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April 2015

# FGA6540WDF 650 V, 40 A Field Stop Trench IGBT

## Features

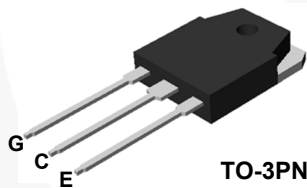
- Maximum Junction Temperature :  $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage:  $V_{CE(sat)} = 1.8\text{ V (Typ.) @ } I_C = 40\text{ A}$
- 100% of the Parts Tested for  $I_{LM}(1)$
- High Input Impedance
- Fast Switching
- Tighten Parameter Distribution
- RoHS Compliant

## General Description

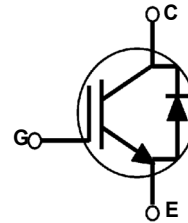
Using novel field stop IGBT technology, Fairchild's new series of field stop 3<sup>rd</sup> generation IGBTs offer the optimum performance for welder and industrial application where low conduction and switching losses are essential.

## Applications

- Welder and Industrial Application
- Power Factor Correction



TO-3PN



## Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted

Symbol	Description	FGA6540WDF	Unit
$V_{CES}$	Collector to Emitter Voltage	650	V
$V_{GES}$	Gate to Emitter Voltage	$\pm 20$	V
	Transient Gate to Emitter Voltage	$\pm 30$	V
$I_C$	Collector Current @ $T_C = 25^\circ\text{C}$	80	A
	Collector Current @ $T_C = 100^\circ\text{C}$	40	A
$I_{LM}(1)$	Pulsed Collector Current @ $T_C = 25^\circ\text{C}$	120	A
$I_{CM}(2)$	Pulsed Collector Current	120	A
$I_F$	Diode Forward Current @ $T_C = 25^\circ\text{C}$	40	A
	Diode Forward Current @ $T_C = 100^\circ\text{C}$	20	A
$I_{FM}(2)$	Pulsed Diode Maximum Forward Current	120	A
$P_D$	Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$	238	W
	Maximum Power Dissipation @ $T_C = 100^\circ\text{C}$	119	W
$T_J$	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	$^\circ\text{C}$

### Notes:

1.  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_C = 120\text{ A}$ ,  $R_G = 60\ \Omega$ , Inductive Load
2. Repetitive rating: Pulse width limited by max. junction temperature

FGA6540WDF — 650 V, 40 A Field Stop Trench IGBT

## Thermal Characteristics

Symbol	Parameter	FGA6540WDF	Unit
$R_{\theta JC}(IGBT)$	Thermal Resistance, Junction to Case, Max.	0.63	$^{\circ}C/W$
$R_{\theta JC}(\text{Diode})$	Thermal Resistance, Junction to Case, Max.	1.75	$^{\circ}C/W$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, Max.	40	$^{\circ}C/W$

## Package Marking and Ordering Information

Part Number	Top Mark	Package	Packing Method	Reel Size	Tape Width	Qty per Tube
FGA6540WDF	FGA6540WDF	TO-3PN	Tube	-	-	30

