WeEn
WeEn Semiconductors

WG50N65MAW1

IGBT

Rev.01 - 27 September 2023 Product data sheet

1. General description

WG50N65MAW1 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 is ideal for wide range switching frequency power converters.

RoHS Halogen-Free

2. Features and benefits

- Maximum junction temperature 175 °C
- Positive Temperature efficient for Easy Parallel Operating
- Very soft, fast recovery anti-parallel diode
- Smooth & Optimized switching
- EMI Improved Design

3. Applications

- Motor control
- PFC
- UPS
- Resonant converters
- Mid to high switching frequency applications

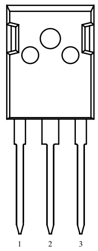
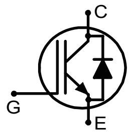
4. Quick reference data

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		-	1.55	1.95	V

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 TO247	 sym200
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
WG50N65MAW1	TO247	WG50N65MAW1Q	Tube	30	SOT429	25-Mar-2013

7. Marking

Table 4. Marking codes

Type number	Marking codes
WG50N65MAW1	G50N65 MAW1

8. Limiting values

Table 5. Limiting values

Symbol	Parameter	Notes	Value	Unit
V_{CE}	Collector-emitter voltage, $T_j \geq 25$ °C		650	V
I_C	DC collector current, limited by $T_{j(max)}$ $T_C = 25$ °C $T_C = 100$ °C		 100 50	A
$I_{C(puls)}$	Pulsed collector current, t_p limited by $T_{j(max)}$		150	A
-	Turn off safe operating area $V_{CE} \leq 650$ V, $T_j \leq 175$ °C, $t_p = 1$ µs		150	A
I_F	Diode forward current, limited by $T_{j(max)}$ $T_C = 25$ °C $T_C = 100$ °C		 60 30	A
I_{Fpuls}	Diode pulsed current, t_p limited by $T_{j(max)}$		90	A
V_{GE}	Gate-emitter voltage		±20	V
P_{tot}	Power dissipation $T_C = 25$ °C Power dissipation $T_C = 100$ °C		454 227	W
t_{sc}	Short circuit withstand time $V_{GE} = 15.0$ V, $V_{CC} \leq 400$ V Allowed number of short circuits < 1000 Time between short circuits: ≥ 1.0 s $T_j = 125$°C		5	us
T_{stg}	Storage temperature		-55 to +150	°C
T_{jmax}	Maximum operating junction temperature		175	°C
-	Peak soldering temperture		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

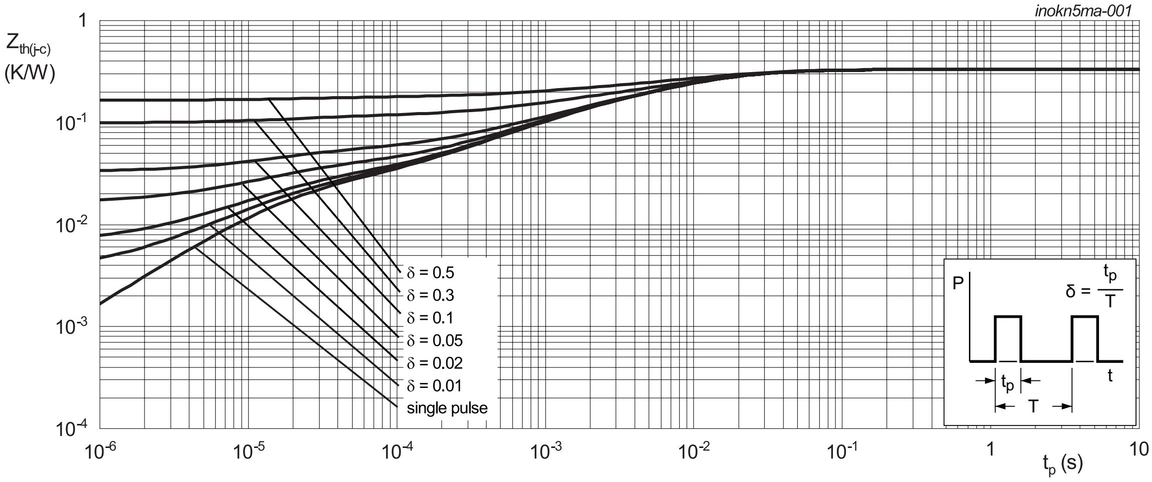


Fig. 1. Transient thermal impedance from junction to case as a function of pulse duration; IGBT

