

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).

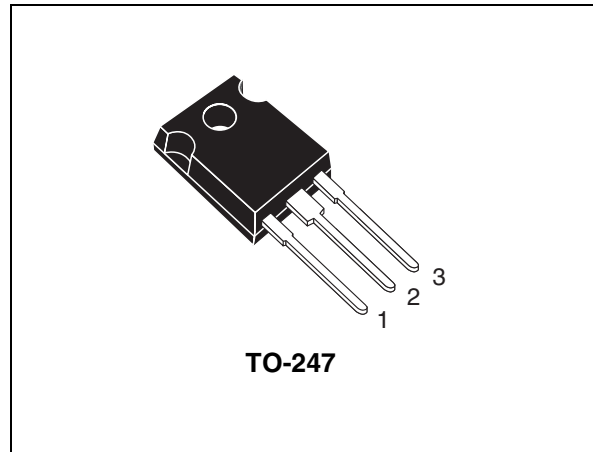


Figure 1. Internal schematic diagram

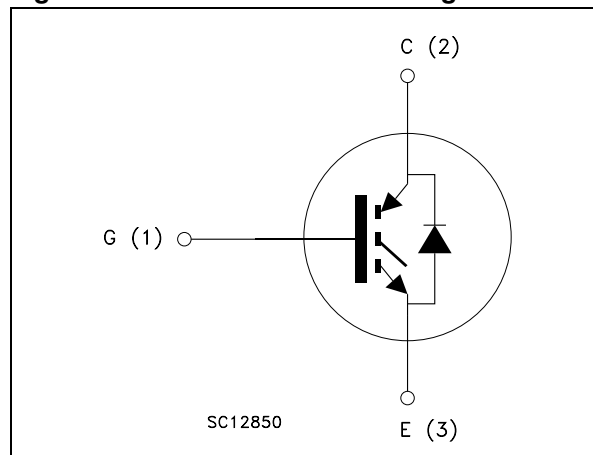


Table 1. Device summary

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

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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 °C | 60 | 70 | A |
| I _C ⁽¹⁾ | Continuous collector current at T _C = 100 °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 | ± 20 | | V |
| I _F | Diode RMS forward current at T _C = 25 °C | 30 | | A |
| I _{FSM} | Surge non repetitive forward current t _p = 10 ms sinusoidal | 130 | | A |
| P _{TOT} | Total dissipation at T _C = 25 °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 V, R_G = 10 Ω, T_J = 150 °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 | $V_{GE} = 15\text{ V}, I_C = 20\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 20\text{ A}, T_J = 125\text{ °C}$ | | 1.9 1.65 | 2.5 | V 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 ($V_{GE} = 0$) | $V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}, T_J = 125\text{ °C}$ | | | 250 1 | μA mA |
| I_{GES} | Gate-emitter leakage current ($V_{CE} = 0$) | $V_{GE} = \pm 20\text{ V}$ | | | ± 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} C_{oes} C_{res} | Input capacitance Output capacitance Reverse transfer capacitance | $V_{CE} = 25\text{ V}, f = 1\text{ MHz},$ $V_{GE} = 0$ | - | 2400 235 50 | - | pF pF pF |
| Q_g Q_{ge} Q_{gc} | Total gate charge Gate-emitter charge Gate-collector charge | $V_{CE} = 390\text{ V}, I_C = 20\text{ A},$ $V_{GE} = 15\text{ V},$ (see Figure 17) | - | 140 13 52 | - | nC nC nC |

Table 6. Switching on/off (inductive load)

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

Table 6. Switching on/off (inductive load)

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

Table 7. Switching energy (inductive load)

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

Table 8. Collector-emitter diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|--------------------------|--|------|------------|------|--------|
| V_F | Forward on-voltage | $I_F = 20\text{ A}$ $I_F = 20\text{ A}$, $T_J = 125\text{ }^\circ\text{C}$ | - | 1.3 1.1 | 1.7 | V 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 Figure 19) | - | 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 Figure 19) | - | 8.7 | - | A |

