

Features

- Improved E_{off} at elevated temperature
- Low C_{RES} / C_{IES} ratio (no cross-conduction susceptibility)

Applications

- High frequency converters
- Power factor correction

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).

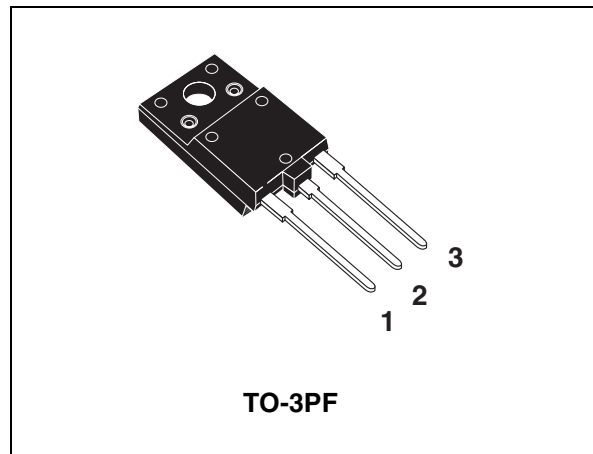


Figure 1. Internal schematic diagram

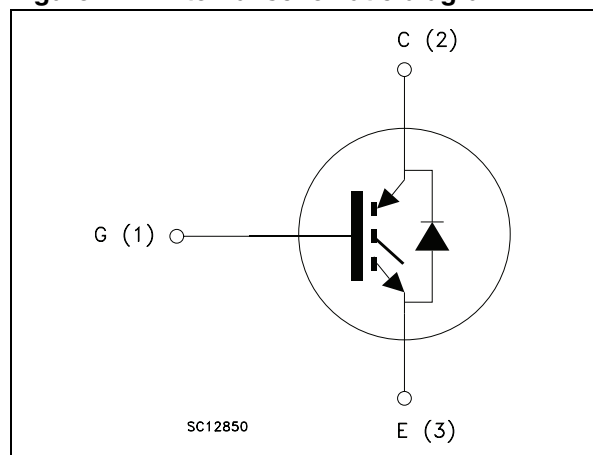


Table 1. Device summary

| Order code | Marking | Package | Packaging |
|--------------|------------|---------|-----------|
| STGFW45HF60W | GFW45HF60W | TO-3PF | Tube |

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 $T_C = 25\text{ °C}$ | 50 | A |
| I_C | Continuous collector current at $T_C = 100\text{ °C}$ | 23 | A |
| $I_{CP}^{(1)}$ | Pulsed collector current | 150 | A |
| $I_{CL}^{(2)}$ | Turn-off latching current | 80 | A |
| V_{GE} | Gate-emitter voltage | ± 20 | V |
| V_{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink ($t = 1\text{ s}$; $T_C = 25\text{ °C}$) | 2500 | V |
| P_{TOT} | Total dissipation at $T_C = 25\text{ °C}$ | 128 | W |
| T_{stg} | Storage temperature | - 55 to 150 | °C |
| T_j | Operating junction temperature | | |

1. Pulse width limited by maximum junction temperature and turn-off within RBSOA
2. $V_{CLAMP} = 80\% (V_{CES})$, $V_{GE} = 15\text{ V}$, $R_G = 10\ \Omega$, $T_j = 150\text{ °C}$

