

40 A, 1200 V short circuit rugged IGBT with Ultrafast diode

Features

- Low on-losses
- High current capability
- Low gate charge
- Short circuit withstand time 10 μ s
- IGBT co-packaged with Ultrafast free-wheeling diode

Applications

- Motor control

Description

This Ultrafast IGBT is developed using a new planar technology to yield a device with tighter switching energy variation (E_{off}) versus temperature. The suffix "W" denotes a subset of products designed for high switching frequency operation (over 100 kHz)".

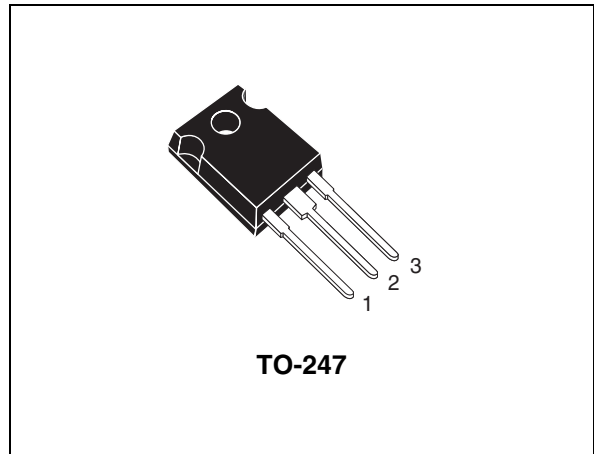


Figure 1. Internal schematic diagram

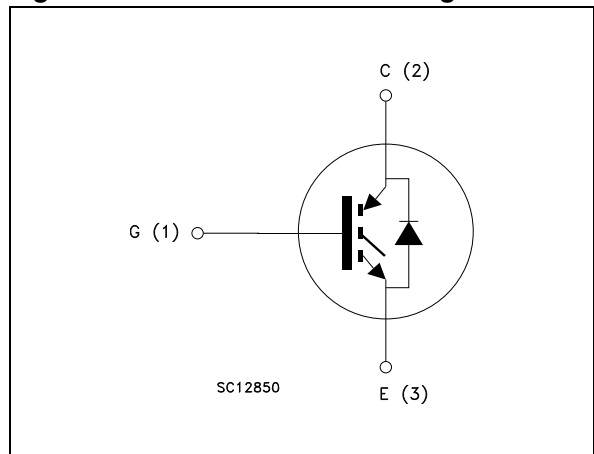


Table 1. Device summary

Order codes	Markings	Package	Packaging
STGW40N120KD	GW40N120KD	TO-247	Tube
STGWA40N120KD	GWA40N120KD	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
$I_C^{(1)}$	Continuous collector current at $T_C = 25\text{ °C}$	80	A
$I_C^{(1)}$	Continuous collector current at $T_C = 100\text{ °C}$	40	A
$I_{CL}^{(2)}$	Turn-off latching current	85	A
$I_{CP}^{(3)}$	Pulsed collector current	120	A
V_{GE}	Gate-emitter voltage	± 25	V
t_{SCW}	Short circuit withstand time, $V_{CE} = 0.5 V_{(BR)CES}$ $T_j = 125\text{ °C}$, $R_G = 10\ \Omega$, $V_{GE} = 12\text{ V}$	10	μs
P_{TOT}	Total dissipation at $T_C = 25\text{ °C}$	240	W
I_F	Diode RMS forward current at $T_C = 25\text{ °C}$	30	A
I_{FSM}	Surge non repetitive forward current $t_p = 10\text{ ms}$ sinusoidal	100	A
T_j	Operating junction temperature	- 55 to 125	$^{\circ}\text{C}$

1. Calculated according to the iterative formula:

$$I_C(T_C) = \frac{T_{j(max)} - T_C}{R_{thj-c} \times V_{CE(sat)(max)}(T_{j(max)}, I_C(T_C))}$$

2. $V_{clamp} = 80\%$ of V_{CES} , $T_j = 125\text{ °C}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$

3. Pulse width limited by maximum junction temperature and turn-off within RBSOA

Table 3. Thermal data

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case IGBT	0.42	$^{\circ}\text{C/W}$
$R_{thj-case}$	Thermal resistance junction-case diode	1.6	$^{\circ}\text{C/W}$
$R_{thj-amb}$	Thermal resistance junction-ambient	50	$^{\circ}\text{C/W}$

