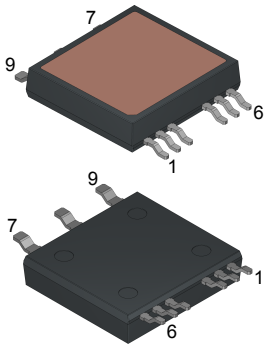
# STGSH50M120D

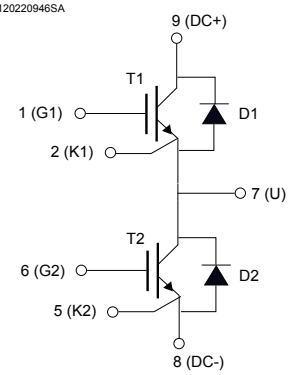
Datasheet

## ACEPACK SMIT half-bridge topology 1200 V, 50 A, M series IGBT with diode




**ACEPACK SMIT**

GADG031120220946SA




## Features

- Low-loss and short-circuit rugged IGBTs
- Maximum junction temperature: $T_J$ = 175 °C
- $V_{CE(sat)}$ = 1.8 V (typ.) @ $I_C$ = 50 A
- Minimized tail current
- Tight parameter distribution
- Low thermal resistance
- Positive $V_{CE(sat)}$ temperature coefficient
- Soft and fast-recovery antiparallel diode
- Isolation rating of 3.4 kVrms/min

## Applications

- Motor drives
- Industrial motor control

## Description

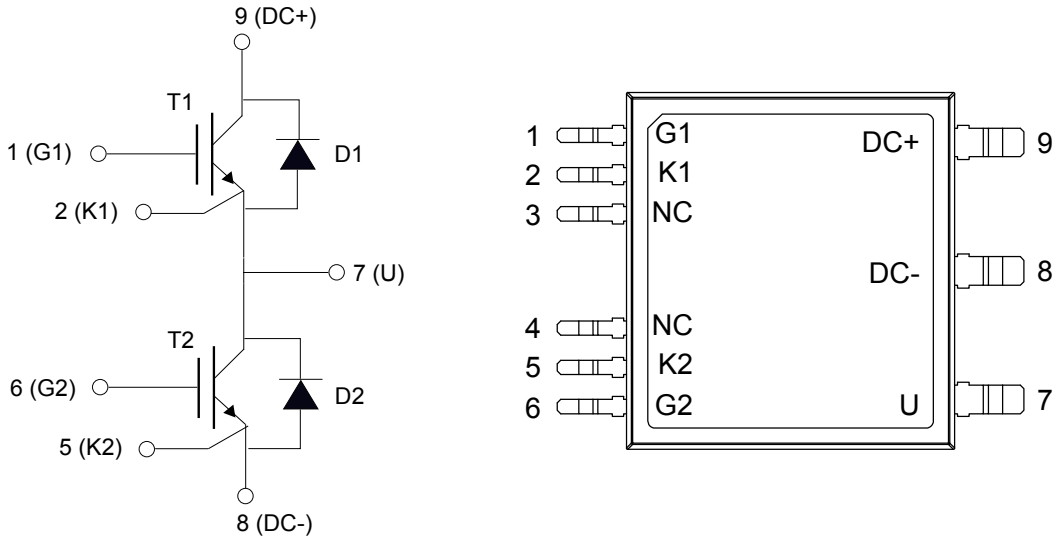
This device combines two IGBTs and diodes in half-bridge topology mounted on a very compact and rugged easily surface-mounted package. The device is optimized both in conduction and switching losses for hard switching commutation, where short-circuit ruggedness is an essential feature. A freewheeling diode with a low drop forward voltage is included in every switch. The result is a product specifically designed to maximize efficiency and power density in industrial drives.

| Product status link |
|---|
| STGSH50M120D |

| Product summary | |
|---|---|
| **Order code** | STGSH50M120D |
| **Marking** | GSH50M120D |
| **Package** | ACEPACK SMIT |
| **Packing** | Tape and reel |

# 1 Internal schematic and pin description

**Figure 1. Electrical topology and pin positioning**




GADG170820230949FF

**Table 1. Pin description**

| Pin | Symbol | Description |
|---|---|---|
| 1 | G1 | Gate of high-side IGBT |
| 2 | K1 | Kelvin emitter of high-side IGBT |
| 3 | NC | Not connected |
| 4 | NC | Not connected |
| 5 | K2 | Kelvin emitter of low-side IGBT |
| 6 | G2 | Gate of low-side IGBT |
| 7 | U | Phase output |
| 8 | DC- | Negative DC input |
| 9 | DC+ | Positive DC input |

# 2 Electrical ratings

Data referred to each IGBT with co-packed diode.