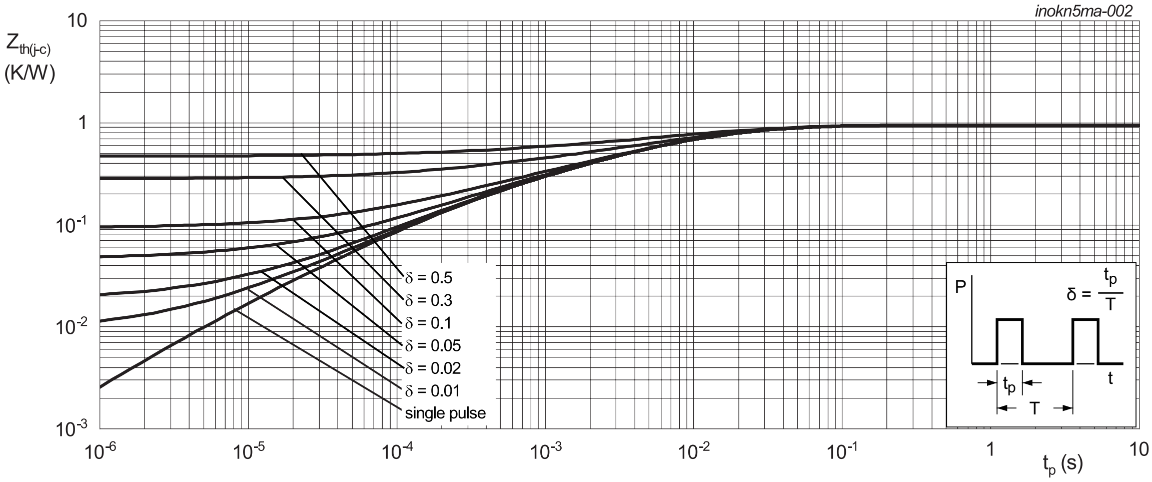


Fig. 2. Transient thermal impedance from junction to case as a function of pulse duration; Diode

