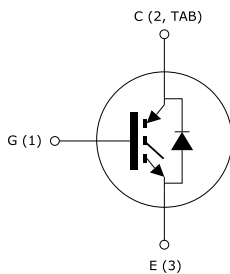
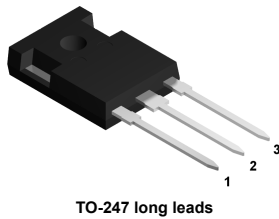


Automotive-grade trench gate field-stop 650 V, 50 A low-loss M series IGBT in a TO-247 long leads package



Product status link

[STGWA50M65DF2AG](#)

Product summary

Order code	STGWA50M65DF2AG
Marking	G50M65DF2AG
Package	TO-247 long leads
Packing	Tube

Features

- AEC-Q101 qualified 
- Maximum junction temperature: $T_J = 175\text{ }^{\circ}\text{C}$
- Low $V_{CE(sat)} = 1.7\text{ V (typ.) @ } I_C = 50\text{ A}$
- Minimized tail current
- Tight parameter distribution
- Safer paralleling
- Low thermal resistance
- Soft and very fast-recovery antiparallel diode

Applications

- Automotive motor control
- e-compressor
- Heating system

Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the M series IGBTs, which represent an optimal balance between inverter system performance and efficiency where the low-loss and the short-circuit functionality is essential. Furthermore, the positive $V_{CE(sat)}$ temperature coefficient and the tight parameter distribution result in safer paralleling operation.

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage ($V_{GE} = 0\text{ V}$)	650	V
I_C	Continuous collector current at $T_C = 25\text{ °C}$	119	A
	Continuous collector current at $T_C = 100\text{ °C}$	79	
$I_{CP}^{(1)}$	Pulsed collector current	207	A
V_{GE}	Gate-emitter voltage	± 20	V
	Transient gate-emitter voltage ($t_p \leq 10\text{ }\mu\text{s}$, $D < 0.01$)	± 30	
I_F	Continuous forward current at $T_C = 25\text{ °C}$	103	A
	Continuous forward current at $T_C = 100\text{ °C}$	60	
$I_{FP}^{(1)}$	Pulsed forward current	198	A
P_{TOT}	Total power dissipation at $T_C = 25\text{ °C}$	576	W
T_{STG}	Storage temperature range	-55 to 150	°C
T_J	Operating junction temperature range	-55 to 175	°C

1. Pulse width is limited by maximum junction temperature.

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case, IGBT	0.26	°C/W
	Thermal resistance, junction-to-case, diode	0.52	
R_{thJA}	Thermal resistance, junction-to-ambient	50	°C/W

2 Electrical characteristics

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

Table 3. Static characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}$, $I_C = 250\text{ }\mu\text{A}$	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$		1.7	2	V
		$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$, $T_J = 125\text{ °C}$		1.9		
		$V_{GE} = 15\text{ V}$, $I_C = 50\text{ A}$, $T_J = 175\text{ °C}$		2.1		
V_F	Forward on-voltage	$I_F = 50\text{ A}$		2.1	2.6	V
		$I_F = 50\text{ A}$, $T_J = 125\text{ °C}$		1.7		
		$I_F = 50\text{ A}$, $T_J = 175\text{ °C}$		1.55		
$V_{GE(th)}$	Gate threshold voltage	$V_{CE} = V_{GE}$, $I_C = 1\text{ mA}$	5	6	7	V
I_{CES}	Collector cut-off current	$V_{GE} = 0\text{ V}$, $V_{CE} = 650\text{ V}$			25	μA
I_{GES}	Gate-emitter leakage current	$V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$			± 250	nA

Table 4. Dynamic characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{ies}	Input capacitance	$V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$	-	4130	-	pF
C_{oes}	Output capacitance		-	256	-	nF
C_{res}	Reverse transfer capacitance		-	85	-	nF
Q_g	Total gate charge	$V_{CC} = 520\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 28. Gate charge test circuit)	-	147	-	nC
Q_{ge}	Gate-emitter charge		-	36	-	nC
Q_{gc}	Gate-collector charge		-	62	-	nC