**Table 2. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CES}$ | Collector-emitter voltage ($V_{GE}$ = 0 V) | 1200 | V |
| $I_C$(1) | Continuous collector current at $T_C$ = 100 °C | 69 | A |
| $I_{CP}$(2) | Pulsed collector current ($t_p$ = 1 ms) | 240 | A |
| $V_{GE}$ | Gate-emitter voltage | ±20 | V |
| $I_F$(1) | Continuous forward current at $T_C$ = 100 °C | 40 | A |
| $I_{FP}$(2) | Pulsed forward current ($t_p$ = 1 ms) | 136 | A |
| $P_{TOT}$ | Total power dissipation at $T_C$ = 25 °C | 536 | W |

1. *Current limited by package.*
2. *Pulse width is limited by maximum junction temperature.*

**Table 3. Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{thJC}$ | Thermal resistance, junction-to-case IGBT | 0.28 | °C/W |
| | Thermal resistance, junction-to-case diode | 0.7 | |

**Table 4. Total system**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{ISO}$ | Isolation withstand voltage applied between each pin and heat sink plate (AC voltage 50/60 Hz, t = 60 s) | 3.4 | kVrms |
| $T_{STG}$ | Storage temperature range | -55 to 150 | °C |
| $T_J$ | Operating junction temperature range | -55 to 175 | °C |

# 3 Electrical characteristics

$T_J$ = 25 °C unless otherwise specified.

**Table 5. 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, $I_C$ = 50 A | | 1.8 | 2.3 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 50 A, $T_J$ = 125 °C | | 2.0 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 50 A, $T_J$ = 175 °C | | 2.2 | | |
| $V_F$ | Forward on-voltage | $I_F$ = 50 A | | 2.8 | | V |
| | | $I_F$ = 50 A, $T_J$ = 125 °C | | 2.3 | | |
| | | $I_F$ = 50 A, $T_J$ = 175 °C | | 2.0 | | |
| $V_{GE(th)}$ | 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 6. 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 | - | 3152 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 310 | - | pF |
| $C_{res}$ | Reverse transfer capacitance | | - | 123 | - | pF |
| $Q_g$ | Total gate charge | $V_{CC}$ = 960 V, $I_C$ = 50 A, $V_{GE}$ = 0 to 15 V | - | 194 | - | nC |

**Table 7. Switching characteristics (inductive load)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$ = 600 V, $V_{GK}$ = -15 to 15 V, $R_G$ = 10 Ω, $I_C$ = 50 A | - | 68 | - | ns |
| $t_r$ | Current rise time | | - | 13 | - | ns |
| $E_{on}$ (1) | Turn-on switching energy | | - | 1.94 | - | mJ |
| $t_{d(off)}$ | Turn-off delay time | | - | 135 | - | ns |
| $t_f$ | Current fall time | | - | 197 | - | ns |
| $E_{off}$ (2) | Turn-off switching energy | | - | 3.44 | - | mJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC}$ = 600 V, $V_{GK}$ = -15 to 15 V, $R_G$ = 10 Ω, $I_C$ = 50 A, $T_J$ = 175 °C | - | 69 | - | ns |
| $t_r$ | Current rise time | | - | 13 | - | ns |
| $E_{on}$ (1) | Turn-on switching energy | | - | 3.98 | - | mJ |
| $t_{d(off)}$ | Turn-off delay time | | - | 152 | - | ns |
| $t_f$ | Current fall time | | - | 296 | - | ns |
| $E_{off}$ (2) | Turn-off switching energy | | - | 4.6 | - | mJ |
| $t_{sc}$ | Short-circuit withstand time | $V_{CC}$ ≤ 600 V, $V_{GE}$ = 15 V, $T_{Jstart}$ ≤ 150 °C | 10 | | | µs |

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

**Table 8. Diode switching characteristics (inductive load)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{rr}$ | Reverse recovery time | $I_F$ = 50 A, $V_R$ = 600 V, $R_G$= 10 Ω | - | 294 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 2.79 | - | µC |
| $I_{rrm}$ | Reverse recovery current | | - | 67 | - | A |
| $E_{rr}$ | Reverse recovery energy | | - | 0.94 | - | mJ |
| $t_{rr}$ | Reverse recovery time | $I_F$ = 50 A, $V_R$ = 600 V, $R_G$= 10 Ω, $T_J$ = 175 °C | - | 382 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 7.52 | - | µC |
| $I_{rrm}$ | Reverse recovery current | | - | 82 | - | A |
| $E_{rr}$ | Reverse recovery energy | | - | 2.66 | - | mJ |

