

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

Datasheet - production data

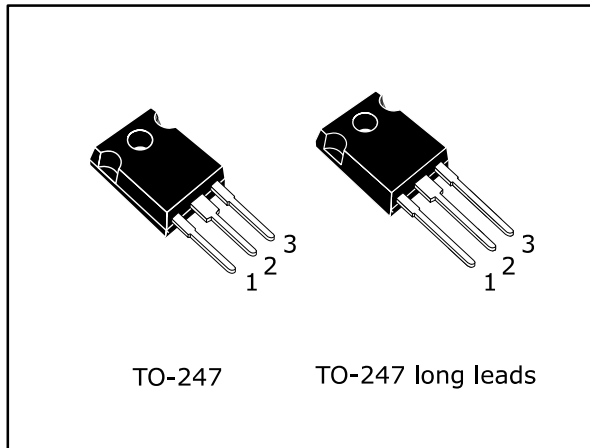
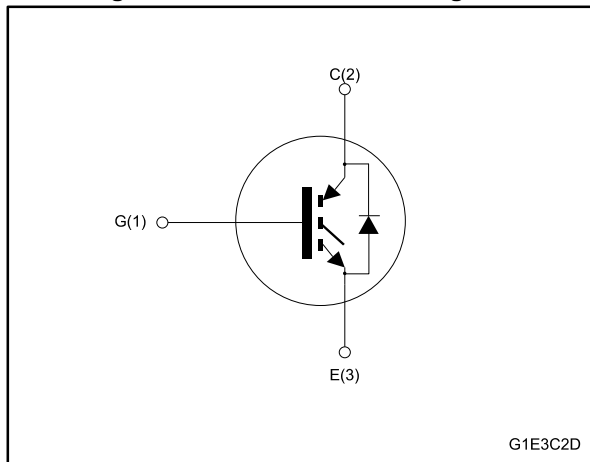


Figure 1: Internal schematic diagram



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 $T_J=150\text{ }^\circ\text{C}$
- Safe paralleling
- Very fast recovery antiparallel diode
- Low thermal resistance

Applications

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

Description

These devices are IGBTs developed using an advanced proprietary trench gate field-stop structure. These devices are part of the H series of IGBTs, which represents an optimum compromise between conduction and switching losses to maximize the efficiency of high switching 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 code	Marking	Package	Packaging
STGW40H120DF2	G40H120DF2	TO-247	Tube
STGWA40H120DF2	G40H120DF2	TO-247 long leads	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	± 20	V
V_{GE}	Transient gate-emitter voltage ($t_p \leq 10\ \mu\text{s}$, $D \leq 0.01$)	± 30	V
I_F	Continuous forward current at $T_C = 25\text{ °C}$	80	A
I_F	Continuous forward current at $T_C = 100\text{ °C}$	40	A
$I_{FP}^{(1)}$	Pulsed forward current	160	A
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	468	W
T_{STG}	Storage temperature range	-55 to 150	$^{\circ}\text{C}$
T_J	Operating junction temperature range	-55 to 175	$^{\circ}\text{C}$

Notes:

⁽¹⁾Pulse width limited by maximum junction temperature.

Table 3: Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case IGBT	0.32	$^{\circ}\text{C/W}$
R_{thJC}	Thermal resistance junction-case diode	1.3	$^{\circ}\text{C/W}$
R_{thJA}	Thermal resistance junction-ambient	50	$^{\circ}\text{C/W}$

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	$V_{GE} = 0\text{ V}$, $I_C = 2\text{ mA}$	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_F	Forward on-voltage	$I_F = 40\text{ A}$		3.9	4.9	V
		$I_F = 40\text{ A}$, $T_J = 125\text{ °C}$		3.05		
		$I_F = 40\text{ A}$, $T_J = 175\text{ °C}$		2.8		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$, $I_C = 2\text{ mA}$	5	6	7	V
I_{CES}	Collector cut-off current	$V_{GE} = 0\text{ V}$, $V_{CE} = 1200\text{ V}$			25	μA
I_{GES}	Gate-emitter leakage current	$V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$			± 250	nA

Table 5: Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$	-	3200	-	pF
C_{oes}	Output capacitance		-	220	-	
C_{res}	Reverse transfer capacitance		-	80	-	
Q_g	Total gate charge	$V_{CC} = 960\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$ (see Figure 30: "Gate charge test circuit")	-	158	-	nC
Q_{ge}	Gate-emitter charge		-	17	-	
Q_{gc}	Gate-collector charge		-	85	-	

