



# STGW35HF60WDI

35 A, 600 V ultra fast IGBT

## 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

The "HF" series is based on a new planar technology concept to yield an IGBT with tighter variation of switching energy ( $E_{off}$ ) versus temperature. The suffix "W" denotes a subset of products tailored to high switching frequency operation (over 100 kHz).

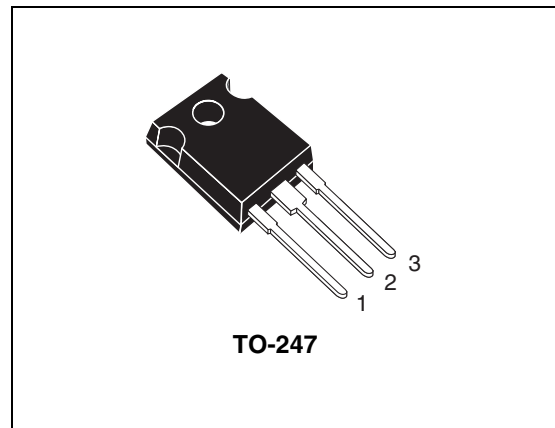


Figure 1. Internal schematic diagram

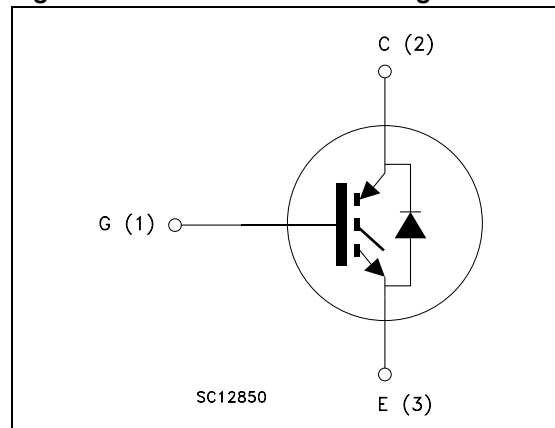


Table 1. Device summary

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

# 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 |
|-----------|------------------------------|---|------|------|------|------|
| $C_{ies}$ | Input capacitance            | $V_{CE} = 25\text{ V}$ , $f = 1\text{ MHz}$ ,<br>$V_{GE} = 0$ | -    | 2400 | -    | pF   |
| $C_{oes}$ | Output capacitance           |   |      | 235  |      | pF   |
| $C_{res}$ | Reverse transfer capacitance |   |      | 50   |      | pF   |
| $Q_g$     | Total gate charge            | $V_{CE} = 390\text{ V}$ , $I_C = 20\text{ A}$ ,               | -    | 140  | -    | nC   |
| $Q_{ge}$  | Gate-emitter charge          | $V_{GE} = 15\text{ V}$ ,                                      |      | 13   |      | nC   |
| $Q_{gc}$  | Gate-collector charge        | (see <a href="#">Figure 3</a> )                               |      | 52   |      | nC   |

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

| Symbol         | Parameter             | Test conditions  | Min. | Typ. | Max. | Unit       |
|----------------|-----------------------|--|------|------|------|------------|
| $t_{d(on)}$    | Turn-on delay time    | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$                        | -    | 30   | -    | ns         |
| $t_r$          | Current rise time     | $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,                        | -    | 15   | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope | (see <a href="#">Figure 2</a> )                                      | -    | 1650 | -    | A/ $\mu$ s |
| $t_{d(on)}$    | Turn-on delay time    | $V_{CC} = 390\text{ V}$ , $I_C = 20\text{ A}$                        | -    | 30   | -    | ns         |
| $t_r$          | Current rise time     | $R_G = 10\ \Omega$ , $V_{GE} = 15\text{ V}$ ,                        | -    | 15   | -    | ns         |
| $(di/dt)_{on}$ | Turn-on current slope | $T_J = 125\text{ }^\circ\text{C}$ (see <a href="#">Figure 2</a> )    | -    | 1600 | -    | A/ $\mu$ s |
| $t_r(V_{off})$ | 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 2</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 2</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 4</a> )                                     | -    | 185  | -    | $\mu$ 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 4</a> ) | -    | 350  | 530  | $\mu$ 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 5</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 5</a> )  | -    | 8.7        | -    | A      |