10. Characteristics

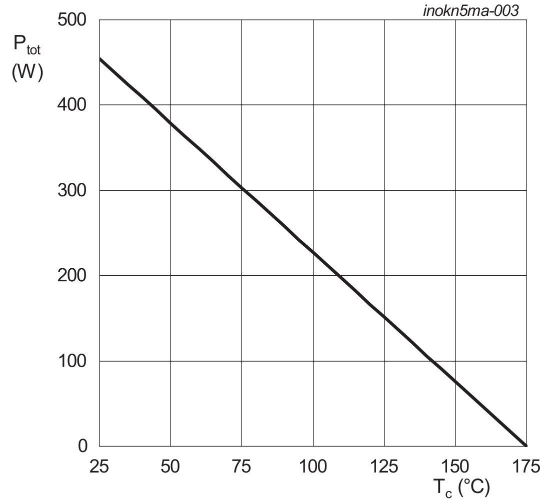
Table 7. Characteristics

Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
Static characteristics							
BV_{CES}	Collector-emitter breakdown voltage	V_{GE} = 0 V; I_C = 50 µA		650	-	-	V
$V_{CE(sat)}$	Collector-emitter saturation voltage	V_{GE} = 15 V; I_C = 50 A; T_j = 25 °C		-	1.55	1.95	V
		V_{GE} = 15 V; I_C = 50 A; T_j = 175 °C		-	2	-	V
V_F	Diode forward voltage	V_{GE} = 0 V; I_F = 30 A; T_j = 25 °C		-	1.9	-	V
		V_{GE} = 0 V; I_F = 30 A; T_j = 175 °C		-	1.5	-	V
$V_{GE(th)}$	Gate-emitter threhold voltage	I_C = 0.5 mA; V_{CE} = V_{GE}		4.3	5.4	6.5	V
I_{CES}	Zero gate voltage collector current	V_{CE} = 650 V; V_{GE} = 0 V; T_j = 25 °C		-	-	100	µA
		V_{CE} = 650 V; V_{GE} = 0 V; T_j = 175 °C		-	-	1	mA
g_{fs}	Transconductance	V_{CE} = 20 V; I_C = 50 A		-	24	-	S
Dynamic characteristics							
C_{ies}	Input capacitance	V_{CE} = 30 V; V_{GE} = 0 V; f = 1 MHz; T_j = 25 °C		-	2968	-	pF
C_{oes}	Output capacitance			-	113	-	pF
C_{res}	Reverse transfer capacitance			-	40	-	pF
Q_G	Gate charge	V_{CC} = 520 V; I_C = 50 A; V_{GE} = 15 V; T_j = 25 °C		-	133	-	nC

11. Switching Characteristics

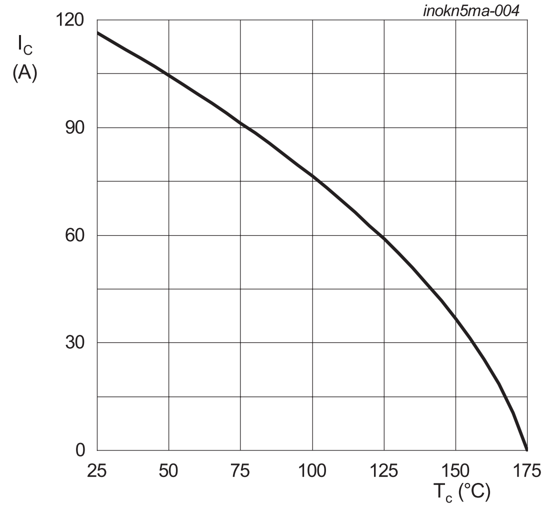
Table 8. Switching Characteristics, Inductive Load

Symbol	Parameter	Conditions	Notes	Min	Typ	Max	Unit
IGBT characteristics							
$t_{d(on)}$	Turn-on delay time	T_j = 25 °C; V_{CC} = 400 V; I_C = 50 A; V_{GE} = 15V / 0V; R_G = 10 Ω		-	44	-	nS
t_r	Rise time			-	56	-	nS
$t_{d(off)}$	Turn-off delay time			-	200	-	nS
t_f	Fall time			-	36	-	nS
E_{on}	Turn-on energy			-	1.37	-	mJ
E_{off}	Turn-off energy			-	0.72	-	mJ
E_{ts}	Total switching energy			-	2.09	-	mJ
$t_{d(on)}$	Turn-on delay time	T_j = 175 °C; V_{CC} = 400 V; I_C = 50 A; V_{GE} = 15V / 0V; R_G = 10 Ω		-	44	-	nS
t_r	Rise time			-	57	-	nS
$t_{d(off)}$	Turn-off delay time			-	222	-	nS
t_f	Fall time			-	63	-	nS
E_{on}	Turn-on energy			-	2.15	-	mJ
E_{off}	Turn-off energy			-	1.0	-	mJ
E_{ts}	Total switching energy			-	3.15	-	mJ
Diode characteristics							
t_{rr}	Reverse recovery time	T_j = 25 °C; V_R = 400 V; I_F = 30 A; dI_F/dt = 500A/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 °C; V_R = 400 V; I_F = 30 A; dI_F/dt = 500A/us		-	100	-	nS
Q_r	Reverse recovery charge			-	990	-	nC
I_{RM}	Reverse recovery peak current			-	17	-	A



