

1. General description

WG40N65HDW5 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 switching speed
- EMI Improved Design

3. Applications

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

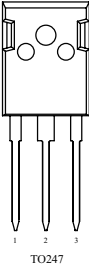
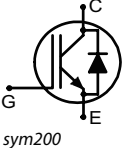
4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Notes	Value			Unit	
V_{CE}	Collector-emitter voltage, $T_j \geq 25\text{ °C}$		650			V	
I_C	DC collector current, limited by $T_{j(max)}$ $T_C = 100\text{ °C}$		40			A	
Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
Static characteristics							
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}; I_C = 40\text{ A}; T_j = 25\text{ °C}$		-	1.45	1.85	V

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate		
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
WG40N65HDW5	TO247	WG40N65HDW5Q	Tube	30	TO247P	09-Mar-2023

7. Marking

Table 4. Marking codes

Type number	Marking codes
WG40N65HDW5	G40N65 HDW5

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 $T_{j(max)}$ $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$		80 40	A
$I_{C(puls)}$	Pulsed collector current, t_p limited by $T_{j(max)}$		120	A
-	Turn off safe operating area $V_{CE} \leq 650\text{ V}$, $T_j \leq 175\text{ °C}$, $t_p = 1\text{ }\mu\text{s}$		120	A
I_F	Diode forward current, limited by $T_{j(max)}$ $T_C = 25\text{ °C}$ $T_C = 100\text{ °C}$		20 10	A
$I_{F(puls)}$	Diode pulsed current, t_p limited by $T_{j(max)}$		40	A
V_{GE}	Gate-emitter voltage		± 20	V
P_{tot}	Power dissipation $T_C = 25\text{ °C}$ Power dissipation $T_C = 100\text{ °C}$		312 156	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			-	0.48	-	K/W
$R_{th(j-c)}$	Diode thermal resistance from junction to case			-	2	-	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient			-	40	-	K/W

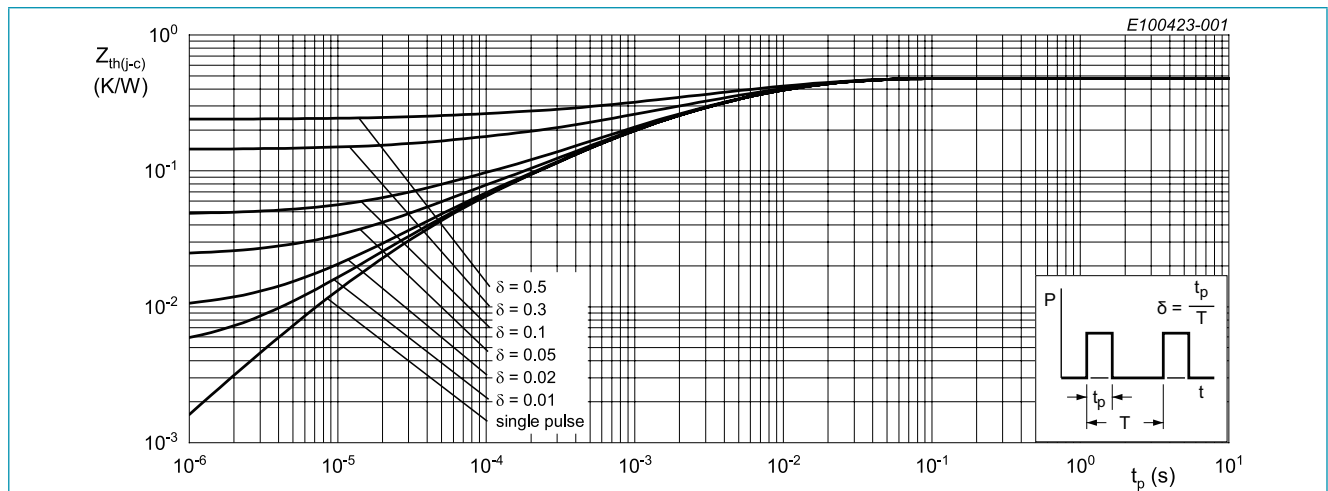


Fig. 1. Transient thermal impedance from junction to case as a function of pulse duration; IGBT