2 Electrical characteristics

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

Table 4. Static

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage ($V_{GE} = 0$)	$I_C = 1\text{ mA}$	1200			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$, $I_C = 30\text{ A}$ $V_{GE} = 15\text{ V}$, $I_C = 30\text{ A}$, $T_J = 125\text{ °C}$		2.8 2.7	3.85	V V
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$, $I_C = 1\text{ mA}$	4.5		6.5	V
I_{CES}	Collector cut-off current ($V_{GE} = 0$)	$V_{CE} = 1200\text{ V}$ $V_{CE} = 1200\text{ V}$, $T_J = 125\text{ °C}$			500 10	μA mA
I_{GES}	Gate-emitter leakage current ($V_{CE} = 0$)	$V_{GE} = \pm 20\text{ V}$			± 100	nA

Table 5. Dynamic

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0$	-	2577	-	pF
C_{oes}	Output capacitance			196		pF
C_{res}	Reverse transfer capacitance			39.5		pF
Q_g	Total gate charge	$V_{CE} = 960\text{ V}$, $I_C = 30\text{ A}$, $V_{GE} = 15\text{ V}$	-	126	-	nC
Q_{ge}	Gate-emitter charge			22.2		nC
Q_{gc}	Gate-collector charge			67		nC

Table 6. Switching on/off (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960\text{ V}$, $I_C = 30\text{ A}$ $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, (see Figure 16)	-	48	-	ns
t_r	Current rise time			40		ns
$(di/dt)_{on}$	Turn-on current slope			540		A/ μs
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 960\text{ V}$, $I_C = 30\text{ A}$ $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ °C}$ (see Figure 16)	-	45	-	ns
t_r	Current rise time			38		ns
$(di/dt)_{on}$	Turn-on current slope			665		A/ μs
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 960\text{ V}$, $I_C = 30\text{ A}$ $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, (see Figure 16)	-	84	-	ns
$t_{d(off)}$	Turn-off delay time			338		ns
t_f	Current fall time			210		ns
$t_r(V_{off})$	Off voltage rise time	$V_{CC} = 960\text{ V}$, $I_C = 30\text{ A}$ $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 125\text{ °C}$ (see Figure 16)	-	144	-	ns
$t_{d(off)}$	Turn-off delay time			420		ns
t_f	Current fall time			360		ns

Table 7. Switching energy (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960\text{ V}$, $I_C = 30\text{ A}$		3.7		mJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	5.7	-	mJ
E_{ts}	Total switching losses	(see Figure 16)		9.4		mJ
$E_{on}^{(1)}$	Turn-on switching losses	$V_{CC} = 960\text{ V}$, $I_C = 30\text{ A}$		4.7		mJ
$E_{off}^{(2)}$	Turn-off switching losses	$R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$,	-	9.3	-	mJ
E_{ts}	Total switching losses	$T_J = 125\text{ °C}$ (see Figure 16)		14		mJ

- E_{on} is the turn-on losses when a typical diode is used in the test circuit in [Figure 16](#). If the IGBT is offered in a package with a co-pack diode, the co-pack diode is used as external diode. IGBTs and diode are at the same temperature (25°C and 125°C)
- Turn-off losses include also the tail of the collector current

Table 8. Collector-emitter diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_F	Forward on-voltage	$I_F = 20\text{ A}$ $I_F = 20\text{ A}$, $T_J = 125\text{ °C}$	-	1.9 1.7	-	V V
t_{rr}	Reverse recovery time	$I_F = 20\text{ A}$, $V_R = 45\text{ V}$,		84		ns
Q_{rr}	Reverse recovery charge	$di/dt = 100\text{ A}/\mu\text{s}$	-	235	-	nC
I_{rrm}	Reverse recovery current	(see Figure 19)		5.6		A
t_{rr}	Reverse recovery time	$I_F = 20\text{ A}$, $V_R = 45\text{ V}$,		152		ns
Q_{rr}	Reverse recovery charge	$T_J = 125\text{ °C}$,	-	722	-	nC
I_{rrm}	Reverse recovery current	$di/dt = 100\text{ A}/\mu\text{s}$ (see Figure 19)		9		A