## 3.1 Electrical characteristics (curves)

**Figure 2. Typical output characteristics ($T_J$ = 25 °C)**

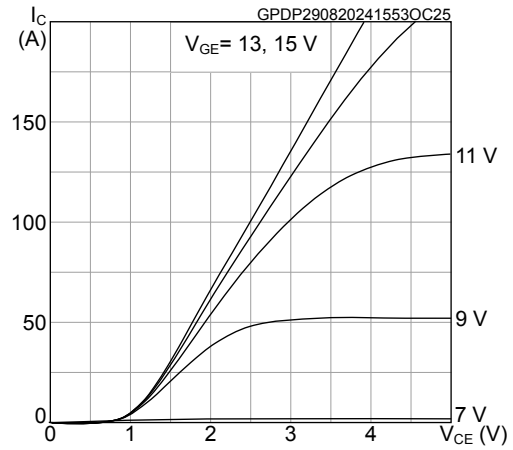



**Figure 3. Typical output characteristics ($T_J$ = 175 °C)**

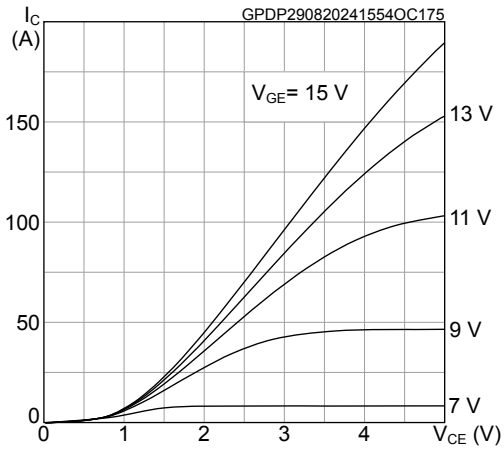



**Figure 4. Normalized $V_{CE(sat)}$ vs temperature**

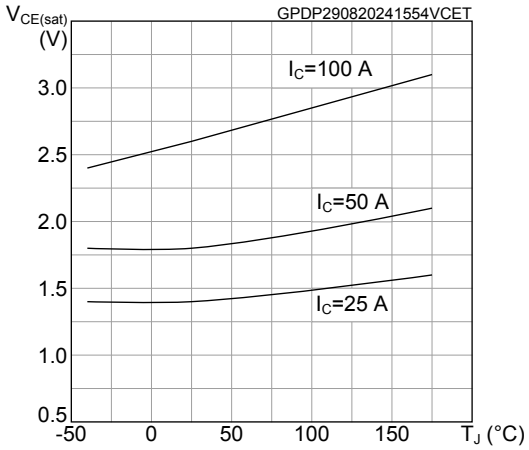



**Figure 5. Typical $V_{CE(sat)}$ vs collector current**

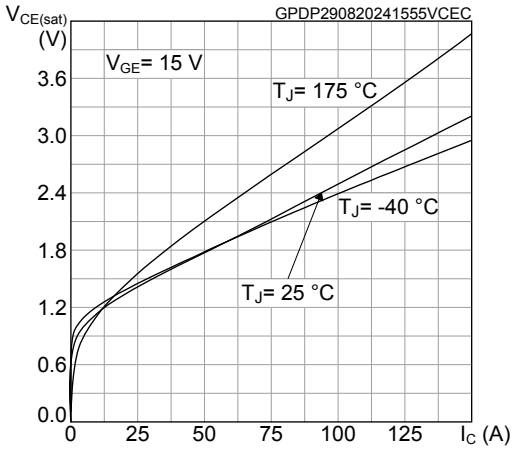



**Figure 6. Typical transfer characteristics**

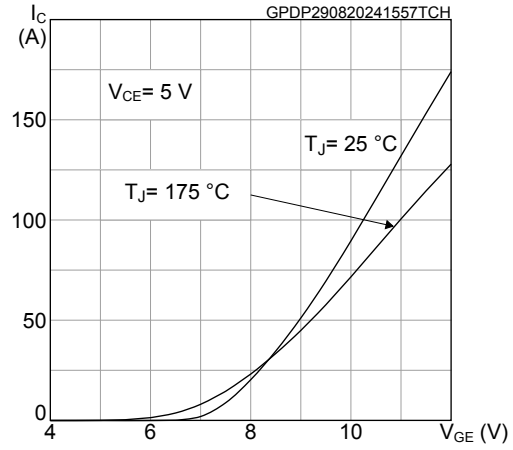



**Figure 7. Typical diode $V_F$ vs forward current**

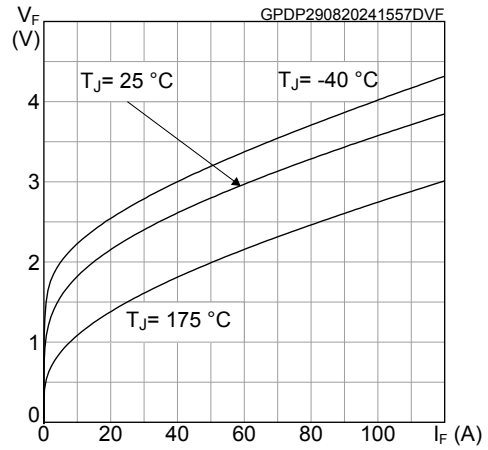