Table 3. Thermal data

| Symbol | Parameter | Value | Unit |
|----------------|---------------------------------------|-------|------|
| $R_{thj-case}$ | Thermal resistance junction-case IGBT | 0.97 | °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 | $V_{GE} = 15\text{ V}$, $I_C = 30\text{ A}$ $V_{GE} = 15\text{ V}$, $I_C = 30\text{ A}$, $T_J = 125\text{ °C}$ | | 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 ($V_{GE} = 0$) | $V_{CE} = 600\text{ V}$ $V_{CE} = 600\text{ V}$, $T_J = 125\text{ °C}$ | | | 500 5 | μA mA |
| I_{GES} | Gate-emitter leakage current ($V_{CE} = 0$) | $V_{GE} = \pm 20\text{ V}$ | | | ± 100 | nA |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------|------------------------------|--|------|------|------|------|
| C_{ies} | Input capacitance | $V_{CE} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GE} = 0$ | - | 2900 | - | pF |
| C_{oes} | Output capacitance | | | 260 | | |
| C_{res} | Reverse transfer capacitance | | | 55 | | |
| Q_g | Total gate charge | $V_{CE} = 400\text{ V}$, $I_C = 30\text{ A}$, $V_{GE} = 15\text{ V}$, Figure 16 | - | 160 | - | nC |
| Q_{ge} | Gate-emitter charge | | | 17 | | nC |
| Q_{gc} | Gate-collector charge | | | 65 | | nC |

Table 6. Switching on/off (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|-----------------------|--|------|------|------|------------|
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 400\text{ V}$, $I_C = 30\text{ A}$ | - | 30 | - | ns |
| t_r | Current rise time | $R_G = 6.8\ \Omega$, $V_{GE} = 15\text{ V}$, | - | 12 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | (<i>Figure 15</i>) | - | 2600 | - | A/ μ s |
| $t_{d(on)}$ | Turn-on delay time | $V_{CC} = 400\text{ V}$, $I_C = 30\text{ A}$ | - | 30 | - | ns |
| t_r | Current rise time | $R_G = 6.8\ \Omega$, $V_{GE} = 15\text{ V}$, | - | 14 | - | ns |
| $(di/dt)_{on}$ | Turn-on current slope | $T_J = 125\text{ }^\circ\text{C}$ (<i>Figure 15</i>) | - | 2200 | - | A/ μ s |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 400\text{ V}$, $I_C = 30\text{ A}$, | - | 30 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | $R_G = 6.8\ \Omega$, $V_{GE} = 15\text{ V}$ | - | 145 | - | ns |
| t_f | Current fall time | (<i>Figure 15</i>) | - | 50 | - | ns |
| $t_r(V_{off})$ | Off voltage rise time | $V_{CC} = 400\text{ V}$, $I_C = 30\text{ A}$, | - | 47 | - | ns |
| $t_{d(off)}$ | Turn-off delay time | $R_G = 6.8\ \Omega$, $V_{GE} = 15\text{ V}$, | - | 185 | - | ns |
| t_f | Current fall time | $T_J = 125\text{ }^\circ\text{C}$ | - | 65 | - | ns |
| | | (<i>Figure 15</i>) | | | | |

Table 7. Switching energy (inductive load)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|---------------------------|--|------|------|------|---------|
| $E_{on}^{(1)}$ | Turn-on switching losses | $V_{CC} = 400\text{ V}$, $I_C = 30\text{ A}$ | - | 200 | - | μ J |
| E_{off} | Turn-off switching losses | $R_G = 6.8\ \Omega$, $V_{GE} = 15\text{ V}$, | - | 330 | - | μ J |
| E_{ts} | Total switching losses | (<i>Figure 17</i>) | - | 530 | - | μ J |
| $E_{on}^{(1)}$ | Turn-on switching losses | $V_{CC} = 400\text{ V}$, $I_C = 30\text{ A}$ | - | 230 | - | μ J |
| E_{off} | Turn-off switching losses | $R_G = 6.8\ \Omega$, $V_{GE} = 15\text{ V}$, | - | 550 | 800 | μ J |
| E_{ts} | Total switching losses | $T_J = 125\text{ }^\circ\text{C}$ (<i>Figure 17</i>) | - | 780 | - | μ J |

1. E_{on} is the turn-on losses when a typical diode is used in the test circuit in *Figure 16*. If the IGBT is offered in a package with a co-pak diode, the co-pak diode is used as external diode. IGBTs & Diode are at the same temperature (25 °C and 125 °C). E_{on} includes diode recovery energy.
If the IGBT is offered in a package without the co-pak diode, a SiC diode is used in the test circuit in *Figure 16*.

