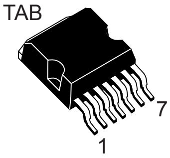
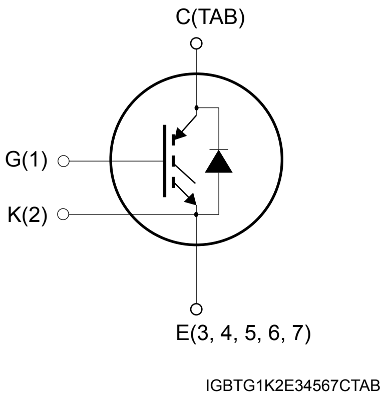
Automotive-grade trench gate field-stop 650 V, 50 A high-speed HB2 series IGBT featuring freewheeling SiC diode in an H2PAK-7 package



H²PAK-7



Features

- AEC-Q101 qualified
- Maximum junction temperature: T_J = 175 °C
- High speed switching series
- Minimized tail current
- Low $V_{CE(sat)}$ = 1.6 V (typ.) @ I_C = 50 A
- Tight parameter distribution
- Low thermal resistance
- Positive $V_{CE(sat)}$ temperature coefficient
- Silicon carbide diode with no-reverse recovery charge is co-packaged in freewheeling configuration
- Excellent switching performance thanks to the extra driving kelvin pin

Application

- On board charger (OBC)
- PFC converter - single phase input
- LLC resonant converter
- High frequency converters

Description

The newest IGBT 650 V HB2 series represents an evolution of the advanced proprietary trench gate field-stop structure. The performance of the HB2 series is optimized in terms of conduction, thanks to a better $V_{CE(sat)}$ behavior at low current values, as well as in terms of reduced switching energy.

Co-packed with the IGBT a silicon carbide diode has been adopted. The wide band-gap material allows the design of a low V_F Schottky diode structure with a 650 V rating. Due to the Schottky construction, no recovery is shown at turn-off and ringing patterns are negligible.

The minimal capacitive turn-off behavior is independent of temperature. Based on technology optimization, this diode has an improved forward surge current capability, making it ideal for use in PFC and LLC.

Product status link
GH50H65DWB2-7AG

Product summary	
Order code	GH50H65DWB2-7AG
Marking	G50H65WB2A
Package	H²PAK-7
Packing	Tape and reel

1 Electrical ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CES}	Collector-emitter voltage (V_{GE} = 0 V)	650	V
I_C	Continuous collector current at T_C = 25 °C	108[(1)]	A
	Continuous collector current at T_C = 100 °C	68	
I_{CP}[(2)]	Pulsed collector current (t_p ≤ 1 µs, T_J < 175 °C)	200	A
V_{GE}	Gate-emitter voltage	±20	V
	Transient gate-emitter voltage (t_p ≤ 10 µs)	±30	
I_F	Continuous forward current at T_C = 25 °C	50[(1)]	A
	Continuous forward current at T_C = 100 °C	30	
I_{FP}[(2)]	Pulsed forward current	120	A
P_{TOT}	Total power dissipation at T_C = 25 °C	385	W
T_{STG}	Storage temperature range	-55 to 150	°C
T_J	Operating junction temperature range	-55 to 175	°C

1. *Limited by package.*
2. *Defined by R_{thJC} and limited by maximum junction temperature, not tested in production.*

Table 2. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance, junction-to-case, IGBT	0.39	°C/W
	Thermal resistance, junction-to-case, diode	1	
R_{thJA}	Thermal resistance, junction-to-ambient	50	°C/W

2 Electrical characteristics

T_J = 25 °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 V, I_C = 250 µA	650			V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V, I_C = 50 A		1.6	2.0	V
		V_{GE} = 15 V, I_C = 50 A, T_J = 125 °C		1.8		
		V_{GE} = 15 V, I_C = 50 A, T_J = 175 °C		1.9		
V_F	Forward on-voltage	I_F = 30 A		1.6		V
		I_F = 30 A, T_J = 175 °C		1.9		
$V_{GE(th)}$	Gate threshold voltage	V_{CE} = V_{GE}, I_C = 1 mA	5	6	7	V

Table 4. 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	-	2928	-	pF
C_{oes}	Output capacitance		-	387	-	pF
C_{res}	Reverse transfer capacitance		-	73	-	pF
Q_g	Total gate charge	V_{CC} = 520 V, I_C = 50 A, V_{GE} = 0 to 15 V (see Figure 26. Gate charge test circuit)	-	152	-	nC
Q_{ge}	Gate-emitter charge		-	21	-	nC
Q_{gc}	Gate-collector charge		-	70	-	nC

Table 5. IGBT switching characteristics (inductive load)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 50 A, V_{GE} = 15 V, R_G = 4.7 Ω (see Figure 25. Test circuit for inductive load switching)	-	25	-	ns
t_r	Current rise time		-	10	-	ns
$t_{d(off)}$	Turn-off delay time		-	116	-	ns
t_f	Current fall time		-	10	-	ns
E_{on}(1)	Turn-on switching energy		-	158	-	µJ
E_{off}(2)	Turn-off switching energy		-	527	-	µJ
$t_{d(on)}$	Turn-on delay time	V_{CE} = 400 V, I_C = 50 A, V_{GE} = 15 V, R_G = 4.7 Ω, T_J = 175 °C (see Figure 25. Test circuit for inductive load switching)	-	24	-	ns
t_r	Current rise time		-	11	-	ns
$t_{d(off)}$	Turn-off delay time		-	137	-	ns
t_f	Current fall time		-	77	-	ns
E_{on}(1)	Turn-on switching energy		-	226	-	µJ
E_{off}(2)	Turn-off switching energy		-	911	-	µJ

