# STGFW40V60DF, STGW40V60DF, STGWT40V60DF

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

Datasheet - production data

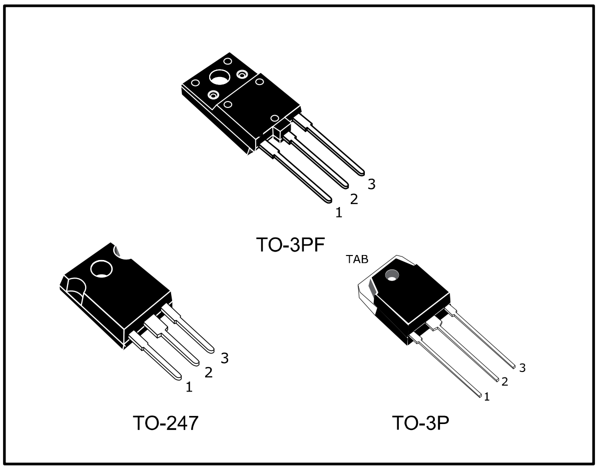
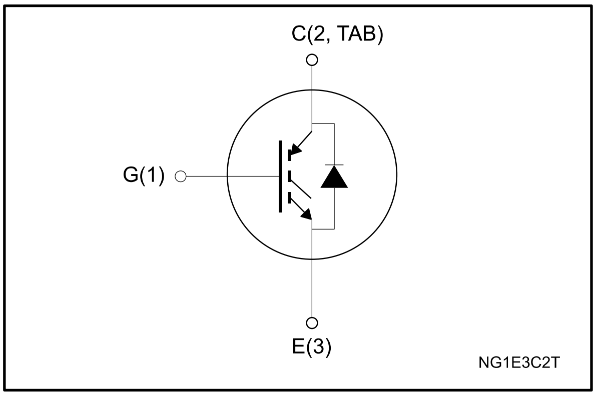


**Figure 1: Internal schematic diagram**



## Features

- Maximum junction temperature: $T_J$ = 175 °C
- Tail-less switching off
- $V_{CE(sat)}$ = 1.8 V (typ.) @ $I_C$ = 40 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 |

This is information on a product in full production.

# Contents

# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | TO-247<br>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<br>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 °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 V, $I_C$ = 2 mA | 600 | | | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE}$ = 15 V, $I_C$ = 40 A | | 1.8 | 2.3 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 40 A, $T_J$ = 125 °C | | 2.15 | | |
| | | $V_{GE}$ = 15 V, $I_C$ = 40 A, $T_J$ = 175 °C | | 2.35 | | |
| $V_F$ | Forward on-voltage | $I_F$ = 40 A | | 1.7 | 2.45 | V |
| | | $I_F$ = 40 A, $T_J$ = 125 °C | | 1.4 | | |
| | | $I_F$ = 40 A, $T_J$ = 175 °C | | 1.3 | | |
| $V_{GE(th)}$ | Gate threshold voltage | $V_{CE}$ = $V_{GE}$, $I_C$ = 1 mA | 5 | 6 | 7 | V |
| $I_{CES}$ | Collector cut-off current | $V_{GE}$ = 0 V, $V_{CE}$ = 0 V | | | 25 | µA |
| $I_{GES}$ | Gate-emitter leakage current | $V_{CE}$ = 0 V, $V_{GE}$ = ±20 V | | | ±250 | nA |

**Table 5: 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 | - | 5400 | - | pF |
| $C_{oes}$ | Output capacitance | | - | 220 | - | pF |
| $C_{res}$ | Reverse transfer capacitance | | - | 180 | - | pF |
| $Q_g$ | Total gate charge | $V_{CC}$ = 480 V, $I_C$ = 40 A, $V_{GE}$ = 0 to 15 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 V, $I_C$ = 40 A, $R_G$ = 10 Ω, $V_{GE}$ = 15 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/µs |
| $t_{d(off)}$ | Turn-off delay time | | - | 208 | - | ns |
| $t_f$ | Current fall time | | - | 20 | - | ns |
| $E_{on}$(1) | Turn-on switching energy | | - | 456 | - | µJ |
| $E_{off}$(2) | Turn-off switching energy | | - | 411 | - | µJ |
| $E_{ts}$ | Total switching energy | | - | 867 | - | µJ |
| $t_{d(on)}$ | Turn-on delay time | $V_{CE}$ = 400 V, $I_C$ = 40 A, $R_G$ = 10 Ω, $V_{GE}$ = 15 V, $T_J$ = 175 °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/µs |
| $t_{d(off)}$ | Turn-off-delay time | | - | 220 | - | ns |
| $t_f$ | Current fall time | | - | 21 | - | ns |
| $E_{on}$(1) | Turn-on switching energy | | - | 1330 | - | µJ |
| $E_{off}$(2) | Turn-off switching energy | | - | 560 | - | µJ |
| $E_{ts}$ | Total switching energy | | - | 1890 | - | µJ |

**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 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 1000 A/µs (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 |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 1363 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 151 | - | µJ |
| $t_{rr}$ | Reverse recovery time | $I_F$ = 40 A, $V_R$ = 400 V, $V_{GE}$ = 15 V, di/dt = 1000 A/µs, $T_J$ = 175 °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 |
| $dI_{rr}/dt$ | Peak rate of fall of reverse recovery current during $t_b$ | | - | 670 | - | A/µs |
| $E_{rr}$ | Reverse recovery energy | | - | 718 | - | µJ |

