



# STGW35HF60WDI

35 A, 600 V ultrafast IGBT with low drop diode

## Features

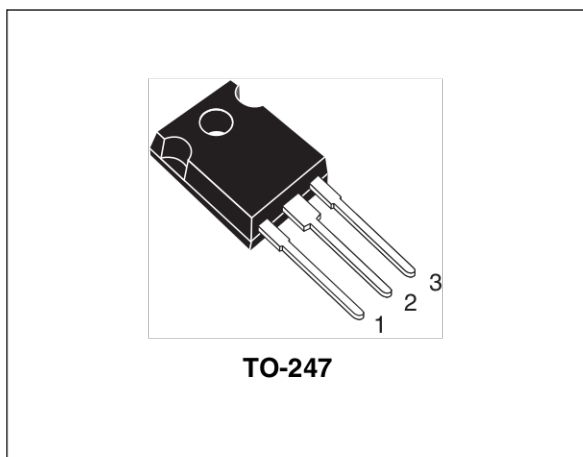
- Improved  $E_{off}$  at elevated temperature
- Low  $C_{RES} / C_{IES}$  ratio (no cross-conduction susceptibility)
- Low  $V_F$  soft recovery antiparallel diode

## Applications

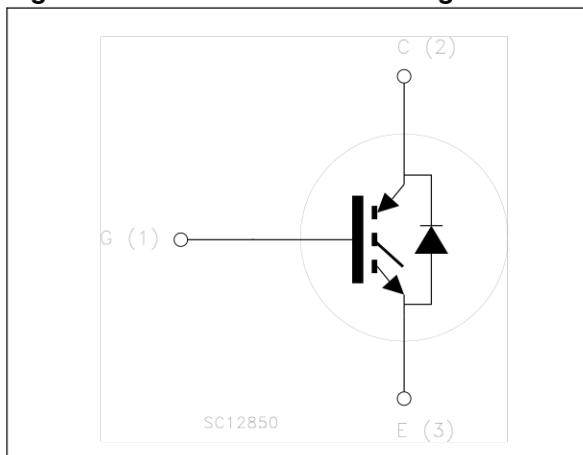
- Welding
- Induction heating
- Resonant converters

## Description

This ultrafast IGBT is developed using a new planar technology to yield a device with tighter switching energy variation ( $E_{off}$ ) versus temperature. The suffix "W" denotes a subset of products designed for high switching frequency operation (over 100 kHz).



**Figure 1. Internal schematic diagram**



**Table 1. Device summary**

| Order code     | Marking     | Package           | Packaging |
|----------------|-------------|-------------------|-----------|
| STGW35HF60WDI  | GW35HF60WDI | TO-247            | Tube      |
| STGWA35HF60WDI | 35HF60WDI   | TO-247 long leads |           |

Contents

1      **Electrical ratings** ..... 2

2      **Electrical characteristics** ..... 3

      2.1    Electrical characteristics (curves) ..... 5

3      **Test circuits** ..... 8

4      **Package mechanical data** ..... 9

5      **Revision history** ..... 13



# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol         | Parameter                                                            | Value       |                   | Unit |
|----------------|----------------------------------------------------------------------|-------------|-------------------|------|
|                |                                                                      | TO-247      | TO-247 long leads |      |
| $V_{CES}$      | Collector-emitter voltage ( $V_{GE} = 0$ )                           | 600         |                   | V    |
| $I_C^{(1)}$    | Continuous collector current at $T_C = 25\text{ °C}$                 | 60          | 70                | A    |
| $I_C^{(1)}$    | Continuous collector current at $T_C = 100\text{ °C}$                | 35          | 40                | A    |
| $I_{CL}^{(2)}$ | Turn-off latching current                                            | 80          |                   | A    |
| $I_{CP}^{(3)}$ | Pulsed collector current                                             | 150         |                   | A    |
| $V_{GE}$       | Gate-emitter voltage                                                 | $\pm 20$    |                   | V    |
| $I_F$          | Diode RMS forward current at $T_C = 25\text{ °C}$                    | 30          |                   | A    |
| $I_{FSM}$      | Surge non repetitive forward current $t_p = 10\text{ ms}$ sinusoidal | 130         |                   | A    |
| $P_{TOT}$      | Total dissipation at $T_C = 25\text{ °C}$                            | 200         | 260               | W    |
| $T_{stg}$      | Storage temperature                                                  | – 55 to 150 |                   | °C   |
| $T_J$          | Operating junction temperature                                       |             |                   |      |

1. Calculated according to the iterative formula:

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

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

3.  $V_{CLAMP} = 80\% (V_{CES})$ ,  $V_{GE} = 15\text{ V}$ ,  $R_G = 10\text{ }\Omega$ ,  $T_J = 150\text{ °C}$

