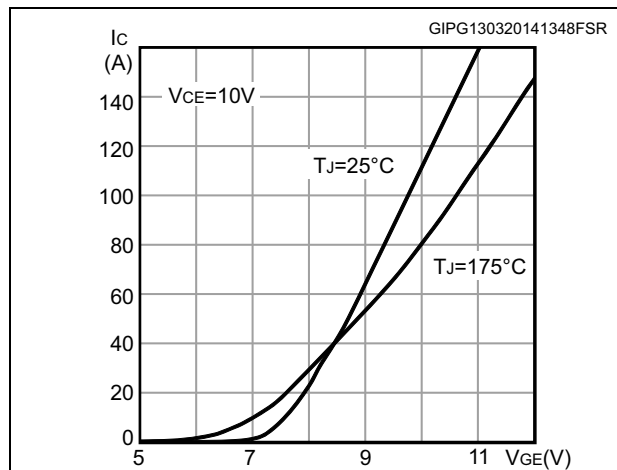
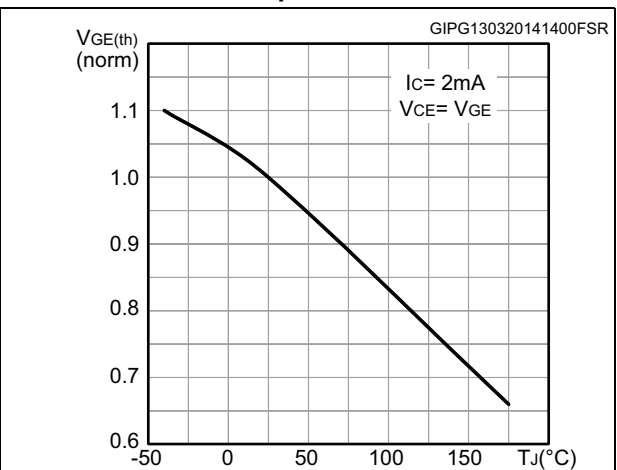
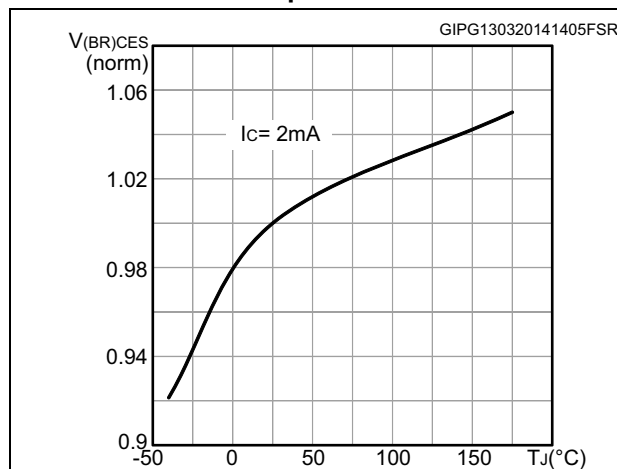
Figure 11. Normalized  $V_{GE(th)}$  vs junction temperatureFigure 12. Normalized  $V_{(BR)CES}$  vs. junction temperature