## 2.1 Electrical characteristics curves

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

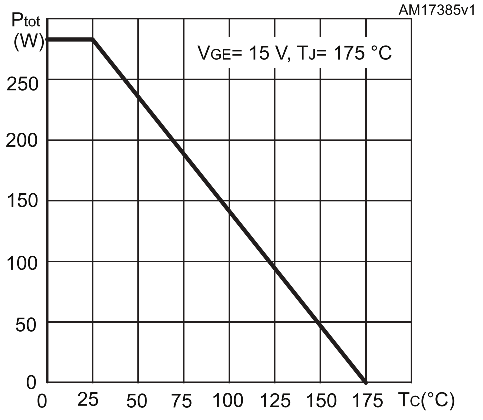


Figure 3: Collector current vs case temperature for TO-247 and TO-3P

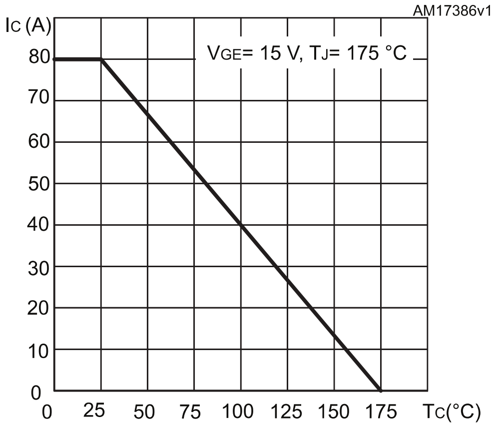


Figure 4: Power dissipation vs case temperature for TO-3PF

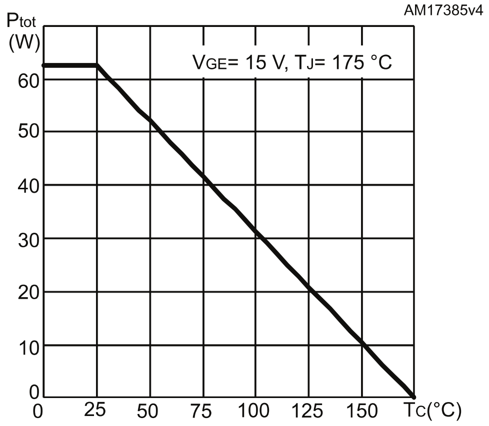


Figure 5: Collector current vs case temperature for TO-3PF

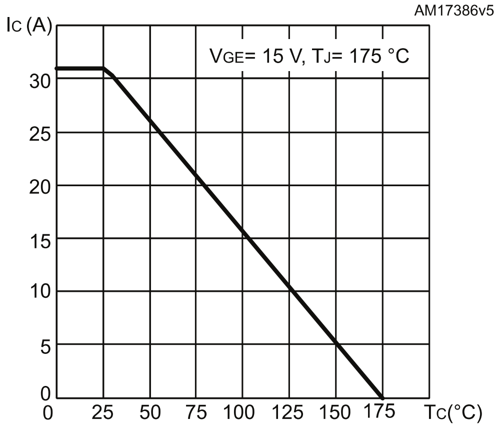


Figure 6: Output characteristics ($T_J$ = 25 °C)

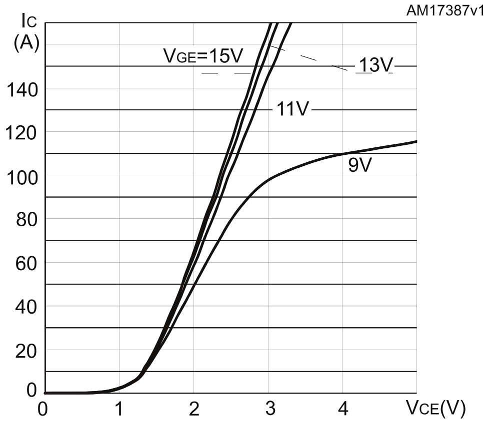


Figure 7: Output characteristics ($T_J$ = 175 °C)

