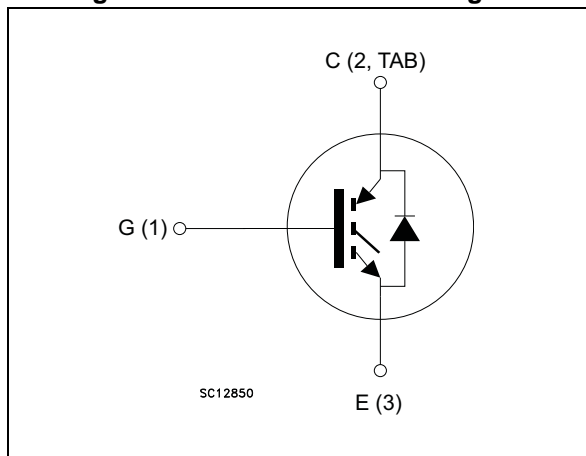


Figure 1. Internal schematic diagram



## Features

- High speed switching
- Tight parameters distribution
- Safe paralleling
- Low thermal resistance
- Short-circuit rated
- Ultrafast soft recovery antiparallel diode

## Applications

- Motor control
- UPS, PFC

## Description

This device is an IGBT developed using an advanced proprietary trench gate and field stop structure. This IGBT series offers the optimum compromise between conduction and switching losses, maximizing the efficiency of very high frequency converters. Furthermore, a positive  $V_{CE(sat)}$  temperature coefficient and very tight parameter distribution result in easier paralleling operation.

Table 1. Device summary

| Order codes  | Marking    | Packages | Packaging |
|--------------|------------|----------|-----------|
| STGW20H60DF  | GW20H60DF  | TO-247   | Tube      |
| STGWT20H60DF | GWT20H60DF | TO-3P    | Tube      |

## Contents

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# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter   | Value       | Unit |
|----------------|---|-------------|------|
| $V_{CES}$      | Collector-emitter voltage ( $V_{GE} = 0$ )            | 600         | V    |
| $I_C$          | Continuous collector current at $T_C = 25\text{ °C}$  | 40          | A    |
|                | Continuous collector current at $T_C = 100\text{ °C}$ | 20          | A    |
| $I_{CP}^{(1)}$ | Pulsed collector current                              | 80          | A    |
| $V_{GE}$       | Gate-emitter voltage                                  | $\pm 20$    | V    |
| $I_F$          | Continuous forward current $T_C = 25\text{ °C}$       | 40          | A    |
|                | Continuous forward current at $T_C = 100\text{ °C}$   | 20          |      |
| $I_{FP}^{(2)}$ | Pulsed forward current                                | 80          | A    |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ °C}$             | 167         | W    |
| $T_{STG}$      | Storage temperature range                             | - 55 to 150 | °C   |
| $T_J$          | Operating junction temperature                        | - 55 to 175 |      |

1. Limited by maximum junction temperature.
2. Pulse width limited by maximum junction temperature and turn-off within RBSOA.

**Table 3. Thermal data**

| Symbol     | Parameter                              | Value | Unit |
|------------|--|-------|------|
| $R_{thJC}$ | Thermal resistance junction-case IGBT  | 0.9   | °C/W |
| $R_{thJC}$ | Thermal resistance junction-case diode | 2.5   | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient    | 62.5  | °C/W |

## 2 Electrical characteristics

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

**Table 4. Static**

| Symbol        | Parameter  | Test conditions  | Min. | Typ. | Max. | Unit          |
|---------------|--|--|------|------|------|---------------|
| $V_{(BR)CES}$ | Collector-emitter breakdown voltage ( $V_{GE} = 0$ ) | $I_C = 2\text{ mA}$  | 600  |      |      | V             |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage                 | $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$                          |      | 1.6  | 2.0  | V             |
|               |  | $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$<br>$T_J = 125\text{ °C}$ |      | 1.75 |      |               |
|               |  | $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$<br>$T_J = 175\text{ °C}$ |      | 1.8  |      |               |
| $V_{GE(th)}$  | Gate threshold voltage                               | $V_{CE} = V_{GE}, I_C = 1\text{ mA}$                               | 5    | 6    | 7    | V             |
| $I_{CES}$     | Collector cut-off current ( $V_{GE} = 0$ )           | $V_{CE} = 600\text{ V}$  |      |      | 25   | $\mu\text{A}$ |
| $I_{GES}$     | Gate-emitter leakage current ( $V_{CE} = 0$ )        | $V_{GE} = \pm 20\text{ V}$   |      |      | 250  | nA            |