Table 5. Switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 6.8\ \Omega$ (see Figure 27. Test circuit for inductive load switching)	-	29.8	-	ns
t_r	Current rise time		-	30.8	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	1.4	-	mJ
$t_{d(off)}$	Turn-off delay time		-	143	-	ns
t_f	Current fall time		-	145	-	ns
$E_{off}^{(2)}$	Turn-off switching energy		-	1.8	-	mJ
$t_{d(on)}$	Turn-on delay time	$V_{CC} = 400\text{ V}$, $I_C = 50\text{ A}$, $V_{GE} = 15\text{ V}$, $R_G = 6.8\ \Omega$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 27. Test circuit for inductive load switching)	-	28	-	ns
t_r	Current rise time		-	37	-	ns
$E_{on}^{(1)}$	Turn-on switching energy		-	2.5	-	mJ
$t_{d(off)}$	Turn-off delay time		-	158	-	ns
t_f	Current fall time		-	255	-	ns
$E_{off}^{(2)}$	Turn-off switching energy		-	2.6	-	mJ
$t_{(sc)}$	Short-circuit withstand time	$V_{CC} = 400\text{ V}$, $V_{GE} = 15\text{ V}$, starting $T_J \leq 150\text{ }^\circ\text{C}$	6	-	-	μs

1. Including the reverse recovery of the diode.

2. Including the tail of the collector current.