**Table 3. Thermal data**

| Symbol         | Parameter                              | Value  |                   | Unit |
|----------------|----------------------------------------|--------|-------------------|------|
|                |                                        | TO-247 | TO-247 long leads |      |
| $R_{thj-case}$ | Thermal resistance junction-case IGBT  | 0.63   | 0.48              | °C/W |
|                | Thermal resistance junction-case diode | 1.5    |                   | °C/W |
| $R_{thj-amb}$  | Thermal resistance junction-ambient    | 50     |                   | °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 ( $V_{GE} = 0$ ) | $I_C = 1\text{ mA}$                                                                                                  | 600  |             |           | V                   |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage                 | $V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$<br>$V_{GE} = 15\text{ V}$ , $I_C = 20\text{ A}$ , $T_J = 125\text{ °C}$ |      | 1.9<br>1.65 | 2.5       | V<br>V              |
| $V_{GE(th)}$  | Gate threshold voltage                               | $V_{CE} = V_{GE}$ , $I_C = 1\text{ mA}$                                                                              | 3.75 |             | 5.75      | V                   |
| $I_{CES}$     | Collector cut-off current ( $V_{GE} = 0$ )           | $V_{CE} = 600\text{ V}$<br>$V_{CE} = 600\text{ V}$ , $T_J = 125\text{ °C}$                                           |      |             | 250<br>1  | $\mu\text{A}$<br>mA |
| $I_{GES}$     | Gate-emitter leakage current ( $V_{CE} = 0$ )        | $V_{GE} = \pm 20\text{ V}$                                                                                           |      |             | $\pm 100$ | nA                  |
| $g_{fs}$      | Forward transconductance                             | $V_{CE} = 15\text{ V}$ , $I_C = 20\text{ A}$                                                                         |      | 15          |           | S                   |

**Table 5. Dynamic**

| Symbol                              | Parameter                                                               | Test conditions                                                                                                 | Min. | Typ.              | Max. | Unit           |
|-------------------------------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|------|-------------------|------|----------------|
| $C_{ies}$<br>$C_{oes}$<br>$C_{res}$ | Input capacitance<br>Output capacitance<br>Reverse transfer capacitance | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GE} = 0$                                                   | -    | 2400<br>235<br>50 | -    | pF<br>pF<br>pF |
| $Q_g$<br>$Q_{ge}$<br>$Q_{gc}$       | Total gate charge<br>Gate-emitter charge<br>Gate-collector charge       | $V_{CE} = 390\text{ V}$ , $I_C = 20\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ ,<br>(see <a href="#">Figure 17</a> ) | -    | 140<br>13<br>52   | -    | nC<br>nC<br>nC |

**Table 6. Switching on/off (inductive load)**

| Symbol                                            | Parameter                                                        | Test conditions                                                                                                                                                | Min. | Typ.             | Max. | Unit                         |
|---------------------------------------------------|------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------|------|------------------------------|
| $t_{d(on)}$<br>$t_r$<br>( $di/dt$ ) <sub>on</sub> | Turn-on delay time<br>Current rise time<br>Turn-on current slope | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$<br>$R_G = 10\text{ }\Omega$ , $V_{GE} = 15\text{ V}$ ,<br>(see <a href="#">Figure 16</a> )                       | -    | 30<br>15<br>1650 | -    | ns<br>ns<br>A/ $\mu\text{s}$ |
| $t_{d(on)}$<br>$t_r$<br>( $di/dt$ ) <sub>on</sub> | Turn-on delay time<br>Current rise time<br>Turn-on current slope | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$<br>$R_G = 10\text{ }\Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_J = 125\text{ °C}$ (see <a href="#">Figure 16</a> ) | -    | 30<br>15<br>1600 | -    | ns<br>ns<br>A/ $\mu\text{s}$ |

**Table 6. Switching on/off (inductive load)**

|                |                       |                                                                       |   |     |   |    |
|----------------|-----------------------|-----------------------------------------------------------------------|---|-----|---|----|
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$ ,                       | - | 30  | - | ns |
| $t_d(off)$     | Turn-off delay time   | $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$                        | - | 175 | - | ns |
| $t_f$          | Current fall time     | (see <a href="#">Figure 16</a> )                                      | - | 40  | - | ns |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$ ,                       | - | 50  | - | ns |
| $t_d(off)$     | Turn-off delay time   | $R_{GE} = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,                      | - | 225 | - | ns |
| $t_f$          | Current fall time     | $T_J = 125\text{ }^\circ\text{C}$<br>(see <a href="#">Figure 16</a> ) | - | 70  | - | ns |