**Table 5. Dynamic**

| Symbol    | Parameter                    | Test conditions   | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|---|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{ V}, f = 1\text{ MHz},$<br>$V_{GE} = 0$             | -    | 2750 | -    | pF   |
| $C_{oes}$ | Output capacitance           |   | -    | 110  | -    | pF   |
| $C_{res}$ | Reverse transfer capacitance |   | -    | 65   | -    | pF   |
| $Q_g$     | Total gate charge            | $V_{CC} = 400\text{ V}, I_C = 20\text{ A},$<br>$V_{GE} = 15\text{ V}$ | -    | 115  | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          |   | -    | 22   | -    | nC   |
| $Q_{gc}$  | Gate-collector charge        |   | -    | 45   | -    | nC   |

Table 6. Switching characteristics (inductive load)

| Symbol         | Parameter                    | Test conditions   | Min. | Typ. | Max. | Unit       |
|----------------|------------------------------|---|------|------|------|------------|
| $t_{d(on)}$    | Turn-on delay time           | $V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$                                      |      | 42.5 | -    | ns         |
| $t_r$          | Current rise time            |   |      | 11.9 | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope        |   |      | 1345 | -    | A/ $\mu$ s |
| $t_{d(on)}$    | Turn-on delay time           | $V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>$T_J = 175\text{ }^\circ\text{C}$ |      | 42.5 | -    | ns         |
| $t_r$          | Current rise time            |   |      | 13.4 |      | ns         |
| $(di/dt)_{on}$ | Turn-on current slope        |   |      | 1180 |      | A/ $\mu$ s |
| $t_{r(Voff)}$  | Off voltage rise time        | $V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$                                      |      | 20   | -    | ns         |
| $t_{d(off)}$   | Turn-off delay time          |   |      | 177  | -    | ns         |
| $t_f$          | Current fall time            |   |      | 55   | -    | ns         |
| $t_{r(Voff)}$  | Off voltage rise time        | $V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>$T_J = 175\text{ }^\circ\text{C}$ |      | 26   | -    | ns         |
| $t_{d(off)}$   | Turn-off delay time          |   |      | 173  | -    | ns         |
| $t_f$          | Current fall time            |   |      | 86   | -    | ns         |
| $t_{sc}$       | Short-circuit withstand time | $V_{CC} \leq 360\text{ V}$ , $V_{GE} = 15\text{ V}$   | 3    | 5    | -    | $\mu$ s    |

Table 7. Switching energy (inductive load)

| Symbol          | Parameter                 | Test conditions   | Min. | Typ. | Max. | Unit    |         |
|-----------------|---------------------------|---|------|------|------|---------|---------|
| $E_{on}^{(1)}$  | Turn-on switching losses  | $V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$                                      | -    | 209  | -    | $\mu$ J |         |
| $E_{off}^{(2)}$ | Turn-off switching losses |   |      | -    | 261  | -       | $\mu$ J |
| $E_{ts}$        | Total switching losses    |   |      | -    | 470  | -       | $\mu$ J |
| $E_{on}^{(1)}$  | Turn-on switching losses  | $V_{CE} = 400\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$<br>$T_J = 175\text{ }^\circ\text{C}$ | -    | 480  | -    | $\mu$ J |         |
| $E_{off}^{(2)}$ | Turn-off switching losses |   |      | -    | 416  | -       | $\mu$ J |
| $E_{ts}$        | Total switching losses    |   |      | -    | 896  | -       | $\mu$ J |

1. Energy losses include reverse recovery of the diode.
2. Turn-off losses include also the tail of the collector current.