**Figure 8. Normalized $V_{GE(th)}$ vs temperature**

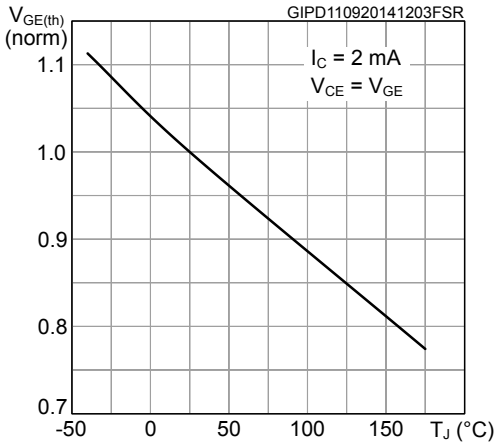



**Figure 9. Normalized $V_{(BR)CES}$ vs temperature**

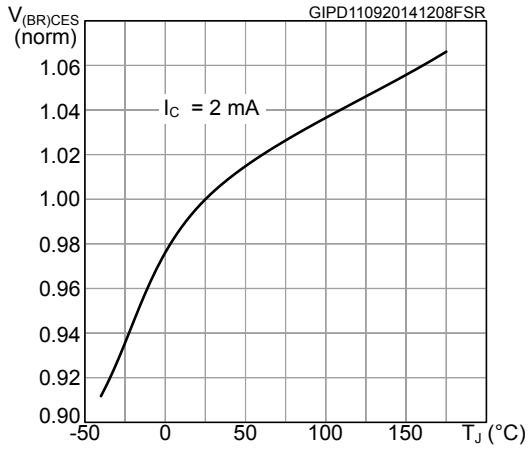



**Figure 10. Typical capacitance characteristics**

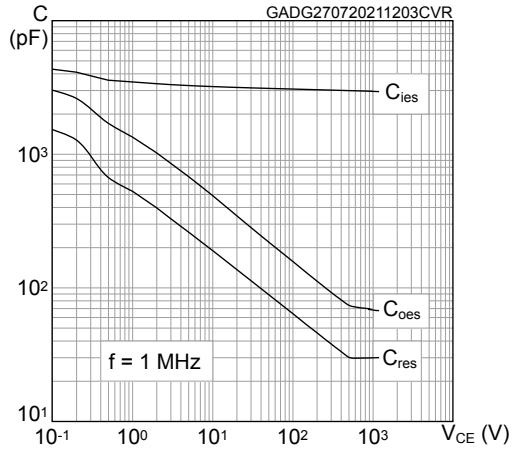



**Figure 11. Typical gate charge characteristics**

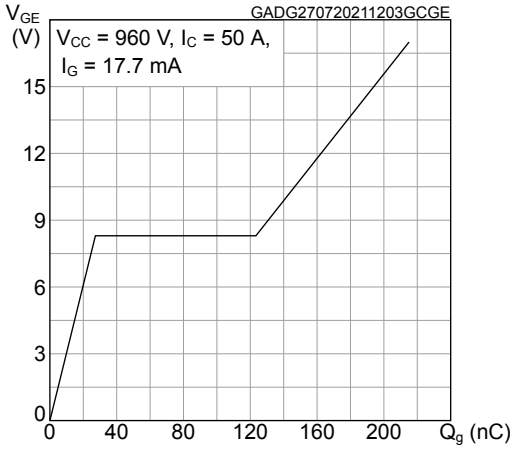



**Figure 12. Typical switching energy vs collector current**

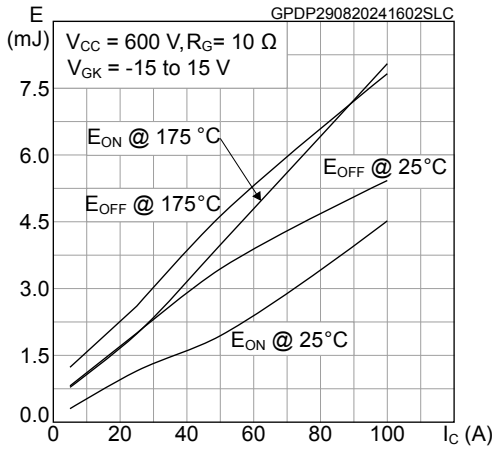



**Figure 13. Typical switching energy vs supply voltage**

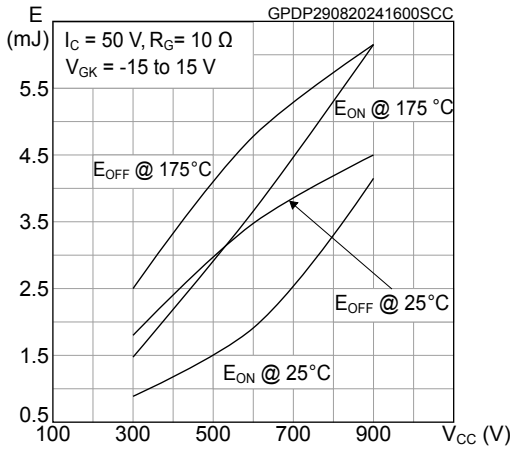