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

| Symbol    | Parameter                 | Test conditions                                                                                                                                                        | Min. | Typ. | Max. | Unit          |
|-----------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $E_{off}$ | Turn-off switching losses | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>(see <a href="#">Figure 18</a> )                                     | -    | 185  |      | $\mu\text{J}$ |
| $E_{off}$ | Turn-off switching losses | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$<br>$R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,<br>$T_J = 125\text{ }^\circ\text{C}$ , (see <a href="#">Figure 18</a> ) | -    | 350  | 530  | $\mu\text{J}$ |

**Table 8. Collector-emitter diode**

| Symbol    | Parameter                | Test conditions                                                                | Min. | Typ.       | Max. | Unit   |
|-----------|--------------------------|--------------------------------------------------------------------------------|------|------------|------|--------|
| $V_F$     | Forward on-voltage       | $I_F = 20\text{ A}$<br>$I_F = 20\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$ | -    | 1.3<br>1.1 | 1.7  | V<br>V |
| $t_{rr}$  | Reverse recovery time    | $I_F = 20\text{ A}$ , $V_R = 50\text{ V}$ ,                                    | -    | 85         | -    | ns     |
| $Q_{rr}$  | Reverse recovery charge  | $di/dt = 100\text{ A}/\mu\text{s}$                                             | -    | 240        | -    | nC     |
| $I_{rrm}$ | Reverse recovery current | (see <a href="#">Figure 19</a> )                                               | -    | 5.2        | -    | A      |
| $t_{rr}$  | Reverse recovery time    | $I_F = 20\text{ A}$ , $V_R = 50\text{ V}$ ,                                    | -    | 230        | -    | ns     |
| $Q_{rr}$  | Reverse recovery charge  | $T_J = 125\text{ }^\circ\text{C}$ , $di/dt = 100\text{ A}/\mu\text{s}$         | -    | 930        | -    | nC     |
| $I_{rrm}$ | Reverse recovery current | (see <a href="#">Figure 19</a> )                                               | -    | 8.7        | -    | A      |

