

1. General description

WG50N65LAW1 uses advanced Fine Trench Field-stop IGBT technology with anti-parallel diode in TO247 package to provide extremely low $V_{CE(sat)}$, and minimal switching performance. This device is ideal for low switching frequency power conversion applications.



2. Features and benefits

- Maximum junction temperature 175 °C
- Positive Temperature efficient for Easy Parallel Operating
- Very soft, fast recovery anti-parallel diode
- Low saturation Voltage $V_{CE(sat)} = 1.3$ V(Typ.) @ $I_C = 50$ A
- EMI Improved Design

3. Applications

- Solar Converters
- UPS, ESS
- PFC
- Converters

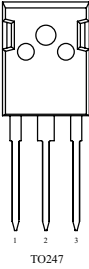
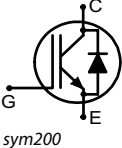
4. Quick reference data

Table 1. Quick reference data

| Symbol | Parameter | Notes | Value | | | Unit | |
|-------------------------------|-----------------------------------------------------------------|----------------------------------------------|-------|-----|-----|------|------|
| V_{CE} | Collector-emitter voltage, $T_j \geq 25$ °C | | 650 | | | V | |
| I_C | DC collector current, limited by $T_{j(max)}$ $T_C = 100$ °C | | 50 | | | A | |
| Symbol | Parameter | Conditions | Notes | Min | Typ | Max | Unit |
| Static characteristics | | | | | | | |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15$ V; $I_C = 50$ A; $T_j = 25$ °C | | - | 1.3 | 1.55 | V |

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|-----|--------|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| 1 | G | gate |  <p style="text-align: center;">TO247</p> |  <p style="text-align: center;"><i>sym200</i></p> |
| 2 | C | collector | | |
| 3 | E | emitter | | |
| mb | C | mounting base; connected to collector | | |

6. Ordering information

Table 3. Ordering information

| Type number | Package Name | Orderable part number | Packing method | Small packing quantity | Package version | Package issue date |
|-------------|--------------|-----------------------|----------------|------------------------|-----------------|--------------------|
| WG50N65LAW1 | TO247 | WG50N65LAW1Q | Tube | 30 | SOT429 | 25-Mar-2013 |

7. Marking

Table 4. Marking codes

| Type number | Marking codes |
|-------------|----------------|
| WG50N65LAW1 | G50N65 LAW1 |

8. Limiting values

Table 5. Limiting values

| Symbol | Parameter | Notes | Value | Unit |
|---------------|----------------------------------------------------------------------------------------------------------------------|-------|-------------|------|
| V_{CE} | Collector-emitter voltage, $T_j \geq 25\text{ °C}$ | | 650 | V |
| I_C | DC collector current, limited by $T_{j(max)}$ $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$ | | 100 50 | A |
| $I_{C(puls)}$ | Pulsed collector current, t_p limited by $T_{j(max)}$ | | 150 | A |
| - | Turn off safe operating area $V_{CE} \leq 650\text{ V}$, $T_j \leq 175\text{ °C}$, $t_p = 1\text{ }\mu\text{s}$ | | 150 | A |
| I_F | Diode forward current, limited by $T_{j(max)}$ $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$ | | 60 30 | A |
| I_{Fpuls} | Diode pulsed current, t_p limited by $T_{j(max)}$ | | 120 | A |
| V_{GE} | Gate-emitter voltage | | ± 20 | V |
| P_{tot} | Power dissipation $T_C = 25\text{ °C}$ Power dissipation $T_C = 100\text{ °C}$ | | 454 227 | W |
| T_{stg} | Storage temperature | | -55 to +150 | °C |
| T_{jmax} | Maximum operating junction temperature | | 175 | °C |
| - | Peak soldering temperature | | 260 | °C |
| M | Mounting Torque with washer | | 0.55 | Nm |

9. Thermal characteristics

Table 6. Thermal characteristics

| Symbol | Parameter | Conditions | Notes | Min | Typ | Max | Unit |
|---------------|------------------------------------------------|------------|-------|-----|------|-----|------|
| $R_{th(j-c)}$ | IGBT thermal resistance from junction to case | | | - | 0.33 | - | K/W |
| $R_{th(j-c)}$ | Diode thermal resistance from junction to case | | | - | 0.94 | - | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | | | - | 40 | - | K/W |