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

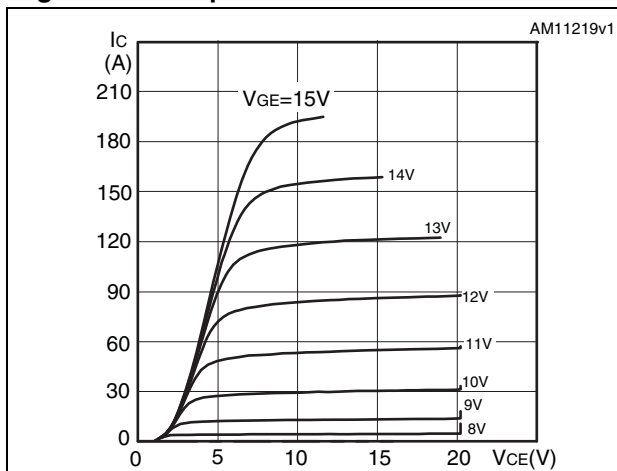


Figure 3. Transfer characteristics

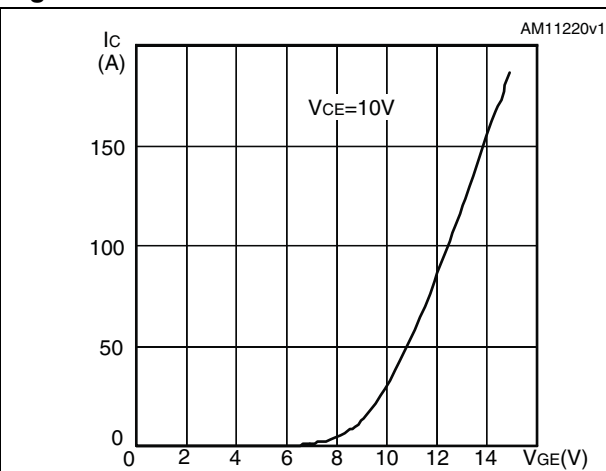


Figure 4. Collector-emitter on voltage vs. collector current

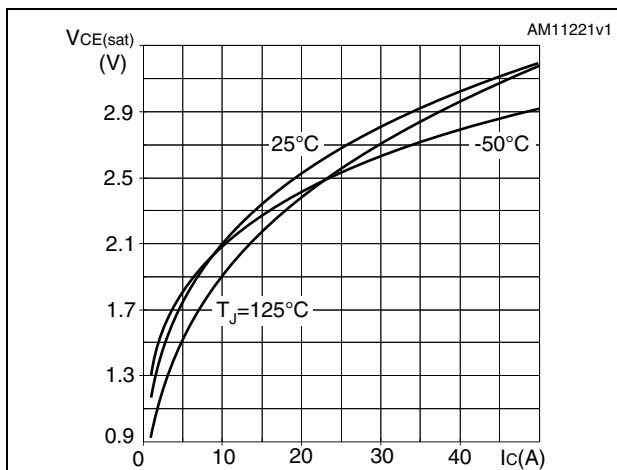


Figure 5. Collector-emitter on voltage vs. temperature

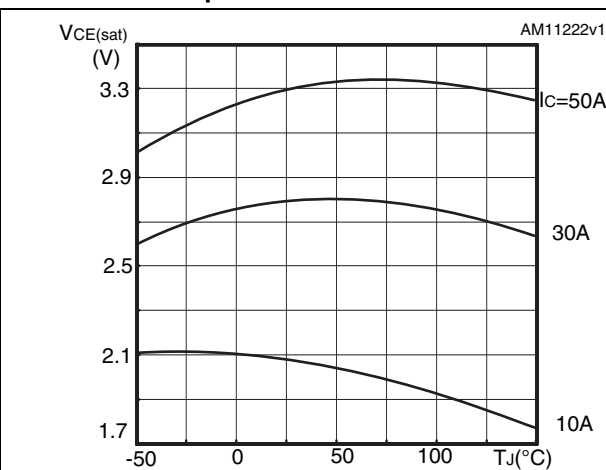