1. *Including the reverse recovery of the diode.*
2. *Including the tail of the collector current.*

Table 6. **SiC diode switching characteristics (inductive load)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
t_{rr}	Reverse recovery time	I_F = 30 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 2500 A/µs (see Figure 25. Test circuit for inductive load switching)	-	11	-	ns
Q_{rr}	Reverse recovery charge		-	92	-	nC
I_{rrm}	Reverse recovery current		-	14	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	3404	-	A/µs
E_{rr}	Reverse recovery energy		-	8	-	µJ
t_{rr}	Reverse recovery time	I_F = 30 A, V_R = 400 V, V_{GE} = 15 V, di/dt = 2500 A/µs, T_J = 175 °C (see Figure 25. Test circuit for inductive load switching)	-	11	-	ns
Q_{rr}	Reverse recovery charge		-	94	-	nC
I_{rrm}	Reverse recovery current		-	14	-	A
dI_{rr}/dt	Peak rate of fall of reverse recovery current during t_b		-	3263	-	A/µs
E_{rr}	Reverse recovery energy		-	9	-	µJ

2.1 Electrical characteristics (curves)

Figure 1. Total power dissipation vs temperature

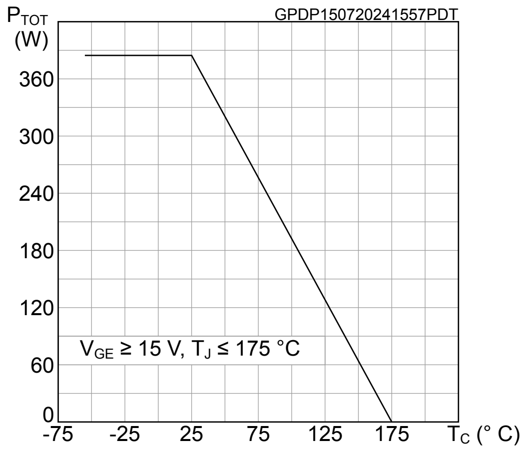


Figure 2. Collector current vs temperature

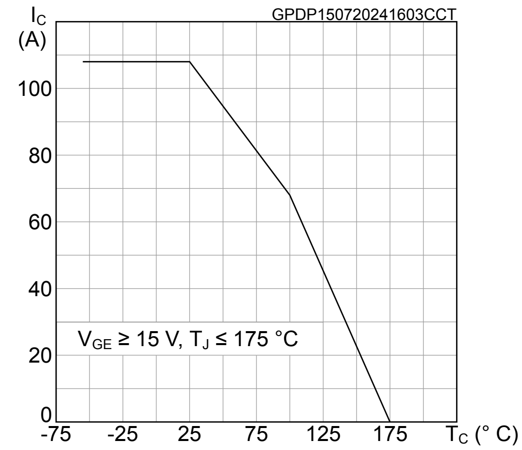


Figure 3. Typical output characteristics (T_J = 25 °C)

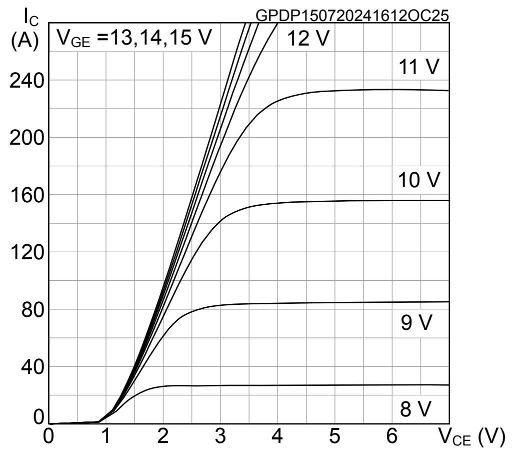


Figure 4. Typical output characteristics (T_J = 175 °C)