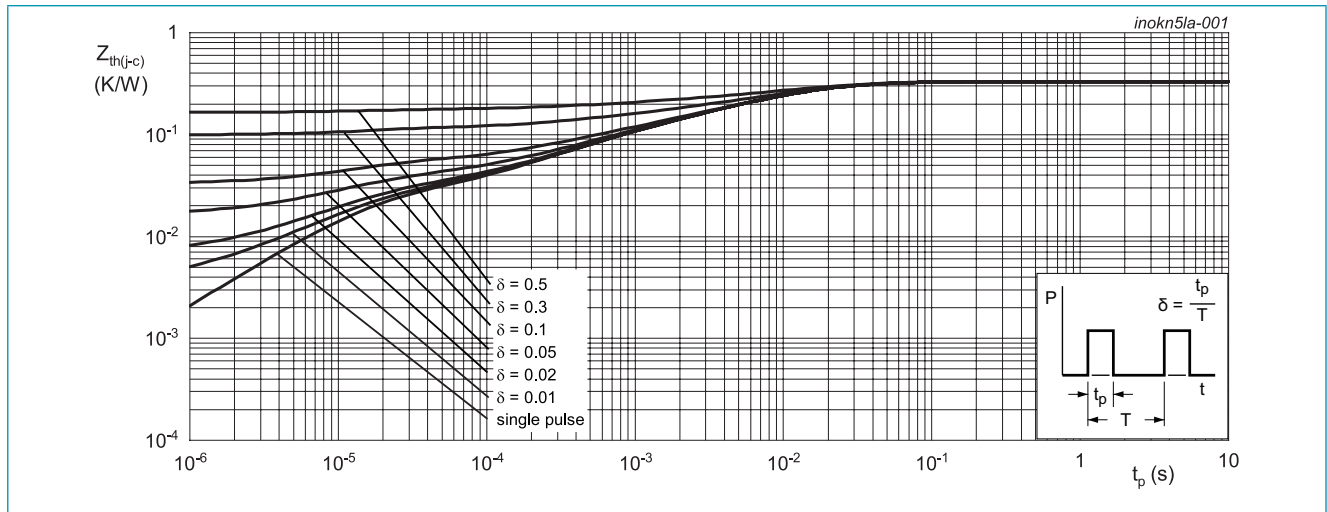


Fig. 1. Transient thermal impedance from junction to case as a function of pulse duration; IGBT

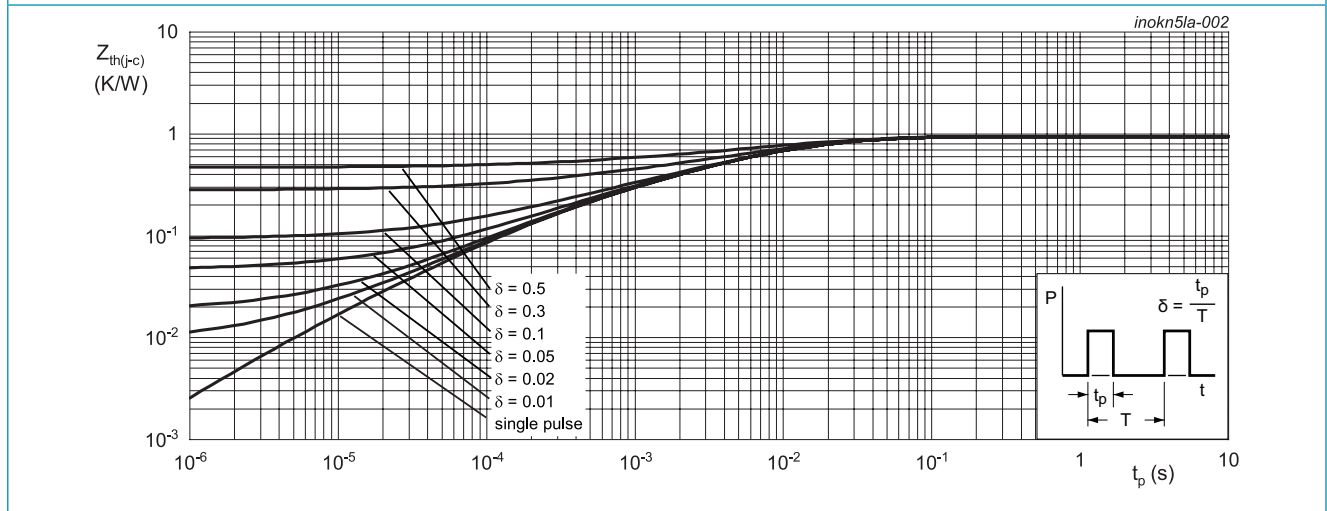


Fig. 2. Transient thermal impedance from junction to case as a function of pulse duration; Diode