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

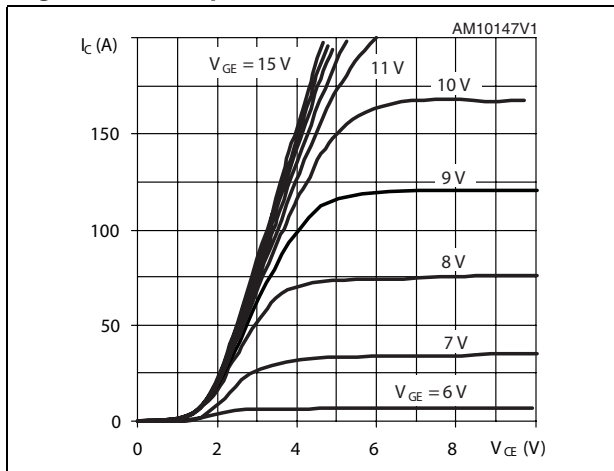


Figure 3. Transfer characteristics

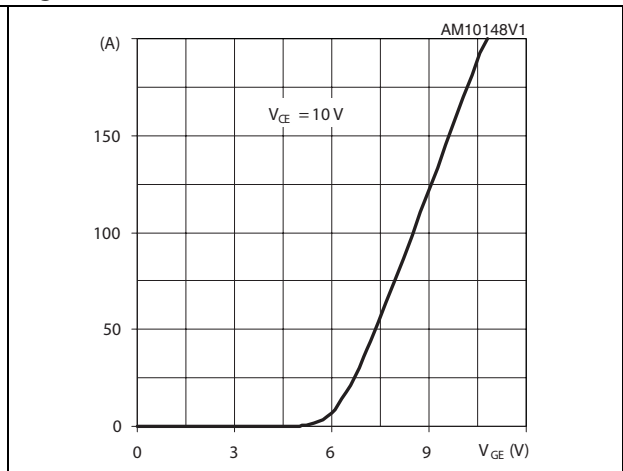


Figure 4. Normalized $V_{CE(sat)}$ vs. I_c

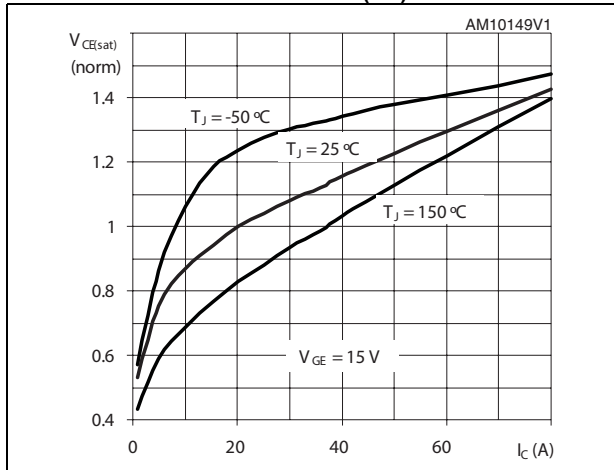


Figure 5. Normalized $V_{CE(sat)}$ vs. temperature

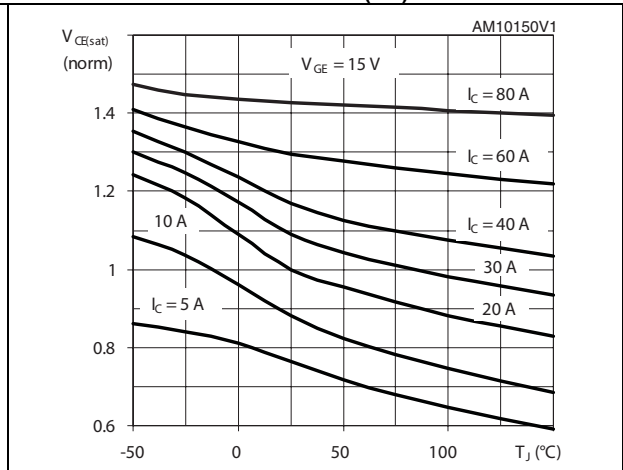


Figure 6. Normalized breakdown voltage vs. temperature

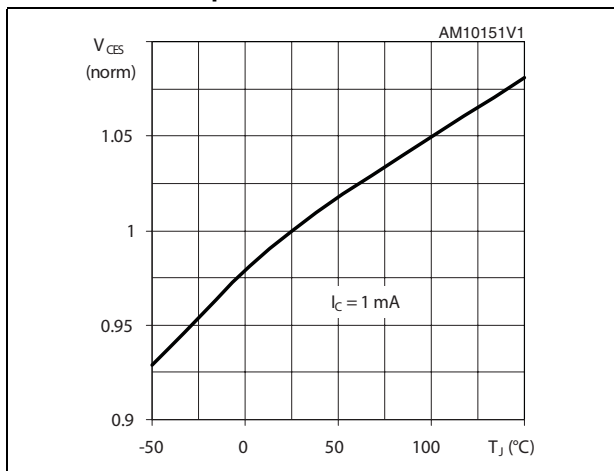