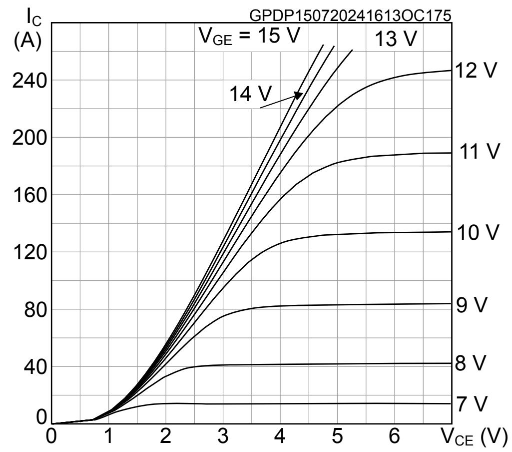


Figure 5. Typical transfer characteristics

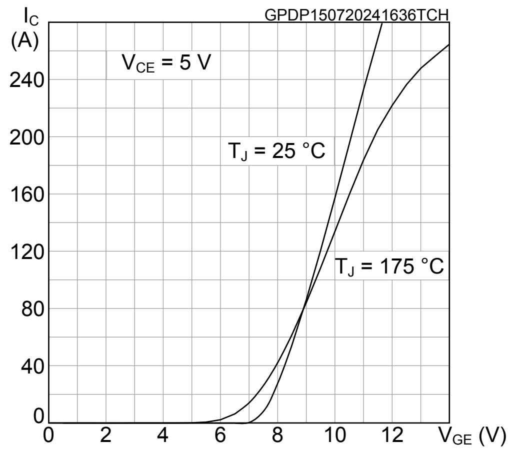


Figure 6. Typical $V_{CE(sat)}$ vs temperature

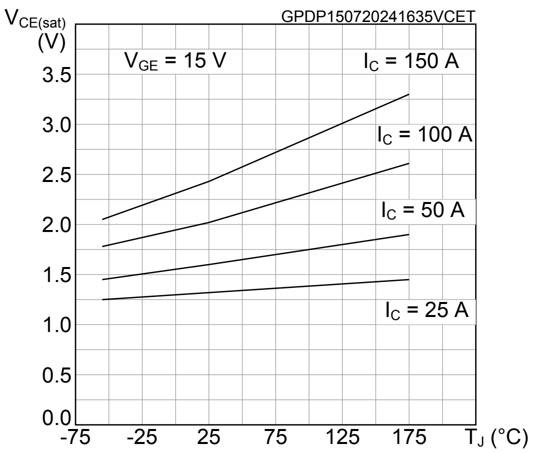


Figure 7. Typical $V_{CE(sat)}$ vs collector current

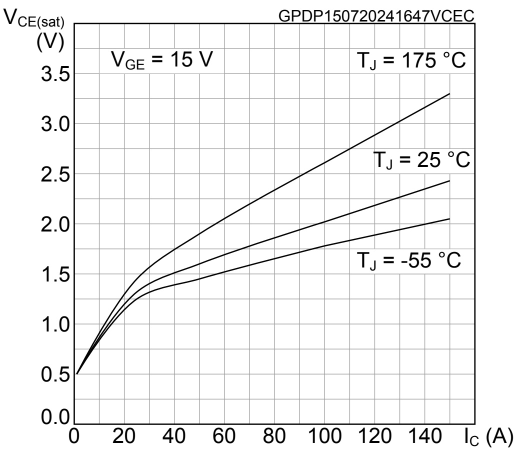


Figure 8. Forward bias safe operating area

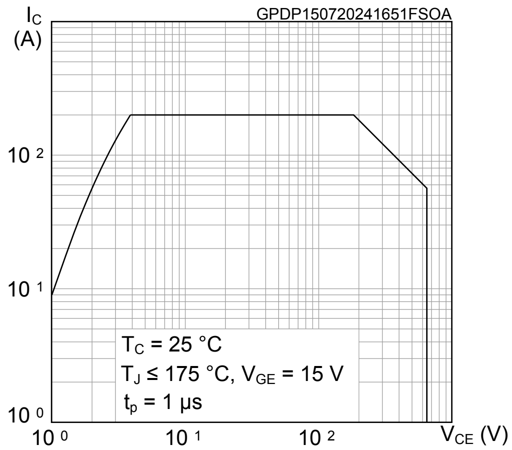


Figure 9. Diode typical forward characteristics

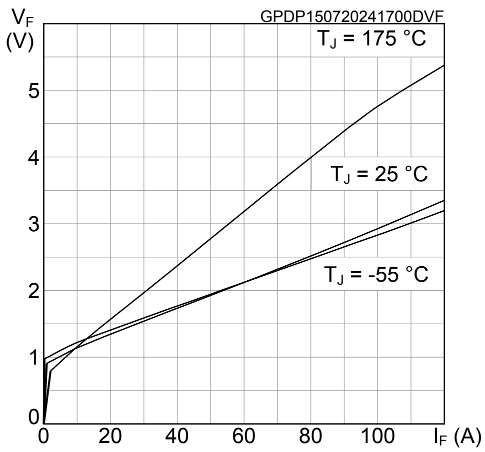


Figure 10. Normalized gate threshold vs temperature

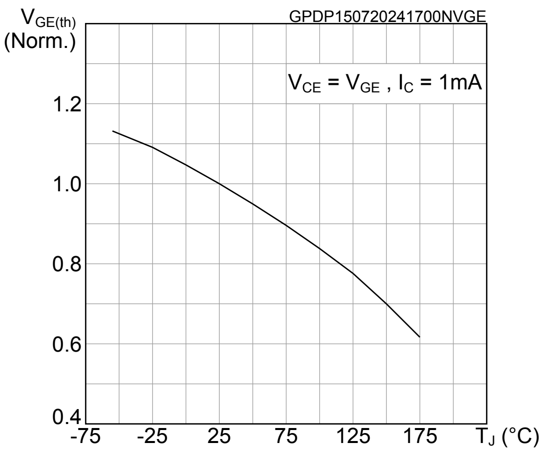


