

## 1. General description

WG50N65HAW1 uses advanced Fine Trench Field-stop IGBT technology with anti-parallel diode in TO247 package to provide extremely low  $V_{CE(sat)}$ , and excellent switching performance. This device offers Best-in-Class efficiency in hard switching and resonant topology.



## 2. Features and benefits

- Maximum junction temperature 175 °C
- Positive Temperature efficient for easy paralleling
- Very soft, fast recovery anti-parallel diode
- High speed switching
- EMI Improved Design

## 3. Applications

- PFC
- Solar converters
- UPS
- Welding Converters
- Mid to high range switching frequency converters

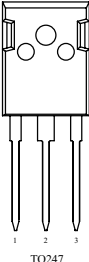
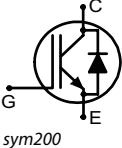
## 4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Notes	Value			Unit	
V <sub>CE</sub>	Collector-emitter voltage, T <sub>j</sub> ≥ 25 °C		650			V	
I <sub>C</sub>	DC collector current, limited by T <sub>j(max)</sub> T <sub>C</sub> = 100 °C		50			A	
Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
Static characteristics							
V <sub>CE(sat)</sub>	Collector-emitter saturation voltage	V <sub>GE</sub> = 15 V; I <sub>C</sub> = 50 A; T <sub>j</sub> = 25 °C		-	1.55	1.95	V

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 <p>TO247</p>	 <p>sym200</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
WG50N65HAW1	TO247	WG50N65HAW1Q	Tube	30	SOT429	25-Mar-2013

## 7. Marking

Table 4. Marking codes

Type number	Marking codes
WG50N65HAW1	G50N65 HAW1

## 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 $T_{j(max)}$		90	A
$V_{GE}$	Gate-emitter voltage		$\pm 20$	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

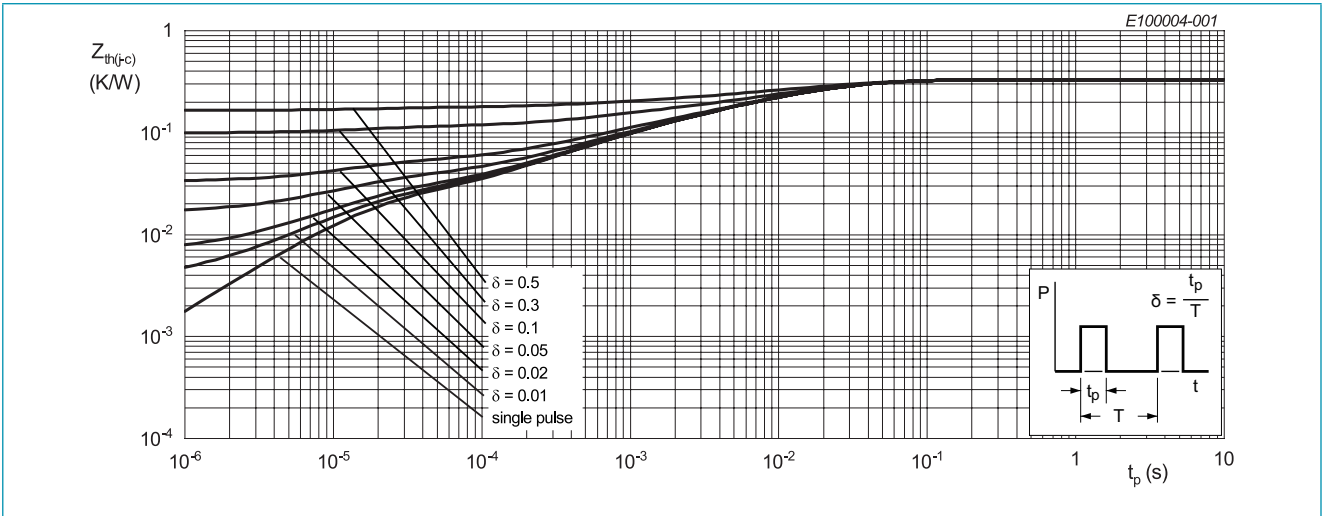


Fig. 1. Transient thermal impedance from junction to case as a function of pulse duration; IGBT