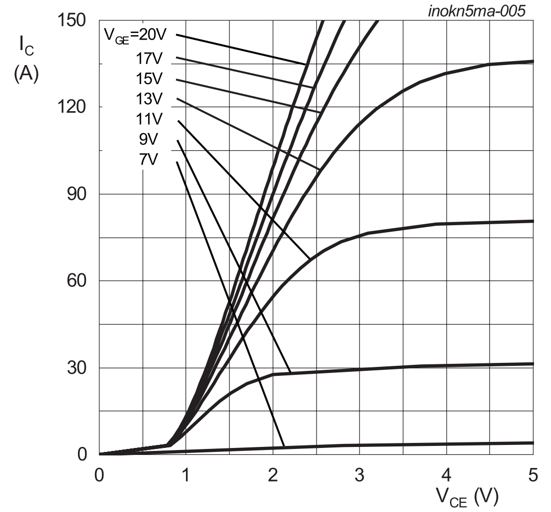
$T_j \leq 175$ °C

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



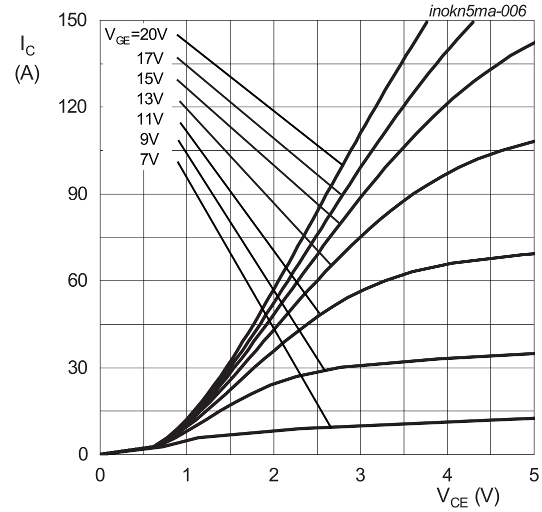
$V_{GE} \geq 15$ V; $T_j \leq 175$ °C

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



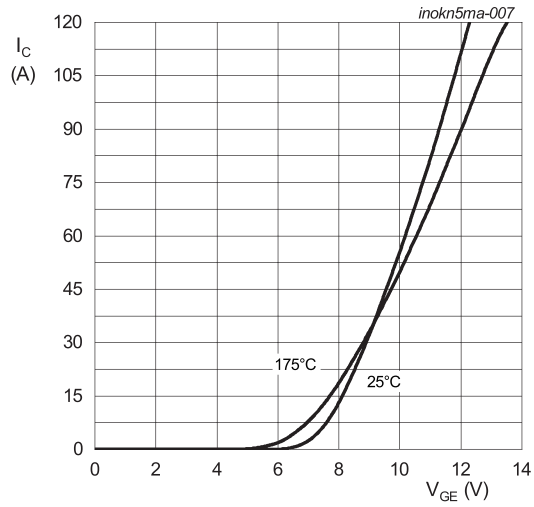
$T_j = 25$ °C

Fig. 5. Typical output characteristic



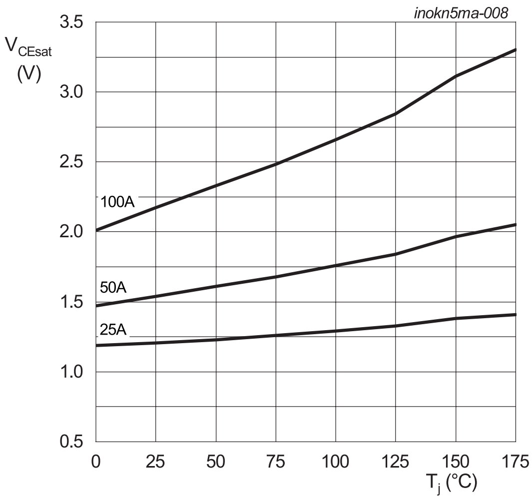
$T_j = 175$ °C