Table 6: IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 600\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 10\ \Omega$ (see Figure 31: "Switching waveform")		18	-	ns
t_r	Current rise time			37	-	ns
$(di/dt)_{on}$	Turn-on current slope			1755	-	A/ μ s
$t_{d(off)}$	Turn-off-delay time			152	-	ns
t_f	Current fall time			83	-	ns
$E_{on}^{(1)}$	Turn-on switching energy			1	-	mJ
$E_{off}^{(2)}$	Turn-off switching energy			1.32	-	mJ
E_{ts}	Total switching energy		2.32	-	mJ	
$t_{d(on)}$	Turn-on delay time	$V_{CE} = 600\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 10\ \Omega$ $T_J = 175\text{ }^\circ\text{C}$ (see Figure 31: "Switching waveform")		36	-	ns
t_r	Current rise time			20	-	ns
$(di/dt)_{on}$	Turn-on current slope			1580	-	A/ μ s
$t_{d(off)}$	Turn-off-delay time			161	-	ns
t_f	Current fall time			190	-	ns
$E_{on}^{(1)}$	Turn-on switching energy			1.81	-	mJ
$E_{off}^{(2)}$	Turn-off switching energy			2.46	-	mJ
E_{ts}	Total switching energy		4.27	-	mJ	
t_{sc}	Short-circuit withstand time	$V_{CC} = 600\text{ V}$, $V_{GE} = 15\text{ V}$, $T_{Jstart} = 150\text{ }^\circ\text{C}$	5		-	μ s

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	$I_F = 40\text{ A}$, $V_R = 600\text{ V}$, $V_{GE} = 15\text{ V}$ (see Figure 31: "Switching waveform") $di/dt = 500\text{ A}/\mu\text{s}$	-	488		ns
Q_{rr}	Reverse recovery charge		-	2.59		μC
I_{rrm}	Reverse recovery current		-	11.6		A
dl_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	406		A/ μ s
E_{rr}	Reverse recovery energy		-	0.38		mJ
t_{rr}	Reverse recovery time	$I_F = 40\text{ A}$, $V_R = 600\text{ V}$, $V_{GE} = 15\text{ V}$ $T_J = 175\text{ }^\circ\text{C}$ (see Figure 31: "Switching waveform") $di/dt = 500\text{ A}/\mu\text{s}$	-	484		ns
Q_{rr}	Reverse recovery charge		-	4.5		μC
I_{rrm}	Reverse recovery current		-	18.6		A
dl_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	170		A/ μ s
E_{rr}	Reverse recovery energy		-	0.94		mJ

2.2 Electrical characteristics (curves)

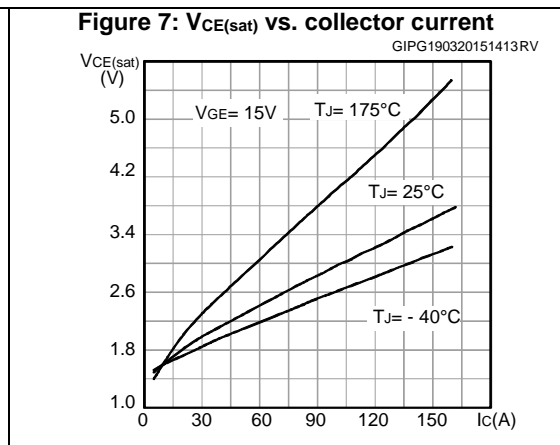
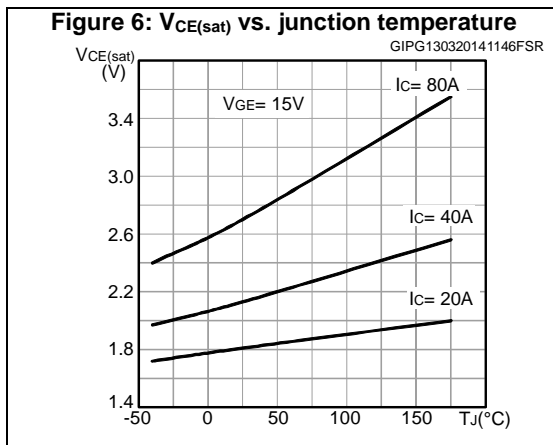
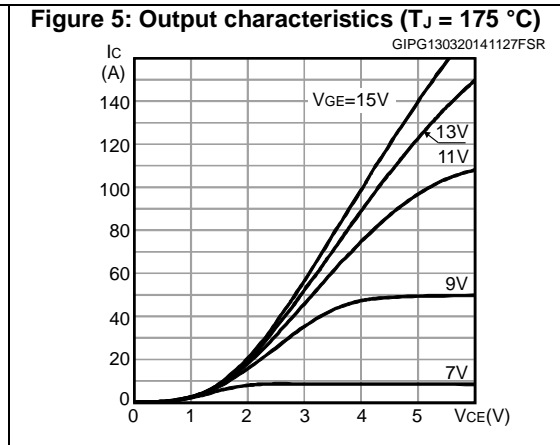
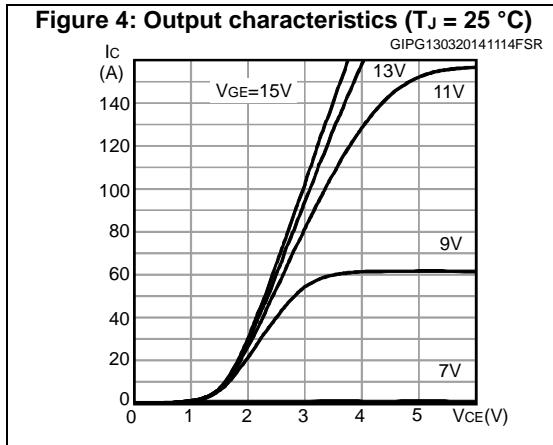
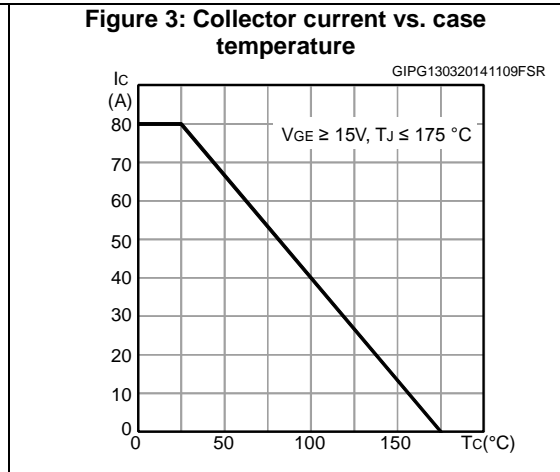
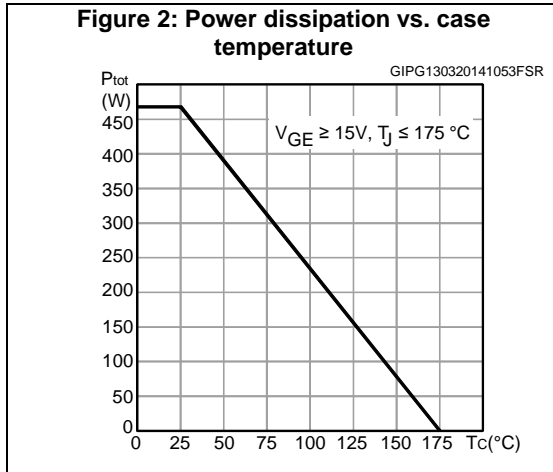