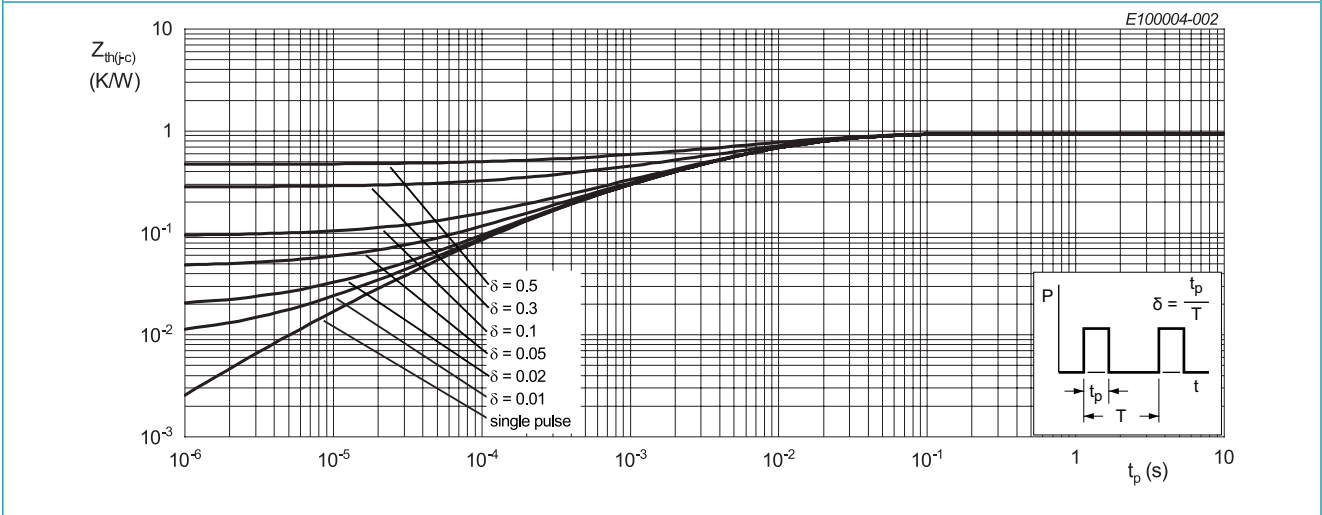


Fig. 2. Transient thermal impedance from junction to case as a function of pulse duration; Diode