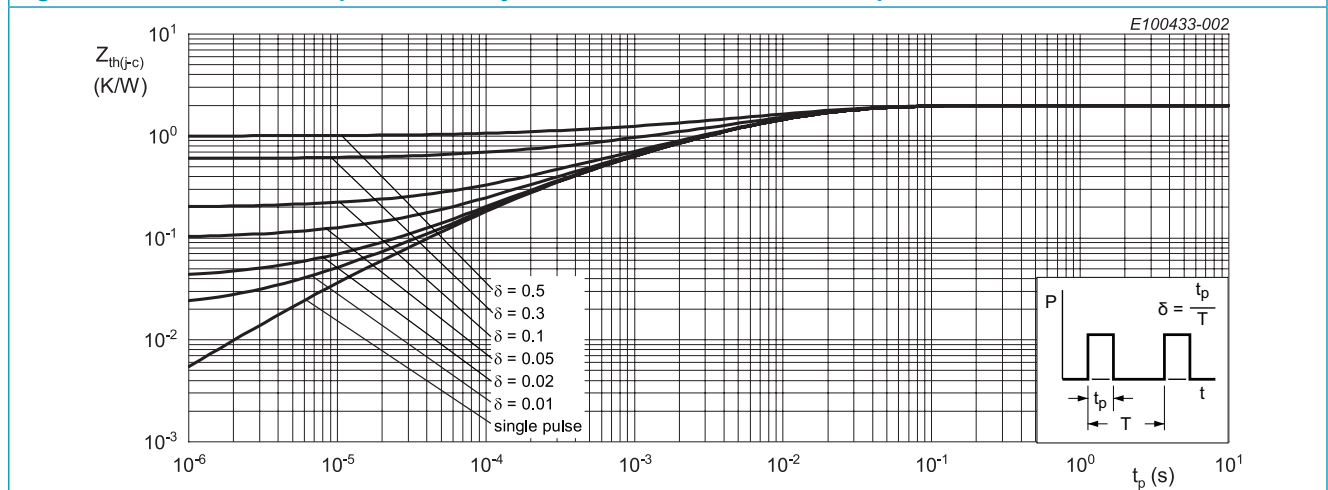


Fig. 2. Transient thermal impedance from junction to case as a function of pulse duration; Diode

10. Characteristics

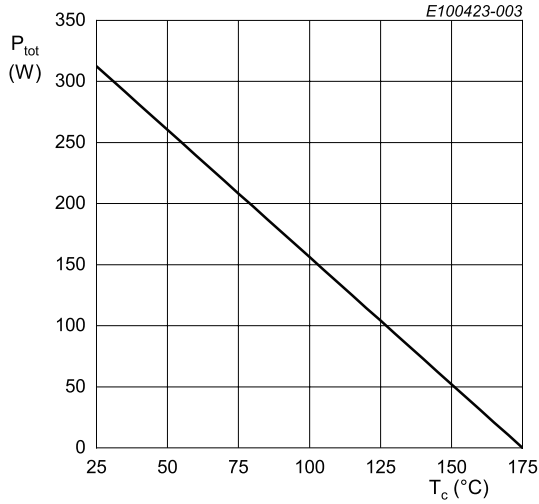
Table 7. Characteristics

Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
Static characteristics							
BV_{CES}	Collector-emitter breakdown voltage	$V_{GE} = 0\text{ V}; I_C = 1.0\text{ mA}$		650	-	-	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	$V_{GE} = 15\text{ V}; I_C = 40\text{ A}; T_j = 25\text{ °C}$		-	1.45	1.85	V
		$V_{GE} = 15\text{ V}; I_C = 40\text{ A}; T_j = 175\text{ °C}$		-	1.8	-	V
V_F	Diode forward voltage	$V_{GE} = 0\text{ V}; I_F = 10\text{ A}; T_j = 25\text{ °C}$		-	1.9	-	V
		$V_{GE} = 0\text{ V}; I_F = 10\text{ A}; T_j = 175\text{ °C}$		-	1.45	-	V
$V_{GE(th)}$	Gate-emitter threshold voltage	$I_C = 400\text{ }\mu\text{A}; V_{CE} = V_{GE}$		3.6	4.3	5.0	V
I_{CES}	Zero gate voltage collector current	$V_{CE} = 650\text{ V}; V_{GE} = 0\text{ V}; T_j = 25\text{ °C}$		-	-	100	μA
		$V_{CE} = 650\text{ V}; V_{GE} = 0\text{ V}; T_j = 175\text{ °C}$		-	-	1	mA
g_{fs}	Transconductance	$V_{CE} = 20\text{ V}; I_C = 40\text{ A}$		-	42	-	S
Dynamic characteristics							
C_{ies}	Input capacitance	$V_{CE} = 40\text{ V}; V_{GE} = 0\text{ V}; f = 1\text{ MHz}; T_j = 25\text{ °C}$		-	3180	-	pF
C_{oes}	Output capacitance			-	39	-	pF
C_{res}	Reverse transfer capacitance			-	14	-	pF
Q_G	Gate charge	$V_{CC} = 520\text{ V}; I_C = 40\text{ A}; V_{GE} = 15\text{ V}; T_j = 25\text{ °C}$		-	124	-	nC