Figure 6. Gate charge vs. gate-source voltage

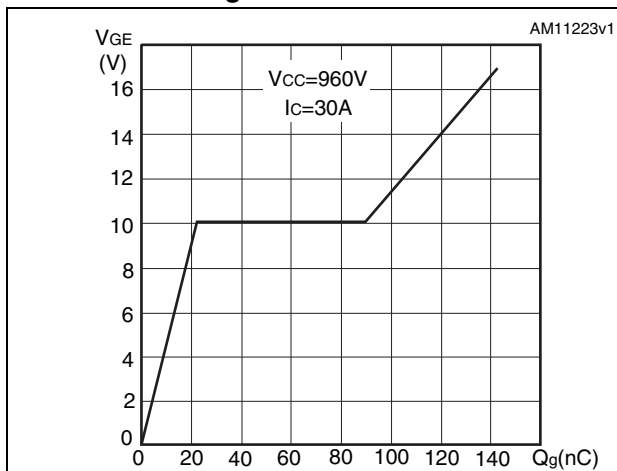


Figure 7. Capacitance variations

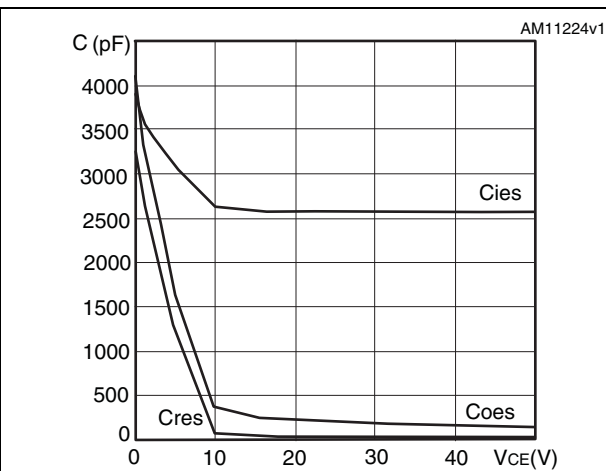


Figure 8. Normalized gate threshold voltage vs. temperature

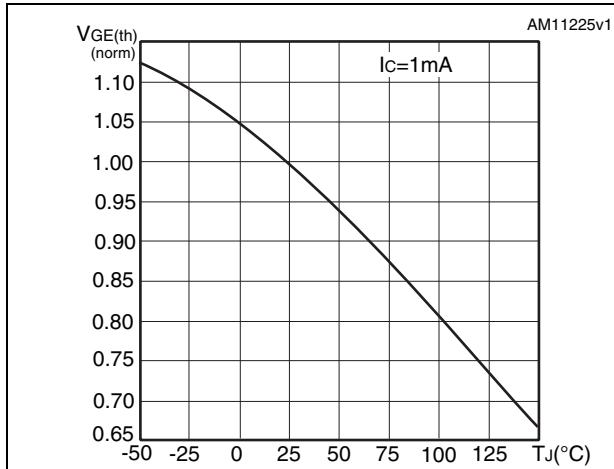


Figure 9. Normalized breakdown voltage vs. temperature

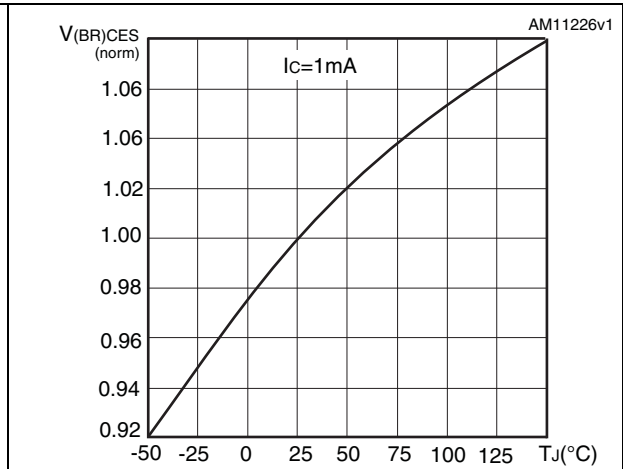


Figure 10. Switching losses vs. collector current