2.1 Electrical characteristics (curves)

Figure 2. Output characteristics

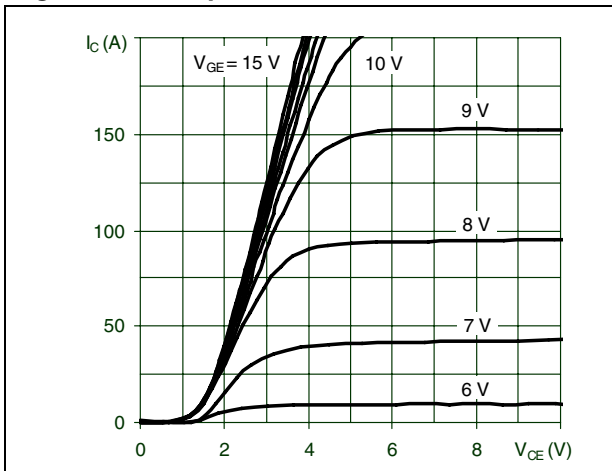


Figure 3. Transfer characteristics

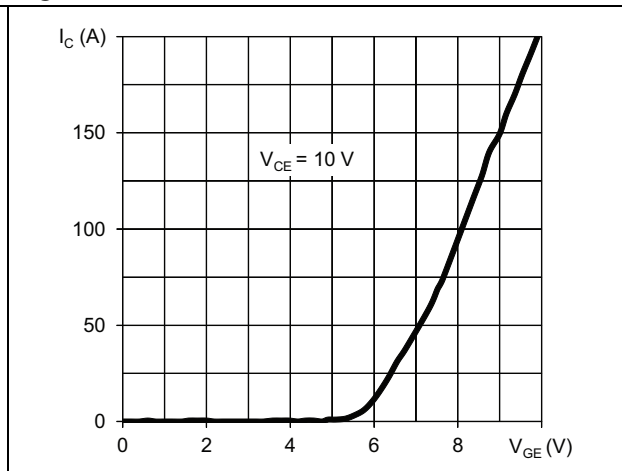


Figure 4. Normalized $V_{CE(sat)}$ vs. I_C

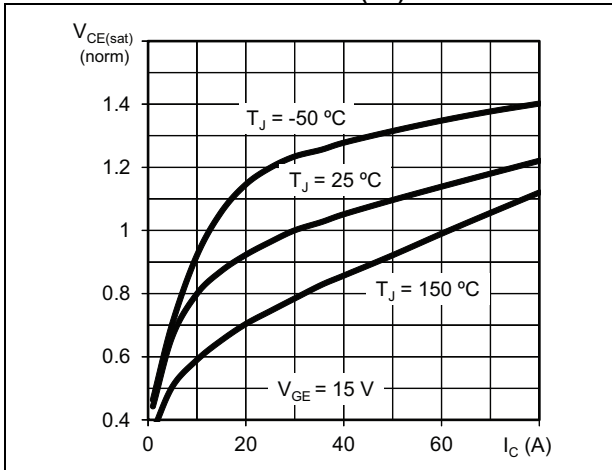


Figure 5. Normalized $V_{CE(sat)}$ vs. temperature

