STGW40H120DF2, STGWA40H120DF2

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

Datasheet - production data

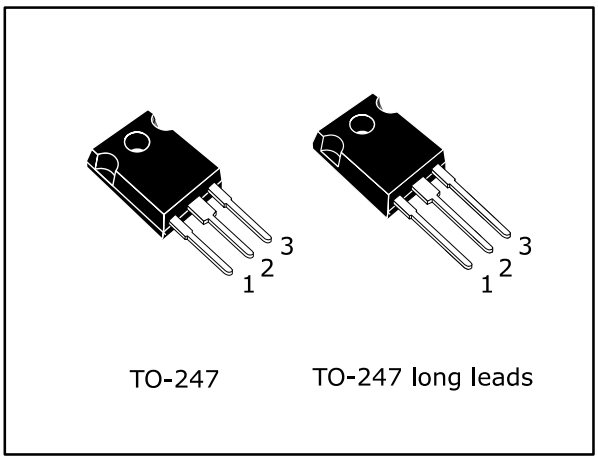
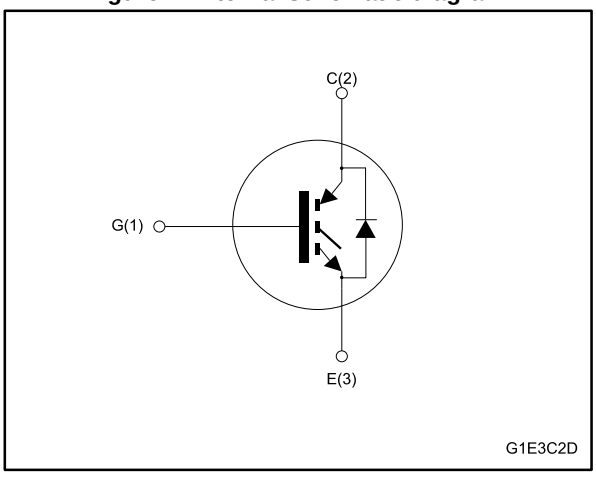


Figure 1: Internal schematic diagram



Features

- Maximum junction temperature: T_J = 175 °C
- High speed switching series
- Minimized tail current
- $V_{CE(sat)}$ = 2.1 V (typ.) @ I_C = 40 A
- 5 µs minimum short circuit withstand time at T_J=150 °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

Contents

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 °C	80	A
I_C	Continuous collector current at T_C = 100 °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 ≤ 10 µs, D ≤ 0.01)	±30	V
I_F	Continuous forward current at T_C = 25 °C	80	A
I_F	Continuous forward current at T_C = 100 °C	40	A
I_{FP}(1)	Pulsed forward current	160	A
P_{TOT}	Total dissipation at T_C = 25 °C	468	W
T_{STG}	Storage temperature range	-55 to 150	°C
T_J	Operating junction temperature range	-55 to 175	°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	°C/W
R_{thJC}	Thermal resistance junction-case diode	1.3	°C/W
R_{thJA}	Thermal resistance junction-ambient	50	°C/W

2 Electrical characteristics

T_C = 25 °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 V, I_C = 2 mA	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 40 A		2.1	2.6	V
		V_{GE} = 15 V, I_C = 40 A, T_J = 125 °C		2.4		
		V_{GE} = 15 V, I_C = 40 A, T_J = 175 °C		2.5		
V_F	Forward on-voltage	I_F = 40 A		3.9	4.9	V
		I_F = 40 A, T_J = 125 °C		3.05		
		I_F = 40 A, T_J = 175 °C		2.8		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 2 mA	5	6	7	V
I_{CES}	Collector cut-off current	V_{GE} = 0 V, V_{CE} = 1200 V			25	µA
I_{GES}	Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = ±20 V			±250	nA