Figure 11. Typical capacitance characteristics

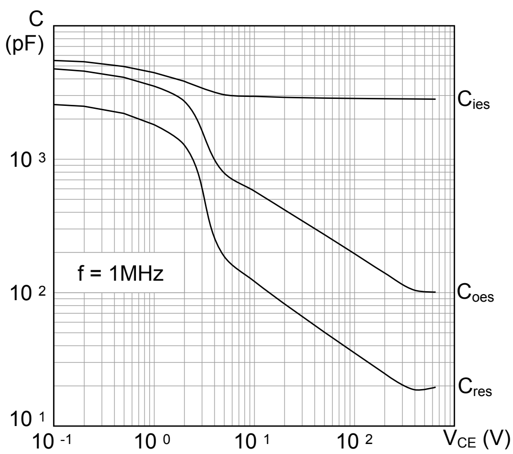


Figure 12. Typical gate charge characteristics

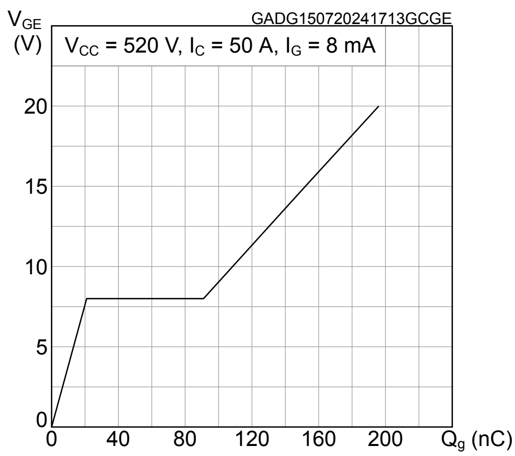


Figure 13. Typical switching energy vs collector current

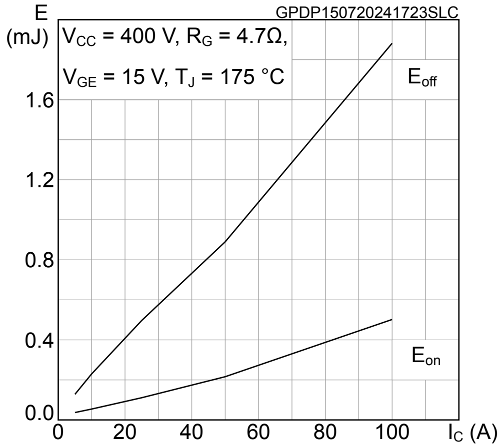


Figure 14. Typical switching energy vs temperature

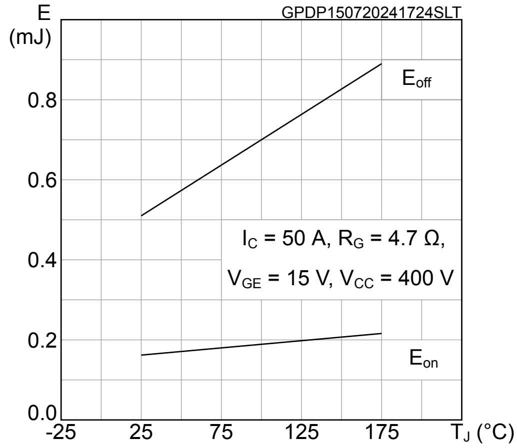


Figure 15. Typical switching energy vs supply voltage

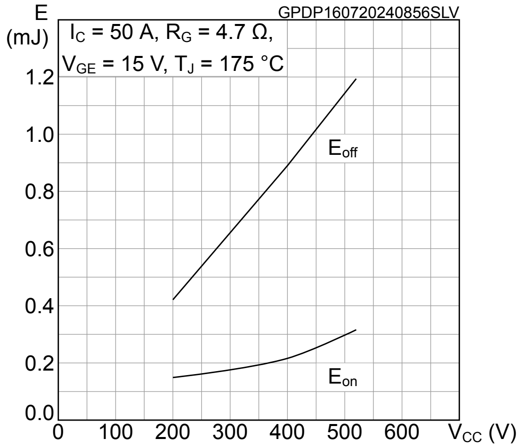


Figure 16. Typical switching energy vs gate resistance

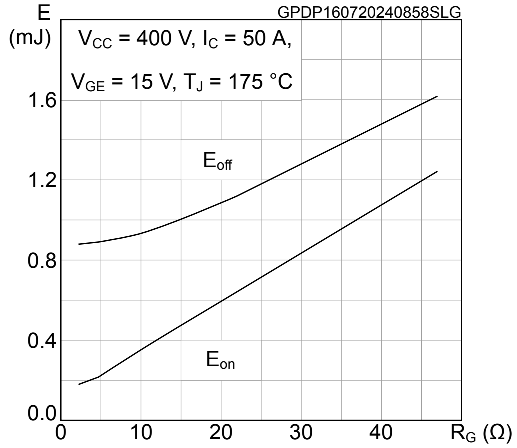


Figure 17. Typical switching times vs collector current