Fig. 6. Typical output characteristic



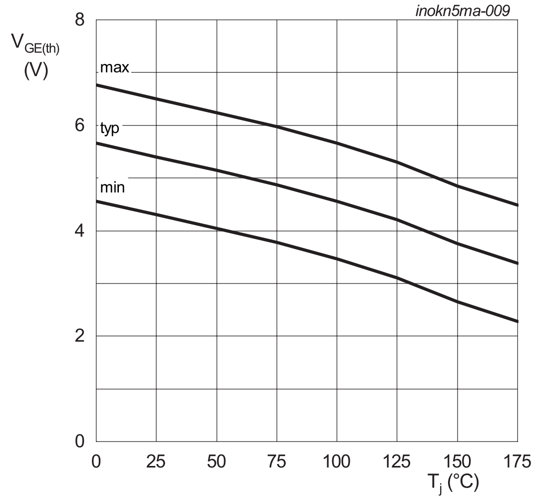
V_{CE} = 20 V

Fig. 7. Typical transfer characteristic



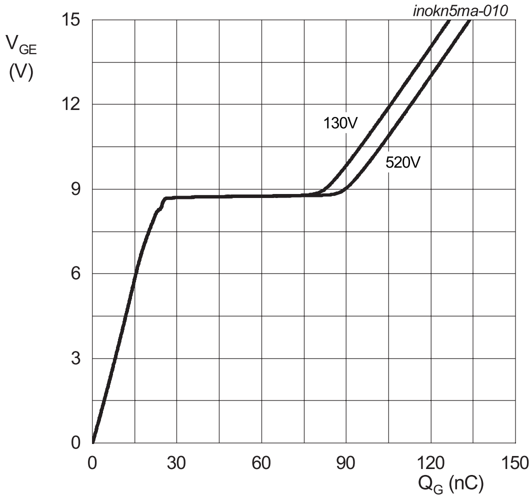
V_{GE} = 15 V

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



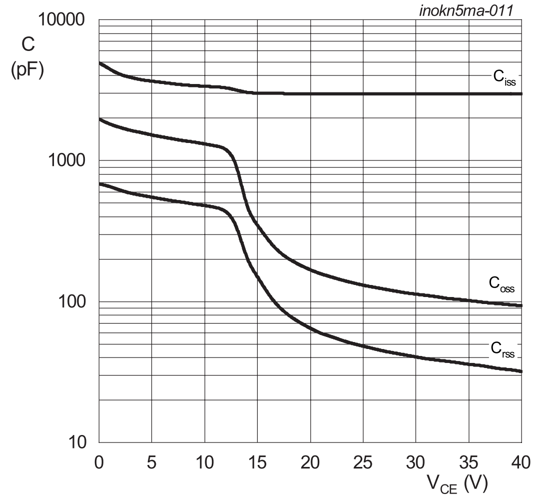
I_C = 500 µA

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

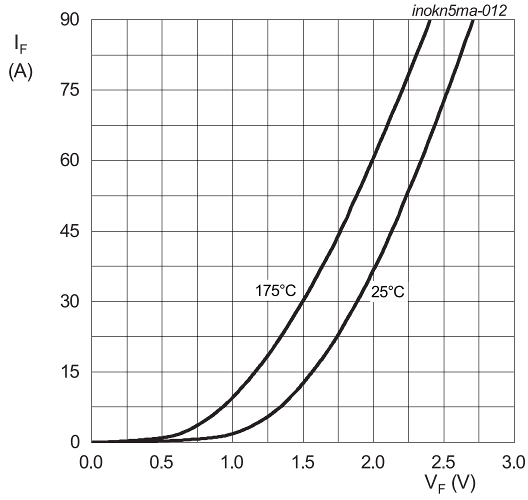
