

# IGBT - FS, Trench

## 1200 V, 40 A

### FGH40T120SMDL4

#### Description

Using innovative field stop trench IGBT technology, ON Semiconductor's new series of field stop trench IGBTs offer the optimum performance for hard switching application such as solar inverter, UPS, welder and PFC applications.

#### Features

- FS Trench Technology, Positive Temperature Coefficient
- Excellent Switching Performance due to Kelvin Emitter Pin
- Low Saturation Voltage:  $V_{CE(sat)} = 1.8\text{ V @ } I_C = 40\text{ A}$
- 100% of the Parts Tested for  $I_{LM}$
- High Input Impedance
- This Device is Pb-Free and is RoHS Compliant

#### Applications

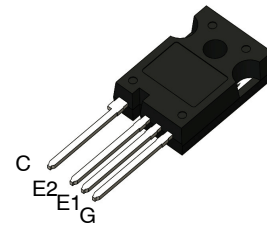
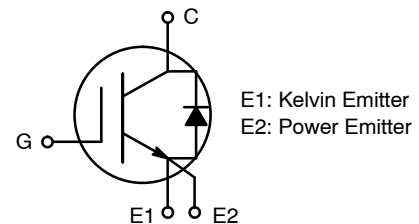
- Solar Inverter, Welder, UPS and PFC Applications



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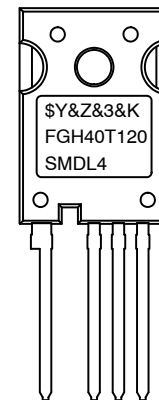
[www.onsemi.com](http://www.onsemi.com)

$V_{CES}$	$I_C$
1200 V	40 A



TO-247-4LD  
CASE 340CJ

#### MARKING DIAGRAM



\$Y = ON Semiconductor Logo  
 &Z = Assembly Plant Code  
 &3 = Numeric Date Code  
 &K = Lot Code  
 FGH40T120SMDL4 = Specific Device Code

#### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# FGH40T120SMDL4

## ABSOLUTE MAXIMUM RATINGS

Symbol	Description	FGH40T120SMDL4	Unit
$V_{CES}$	Collector to Emitter Voltage	1200	V
$V_{GES}$	Gate to Emitter Voltage	$\pm 25$	V
	Transient Gate to Emitter Voltage	$\pm 30$	V
$I_C$	Collector Current	$T_C = 25^\circ\text{C}$	80
		$T_C = 100^\circ\text{C}$	40
$I_{LM}$ (Note 1)	Clamped Inductive Load Current	$T_C = 25^\circ\text{C}$	160
$I_{CM}$ (Note 2)	Pulsed Collector Current		160
$I_F$	Diode Continuous Forward Current	$T_C = 25^\circ\text{C}$	80
	Diode Continuous Forward Current	$T_C = 100^\circ\text{C}$	40
$I_{FM}$	Diode Maximum Forward Current		240
$P_D$	Maximum Power Dissipation	$T_C = 25^\circ\text{C}$	555
		$T_C = 100^\circ\text{C}$	277
$T_J$	Operating Junction Temperature	-55 to +175	$^\circ\text{C}$
$T_{STG}$	Storage Temperature Range	-55 to +175	$^\circ\text{C}$
$T_L$	Maximum Lead Temp. for Soldering Purposes, 1/8" from Case for 5 Seconds	300	$^\circ\text{C}$

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

- $V_{CC} = 600\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_C = 160\text{ A}$ ,  $R_G = 20\ \Omega$ , Inductive Load.
- Limited by  $T_{jmax}$ .