Figure 8: Collector current vs. switching frequency

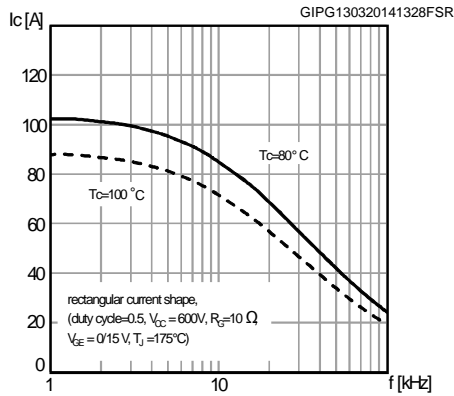


Figure 9: Forward bias safe operating area

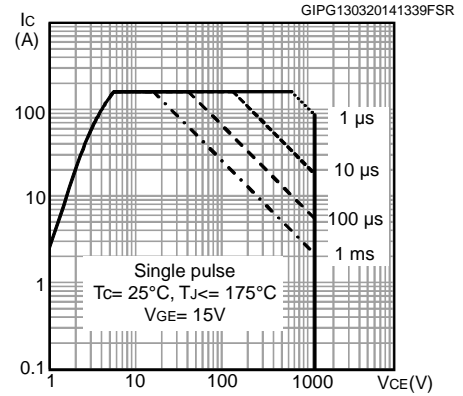


Figure 10: Transfer characteristics

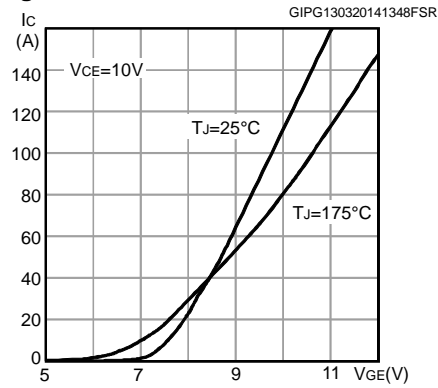


Figure 11: Diode V_F vs. forward current

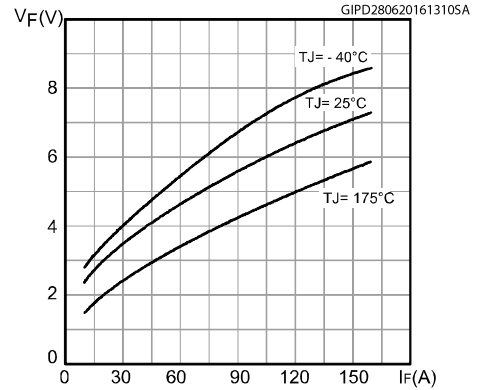


Figure 12: Normalized V_{GE(th)} vs. junction temperature

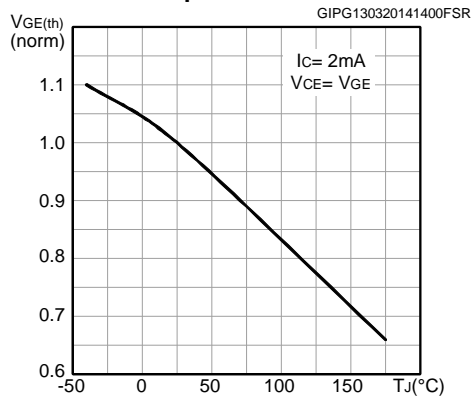


Figure 13: Normalized V_{(BR)CES} vs. junction temperature

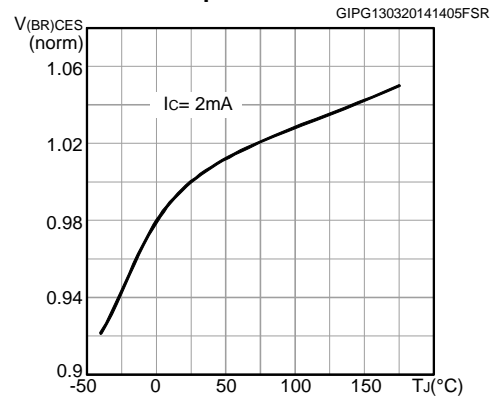