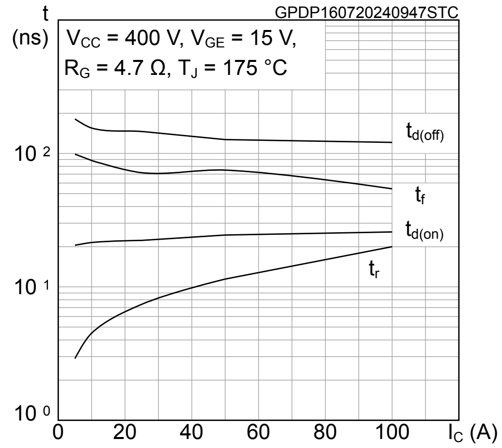


Figure 18. Typical switching times vs gate resistance

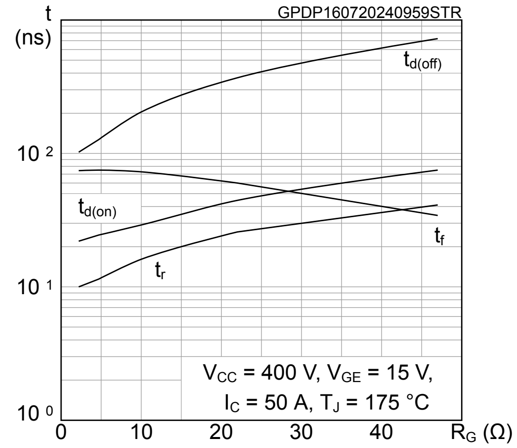


Figure 19. Typical reverse recovery current vs diode current slope

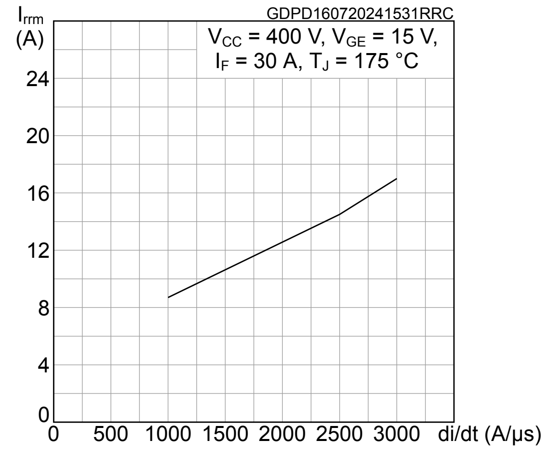


Figure 20. Typical reverse recovery time vs diode current slope

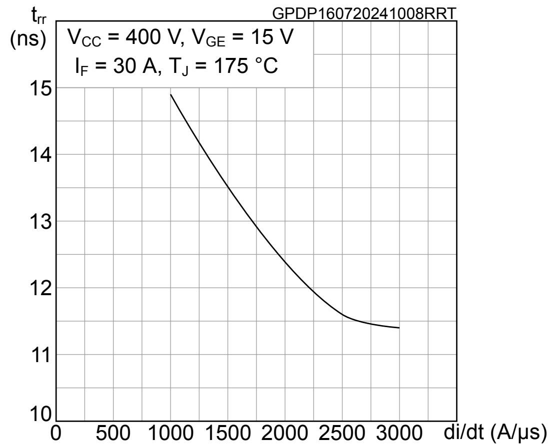


Figure 21. Typical reverse recovery charge vs diode current slope

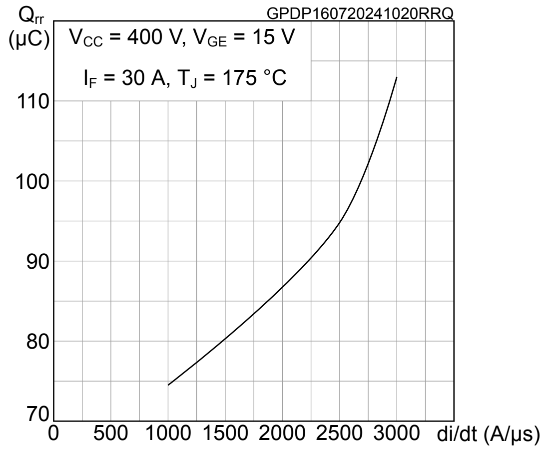


Figure 22. Typical reverse recovery energy vs diode current slope

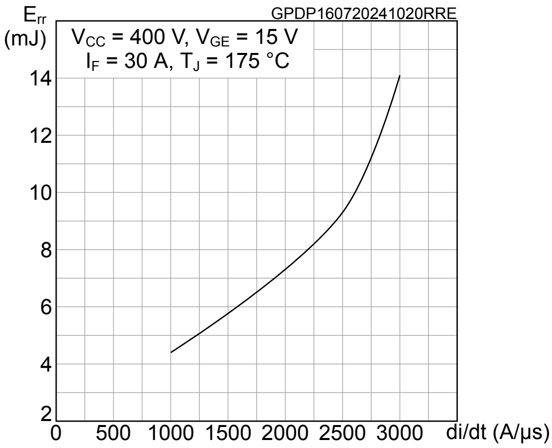