**Figure 14. Typical switching energy vs temperature**

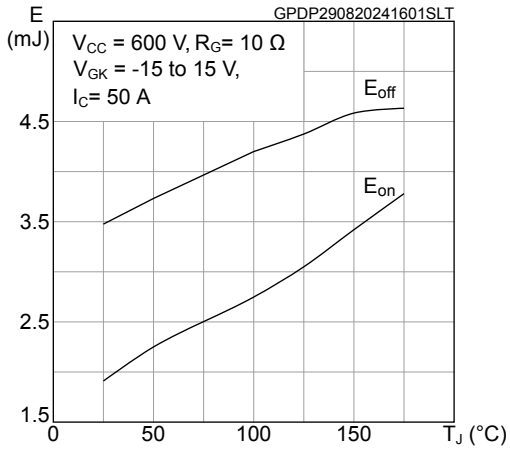



**Figure 15. Typical switching energy vs $R_G$**

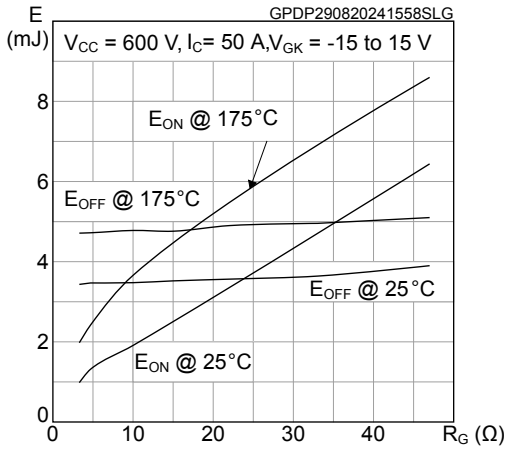



**Figure 16. Diode reverse recovery time vs forward current**

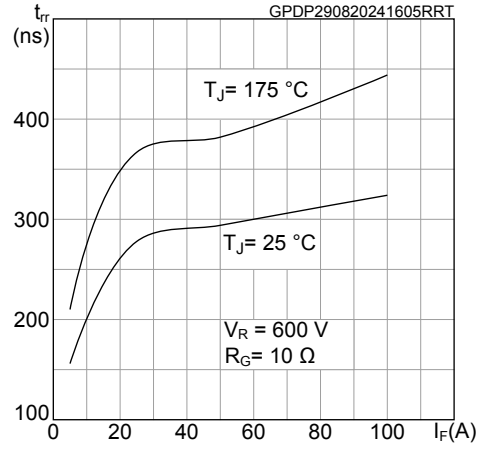



**Figure 17. Diode reverse recovery current vs forward current**

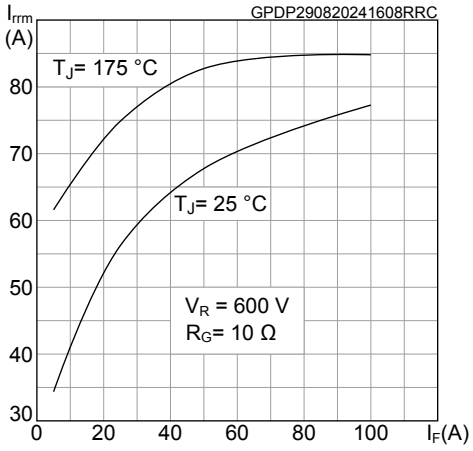



**Figure 18. Diode reverse recovery energy vs forward current**

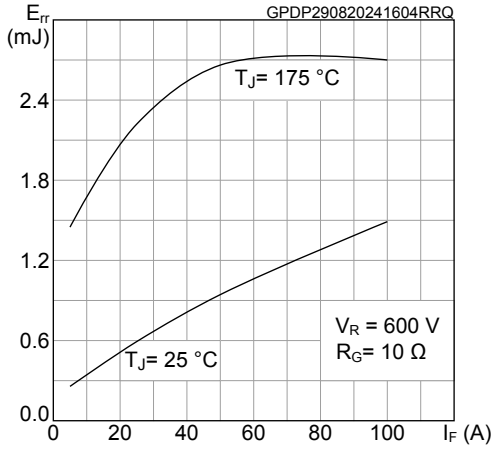



**Figure 19. Diode reverse recovery charge vs forward current**

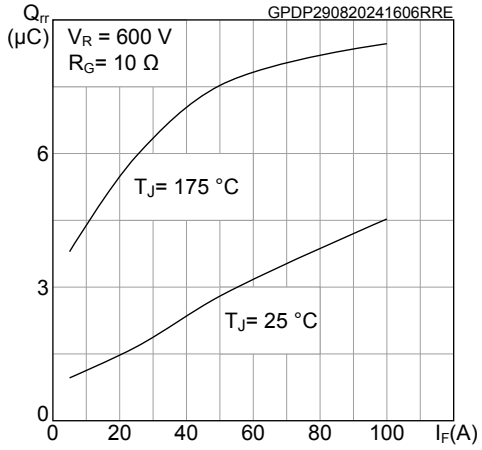