Table 8. Collector-emitter diode

| Symbol    | Parameter                | Test conditions  | Min. | Typ. | Max. | Unit |
|-----------|--------------------------|--|------|------|------|------|
| $V_F$     | Forward on-voltage       | $I_F = 20\text{ A}$<br>$I_F = 20\text{ A}, T_J = 175\text{ °C}$  | -    | 1.8  | 2.2  | V    |
|           |                          |  |      | 1.3  |      | V    |
| $t_{rr}$  | Reverse recovery time    | $V_r = 60\text{ V}; I_F = 20\text{ A};$<br>$di_F/dt = 100\text{ A} / \mu\text{s}$                          | -    | 90   | -    | ns   |
| $Q_{rr}$  | Reverse recovery charge  |  |      | 110  |      | nC   |
| $I_{rrm}$ | Reverse recovery current |  |      |      | 2.4  |      |
| $t_{rr}$  | Reverse recovery time    | $V_r = 60\text{ V}; I_F = 20\text{ A};$<br>$di_F/dt = 100\text{ A} / \mu\text{s}$<br>$T_J = 175\text{ °C}$ | -    | 180  | -    | ns   |
|           |                          |  |      | 466  |      | nC   |
| $I_{rrm}$ | Reverse recovery current |  | -    | 5.2  | -    | A    |

## 2.1 Electrical characteristics (curves)

Figure 2. Output characteristics ( $T_J = 25^\circ\text{C}$ )

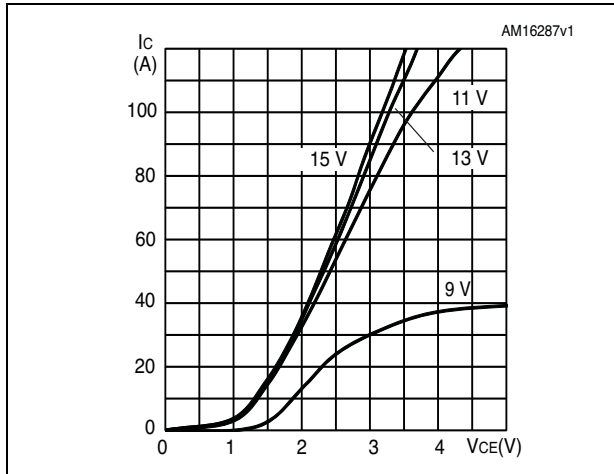


Figure 3. Output characteristics ( $T_J = 175^\circ\text{C}$ )