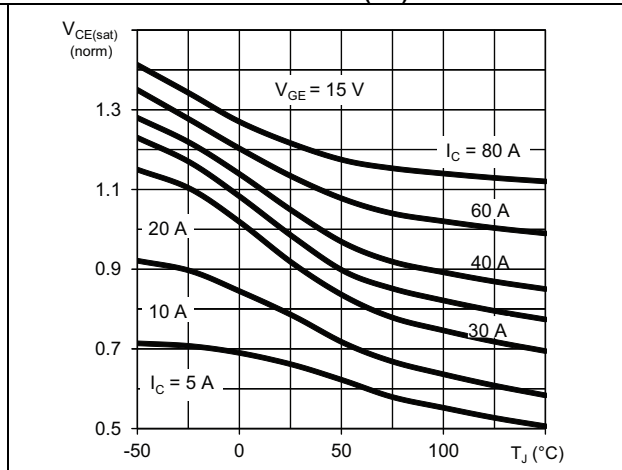


Figure 6. Normalized breakdown voltage vs. temperature

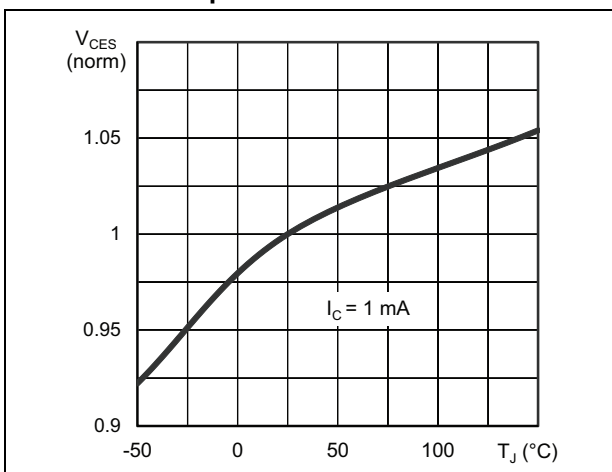


Figure 7. Normalized gate threshold voltage vs. temperature

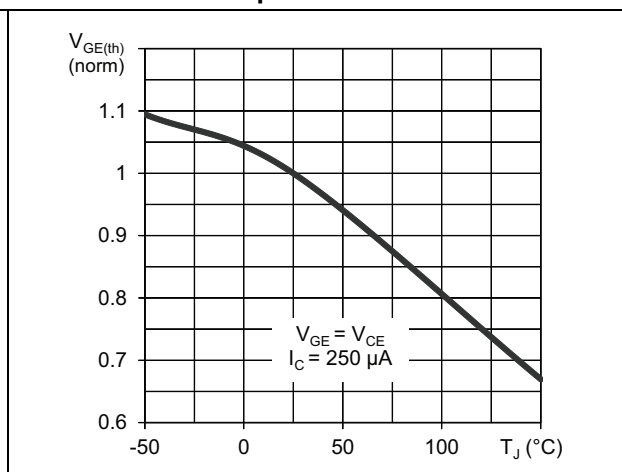


Figure 8. Gate charge vs. gate-emitter voltage

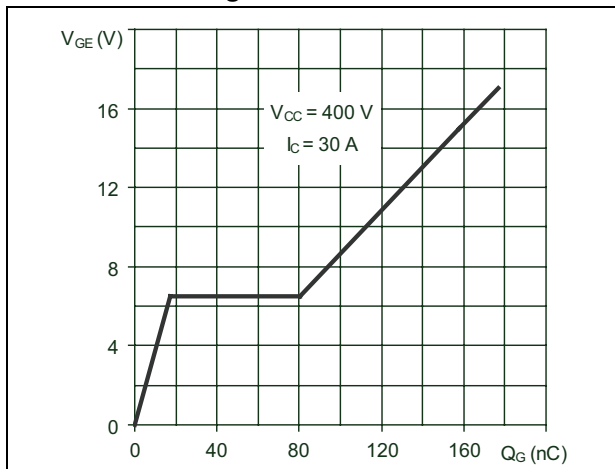


Figure 9. Capacitance variations