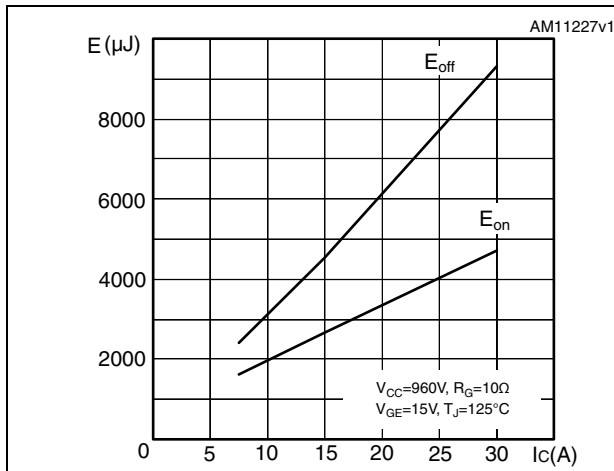


Figure 11. Switching losses vs. gate resistance

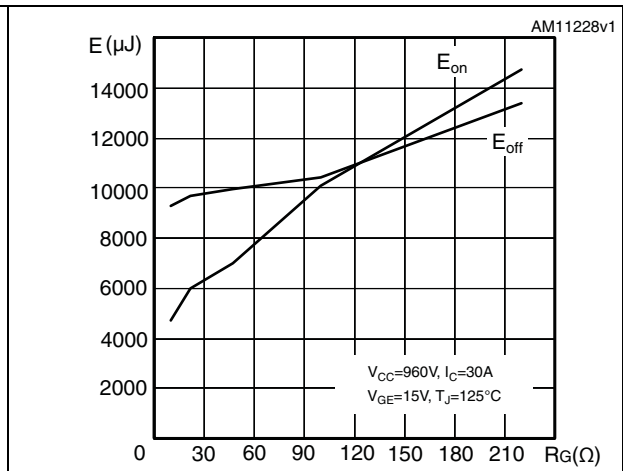


Figure 12. Switching losses vs. temperature

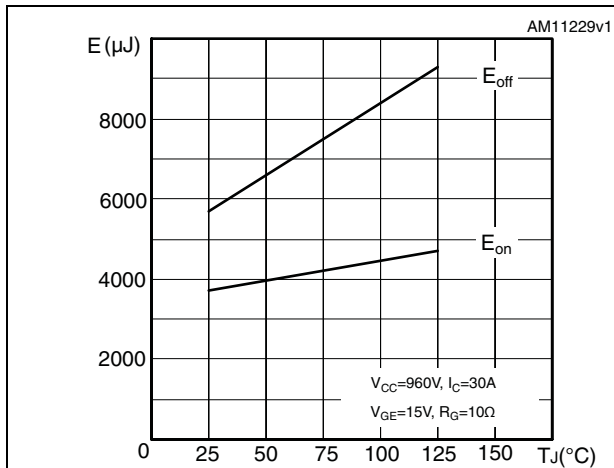


Figure 13. Thermal impedance

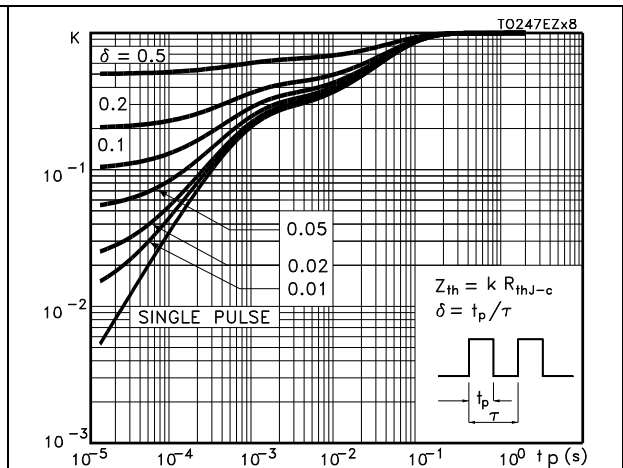


Figure 14. Turn-off SOA

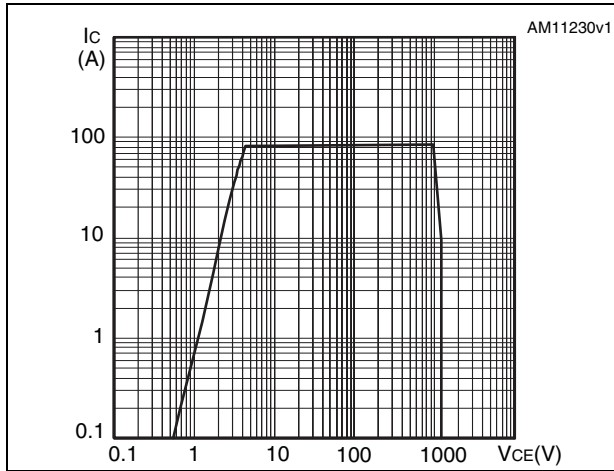
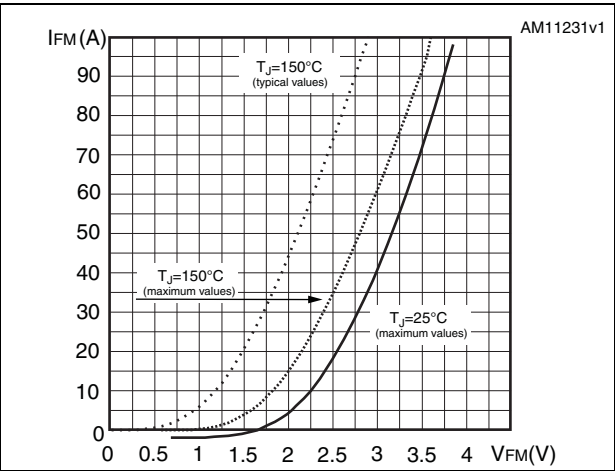