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

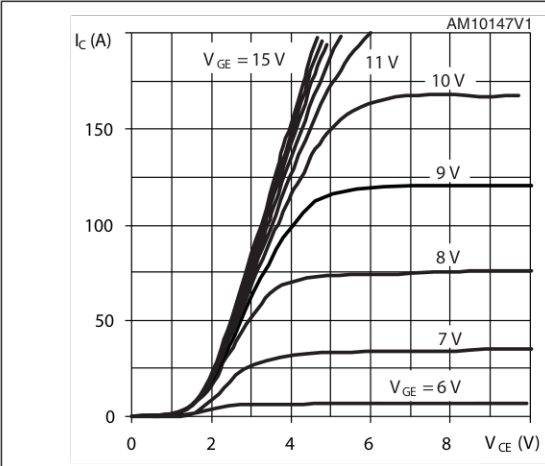


Figure 3. Transfer characteristics

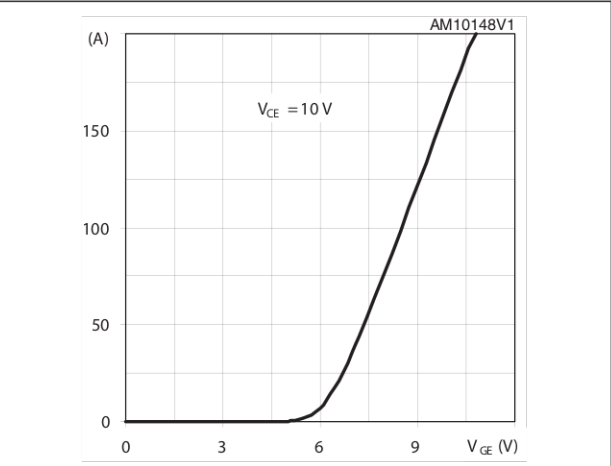


Figure 4. Normalized  $V_{CE(sat)}$  vs.  $I_C$

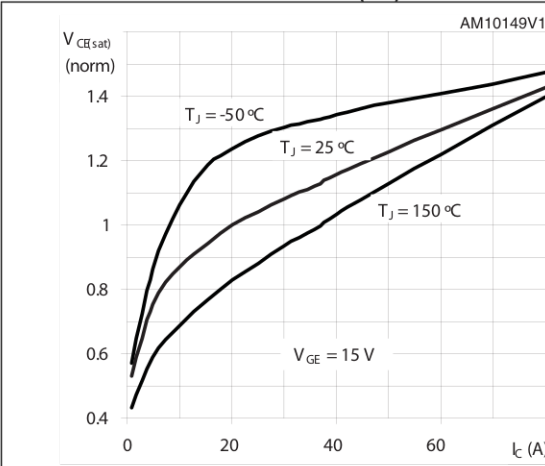


Figure 5. Normalized  $V_{CE(sat)}$  vs. temperature

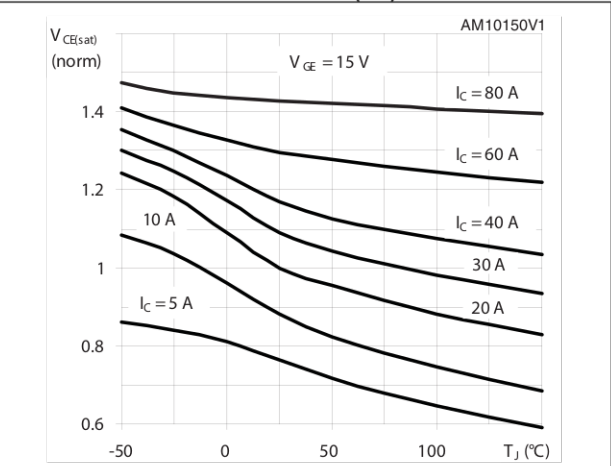


Figure 6. Normalized breakdown voltage vs. temperature

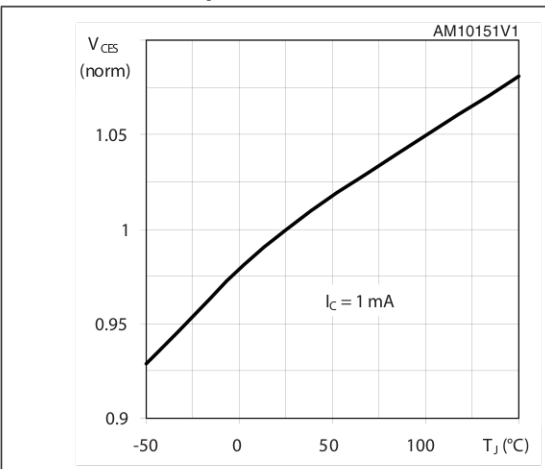


Figure 7. Normalized gate threshold voltage vs. temperature

