

Trench gate field-stop IGBT, V series 600 V, 40 A very high speed

Datasheet - production data

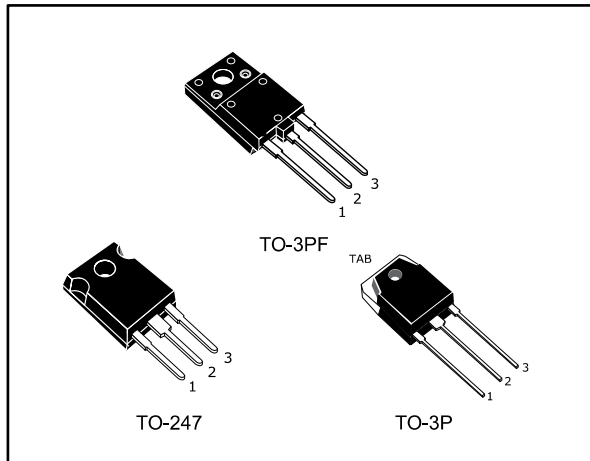
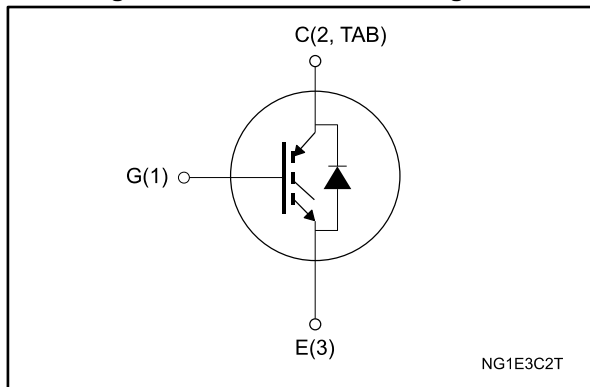


Figure 1: Internal schematic diagram



Features

- Maximum junction temperature: $T_J = 175\text{ }^\circ\text{C}$
- Tail-less switching off
- $V_{CE(sat)} = 1.8\text{ V (typ.) @ } I_c = 40\text{ A}$
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Very fast soft recovery antiparallel diode

Applications

- Photovoltaic inverters
- Uninterruptible power supply
- Welding
- Power factor correction
- Very high frequency converters

Description

This device is an IGBT developed using an advanced proprietary trench gate field-stop structure. The device is part of the V series IGBTs, which represent an optimum compromise between conduction and switching losses to maximize the efficiency of very high frequency converters. Furthermore, the positive $V_{CE(sat)}$ temperature coefficient and very tight parameter distribution result in safer paralleling operation.

Table 1: Device summary

| Order code | Marking | Package | Packing |
|--------------|------------|---------|---------|
| STGFW40V60DF | GFW40V60DF | TO-3PF | Tube |
| STGW40V60DF | GW40V60DF | TO-247 | Tube |
| STGWT40V60DF | GWT40V60DF | TO-3P | Tube |

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1 Electrical ratings

Table 2: Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|--------------------------------|---|-----------------|--------|------|
| | | TO-247 TO-3P | TO-3PF | |
| V _{CES} | Collector-emitter voltage (V _{GE} = 0 V) | 600 | | V |
| I _C | Continuous collector current at T _C = 25 °C | 80 | | A |
| | Continuous collector current at T _C = 100 °C | 40 | | A |
| I _{CP} ⁽¹⁾ | Pulsed collector current | 160 | | A |
| V _{GE} | Gate-emitter voltage | ±20 | | V |
| I _F | Continuous forward current at T _C = 25 °C | 80 | | A |
| | Continuous forward current at T _C = 100 °C | 40 | | A |
| I _{FP} ⁽¹⁾ | Pulsed forward current | 160 | | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 283 | 62.5 | W |
| V _{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t = 1 s, T _C = 25 °C) | 3.5 | | kV |
| T _{STG} | Storage temperature range | -55 to 150 | | °C |
| T _J | Operating junction temperature range | -55 to 175 | | °C |

Notes:

⁽¹⁾Pulse width is limited by maximum junction temperature.

Table 3: Thermal data

| Symbol | Parameter | Value | | Unit |
|-------------------|--|-----------------|--------|------|
| | | TO-247 TO-3P | TO-3PF | |
| R _{thJC} | Thermal resistance junction-case IGBT | 0.53 | 2.4 | °C/W |
| R _{thJC} | Thermal resistance junction-case diode | 1.14 | 2.6 | °C/W |
| R _{thJA} | Thermal resistance junction-ambient | 50 | | °C/W |

2 Electrical characteristics

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

Table 4: Static characteristics

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--------------------------------------|---|------|------|-----------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage | $V_{GE} = 0\text{ V}$, $I_C = 2\text{ mA}$ | 600 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$ | | 1.8 | 2.3 | V |
| | | $V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$, $T_J = 125\text{ °C}$ | | 2.15 | | |
| | | $V_{GE} = 15\text{ V}$, $I_C = 40\text{ A}$, $T_J = 175\text{ °C}$ | | 2.35 | | |
| V_F | Forward on-voltage | $I_F = 40\text{ A}$ | | 1.7 | 2.45 | V |
| | | $I_F = 40\text{ A}$, $T_J = 125\text{ °C}$ | | 1.4 | | |
| | | $I_F = 40\text{ A}$, $T_J = 175\text{ °C}$ | | 1.3 | | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE} = V_{GE}$, $I_C = 1\text{ mA}$ | 5 | 6 | 7 | V |
| I_{CES} | Collector cut-off current | $V_{GE} = 0\text{ V}$, $V_{CE} = 0\text{ V}$ | | | 25 | μA |
| I_{GES} | Gate-emitter leakage current | $V_{CE} = 0\text{ V}$, $V_{GE} = \pm 20\text{ V}$ | | | ± 250 | nA |

Table 5: Dynamic characteristics

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0\text{ V}$ | - | 5400 | - | pF |
| C_{oes} | Output capacitance | | - | 220 | - | pF |
| C_{res} | Reverse transfer capacitance | | - | 180 | - | pF |
| Q_g | Total gate charge | $V_{CC} = 480\text{ V}$, $I_C = 40\text{ A}$, $V_{GE} = 0\text{ to }15\text{ V}$ (see Figure 35: "Gate charge test circuit") | - | 226 | - | nC |
| Q_{ge} | Gate-emitter charge | | - | 38 | - | nC |
| Q_{gc} | Gate-collector charge | | - | 95 | - | nC |

Table 6: IGBT switching characteristics (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|---------------------------|--|------|------|------|------------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$ (see Figure 34: "Test circuit for inductive load switching") | - | 52 | - | ns |
| t_r | Current rise time | | - | 17 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1850 | - | A/ μ s |
| $t_{d(off)}$ | Turn-off delay time | | - | 208 | - | ns |
| t_f | Current fall time | | - | 20 | - | ns |
| $E_{on}^{(1)}$ | Turn-on switching energy | | - | 456 | - | μ J |
| $E_{off}^{(2)}$ | Turn-off switching energy | | - | 411 | - | μ J |
| E_{ts} | Total switching energy | | - | 867 | - | μ J |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE} = 400\text{ V}$, $I_C = 40\text{ A}$, $R_G = 10\ \Omega$, $V_{GE} = 15\text{ V}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 34: "Test circuit for inductive load switching") | - | 52 | - | ns |
| t_r | Current rise time | | - | 21 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | | - | 1538 | - | A/ μ s |
| $t_{d(off)}$ | Turn-off-delay time | | - | 220 | - | ns |
| t_f | Current fall time | | - | 21 | - | ns |
| $E_{on}^{(1)}$ | Turn-on switching energy | | - | 1330 | - | μ J |
| $E_{off}^{(2)}$ | Turn-off switching energy | | - | 560 | - | μ J |
| E_{ts} | Total switching energy | | - | 1890 | - | μ J |

Notes:

(1)Including the reverse recovery of the diode.