Figure 15. Forward voltage drop vs. forward current



3 Test circuits

Figure 16. Test circuit for inductive load switching

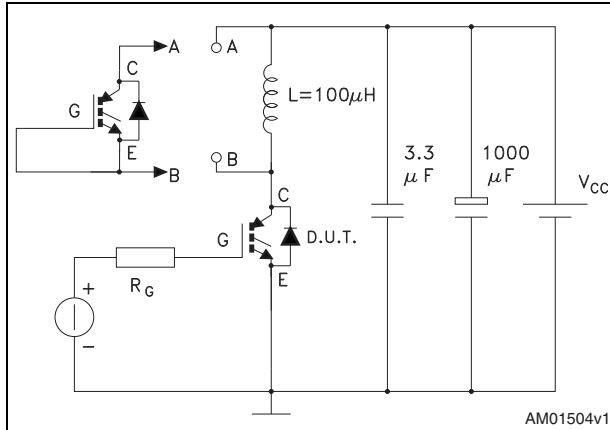


Figure 17. Gate charge test circuit

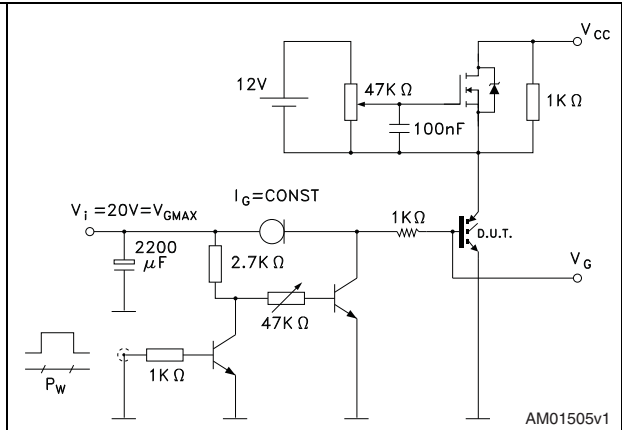


Figure 18. Switching waveform

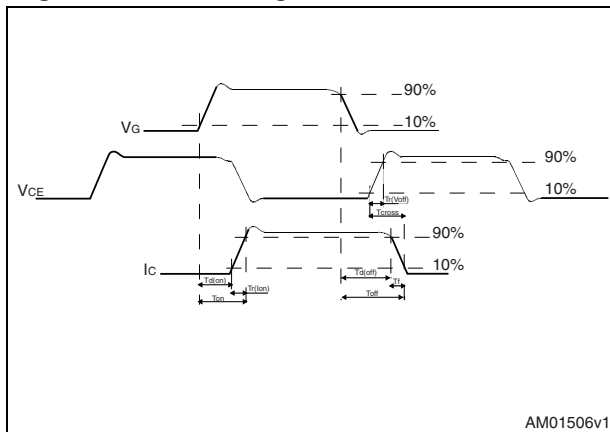
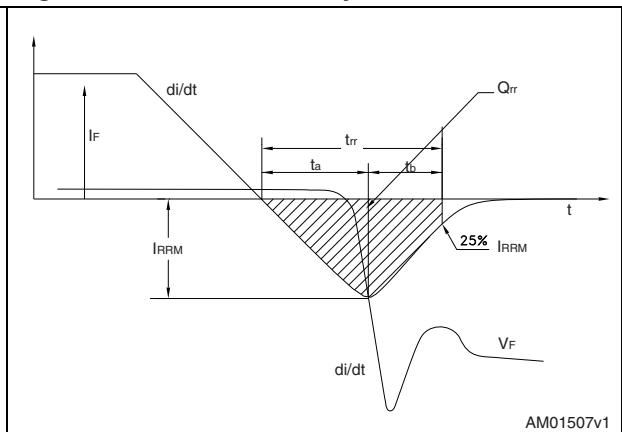


