

Automotive-grade 390 V internally clamped IGBT E_{SCIS} 180 mJ

Datasheet - production data

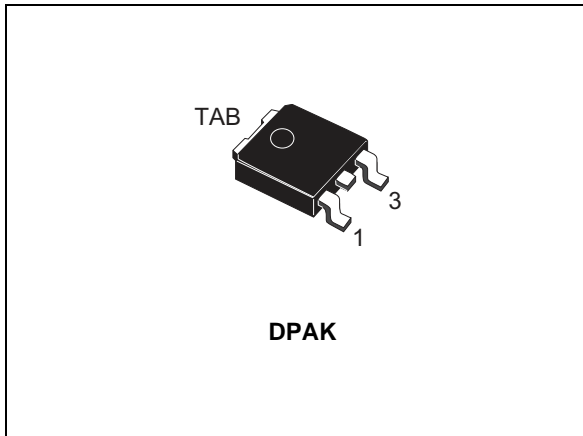
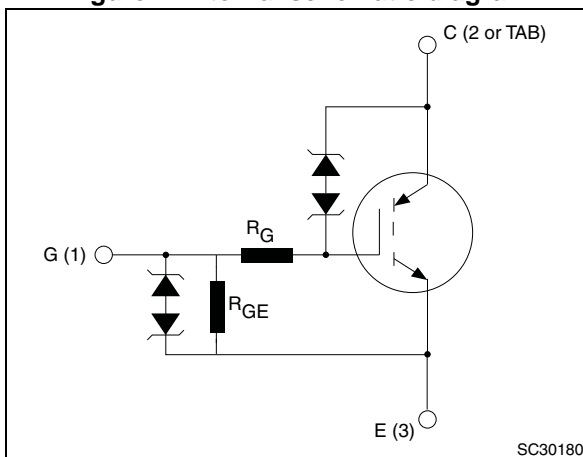


Figure 1. Internal schematic diagram



Features



- AEC-Q101 qualified
- 180 mJ of avalanche energy @ $T_C = 150\text{ }^\circ\text{C}$, $L = 3\text{ mH}$
- ESD gate-emitter protection
- Gate-collector high voltage clamping
- Logic level gate drive
- Low saturation voltage
- High pulsed current capability
- Gate and gate-emitter resistor

Applications

- Pencil coil electronic ignition driver

Description

This application-specific IGBT utilizes the most advanced PowerMESH™ technology. The built-in Zener diodes between gate-collector and gate-emitter provide overvoltage protection capabilities. The device also exhibits low on-state voltage drop and low threshold drive for use in automotive ignition systems.

Table 1. Device summary

| Order code | Marking | Packages | Packing |
|-------------|-----------|----------|---------------|
| STGD19N40LZ | GD19N40LZ | DPAK | Tape and reel |

Contents

- 1 Electrical ratings 3**
- 2 Electrical characteristics 4**
 - 2.1 Electrical characteristics (curves) 6
- 3 Test circuits 9**
- 4 Package information 10**
 - 4.1 DPAK (TO-252) type A2 package information11
 - 4.2 Packing information 14
- 5 Revision history 16**

1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|------------------|--|---------------------------|------|
| V_{CES} | Collector-emitter voltage ($V_{GE} = 0$) | $V_{CES(\text{clamped})}$ | V |
| V_{ECS} | Emitter collector voltage ($V_{GE} = 0$) | 20 | V |
| $I_C^{(1)}$ | Collector current (continuous) at $T_C = 100\text{ °C}$ | 25 | A |
| $I_{CP}^{(2)}$ | Pulsed collector current | 40 | A |
| V_{GE} | Gate-emitter voltage | $V_{GE(\text{clamped})}$ | V |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 125 | W |
| $E_{SCIS}^{(3)}$ | Single pulse energy $T_C = 25\text{ °C}$, $L = 3\text{ mH}$, $V_{CC} = 50\text{ V}$ | 300 | mJ |
| | Single pulse energy $T_C = 150\text{ °C}$, $L = 3\text{ mH}$, $V_{CC} = 50\text{ V}$ | 180 | mJ |
| I_{SCIS} | Avalanche current $T_C = 25\text{ °C}$, $L = 3\text{ mH}$, $V_{CC} = 50\text{ V}$ | 13.1 | A |
| | Avalanche current $T_C = 150\text{ °C}$, $L = 3\text{ mH}$, $V_{CC} = 50\text{ V}$ | 10.2 | A |
| ESD | Human body model, $R = 1.5\text{ k}\Omega$, $C = 100\text{ pF}$ | 8 | kV |
| | Machine model, $R = 0$, $C = 100\text{ pF}$ | 800 | V |
| | Charged device model | 2 | kV |
| T_{STG} | Storage temperature | - 55 to 175 | °C |
| T_J | Operating junction temperature | | |

1. Calculated according to the iterative formula

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

2. Pulse width limited by max. junction temperature allowed

3. For E_{SCIS} test circuit refer to [Figure 16](#). (Inductive load switching), with A and B not connected.

Table 3. Thermal data

| Symbol | Parameter | Value | Unit |
|-----------------------|--|-------|------|
| $R_{\text{thj-case}}$ | Thermal resistance junction-case | 1.2 | °C/W |
| $R_{\text{thj-amb}}$ | Thermal resistance junction-ambient device in free air | 100 | °C/W |