(2)Including the tail of the collector current.

Table 7: Diode switching characteristics (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|--|---|------|------|------|------------|
| t_{rr} | Reverse recovery time | $I_F = 40\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$ (see Figure 34: "Test circuit for inductive load switching") | - | 41 | - | ns |
| Q_{rr} | Reverse recovery charge | | - | 440 | - | nC |
| I_{rrm} | Reverse recovery current | | - | 21.6 | - | A |
| dl_{rr}/dt | Peak rate of fall of reverse recovery current during t_b | | - | 1363 | - | A/ μ s |
| E_{rr} | Reverse recovery energy | | - | 151 | - | μ J |
| t_{rr} | Reverse recovery time | $I_F = 40\text{ A}$, $V_R = 400\text{ V}$, $V_{GE} = 15\text{ V}$, $di/dt = 1000\text{ A}/\mu\text{s}$, $T_J = 175\text{ }^\circ\text{C}$ (see Figure 34: "Test circuit for inductive load switching") | - | 109 | - | ns |
| Q_{rr} | Reverse recovery charge | | - | 2400 | - | nC |
| I_{rrm} | Reverse recovery current | | - | 44.4 | - | A |
| dl_{rr}/dt | Peak rate of fall of reverse recovery current during t_b | | - | 670 | - | A/ μ s |
| E_{rr} | Reverse recovery energy | | - | 718 | - | μ J |

2.1 Electrical characteristics curves

Figure 2: Power dissipation vs case temperature for TO-247 and TO-3P

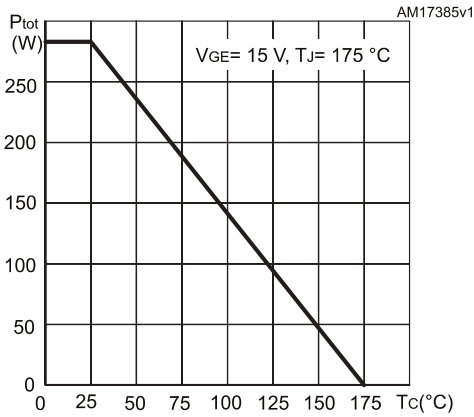


Figure 3: Collector current vs case temperature for TO-247 and TO-3P

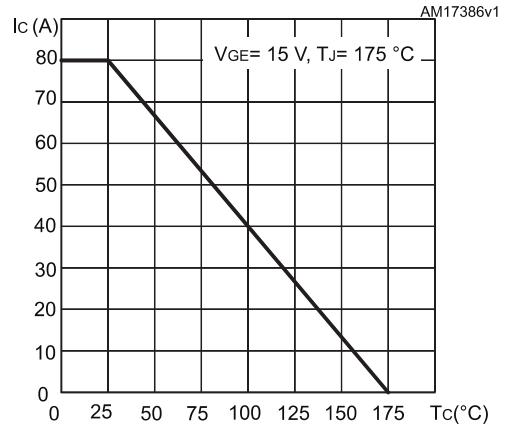


Figure 4: Power dissipation vs case temperature for TO-3PF

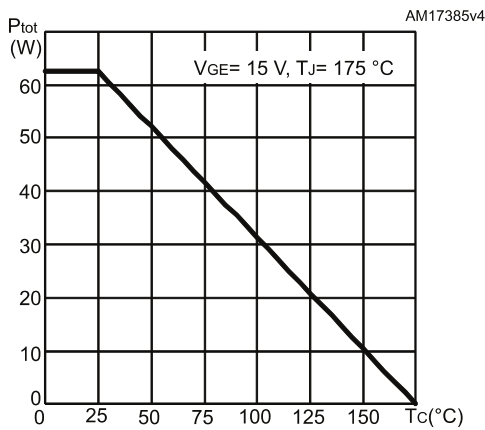


Figure 5: Collector current vs case temperature for TO-3PF

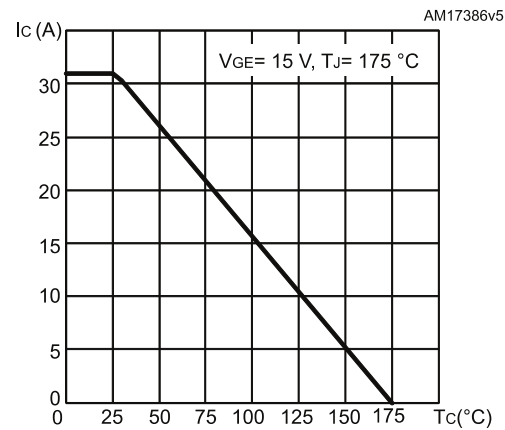


Figure 6: Output characteristics (Tj = 25 °C)