## Electrical Characteristics of the IGBT $T_C = 25^{\circ}C$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
<b>Off Characteristics</b>						
$BV_{CES}$	Collector to Emitter Breakdown Voltage	$V_{GE} = 0V, I_C = 1\text{ mA}$	650	-	-	V
$\Delta BV_{CES} / \Delta T_J$	Temperature Coefficient of Breakdown Voltage	$I_C = 1\text{ mA}$ , Reference to $25^{\circ}C$	-	0.6	-	$V/^{\circ}C$
$I_{CES}$	Collector Cut-Off Current	$V_{CE} = V_{CES}, V_{GE} = 0\text{ V}$	-	-	250	$\mu A$
$I_{GES}$	G-E Leakage Current	$V_{GE} = V_{GES}, V_{CE} = 0\text{ V}$	-	-	$\pm 400$	nA
<b>On Characteristics</b>						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 40\text{ mA}, V_{CE} = V_{GE}$	4.1	5.6	7.6	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 40\text{ A}, V_{GE} = 15\text{ V}$	-	1.8	2.3	V
		$I_C = 40\text{ A}, V_{GE} = 15\text{ V}, T_C = 175^{\circ}C$	-	2.31	-	V
<b>Dynamic Characteristics</b>						
$C_{ies}$	Input Capacitance	$V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$	-	1525	-	pF
$C_{oes}$	Output Capacitance		-	60	-	pF
$C_{res}$	Reverse Transfer Capacitance		-	20	-	pF
<b>Switching Characteristics</b>						
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}, I_C = 40\text{ A}, R_G = 6\ \Omega, V_{GE} = 15\text{ V}, \text{Inductive Load}, T_C = 25^{\circ}C$	-	16.8	-	ns
$t_r$	Rise Time		-	34.4	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	54.4	-	ns
$t_f$	Fall Time		-	10	-	ns
$E_{on}$	Turn-On Switching Loss		-	1.37	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.25	-	mJ
$E_{ts}$	Total Switching Loss		-	1.62	-	mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 400\text{ V}, I_C = 40\text{ A}, R_G = 6\ \Omega, V_{GE} = 15\text{ V}, \text{Inductive Load}, T_C = 175^{\circ}C$	-	16	-	ns
$t_r$	Rise Time		-	35.2	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	57.6	-	ns
$t_f$	Fall Time		-	12.8	-	ns
$E_{on}$	Turn-On Switching Loss		-	1.89	-	mJ
$E_{off}$	Turn-Off Switching Loss		-	0.47	-	mJ
$E_{ts}$	Total Switching Loss		-	2.36	-	mJ

### Electrical Characteristics of the IGBT (Continued)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Unit
$Q_g$	Total Gate Charge	$V_{CE} = 400\text{ V}, I_C = 40\text{ A},$ $V_{GE} = 15\text{ V}$	-	55.5	-	nC
$Q_{ge}$	Gate to Emitter Charge		-	9.8	-	nC
$Q_{gc}$	Gate to Collector Charge		-	21	-	nC

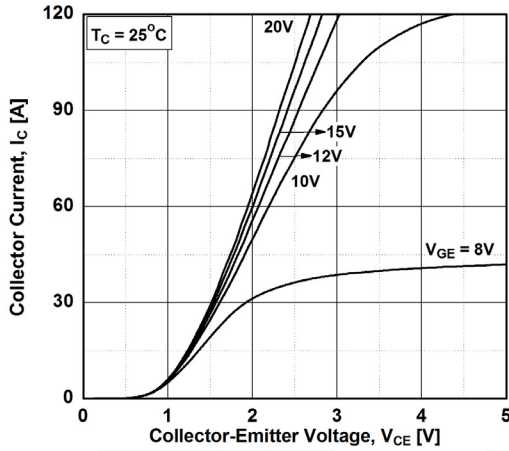
### Electrical Characteristics of the Diode $T_C = 25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max	Unit	
$V_{FM}$	Diode Forward Voltage	$I_F = 20\text{ A}$	$T_C = 25^\circ\text{C}$	-	1.5	1.95	V
			$T_C = 175^\circ\text{C}$	-	1.37	-	
$E_{rec}$	Reverse Recovery Energy	$I_F = 20\text{ A}, dI_F/dt = 200\text{ A}/\mu\text{s}$	$T_C = 175^\circ\text{C}$	-	153	-	uJ
$t_{rr}$	Diode Reverse Recovery Time		$T_C = 25^\circ\text{C}$	-	101	-	ns
			$T_C = 175^\circ\text{C}$	-	238	-	
$Q_{rr}$	Diode Reverse Recovery Charge		$T_C = 25^\circ\text{C}$	-	343	-	nC
		$T_C = 175^\circ\text{C}$	-	1493	-		