10. Characteristics

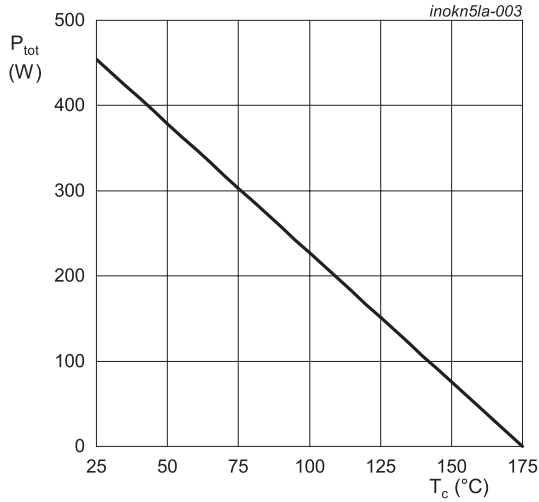
Table 7. Characteristics

| Symbol | Parameter | Conditions | Notes | Min | Typ | Max | Unit |
|--------------------------------|--------------------------------------|--------------------------------------------------------------------------------------------------|-------|-----|------|------|---------------|
| Static characteristics | | | | | | | |
| BV_{CES} | Collector-emitter breakdown voltage | $V_{GE} = 0\text{ V}; I_C = 50\ \mu\text{A}$ | | 650 | - | - | V |
| $V_{CE(sat)}$ | Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}; I_C = 50\text{ A}; T_j = 25\text{ }^\circ\text{C}$ | | - | 1.3 | 1.55 | V |
| | | $V_{GE} = 15\text{ V}; I_C = 50\text{ A}; T_j = 175\text{ }^\circ\text{C}$ | | - | 1.5 | - | V |
| V_F | Diode forward voltage | $V_{GE} = 0\text{ V}; I_F = 30\text{ A}; T_j = 25\text{ }^\circ\text{C}$ | | - | 1.9 | - | V |
| | | $V_{GE} = 0\text{ V}; I_F = 30\text{ A}; T_j = 175\text{ }^\circ\text{C}$ | | - | 1.5 | - | V |
| $V_{GE(th)}$ | Gate-emitter threshold voltage | $I_C = 0.5\text{ mA}; V_{CE} = V_{GE}$ | | 4 | 5 | 6 | V |
| I_{CES} | Zero gate voltage collector current | $V_{CE} = 650\text{ V}; V_{GE} = 0\text{ V}; T_j = 25\text{ }^\circ\text{C}$ | | - | - | 100 | μA |
| | | $V_{CE} = 650\text{ V}; V_{GE} = 0\text{ V}; T_j = 175\text{ }^\circ\text{C}$ | | - | - | 1 | mA |
| g_{fs} | Transconductance | $V_{CE} = 20\text{ V}; I_C = 50\text{ A}$ | | - | 60 | - | S |
| Dynamic characteristics | | | | | | | |
| C_{ies} | Input capacitance | $V_{CE} = 30\text{ V}; V_{GE} = 0\text{ V}; f = 1\text{ MHz}; T_j = 25\text{ }^\circ\text{C}$ | | - | 5571 | - | pF |
| C_{oes} | Output capacitance | | | - | 92 | - | pF |
| C_{res} | Reverse transfer capacitance | | | - | 65 | - | pF |
| Q_G | Gate charge | $V_{CC} = 520\text{ V}; I_C = 50\text{ A}; V_{GE} = 15\text{ V}; T_j = 25\text{ }^\circ\text{C}$ | | - | 237 | - | nC |

11. Switching Characteristics

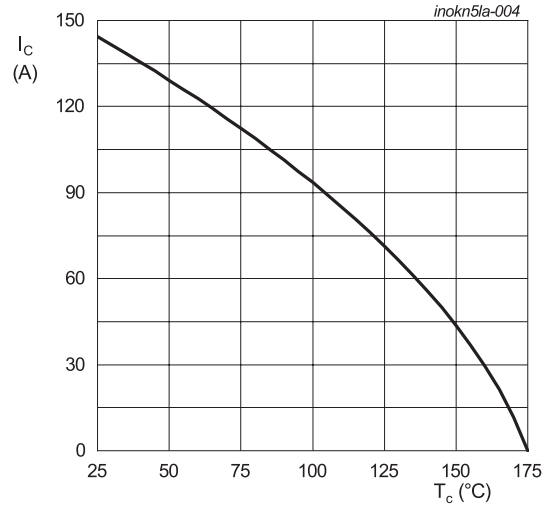
Table 8. Switching Characteristics, Inductive Load

| Symbol | Parameter | Conditions | Notes | Min | Typ | Max | Unit |
|------------------------------|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-------|-----|------|-----|------|
| IGBT characteristics | | | | | | | |
| $t_{d(on)}$ | Turn-on delay time | $T_J = 25\text{ }^\circ\text{C};$ $V_{CC} = 400\text{ V}; I_C = 50\text{ A}; V_{GE} = 15\text{V} / 0\text{V};$ $R_G = 10\ \Omega$ | | - | 54 | - | nS |
| t_r | Rise time | | | - | 49 | - | nS |
| $t_{d(off)}$ | Turn-off delay time | | | - | 342 | - | nS |
| t_f | Fall time | | | - | 76 | - | nS |
| E_{on} | Turn-on energy | | | - | 1.18 | - | mJ |
| E_{off} | Turn-off energy | | | - | 1.12 | - | mJ |
| E_{ts} | Total switching energy | | | - | 2.3 | - | mJ |
| $t_{d(on)}$ | Turn-on delay time | $T_J = 175\text{ }^\circ\text{C};$ $V_{CC} = 400\text{ V}; I_C = 50\text{ A}; V_{GE} = 15\text{V} / 0\text{V};$ $R_G = 10\ \Omega$ | | - | 49 | - | nS |
| t_r | Rise time | | | - | 50 | - | nS |
| $t_{d(off)}$ | Turn-off delay time | | | - | 388 | - | nS |
| t_f | Fall time | | | - | 122 | - | nS |
| E_{on} | Turn-on energy | | | - | 1.66 | - | mJ |
| E_{off} | Turn-off energy | | | - | 1.56 | - | mJ |
| E_{ts} | Total switching energy | | | - | 3.22 | - | mJ |
| Diode characteristics | | | | | | | |
| t_{rr} | Reverse recovery time | $T_J = 25\text{ }^\circ\text{C};$ $V_R = 400\text{ V}; I_F = 30\text{ A}; di_F/dt = 500\text{A/us}$ | | - | 44 | - | nS |
| Q_r | Reverse recovery charge | | | - | 221 | - | nC |
| I_{RM} | Reverse recovery peak current | | | - | 9 | - | A |
| t_{rr} | Reverse recovery time | $T_J = 175\text{ }^\circ\text{C};$ $V_R = 400\text{ V}; I_F = 30\text{ A}; di_F/dt = 500\text{A/us}$ | | - | 100 | - | nS |
| Q_r | Reverse recovery charge | | | - | 990 | - | nC |
| I_{RM} | Reverse recovery peak current | | | - | 17 | - | A |