## 10. Characteristics

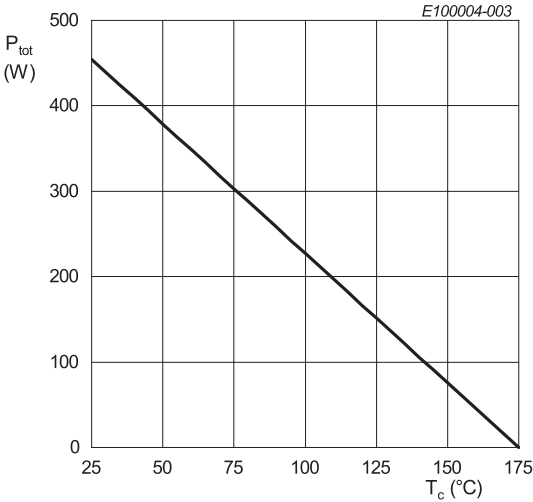
Table 7. Characteristics

Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
<b>Static characteristics</b>							
$BV_{CES}$	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}; I_C = 1.0\text{ mA}$		650	-	-	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}; I_C = 50\text{ A}; T_j = 25\text{ °C}$		-	1.55	1.95	V
		$V_{GE} = 15\text{ V}; I_C = 50\text{ A}; T_j = 175\text{ °C}$		-	2.1	-	V
$V_F$	Diode forward voltage	$V_{GE} = 0\text{ V}; I_F = 30\text{ A}; T_j = 25\text{ °C}$		-	1.9	-	V
		$V_{GE} = 0\text{ V}; I_F = 30\text{ A}; T_j = 175\text{ °C}$		-	1.5	-	V
$V_{GE(th)}$	Gate-emitter threshold voltage	$I_C = 0.5\text{ mA}; V_{CE} = V_{GE}$		4.2	5.2	6.2	V
$I_{CES}$	Zero gate voltage collector current	$V_{CE} = 650\text{ V}; V_{GE} = 0\text{ V}; T_j = 25\text{ °C}$		-	-	100	$\mu\text{A}$
		$V_{CE} = 650\text{ V}; V_{GE} = 0\text{ V}; T_j = 175\text{ °C}$		-	-	1	mA
$g_{fs}$	Transconductance	$V_{CE} = 20\text{ V}; I_C = 50\text{ A}$		-	34	-	S
<b>Dynamic characteristics</b>							
$C_{ies}$	Input capacitance	$V_{CE} = 30\text{ V}; V_{GE} = 0\text{ V}; f = 1\text{ MHz}; T_j = 25\text{ °C}$		-	2955	-	pF
$C_{oes}$	Output capacitance			-	105	-	pF
$C_{res}$	Reverse transfer capacitance			-	41	-	pF
$Q_G$	Gate charge	$V_{CC} = 520\text{ V}; I_C = 50\text{ A}; V_{GE} = 15\text{ V}; T_j = 25\text{ °C}$		-	138	-	nC

## 11. Switching Characteristics

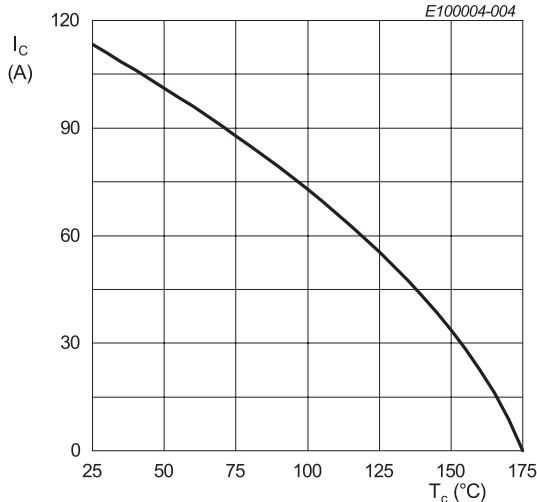
Table 8. Switching Characteristics, Inductive Load

Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
IGBT characteristics							
t <sub>d(on)</sub>	Turn-on delay time	T <sub>J</sub> = 25 °C; V <sub>CC</sub> = 400 V; I <sub>C</sub> = 50 A; V <sub>GE</sub> = 15V / 0V; R <sub>G</sub> = 10 Ω		-	51	-	nS
t <sub>r</sub>	Rise time			-	51	-	nS
t <sub>d(off)</sub>	Turn-off delay time			-	209	-	nS
t <sub>f</sub>	Fall time			-	33	-	nS
E <sub>on</sub>	Turn-on energy			-	1.24	-	mJ
E <sub>off</sub>	Turn-off energy			-	0.65	-	mJ
E <sub>ts</sub>	Total switching energy			-	1.89	-	mJ
t <sub>d(on)</sub>	Turn-on delay time	T <sub>J</sub> = 175 °C; V <sub>CC</sub> = 400 V; I <sub>C</sub> = 50 A; V <sub>GE</sub> = 15V / 0V; R <sub>G</sub> = 10 Ω		-	48	-	nS
t <sub>r</sub>	Rise time			-	49	-	nS
t <sub>d(off)</sub>	Turn-off delay time			-	241	-	nS
t <sub>f</sub>	Fall time			-	38	-	nS
E <sub>on</sub>	Turn-on energy			-	1.88	-	mJ
E <sub>off</sub>	Turn-off energy			-	0.85	-	mJ
E <sub>ts</sub>	Total switching energy			-	2.73	-	mJ
Diode characteristics							
t <sub>rr</sub>	Reverse recovery time	T <sub>J</sub> = 25 °C; V <sub>R</sub> = 400 V; I <sub>F</sub> = 30 A; dI <sub>F</sub> /dt = 500A/us		-	44	-	nS
Q <sub>r</sub>	Reverse recovery charge			-	221	-	nC
I <sub>RM</sub>	Reverse recovery peak current			-	9	-	A
t <sub>rr</sub>	Reverse recovery time	T <sub>J</sub> = 175 °C; V <sub>R</sub> = 400 V; I <sub>F</sub> = 30 A; dI <sub>F</sub> /dt = 500A/us		-	100	-	nS
Q <sub>r</sub>	Reverse recovery charge			-	990	-	nC
I <sub>RM</sub>	Reverse recovery peak current			-	17	-	A