Table 6. Diode switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_{rr}	Reverse recovery time	$I_F = 50\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 27. Test circuit for inductive load switching)	-	121.6	-	ns
Q_{rr}	Reverse recovery charge		-	0.85	-	μC
I_{rrm}	Reverse recovery current		-	14.2	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	610	-	$\text{A}/\mu\text{s}$
E_{rr}	Reverse recovery energy		-	195	-	μJ
t_{rr}	Reverse recovery time	$I_F = 50\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 27. Test circuit for inductive load switching)	-	214	-	ns
Q_{rr}	Reverse recovery charge		-	3.3	-	μC
I_{rrm}	Reverse recovery current		-	31	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	530	-	$\text{A}/\mu\text{s}$
E_{rr}	Reverse recovery energy		-	867	-	μJ

2.1 Electrical characteristics (curves)

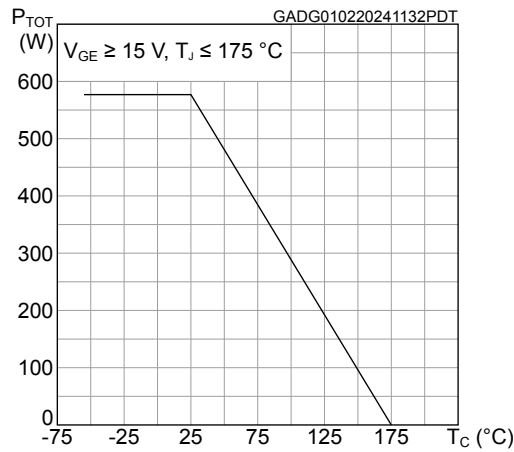
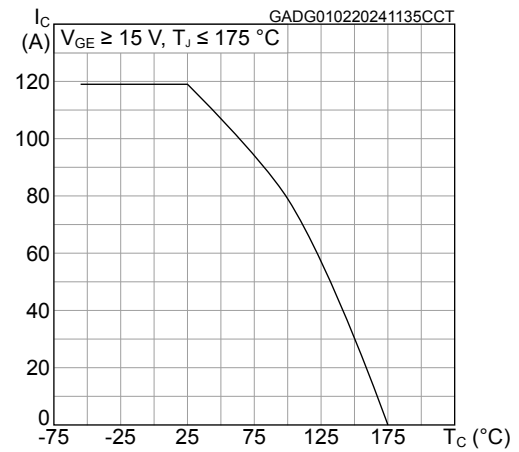
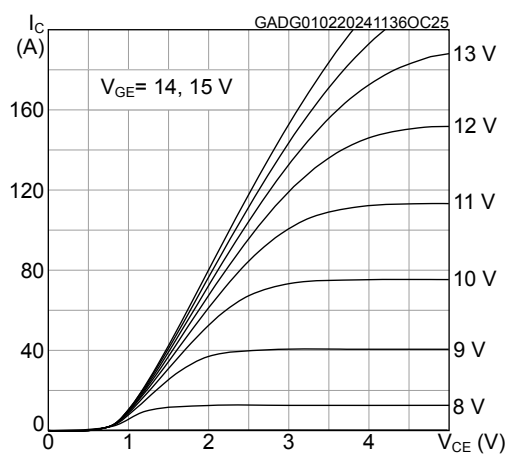
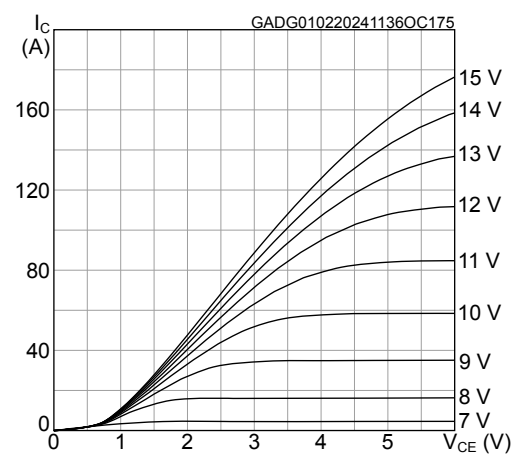
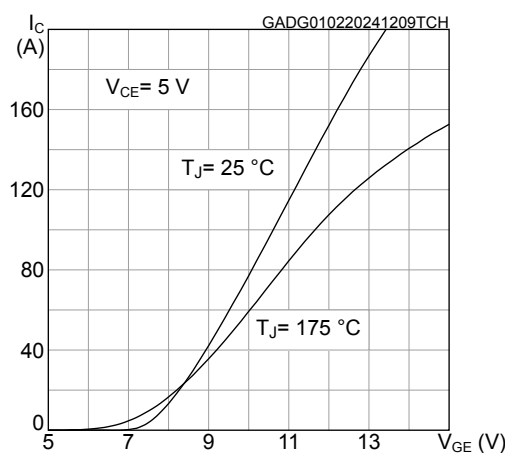
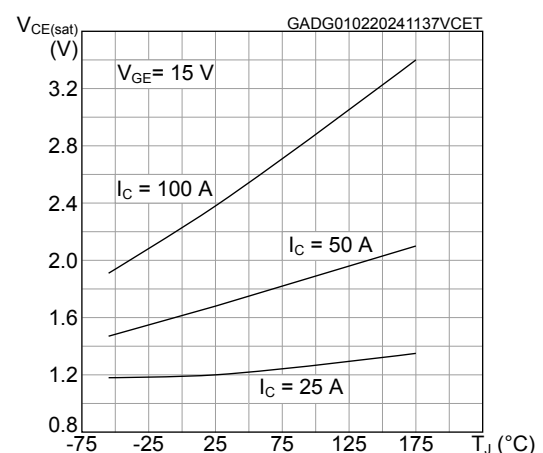
Figure 1. Total power dissipation vs temperature