## THERMAL CHARACTERISTICS

Symbol	Parameter	FGH75T65SQDT-F155	Unit
$R_{\theta JC}$ (IGBT)	Thermal Resistance, Junction to Case	0.27	$^\circ\text{C/W}$
$R_{\theta JC}$ (Diode)	Thermal Resistance, Junction to Case	0.89	$^\circ\text{C/W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	40	$^\circ\text{C/W}$

## PACKAGE MARKING AND ORDERING INFORMATION

Part Number	Top Mark	Package	Reel Size	Tape Width	Quantity
FGH40T120SMDL4	FGH40T120SMDL4	TO-247-4LD	-	-	30

# FGH40T120SMDL4

## ELECTRICAL CHARACTERISTICS OF THE IGBT ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

BV <sub>CES</sub>	Collector to Emitter Breakdown Voltage	V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 $\mu$ A	1200	–	–	V
I <sub>CES</sub>	Collector Cut-Off Current	V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0 V	–	–	250	$\mu$ A
I <sub>GES</sub>	G-E Leakage Current	V <sub>GE</sub> = V <sub>GES</sub> , V <sub>CE</sub> = 0 V	–	–	$\pm$ 400	nA

### ON CHARACTERISTICS

V <sub>GE(th)</sub>	G-E Threshold Voltage	I <sub>C</sub> = 40 mA, V <sub>CE</sub> = V <sub>GE</sub>	4.9	6.2	7.5	V
V <sub>CE(sat)</sub>	Collector to Emitter Saturation Voltage	I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V, T <sub>C</sub> = 25 $^\circ$ C	–	1.8	2.4	V
		I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V, T <sub>C</sub> = 175 $^\circ$ C	–	2.0	–	V

### DYNAMIC CHARACTERISTICS

C <sub>ies</sub>	Input Capacitance	V <sub>CE</sub> = 30 V, V <sub>GE</sub> = 0 V, f = 1MHz	–	4300	–	pF
C <sub>oes</sub>	Output Capacitance		–	180	–	pF
C <sub>res</sub>	Reverse Transfer Capacitance		–	100	–	pF

### SWITCHING CHARACTERISTICS

T <sub>d(on)</sub>	Turn-On Delay Time	V <sub>CC</sub> = 600 V, I <sub>C</sub> = 40 A, R <sub>G</sub> = 10 $\Omega$ , V <sub>GE</sub> = 15 V, Inductive Load, T <sub>C</sub> = 25 $^\circ$ C	–	44	–	ns
T <sub>r</sub>	Rise Time		–	42	–	ns
T <sub>d(off)</sub>	Turn-Off Delay Time		–	464	–	ns
T <sub>f</sub>	Fall Time		–	24	–	ns
E <sub>on</sub>	Turn-On Switching Loss		–	2.24	–	mJ
E <sub>off</sub>	Turn-Off Switching Loss		–	1.02	–	mJ
E <sub>ts</sub>	Total Switching Loss		–	3.26	–	mJ
T <sub>d(on)</sub>	Turn-On Delay Time	V <sub>CC</sub> = 600 V, I <sub>C</sub> = 40 A, R <sub>G</sub> = 10 $\Omega$ , V <sub>GE</sub> = 15 V, Inductive Load, T <sub>C</sub> = 25 $^\circ$ C	–	42	–	ns
T <sub>r</sub>	Rise Time		–	48	–	ns
T <sub>d(off)</sub>	Turn-Off Delay Time		–	518	–	ns
T <sub>f</sub>	Fall Time		–	24	–	ns
E <sub>on</sub>	Turn-On Switching Loss		–	3.11	–	mJ
E <sub>off</sub>	Turn-Off Switching Loss		–	2.01	–	mJ
E <sub>ts</sub>	Total Switching Loss		–	5.12	–	mJ
Q <sub>g</sub>	Total Gate Charge	V <sub>CE</sub> = 600 V, I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V	–	370	–	nC
Q <sub>ge</sub>	Gate to Emitter Charge		–	23	–	nC
Q <sub>gc</sub>	Gate to Collector Charge		–	210	–	nC