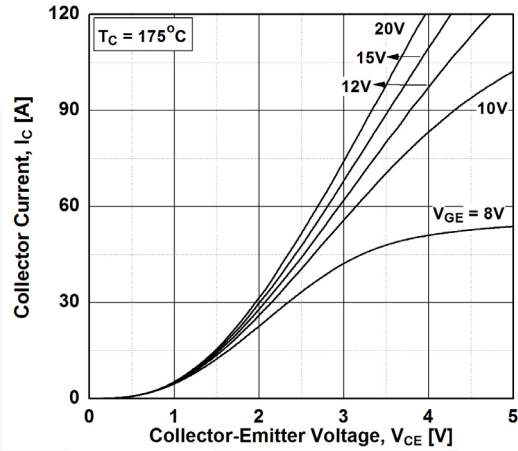


## Typical Performance Characteristics

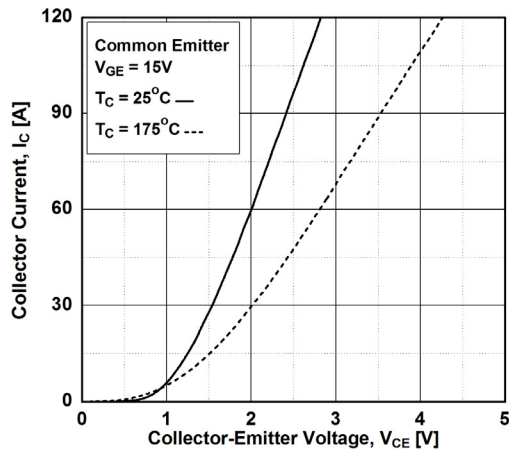
**Figure 1. Typical Output Characteristics**



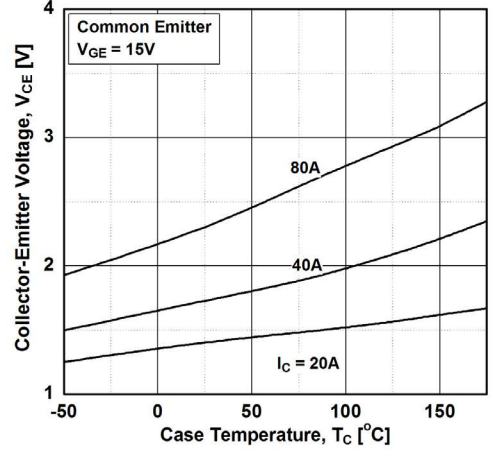
**Figure 2. Typical Output Characteristics**



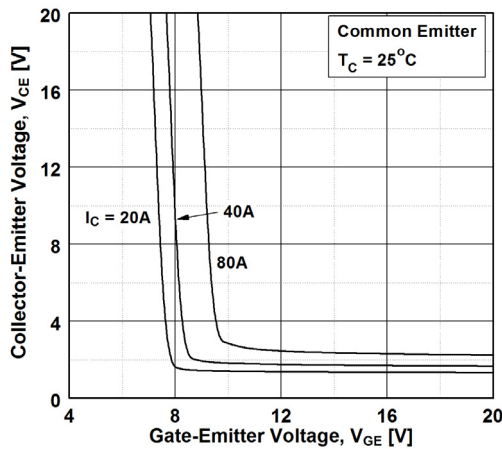
**Figure 3. Typical Saturation Voltage Characteristics**



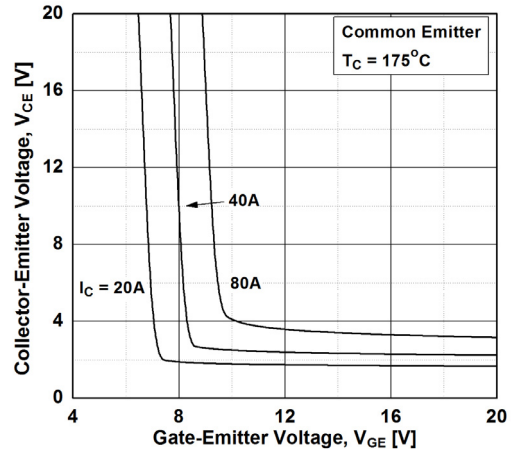
**Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level**