Figure 2. Collector current vs temperature

Figure 3. Typical output characteristics (T_J = 25 °C)

Figure 4. Typical output characteristics (T_J = 175 °C)

Figure 5. Typical transfer characteristics

Figure 6. Typical V_CE(sat) vs temperature


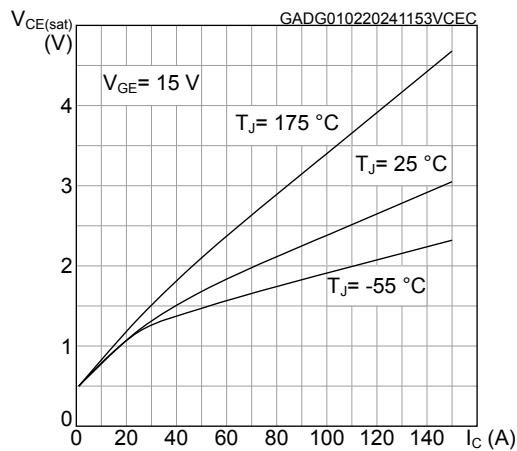
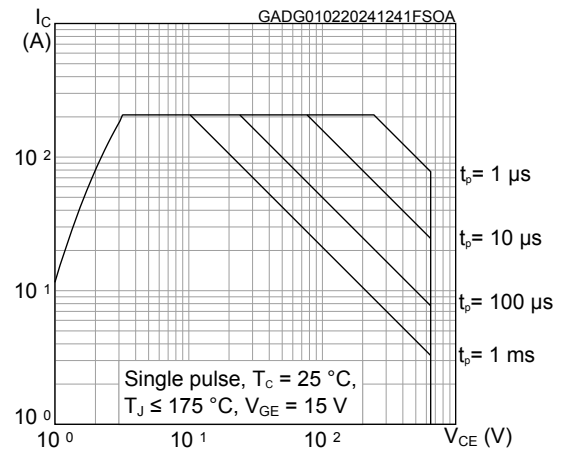
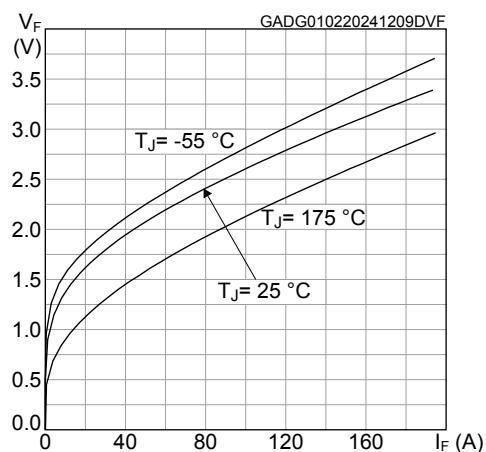
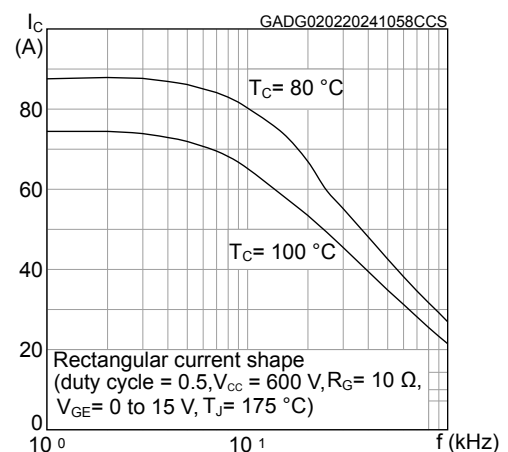
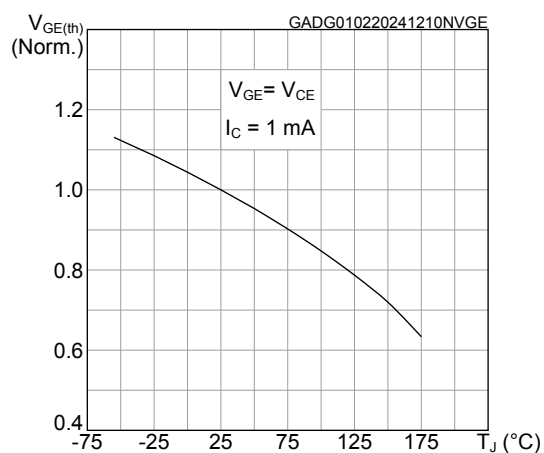
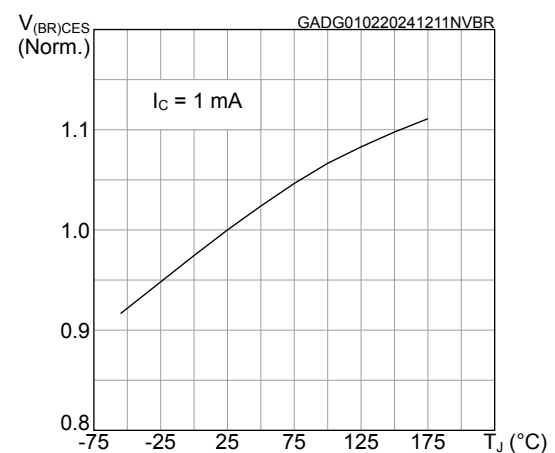
Figure 7. Typical $V_{CE(sat)}$ vs collector current