2 Electrical characteristics

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

Table 4. Static electrical characteristics

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------------------|---|--|------|------|------|------------------|
| $V_{CES(\text{clamped})}$ | Collector emitter clamped voltage ($V_{GE} = 0$) | $I_C = 2\text{ mA}$ | | 390 | | V |
| | | $I_C = 2\text{ mA}, T_J = -40\text{ °C to }175\text{ °C}$ | 365 | | 425 | V |
| $V_{(BR)ECS}$ | Emitter collector break-down voltage ($V_{GE} = 0$) | $I_C = 75\text{ mA}$ | | 28 | | V |
| | | $I_C = 75\text{ mA}, T_J = -40\text{ °C to }175\text{ °C}$ | 20 | | | V |
| $V_{GE(\text{clamped})}$ | Gate emitter clamped voltage | $I_G = \pm 2\text{ mA}$ $T_J = -40\text{ °C to }175\text{ °C}$ | 12 | | 16 | V |
| I_{CES} | Collector cut-off current ($V_{GE} = 0$) | $V_{CE} = 15\text{ V}, T_J = 175\text{ °C}$ | | | 20 | μA |
| | | $V_{CE} = 200\text{ V}, T_J = 175\text{ °C}$ | | | 100 | μA |
| I_{GES} | Gate-emitter leakage current ($V_{CE} = 0$) | $V_{GE} = \pm 10\text{ V}$ | | 625 | | μA |
| | | $V_{GE} = \pm 10\text{ V}, T_J = -40\text{ °C to }175\text{ °C}$ | 450 | | 830 | μA |
| R_{GE} | Gate emitter resistance | $0 < V_{GE} < V_{GE}(\text{clamped})$ | 12 | 16 | 22 | $\text{k}\Omega$ |
| R_G | Gate resistance | | | 1.6 | | $\text{k}\Omega$ |
| $V_{GE(\text{th})}$ | Gate threshold voltage | $V_{GE} = V_{CE}, I_C = 1\text{ mA}, T_J = -40\text{ °C}$ | 1.75 | 2.3 | 2.9 | V |
| | | $V_{GE} = V_{CE}, I_C = 1\text{ mA}$ | 1.55 | 2.0 | 2.6 | V |
| | | $V_{GE} = V_{CE}, I_C = 1\text{ mA}, T_J = 175\text{ °C}$ | 1.05 | 1.4 | 2.0 | V |
| $V_{CE(\text{sat})}$ | Collector emitter saturation voltage | $V_{GE} = 4.5\text{ V}, I_C = 10\text{ A}$ | | 1.5 | | V |
| | | $V_{GE} = 4.5\text{ V}, I_C = 10\text{ A}, T_J = -40\text{ °C to }175\text{ °C}$ | | | 1.85 | V |
| | | $V_{GE} = 3.8\text{ V}, I_C = 6\text{ A}$ | | 1.35 | | V |
| | | $V_{GE} = 3.8\text{ V}, I_C = 6\text{ A}, T_J = -40\text{ °C to }175\text{ °C}$ | | | 1.65 | V |

Table 5. Dynamic electrical characteristics

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|--|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0$ | - | 730 | - | pF |
| C_{oes} | Output capacitance | | - | 85 | - | pF |
| C_{res} | Reverse transfer capacitance | | - | 4 | - | pF |
| Q_g | Gate charge | $V_{CE} = 280\text{ V}$, $I_C = 10\text{ A}$, $V_{GE} = 5\text{ V}$ | - | 17 | - | nC |

Table 6. Switching on/off

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------|------------------------|--|------|------|------|------------------------|
| $t_{d(on)}$ t_r | Resistive load | $V_{CC} = 14\text{ V}$, $R_L = 1\ \Omega$, $V_{GE} = 5\text{ V}$ $R_G = 1\text{ k}\Omega$ | - | 0.65 | - | μs |
| | Turn-on delay time | | | | | |
| t_r | Rise time | $V_{CC} = 14\text{ V}$, $R_L = 1\ \Omega$, $V_{GE} = 5\text{ V}$, $R_G = 1\text{ k}\Omega$, $T_J = 150\text{ }^\circ\text{C}$ | - | 3.5 | - | μs |
| | Resistive load | | | | | |
| $t_{d(on)}$ t_r | Turn-on delay time | $V_{CC} = 14\text{ V}$, $R_L = 1\ \Omega$, $V_{GE} = 5\text{ V}$, $R_G = 1\text{ k}\Omega$, $T_J = 150\text{ }^\circ\text{C}$ | - | 0.65 | - | μs |
| | Rise time | | | | | |
| $t_{d(off)}$ t_f | Inductive load | $V_{CC} = 300\text{ V}$, $L = 1\text{ mH}$ $I_C = 10\text{ A}$, $V_{GE} = 5\text{ V}$, $R_G = 1\text{ k}\Omega$ | - | 13.5 | - | μs |
| | Turn-off delay time | | | | | |
| t_f | Fall time | $V_{CC} = 300\text{ V}$, $L = 1\text{ mH}$ $I_C = 10\text{ A}$, $V_{GE} = 5\text{ V}$, $R_G = 1\text{ k}\Omega$, $T_J = 150\text{ }^\circ\text{C}$ | - | 5.5 | - | μs |
| | Turn-off voltage slope | | | | | |
| dv/dt | Turn-off voltage slope | $V_{CC} = 300\text{ V}$, $L = 1\text{ mH}$ $I_C = 10\text{ A}$, $V_{GE} = 5\text{ V}$, $R_G = 1\text{ k}\Omega$, $T_J = 150\text{ }^\circ\text{C}$ | - | 105 | - | $\text{V}/\mu\text{s}$ |
| | Inductive load | | | | | |
| $t_{d(off)}$ t_f | Turn-off delay time | $V_{CC} = 300\text{ V}$, $L = 1\text{ mH}$ $I_C = 10\text{ A}$, $V_{GE} = 5\text{ V}$, $R_G = 1\text{ k}\Omega$, $T_J = 150\text{ }^\circ\text{C}$ | - | 14.2 | - | μs |
| | Fall time | | | | | |
| dv/dt | Turn-off voltage slope | $V_{CC} = 300\text{ V}$, $L = 1\text{ mH}$ $I_C = 10\text{ A}$, $V_{GE} = 5\text{ V}$, $R_G = 1\text{ k}\Omega$, $T_J = 150\text{ }^\circ\text{C}$ | - | 8 | - | μs |
| | Inductive load | | | | | |
| dv/dt | Turn-off voltage slope | $V_{CC} = 300\text{ V}$, $L = 1\text{ mH}$ $I_C = 10\text{ A}$, $V_{GE} = 5\text{ V}$, $R_G = 1\text{ k}\Omega$, $T_J = 150\text{ }^\circ\text{C}$ | - | 97 | - | $\text{V}/\mu\text{s}$ |
| | Inductive load | | | | | |