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

# FGH40T120SMDL4

## ELECTRICAL CHARACTERISTICS OF THE DIODE ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
$V_{FM}$	Diode Forward Voltage	$I_F = 40\text{ A}$	$T_C = 25^\circ\text{C}$	-	3.8	4.8	V
			$T_C = 175^\circ\text{C}$	-	2.7	-	
$T_{rr}$	Diode Reverse Recovery Time	$V_R = 600\text{ V}, I_F = 40\text{ A}$ $di_F/dt = 200\text{ A}/\mu\text{s}, T_C = 25^\circ\text{C}$		-	65	-	ns
$I_{rr}$	Diode Peak Reverse Recovery Current			-	7.2	-	A
$Q_{rr}$	Diode Reverse Recovery Charge			-	234	-	nC
$T_{rr}$	Diode Reverse Recovery Time	$V_R = 600\text{ V}, I_F = 40\text{ A}$ $di_F/dt = 200\text{ A}/\mu\text{s}, T_C = 175^\circ\text{C}$		-	200	-	ns
$I_{rr}$	Diode Peak Reverse Recovery Current			-	18.0	-	A
$Q_{rr}$	Diode Reverse Recovery Charge			-	1800	-	nC

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

# FGH40T120SMDL4

## TYPICAL PERFORMANCE CHARACTERISTICS

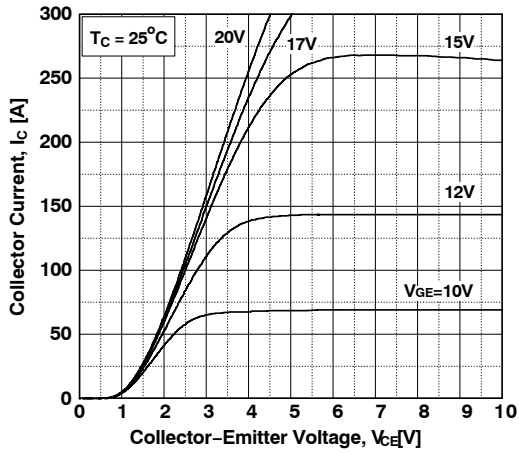


Figure 1. Typical Output Characteristics

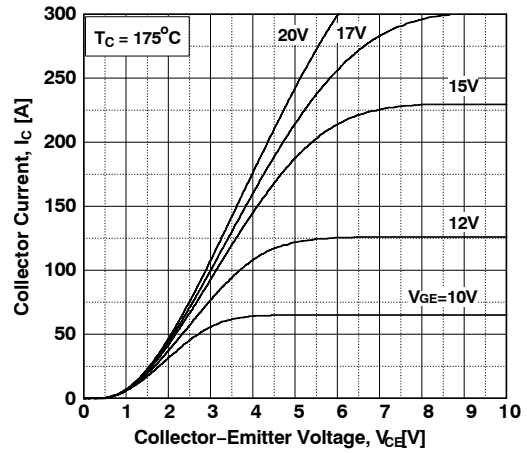


Figure 2. Typical Output Characteristics

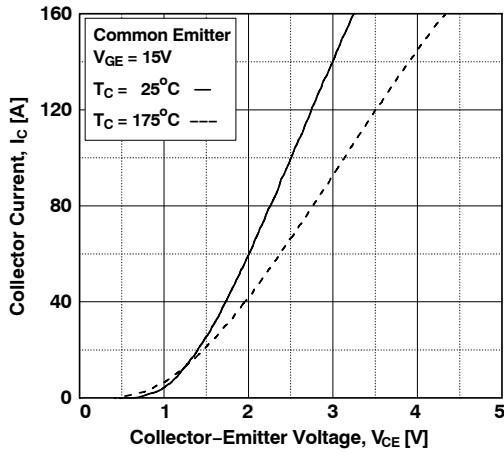


Figure 3. Typical Saturation Voltage Characteristics

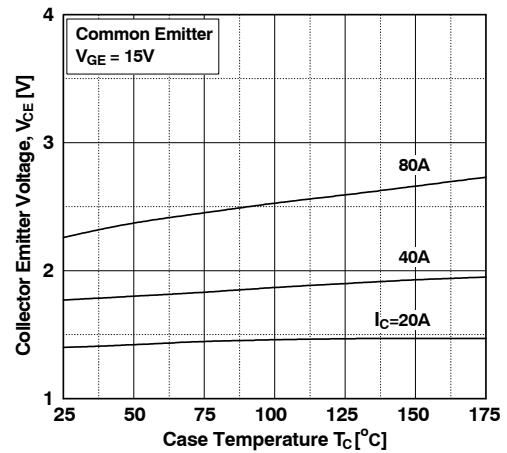


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

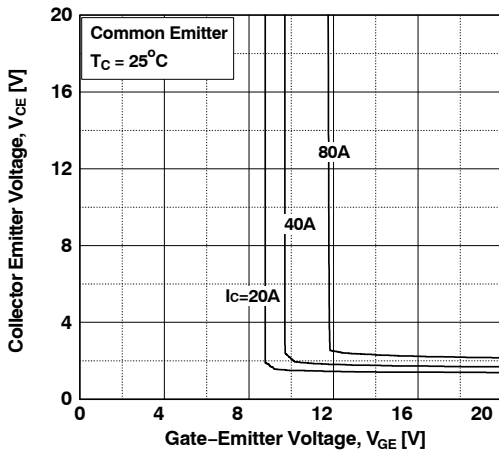


Figure 5. Saturation Voltage vs.  $V_{GE}$