Figure 8. Forward bias safe operating area

Figure 9. Diode typical V_F vs forward current

Figure 10. Typical I_C vs switching frequency

Figure 11. Normalized $V_{GE(th)}$ vs junction temperature

Figure 12. Normalized $V_{(BR)CES}$ vs junction temperature


Figure 13. Typical capacitance characteristics

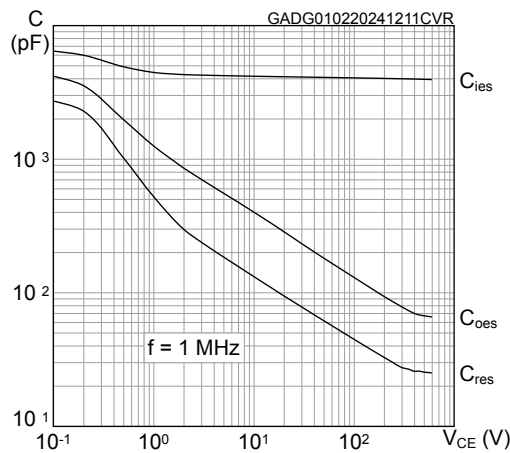


Figure 14. Typical gate charge characteristics

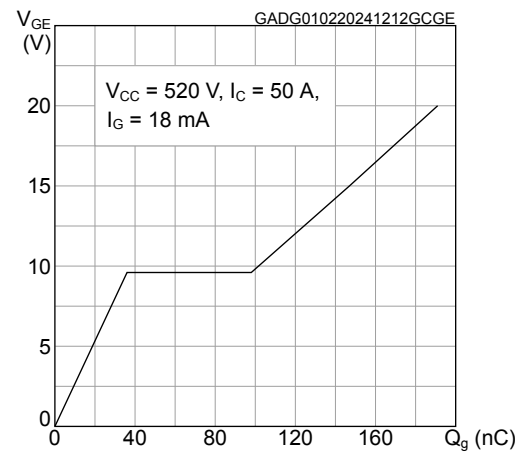


Figure 15. Typical switching energy vs collector current

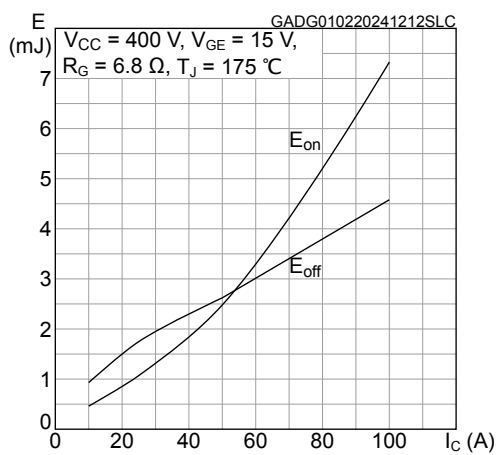