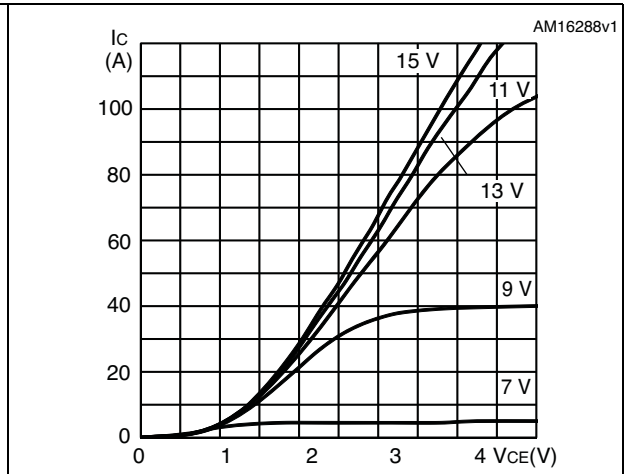


Figure 4. Transfer characteristics

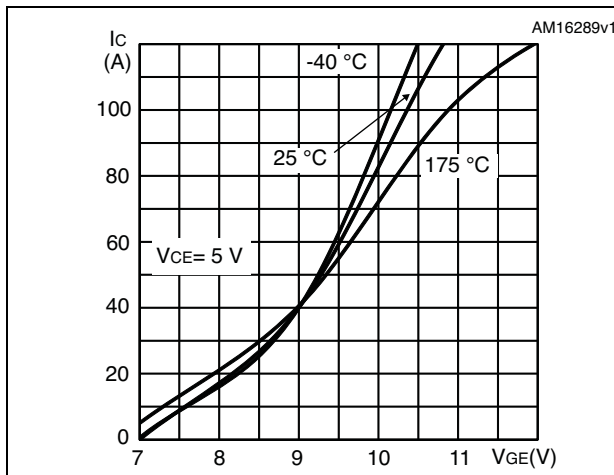


Figure 5. Normalized  $V_{GE(th)}$  vs junction temperature

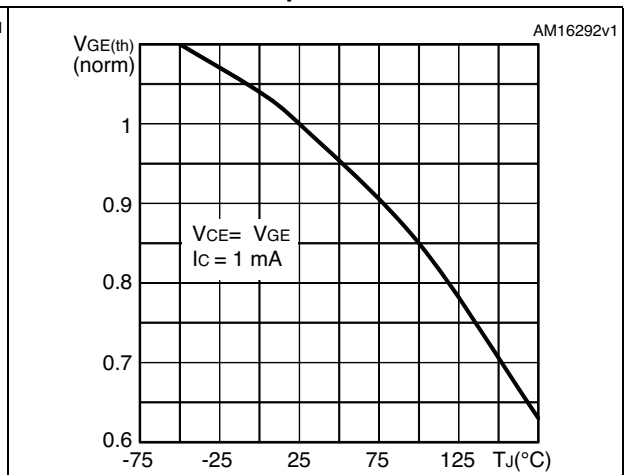


Figure 6. Collector current vs. case temperature

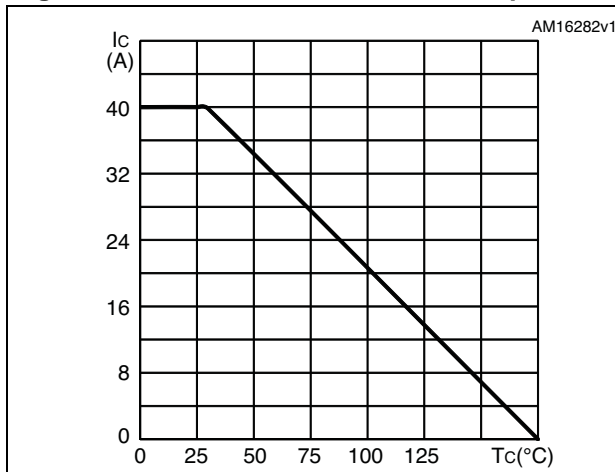


Figure 7. Collector current vs. frequency

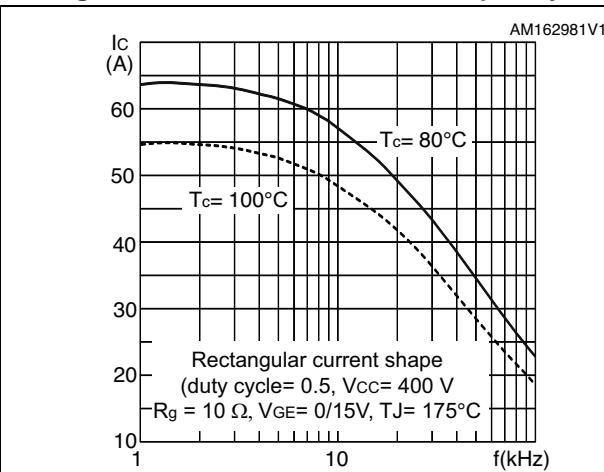