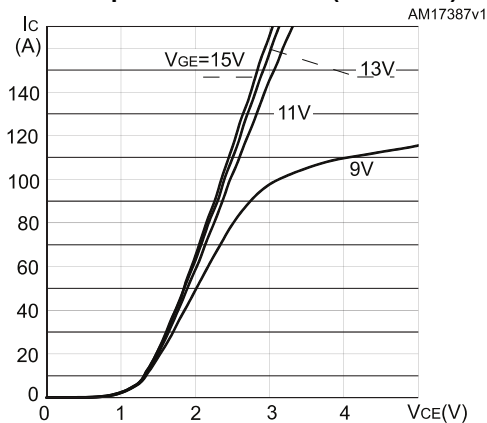
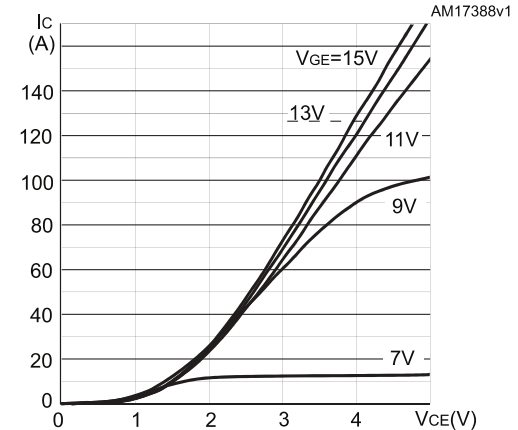
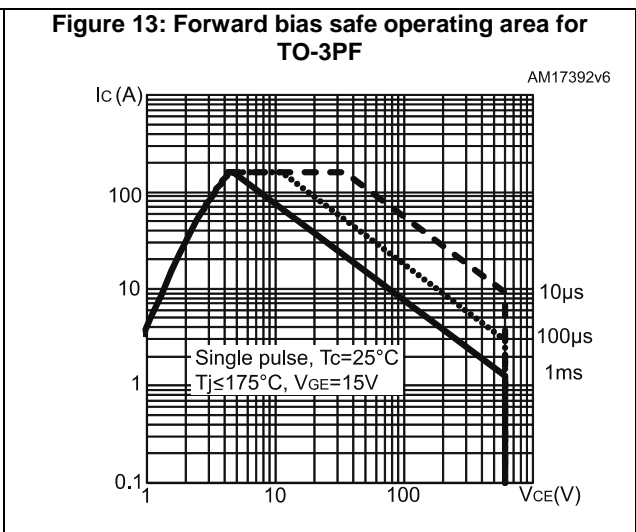
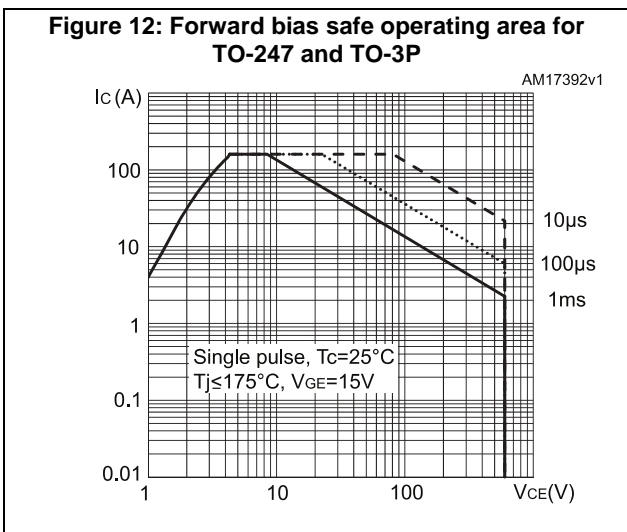
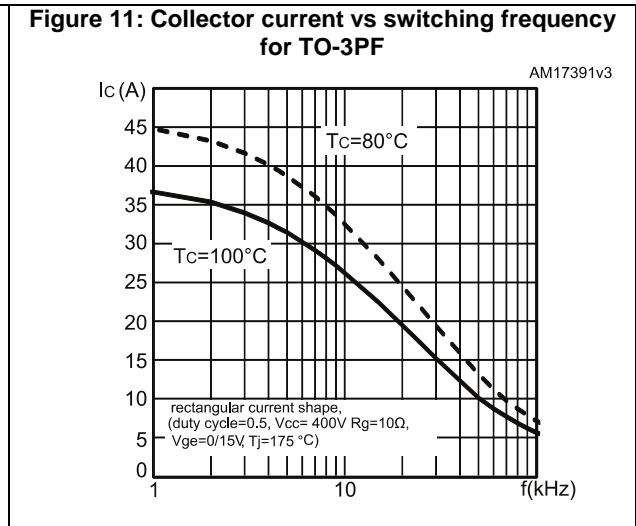
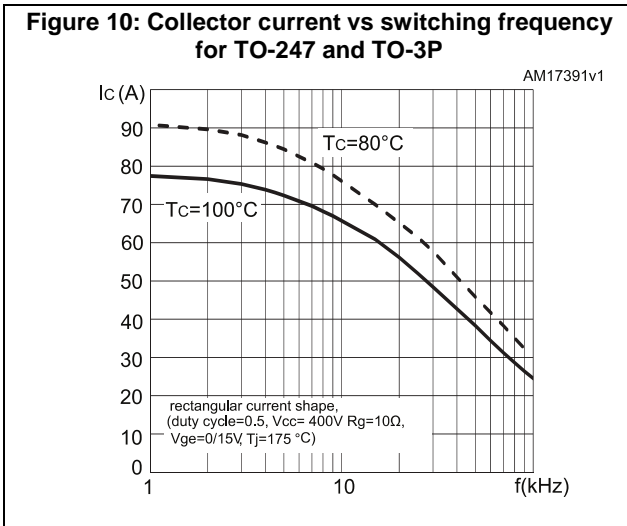
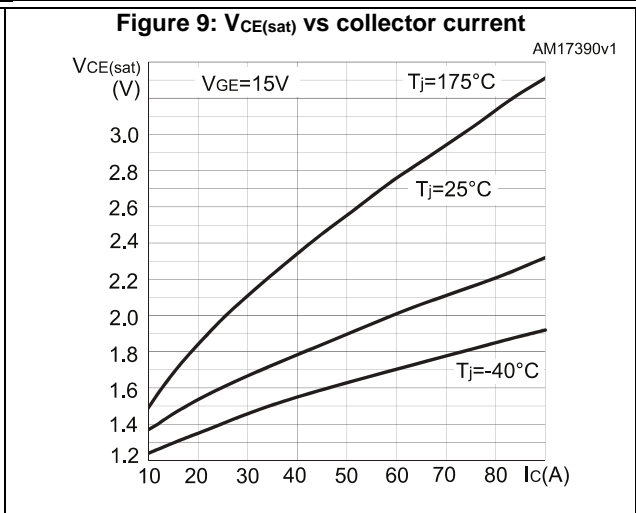