2.1 Electrical characteristics (curves)

Figure 2. Collector-emitter on voltage vs. temperature ($I_C = 6\text{ A}$)

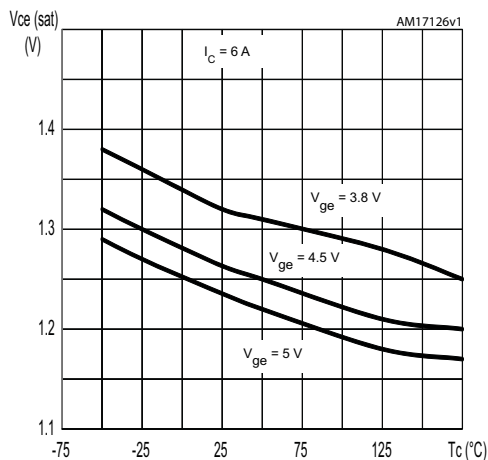


Figure 3. Collector-emitter on voltage vs. temperature ($I_C = 10\text{ A}$)

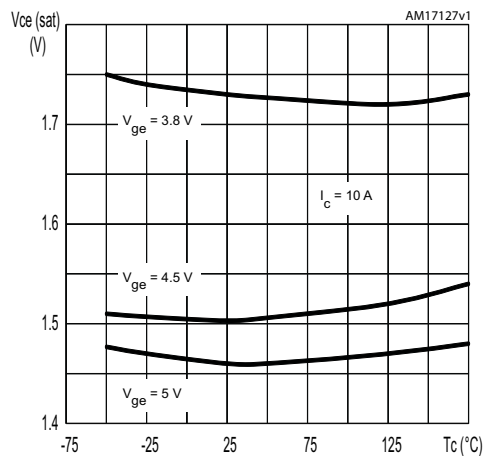


Figure 4. Collector-emitter on voltage vs. temperature ($V_{GE} = 4.5\text{ V}$)

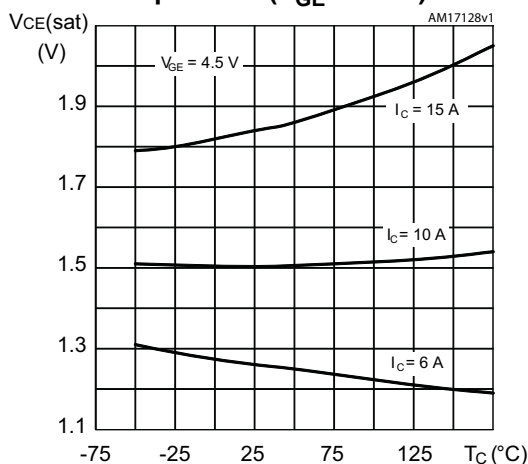


Figure 5. Self clamped inductive switch

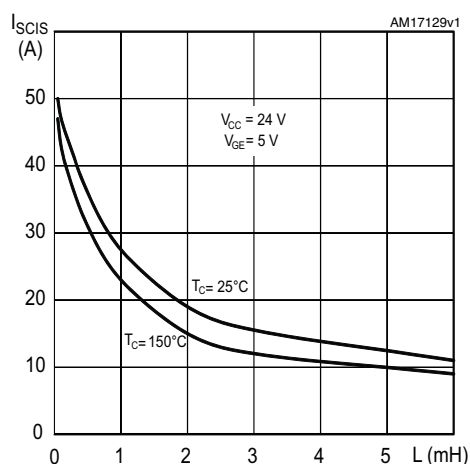


Figure 6. Output characteristics ($T_J = 25\text{ }^{\circ}\text{C}$)

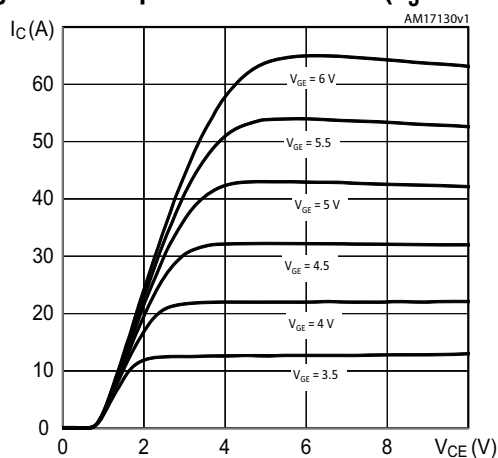


Figure 7. Output characteristics ($T_J = -175\text{ }^{\circ}\text{C}$)