Figure 8. V<sub>CE(sat)</sub> vs. junction temperature

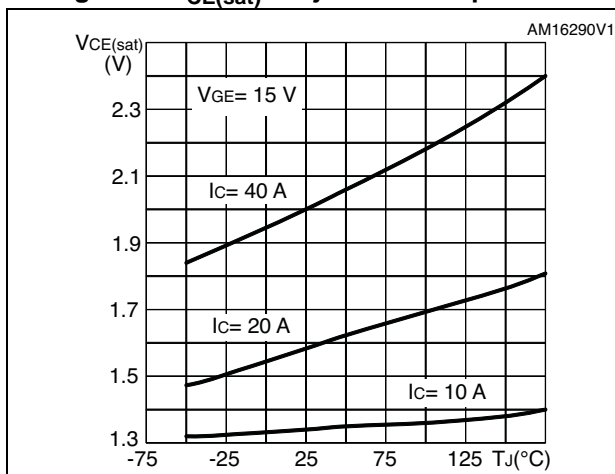


Figure 9. V<sub>CE(sat)</sub> vs. collector current

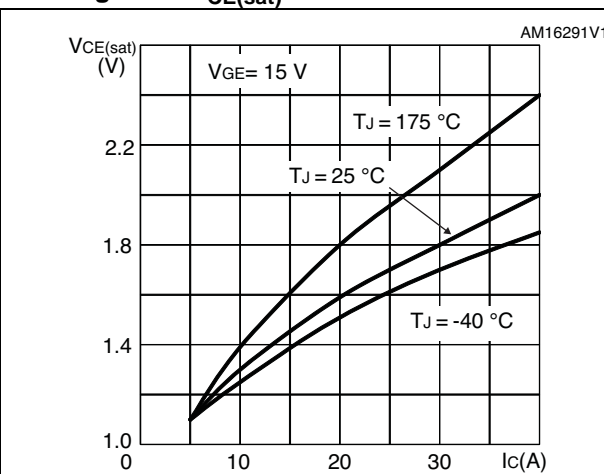


Figure 10. Forward bias safe operating area

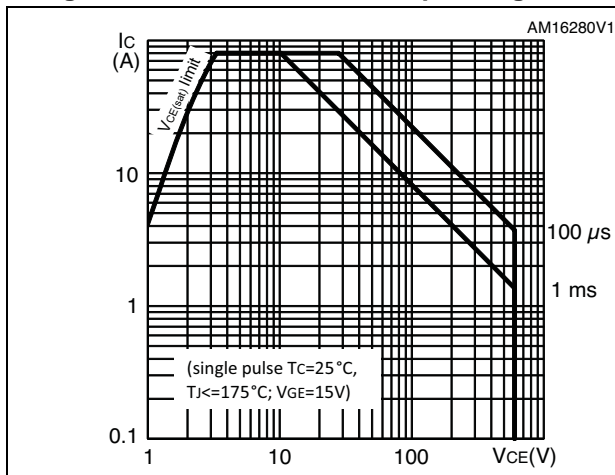


Figure 11. Thermal impedance

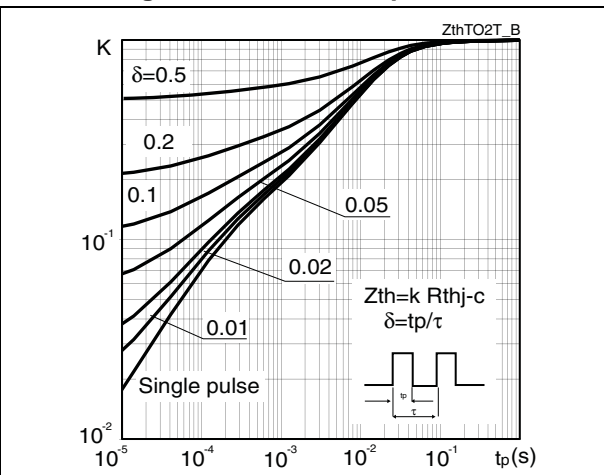




Figure 12. Diode  $V_F$  vs. forward current

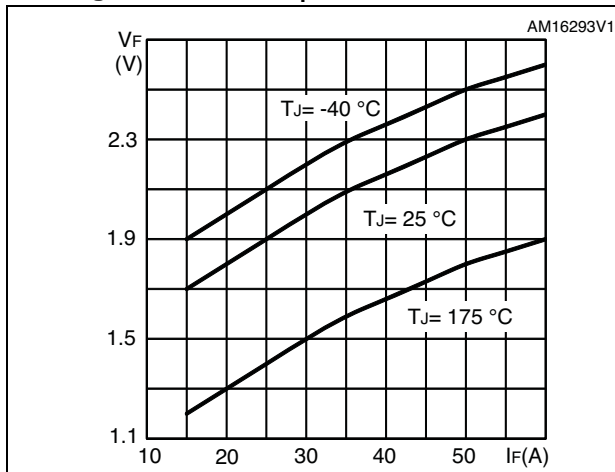