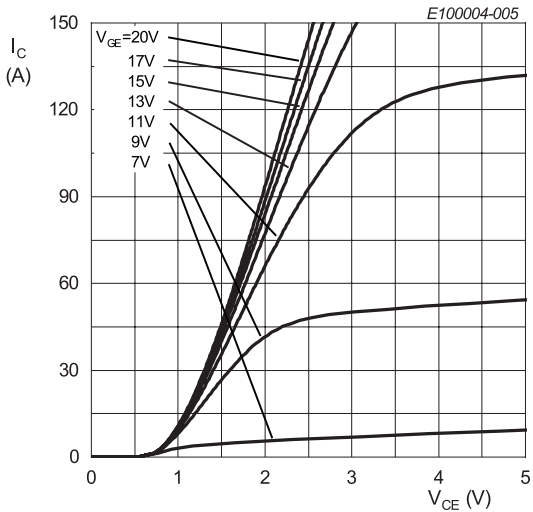
$T_j \leq 175^{\circ}C$

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



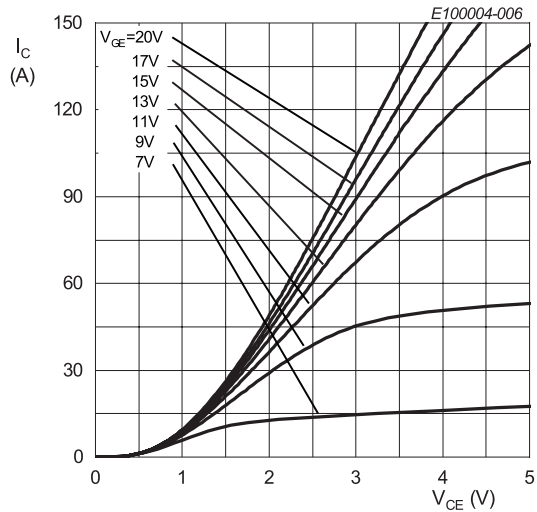
$V_{GE} \geq 15 V; T_j \leq 175^{\circ}C$