Figure 13. Capacitance variation

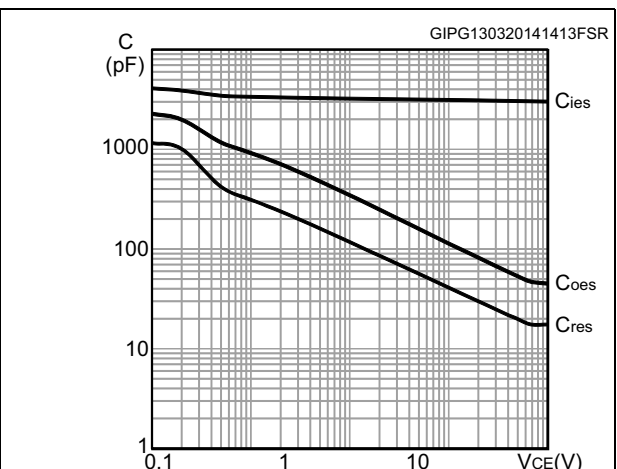


Figure 14. Gate charge vs. gate-emitter voltage

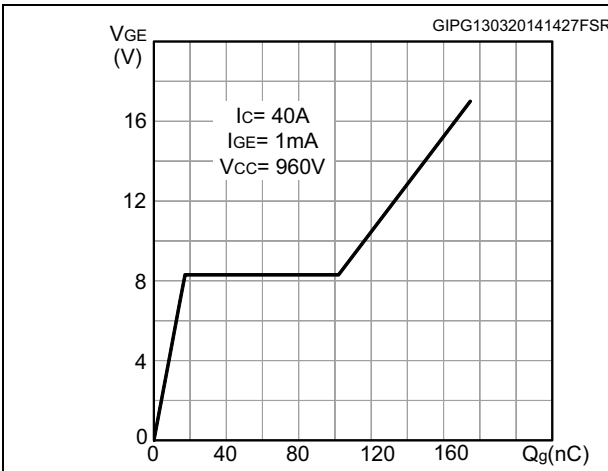


Figure 15. Switching loss vs collector current

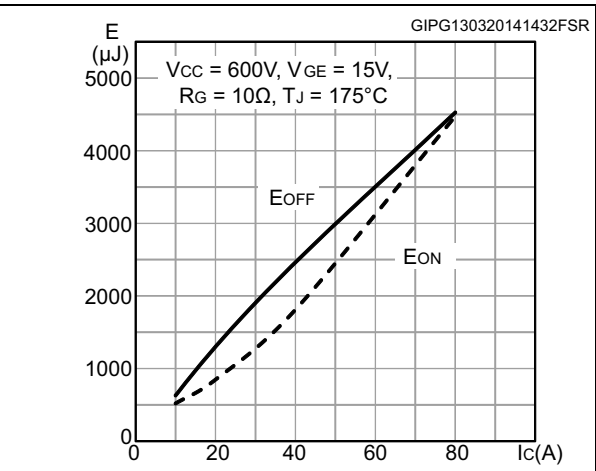


Figure 16. Switching loss vs gate resistance

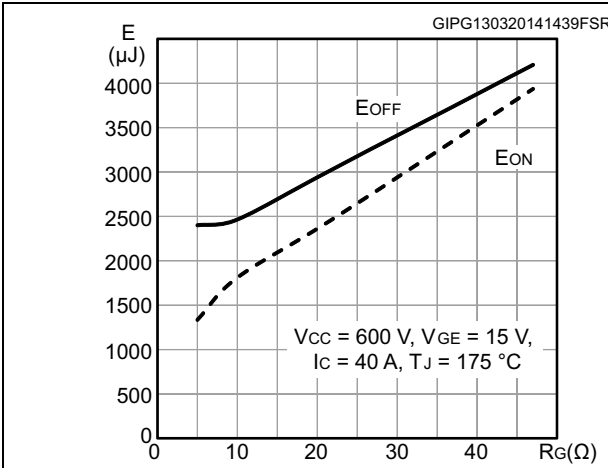


Figure 17. Switching loss vs temperature

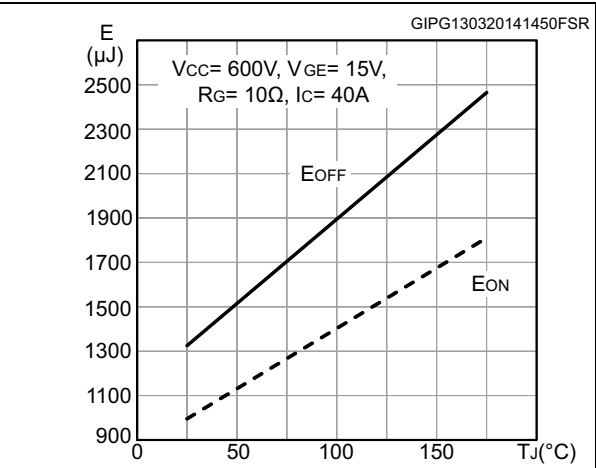


Figure 18. Switching loss vs collector-emitter voltage

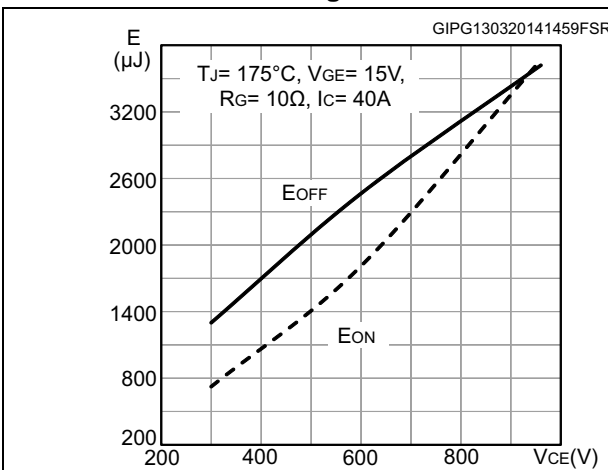


Figure 19. Switching times vs. collector current

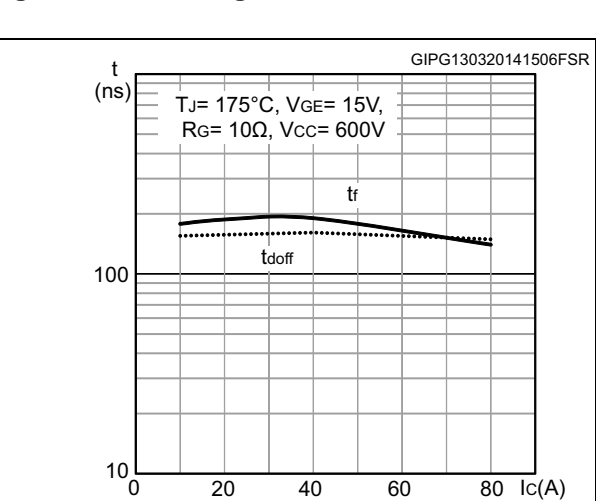




Figure 20. Switching times vs. gate resistance

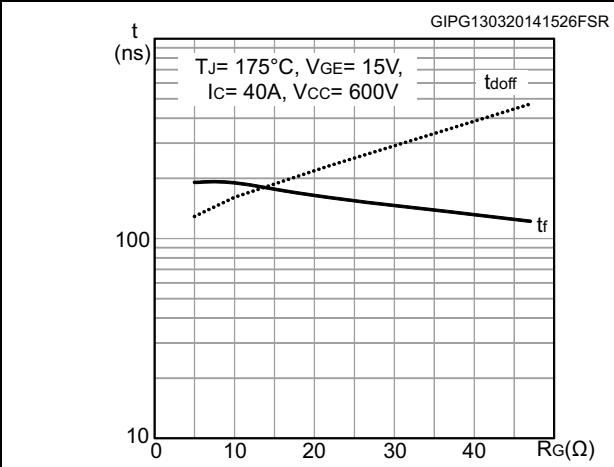