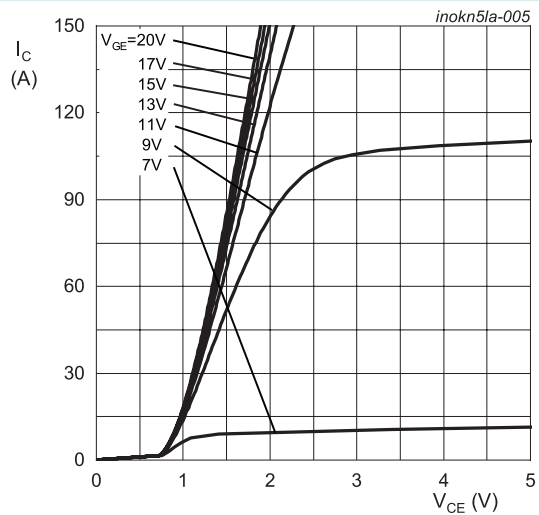
$T_j \leq 175 \text{ }^\circ\text{C}$

Fig. 3. Power dissipation as a function of case temperature



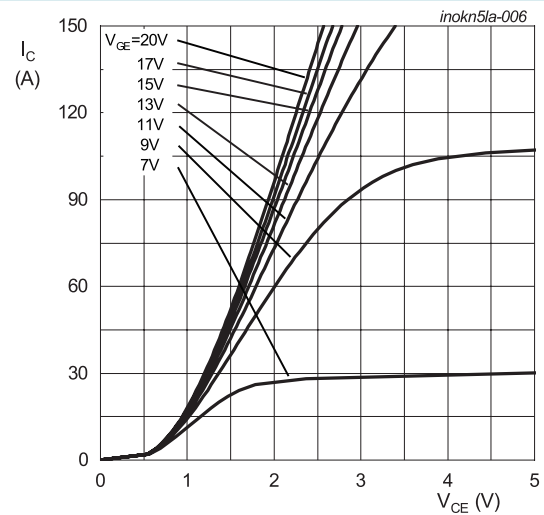
$V_{GE} \geq 15 \text{ V}; T_j \leq 175 \text{ }^\circ\text{C}$