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



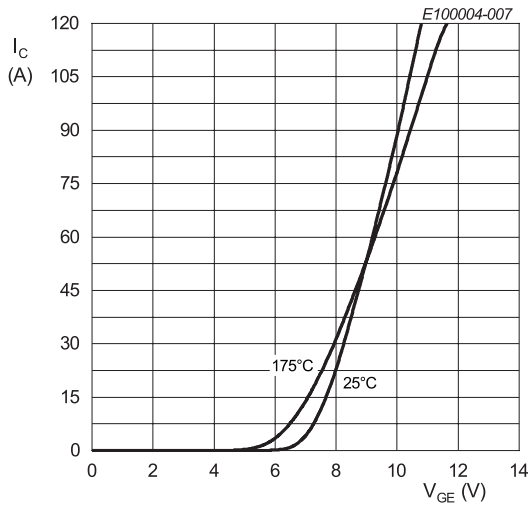
$T_j = 25^{\circ}C$

Fig. 5. Typical output characteristic



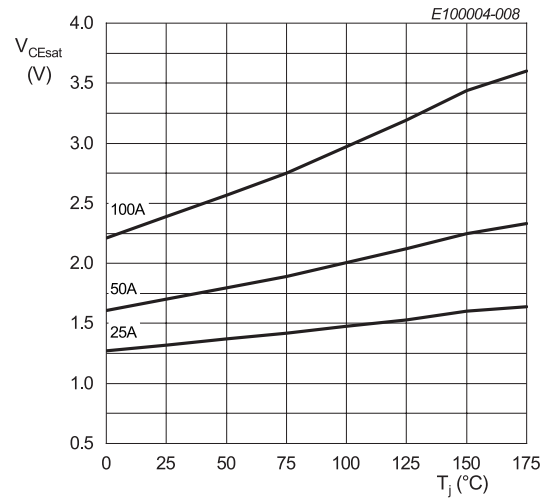
$T_j = 175^{\circ}C$

Fig. 6. Typical output characteristic



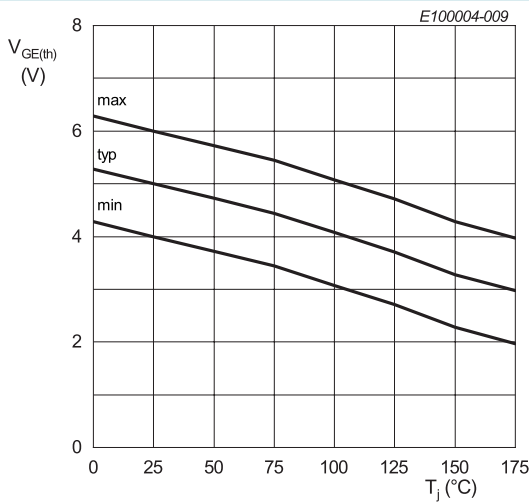
$V_{CE} = 20$  V

Fig. 7. Typical transfer characteristic



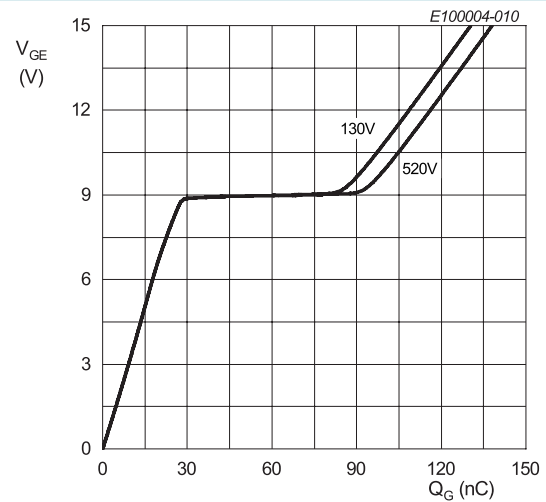
$V_{GE} = 15$  V

Fig. 8. Typical collector-emitter saturation voltage as a function of junction temperature



$I_C = 500$   $\mu\text{A}$

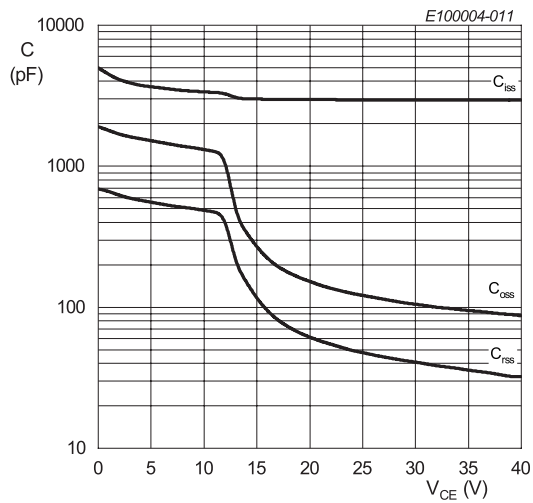
Fig. 9. Gate-emitter threshold voltage as a function of junction temperature