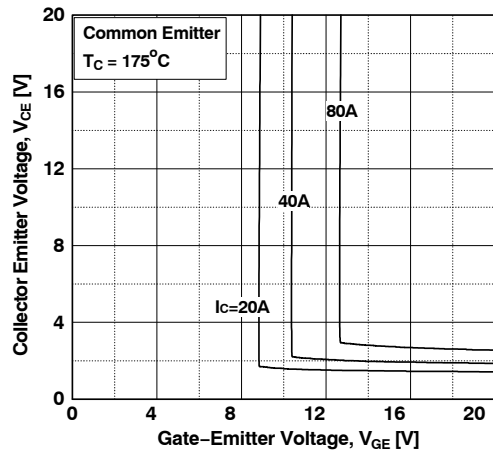


Figure 6. Saturation Voltage vs.  $V_{GE}$

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

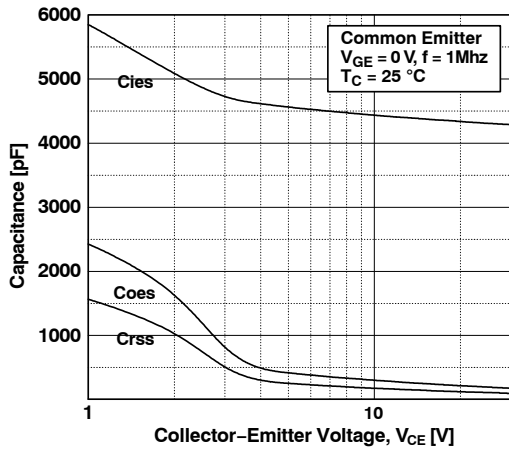


Figure 7. Capacitance Characteristics

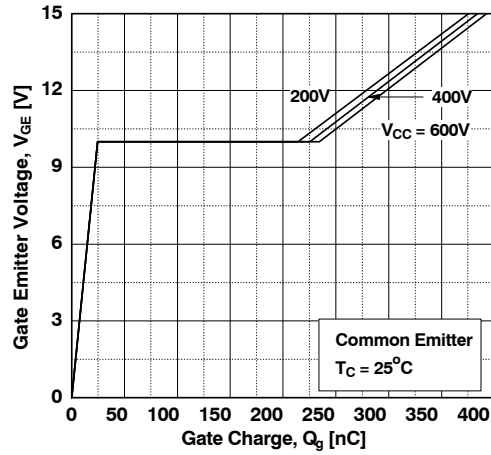


Figure 8. Gate Charge Characteristics

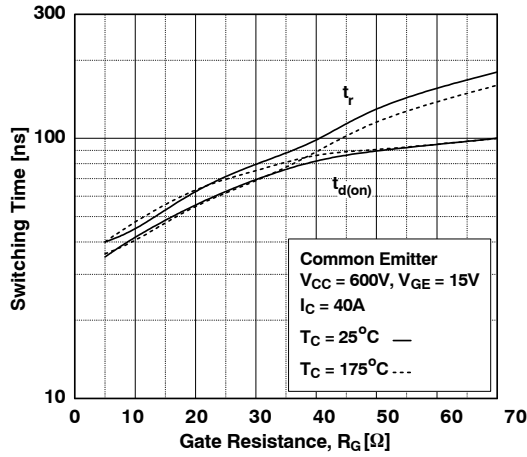


Figure 9. Turn-on Characteristics vs. Gate Resistance

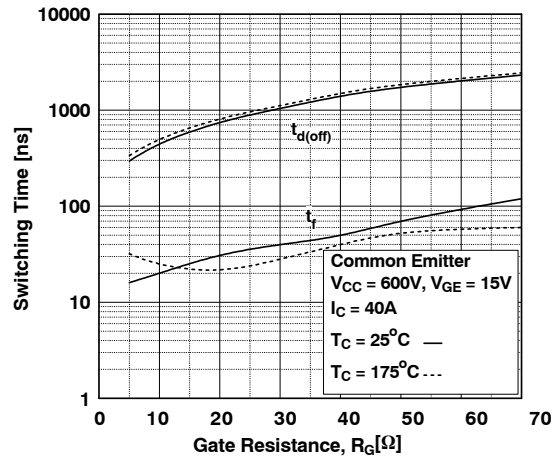


Figure 10. Turn-off Characteristics vs. Gate Resistance

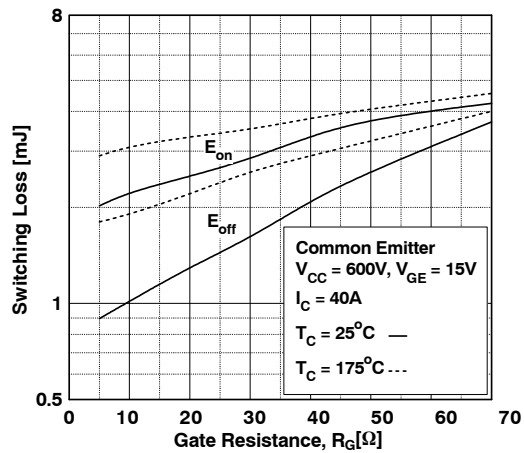


Figure 11. Switching Loss vs. Gate Resistance

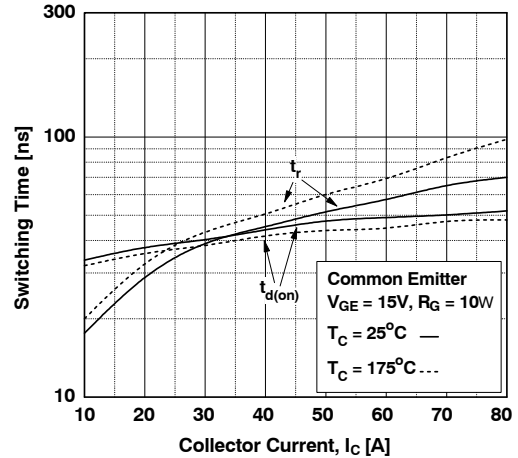


Figure 12. Turn-on Characteristics vs. Collector Current

TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

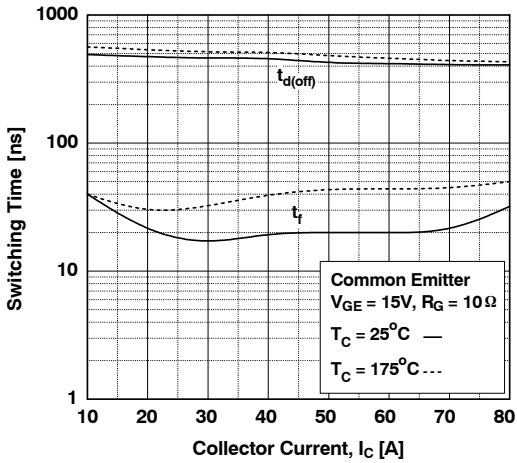


Figure 13. Turn-off Characteristics vs. Collector Current

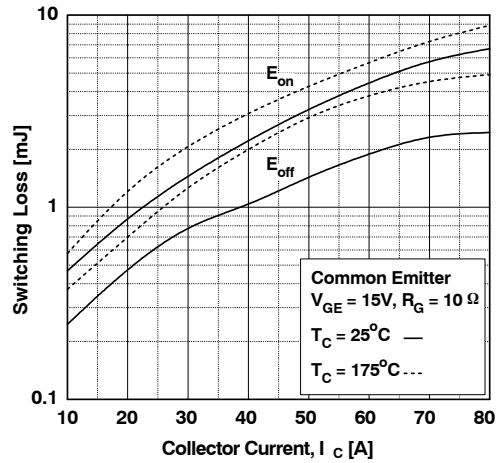


Figure 14. Switching Loss vs. Collector Current

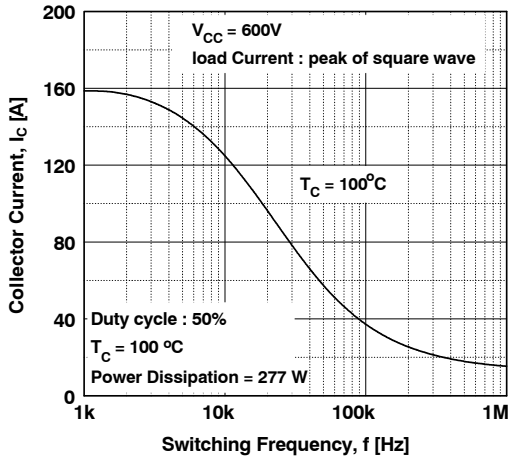


Figure 15. Load Current vs. Frequency

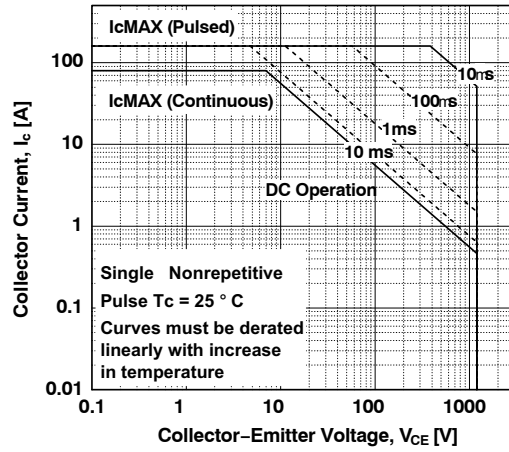


Figure 16. SOA Characteristics

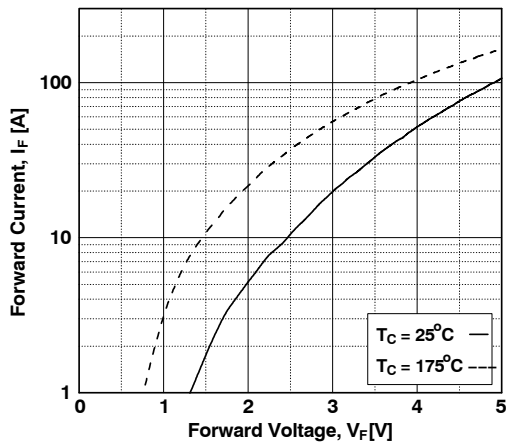


Figure 17. Forward Characteristics

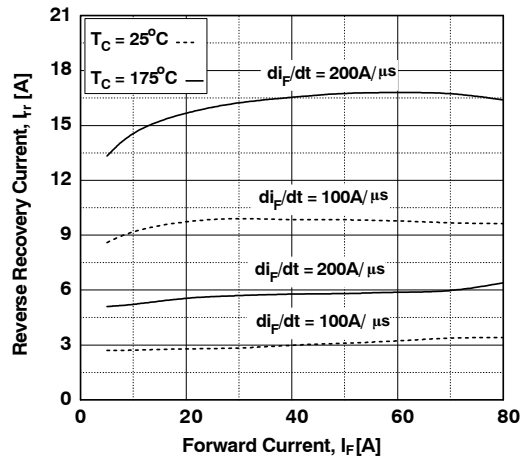


Figure 18. Reverse Recovery Current

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## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