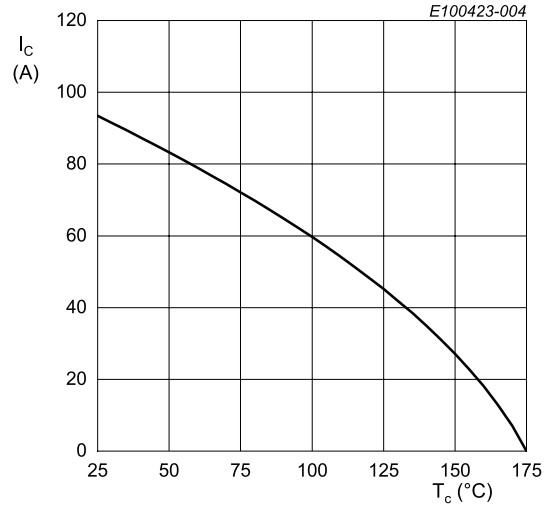
11. Switching Characteristics

Table 8. Switching Characteristics, Inductive Load

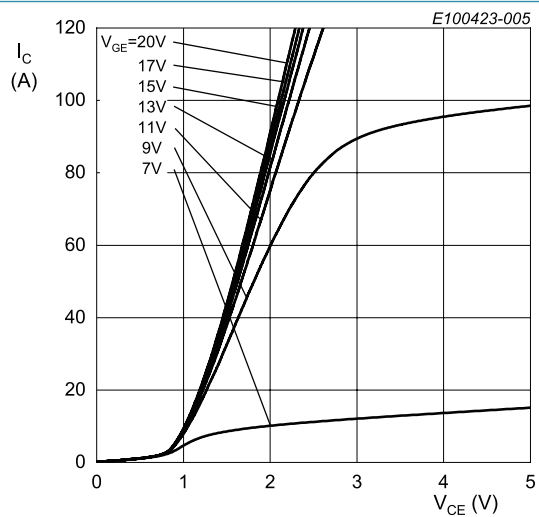
Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
IGBT characteristics							
$t_{d(on)}$	Turn-on delay time	$T_J = 25\text{ °C};$ $V_{CC} = 400\text{ V}; I_C = 40\text{ A}; V_{GE} = 15\text{V} / 0\text{V};$ $R_G = 10\ \Omega$		-	38	-	nS
t_r	Rise time			-	35	-	nS
$t_{d(off)}$	Turn-off delay time			-	173	-	nS
t_f	Fall time			-	27	-	nS
E_{on}	Turn-on energy			-	0.9	-	mJ
E_{off}	Turn-off energy			-	0.35	-	mJ
E_{ts}	Total switching energy			-	1.25	-	mJ
$t_{d(on)}$	Turn-on delay time	$T_J = 175\text{ °C};$ $V_{CC} = 400\text{ V}; I_C = 40\text{ A}; V_{GE} = 15\text{V} / 0\text{V};$ $R_G = 10\ \Omega$		-	36	-	nS
t_r	Rise time			-	34	-	nS
$t_{d(off)}$	Turn-off delay time			-	201	-	nS
t_f	Fall time			-	37	-	nS
E_{on}	Turn-on energy			-	1.15	-	mJ
E_{off}	Turn-off energy			-	0.5	-	mJ
E_{ts}	Total switching energy			-	1.65	-	mJ
Diode characteristics							
t_{rr}	Reverse recovery time	$T_J = 25\text{ °C};$ $V_R = 400\text{ V}; I_F = 10\text{ A}; di_F/dt = 800\text{A/us}$		-	33	-	nS
Q_r	Reverse recovery charge			-	190	-	nC
I_{RM}	Reverse recovery peak current			-	10.5	-	A
t_{rr}	Reverse recovery time	$T_J = 175\text{ °C};$ $V_R = 400\text{ V}; I_F = 10\text{ A}; di_F/dt = 800\text{A/us}$		-	61	-	nS
Q_r	Reverse recovery charge			-	479	-	nC
I_{RM}	Reverse recovery peak current			-	15.1	-	A