Figure 16. Typical switching energy vs temperature

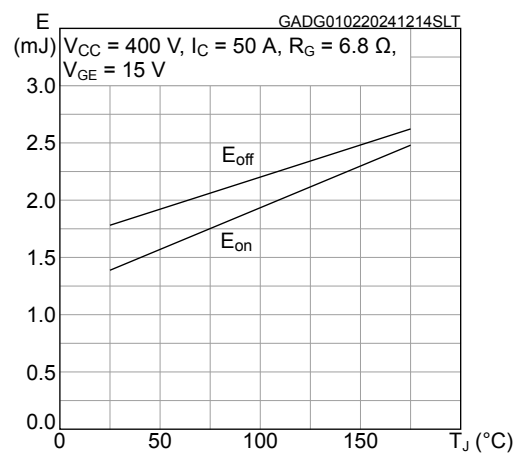


Figure 17. Typical switching energy vs supply voltage

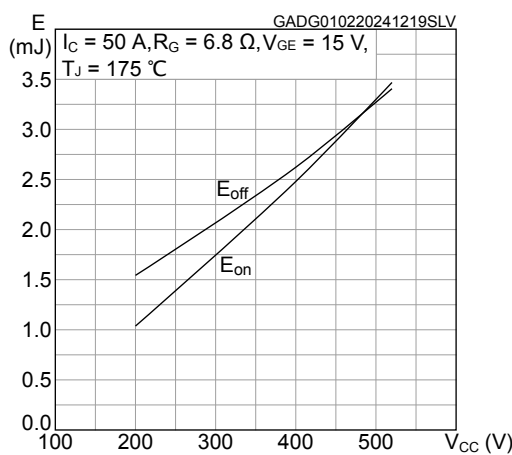


Figure 18. Typical switching energy vs gate resistance

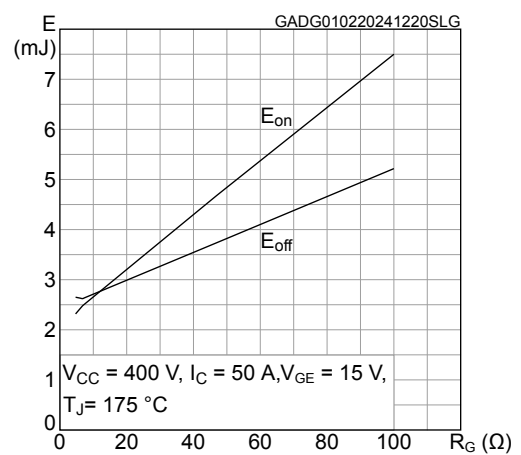


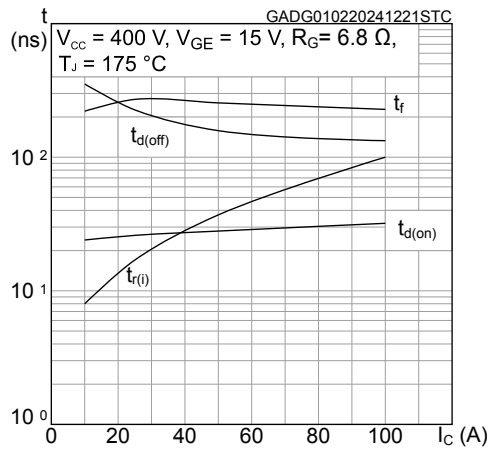
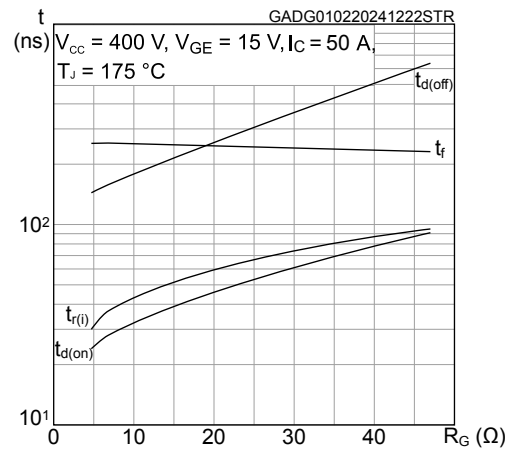
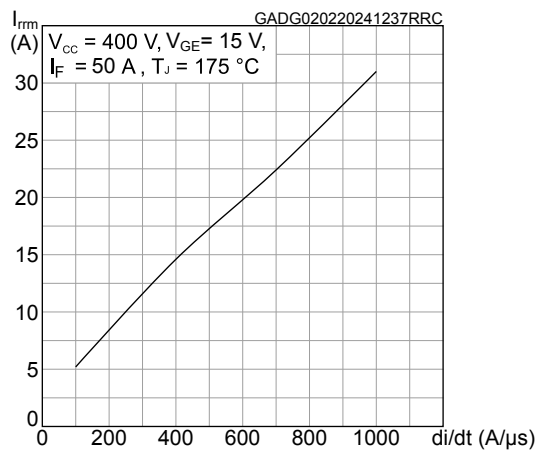
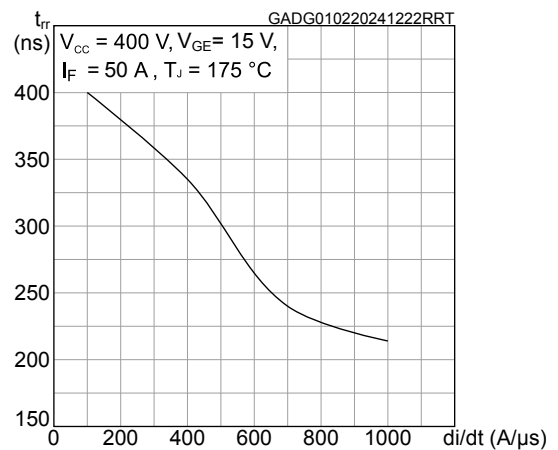
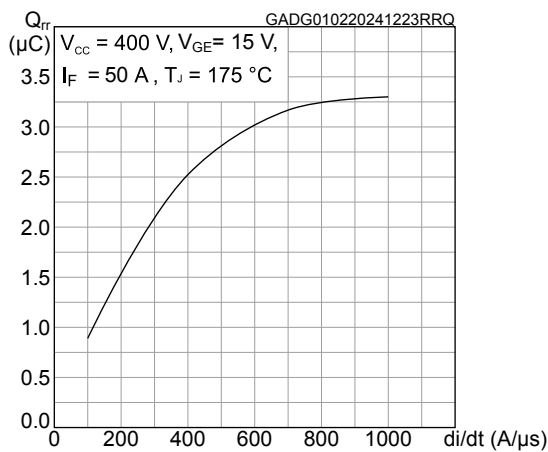
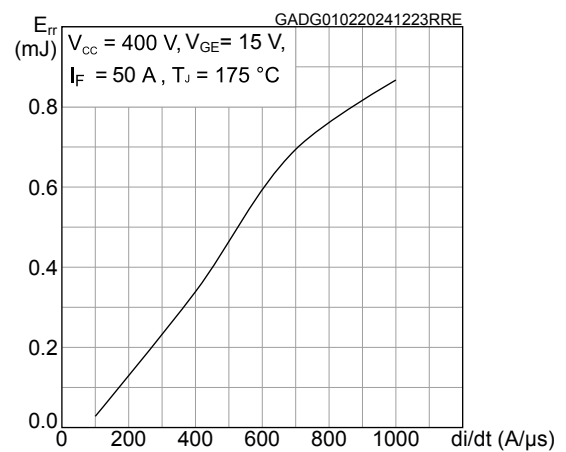
Figure 19. Typical switching times vs collector current