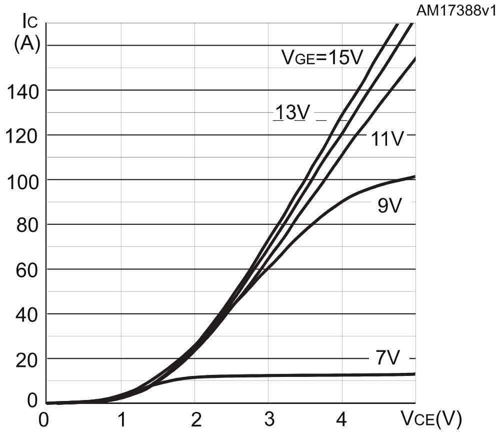


**Figure 8: $V_{CE(sat)}$ vs junction temperature**

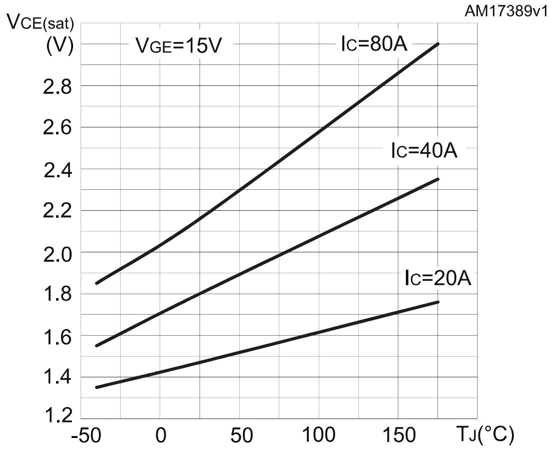


**Figure 9: $V_{CE(sat)}$ vs collector current**

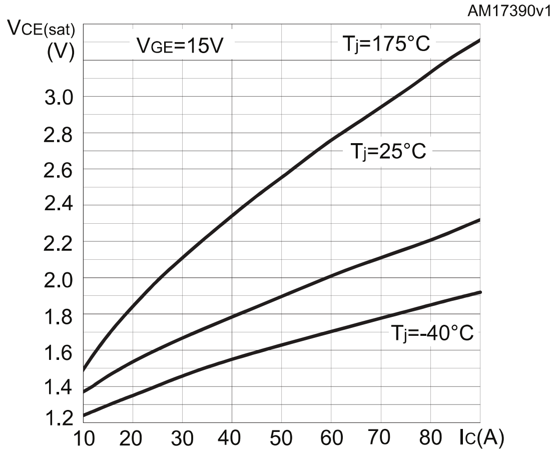


**Figure 10: Collector current vs switching frequency for TO-247 and TO-3P**

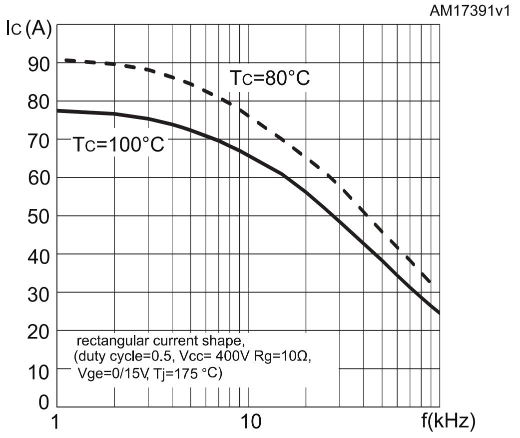


**Figure 11: Collector current vs switching frequency for TO-3PF**

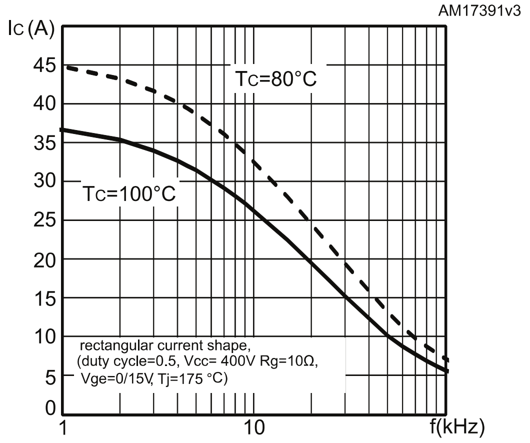


**Figure 12: Forward bias safe operating area for TO-247 and TO-3P**

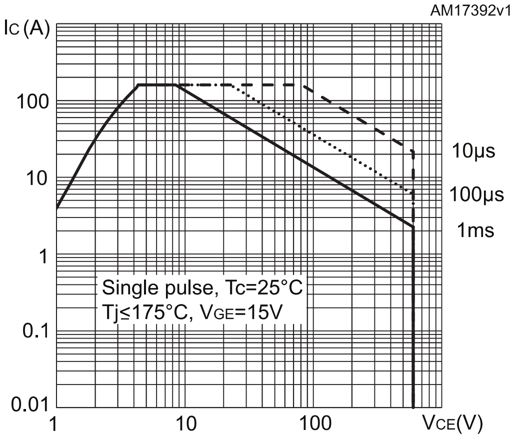


**Figure 13: Forward bias safe operating area for TO-3PF**

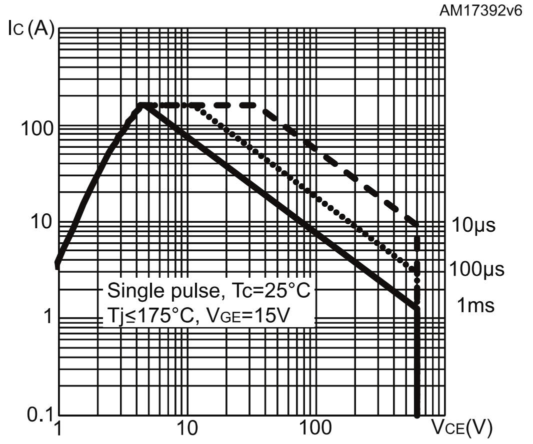