Table 5: Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	V_{CE}= 25 V, f = 1 MHz, V_{GE} = 0 V	-	3200	-	pF
C_{oes}	Output capacitance		-	220	-	
C_{res}	Reverse transfer capacitance		-	80	-	
Q_g	Total gate charge	V_{CC} = 960 V, I_C = 40 A, V_{GE} = 15 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 V, I_C = 40 A, V_{GE} = 15 V, R_G = 10 Ω (see *Figure 31: " Switching waveform"*)		18	-	ns
t_r	Current rise time			37	-	ns
$(di/dt)_{on}$	Turn-on current slope			1755	-	A/µs
$t_{d(off)}$	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 V, I_C = 40 A, V_{GE} = 15 V, R_G = 10 Ω T_J = 175 °C (see *Figure 31: " Switching waveform"*)		36	-	ns
t_r	Current rise time			20	-	ns
$(di/dt)_{on}$	Turn-on current slope			1580	-	A/µs
$t_{d(off)}$	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 V, V_{GE} = 15 V, T_{Jstart} = 150 °C	5		-	µs

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

2.2 Electrical characteristics (curves)

Figure 2: Power dissipation vs. case temperature

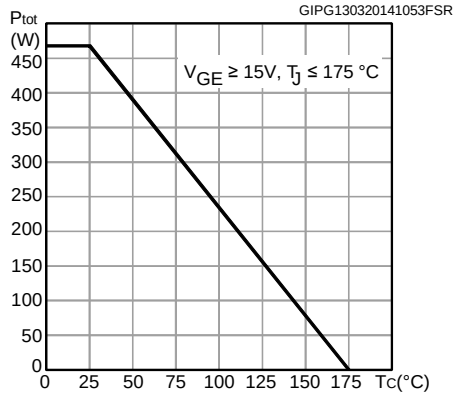


Figure 3: Collector current vs. case temperature

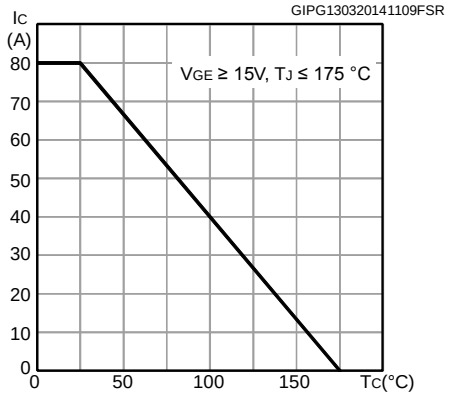


Figure 4: Output characteristics (T_J = 25 °C)

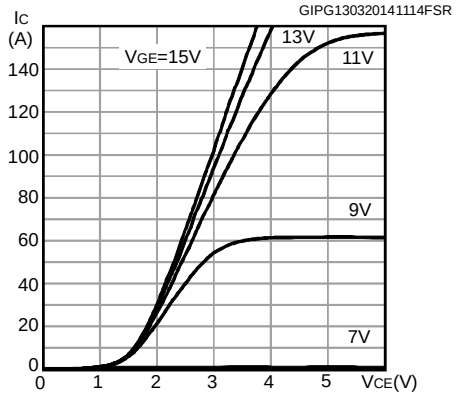


Figure 5: Output characteristics (T_J = 175 °C)