Figure 14: Capacitance variations

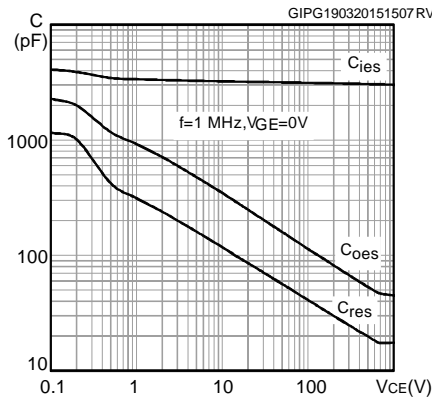


Figure 15: Gate charge vs. gate-emitter voltage

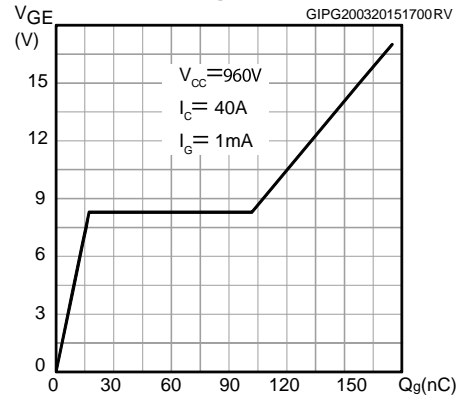


Figure 16: Switching energy vs. collector current

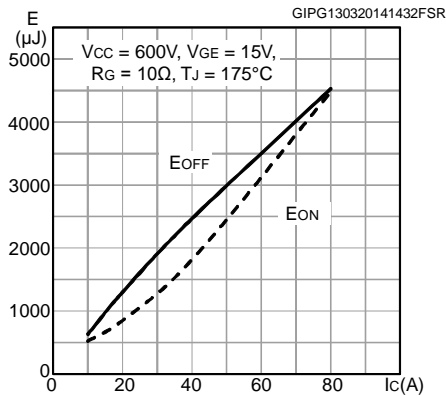


Figure 17: Switching energy vs. gate resistance

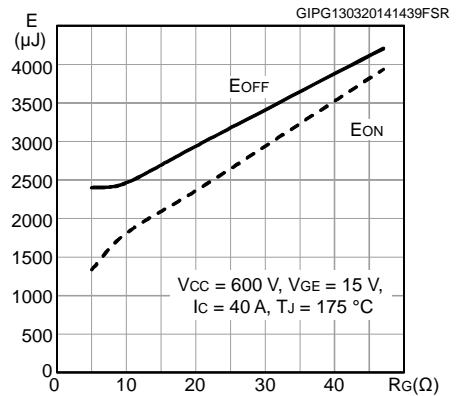


Figure 18: Switching energy vs. temperature

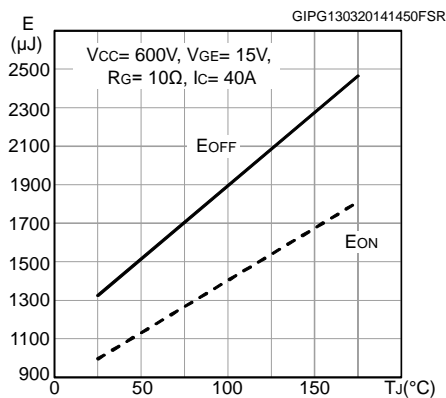


Figure 19: Switching energy vs. collector emitter voltage

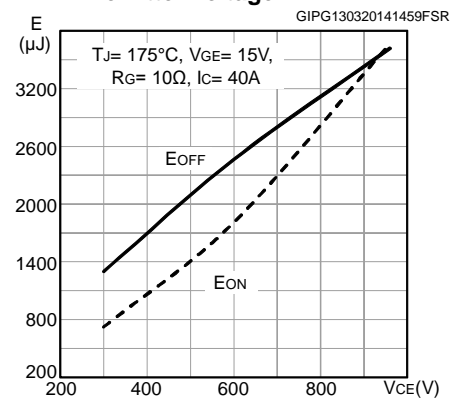