$I_C = 50$  A

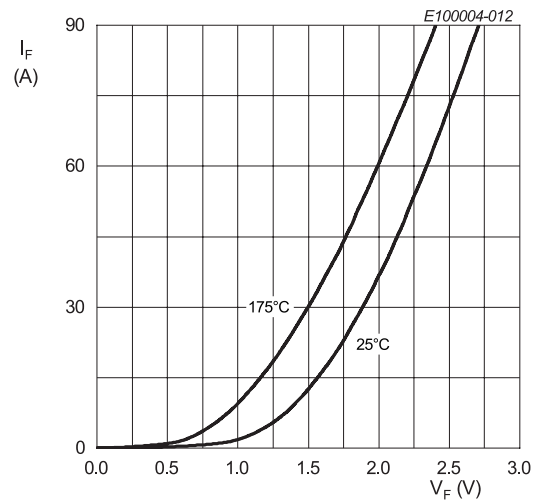
Fig. 10. Typical gate charge



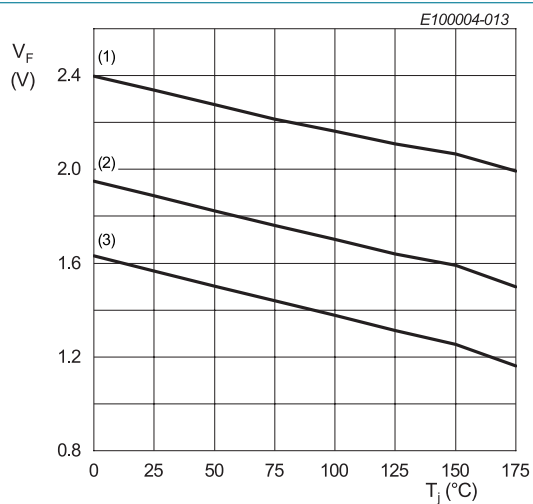


$V_{GE} = 0$  V;  $f = 1$  MHz

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



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

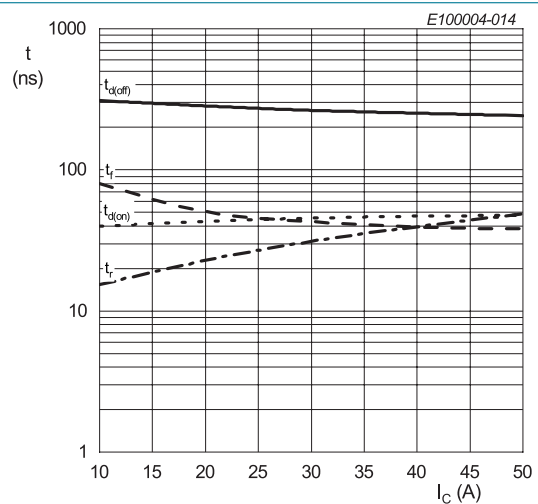


(1)  $I_F = 60$  A

(2)  $I_F = 30$  A

(3)  $I_F = 15$  A

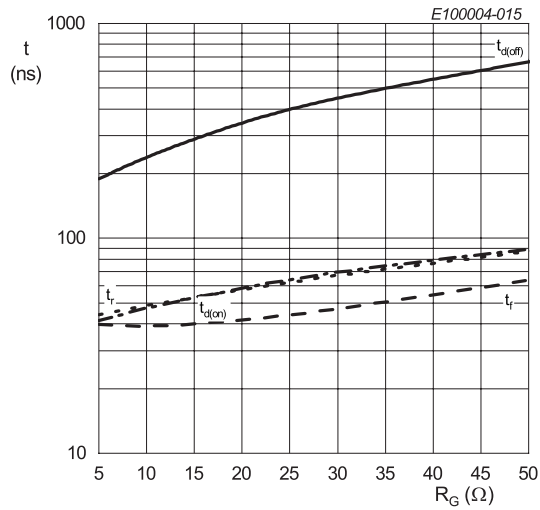
**Fig. 13. Typical diode forward voltage as a function of junction temperature**