### 3 Test circuits

Figure 2. Test circuit for inductive load switching

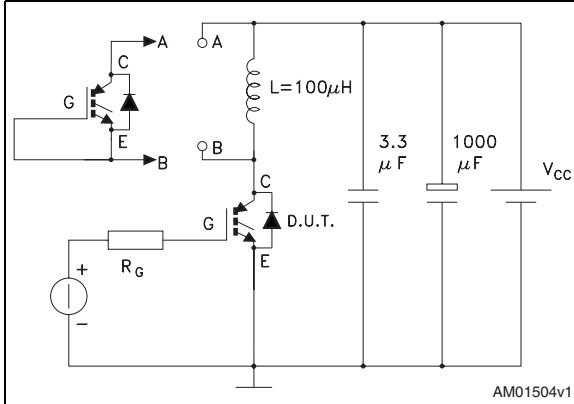


Figure 3. Gate charge test circuit

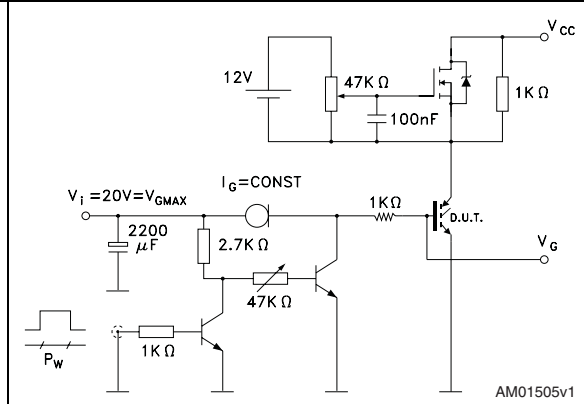


Figure 4. Switching waveform

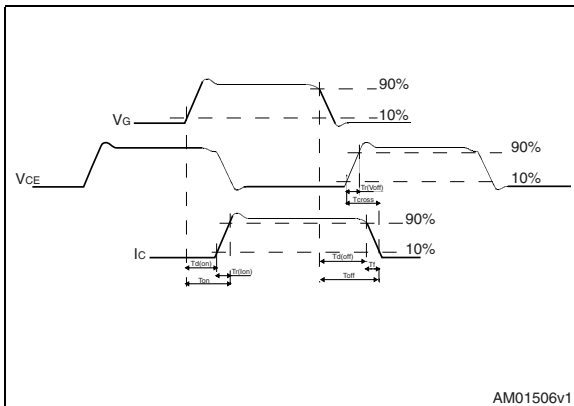
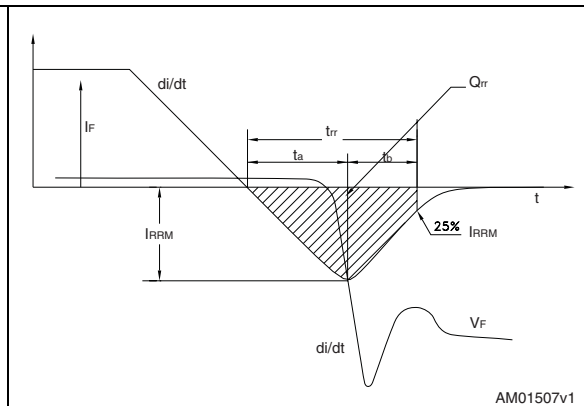