Figure 20. Typical switching times vs gate resistance

Figure 21. Typical reverse recovery current vs diode current slope

Figure 22. Typical reverse recovery time vs diode current slope

Figure 23. Typical reverse recovery charge vs diode current slope

Figure 24. Typical reverse recovery energy vs diode current slope


Figure 25. IGBT maximum transient thermal impedance

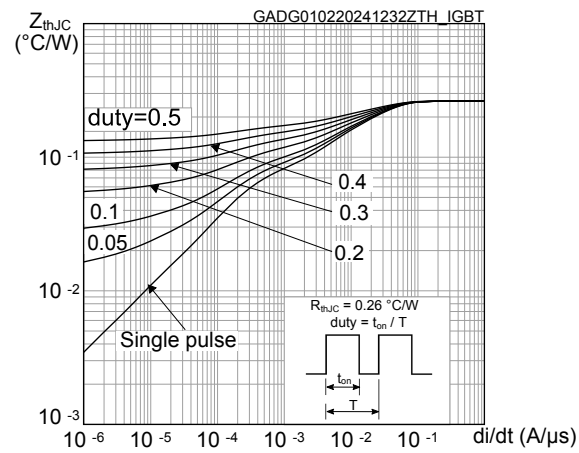
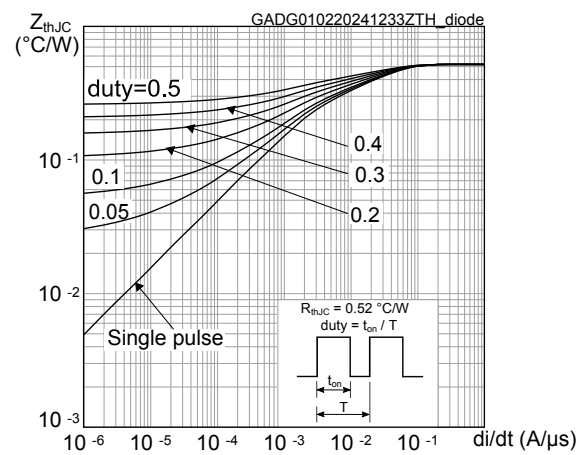


Figure 26. Diode maximum transient thermal impedance



3 Test circuits

Figure 27. Test circuit for inductive load switching

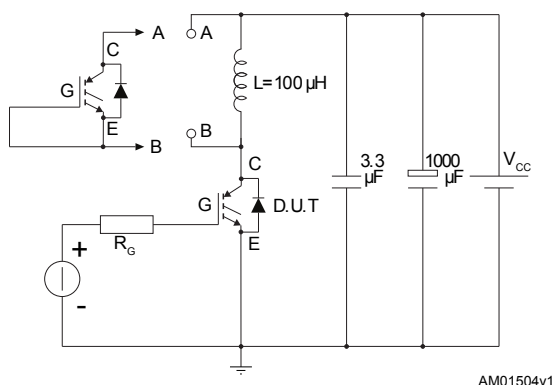


Figure 28. Gate charge test circuit

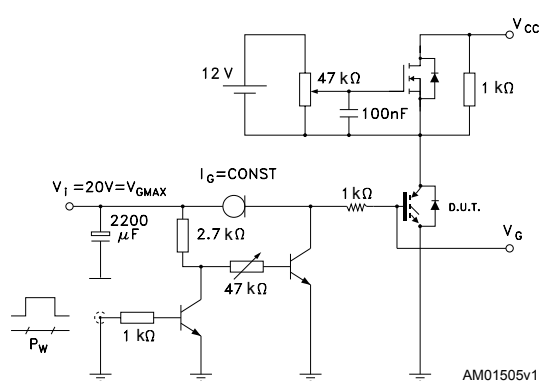


Figure 29. Switching waveform

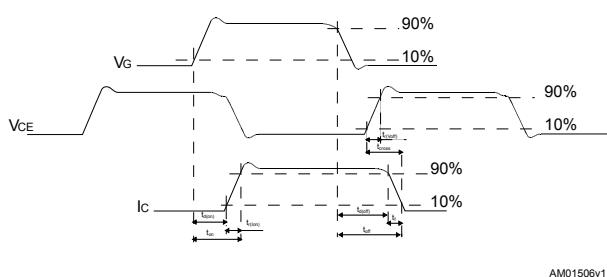
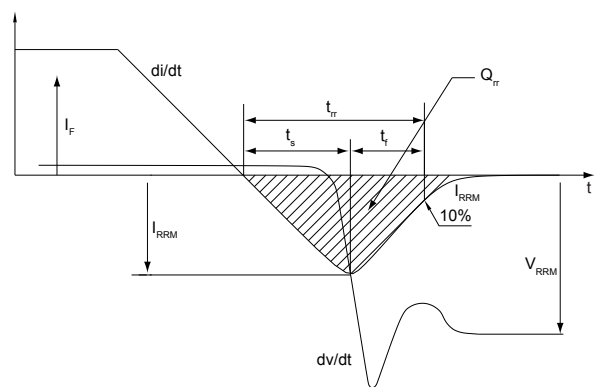