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

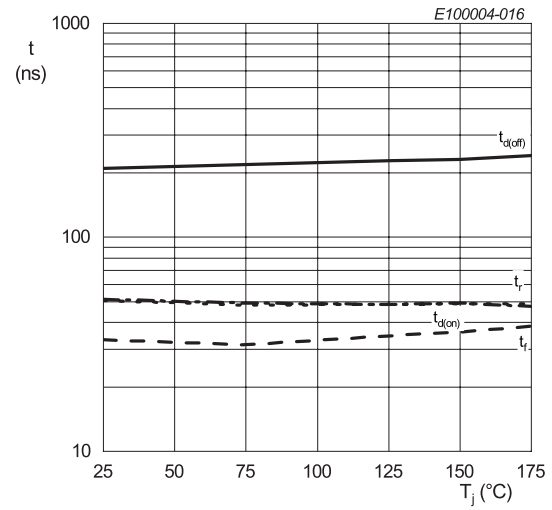
$V_{CE} = 400$  V; inductive load

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



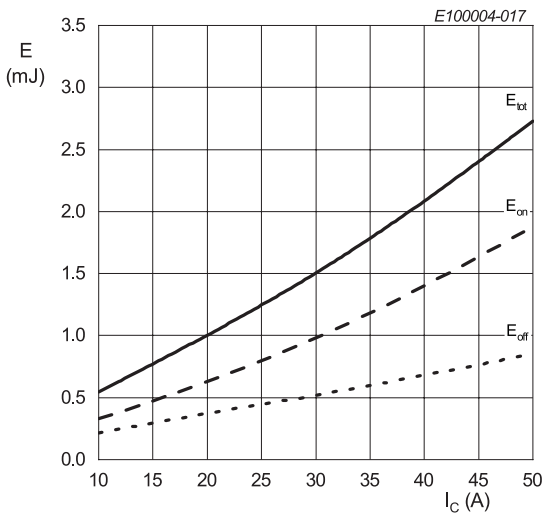
$I_C = 50$  A;  $V_{GE} = 15$  V/0 V;  $T_J = 175$  °C;  
 $V_{CE} = 400$  V; inductive load

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



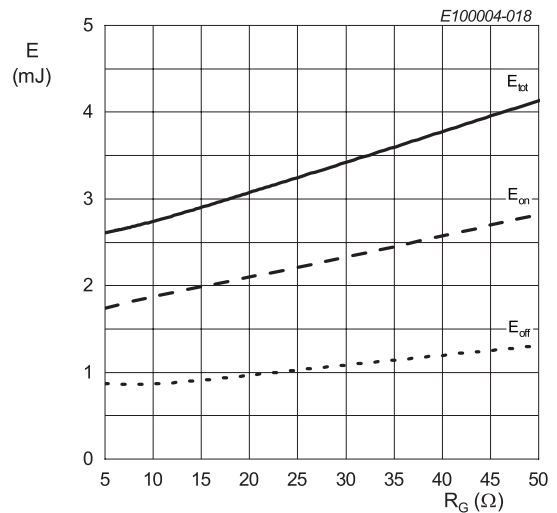
$I_C = 50$  A;  $V_{GE} = 15$  V/0 V;  $R_g = 10$   $\Omega$ ;  
 $V_{CE} = 400$  V; inductive load

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



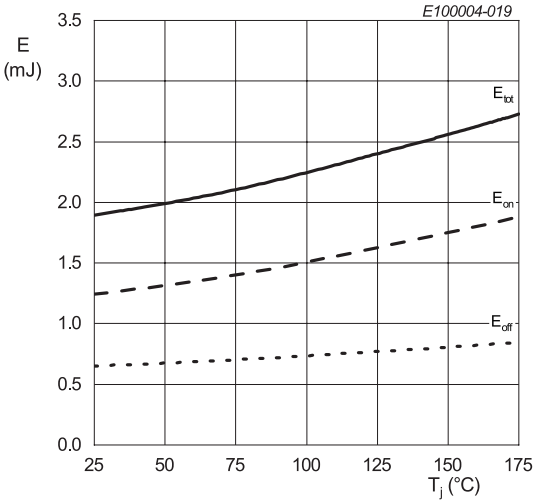
$R_g = 10$   $\Omega$ ;  $V_{GE} = 15$  V/0 V;  $T_J = 175$  °C;  
 $V_{CE} = 400$  V; inductive load

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



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

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



I<sub>C</sub> = 50 A; V<sub>GE</sub> = 15V/0V; R<sub>g</sub> = 10 Ω;  
V<sub>CE</sub> = 400 V; inductive load