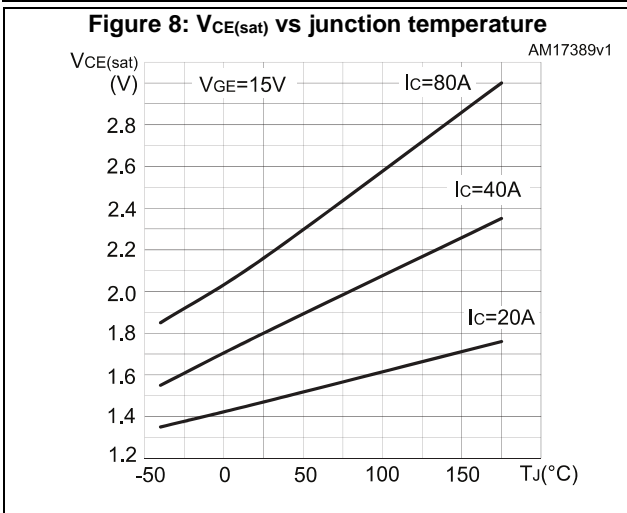
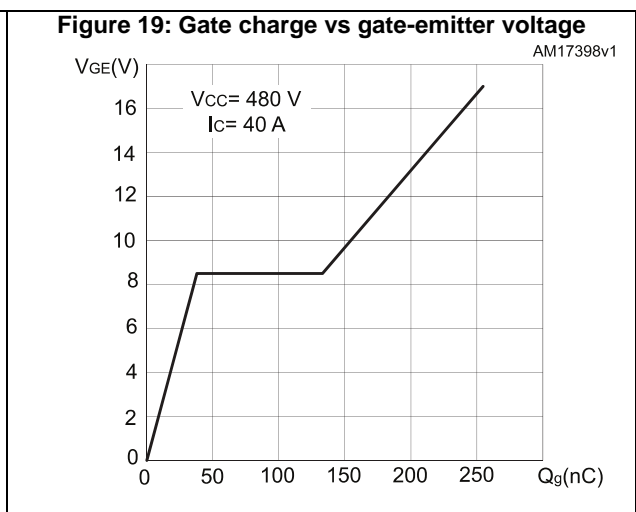
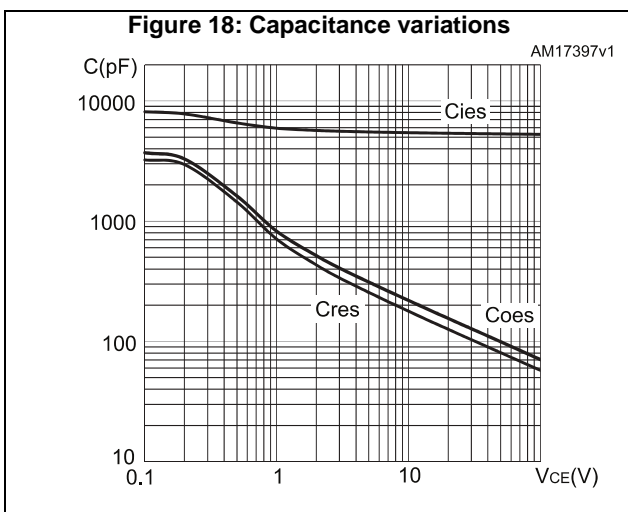
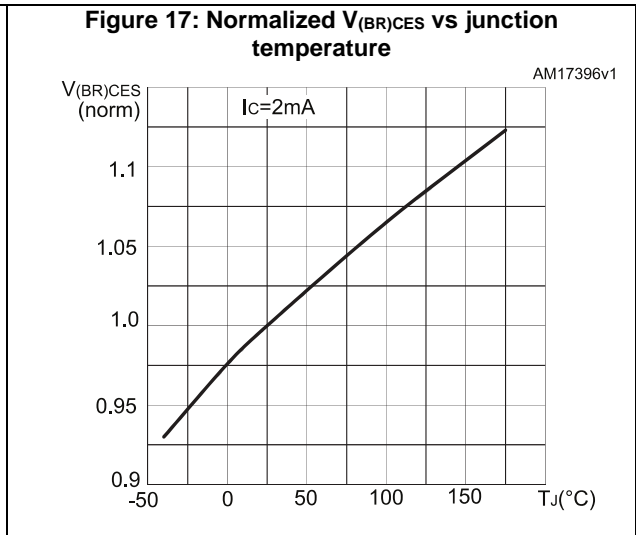
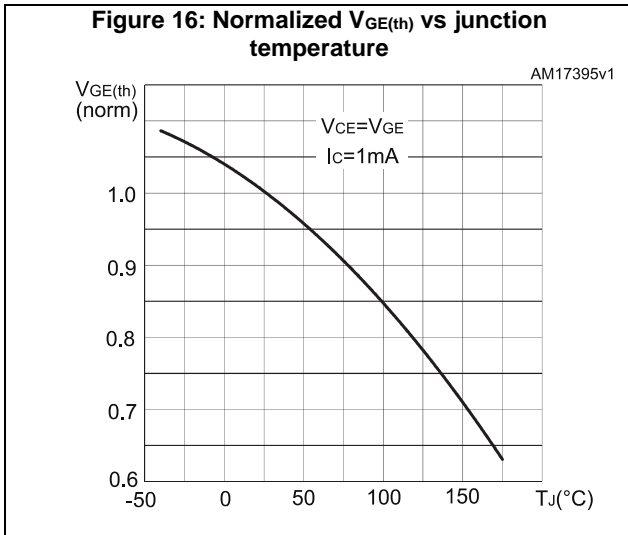
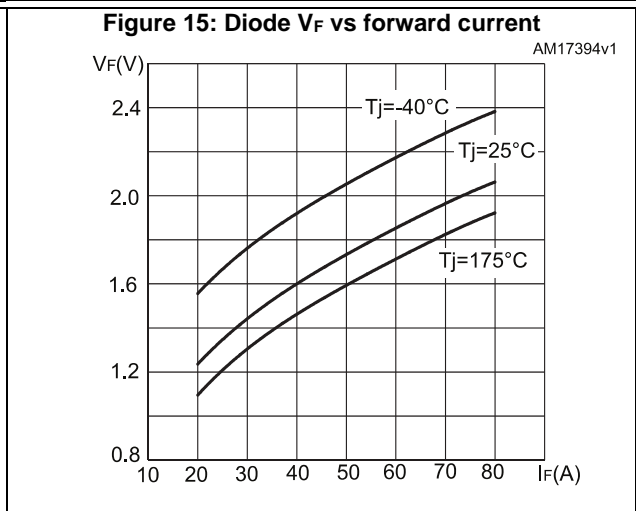
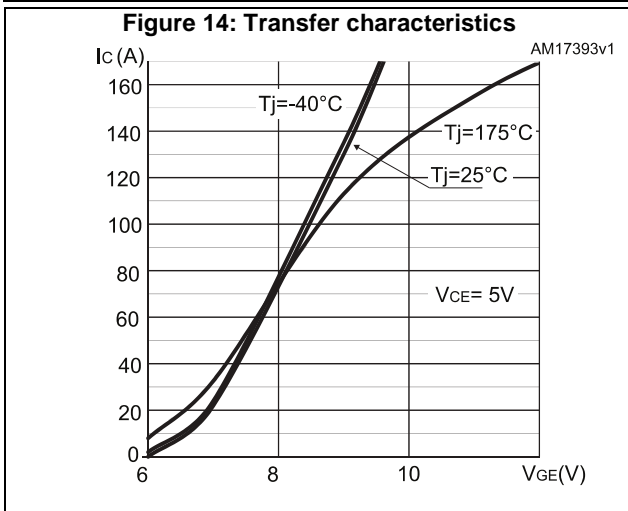