Figure 20: Short-circuit time and current vs. V_{GE}

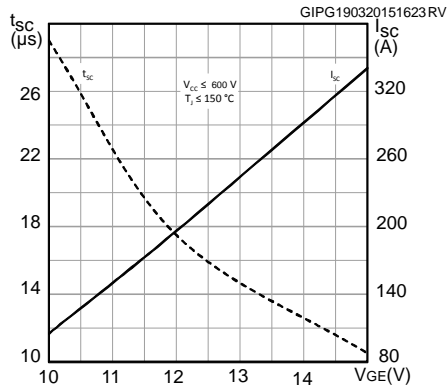


Figure 21: Switching times vs. collector current

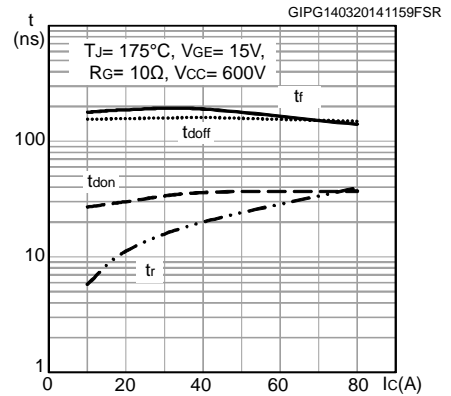


Figure 22: Switching times vs. gate resistance

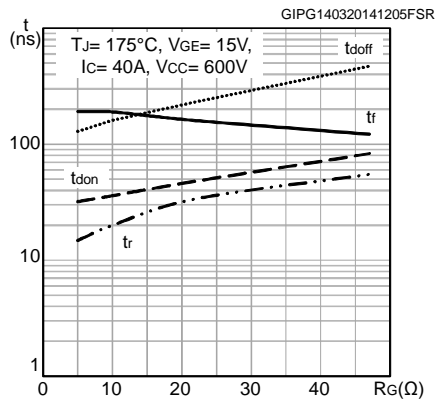


Figure 23: Reverse recovery current vs. diode current slope

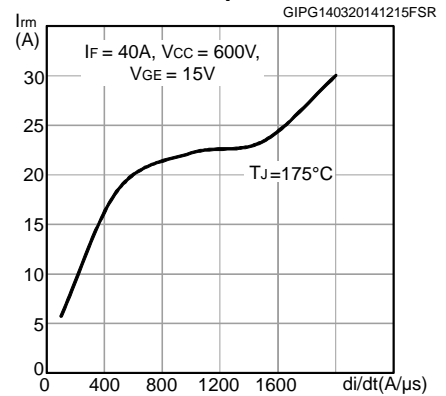


Figure 24: Reverse recovery time vs. diode current slope

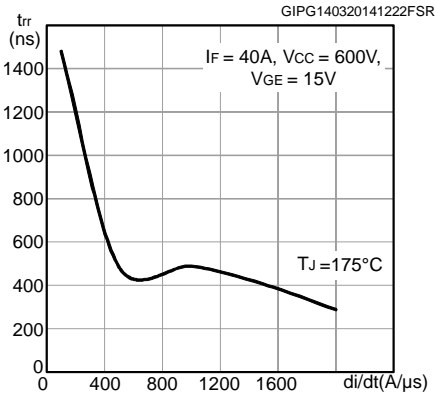


Figure 25: Reverse recovery charge vs. diode current slope

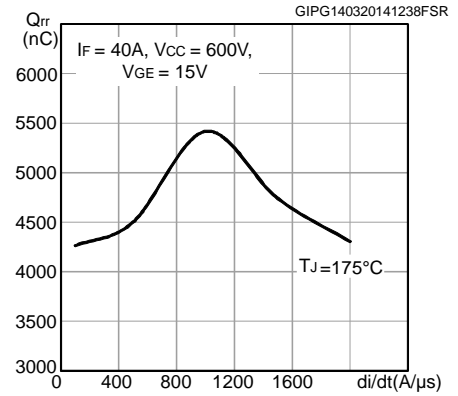