Figure 13. Gate charge vs. gate-emitter voltage

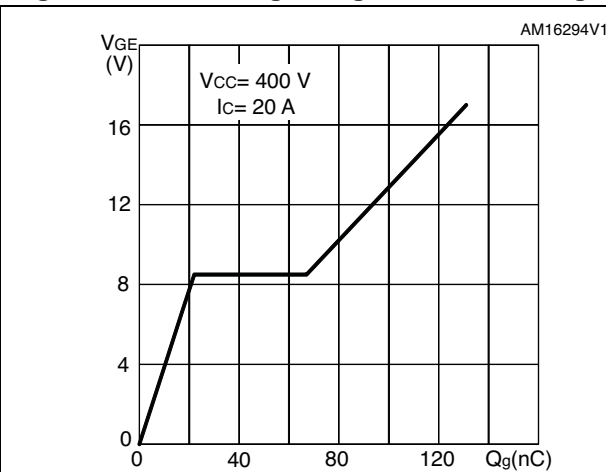


Figure 14. Capacitance variations vs.  $V_{CE}$

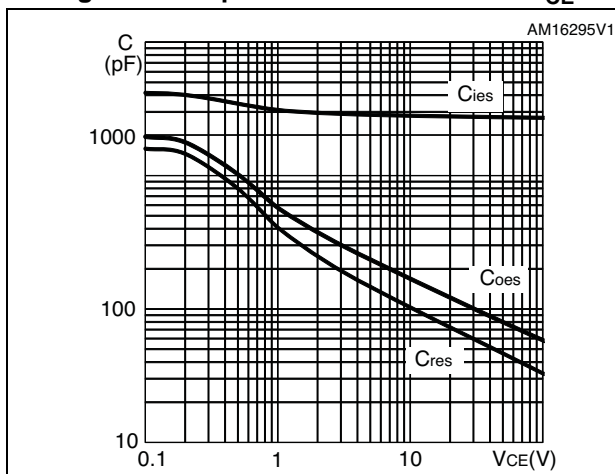


Figure 15. Switching losses vs. gate resistance

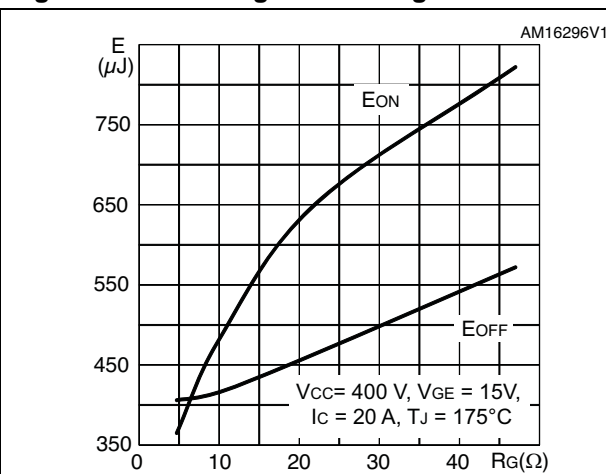


Figure 16. Switching losses vs. collector current

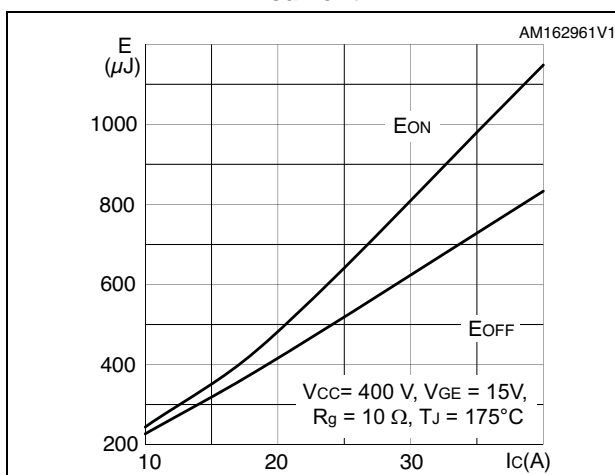


Figure 17. Switching losses vs. temperature