Figure 23. IGBT maximum transient thermal impedance

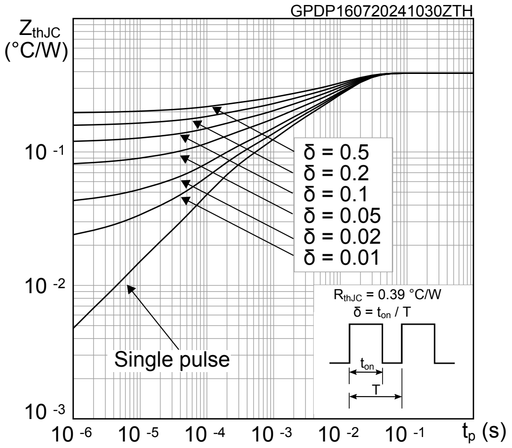
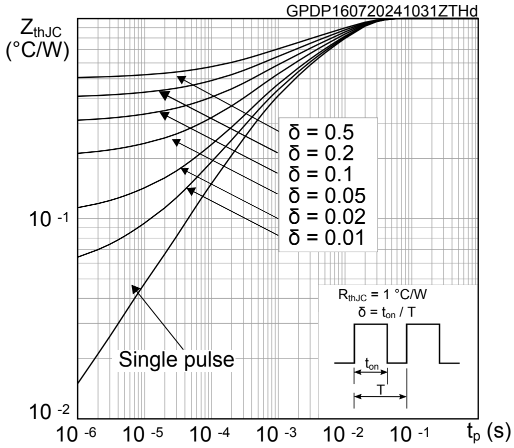


Figure 24. Diode maximum transient thermal impedance



3 Test circuits

Figure 25. Test circuit for inductive load switching

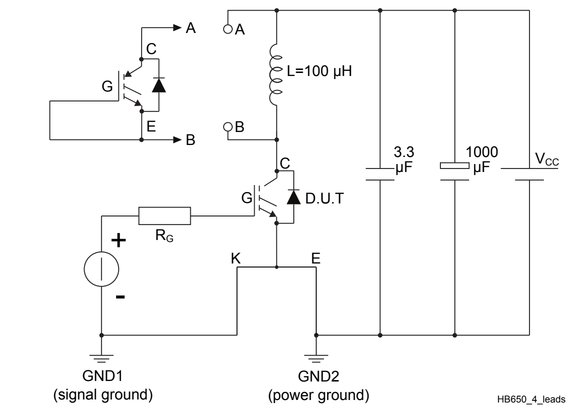


Figure 26. Gate charge test circuit

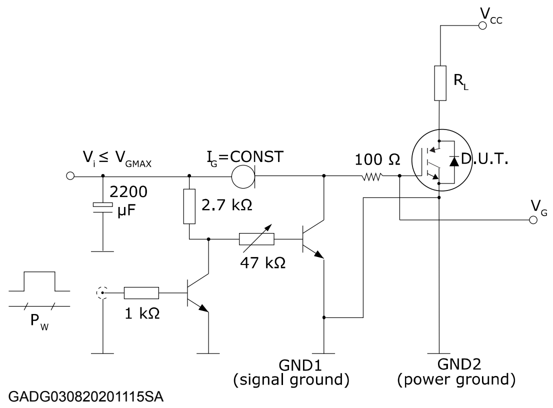


Figure 27. Switching waveform

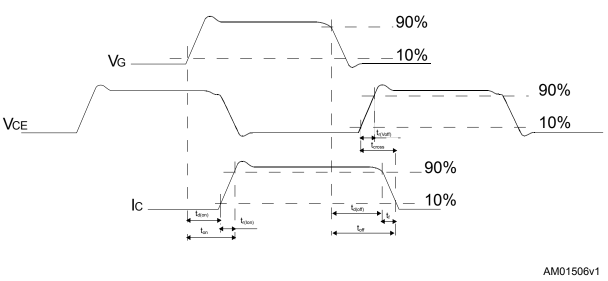
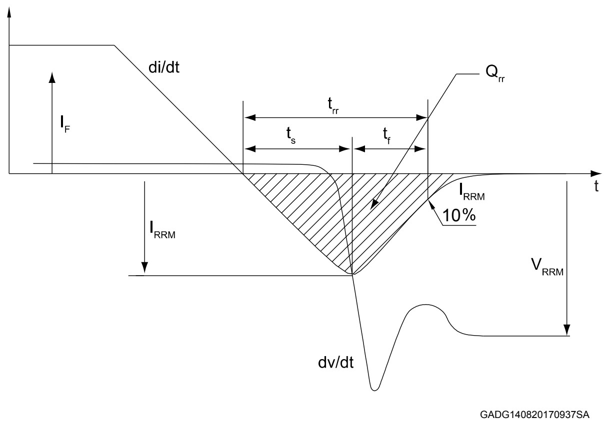


Figure 28. Diode reverse recovery waveform



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 H²PAK-7 package information