Figure 1 is a log-log plot showing the normalized thermal impedance  $Z_{thTO2T\_A}$  (Y-axis, ranging from  $10^{-2}$  to  $10^0$  K) versus the pulse width  $t_p$  (X-axis, ranging from  $10^{-5}$  to  $10^{-1}$  s). The plot includes curves for various duty cycles  $d$  (0.5, 0.2, 0.1, 0.05, 0.02, 0.01). The curves show that the normalized thermal impedance increases with pulse width and decreases with duty cycle. An inset diagram illustrates a single pulse waveform with pulse width  $t_p$  and period  $\tau$ , and the formula  $Z_{th} = k R_{thJ-c}$  and  $\delta = t_p/\tau$ .

### 3 Test circuits

Figure 22. Test circuit for inductive load switching

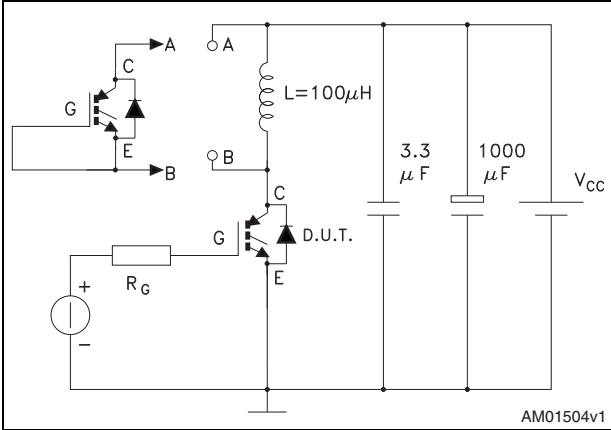


Figure 23. Gate charge test circuit

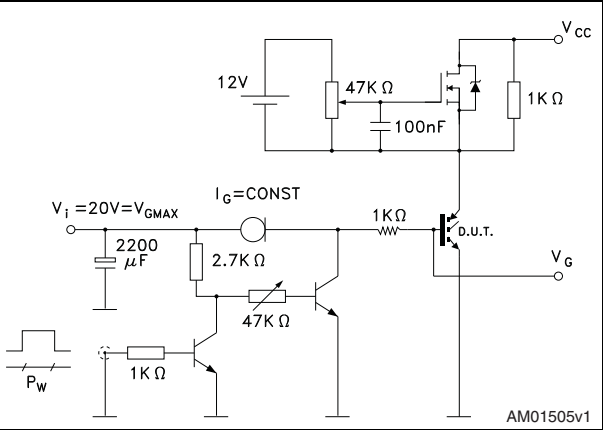
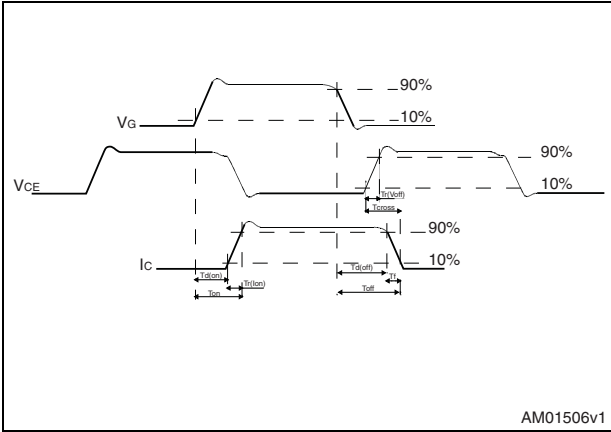


Figure 24. Switching waveform



## 4 Package mechanical data

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.