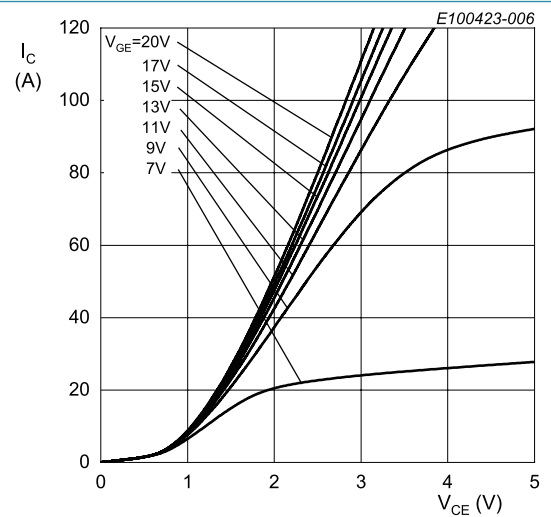
$T_j \leq 175 \text{ }^\circ\text{C}$
Fig. 3. Power dissipation as a function of case temperature



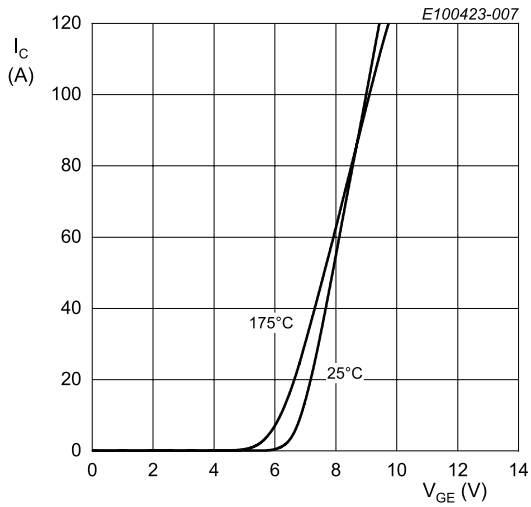
$V_{GE} \geq 15 \text{ V}; T_j \leq 175 \text{ }^\circ\text{C}$
Fig. 4. Collector current as a function of case temperature