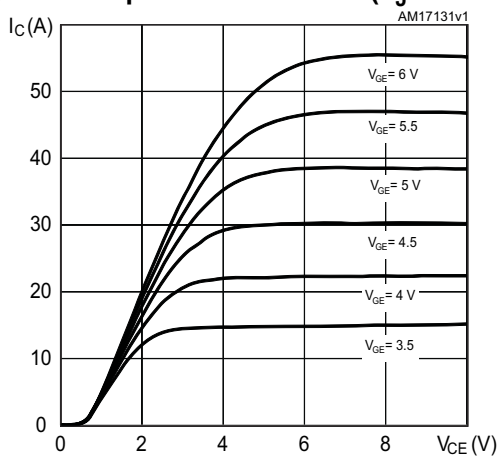


Figure 8. Output characteristics ($T_J = -40\text{ }^\circ\text{C}$)

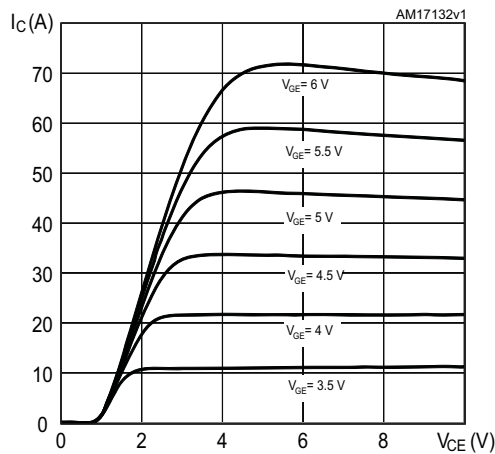


Figure 9. Transfer characteristics

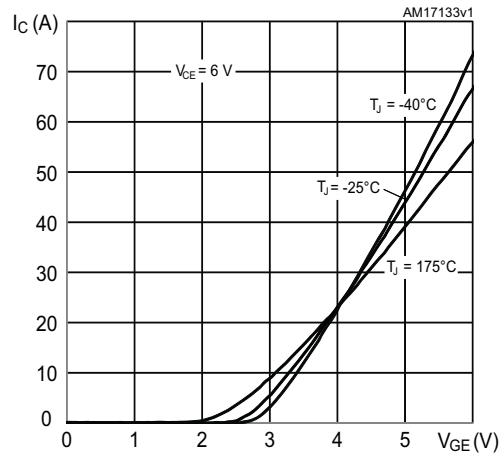


Figure 10. Collector cut-off current vs. temperature

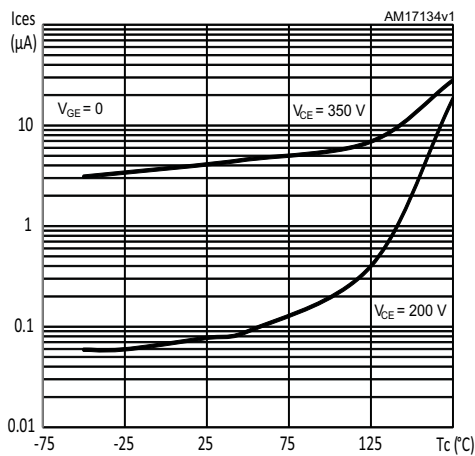


Figure 11. Normalized collector emitter voltage vs. temperature ($I_C = 2\text{ mA}$)