Figure 5. Diode recovery time waveform

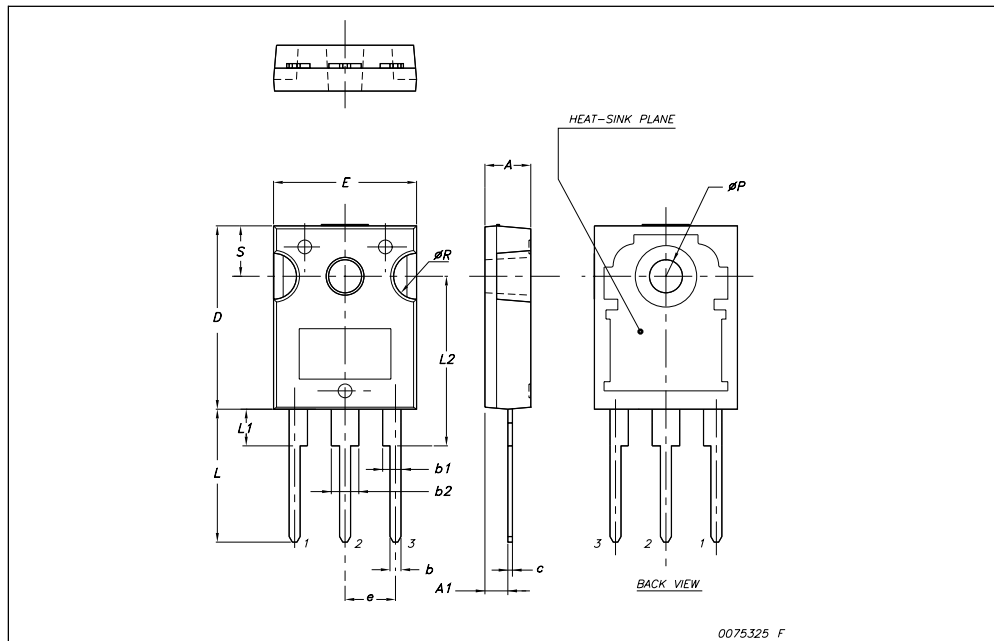


## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK is an ST trademark.

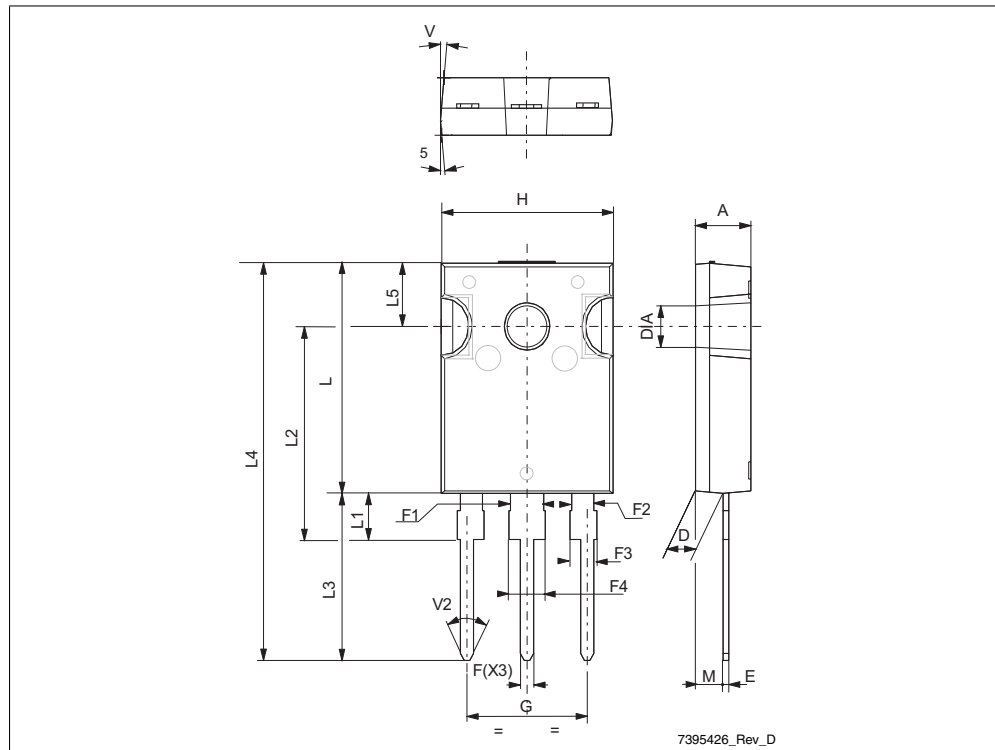
**TO-247 Mechanical data**

| 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  |       |



TO-247 long leads mechanical data

| Dim. | mm    |      |       |
|------|-------|------|-------|
|      | Min.  | Typ. | Max.  |
| A    | 4.85  |      | 5.16  |
| D    | 2.2   |      | 2.6   |
| E    | 0.4   |      | 0.8   |
| F    | 1     |      | 1.4   |
| F1   |       | 3    |       |
| F2   |       | 2    |       |
| F3   | 1.9   |      | 2.4   |
| F4   | 3     |      | 3.4   |
| G    |       | 10.9 |       |
| H    | 15.45 |      | 16.03 |
| L    | 19.85 |      | 21.09 |
| L1   | 3.7   |      | 4.3   |
| L2   | 18.3  |      | 19.13 |
| L3   | 14.2  |      | 20.3  |
| L4   | 34.05 |      | 41.38 |
| L5   | 5.35  |      | 6.3   |
| M    | 2     |      | 3     |
| V    |       | 5°   |       |
| V2   |       | 60°  |       |
| DIAM | 3.55  |      | 3.65  |





## 5 Revision history

Table 9. 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 |

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