Figure 7. Normalized gate threshold voltage vs. temperature

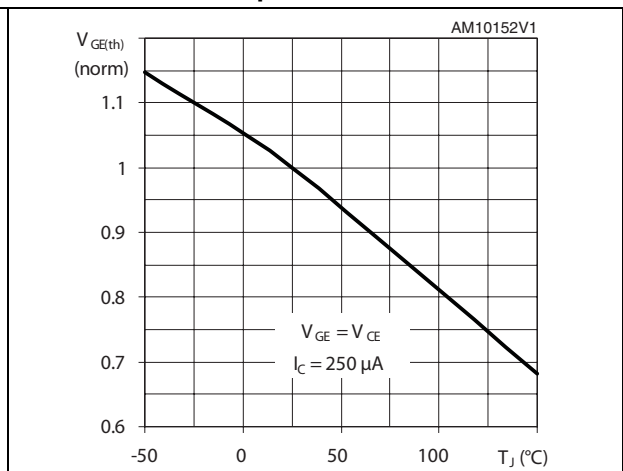


Figure 8. Gate charge vs. gate-emitter voltage

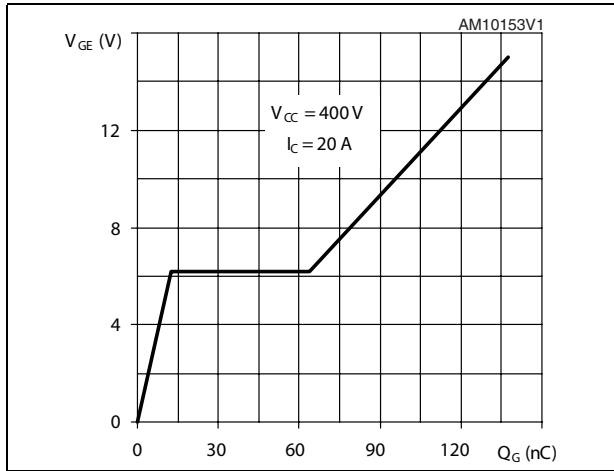


Figure 9. Capacitance variations

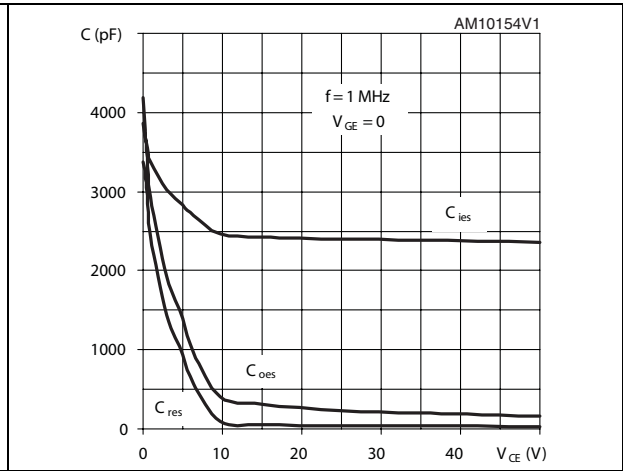


Figure 10. Switching losses vs temperature

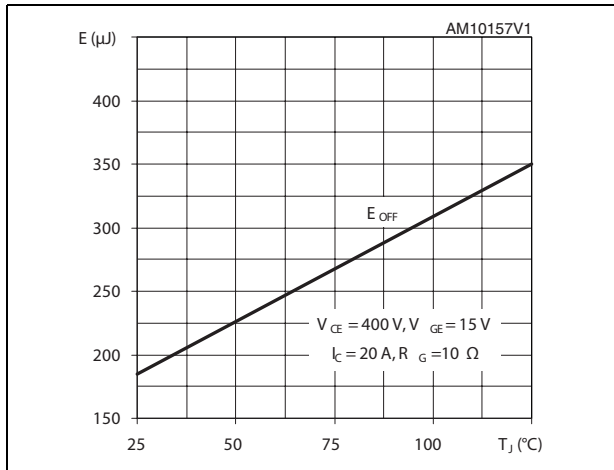


Figure 11. Switching losses vs gate resistance

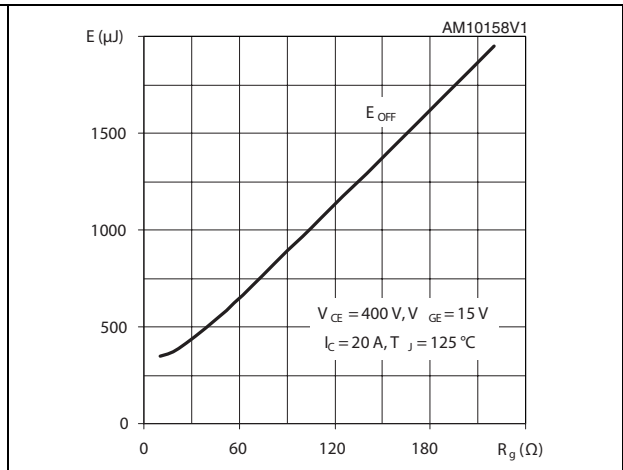