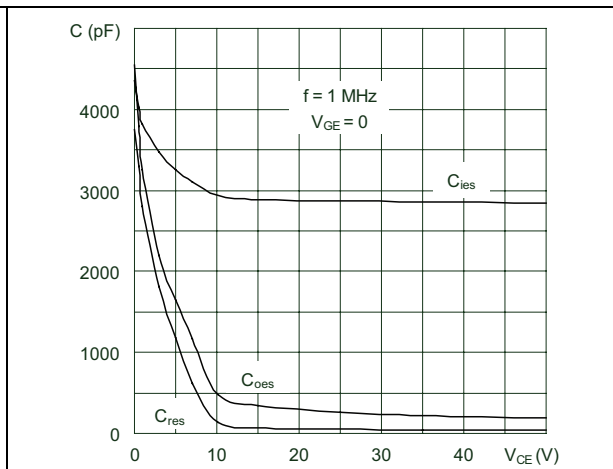


Figure 10. Switching losses vs temperature

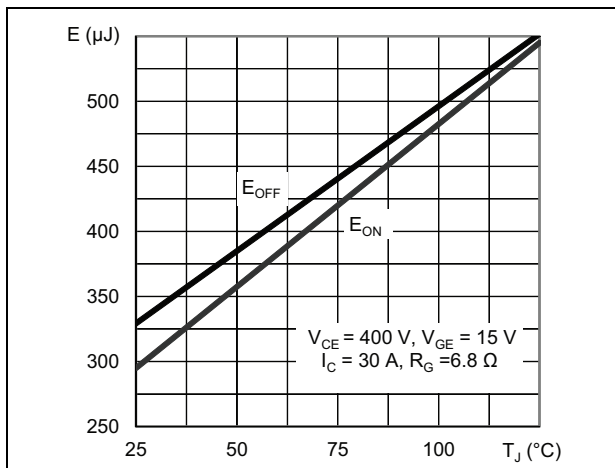


Figure 11. Switching losses vs. gate resistance

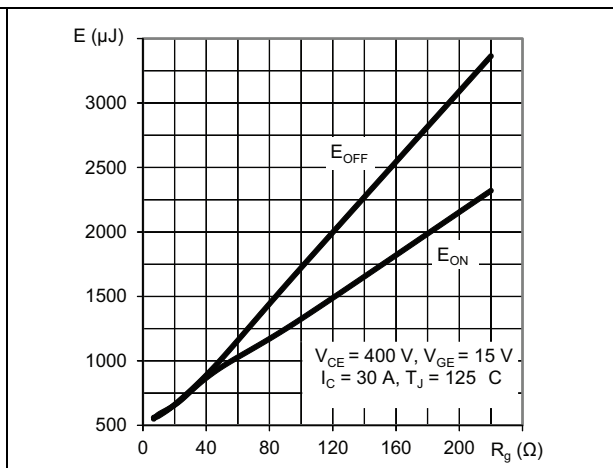


Figure 12. Switching losses vs. collector current

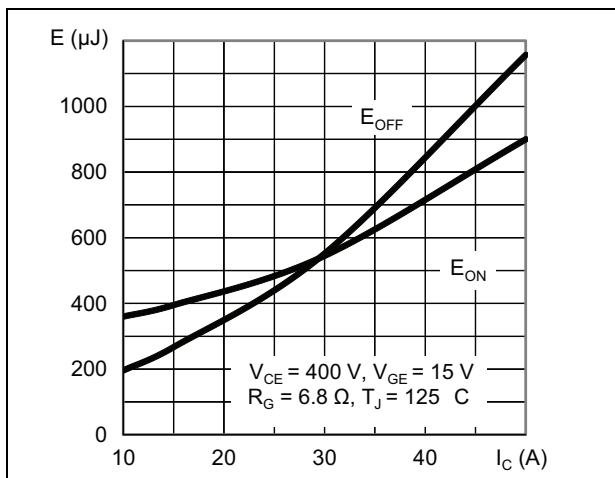


Figure 13. Turn-off SOA