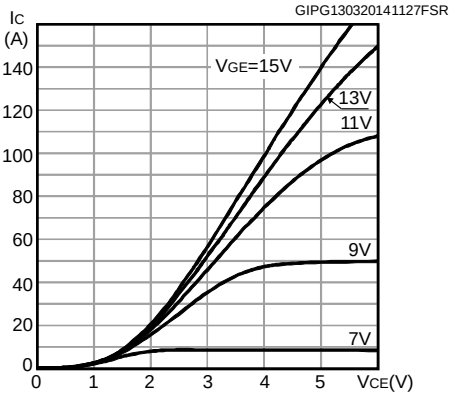


Figure 6: $V_{CE(sat)}$ vs. junction temperature

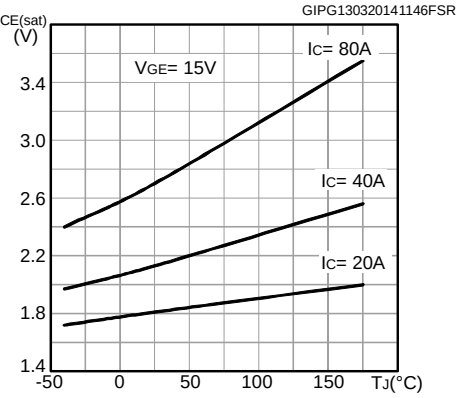


Figure 7: $V_{CE(sat)}$ vs. collector current

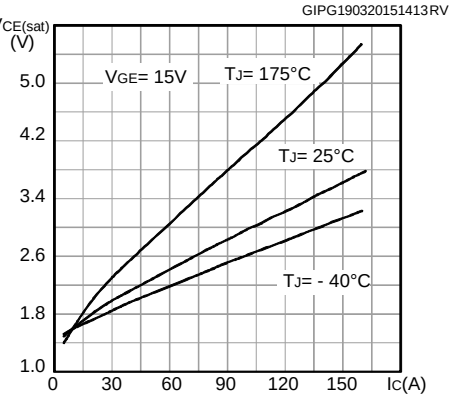


Figure 8: Collector current vs. switching frequency

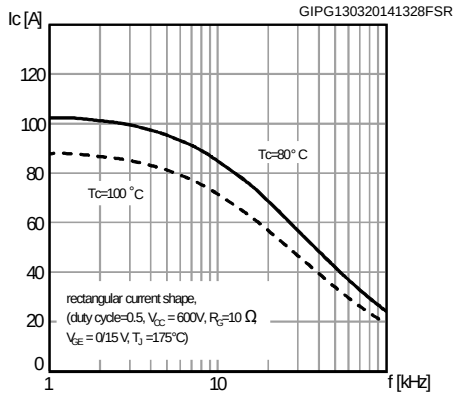


Figure 9: Forward bias safe operating area

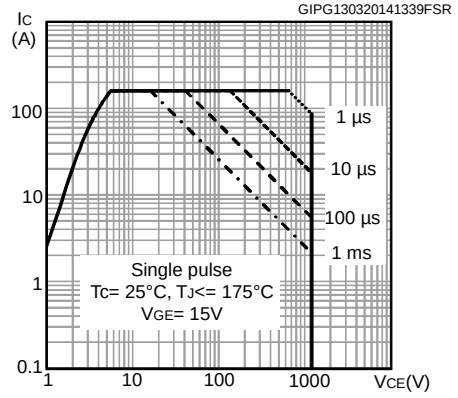


Figure 10: Transfer characteristics

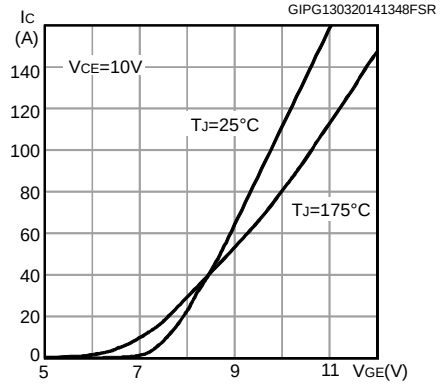


Figure 11: Diode V_F vs. forward current

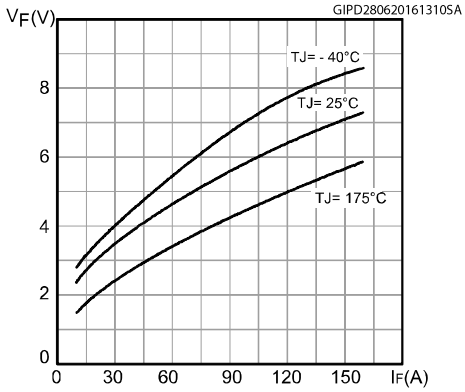


Figure 12: Normalized $V_{GE(th)}$ vs. junction temperature