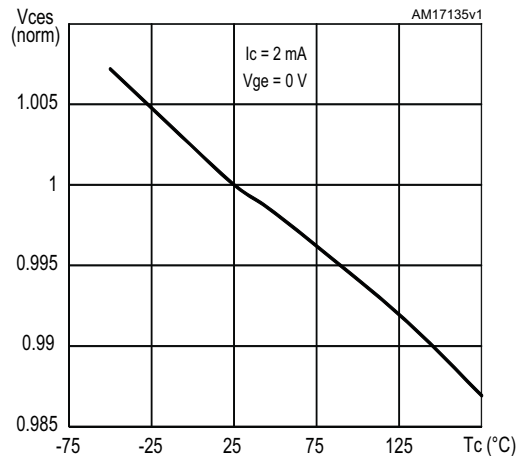


Figure 12. Normalized gate threshold voltage vs. temperature

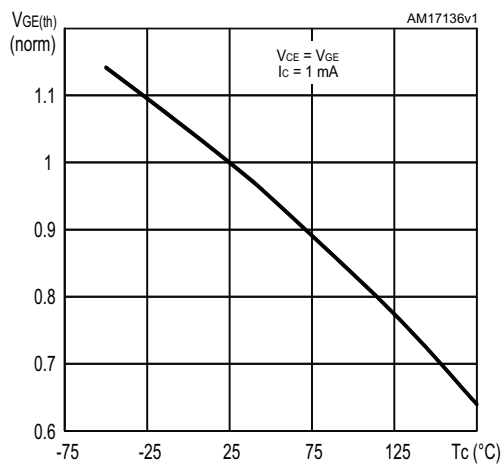
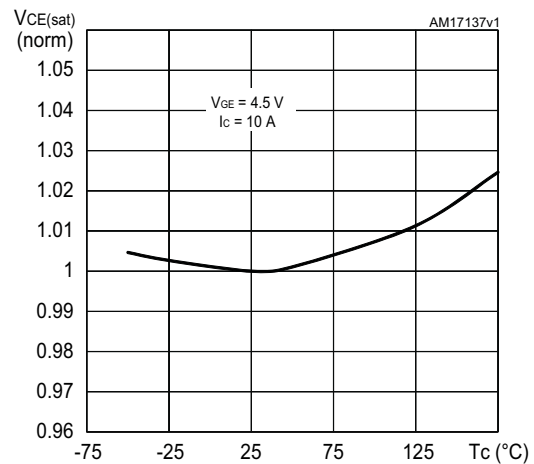
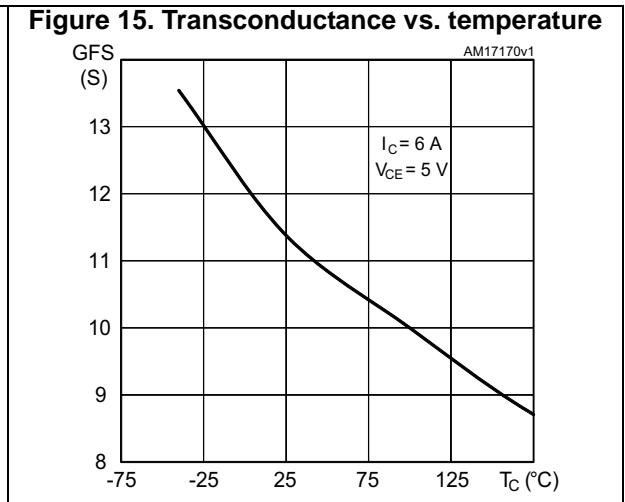
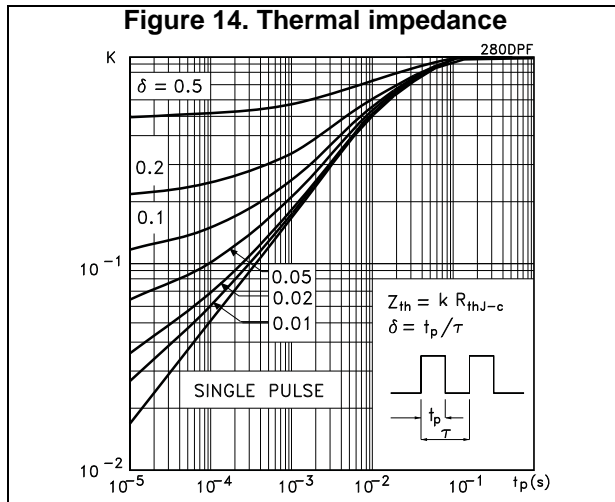
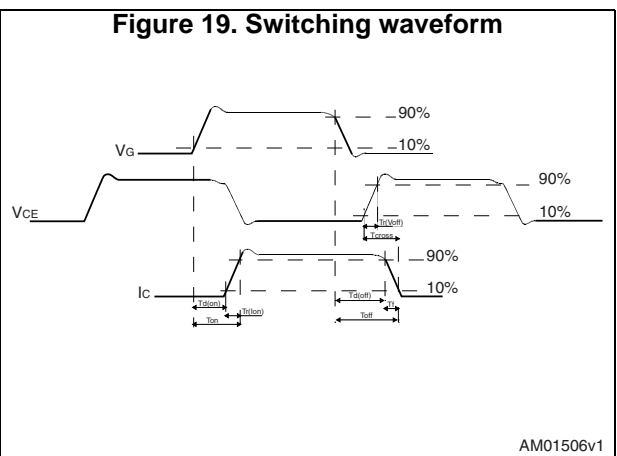
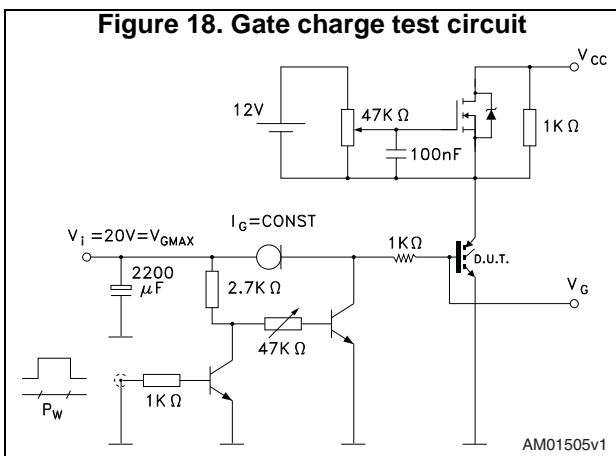
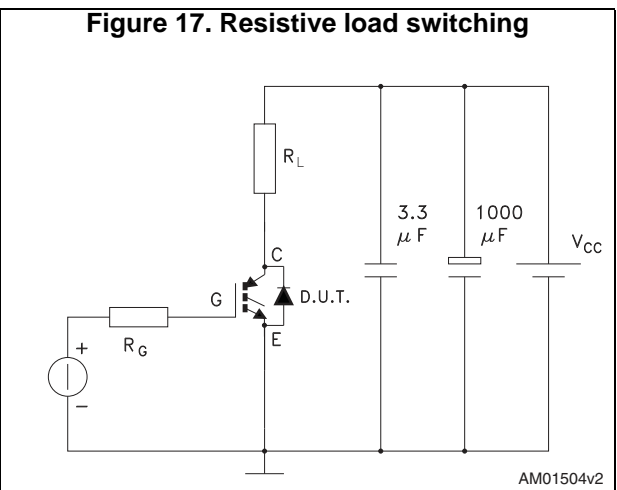
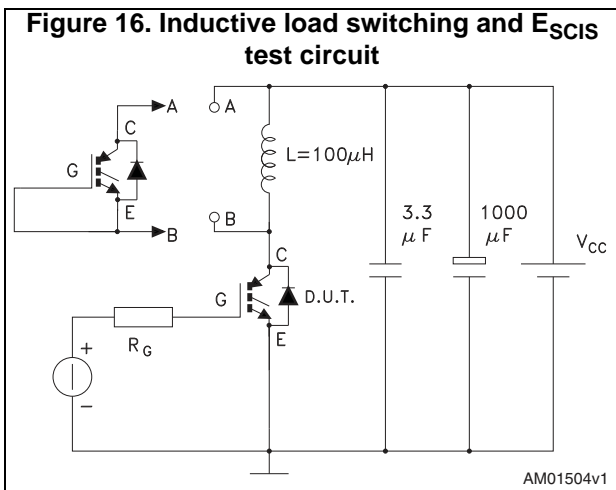