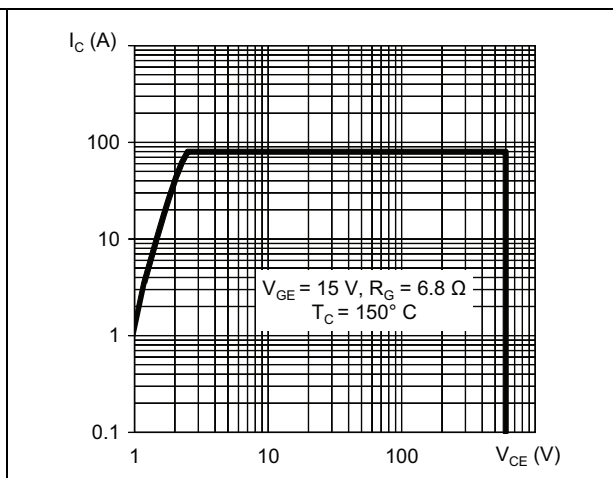
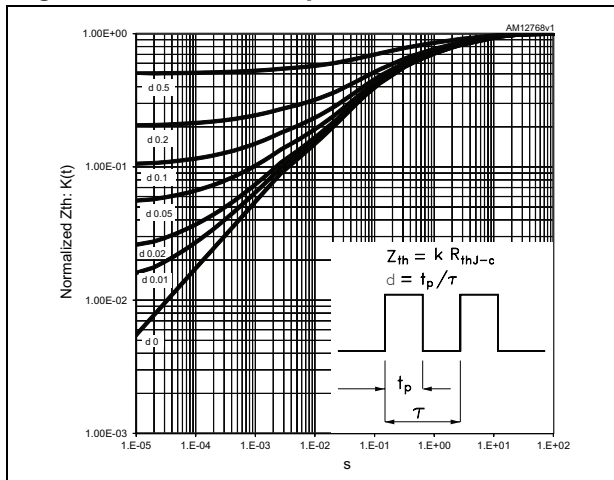


Figure 14. Thermal impedance



3 Test circuits

Figure 15. Test circuit for inductive load switching

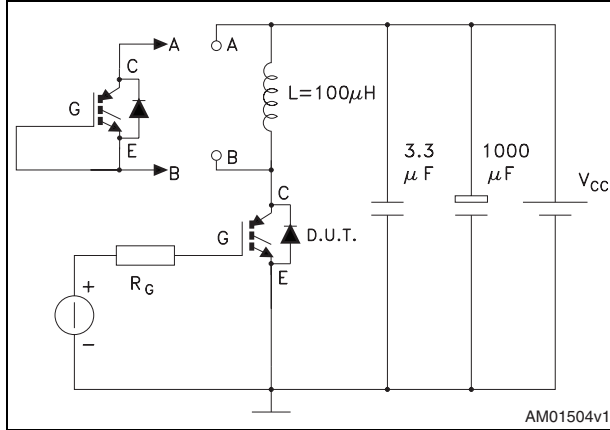


Figure 16. Gate charge test circuit

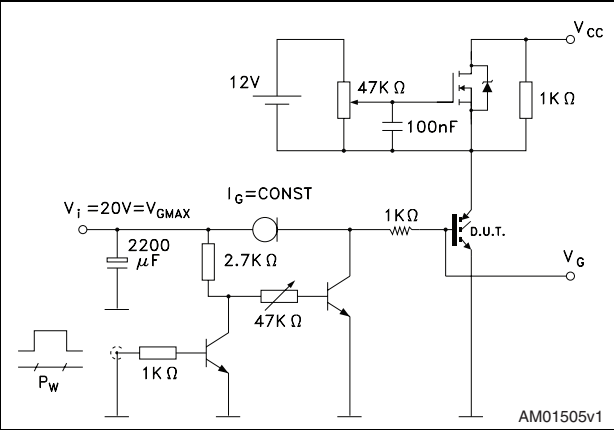
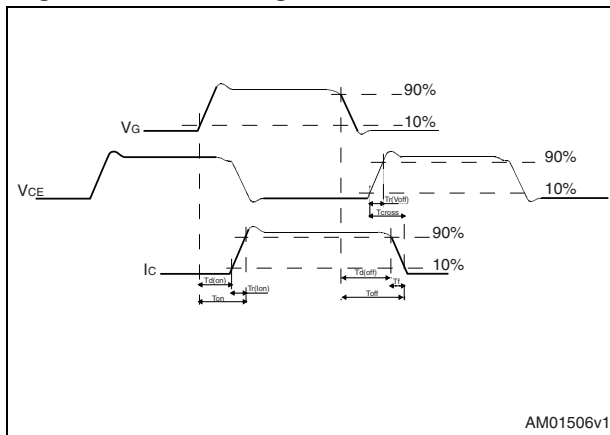