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

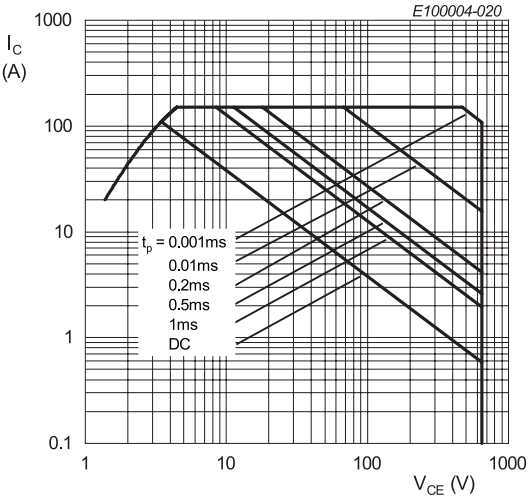


Fig. 20. Forward bias safe operating area

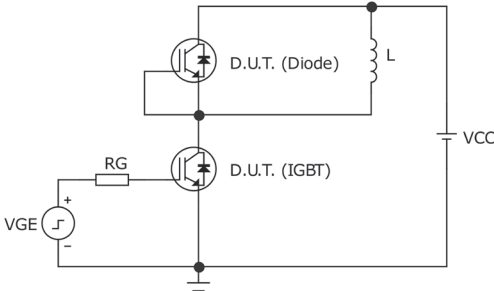


Fig. 21. Test circuit for inductive load switching

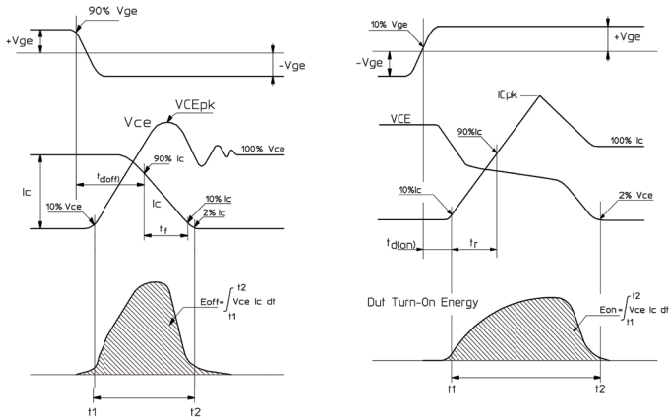
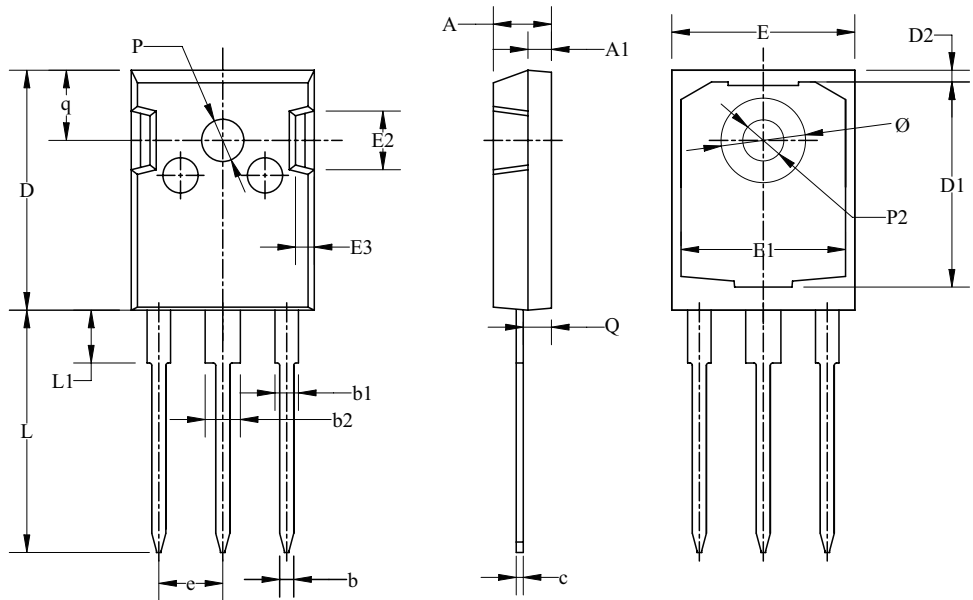


Fig. 22. Definition of switching times and losses

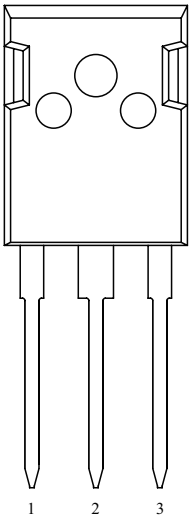
# 12. Package outline

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.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
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