$T_j = 25 \text{ }^\circ\text{C}$
Fig. 5. Typical output characteristic

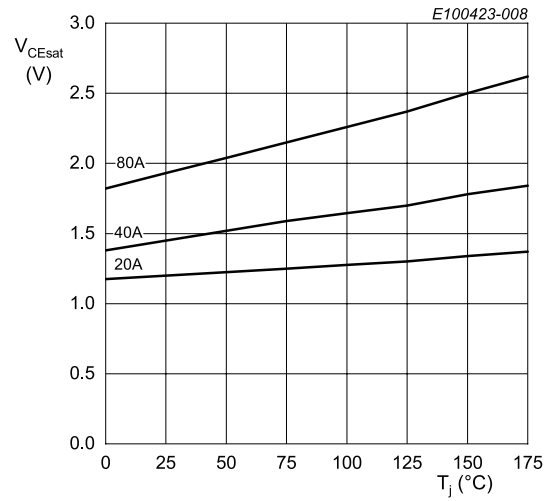


$T_j = 175 \text{ }^\circ\text{C}$
Fig. 6. Typical output characteristic



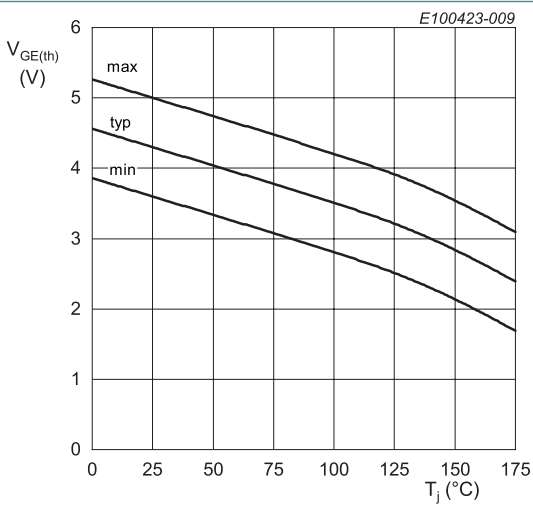
$V_{CE} = 20\text{ V}$

Fig. 7. Typical transfer characteristic



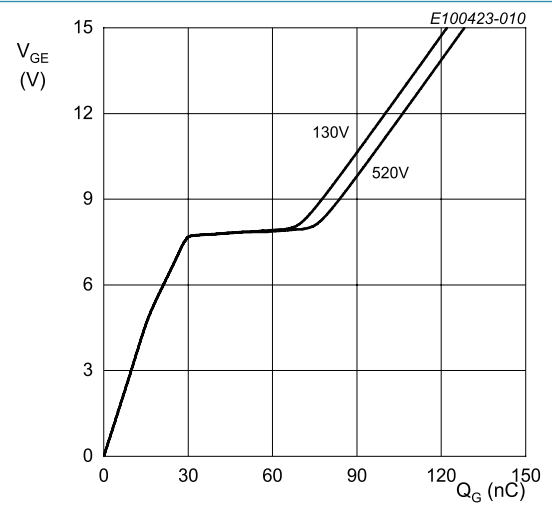
$V_{GE} = 15\text{ V}$

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



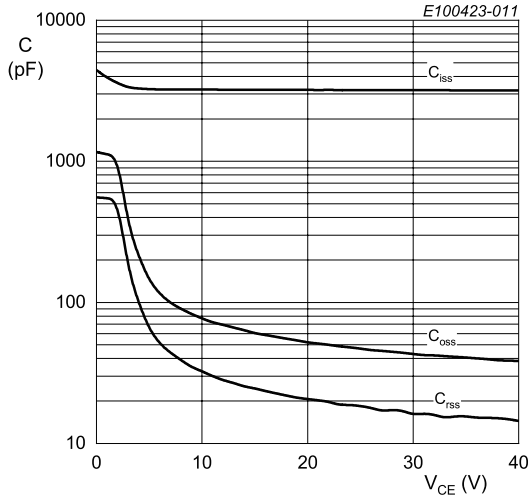
$I_C = 400\ \mu\text{A}$

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



$I_C = 40\text{ A}$

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

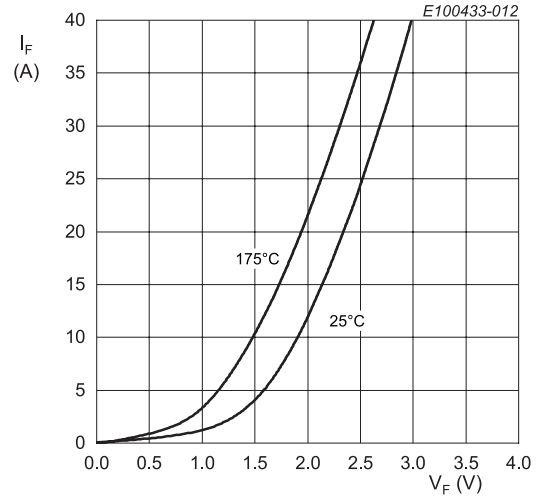
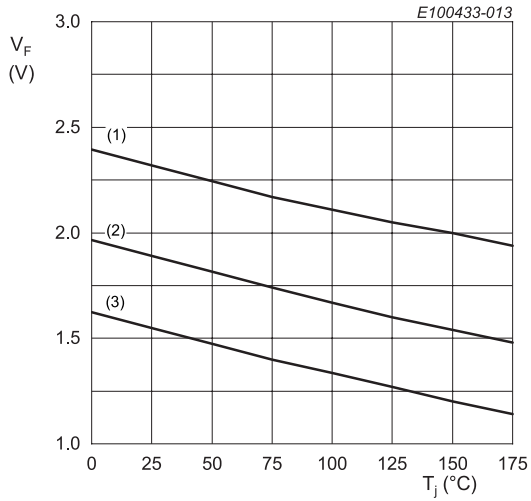
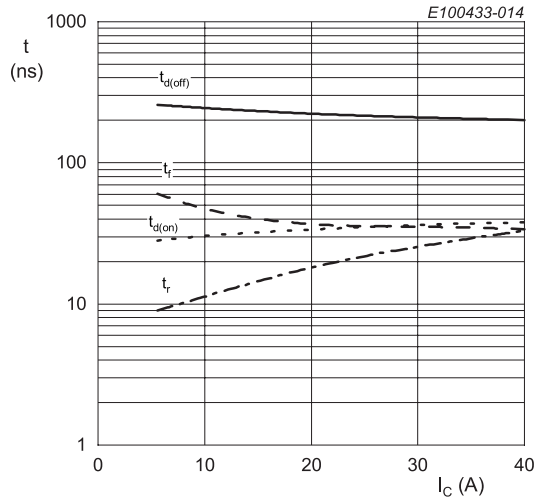