Fig. 4. Collector current as a function of case temperature



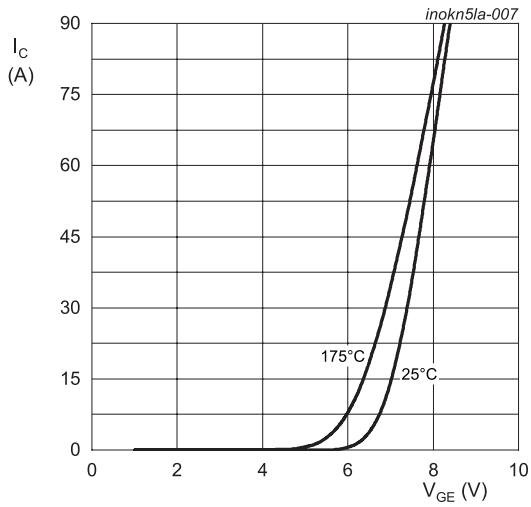
$T_j = 25 \text{ }^\circ\text{C}$

Fig. 5. Typical output characteristic

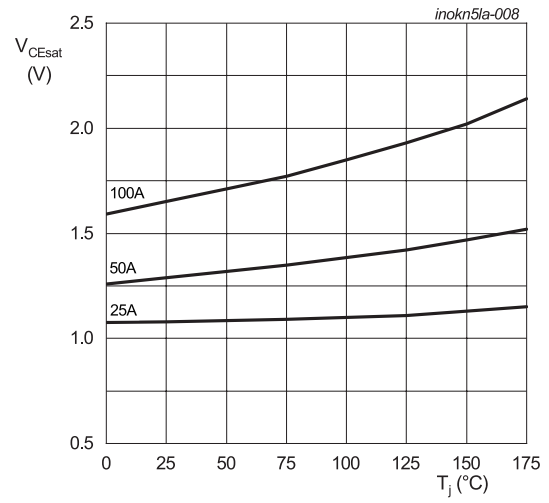


$T_j = 175 \text{ }^\circ\text{C}$

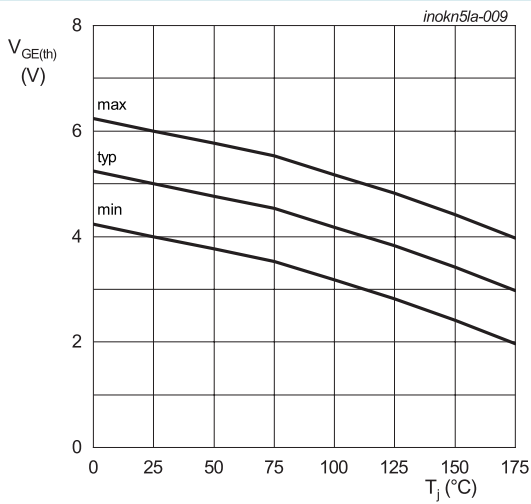
Fig. 6. Typical output characteristic



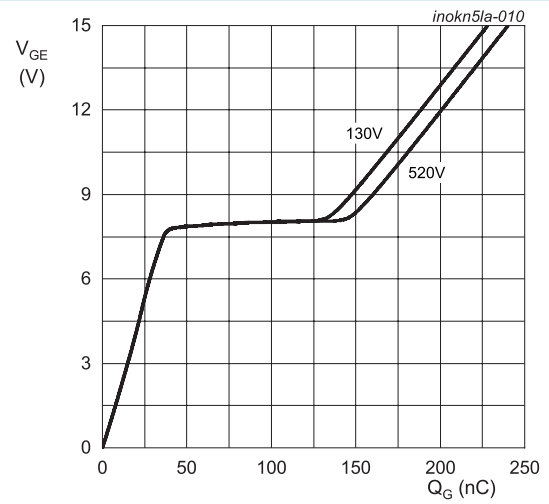
$V_{CE} = 20\text{ V}$
Fig. 7. Typical transfer characteristic



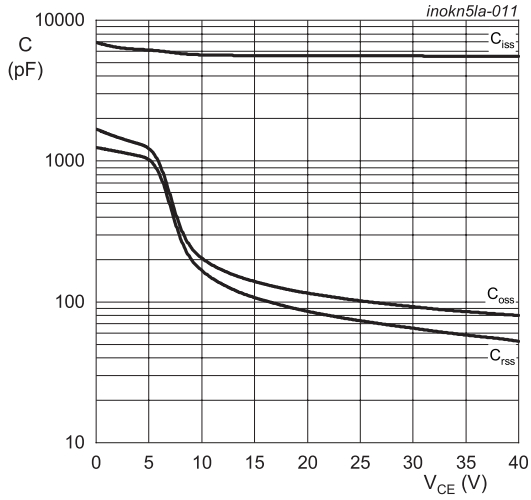
$V_{GE} = 15\text{ V}$
Fig. 8. Typical collector-emitter saturation voltage as a function of junction temperature



$I_C = 500\ \mu\text{A}$
Fig. 9. Gate-emitter threshold voltage as a function of junction temperature