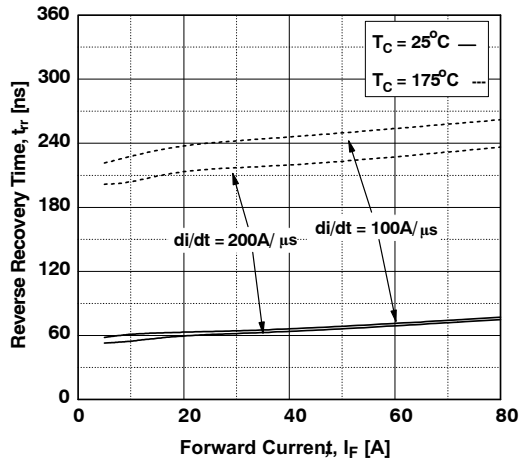


Figure 19. Reverse Recovery Time

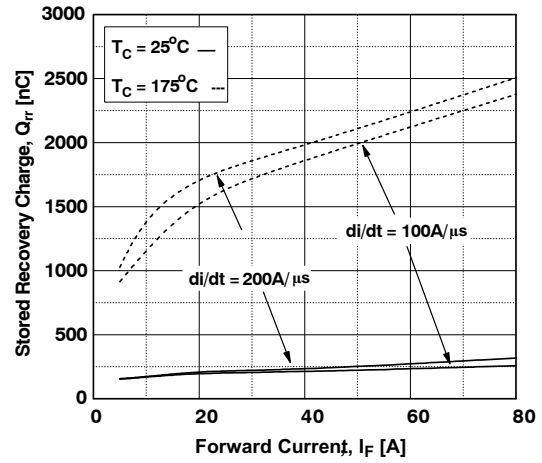


Figure 20. Stored Charge

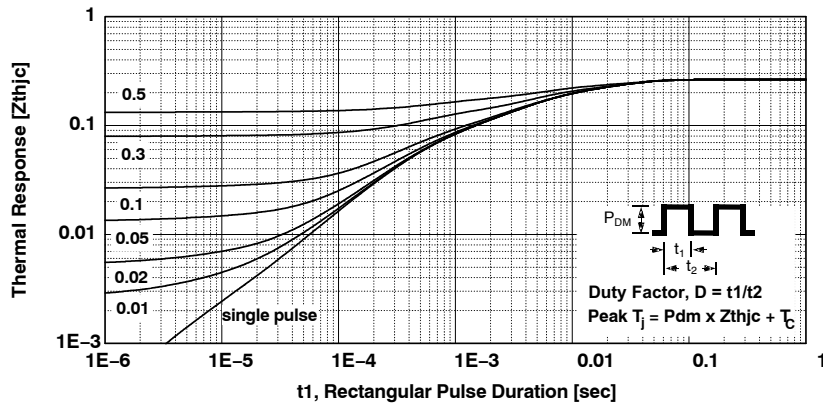


Figure 21. Transient Thermal Impedance of IGBT

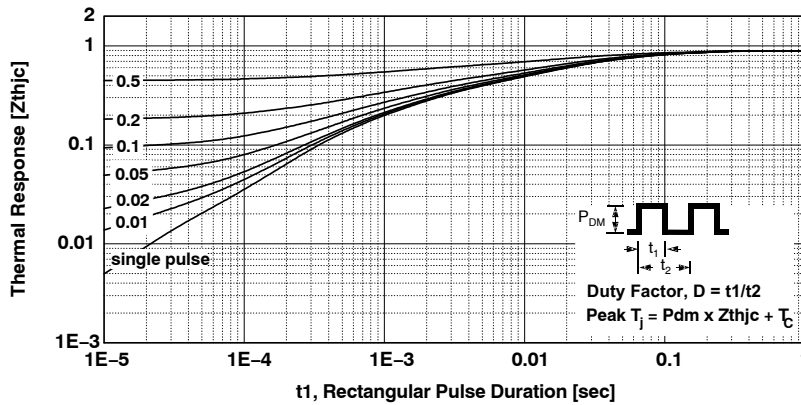


Figure 22. Transient Thermal Impedance of Diode



# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

ON Semiconductor®



TO-247-4LD  
CASE 340CJ  
ISSUE A

DATE 16 SEP 2019



DIM	MILLIMETERS		
	MIN	NOM	MAX
A	4.80	5.00	5.20
A1	2.10	2.40	2.70
A2	1.80	2.00	2.20
b	1.07	1.20	1.33
b1	1.20	1.40	1.60
b2	2.02	2.22	2.42
c	0.50	0.60	0.70
D	22.34	22.54	22.74
D1	16.00	16.25	16.50
D2	0.97	1.17	1.37
e	2.54 BSC		
e1	5.08 BSC		
E	15.40	15.60	15.80
E1	12.80	13.00	13.20
E/2	4.80	5.00	5.20
L	18.22	18.42	18.62
L1	2.42	2.62	2.82
p	3.40	3.60	3.80
p1	6.60	6.80	7.00
Q	5.97	6.17	6.37
S	5.97	6.17	6.37

**NOTES:**

- A. NO INDUSTRY STANDARD APPLIES TO THIS PACKAGE.