Figure 19. Diode recovery time waveform



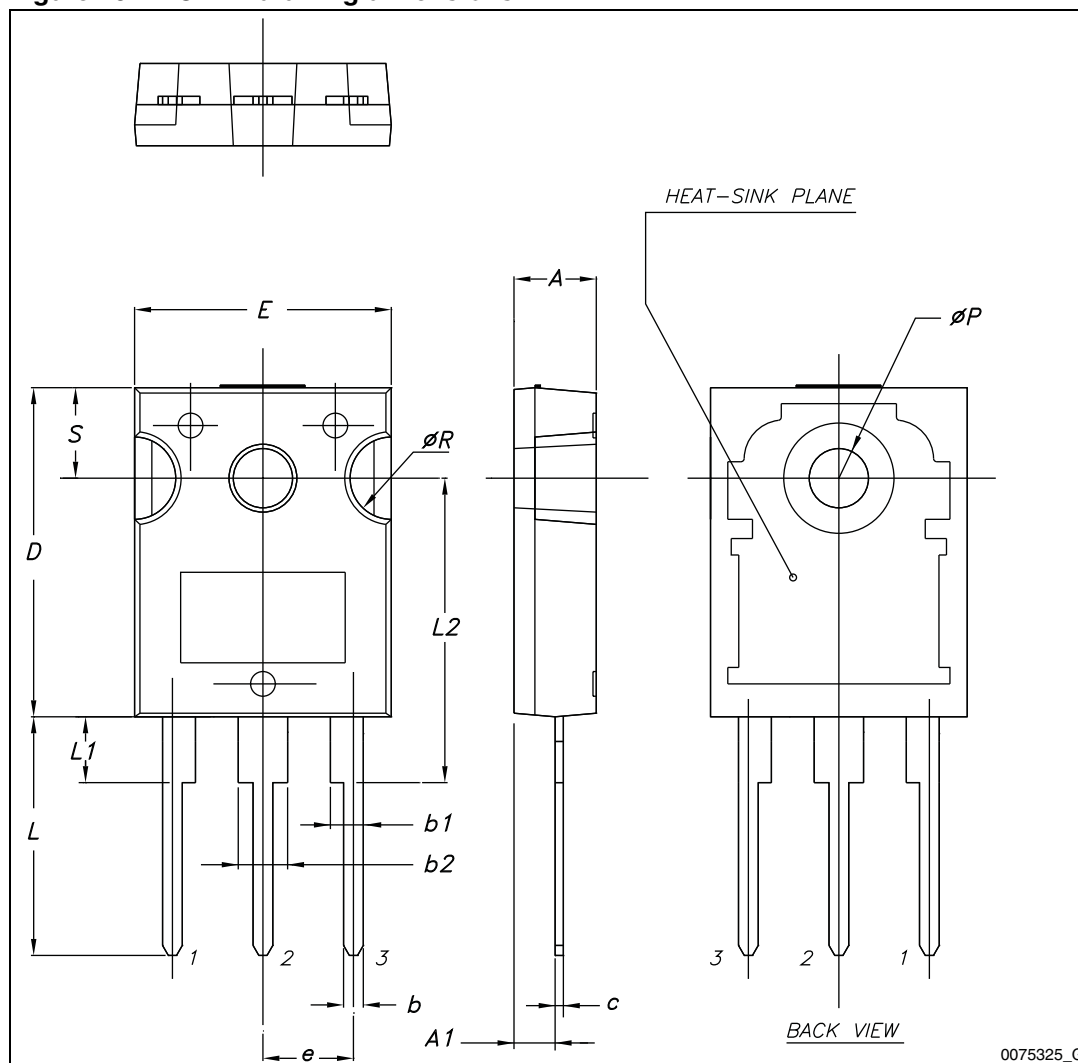
4 Package mechanical data

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. ECOPACK is an ST trademark.