$I_C = 50\text{ A}$
Fig. 10. Typical gate charge



$V_{GE} = 0\text{ V}; f = 1\text{ MHz}$

Fig. 11. Typical capacitance as a function of collector-emitter voltage

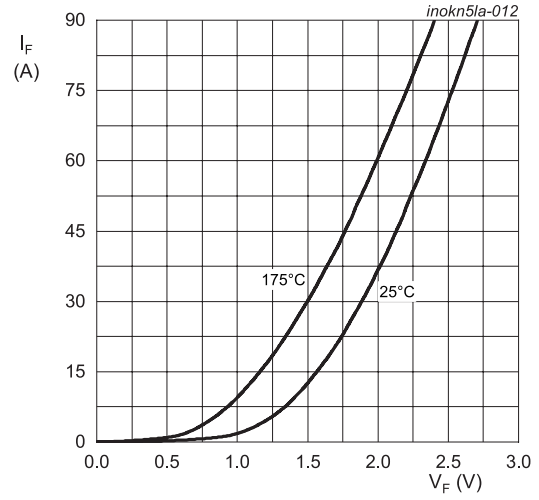
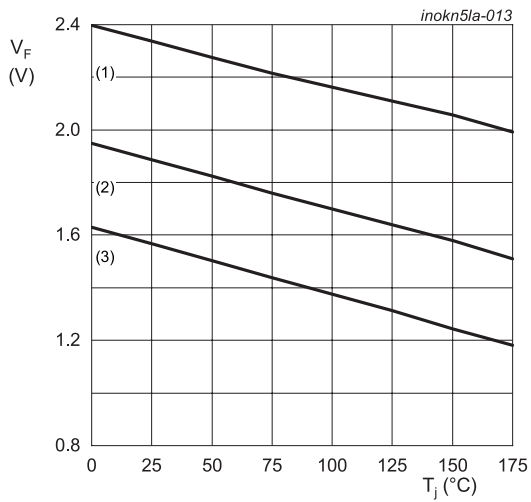
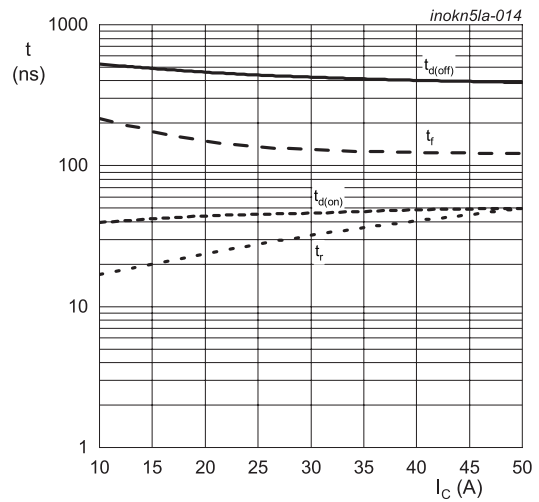


Fig. 12. Typical diode forward current as a function of forward voltage



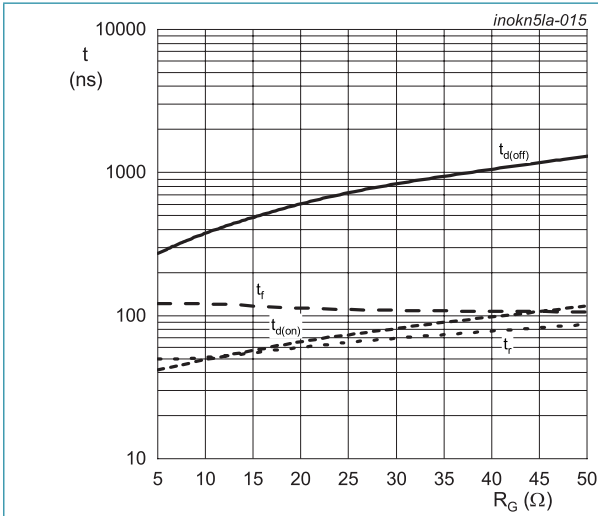
- (1) $I_F = 60\text{ A}$
- (2) $I_F = 30\text{ A}$
- (3) $I_F = 15\text{ A}$

Fig. 13. Typical diode forward voltage as a function of junction temperature



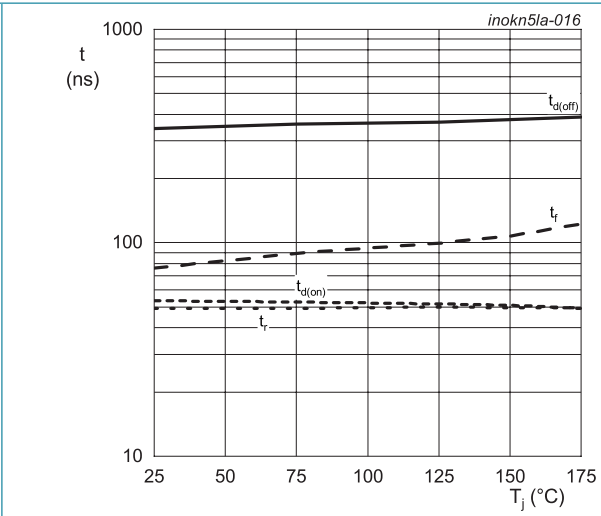
$R_g = 10\ \Omega; V_{GE} = 15\text{V}/0\text{V}; T_j = 175\text{ }^\circ\text{C};$
 $V_{CE} = 400\text{ V};$ inductive load

Fig. 14. Typical switching times as a function of collector current



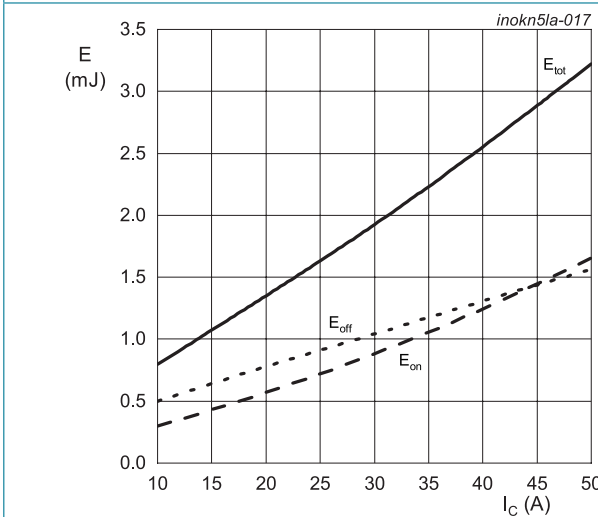
$I_C = 50 \text{ A}$; $V_{GE} = 15\text{V}/0\text{V}$; $T_J = 175 \text{ }^\circ\text{C}$;
 $V_{CE} = 400 \text{ V}$; inductive load