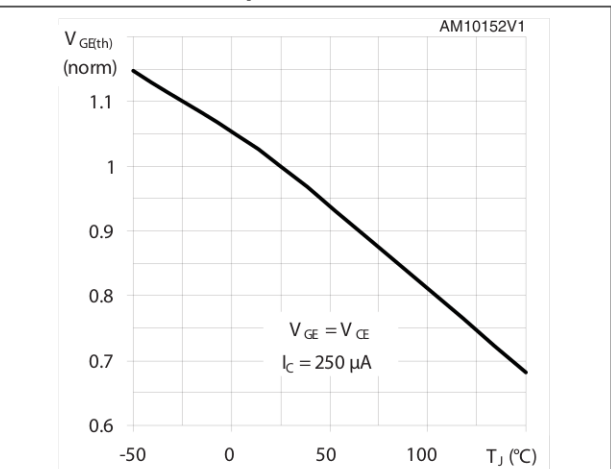


Figure 8. Gate charge vs. gate-emitter voltage

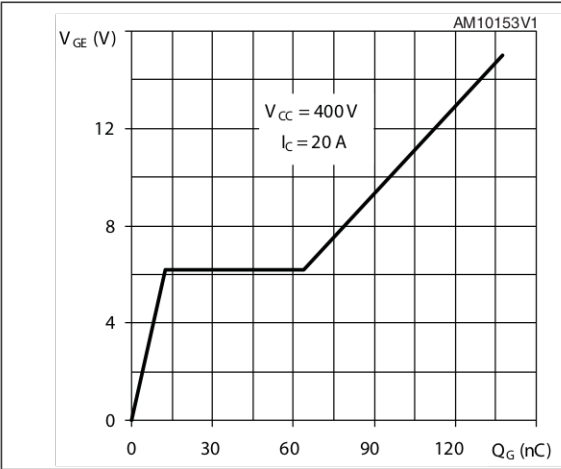


Figure 9. Capacitance variations

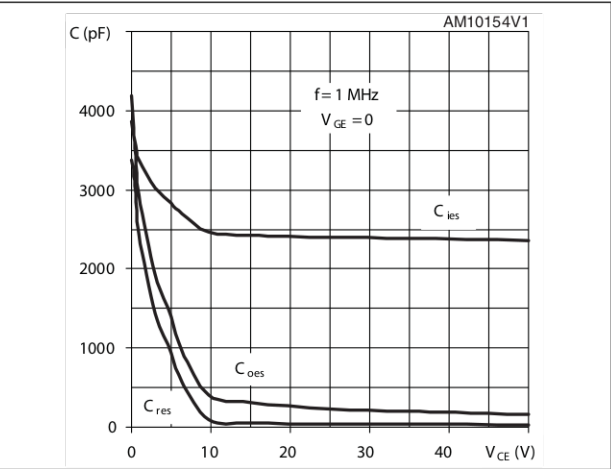


Figure 10. Switching losses vs temperature

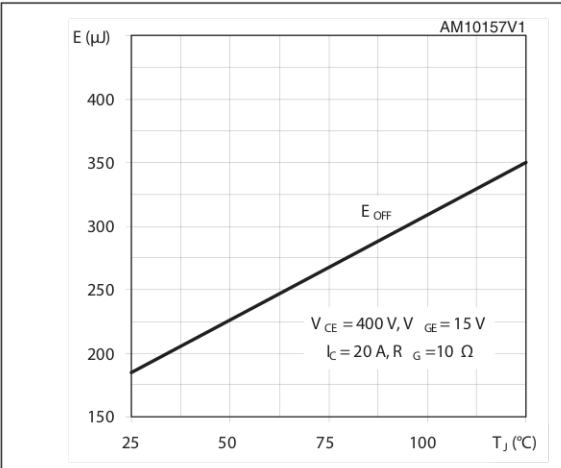


Figure 11. Switching losses vs gate resistance

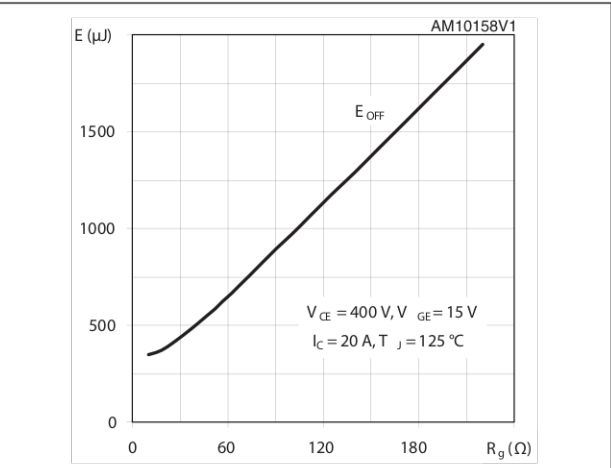


Figure 12. Switching losses vs collector current

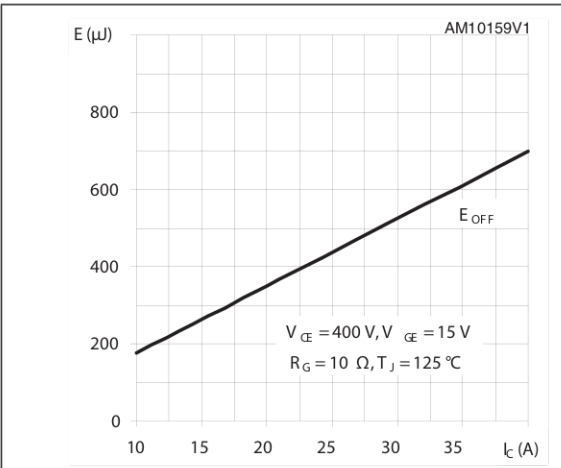


Figure 13. Diode forward on voltage