Figure 13. Normalized collector emitter on voltage vs. temperature ($I_C = 10\text{ A}$)





3 Test circuits



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 DPAK (TO-252) type A2 package information

Figure 20. DPAK (TO-252) type A2 package outline

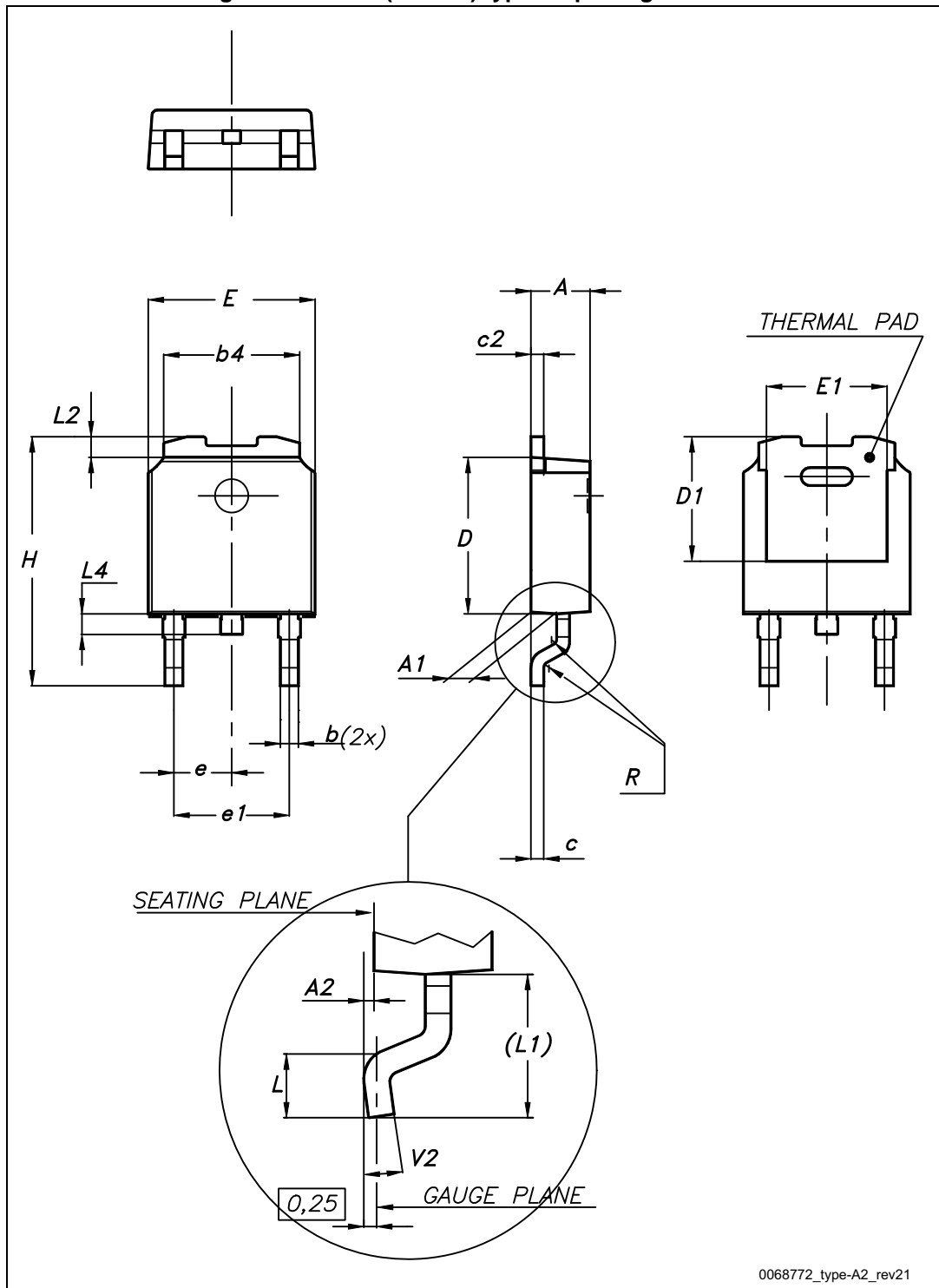
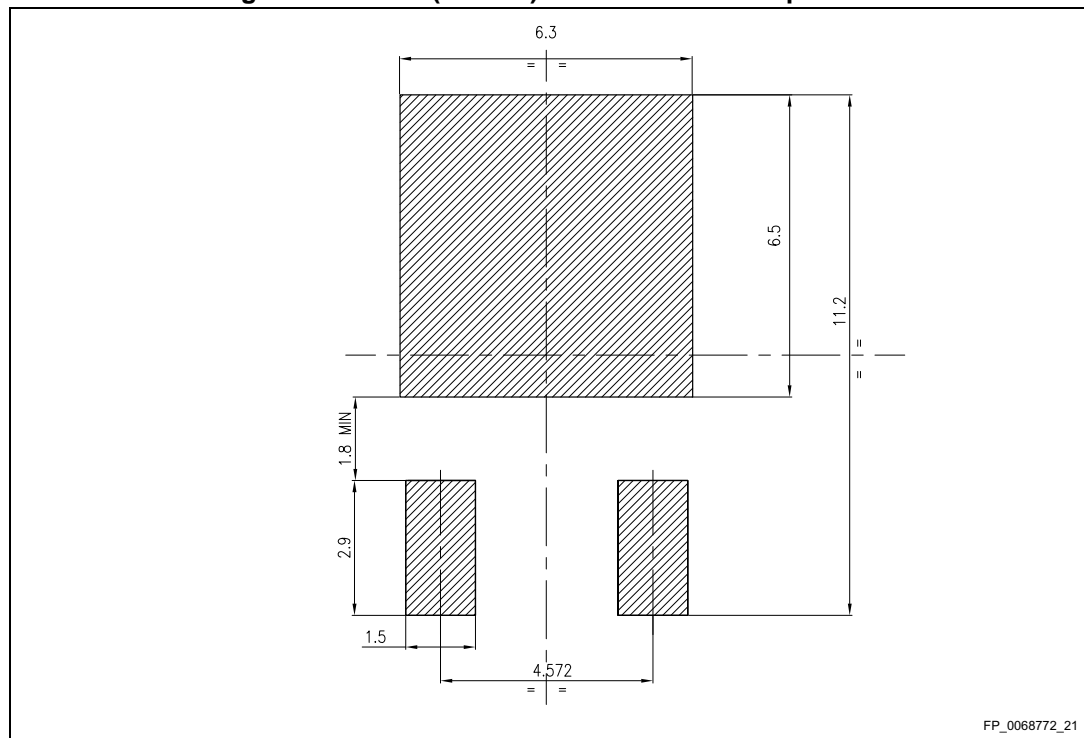