Fig. 15. Typical switching times as a function of gate resistance



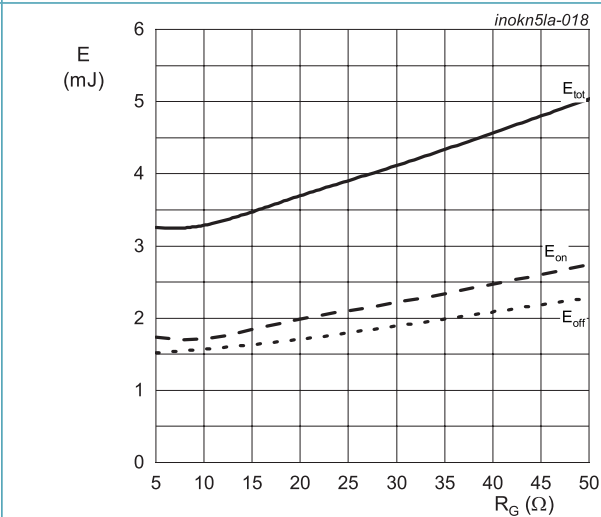
$I_C = 50 \text{ A}$; $V_{GE} = 15\text{V}/0\text{V}$; $R_g = 10 \text{ } \Omega$;
 $V_{CE} = 400 \text{ V}$; inductive load

Fig. 16. Typical switching times as a function of junction temperature



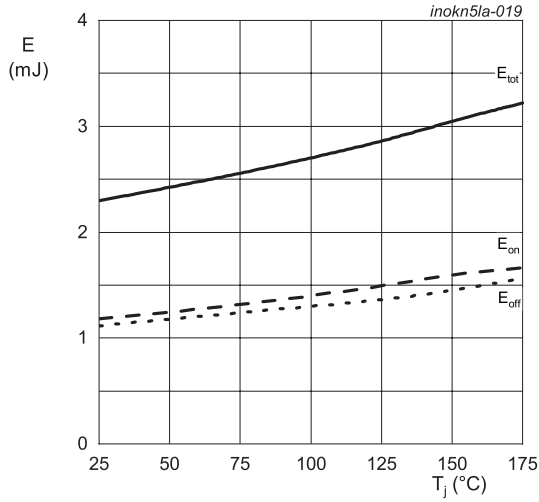
$R_g = 10 \text{ } \Omega$; $V_{GE} = 15\text{V}/0\text{V}$; $T_J = 175 \text{ }^\circ\text{C}$;
 $V_{CE} = 400 \text{ V}$; inductive load

Fig. 17. Typical switching energy losses as a function of collector current



$I_C = 50 \text{ A}$; $V_{GE} = 15\text{V}/0\text{V}$; $T_J = 175 \text{ }^\circ\text{C}$;
 $V_{CE} = 400 \text{ V}$; inductive load

Fig. 18. Typical switching energy losses as a function of gate resistance



$I_C = 50\text{ A}$; $V_{GE} = 15\text{V}/0\text{V}$; $R_g = 10\ \Omega$;
 $V_{CE} = 400\text{ V}$; inductive load