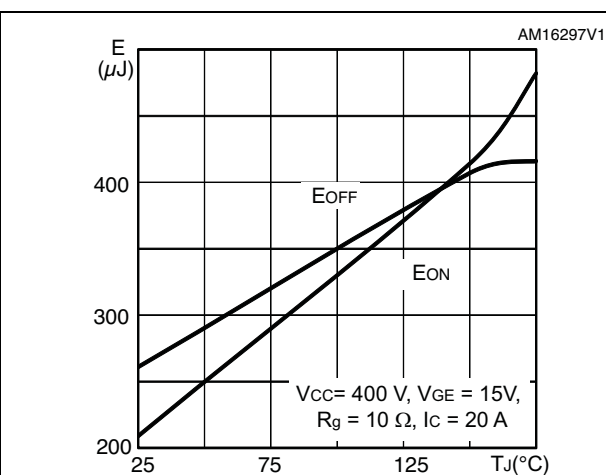


Figure 18. Short-circuit time and current vs.  $V_{GE}$

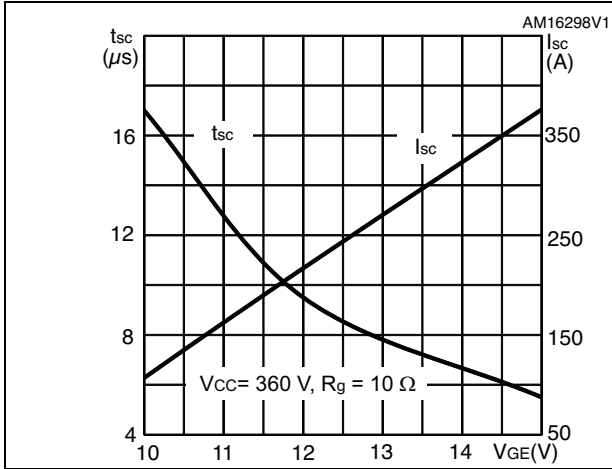
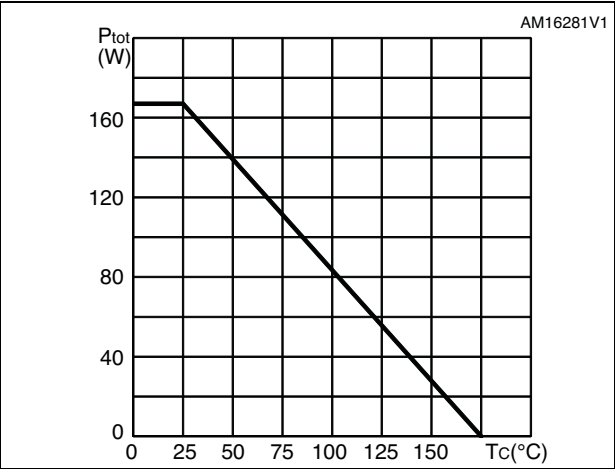


Figure 19. Power dissipation vs. case temperature



### 3 Test circuits

Figure 20. Test circuit for inductive load switching



Figure 21. Gate charge test circuit

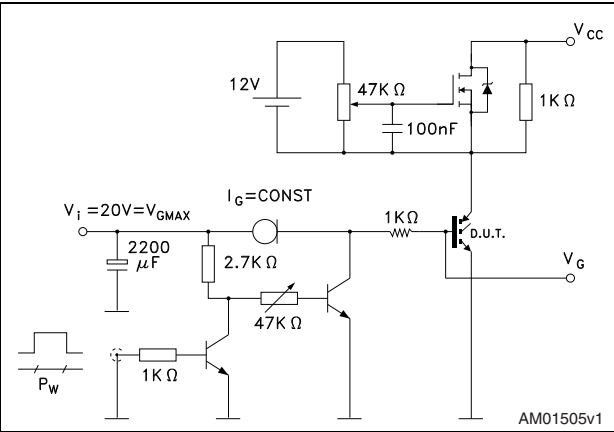
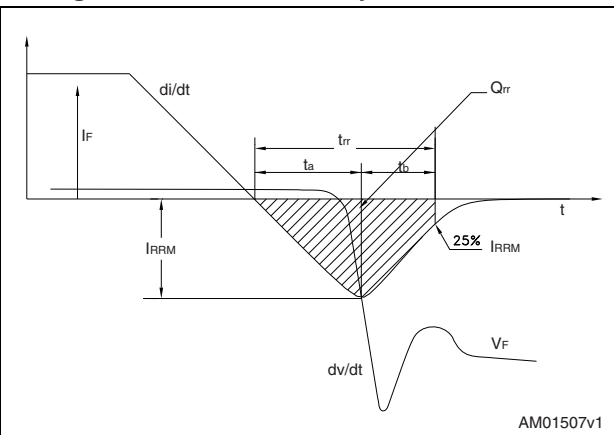