Figure 7: Output characteristics (Tj = 175 °C)







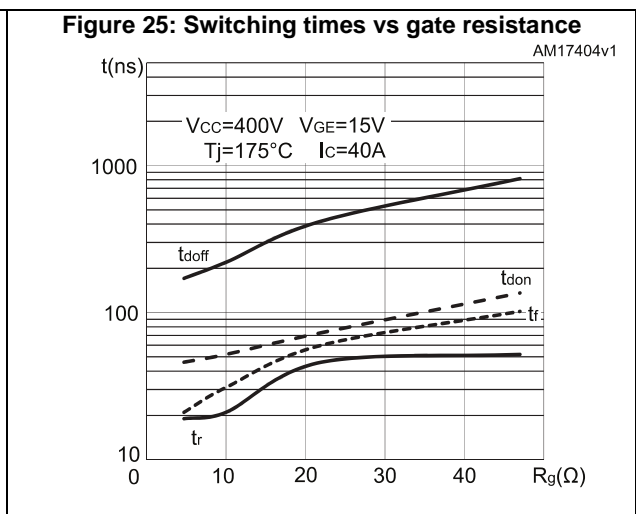
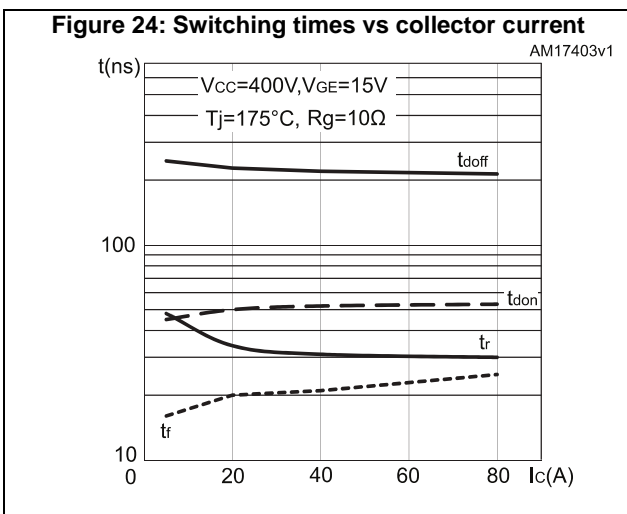
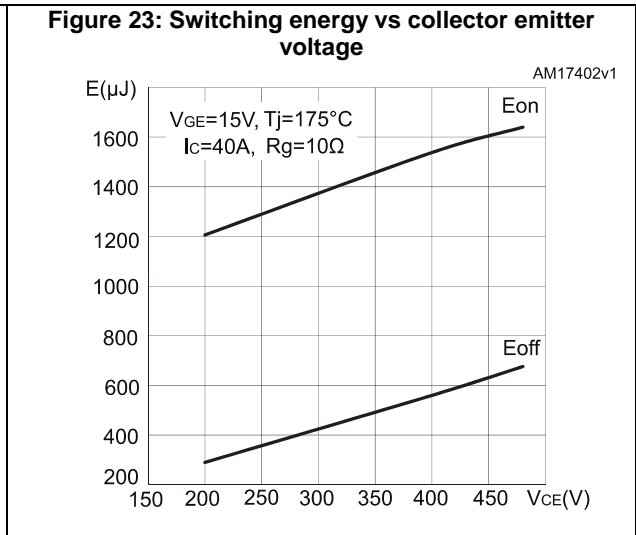
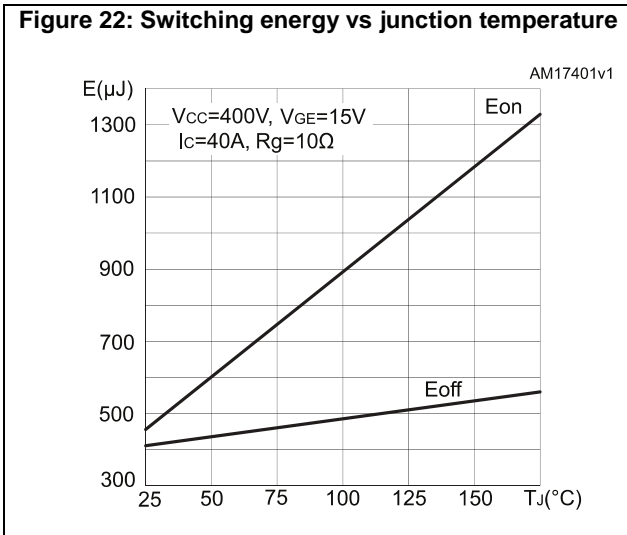
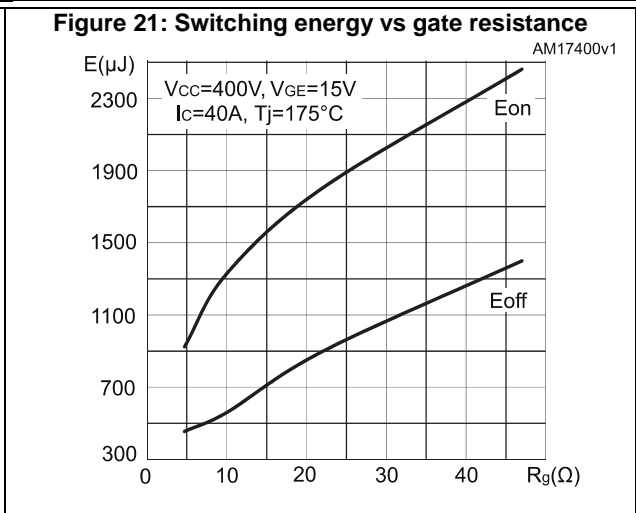
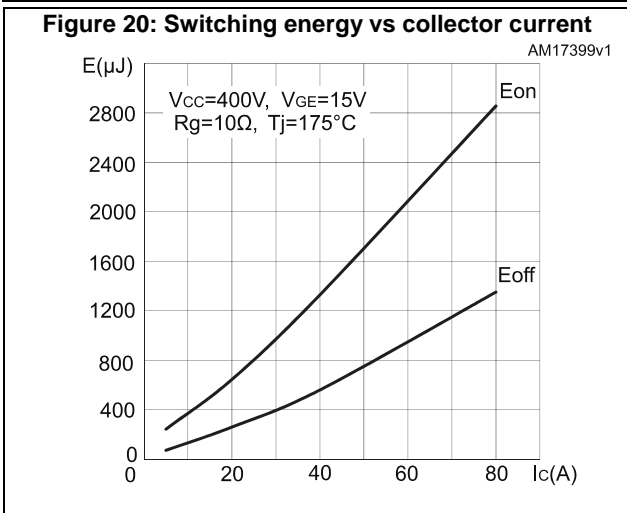