Fig. 19. Typical switching energy losses as a function of junction temperature

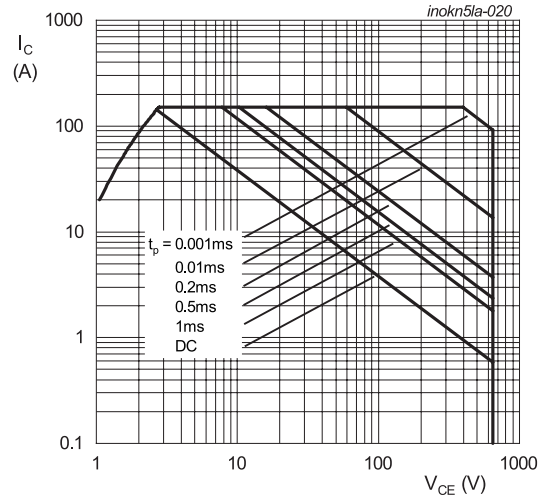


Fig. 20. Forward bias safe operating area

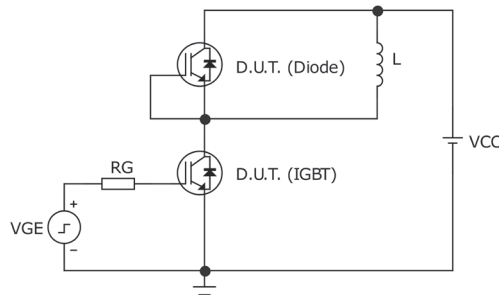


Fig. 21. Test circuit for inductive load switching

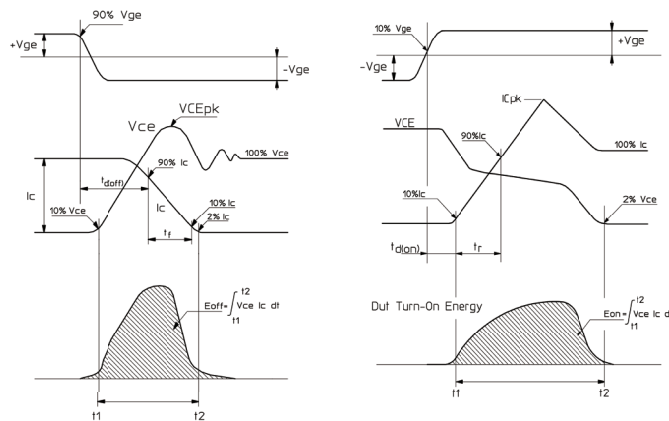
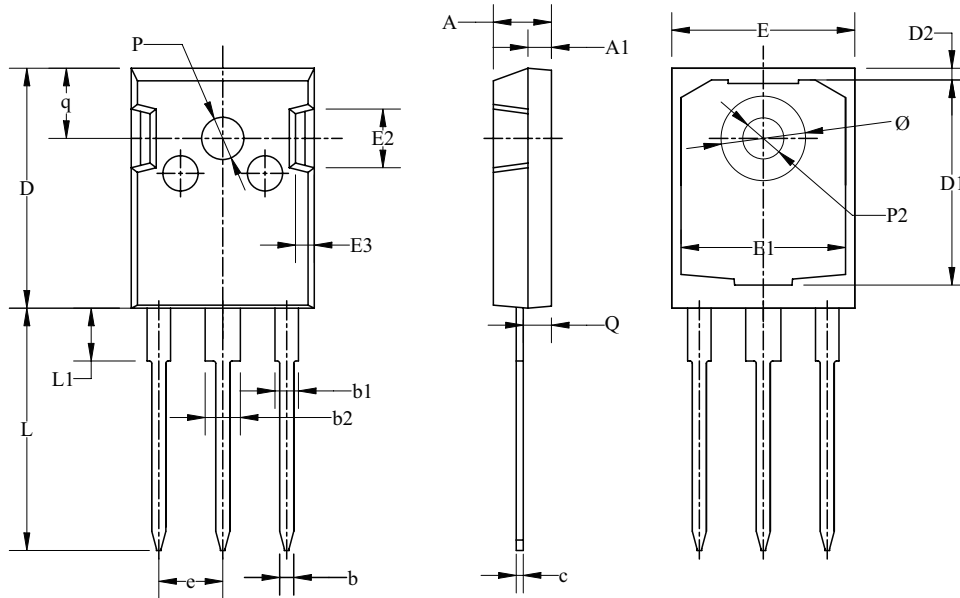


Fig. 22. Definition of switching times and losses

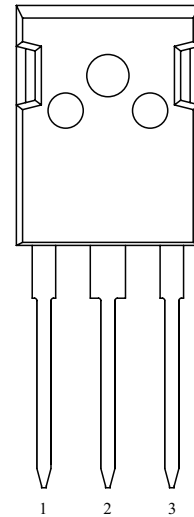
12. Package outline

Plastic single-ended through-hole pack age; headsink mounted; 1 mounting hole; 3 leads TO-247

TO247



| Dim | All Dimensions in Millimeters | | |
|-----|-------------------------------|-------|-------|
| | Min | Typ | Max |
| A | 4.70 | 4.95 | 5.20 |
| A1 | 1.90 | 2.00 | 2.10 |
| b | 1.00 | 1.20 | 1.40 |
| b1 | 1.80 | 2.00 | 2.20 |
| b2 | 2.80 | 3.00 | 3.20 |
| c | 0.50 | 0.60 | 0.70 |
| D | 20.30 | 20.45 | 20.60 |
| D1 | 17.28 | 17.48 | 17.68 |
| D2 | 0.80 | 1.00 | 1.20 |
| E | 15.45 | 15.60 | 15.75 |
| E1 | 13.82 | 14.02 | 14.22 |
| E2 | 4.80 | 5.00 | 5.20 |
| E3 | 1.40 | 1.60 | 1.80 |
| e | 5.45 BSC | | |
| L | 20.40 | 20.65 | 20.90 |
| L1 | 4.25 | 4.50 | 4.75 |
| P2 | 3.40 | 3.50 | 3.60 |
| P | 3.50 | 3.60 | 3.70 |
| Q | 2.20 | 2.40 | 2.60 |
| q | 5.78 | 5.98 | 6.18 |
| Ø | 7.10 | 7.19 | 7.30 |



TO247

13. Legal information

Data sheet status

| Document status [1][2] | Product status [3] | Definition |
|--------------------------------|--------------------|---------------------------------------------------------------------------------------|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

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- [2] The term 'short data sheet' is explained in section "Definitions".
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14. Contents

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