Figure 17. Switching waveform



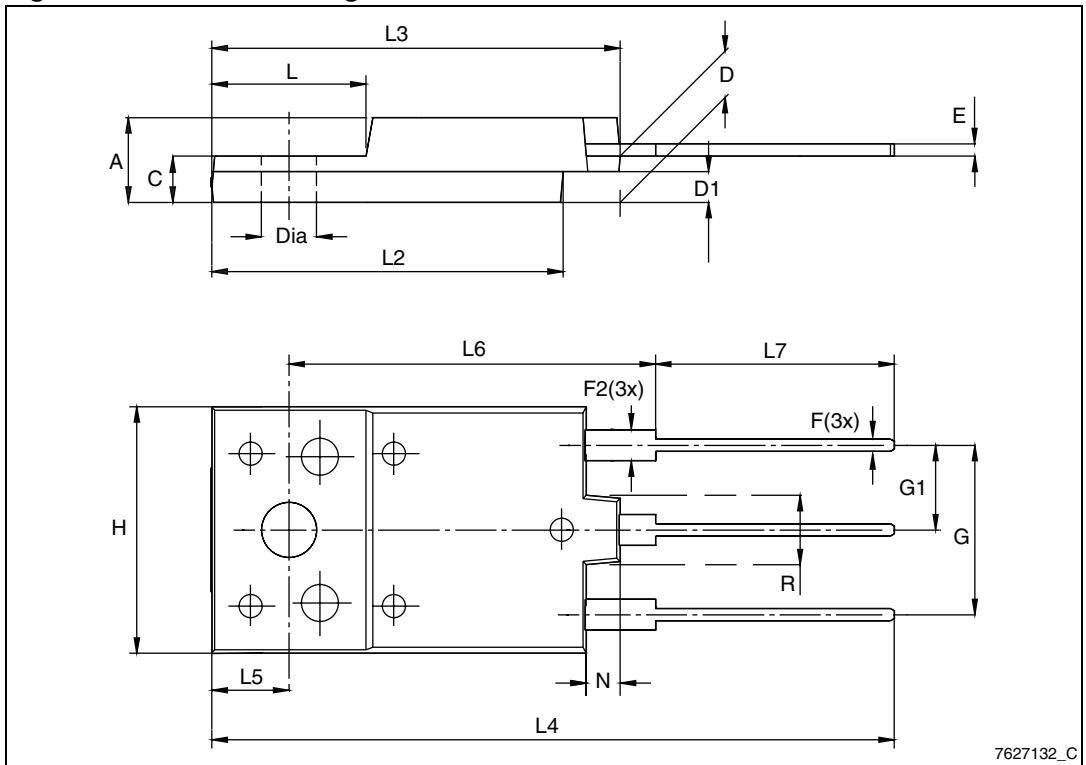
4 Package mechanical data

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. ECOPACK is an ST trademark.

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 |

Figure 18. TO-3PF drawing



7627132_C

5 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|------------------|
| 24-Jul-2012 | 1 | Initial release. |

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