- B. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- C. ALL DIMENSIONS ARE IN MILLIMETERS.
- D. DRAWING CONFORMS TO ASME Y14.5-2009.

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<b>DESCRIPTION:</b>	<b>TO-247-4LD</b>	<b>PAGE 1 OF 1</b>

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[GT50JR22\(STA1ES\)](#) [TIG058E8-TL-H](#) [VS-CPV364M4KPBF](#) [NGTB25N120FL2WAG](#) [NGTG40N120FL2WG](#) [RJH60F3DPQ-A0#T0](#)  
[APT40GR120B2SCD10](#) [APT15GT120BRG](#) [APT20GT60BRG](#) [NGTB75N65FL2WAG](#) [NGTG15N120FL2WG](#) [IXA30RG1200DHGLB](#)  
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[IGW30N60H3FKSA1](#) [STGWA8M120DF3](#) [IGW08T120FKSA1](#) [IGW75N60H3FKSA1](#) [HGTG40N60B3](#) [FGH60N60SMD\\_F085](#)  
[FGH75T65UPD](#) [STGWA15H120F2](#) [IKA10N60TXKSA1](#) [IHW20N120R5XKSA1](#) [RJH60D2DPP-M0#T2](#) [IKP20N60TXKSA1](#)  
[IHW20N65R5XKSA1](#) [IDW40E65D2FKSA1](#)