Fig. 12. Typical diode forward current as a function of forward voltage



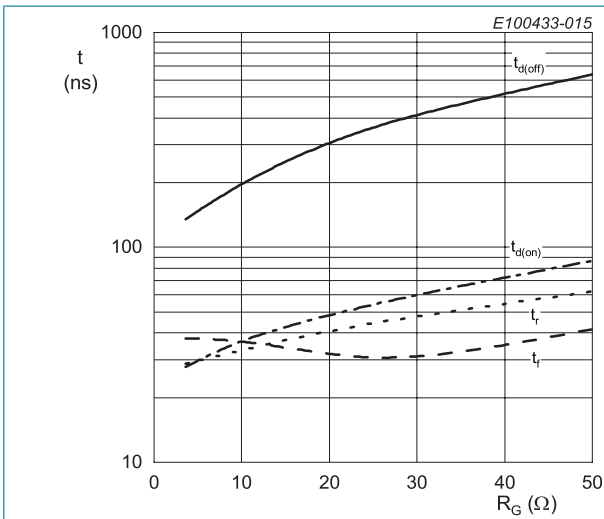
- (1) $I_F = 20 \text{ A}$
- (2) $I_F = 10 \text{ A}$
- (3) $I_F = 5 \text{ A}$

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



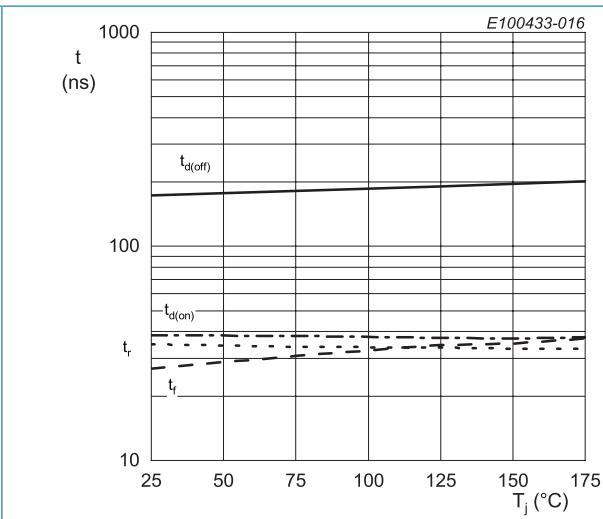
$R_g = 10 \text{ } \Omega; V_{GE} = 15\text{V}/0\text{V}; T_j = 175 \text{ } ^\circ\text{C};$
 $V_{CE} = 400 \text{ V};$ inductive load