Figure 25. TO-247 drawing

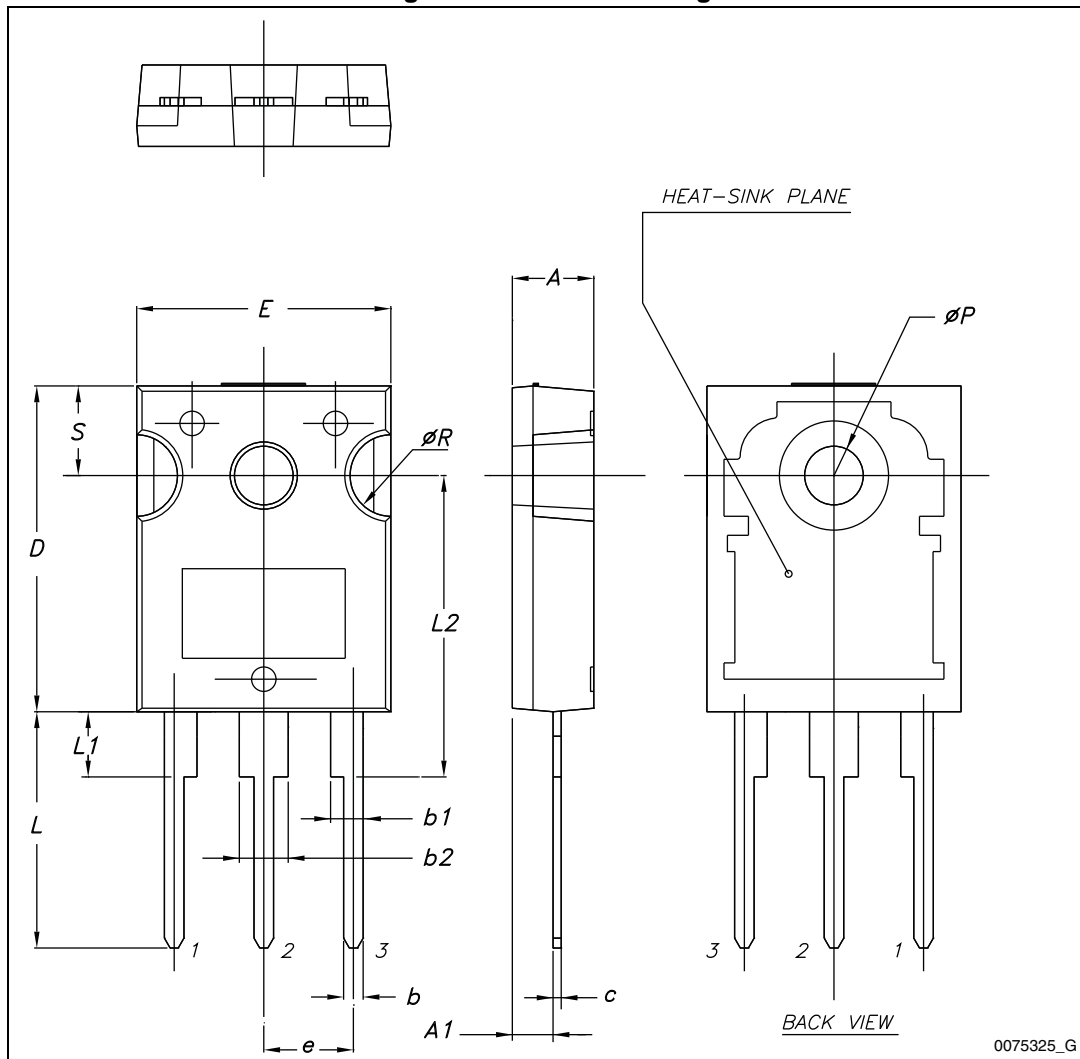


Table 7. TO-247 mechanical data

Dim.	mm.		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

## 5 Revision history

**Table 8. Document revision history**

Date	Revision	Changes
29-Jan-2014	1	Initial release.
14-Mar-2014	2	Updated <a href="#">Table 4: Static characteristics</a> and <a href="#">Table 5: Dynamic characteristics</a> . Added <a href="#">Section 2.1: Electrical characteristics (curves)</a> . Updated title in cover page. Minor text changes.

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