Table 7. DPAK (TO-252) type A2 mechanical data

| Dim. | mm | | |
|------|------|------|-------|
| | Min. | Typ. | Max. |
| A | 2.20 | | 2.40 |
| A1 | 0.90 | | 1.10 |
| A2 | 0.03 | | 0.23 |
| b | 0.64 | | 0.90 |
| b4 | 5.20 | | 5.40 |
| c | 0.45 | | 0.60 |
| c2 | 0.48 | | 0.60 |
| D | 6.00 | | 6.20 |
| D1 | 4.95 | 5.10 | 5.25 |
| E | 6.40 | | 6.60 |
| E1 | 5.10 | 5.20 | 5.30 |
| e | 2.16 | 2.28 | 2.40 |
| e1 | 4.40 | | 4.60 |
| H | 9.35 | | 10.10 |
| L | 1.00 | | 1.50 |
| L1 | 2.60 | 2.80 | 3.00 |
| L2 | 0.65 | 0.80 | 0.95 |
| L4 | 0.60 | | 1.00 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

Figure 21. DPAK (TO-252) recommended footprint (a)



a. All dimensions are in millimeters

4.2 Packing information

Figure 22. Tape outline for DPAK (TO-252)

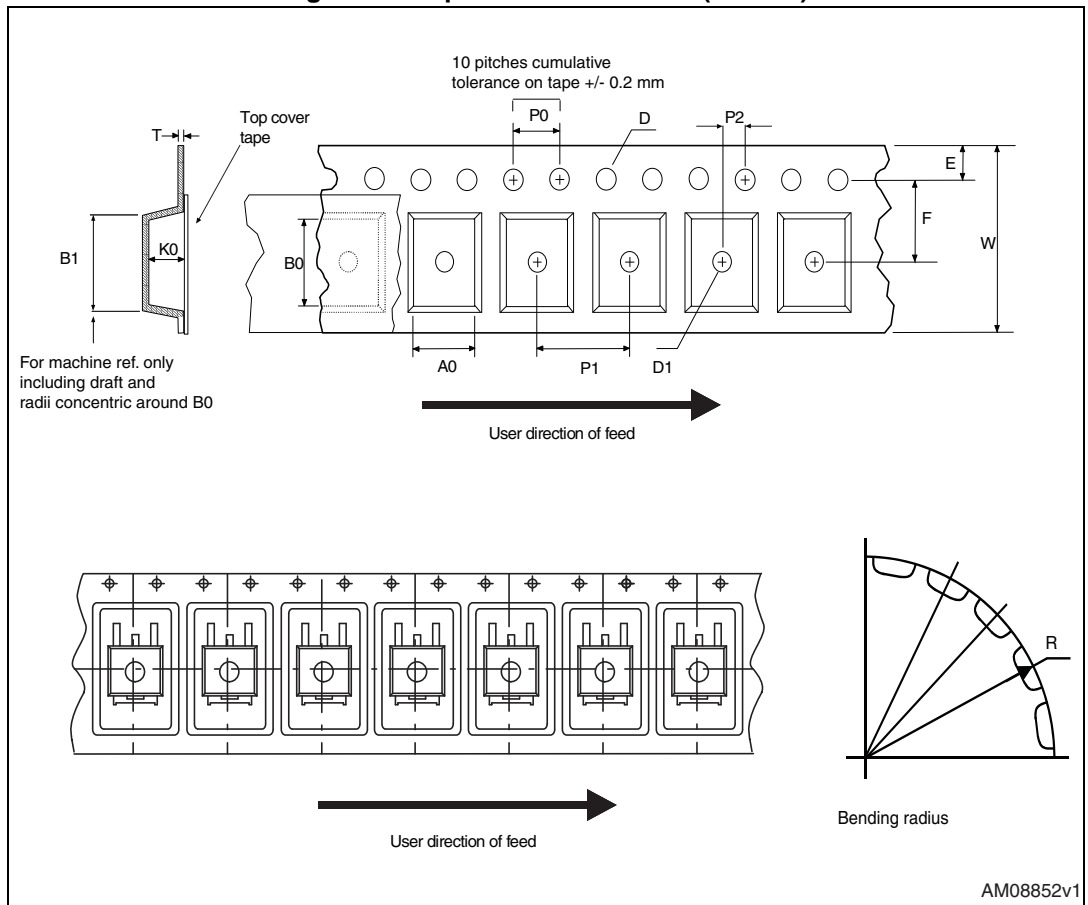


Figure 23. Reel outline for DPAK (TO-252)

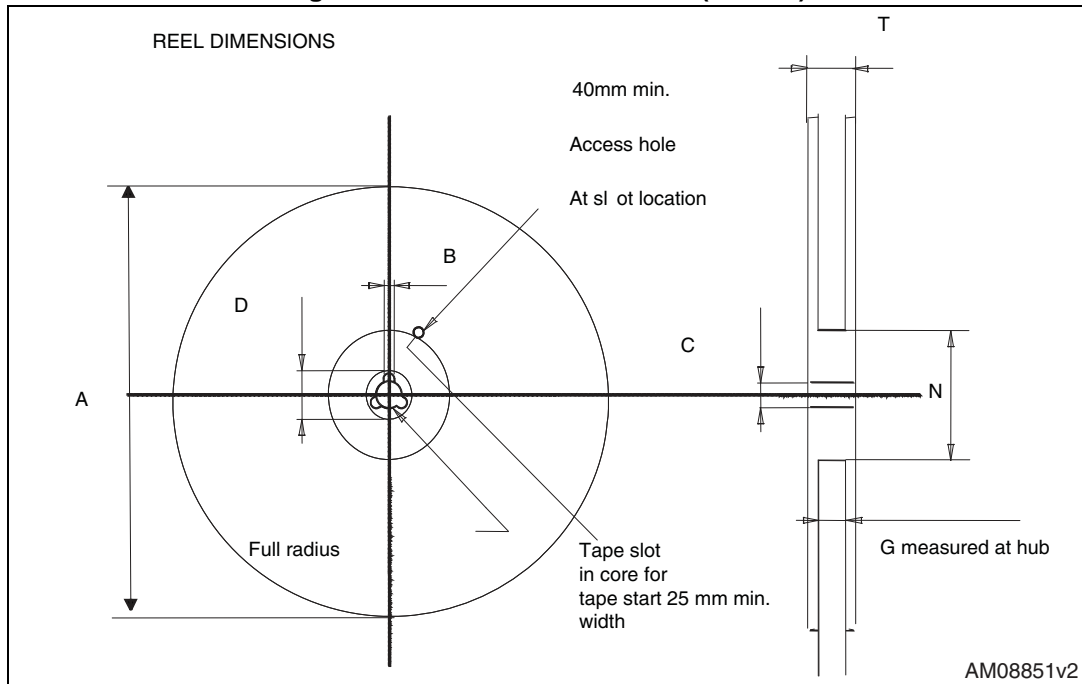


Table 8. DPAK (TO-252) tape and reel mechanical data

| Tape | | | Reel | | |
|------|------|------|------|-----------|------|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 6.8 | 7 | A | | 330 |