Figure 26: Reverse recovery current vs diode current slope

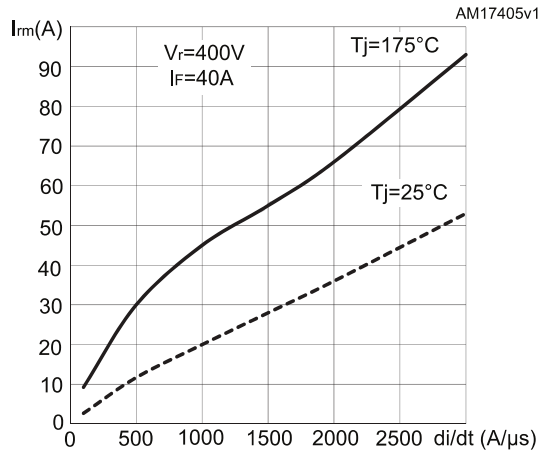


Figure 27: Reverse recovery time vs diode current slope

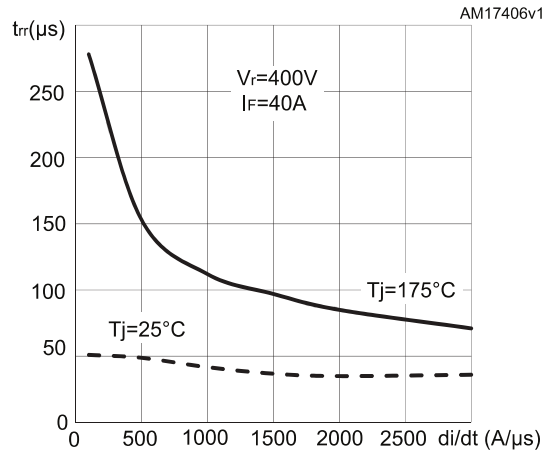


Figure 28: Reverse recovery charge vs diode current slope

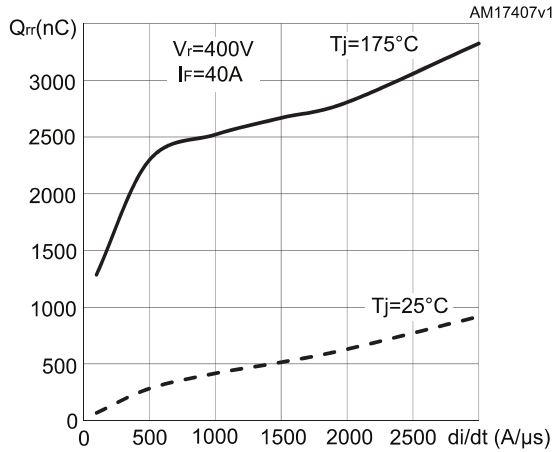


Figure 29: Reverse recovery energy vs diode current slope

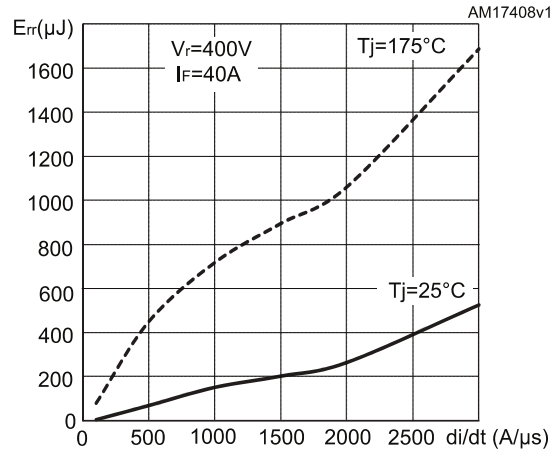


Figure 30: Thermal impedance for IGBT in TO-247 and TO-3P

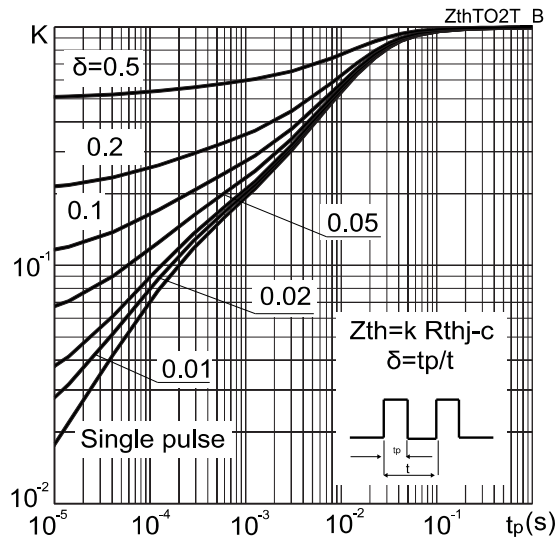


Figure 31: Thermal impedance for IGBT in TO-3PF

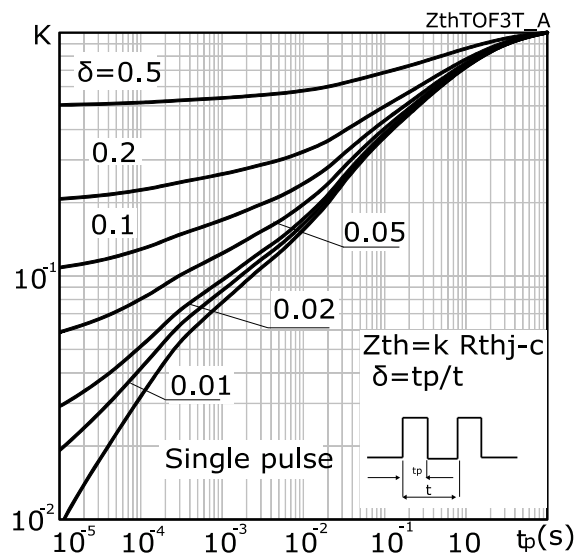


Figure 32: Thermal impedance for diode in TO-247 and TO-3P

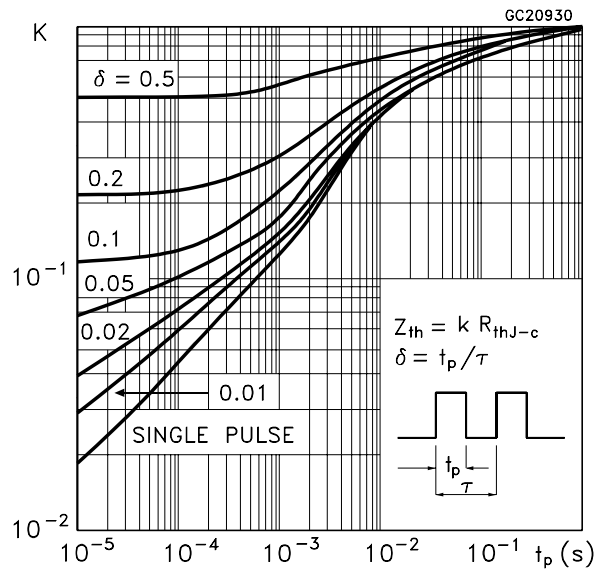
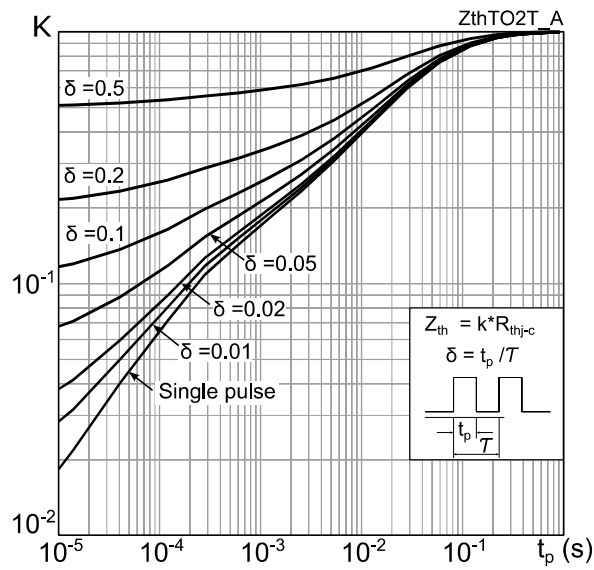
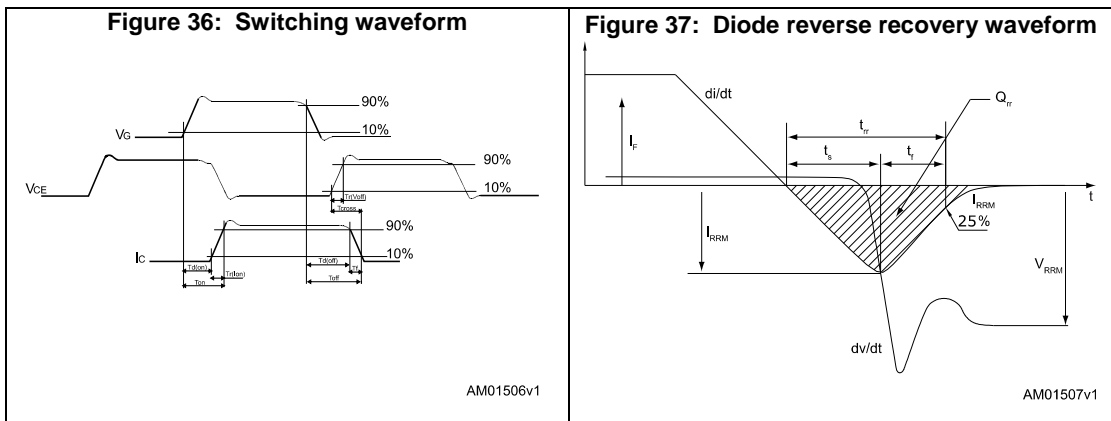
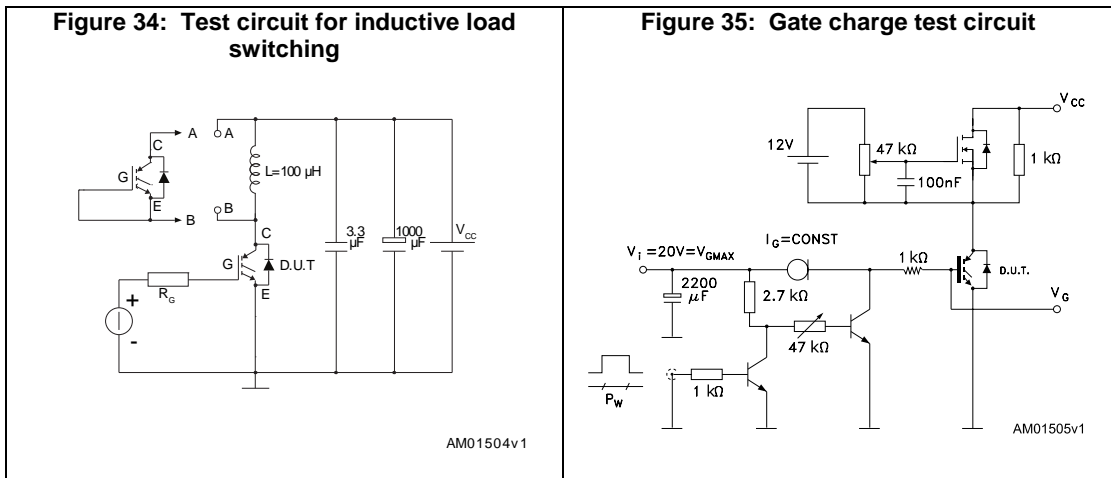