**Figure 5. Saturation Voltage vs. VGE**

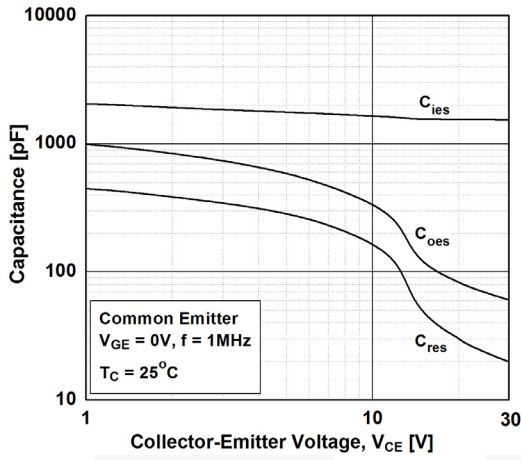


**Figure 6. Saturation Voltage vs. VGE**

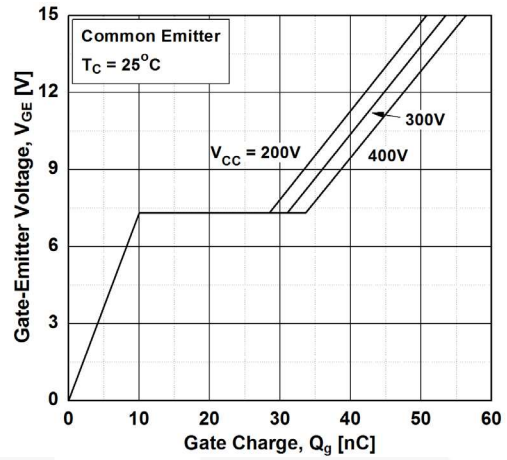


## Typical Performance Characteristics

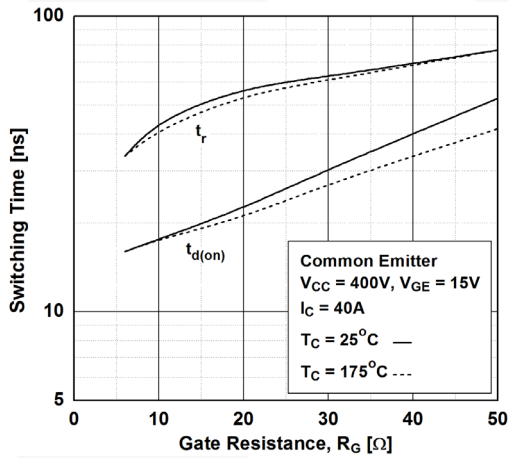
**Figure 7. Capacitance Characteristics**



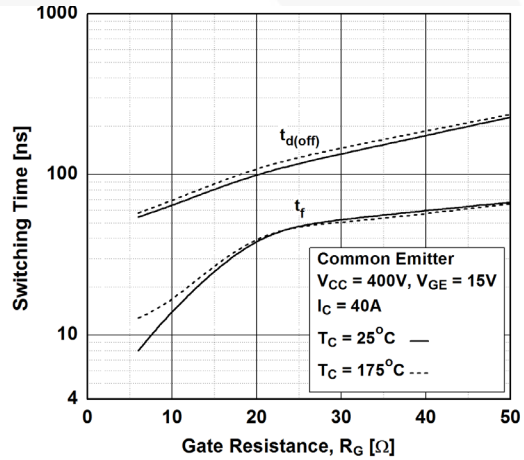
**Figure 8. Gate charge Characteristics**



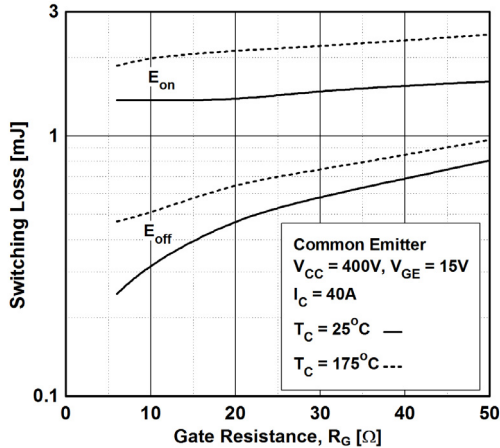
**Figure 9. Turn-on Characteristics vs. Gate Resistance**



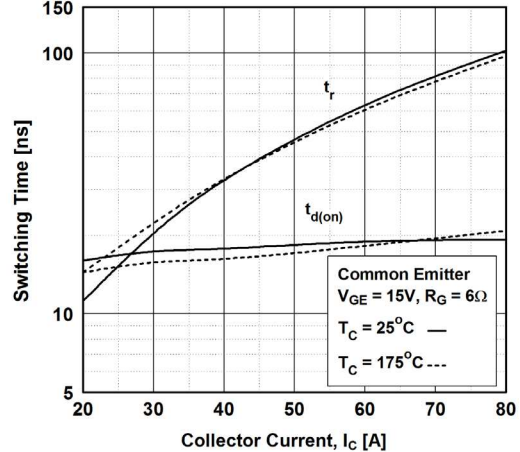
**Figure 10. Turn-off Characteristics vs. Gate Resistance**