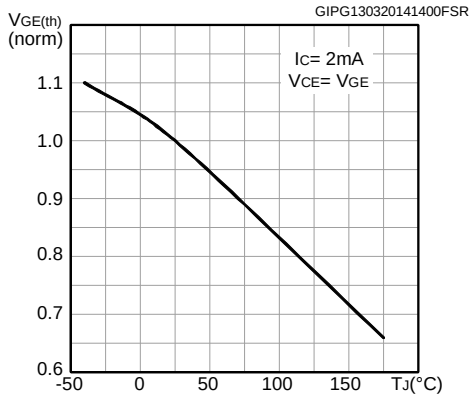


Figure 13: Normalized $V_{(BR)CES}$ vs. junction temperature

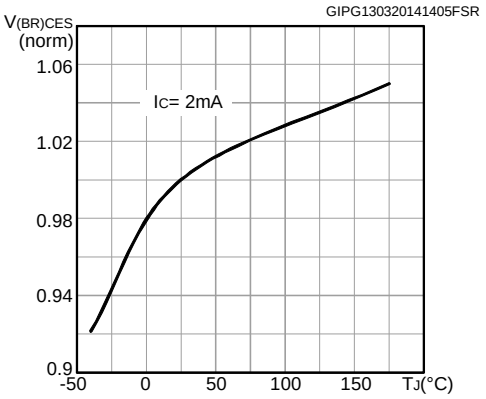


Figure 14: Capacitance variations

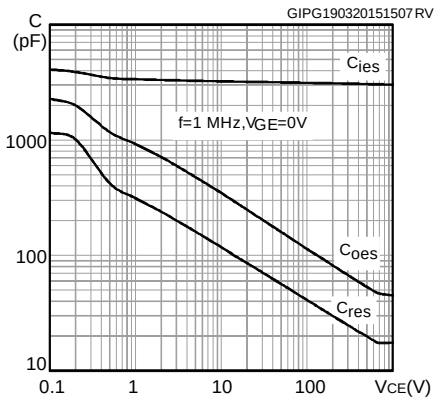


Figure 15: Gate charge vs. gate-emitter voltage

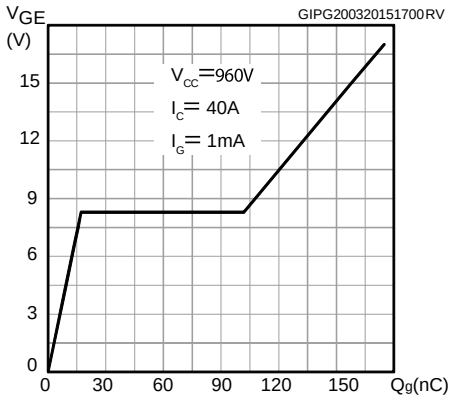


Figure 16: Switching energy vs. collector current

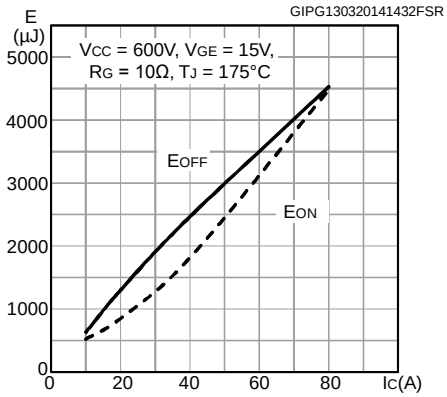


Figure 17: Switching energy vs. gate resistance

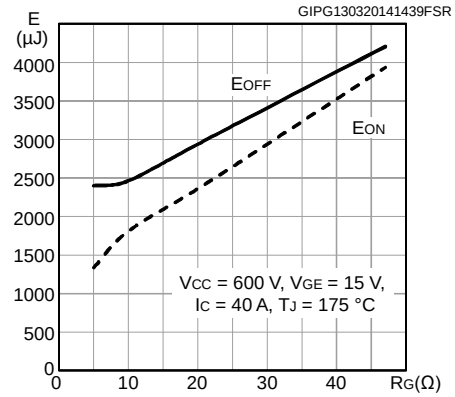


Figure 18: Switching energy vs. temperature

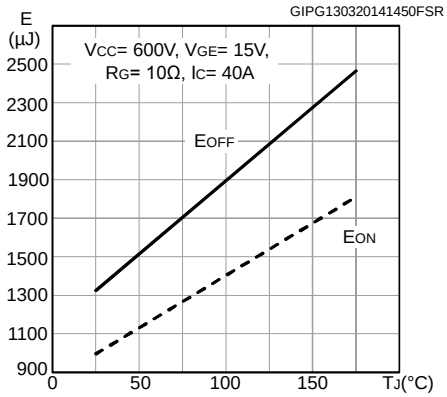