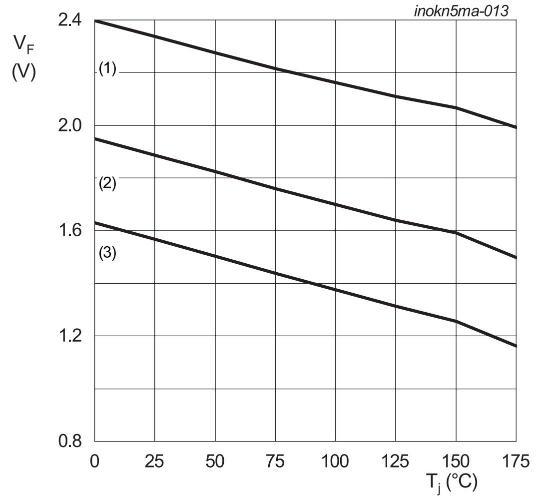
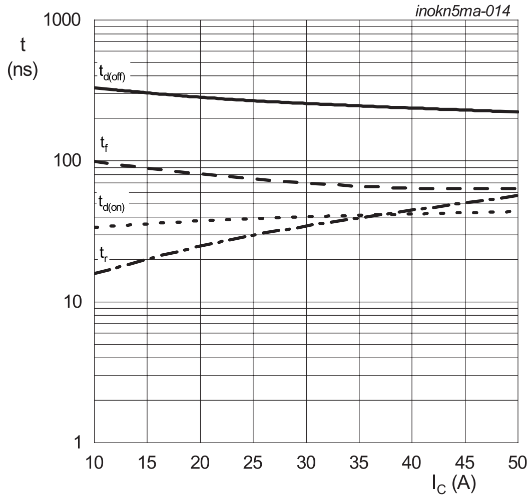


Fig. 12. Typical diode forward current as a function of forward voltage



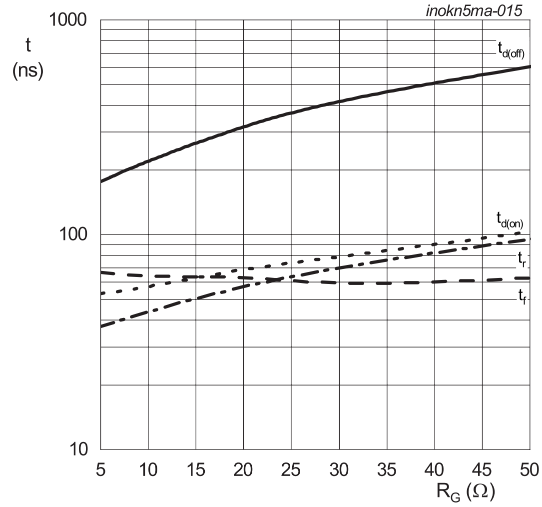
(1) I_F = 60 A
(2) I_F = 30 A
(3) I_F = 15 A

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



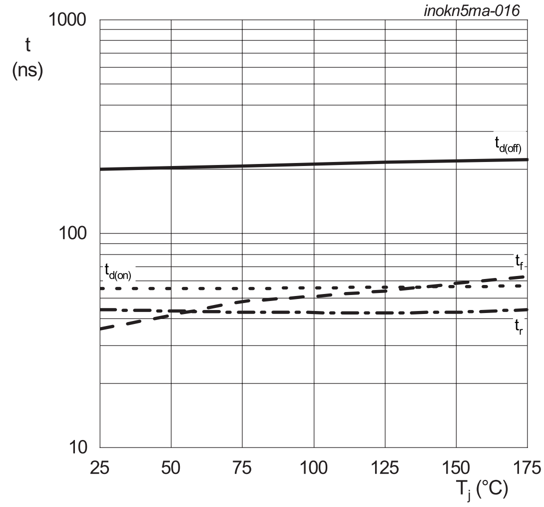
R_g = 10 Ω; V_{GE} = 15V/0V; T_j = 175 °C; V_{CE} = 400 V; inductive load