| B0 | 10.4 | 10.6 | B | 1.5 | |
| B1 | | 12.1 | C | 12.8 | 13.2 |
| D | 1.5 | 1.6 | D | 20.2 | |
| D1 | 1.5 | | G | 16.4 | 18.4 |
| E | 1.65 | 1.85 | N | 50 | |
| F | 7.4 | 7.6 | T | | 22.4 |
| K0 | 2.55 | 2.75 | | | |
| P0 | 3.9 | 4.1 | | Base qty. | 2500 |
| P1 | 7.9 | 8.1 | | Bulk qty. | 2500 |
| P2 | 1.9 | 2.1 | | | |
| R | 40 | | | | |
| T | 0.25 | 0.35 | | | |
| W | 15.7 | 16.3 | | | |

5 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 22-Apr-2013 | 1 | Initial release. |
| 20-May-2013 | 2 | Added <i>Figure 15</i> . |
| 17-Apr-2014 | 3 | Modified title and features Modified $V_{CES(\text{clamped})}$, $V_{(BR)ECS}$ and I_{GES} test conditions Modified <i>Figure 5</i> and <i>9</i> Updated <i>Section 4: Package information</i> Minor text changes |
| 04-Jun-2014 | 4 | Updated features in cover page. |
| 30-Jul-2015 | 5 | Text and formatting changes throughout document. Updated <i>Section 4: Package information</i> |
| 05-Oct-2016 | 6 | Updated <i>Figure 9: Transfer characteristics</i> . Minor text changes. |

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