Figure 19: Switching energy vs. collector emitter voltage

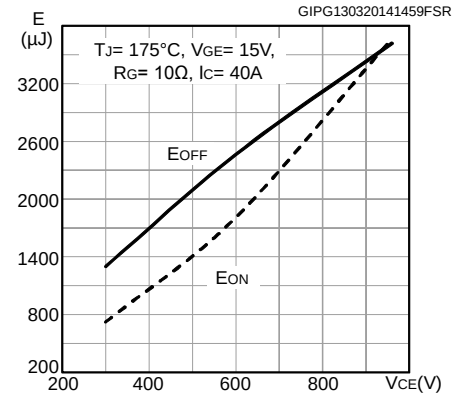


Figure 20: Short-circuit time and current vs. V_{GE}

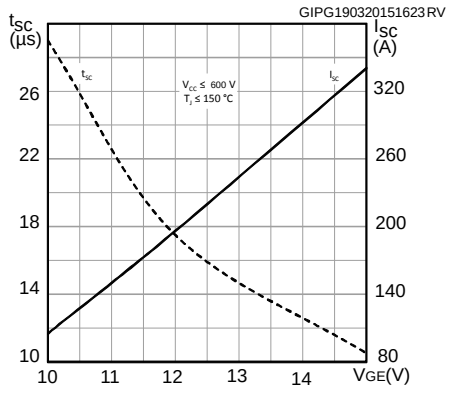


Figure 21: Switching times vs. collector current

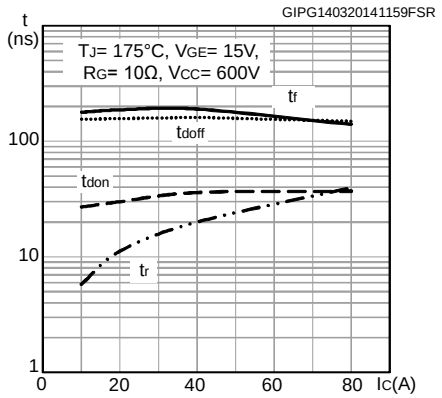


Figure 22: Switching times vs. gate resistance

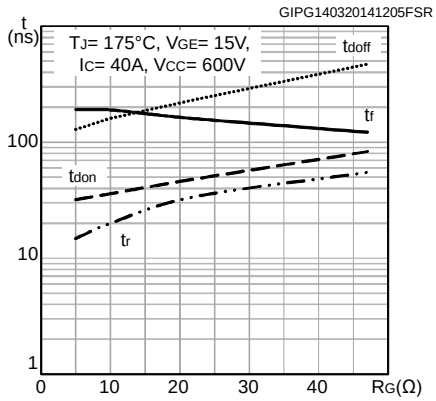


Figure 23: Reverse recovery current vs. diode current slope

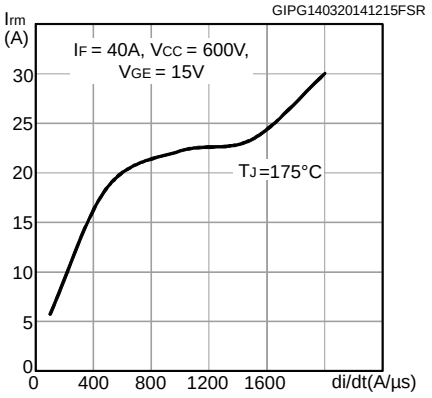


Figure 24: Reverse recovery time vs. diode current slope

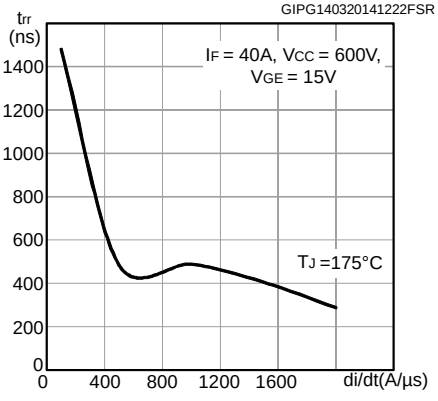


Figure 25: Reverse recovery charge vs. diode current slope