**Figure 14: Transfer characteristics**

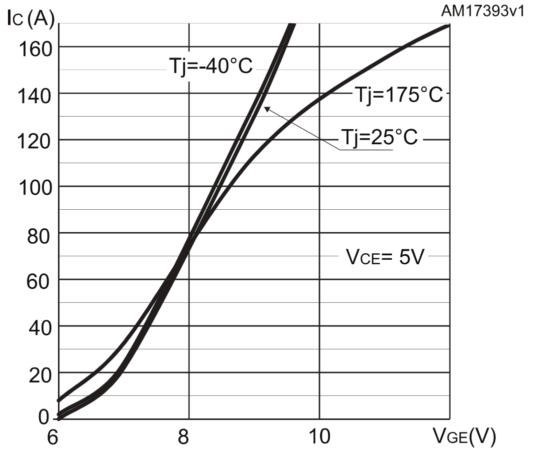


**Figure 15: Diode $V_F$ vs forward current**

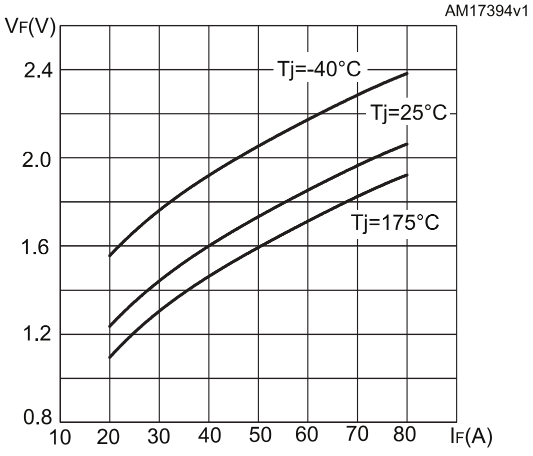


**Figure 16: Normalized $V_{GE(th)}$ vs junction temperature**

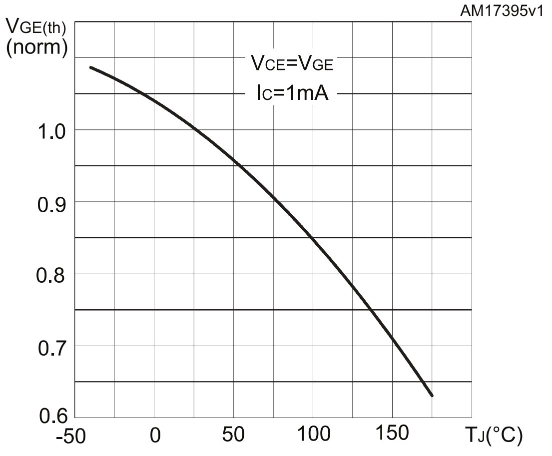


**Figure 17: Normalized $V_{(BR)CES}$ vs junction temperature**

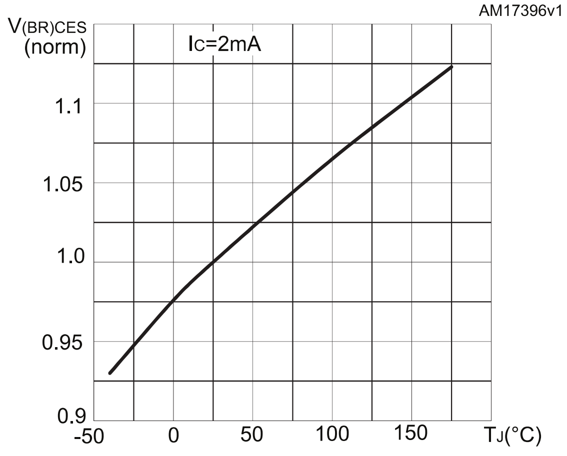


**Figure 18: Capacitance variations**

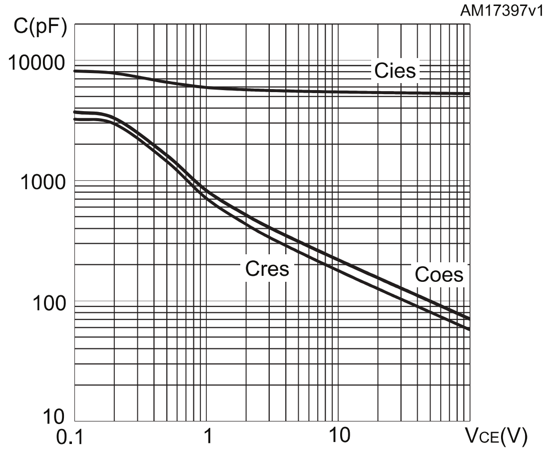


**Figure 19: Gate charge vs gate-emitter voltage**

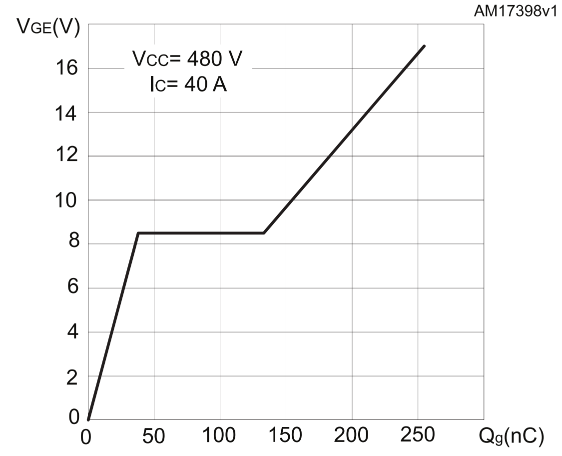


**Figure 20: Switching energy vs collector current**

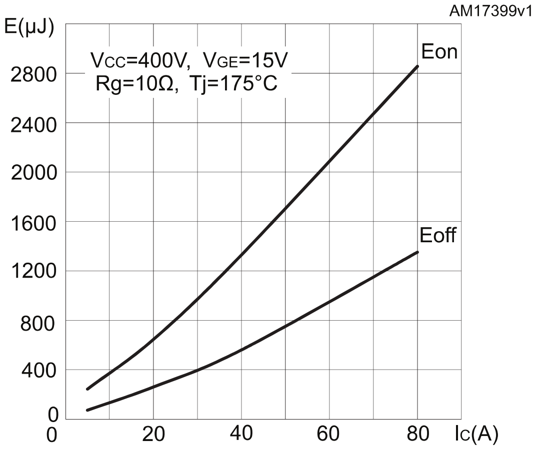