Figure 12. Switching losses vs collector current

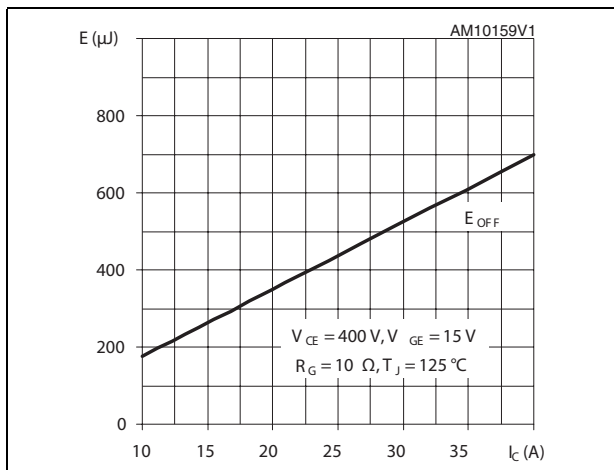


Figure 13. Diode forward on voltage

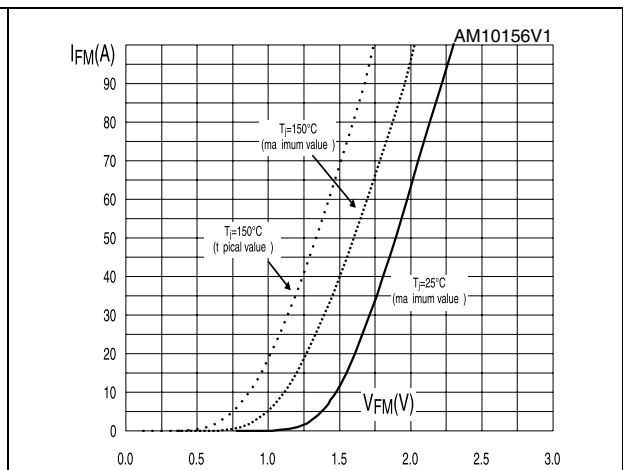


Figure 14. Turn-off SOA

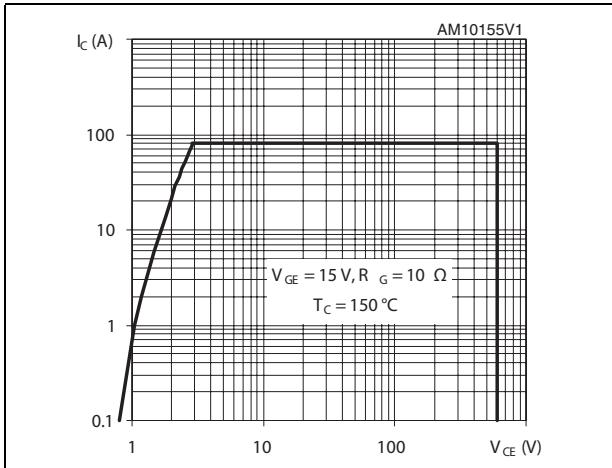
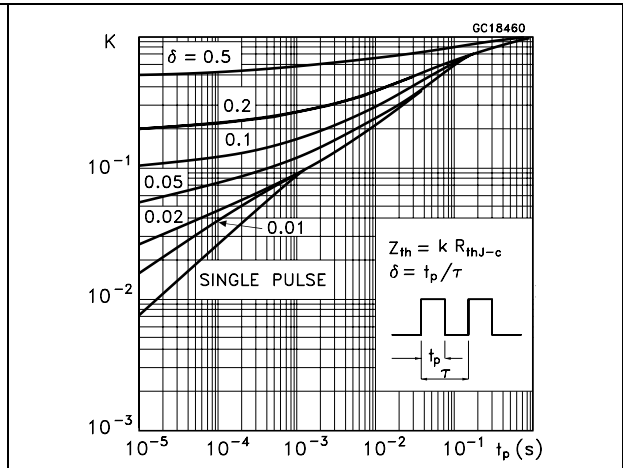


Figure 15. Thermal impedance



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. 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