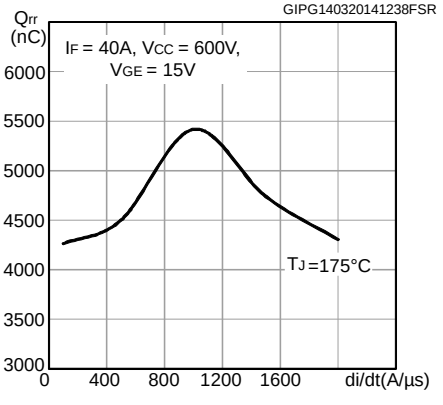


Figure 26: Reverse recovery energy vs. diode current slope

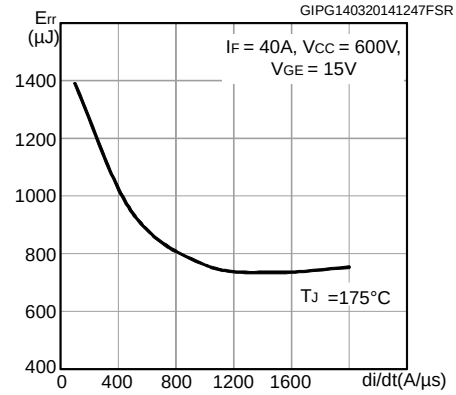


Figure 27: Thermal impedance for IGBT

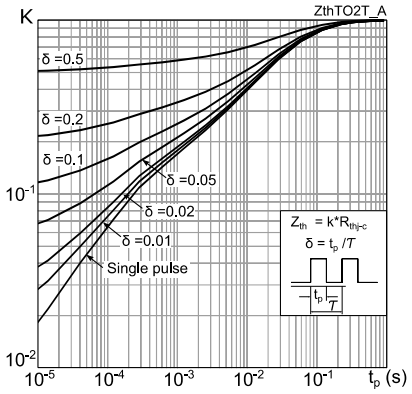
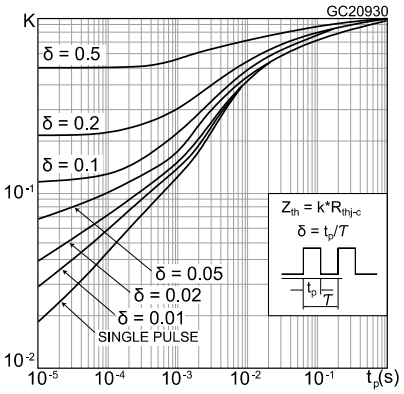


Figure 28: Thermal impedance for diode



3 Test circuits

Figure 29: Test circuit for inductive load switching

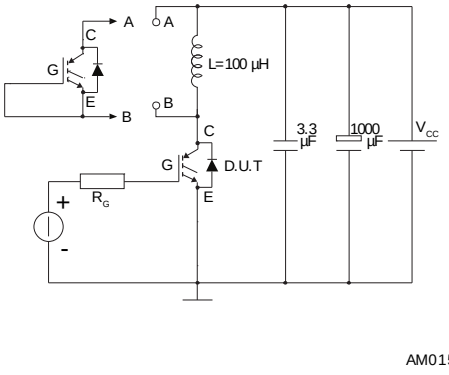


Figure 30: Gate charge test circuit

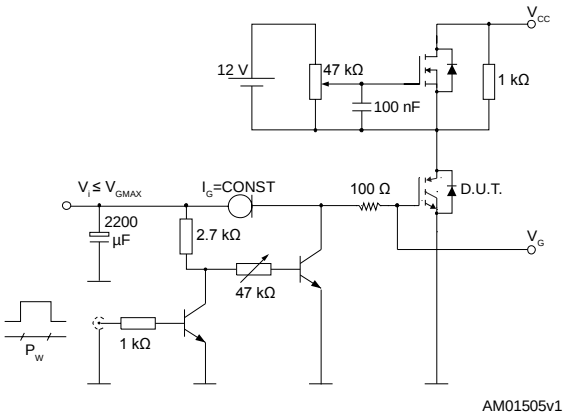


Figure 31: Switching waveform

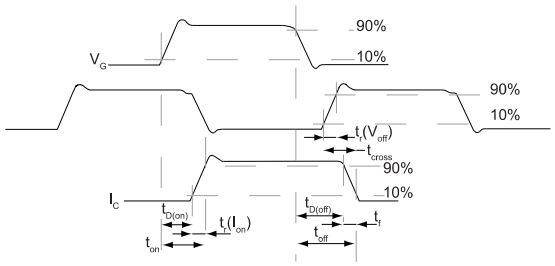
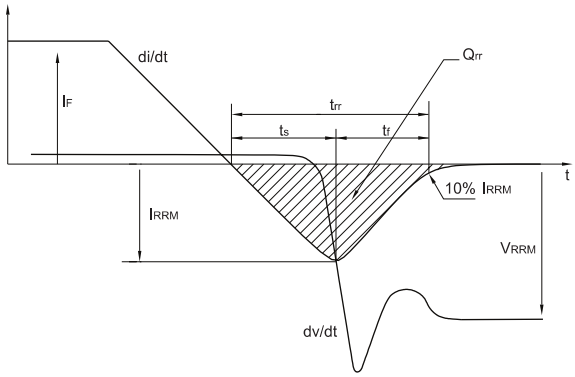