**Figure 21: Switching energy vs gate resistance**

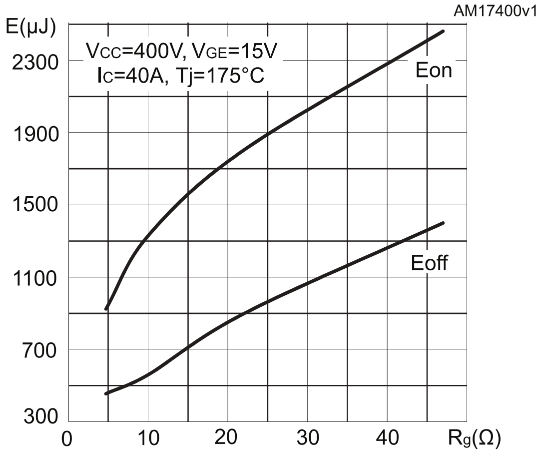


**Figure 22: Switching energy vs junction temperature**

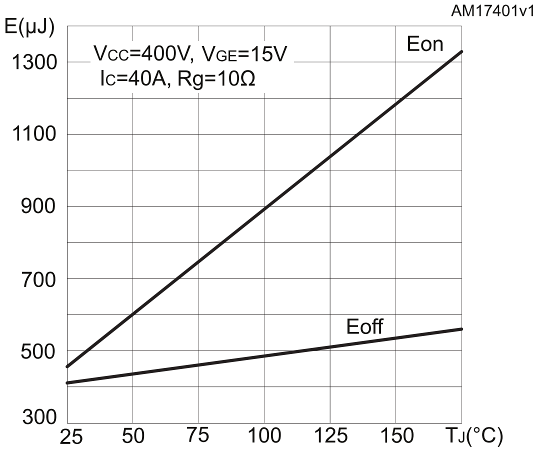


**Figure 23: Switching energy vs collector emitter voltage**

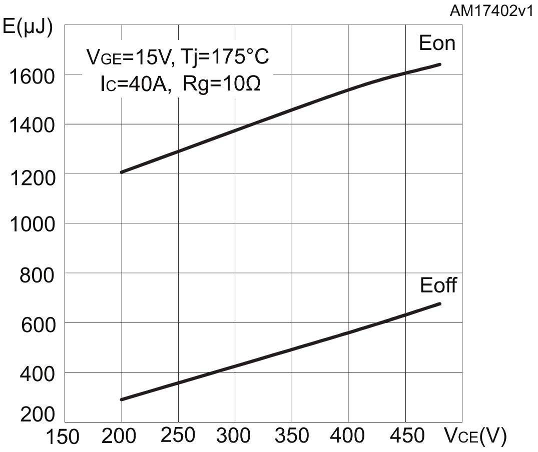


**Figure 24: Switching times vs collector current**

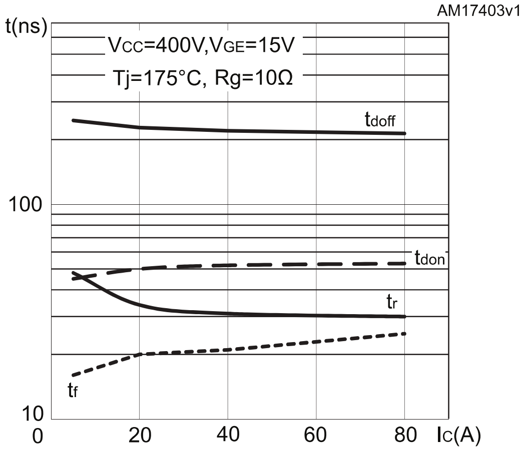
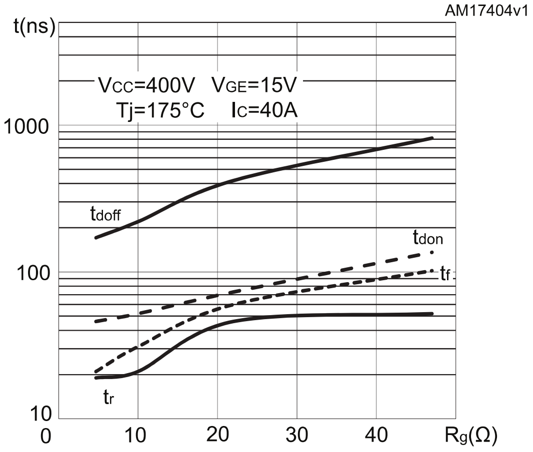
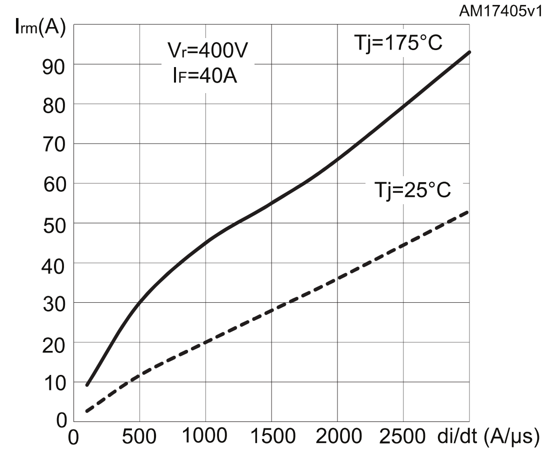


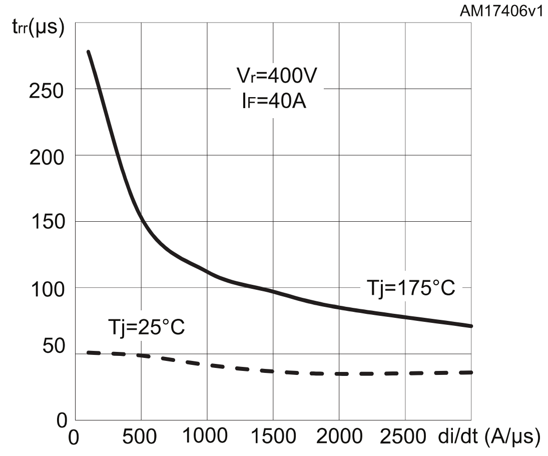
**Figure 25: Switching times vs gate resistance**



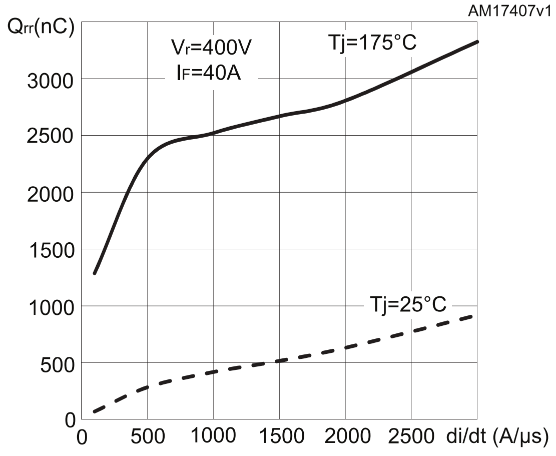
### Figure 26: Reverse recovery current vs diode current slope