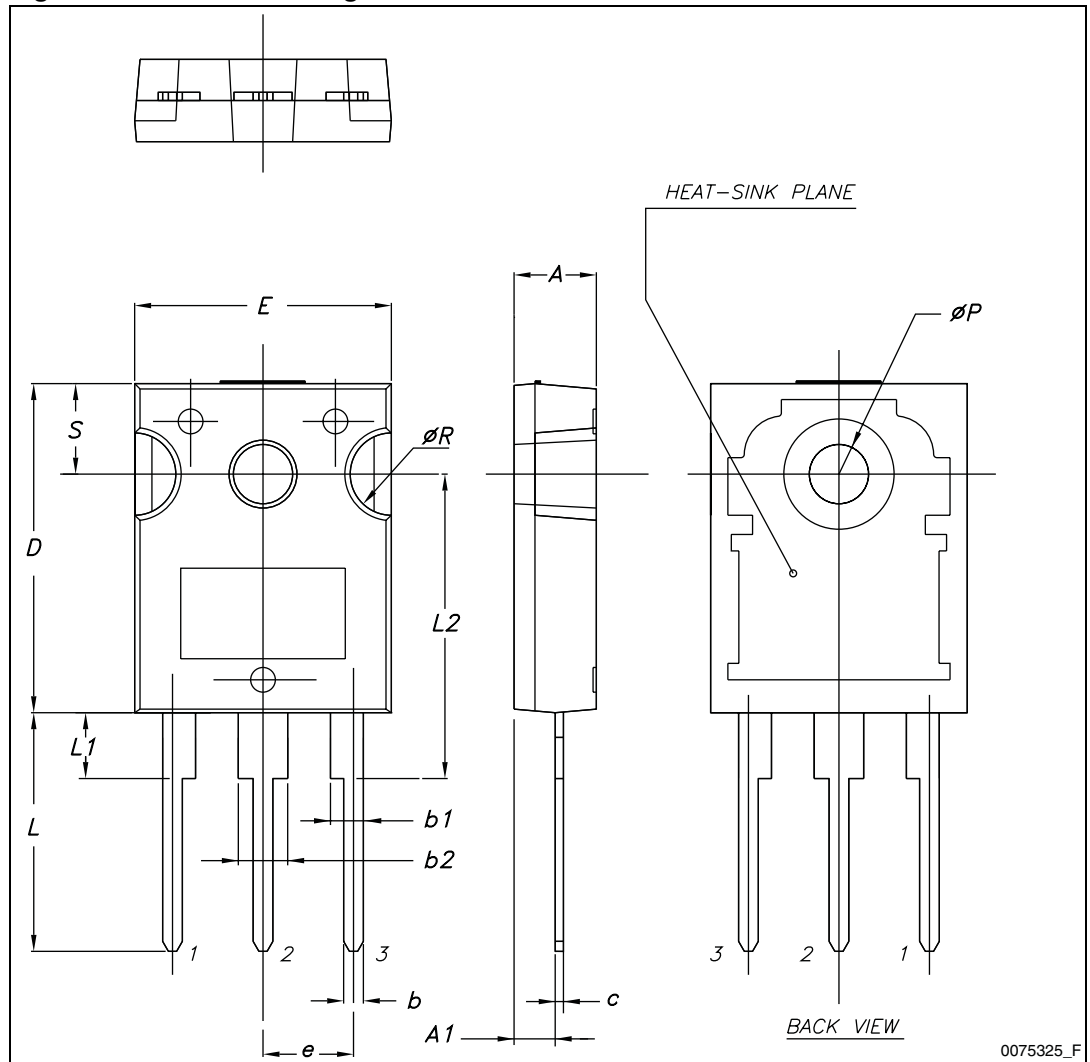
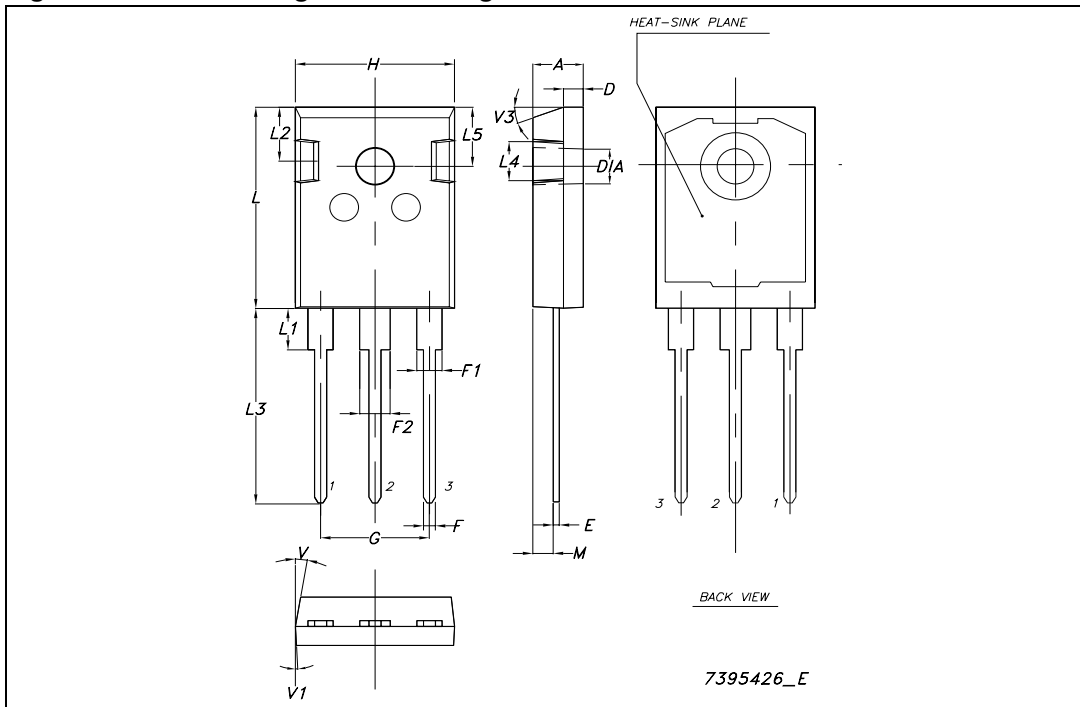


Table 10. TO-247 long leads mechanical data

| 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 Removed watermark. |
| 25-Aug-2011 | 3 | Inserted new <i>Section 2.1: Electrical characteristics (curves)</i> . Updated <i>Section 4: Package mechanical data</i> . Minor text changes. |

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[IHW20N65R5XKSA1](#) [IDW40E65D2FKSA1](#)