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



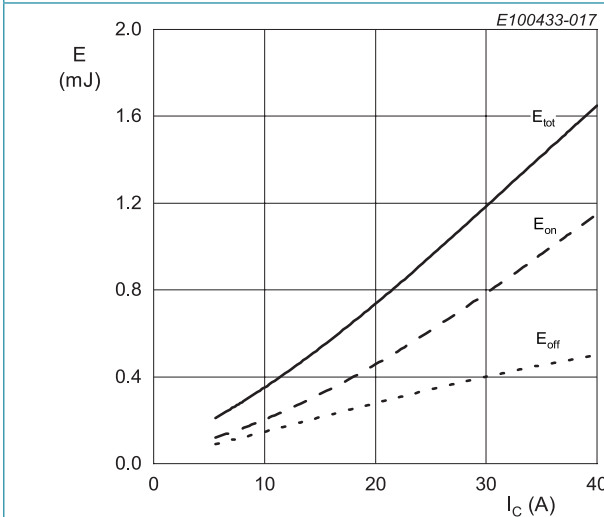
$I_C = 40\text{ A}$; $V_{GE} = 15\text{V}/0\text{V}$; $T_J = 175\text{ }^\circ\text{C}$;
 $V_{CE} = 400\text{ V}$; inductive load

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



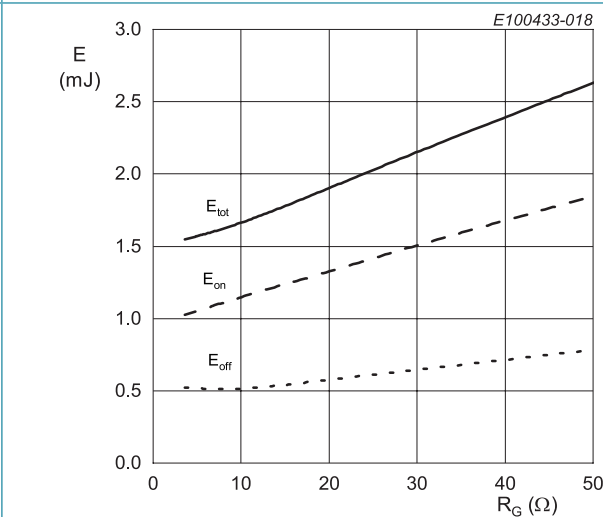
$I_C = 40\text{ A}$; $V_{GE} = 15\text{V}/0\text{V}$; $R_g = 10\text{ }\Omega$;
 $V_{CE} = 400\text{ V}$; inductive load

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



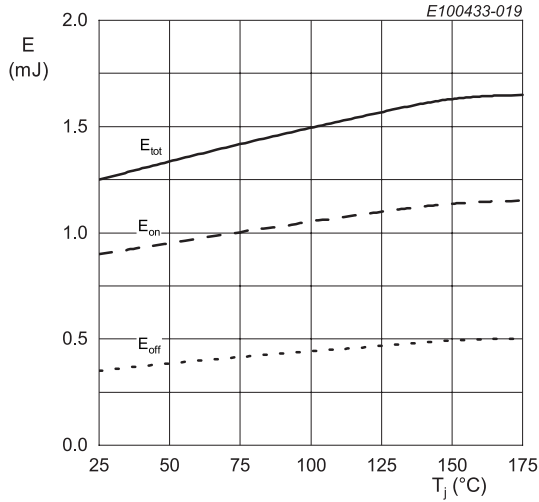
$R_g = 10\text{ }\Omega$; $V_{GE} = 15\text{V}/0\text{V}$; $T_J = 175\text{ }^\circ\text{C}$;
 $V_{CE} = 400\text{ V}$; inductive load

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



$I_C = 40\text{ A}$; $V_{GE} = 15\text{V}/0\text{V}$; $T_J = 175\text{ }^\circ\text{C}$;
 $V_{CE} = 400\text{ V}$; inductive load

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



$I_C = 40\text{ A}$; $V_{GE} = 15\text{V}/0\text{V}$; $R_g = 10\ \Omega$;
 $V_{CE} = 400\text{ V}$; inductive load