Figure 30. Diode reverse recovery waveform

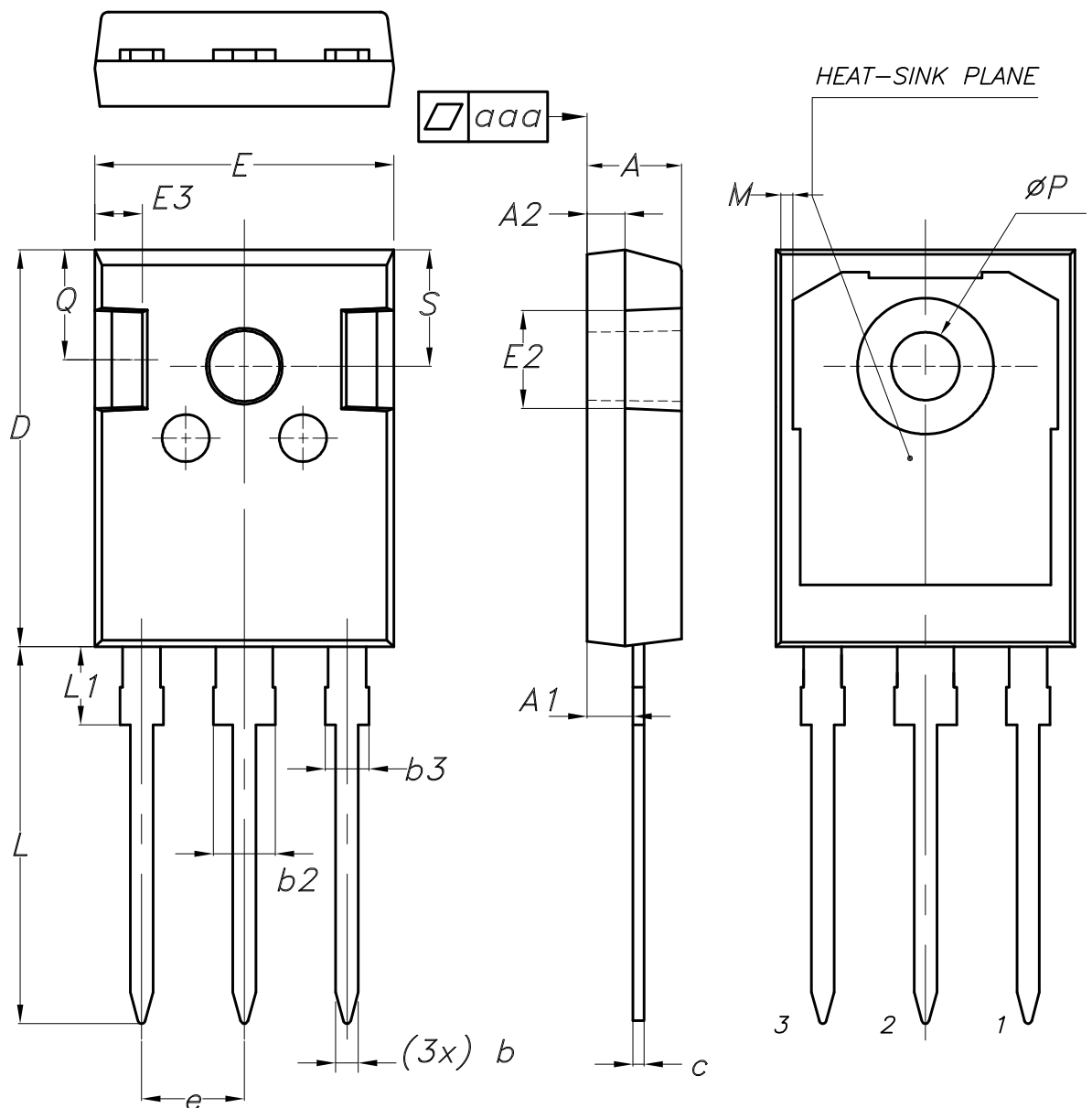


4 Package information

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 long leads package information

Figure 31. TO-247 long leads package outline



BACK VIEW

8463846_5

Table 7. TO-247 long leads 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
M	0.35		0.95
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25
aaa		0.04	0.10

Revision history

Table 8. Document revision history

Date	Revision	Changes
06-Feb-2024	1	First release.
07-Feb-2024	2	Modified title on cover page.
09-Jul-2024	3	Updated <i>Table 1. Absolute maximum ratings.</i> Updated <i>Table 5. Switching characteristics (inductive load).</i> Updated <i>Table 6. Diode switching characteristics (inductive load).</i>
22-Nov-2024	4	Updated Table 6. Diode switching characteristics (inductive load).

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