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



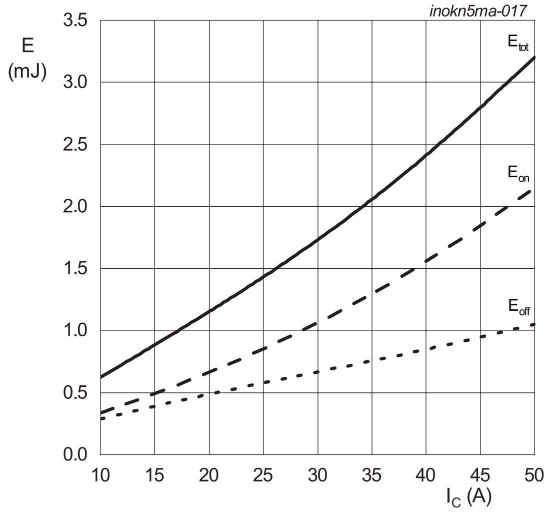
I_C = 50 A; V_{GE} = 15V/0V; T_j = 175 °C;
V_{CE} = 400 V; inductive load

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



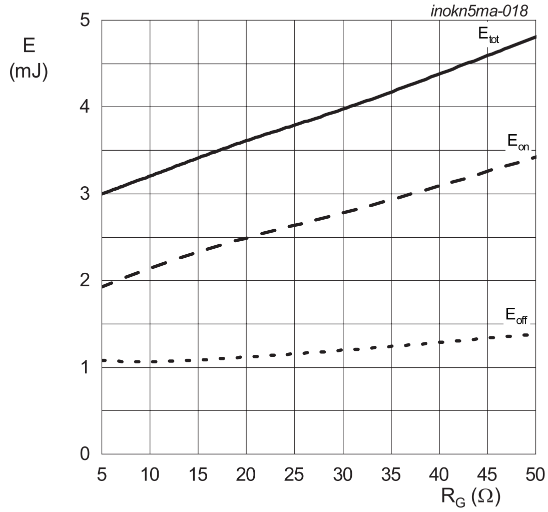
I_C = 50 A; V_{GE} = 15V/0V; R_g = 10 Ω;
V_{CE} = 400 V; inductive load

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



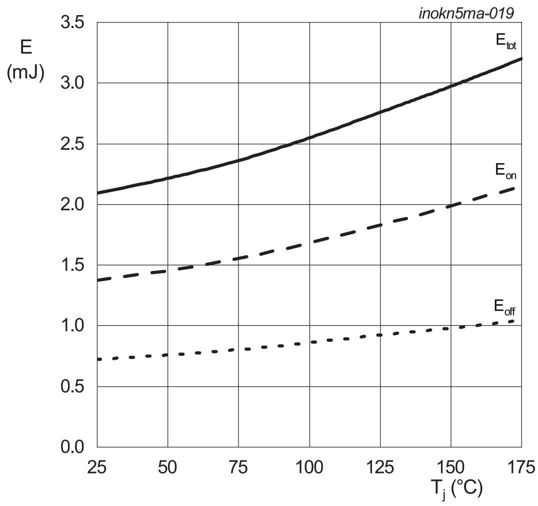
R_g = 10 Ω; V_{GE} = 15V/0V; T_j = 175 °C;
V_{CE} = 400 V; inductive load