Figure 26: Reverse recovery energy vs. diode current slope

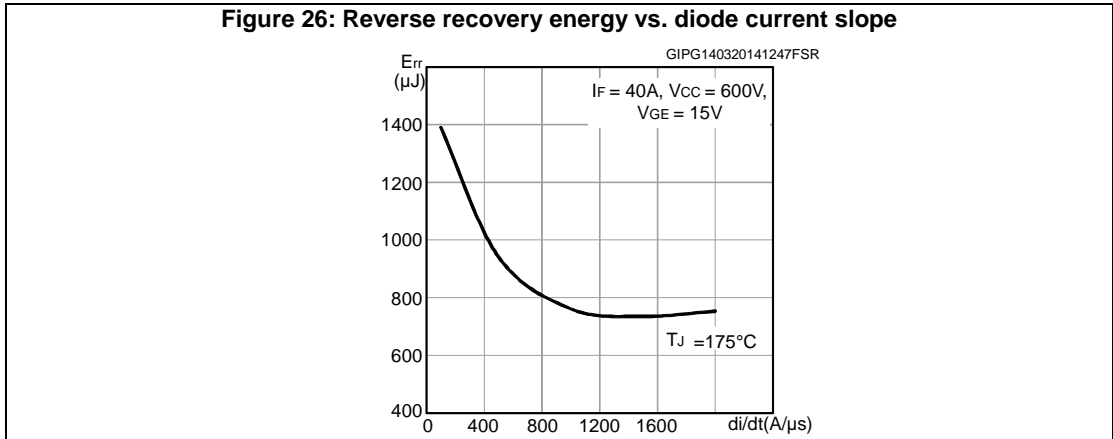


Figure 27: Thermal impedance for IGBT

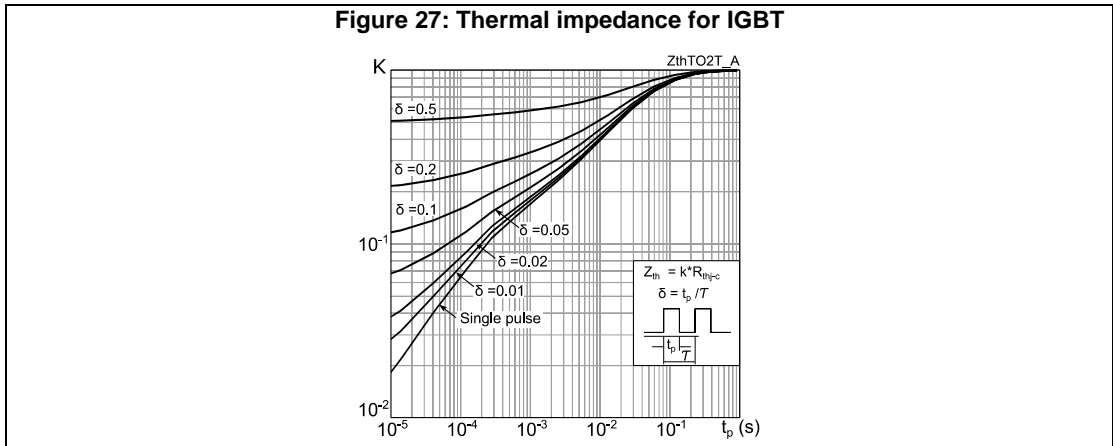
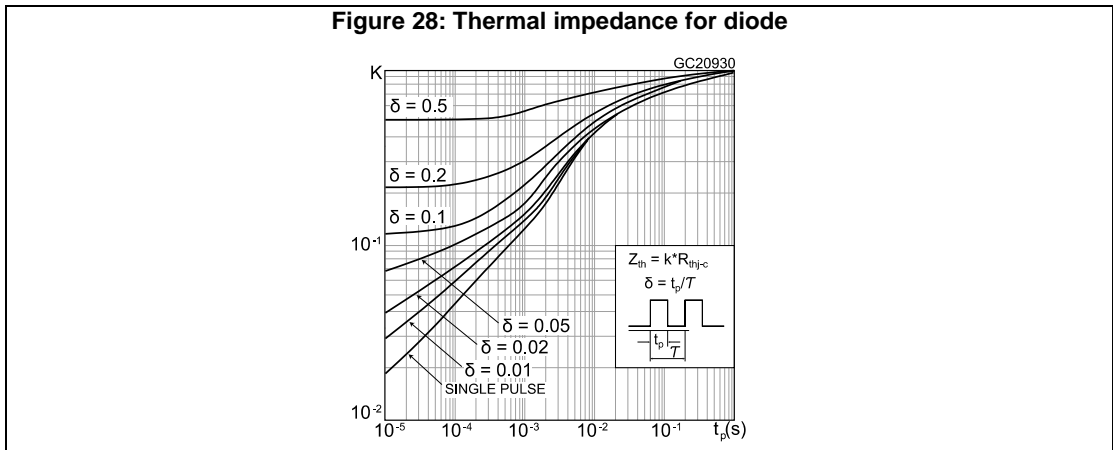
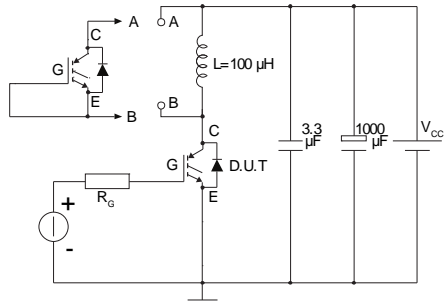


Figure 28: Thermal impedance for diode



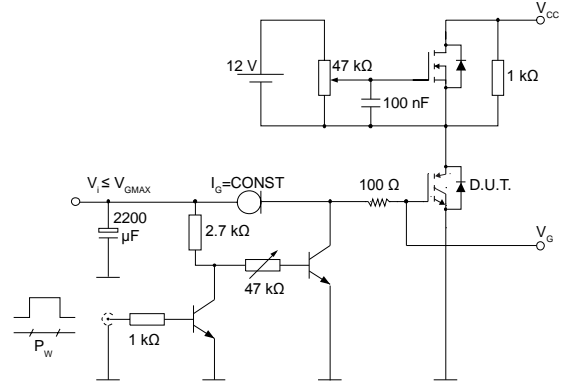
3 Test circuits

Figure 29: Test circuit for inductive load switching



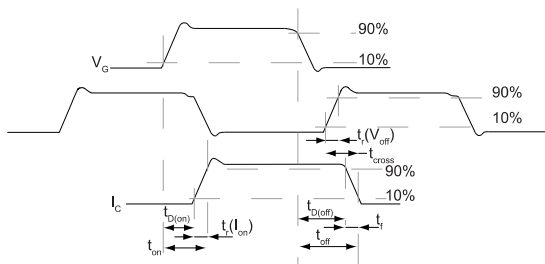
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Figure 30: Gate charge test circuit