Figure 33: Thermal impedance for diode in TO-3PF



3 Test circuits

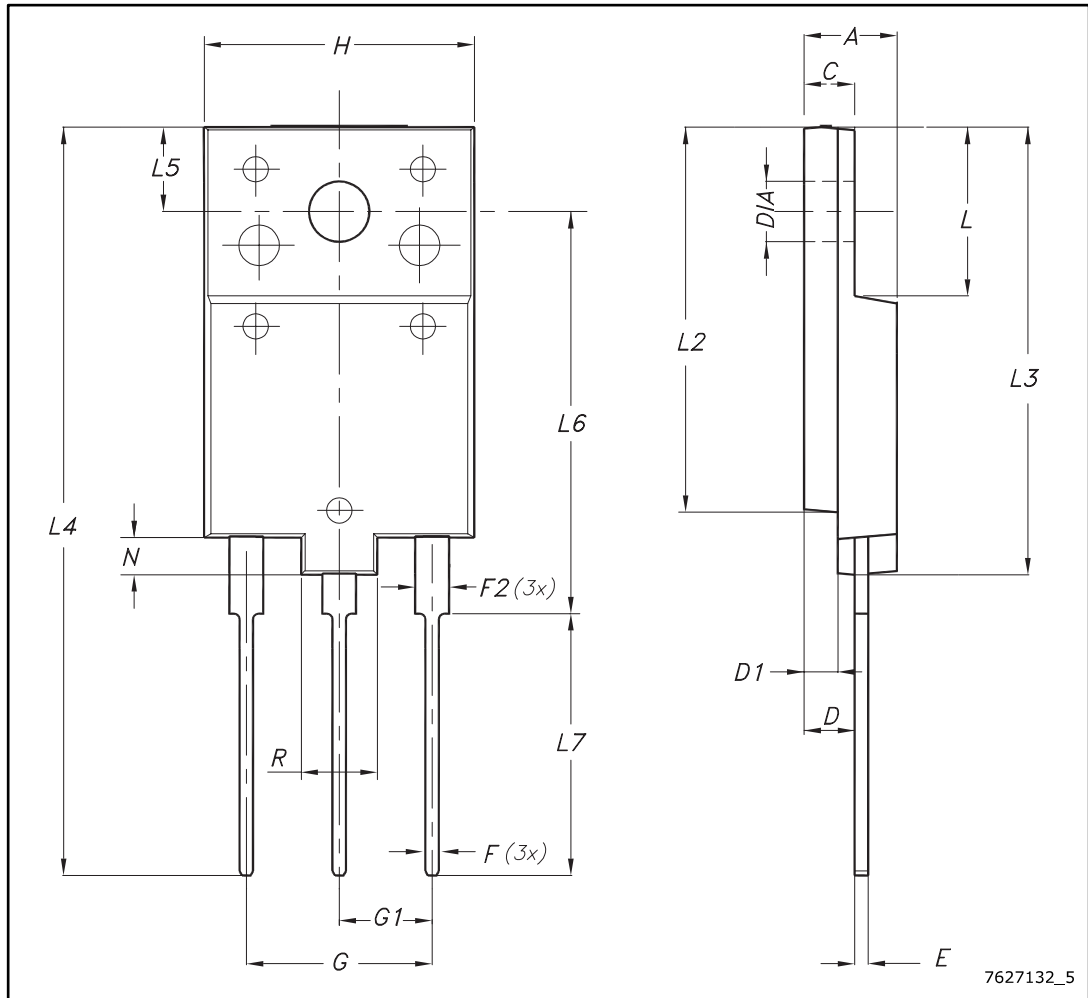


4 Package information

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 TO-3PF package information

Figure 38: TO-3PF package outline



7627132_5

Table 8: TO-3PF mechanical data

| Dim. | mm | | |
|------|-------|------|-------|
| | Min. | Typ. | Max. |
| A | 5.30 | | 5.70 |
| C | 2.80 | | 3.20 |
| D | 3.10 | | 3.50 |
| D1 | 1.80 | | 2.20 |
| E | 0.80 | | 1.10 |
| F | 0.65 | | 0.95 |
| F2 | 1.80 | | 2.20 |
| G | 10.30 | | 11.50 |
| G1 | | 5.45 | |
| H | 15.30 | | 15.70 |
| L | 9.80 | 10 | 10.20 |
| L2 | 22.80 | | 23.20 |
| L3 | 26.30 | | 26.70 |
| L4 | 43.20 | | 44.40 |
| L5 | 4.30 | | 4.70 |
| L6 | 24.30 | | 24.70 |
| L7 | 14.60 | | 15 |
| N | 1.80 | | 2.20 |
| R | 3.80 | | 4.20 |
| Dia | 3.40 | | 3.80 |