**Figure 20. Maximum transient thermal impedance for IGBT**

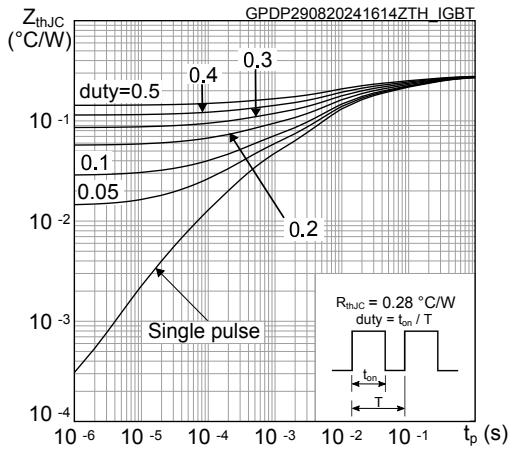



**Figure 21. Maximum transient thermal impedance for diode**

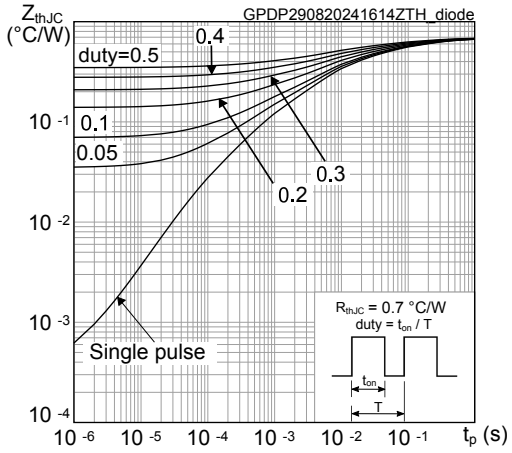
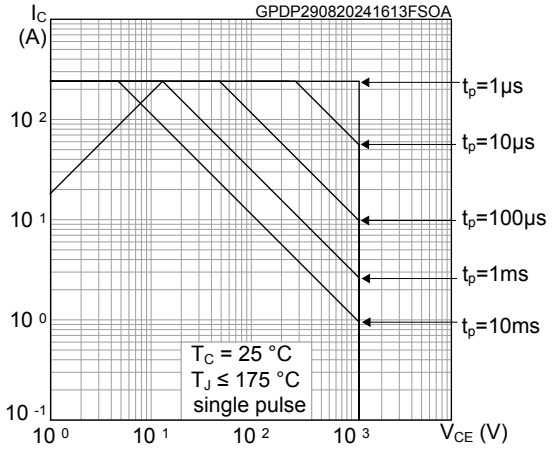



**Figure 22. Forward bias safe operating area**



# 4 Test circuits

**Figure 23. Test circuit for inductive load switching**

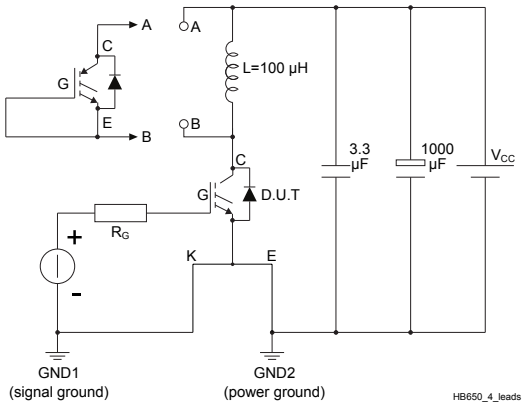



**Figure 24. Gate charge test circuit**

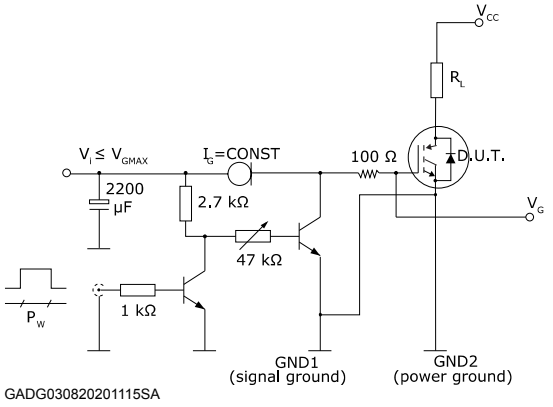



**Figure 25. Switching waveform**

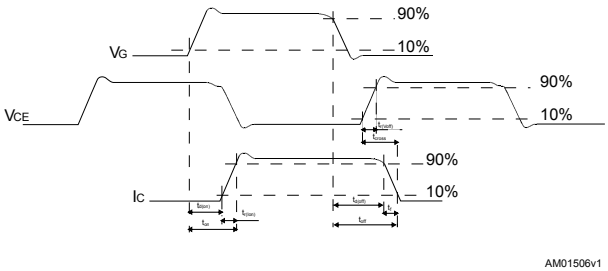
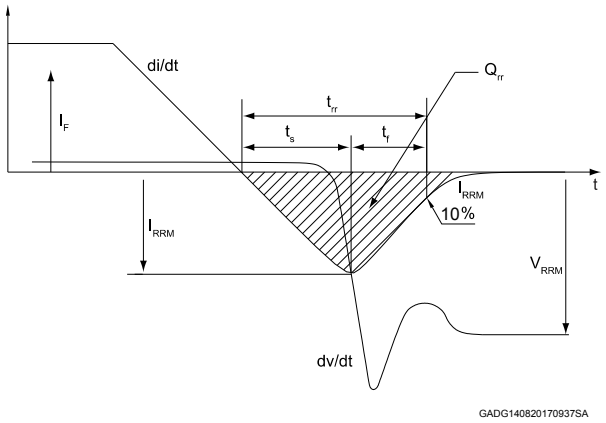