Table 9. 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

Figure 20. TO-247 drawing dimensions

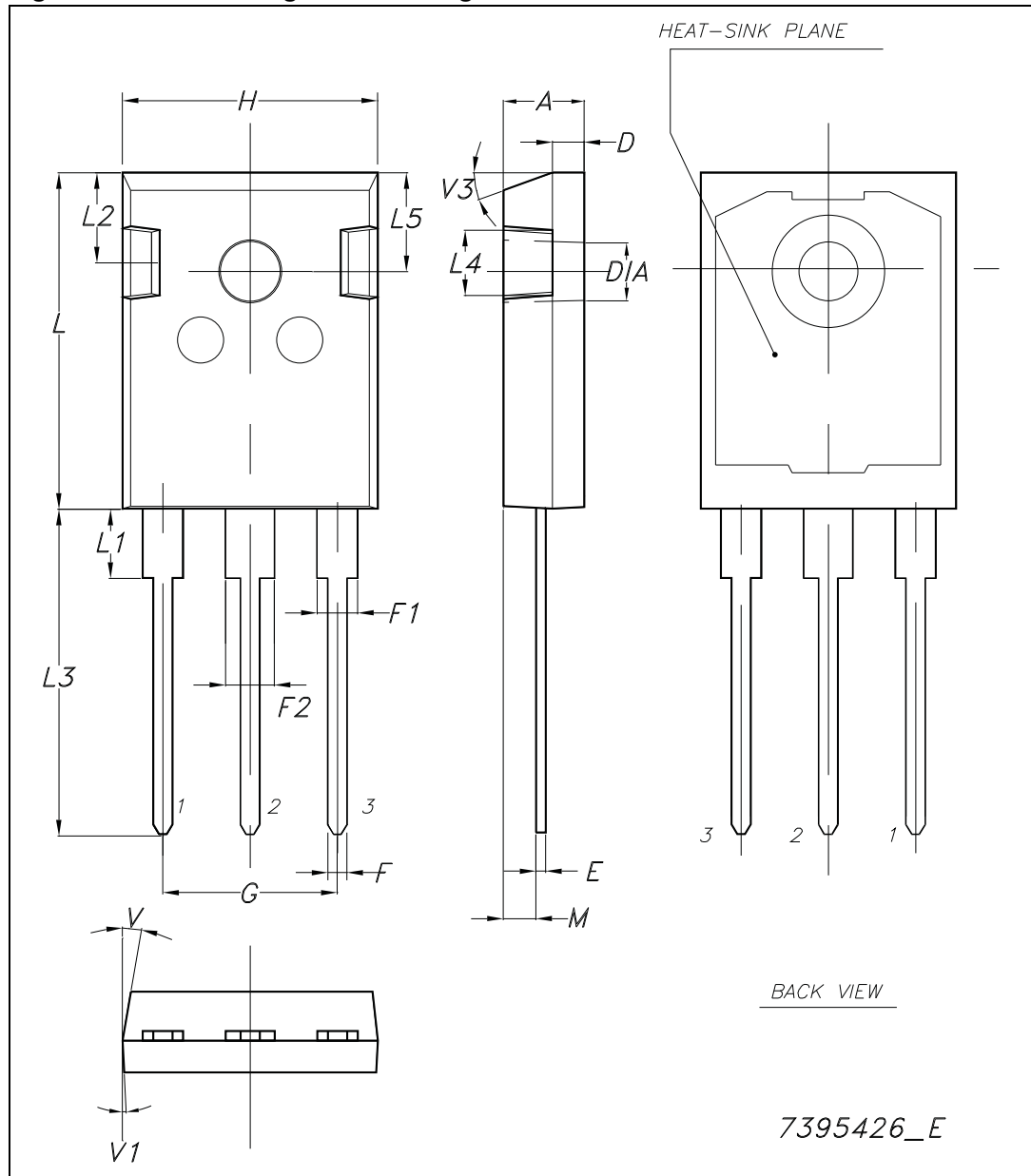


0075325_G

Table 10. TO-247 long leads mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.90		5.15
D	1.85		2.10
E	0.55		0.67
F	1.07		1.32
F1	1.90		2.38
F2	2.87		3.38
G	10.90 BSC		
H	15.77		16.02
L	20.82		21.07
L1	4.16		4.47
L2	5.49		5.74
L3	20.05		20.30
L4	3.68		3.93
L5	6.04		6.29
M	2.27		2.52
V		10°	
V1		3°	
V3		20°	
Dia.	3.55		3.66

Figure 21. TO-247 long leads drawing



5 Revision history

Table 11. Document revision history

Date	Revision	Changes
22-Jan-2009	1	Initial release
29-Jun-2009	2	Document status promoted from preliminary data to datasheet.
09-Jul-2009	3	Inserted dynamic values Table 5 on page 4 , Table 6 on page 4 and Table 7 on page 5 .
11-Jan-2012	4	Added order code STGWA40N120KD Table 1 on page 1 , Section 2.1 on page 6 , mechanical data TO-247 long leads Table 10 on page 12 and Figure 21 on page 13 .

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