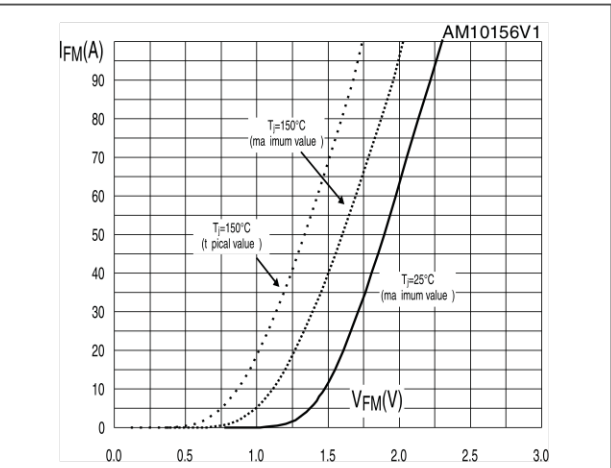


Figure 14. Turn-off SOA

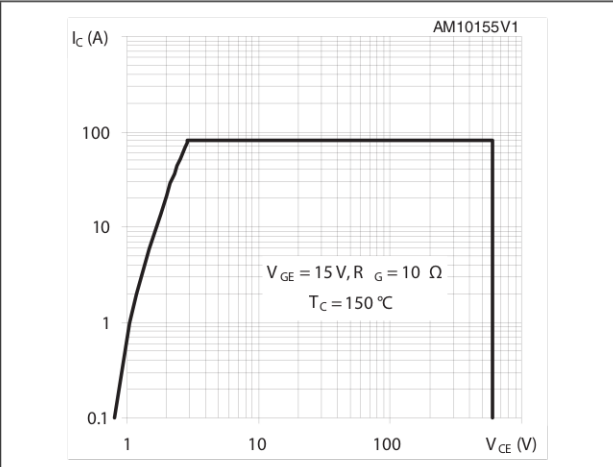
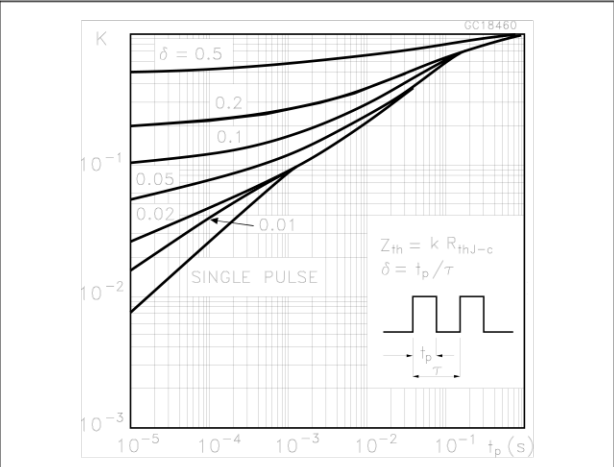


Figure 15. Thermal impedance



### 3 Test circuits

Figure 16. Test circuit for inductive load switching

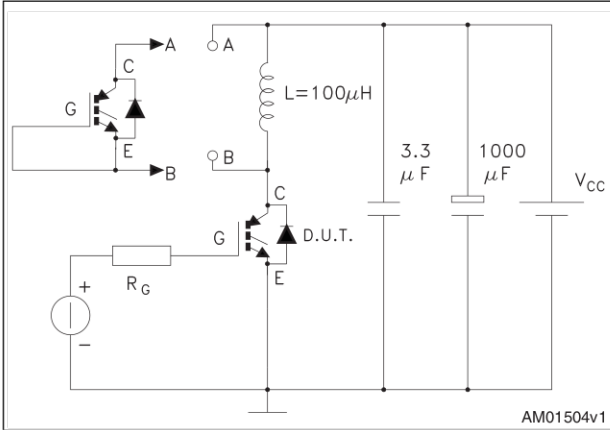


Figure 17. Gate charge test circuit

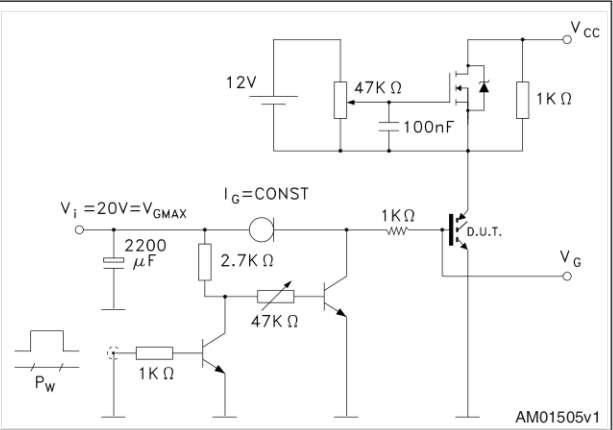


Figure 18. Switching waveform

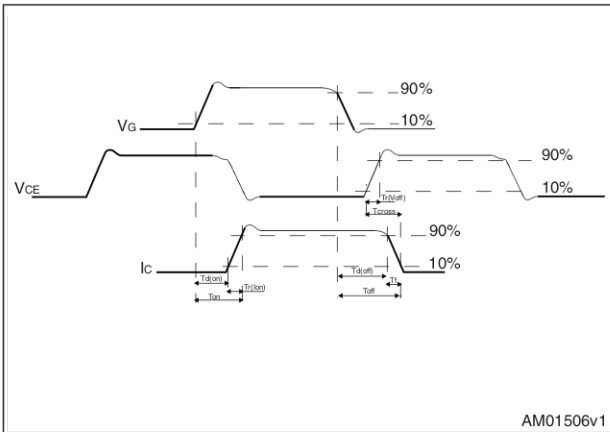
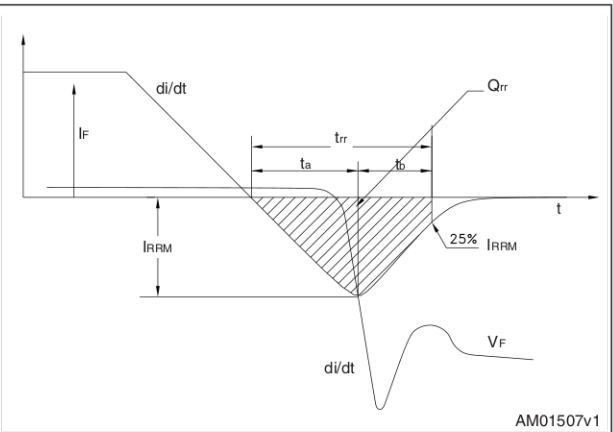