**Figure 26. Diode reverse recovery waveform**

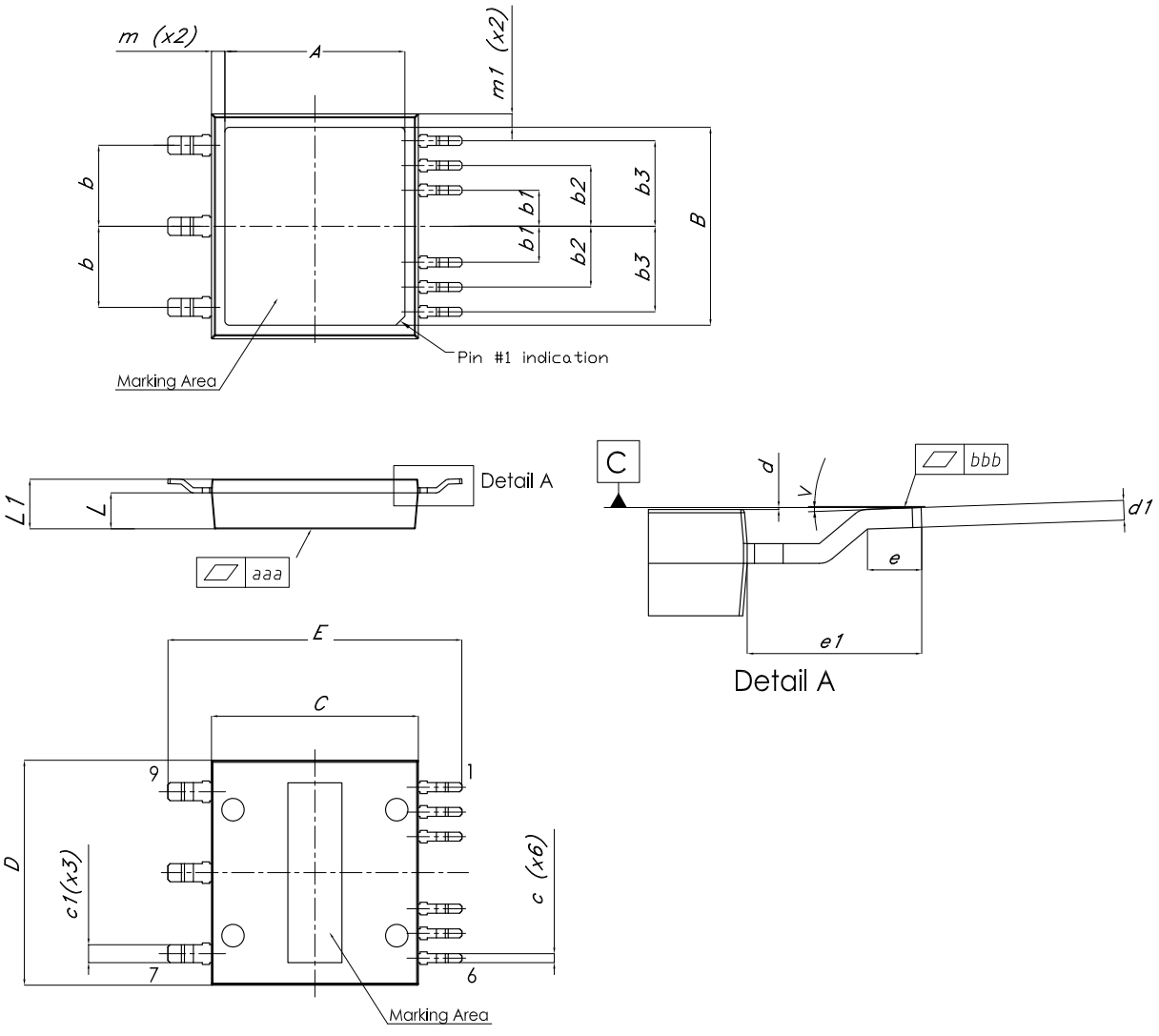


# 5 Package information

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.

## 5.1 ACEPACK SMIT package information

**Figure 27. ACEPACK SMIT package outline**

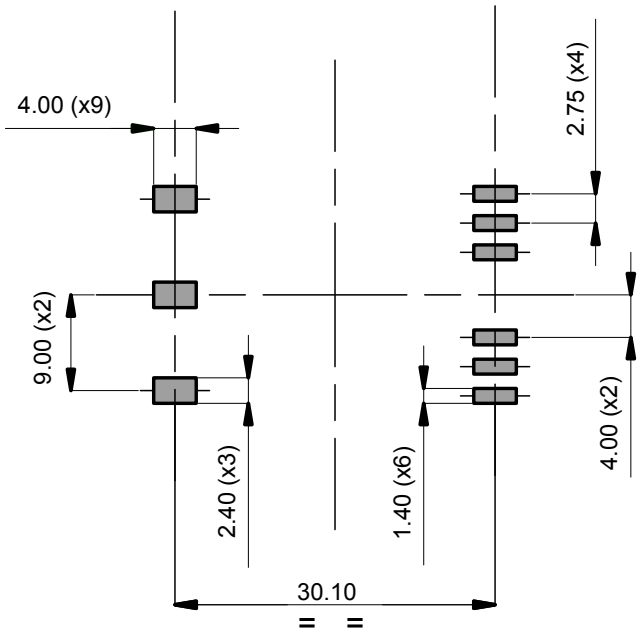



DM00447519_Rev.7

Table 9. **ACEPACK SMIT package mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 19.50 | 20.00 | 20.50 |
| B | 21.50 | 22.00 | 22.50 |
| C | 22.80 | 23.00 | 23.20 |
| D | 24.80 | 25.00 | 25.20 |
| E | 32.20 | 32.70 | 33.20 |
| b | | 9.00 | |
| b1 | | 4.00 | |
| b2 | | 6.75 | |
| b3 | | 9.50 | |
| c | 0.95 | 1.00 | 1.10 |
| c1 | 1.95 | 2.00 | 2.10 |
| d | 0.00 | | 0.15 |
| d1 | 0.45 | 0.55 | 0.65 |
| e | 1.30 | 1.50 | 1.70 |
| e1 | 4.65 | 4.85 | 5.05 |
| L | 3.95 | 4.00 | 4.05 |
| L1 | 5.40 | 5.50 | 5.60 |
| m | 1.30 | 1.50 | 1.80 |
| m1 | 1.30 | 1.50 | 1.80 |
| V | 0° | 2° | 4° |
| aaa | 0.01 | | 0.05 |
| bbb | 0.00 | | 0.10 |