### 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

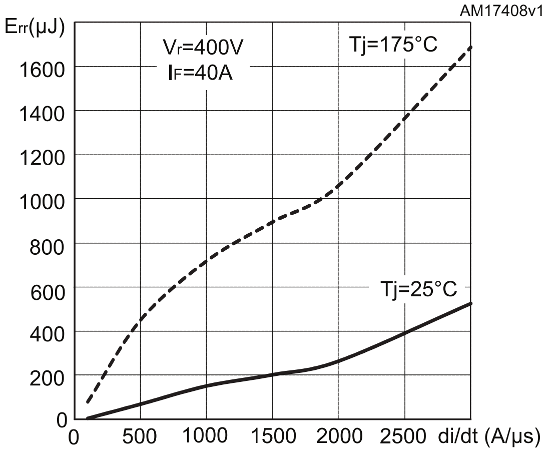


Figure 30: Thermal impedance for IGBT in TO-247 and TO-3P

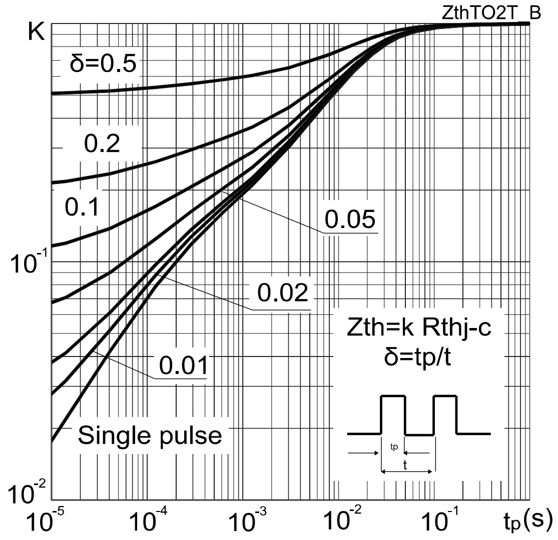


Figure 31: Thermal impedance for IGBT in TO-3PF

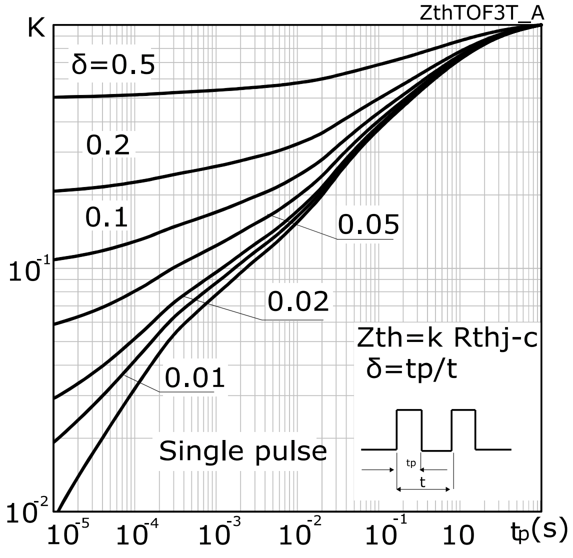


Figure 32: Thermal impedance for diode in TO-247 and TO-3P

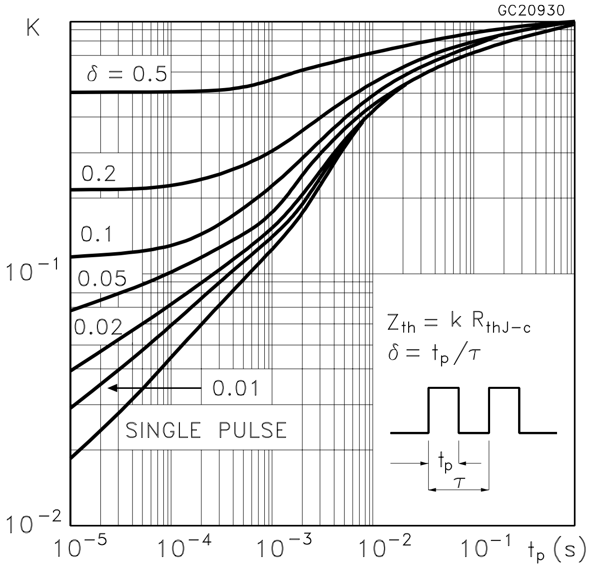
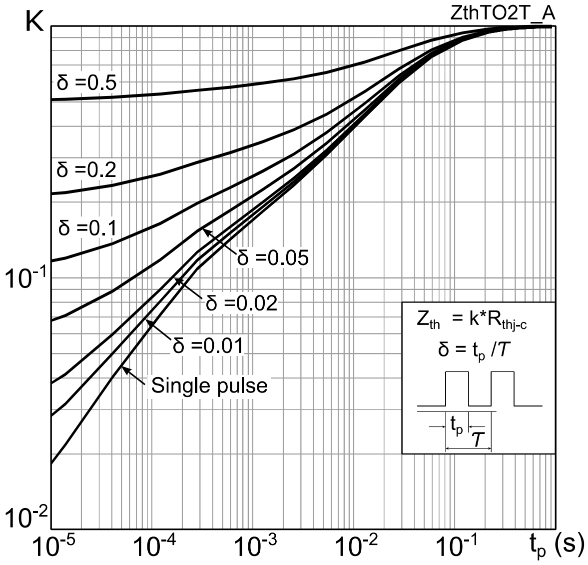


Figure 33: Thermal impedance for diode in TO-3PF



# 3 Test circuits

**Figure 34: Test circuit for inductive load switching**

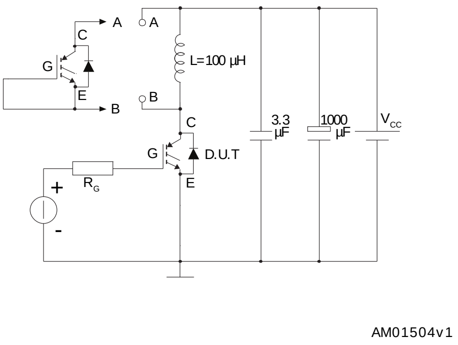


**Figure 35: Gate charge test circuit**

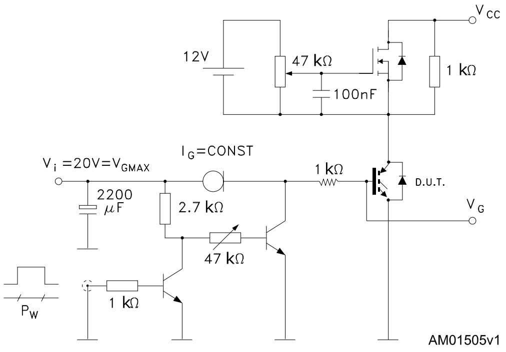


**Figure 36: Switching waveform**

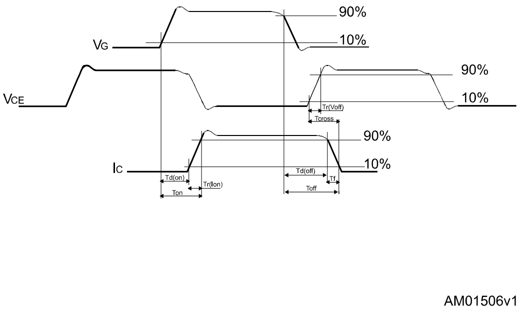
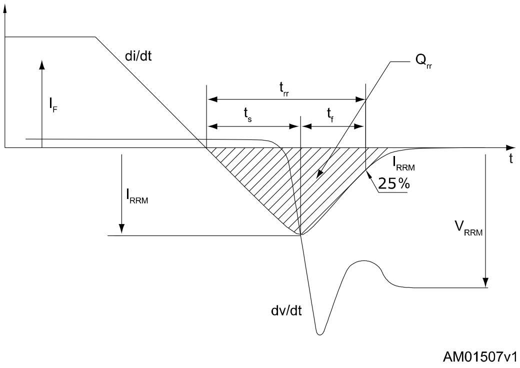