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

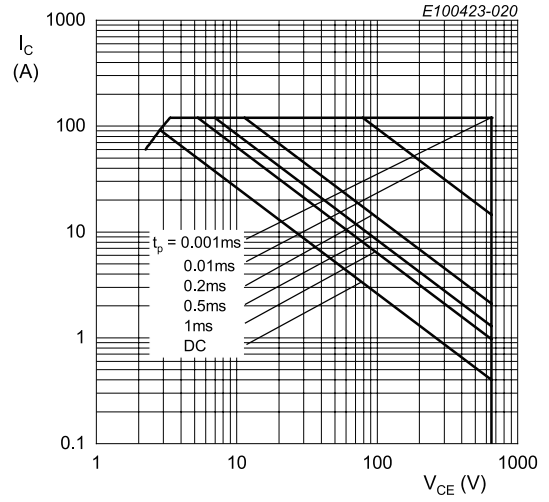


Fig. 20. Forward bias safe operating area

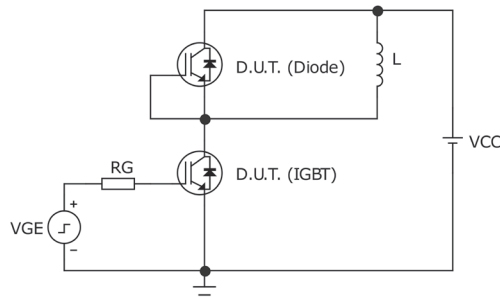


Fig. 21. Test circuit for inductive load switching

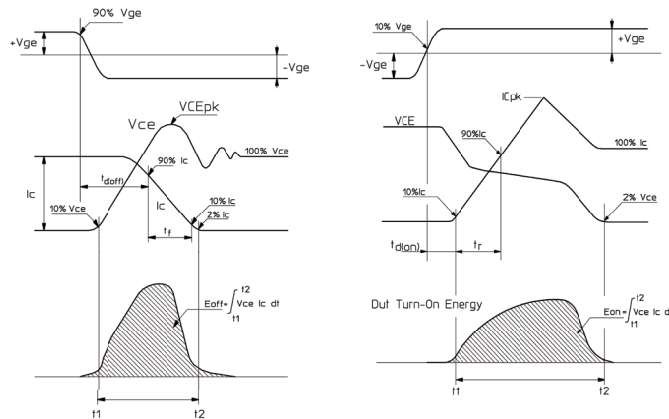
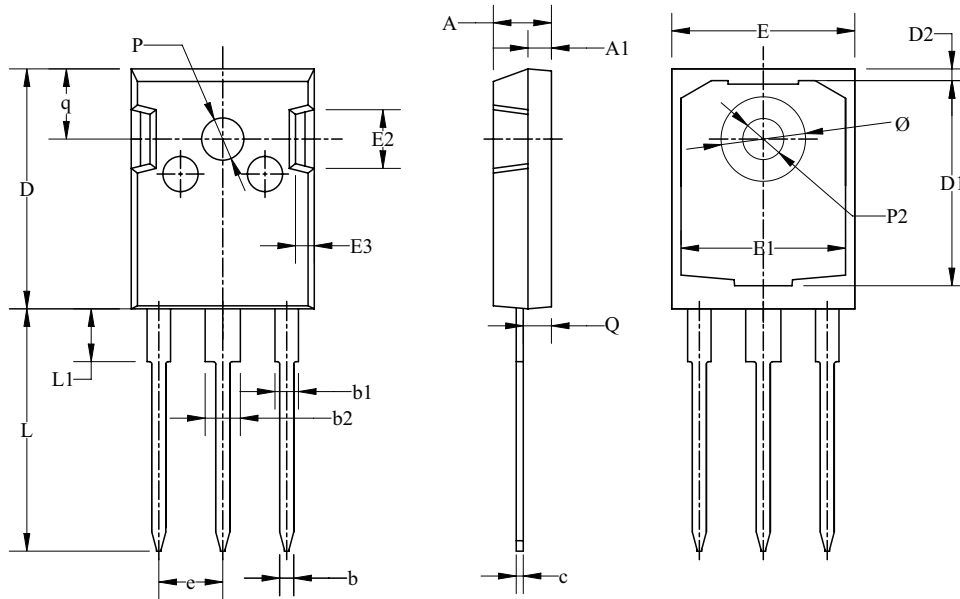


Fig. 22. Definition of switching times and losses

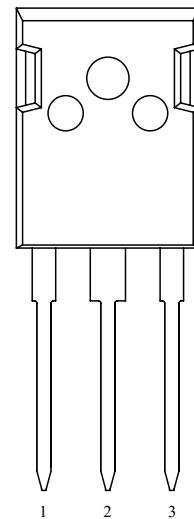
12. Package outline

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.

- [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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