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



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

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



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

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

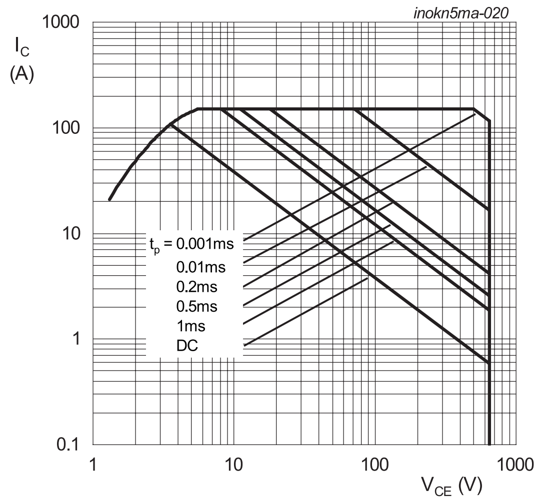


Fig. 20. Forward bias safe operating area

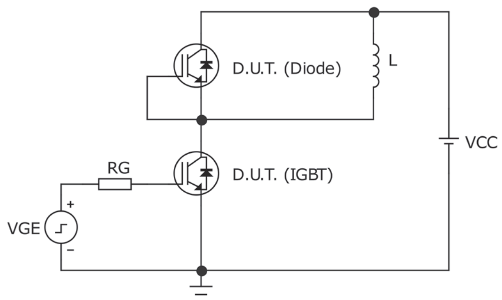


Fig. 21. Test circuit for inductive load switching

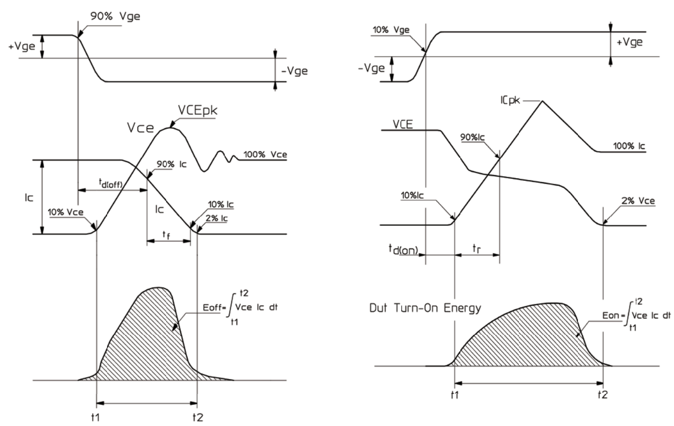
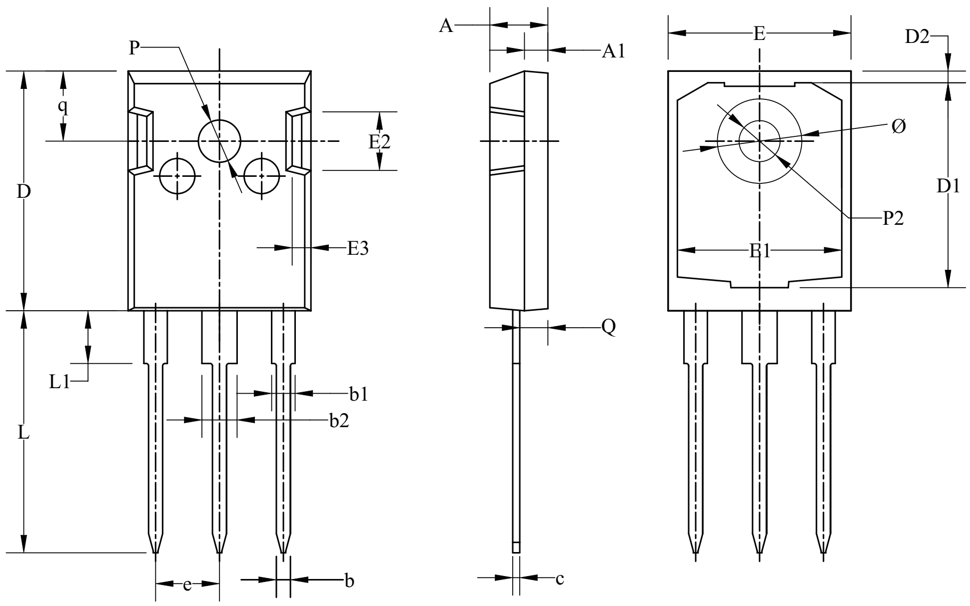


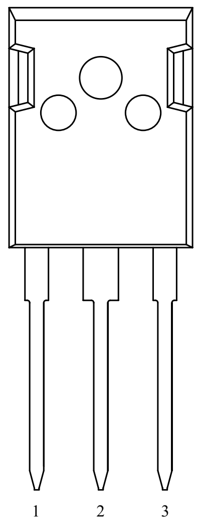
Fig. 22. Definition of switching times and losses

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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14. Contents

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Date of release: 27 September 2023