Figure 22. Switching waveform



Figure 23. Diode recovery time waveform



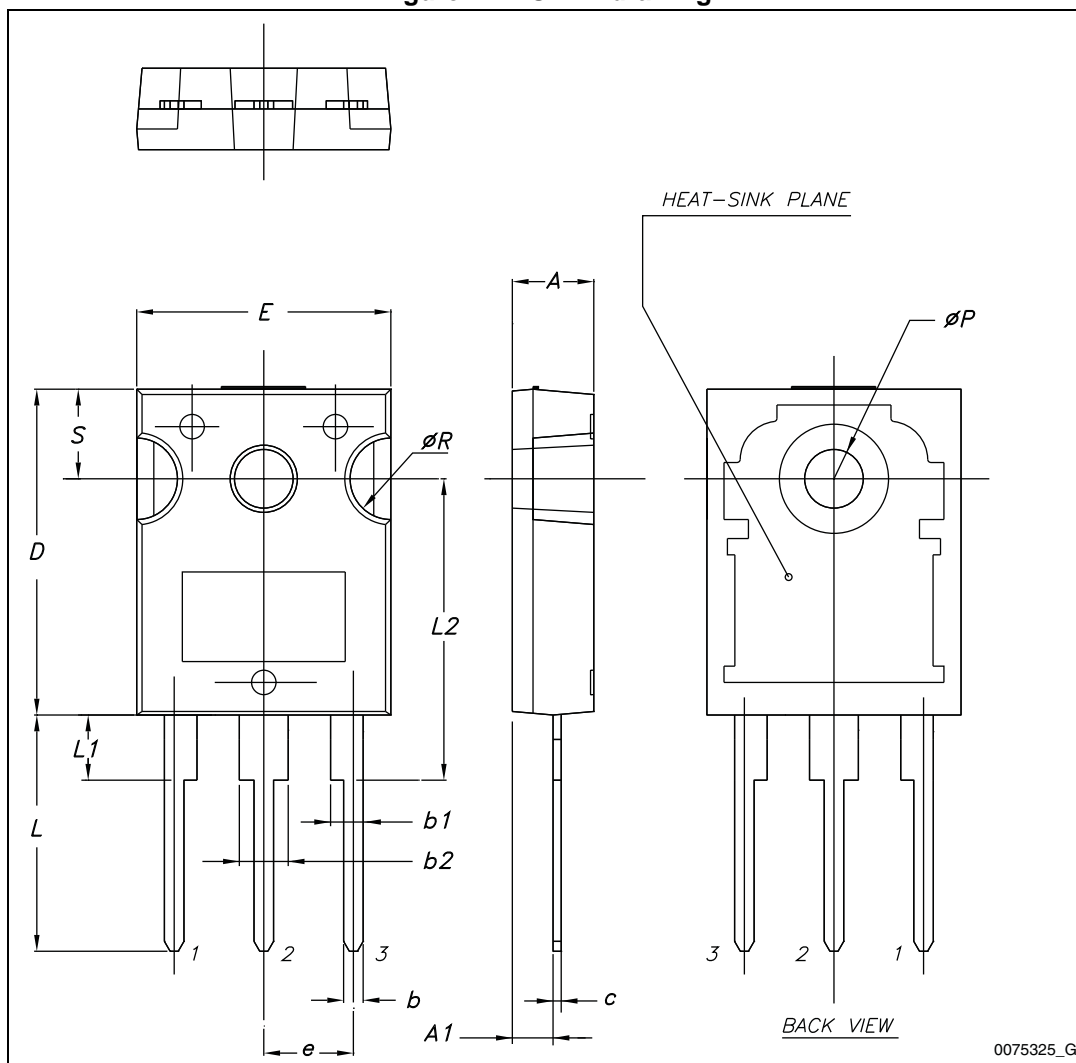
## 4 Package mechanical data

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**Table 9. TO-247 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  |

Figure 24. TO-247 drawing



0075325\_G

Table 10. TO-3P mechanical data

| Dim. | mm    |       |       |
|------|-------|-------|-------|
|      | Min.  | Typ.  | Max.  |
| A    | 4.60  |       | 5     |
| A1   | 1.45  | 1.50  | 1.65  |
| A2   | 1.20  | 1.40  | 1.60  |
| b    | 0.80  | 1     | 1.20  |
| b1   | 1.80  |       | 2.20  |
| b2   | 2.80  |       | 3.20  |
| c    | 0.55  | 0.60  | 0.75  |
| D    | 19.70 | 19.90 | 20.10 |
| D1   |       | 13.90 |       |
| E    | 15.40 |       | 15.80 |
| E1   |       | 13.60 |       |
| E2   |       | 9.60  |       |
| e    | 5.15  | 5.45  | 5.75  |
| L    | 19.50 | 20    | 20.50 |
| L1   |       | 3.50  |       |
| L2   | 18.20 | 18.40 | 18.60 |
| øP   | 3.10  |       | 3.30  |
| Q    |       | 5     |       |
| Q1   |       | 3.80  |       |

Figure 25. TO-3P drawing



8045950\_A

## 5 Revision history

Table 11. Document revision history

| Date        | Revision | Changes          |
|-------------|----------|------------------|
| 06-Jun-2013 | 1        | Initial release. |



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### 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](mailto:info@moschip.ru)

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