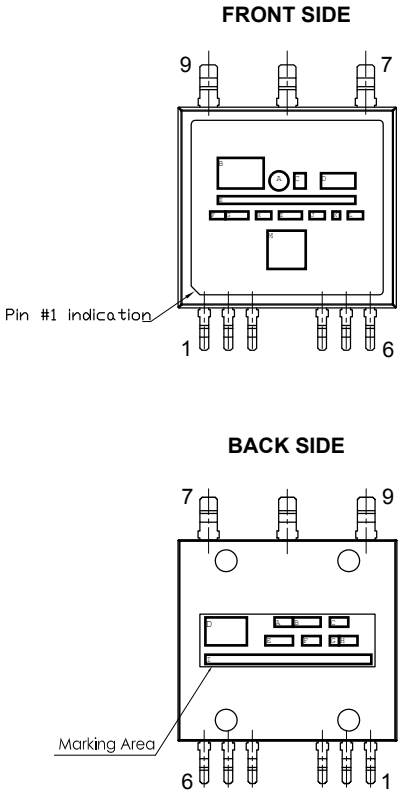
Figure 28. **ACEPACK SMIT recommended footprint**




DM00447519_FP_Rev.7

*Note: Dimensions in mm.*

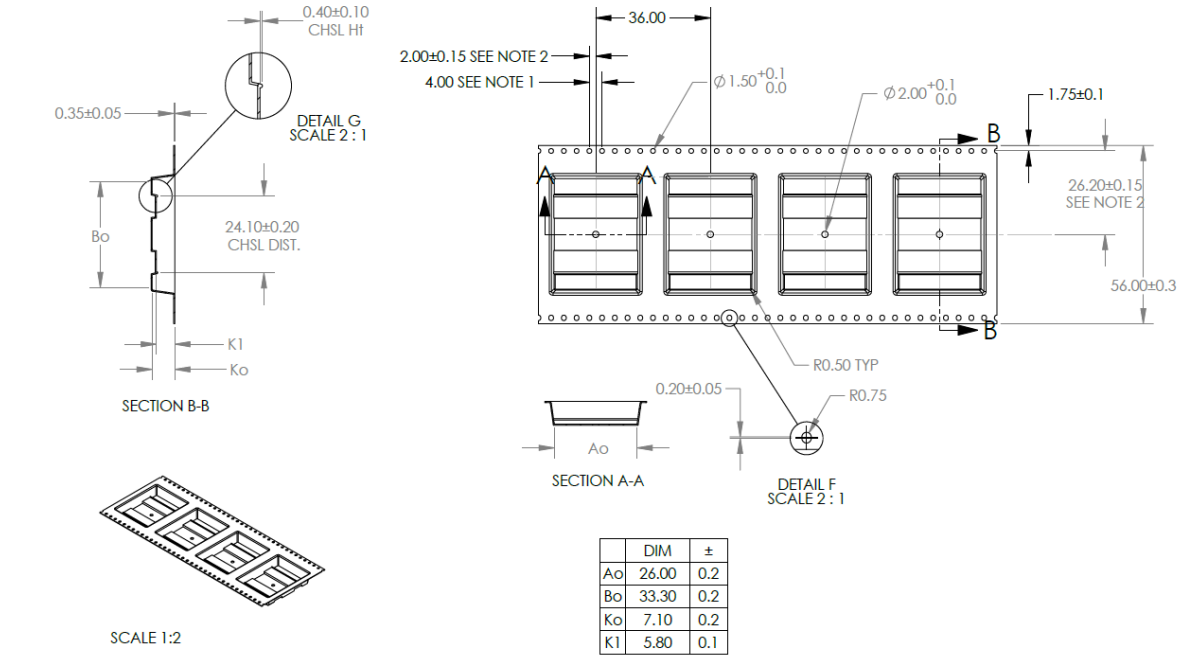
Figure 29. **ACEPACK SMIT marking orientation vs pinout**




DM00447519_MO_Rev.7

## 5.2 ACEPACK SMIT packing information

**Figure 30. ACEPACK SMIT tape outline**




| | DIM | ± |
|---|---|---|
| Ao | 26.00 | 0.2 |
| Bo | 33.30 | 0.2 |
| Ko | 7.10 | 0.2 |
| K1 | 5.80 | 0.1 |

NOTES:
1. 10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ±0.2
2. POCKET POSITION RELATIVE TO SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE.
3. Ao AND Bo ARE MEASURED ON A PLANE AT A DISTANCE "R" ABOVE THE BOTTOM OF THE POCKET.

DM00631393_Tape_Rev.1

*Note: Dimensions in mm.*

## Revision history

Table 10. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 09-Sep-2024 | 1 | First release. |
| 11-Nov-2024 | 2 | Updated Table 2. Absolute maximum ratings and Table 5. Static characteristics. |

# Contents