**Figure 11. Switching Loss vs. Gate Resistance**

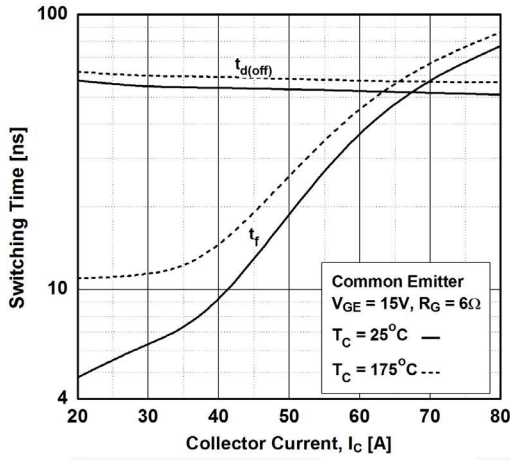


**Figure 12. Turn-on Characteristics vs. Collector Current**

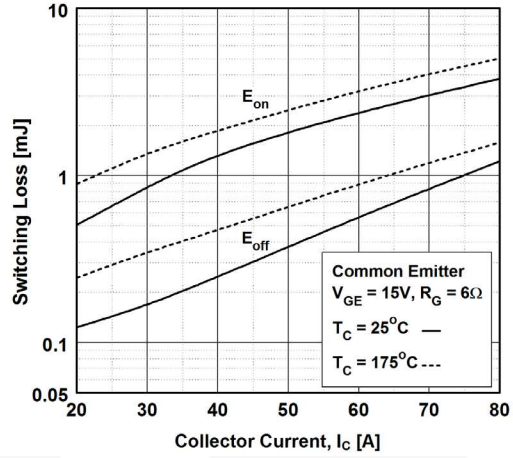


## Typical Performance Characteristics

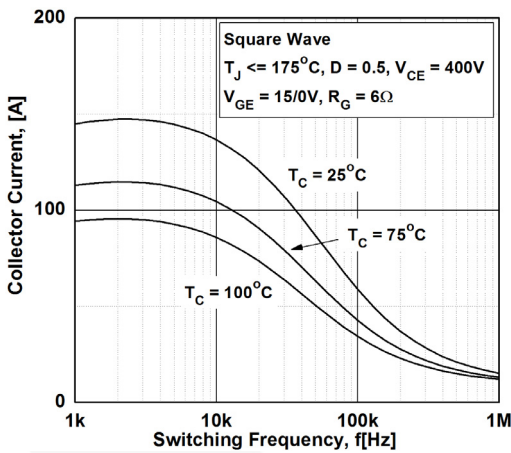
**Figure 13. Turn-off Characteristics vs. Collector Current**



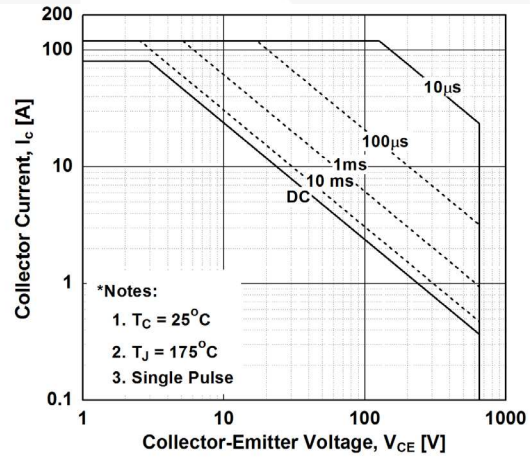
**Figure 14. Switching Loss vs. Collector Current**



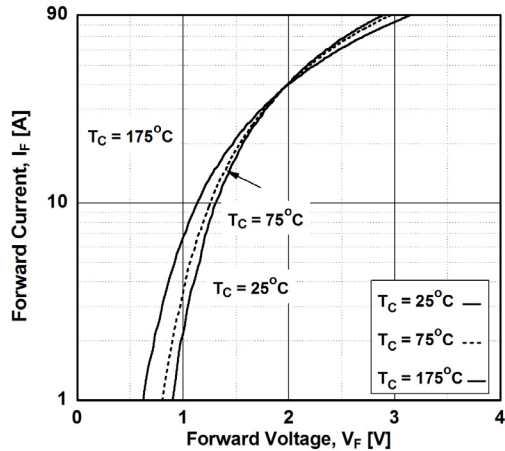
**Figure 15. Load Current Vs. