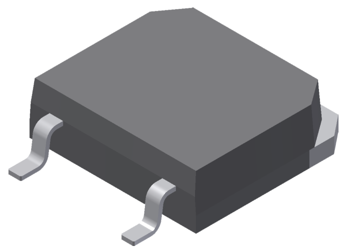
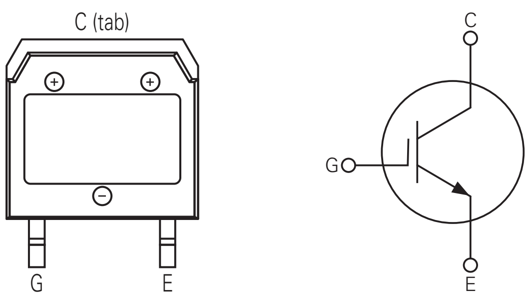
IXYT90N65A5HV

650 V, 90 A Gen5 XPT™ IGBT

Extreme Light Punch Through IGBT for up to 5 kHz Switching



Pinout Diagram (TO-268HV)



G: Gate; **C:** Collector; **E:** Emitter; **Tab:** Collector

Description:

Developed using our proprietary XPT™ thin-wafer technology and state-of-the-art Trench IGBT process, these devices feature reduced thermal resistance, low conduction losses, and low gate drive requirements.

Features & Benefits:

- Optimized for Low Conduction Losses
- High Surge Current Capability
- Square RBSOA
- International Standard Package
- Low Gate Charge Q_G
- Low Gate Drive Requirement

Applications:

- Power Inverters
- UPS
- PFC Circuits
- Battery Chargers
- Welding Machines
- Lamp Ballasts
- Inrush Current Protection Circuits

Product Summary

Characteristic	Value	Unit
V_{CES}	650	V
I_{C110}	90	A
$V_{CE(sat)}$	1.35	V
$t_{fi(typ)}$	270	ns

Maximum Ratings

Symbol	Characteristic	Conditions	Value	Unit
V_{CES}	Collector-Emitter Voltage	T_J = 25 °C to 175 °C	650	V
V_{CGR}	Collector-Gate Voltage	T_J = 25 °C to 175 °C, R_{GE} = 1 MΩ	650	V
V_{GES}	Gate-Emitter Voltage	Continuous	±20	V
V_{GEM}	Transient Gate-Emitter Voltage	Transient	±30	V
I_{C25}	Continuous Collector Current	T_C = 25 °C (Chip Capability)	220	A
I_{LRMS}	Terminal Current Limit	–	160	A
I_{C110}	Continuous Collector Current	T_C = 110 °C	90	A
I_{CM}	Pulsed Collector Current	T_C = 25 °C, 1 ms	600	A
SSOA (RBSOA)	Switching Safe Operating Area (Reverse Biased Safe Operating Area)	V_{GE} = 15 V, T_{VJ} = 150 °C, R_G = 5 Ω, Clamped Inductive Load, I_{CM} @ $V_{CE} \leq V_{CES}$	180	A
P_C	Collector Power Dissipation	T_C = 25 °C	650	W
T_J	Junction Temperature	–	−55 to 175	°C
T_{JM}	Maximum Junction Temperature	–	175	°C
T_{stg}	Storage Temperature	–	−55 to 175	°C
T_{SOLD}	Soldering Temperature	Plastic Body for 10 s	260	°C
W	Weight	–	4	g

Thermal Characteristic

Symbol	Characteristic	Value			Unit
		Min.	Typ.	Max.	
$R_{th, JC}$	Thermal Resistance, Junction-to-Case	–	–	0.23	°C/W

Electrical Characteristics – Static (T_J = 25 °C unless otherwise specified)

Symbol	Characteristic	Conditions	Value			Unit
			Min.	Typ.	Max.	
BV_{CES}	Collector-Emitter Breakdown Voltage	I_C = 250 µA, V_{GE} = 0 V	650	–	–	V
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	I_C = 250 µA, V_{CE} = V_{GE}	3.7	–	5.8	V
I_{GES}	Gate-Emitter Leakage Current	V_{CE} = 0 V, V_{GE} = ±20 V	–	–	±100	nA
I_{CES}	Zero Gate Voltage Collector Current	V_{CE} = V_{CES}, V_{GE} = 0 V	–	–	5	µA
		V_{CE} = V_{CES}, V_{GE} = 0 V, T_J = 150 °C	–	–	500	µA
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage[1]	I_C = 60 A, V_{GE} = 15 V	–	1.22	1.35	V
		I_C = 60 A, V_{GE} = 15 V, T_J = 150 °C	–	1.30	–	V

Note 1: Pulse test, t ≤ 300 µs, duty cycle, d ≤ 2%

Electrical Characteristics – Dynamic (T_J = 25 °C unless otherwise specified)

<table>
<tr><th rowspan="2">Symbol</th><th rowspan="2">Characteristic</th><th rowspan="2" colspan="2">Conditions</th><th colspan="3">Value</th><th rowspan="2">Unit</th></tr>
<tr><th>Min.</th><th>Typ.</th><th>Max.</th></tr>
<tr><td>g_{fs}</td><td>Transconductance[1]</td><td colspan="2">I_C = 60 A, V_{CE} = 10 V</td><td>40</td><td>68</td><td>–</td><td>S</td></tr>
<tr><td>C_{ies}</td><td>Input Capacitance</td><td rowspan="3" colspan="2">V_{GE} = 25 V, V_{CE} = 0 V, f = 1 MHz</td><td>–</td><td>4040</td><td>–</td><td rowspan="3">pF</td></tr>
<tr><td>C_{oes}</td><td>Output Capacitance</td><td>–</td><td>200</td><td>–</td></tr>
<tr><td>C_{res}</td><td>Reverse Transfer Capacitance</td><td>–</td><td>150</td><td>–</td></tr>
<tr><td>$Q_{g(on)}$</td><td>Total Gate Charge</td><td rowspan="3" colspan="2">V_{GE} = 15 V, V_{CE} = 0.5 x $V_{CES,}$
I_C = 90 A</td><td>–</td><td>260</td><td>–</td><td rowspan="3">nC</td></tr>
<tr><td>Q_{ge}</td><td>Gate-Emitter Charge</td><td>–</td><td>33</td><td>–</td></tr>
<tr><td>Q_{gc}</td><td>Gate-Collector Charge</td><td>–</td><td>128</td><td>–</td></tr>
<tr><td rowspan="2">$t_{d(on)}$</td><td rowspan="2">Turn-on Delay Time[2]</td><td rowspan="12">Inductive Load,
V_{GE} = 15 V, V_{CE} = 400 V,
I_C = 40 A, $R_{G(ext)}$ = 5 Ω</td><td>T_J = 25 °C</td><td>–</td><td>37</td><td>–</td><td rowspan="2">ns</td></tr>
<tr><td>T_J = 150 °C</td><td>–</td><td>20</td><td>–</td></tr>
<tr><td rowspan="2">t_{ri}</td><td rowspan="2">Turn-on Rise Time[2]</td><td>T_J = 25 °C</td><td>–</td><td>43</td><td>–</td><td rowspan="2">ns</td></tr>
<tr><td>T_J = 150 °C</td><td>–</td><td>40</td><td>–</td></tr>
<tr><td rowspan="2">E_{on}</td><td rowspan="2">Turn-on Energy[2]</td><td>T_J = 25 °C</td><td>–</td><td>1.0</td><td>–</td><td rowspan="2">mJ</td></tr>
<tr><td>T_J = 150 °C</td><td>–</td><td>2.2</td><td>–</td></tr>
<tr><td rowspan="2">$t_{d(off)}$</td><td rowspan="2">Turn-off Delay Time[2]</td><td>T_J = 25 °C</td><td>–</td><td>436</td><td>–</td><td rowspan="2">ns</td></tr>
<tr><td>T_J = 150 °C</td><td>–</td><td>407</td><td>–</td></tr>
<tr><td rowspan="2">t_{fi}</td><td rowspan="2">Turn-off Fall Time[2]</td><td>T_J = 25 °C</td><td>–</td><td>270</td><td>–</td><td rowspan="2">ns</td></tr>
<tr><td>T_J = 150 °C</td><td>–</td><td>405</td><td>–</td></tr>
<tr><td rowspan="2">E_{off}</td><td rowspan="2">Turn-off Energy[2]</td><td>T_J = 25 °C</td><td>–</td><td>3.0</td><td>–</td><td rowspan="2">mJ</td></tr>
<tr><td>T_J = 150 °C</td><td>–</td><td>4.2</td><td>–</td></tr>
</table>

Note 1: Pulse test, t ≤ 300 µs, duty cycle, d ≤ 2%
Note 2: Switching times and energy losses may increase for higher $V_{CE(clamp)}$, T_J, or R_G.

Characteristic Curves

Fig. 1. Output Characteristics @ T_J = 25 °C

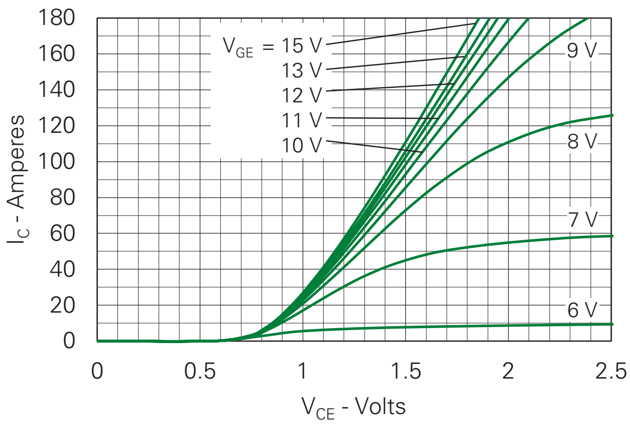


Fig. 2. Extended Output Characteristics @ T_J = 25 °C

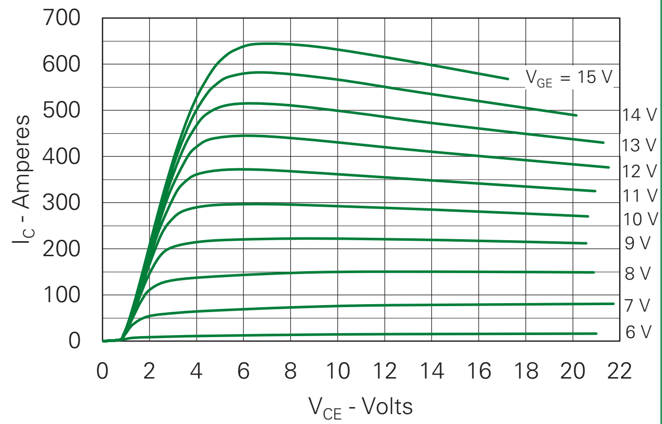


Fig. 3. Output Characteristics @ T_J = 150 °C

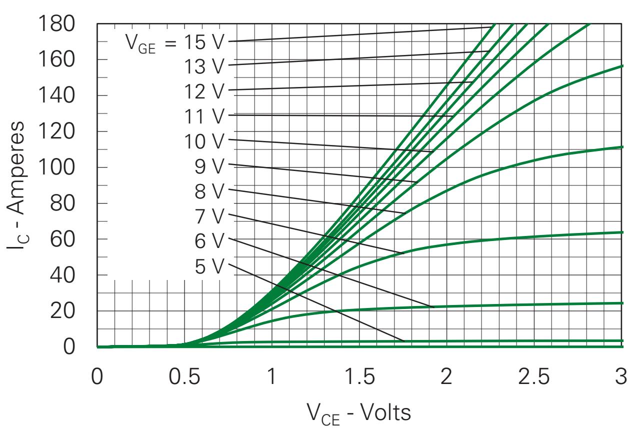


Fig. 4. Dependence of $V_{CE(sat)}$ on Junction Temperature

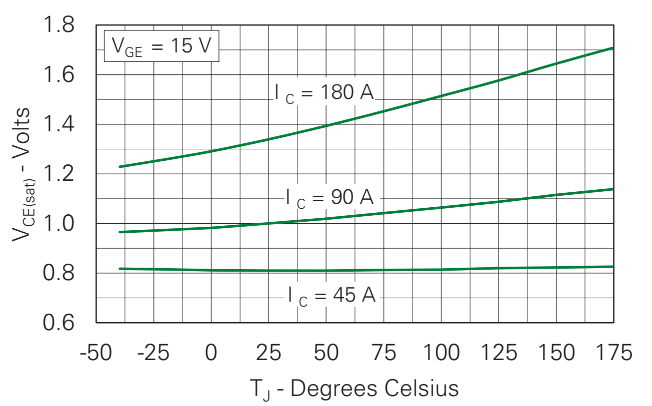


Fig. 5. Collector-to-Emitter Voltage vs. Gate-to-Emitter Voltage

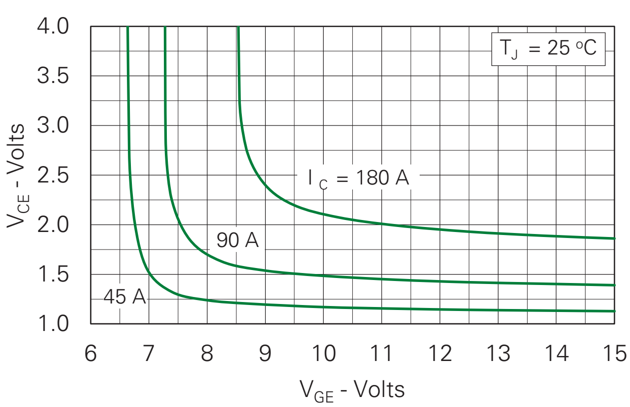
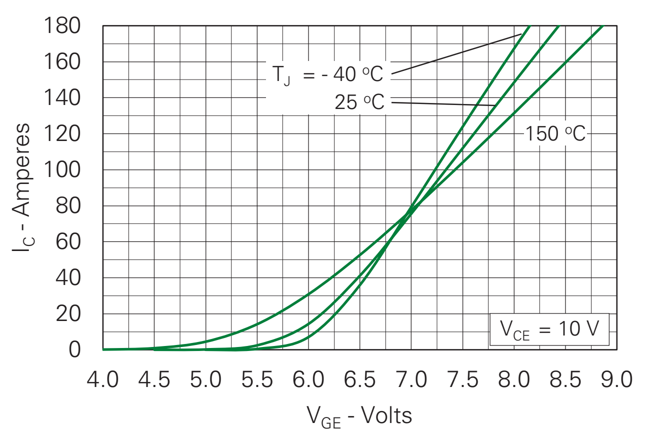


Fig. 6. Input Admittance



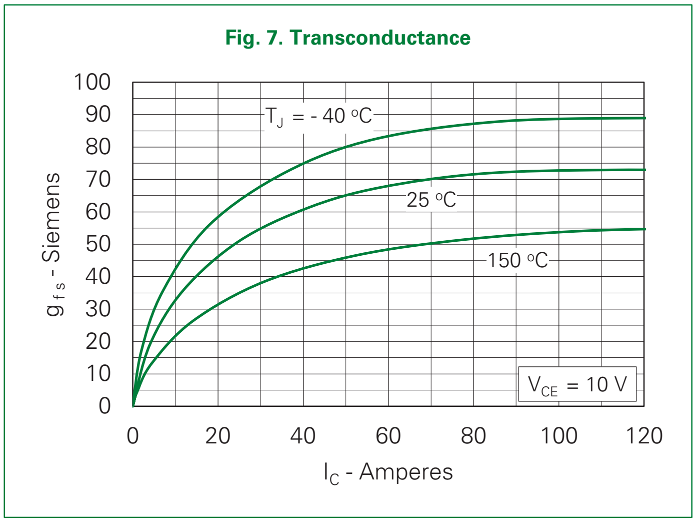


Fig. 7. Transconductance
g f s - Siemens
I C - Amperes
T J = - 40 ºC
25 ºC
150 ºC
V CE = 10 V
0
10
20
30
40
50
60
70
80
90
100
0
20
40
60
80
100
120

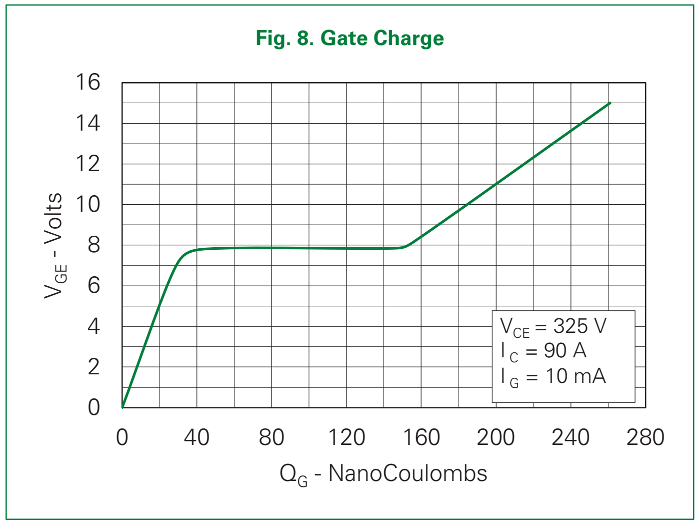


Fig. 8. Gate Charge
V GE - Volts
Q G - NanoCoulombs
V CE = 325 V
I C = 90 A
I G = 10 mA
0
2
4
6
8
10
12
14
16
0
40
80
120
160
200
240
280

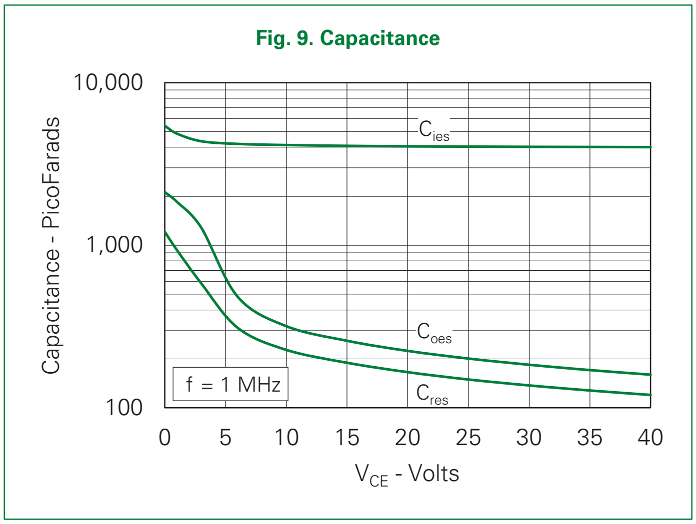


Fig. 9. Capacitance
Capacitance - PicoFarads
V CE - Volts
C ies
C oes
C res
f = 1 MHz
100
1,000
10,000
0
5
10
15
20
25
30
35
40

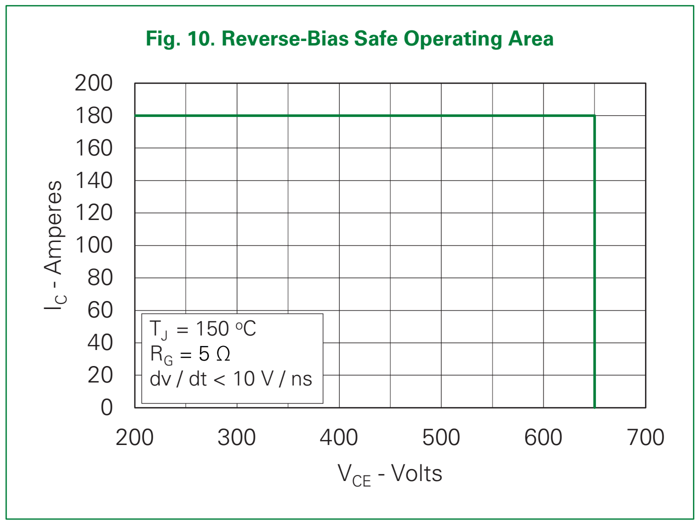


Fig. 10. Reverse-Bias Safe Operating Area
I C - Amperes
V CE - Volts
T J = 150 ºC
R G = 5 Ω
dv / dt < 10 V / ns
0
20
40
60
80
100
120
140
160
180
200
200
300
400
500
600
700

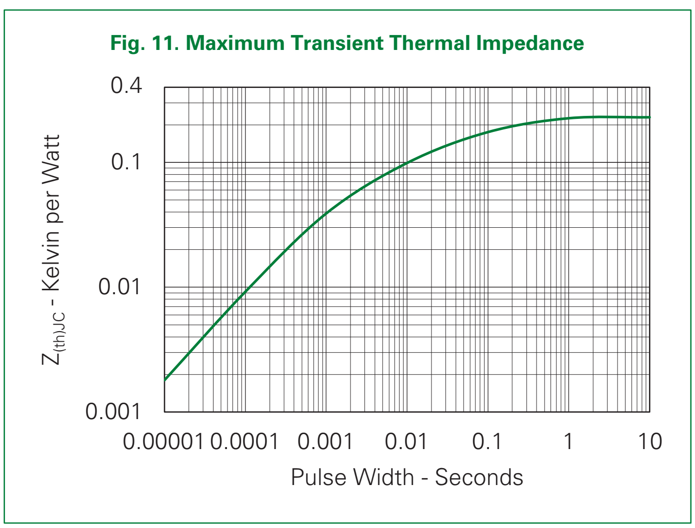


Fig. 11. Maximum Transient Thermal Impedance
Z (th)JC - Kelvin per Watt
Pulse Width - Seconds
0.001
0.01
0.1
0.4
0.00001
0.0001
0.001
0.01
0.1
1
10

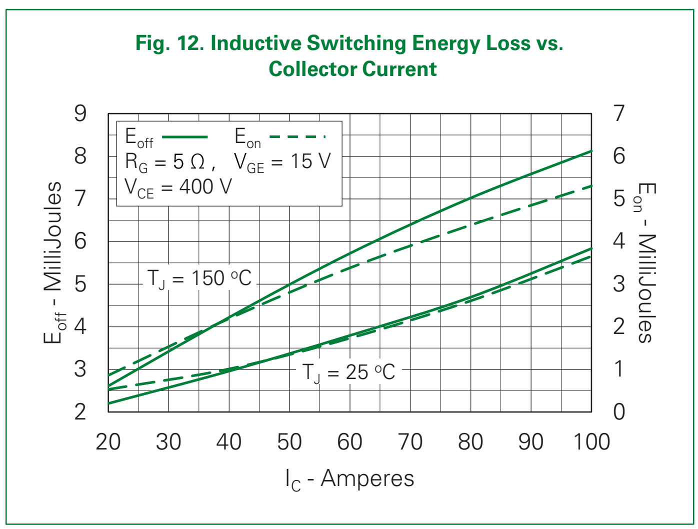


Fig. 12. Inductive Switching Energy Loss vs. Collector Current
E off - MilliJoules
E on - MilliJoules
I C - Amperes
E off
E on
R G = 5 Ω , V GE = 15 V
V CE = 400 V
T J = 150 ºC
T J = 25 ºC
2
3
4
5
6
7
8
9
0
1
2
3
4
5
6
7
20
30
40
50
60
70
80
90
100

Fig. 13. Inductive Switching Energy Loss vs. Gate Resistance

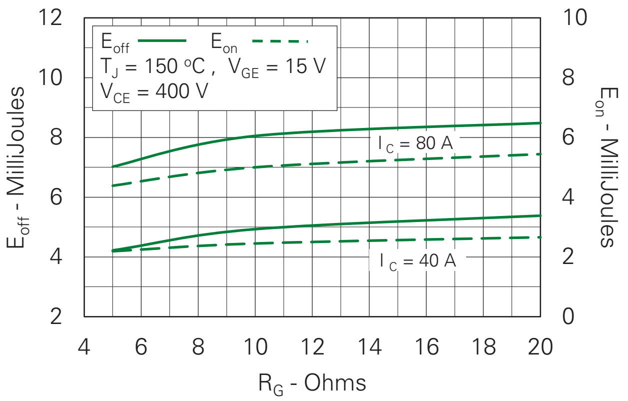


Fig. 14. Inductive Switching Energy Loss vs. Junction Temperature

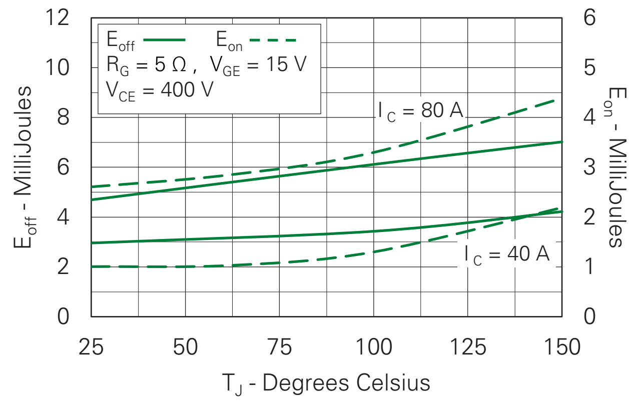


Fig. 15. Inductive Turn-off Switching Times vs. Gate Resistance

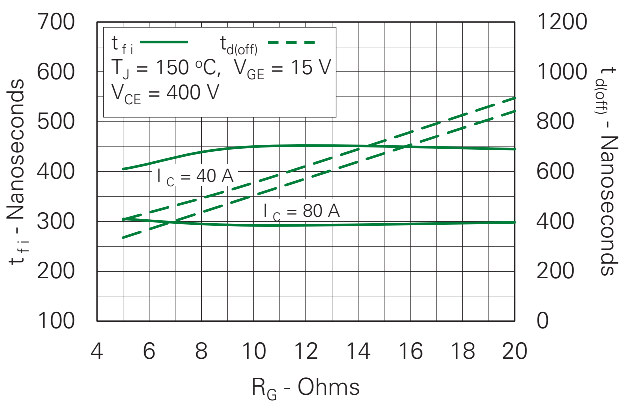


Fig. 16. Inductive Turn-off Switching Times vs. Collector Current

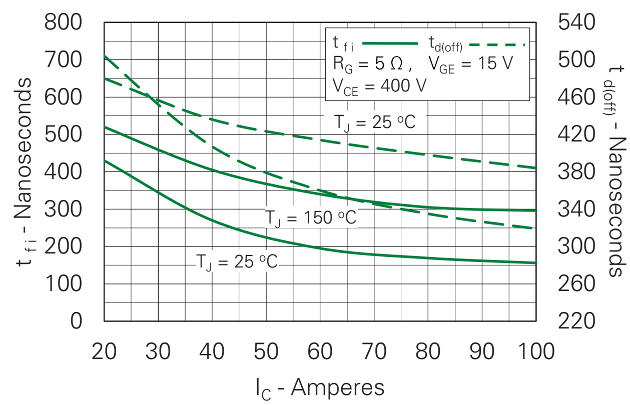


Fig. 17. Inductive Turn-off Switching Times vs. Junction Temperature

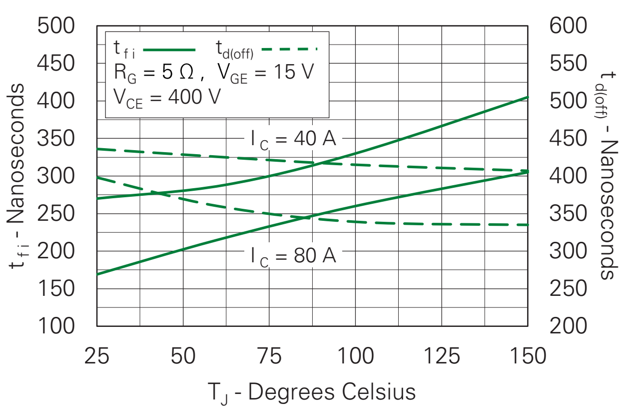


Fig. 18. Inductive Turn-on Switching Times vs. Gate Resistance

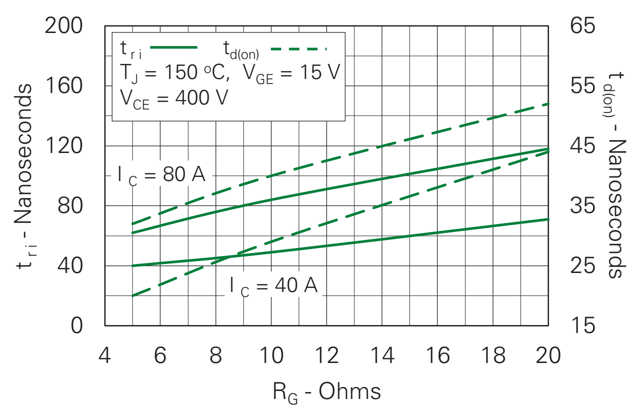


Fig. 19. Inductive Turn-on Switching Times vs. Collector Current

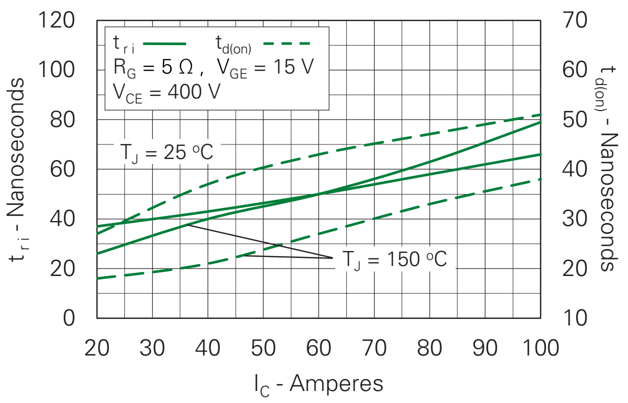


Fig. 20. Inductive Turn-on Switching Times vs. Junction Temperature

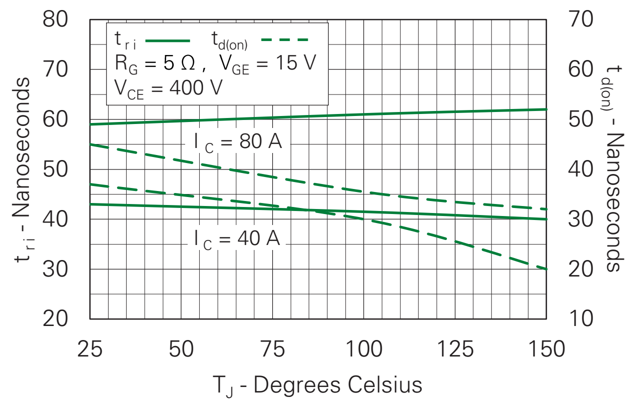
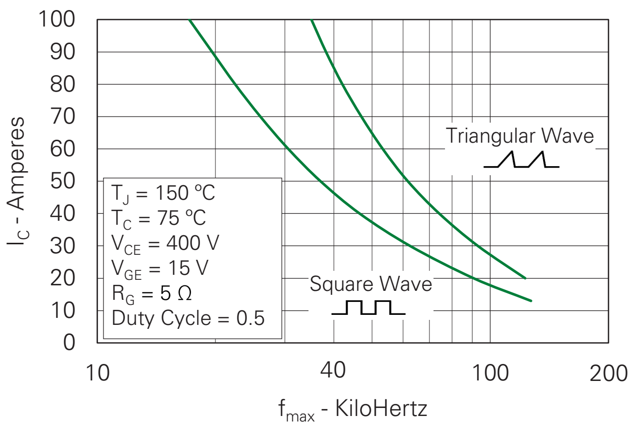
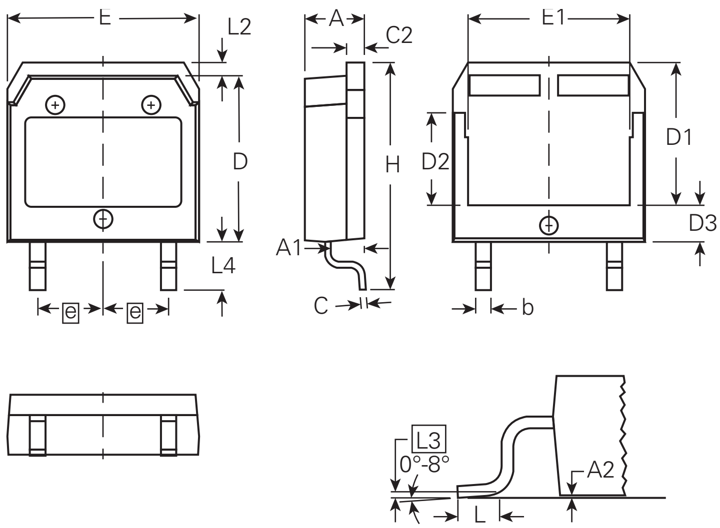


Fig. 21. Maximum Peak Load Current vs. Frequency



Revised: XZ 12/08/2023

Part Outline Drawing (TO-268HV)



Symbol	Inches			Millimeters		
	Min.	Typical	Max.	Min.	Typical	Max
A	0.193	–	0.201	4.90	–	5.10
A1	0.106	–	0.114	2.70	–	2.90
A2	0.001	–	0.010	0.02	–	0.25
b	0.045	–	0.057	1.15	–	1.45
C	0.016	–	0.026	0.40	–	0.65
C2	0.057	–	0.063	1.45	–	1.60
D	0.543	–	0.551	13.80	–	14.00
D1	0.465	–	0.476	11.80	–	12.10
D2	0.295	–	0.307	7.50	–	7.80
D3	0.114	–	0.126	2.90	–	3.20
E	0.624	–	0.632	15.85	–	16.05
E1	0.524	–	0.535	13.30	–	13.60
e	0.215 BSC			5.45 BSC		
e2	0.374	–	0.386	9.50	–	9.80
H	0.736	–	0.752	18.70	–	19.10
L	0.067	–	0.079	1.70	–	2.00
L2	0.039	–	0.045	1.00	–	1.15
L3	0.010 BSC			0.25 BSC		
L4	0.150	–	0.161	3.80	–	4.10

REVISION HISTORY		
08/03/2023	XZ	▪ New Datasheet. Version 0.3
08/04/2023	XZ	▪ Updated Characteristic Curves: Fig. 4., Fig. 11., Fig. 21
08/08/2023	XZ	▪ Updated Descriptions, Features & Benefits, Applications.