4.2 TO-247 package information

Figure 39: TO-247 package outline

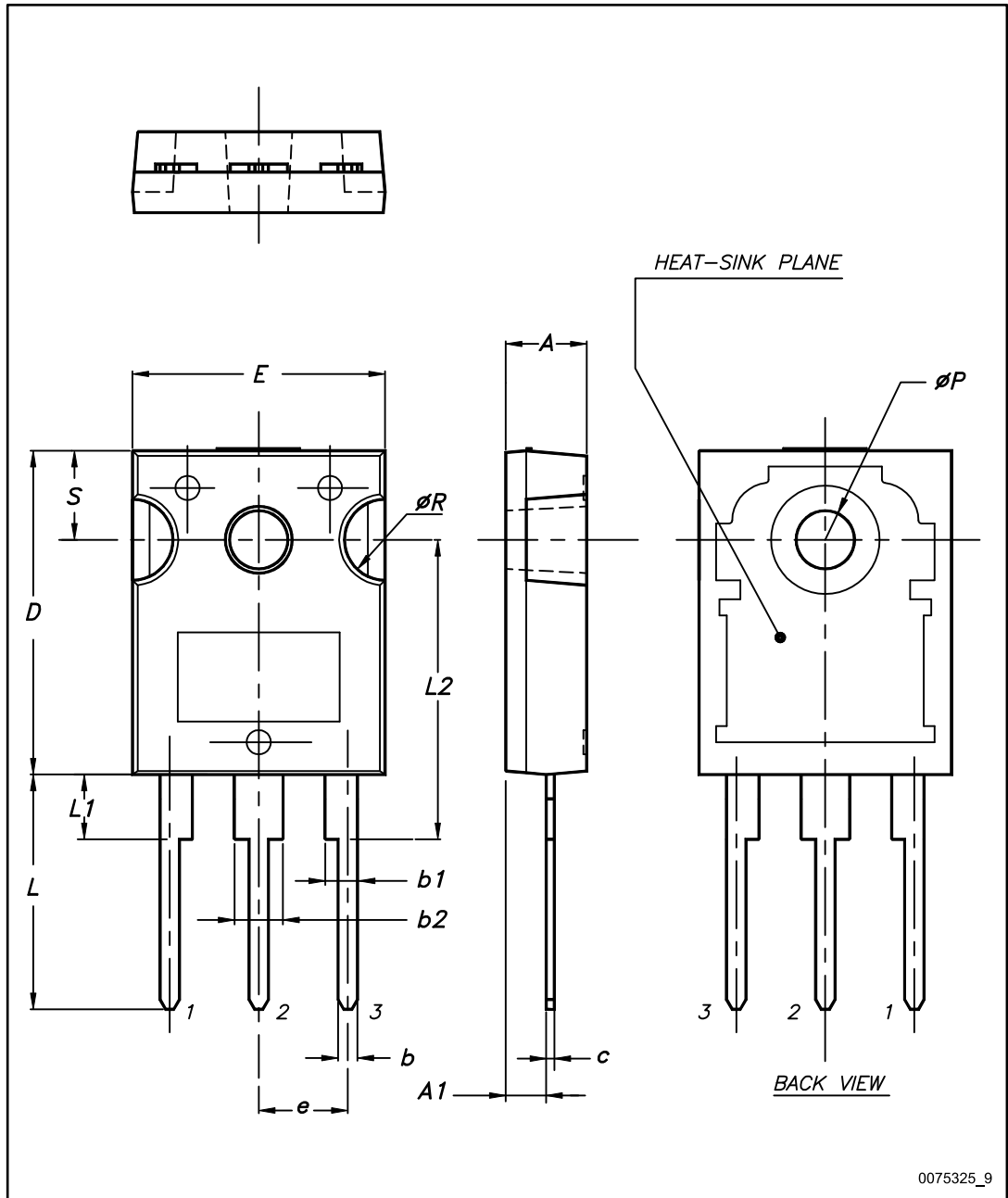


Table 9: TO-247 package mechanical data

| 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 |

4.3 TO-3P package information

Figure 40: TO-3P package outline



Table 10: TO-3P package mechanical data

| Dim. | mm | | |
|------|-------|-------|-------|
| | Min. | Typ. | Max. |
| A | 4.60 | 4.80 | 5.00 |
| A1 | 1.45 | 1.50 | 1.65 |
| A2 | 1.20 | 1.40 | 1.60 |
| b | 0.80 | 1.00 | 1.20 |
| b1 | 1.80 | 2.00 | 2.20 |
| b2 | 2.80 | 3.00 | 3.20 |
| c | 0.55 | 0.60 | 0.75 |
| D | 19.70 | 19.90 | 20.10 |
| D1 | 13.70 | 13.90 | 14.10 |
| E | 15.40 | 15.60 | 15.80 |
| E1 | 13.40 | 13.60 | 13.80 |
| E2 | 9.40 | 9.60 | 9.90 |
| e | 5.15 | 5.45 | 5.75 |
| L | 19.80 | 20.00 | 20.20 |
| L1 | 3.30 | 3.50 | 3.70 |
| L2 | 18.20 | 18.40 | 18.60 |
| ØP | 3.30 | 3.40 | 3.50 |
| ØP1 | 3.10 | 3.20 | 3.30 |
| Q | 4.80 | 5.00 | 5.20 |
| Q1 | 3.60 | 3.80 | 4 |

5 Revision history

Table 11: Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 20-Mar-2013 | 1 | Initial release |
| 17-Apr-2013 | 2 | Document status promoted from preliminary data to production data. Added: <i>Section 2.1: Electrical characteristics (curves)</i> |
| 04-Jun-2013 | 3 | Added minimum and maximum values for $V_{GE(th)}$ in <i>Table 4: Static characteristics</i> . |
| 11-Sep-2013 | 4 | Updated V_F value in <i>Table 4: Static characteristics</i> . |
| 08-Oct-2013 | 5 | Updated title, features and description in cover page. |
| 10-Jan-2014 | 6 | Updated <i>Figure 8: $V_{CE(sat)}$ vs. junction temperature</i> , <i>Figure 15: Diode V_F vs. forward current</i> and <i>Figure 16: Normalized $V_{GE(th)}$ vs junction temperature</i> . |
| 03-Mar-2014 | 7 | Updated test conditions in <i>Table 7: Diode switching characteristics (inductive load)</i> . |
| 23-Apr-2014 | 8 | Added new device in TO-3PF. Updated <i>Table 1: Device summary</i> , <i>Table 2: Absolute maximum ratings</i> , <i>Table 3: Thermal data</i> and <i>Section 4: Package mechanical data</i> . Added <i>Figure 4: Power dissipation vs. case temperature for TO-3PF</i> , <i>Figure 5: Collector current vs. case temperature for TO-3PF</i> , <i>Figure 11: Collector current vs. switching frequency for TO-3PF</i> and <i>Figure 12: Forward bias safe operating area for TO-247 and TO-3P</i> . Minor text changes. |
| 27-Oct-2017 | 9 | Updated <i>Table 3: "Thermal data"</i> . Added <i>Figure 33: "Thermal impedance for diode in TO-3PF"</i> . Updated <i>Section 4: "Package information"</i> . Minor text changes |

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