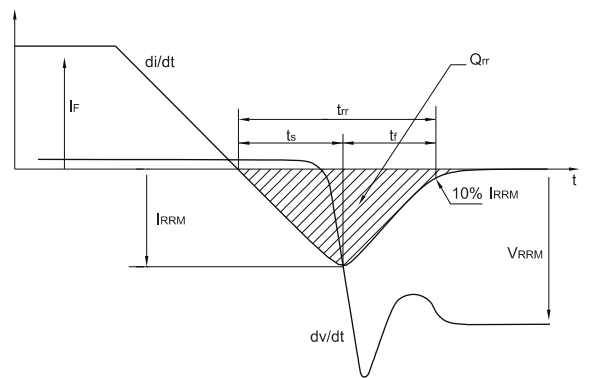
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Figure 31: Switching waveform



AM01506v1

Figure 32: Diode reverse recovery waveform



AM01507v1

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. ECOPACK® is an ST trademark.

4.1 TO-247 package information

Figure 33: TO-247 package outline

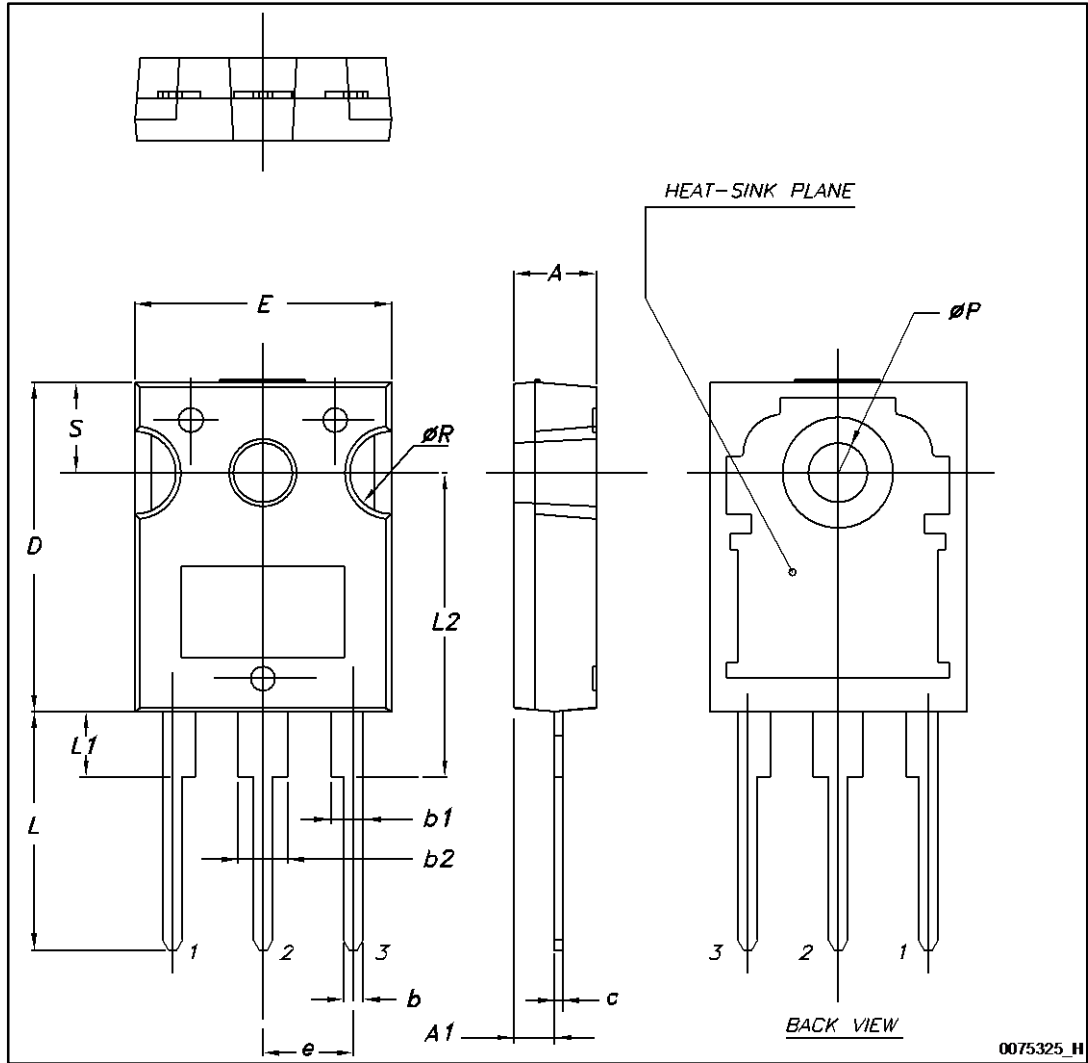


Table 8: TO-247 package mechanical data

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

4.2 TO-247 long leads package information

Figure 34: TO-247 long lead package outline

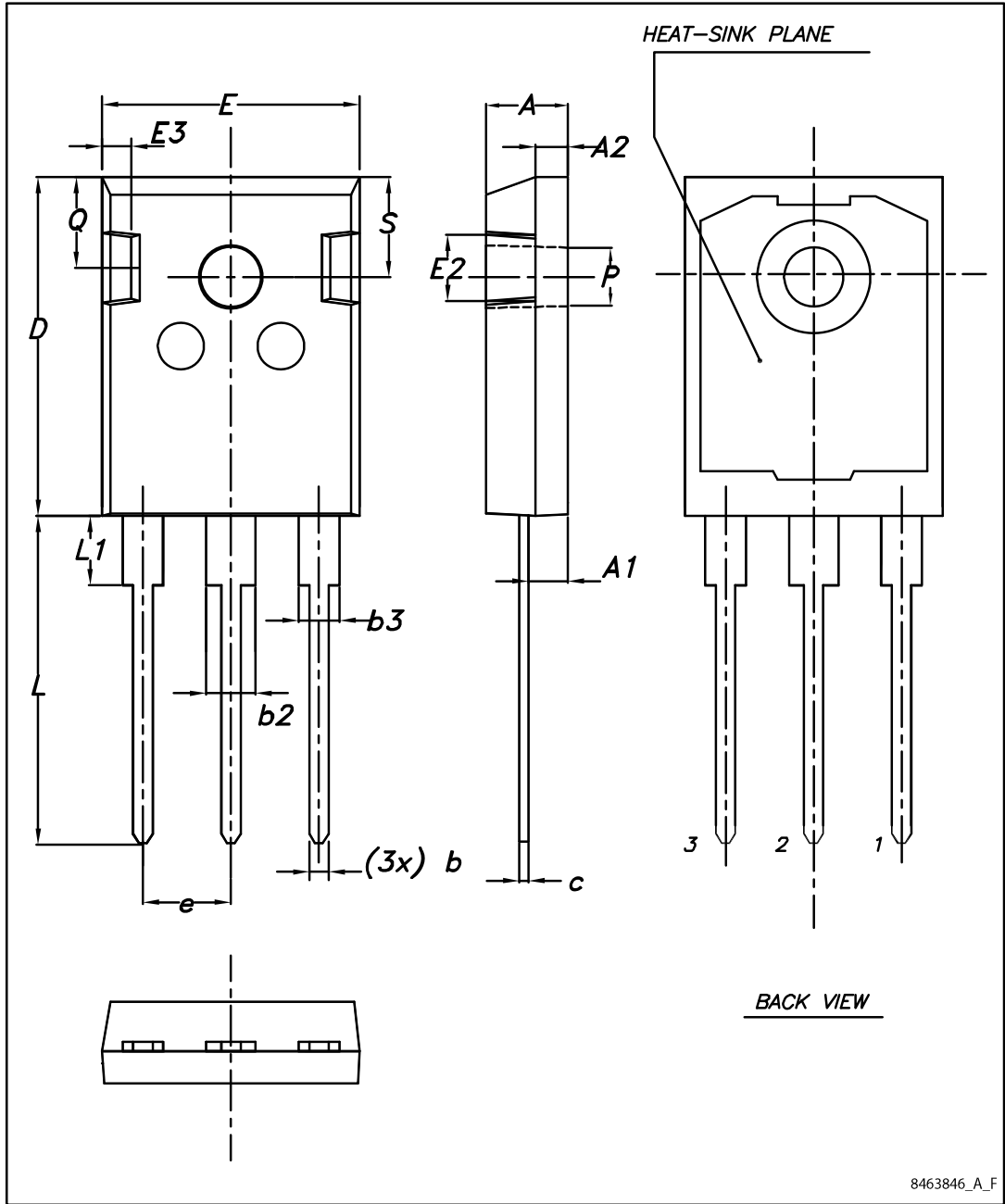


Table 9: TO-247 long lead package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.26
b2			3.25
b3			2.25
c	0.59		0.66
D	20.90	21.00	21.10
E	15.70	15.80	15.90
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25

5 Revision history

Table 10: Document revision history

Date	Revision	Changes
03-Oct-2012	1	First release.
29-Jan-2014	2	Updated features in cover page. Updated Table 4: Static characteristics, Table 5: Dynamic characteristics and Table 7: Diode switching characteristics (inductive load). Minor text changes.
24-Mar-2014	3	Updated title and description in cover page. Updated Table 4: Static characteristics, Table 5: Dynamic characteristics and Table 7: Diode switching characteristics (inductive load). Added Section 2.1: Electrical characteristics (curves).
31-Mar-2015	4	Added device in TO-247 long leads. Updated 4: Package information. Updated Figure 7, Figure 11, Figure 14, Figure 15, Figure 20, Figure 21 and added Figure 26. Minor text changes.
28-Jun-2016	5	Modified: <i>Table 2: "Absolute maximum ratings"</i> , <i>Section 2: "Electrical characteristics"</i> , <i>Table 6: "IGBT switching characteristics (inductive load)"</i> Minor text changes.

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