Figure 29. H²PAK-7 package outline

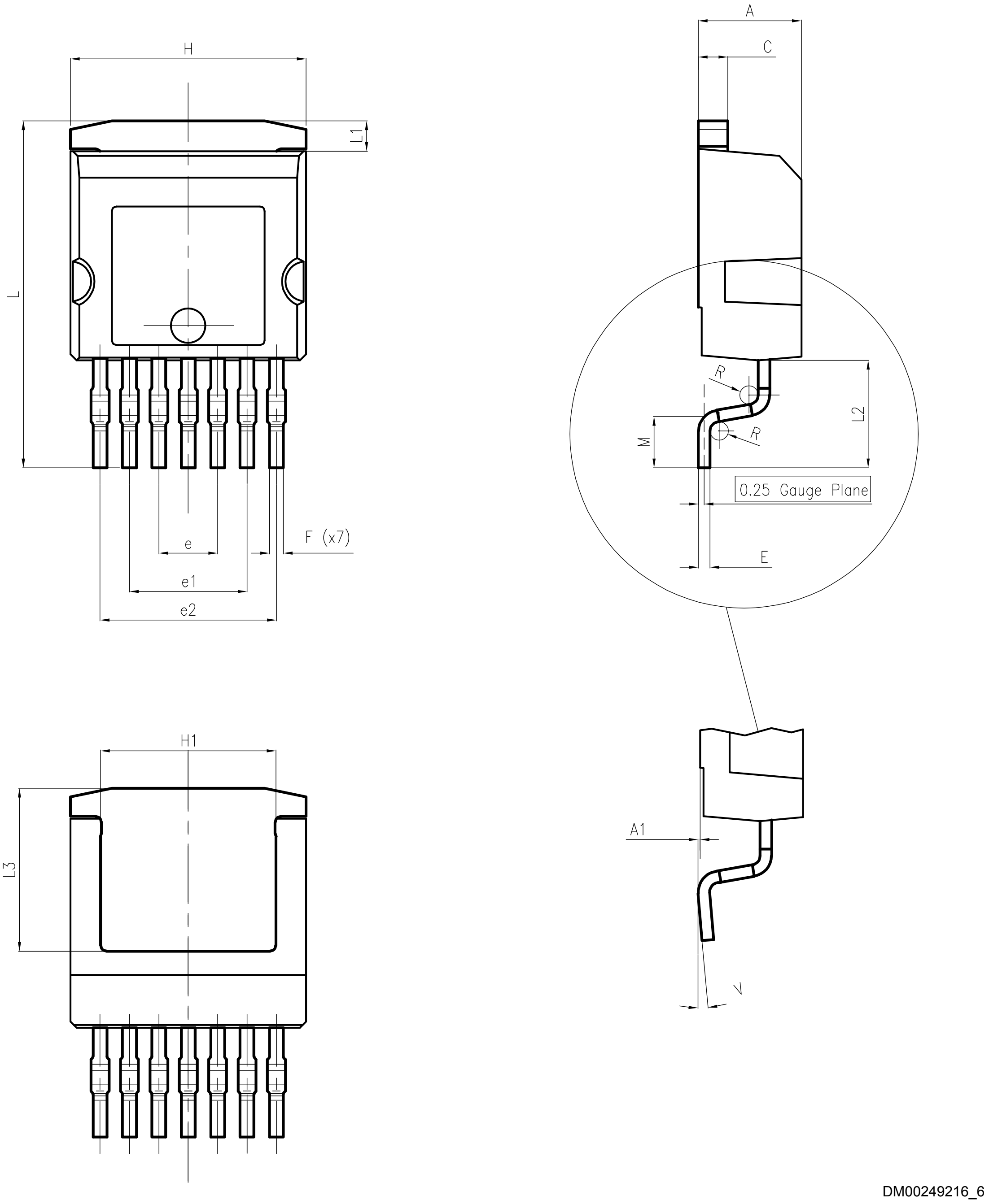
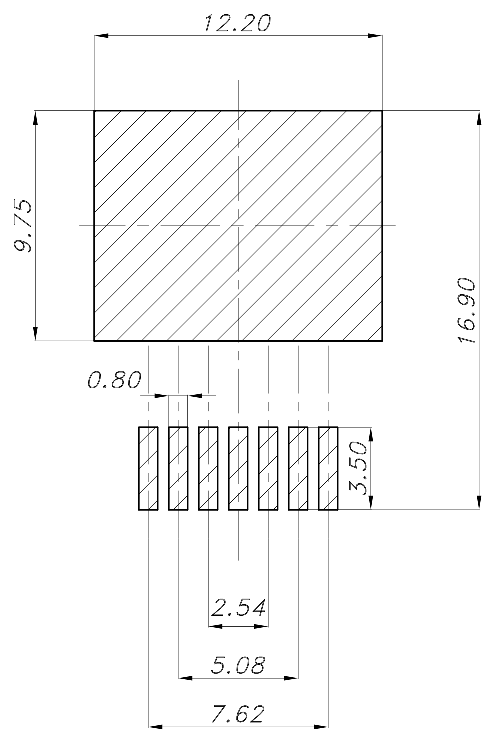


Table 7. **H²PAK-7 package mechanical data**

Dim.	mm	
	Min.	Max.
A	4.30	4.80
A1	0.03	0.20
C	1.17	1.37
e	2.34	2.74
e1	4.88	5.28
e2	7.42	7.82
E	0.45	0.60
F	0.50	0.70
H	10.00	10.40
H1	7.40	8.00
L	14.75	15.25
L1	1.27	1.40
L2	4.35	4.95
L3	6.85	7.25
M	1.90	2.50
R	0.20	0.60
V	0°	8°