Figure 19. Diode recovery time waveform



## 4 Package mechanical data

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](http://www.st.com). ECOPACK is an ST trademark.

**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    |       | 5.45  |       |
| L    | 14.20 |       | 14.80 |
| L1   | 3.70  |       | 4.30  |
| L2   |       | 18.50 |       |
| ØP   | 3.55  |       | 3.65  |
| ØR   | 4.50  |       | 5.50  |
| S    |       | 5.50  |       |

Figure 20. TO-247 drawing

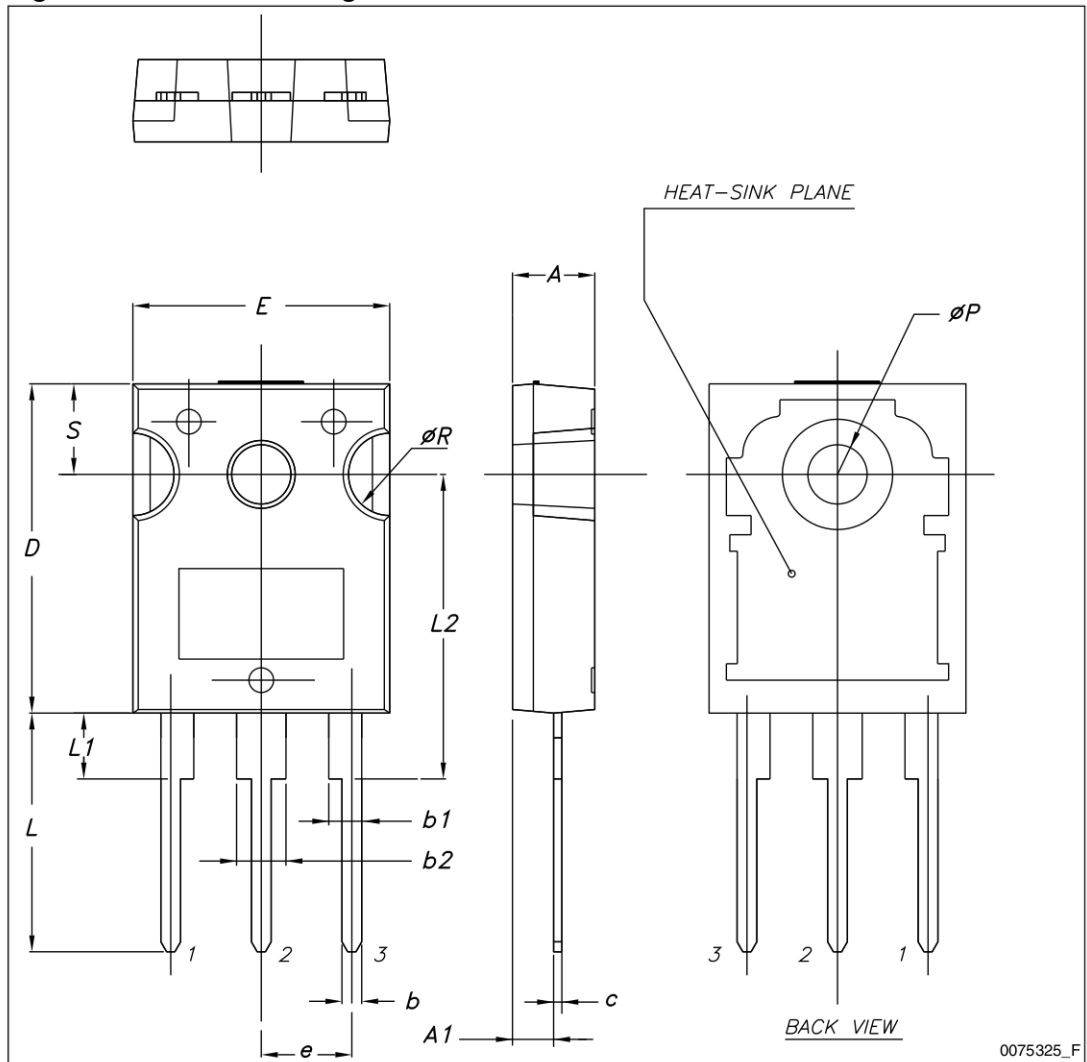
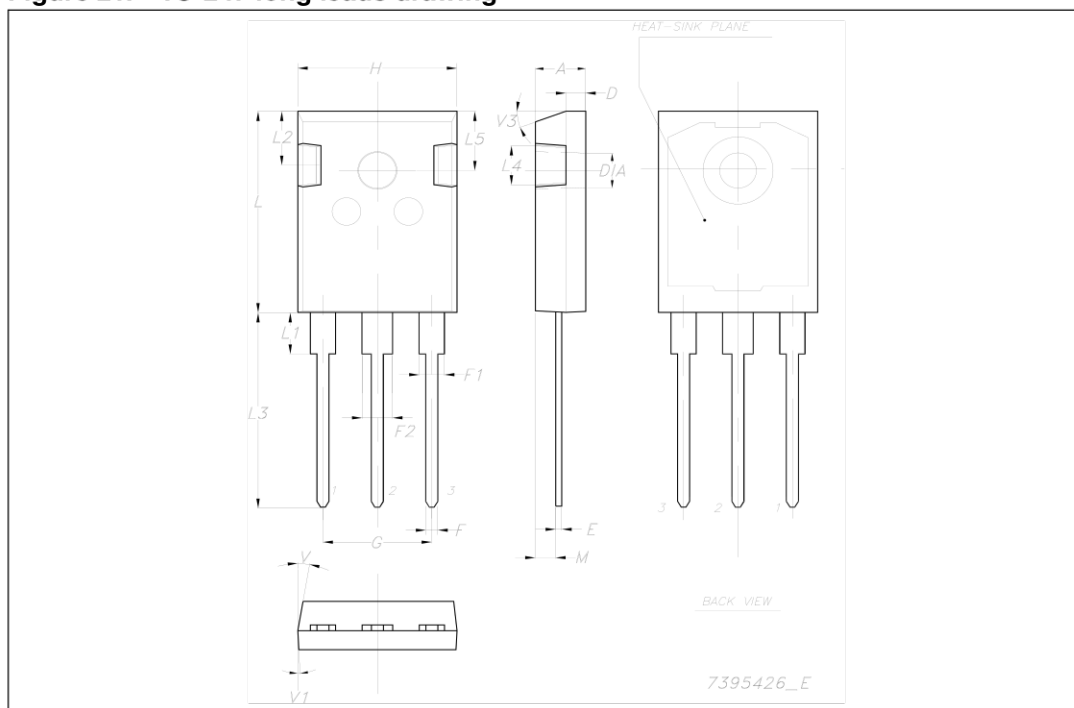