**Figure 37: Diode reverse recovery waveform**



# 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 TO-3PF package information

**Figure 38: TO-3PF package outline**

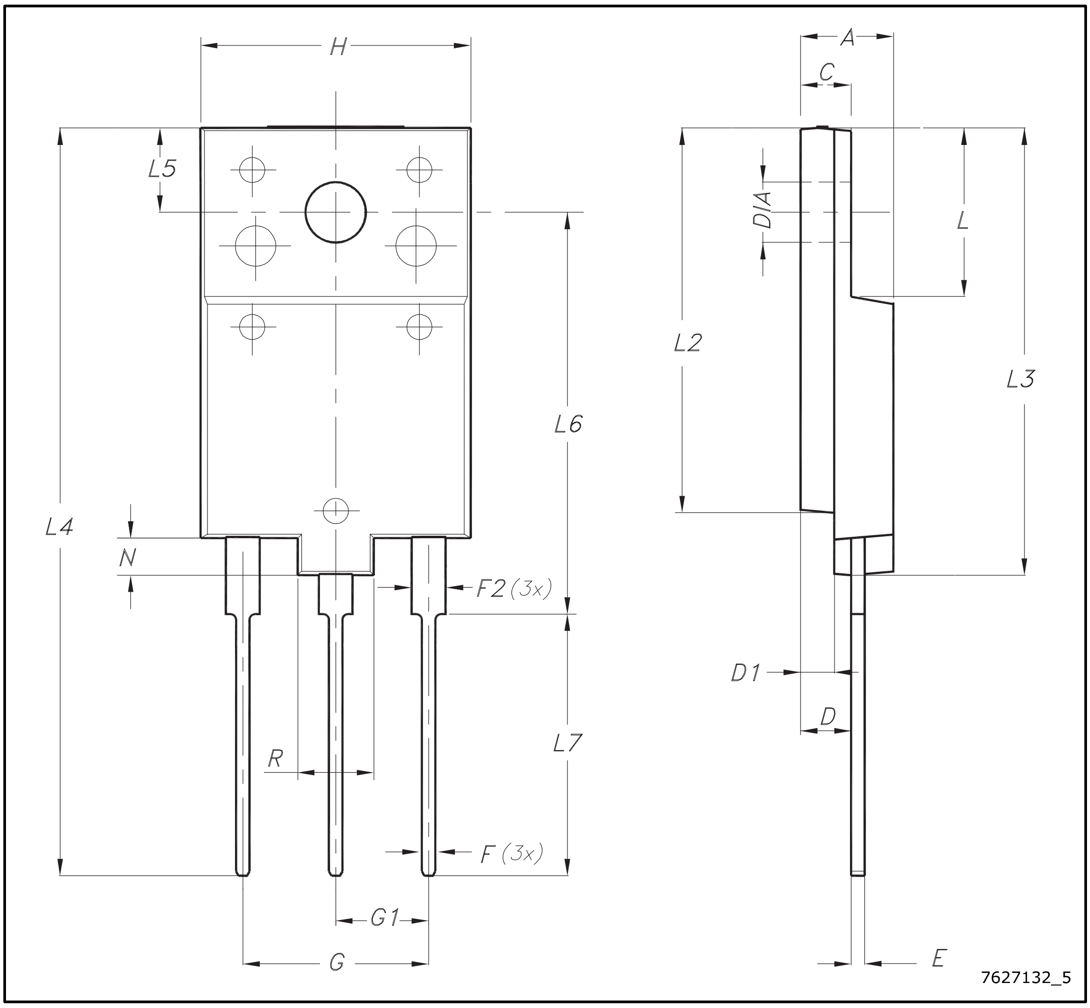


Table 8: TO-3PF mechanical data

| 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

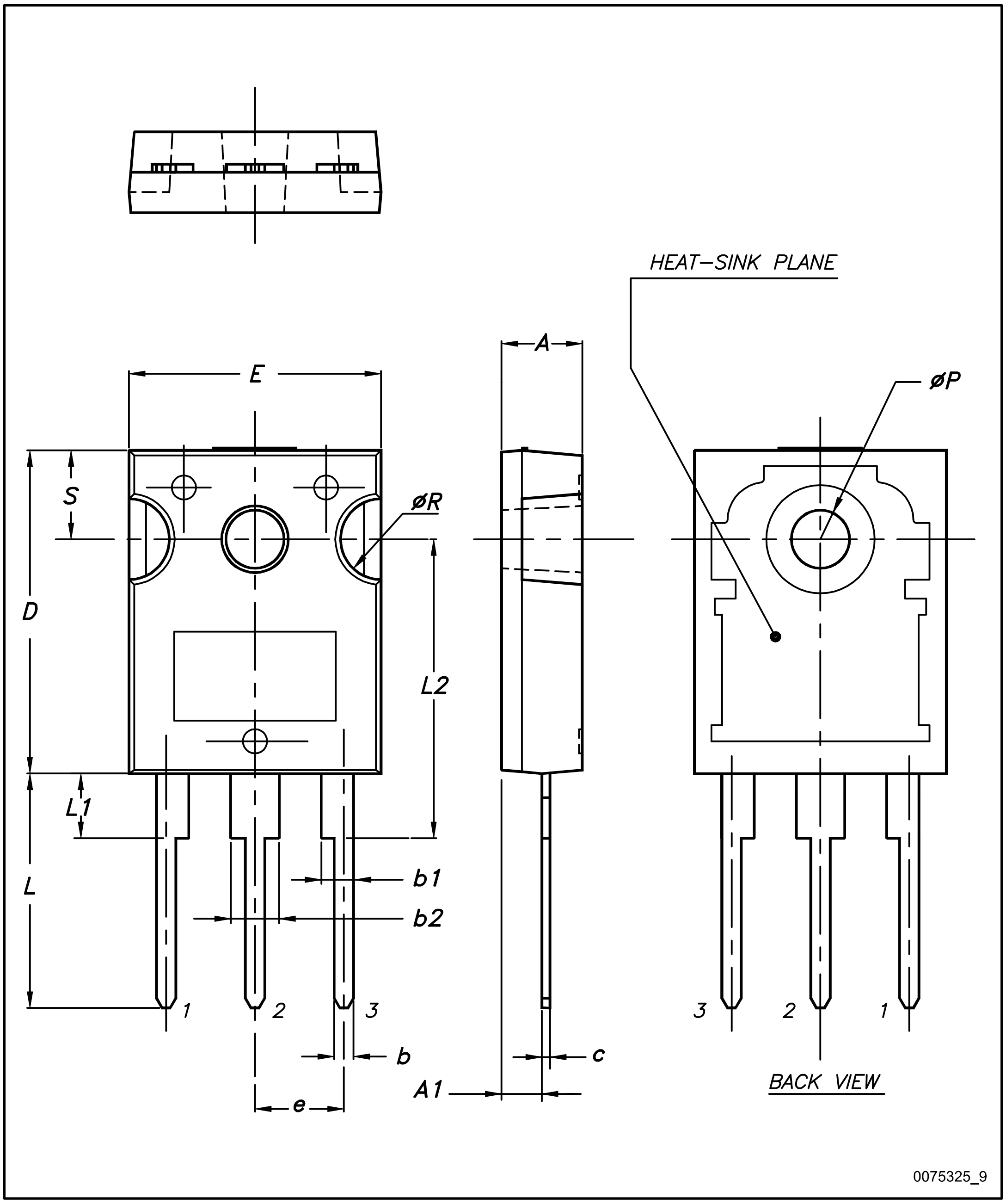


Table 9: TO-247 package mechanical data

| 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**

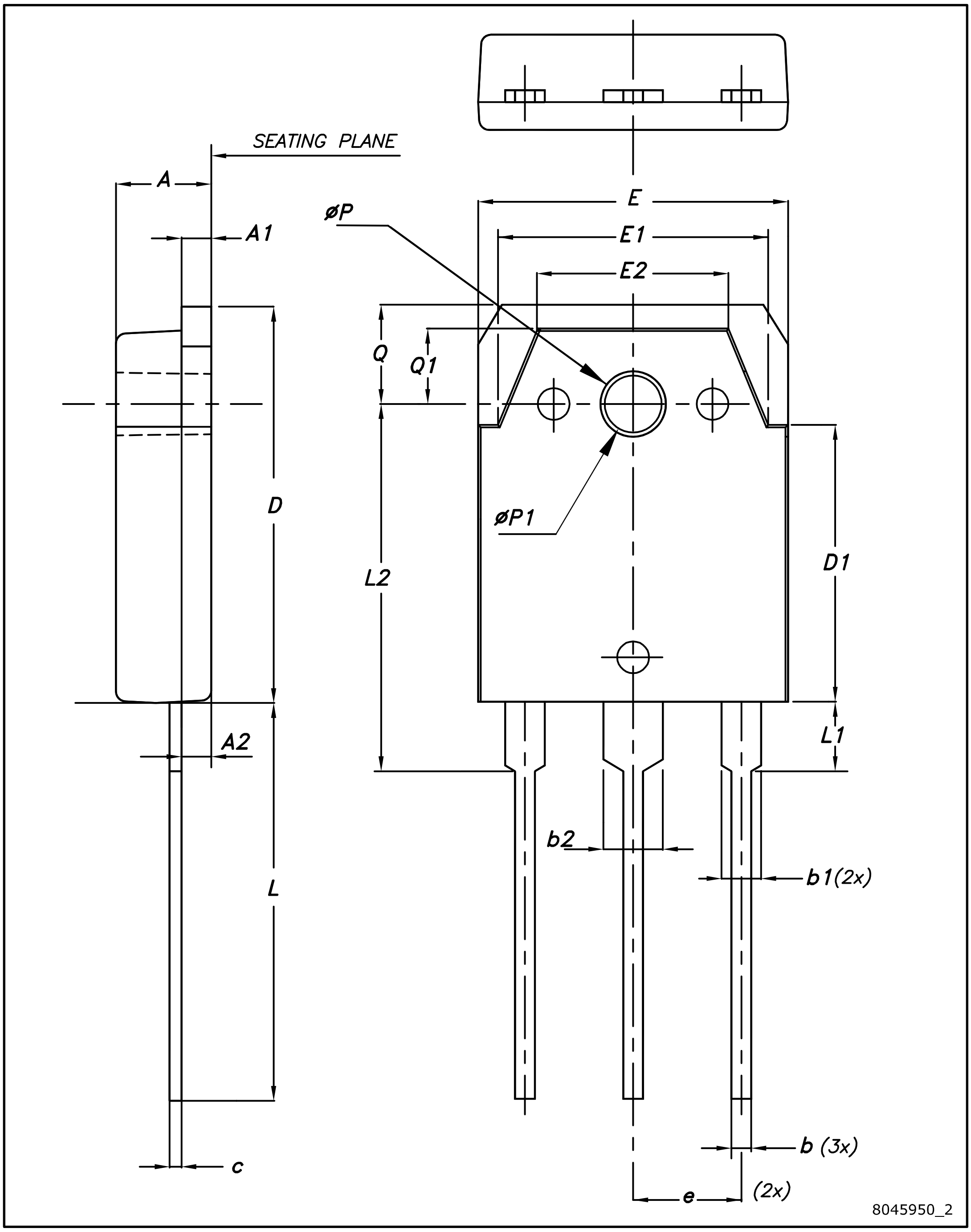


Table 10: TO-3P package mechanical data

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

## IMPORTANT NOTICE – PLEASE READ CAREFULLY

MOSCHIP.RU
ВМЕСТЕ МЫ СОЗДАЕМ БУДУЩЕЕ

ПОСТАВКА
ЭЛЕКТРОННЫХ КОМПОНЕНТОВ

многоканальный
+7 495 668 12 70
info@moschip.ru

Общество с ограниченной ответственностью «МосЧип» ИНН 7719860671 / КПП 771901001
Адрес: 105318, г.Москва, ул.Щербаковская д.3, офис 1107

**Данный компонент на территории Российской Федерации**

**Вы можете приобрести в компании MosChip.**

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

http://moschip.ru/get-element

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

**Офис по работе с юридическими лицами:**

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:
moschip.ru
moschip.ru_4
moschip.ru_6
moschip.ru_9