Figure 30. **H²PAK-7 recommended footprint**



footprint_DM00249216_6

Note: *Dimensions are in mm.*

4.2 Packing information

Figure 31. Tape outline

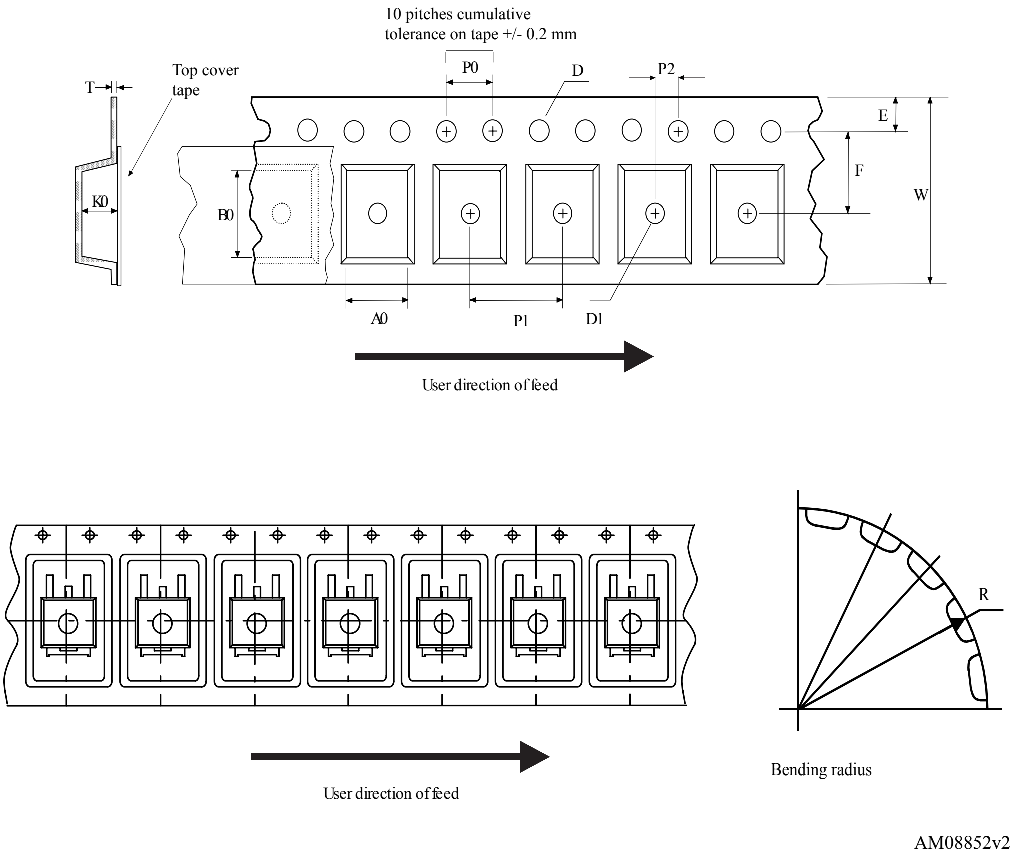


Figure 32. Reel outline

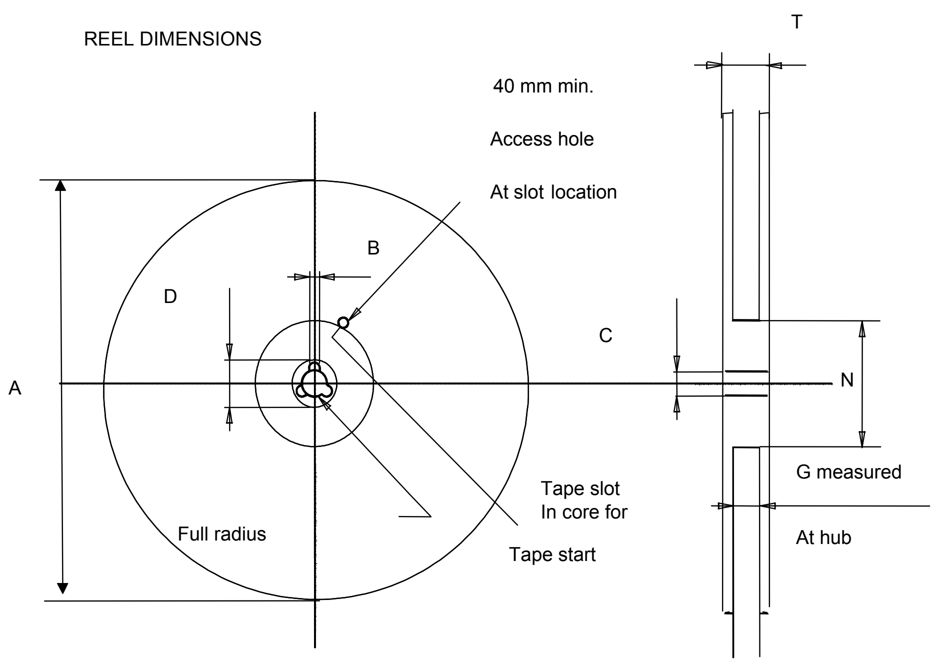


Table 8. Tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	10.5	10.7	A		330
B0	15.7	15.9	B	1.5	
D	1.5	1.6	C	12.8	13.2
D1	1.59	1.61	D	20.2	
E	1.65	1.85	G	24.4	26.4
F	11.4	11.6	N	100	
K0	4.8	5.0	T		30.4
P0	3.9	4.1			
P1	11.9	12.1	Base quantity		1000
P2	1.9	2.1	Bulk quantity		1000
R	50				
T	0.25	0.35			
W	23.7	24.3			

Revision history

Table 9. **Document revision history**

Date	Revision	Changes
15-Jul-2024	1	First release.
16-Aug-2024	2	Modified marking on cover page.

Contents