Table 10. TO-247 long leads mechanical data

| Dim. | mm        |      |       |
|------|-----------|------|-------|
|      | Min.      | Typ. | Max.  |
| A    | 4.90      |      | 5.15  |
| D    | 1.85      |      | 2.10  |
| E    | 0.55      |      | 0.67  |
| F    | 1.07      |      | 1.32  |
| F1   | 1.90      |      | 2.38  |
| F2   | 2.87      |      | 3.38  |
| G    | 10.90 BSC |      |       |
| H    | 15.77     |      | 16.02 |
| L    | 20.82     |      | 21.07 |
| L1   | 4.16      |      | 4.47  |
| L2   | 5.49      |      | 5.74  |
| L3   | 20.05     |      | 20.30 |
| L4   | 3.68      |      | 3.93  |
| L5   | 6.04      |      | 6.29  |
| M    | 2.27      |      | 2.52  |
| V    |           | 10°  |       |
| V1   |           | 3°   |       |
| V3   |           | 20°  |       |
| Dia. | 3.55      |      | 3.66  |

Figure 21. TO-247 long leads drawing



## 5 Revision history

**Table 11. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 03-Aug-2009 | 1        | Initial release.                                                                                                                                                       |
| 02-Sep-2009 | 2        | Minor text changes throughout the document<br>Removed watermark.                                                                                                       |
| 25-Aug-2011 | 3        | Inserted new <a href="#">Section 2.1: Electrical characteristics (curves)</a> .<br>Updated <a href="#">Section 4: Package mechanical data</a> .<br>Minor text changes. |

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY TWO AUTHORIZED ST REPRESENTATIVES, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2011 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)