Figure 32: Diode reverse recovery waveform



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

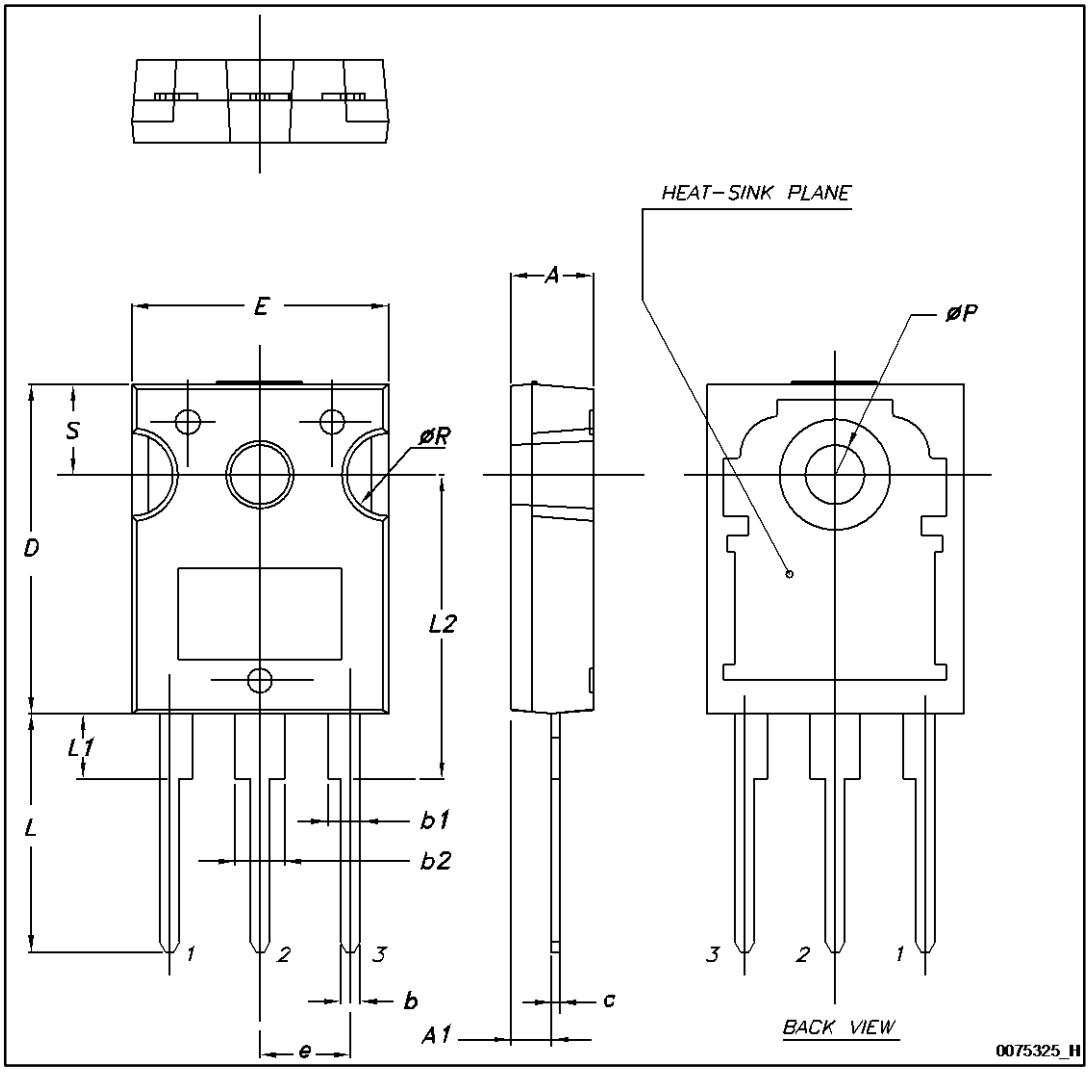


Table 8: TO-247 package mechanical data

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

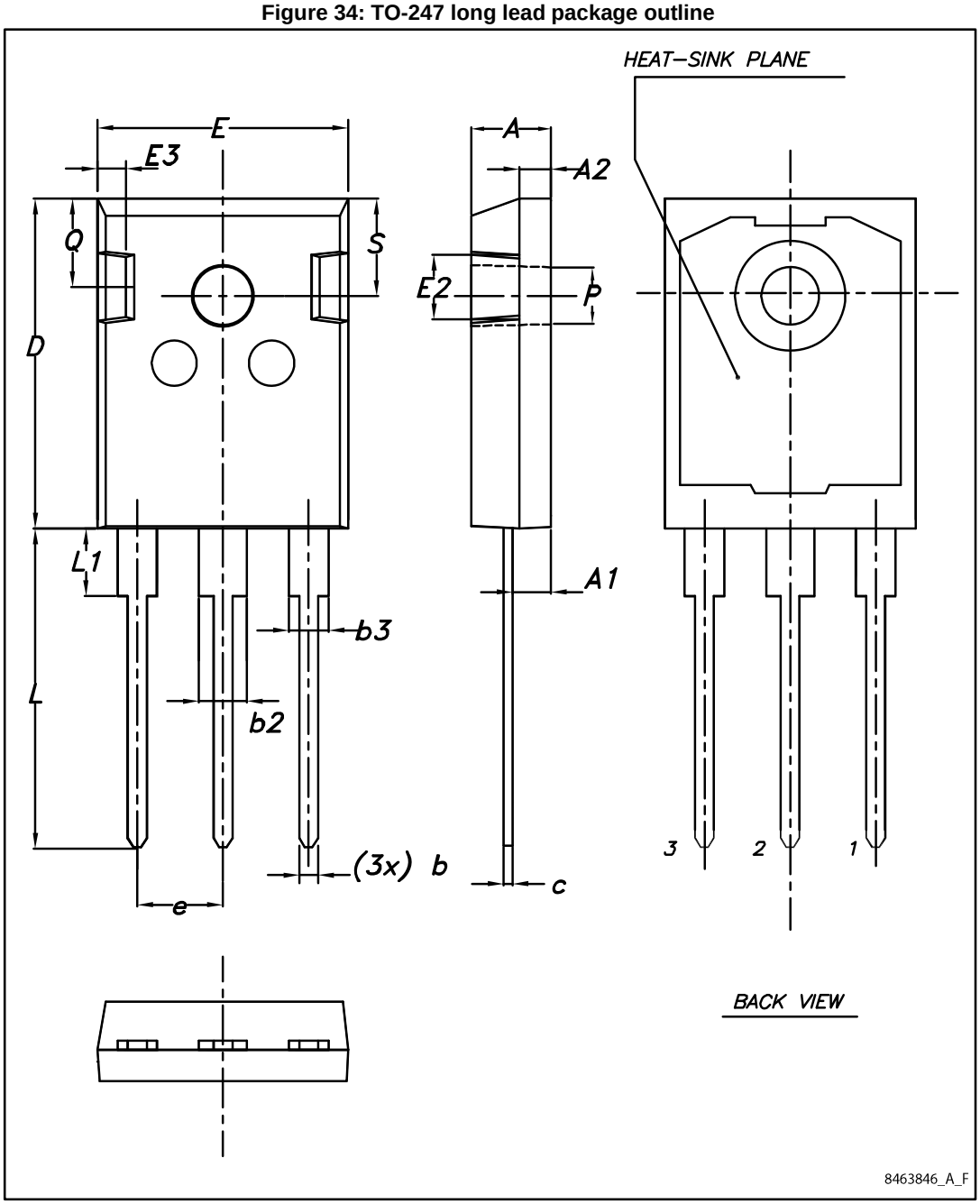


Table 9: TO-247 long lead package mechanical data

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: *Table 2: "Absolute maximum ratings"*, *Section 2: "Electrical characteristics"*, *Table 6: "IGBT switching characteristics (inductive load)"* Minor text changes.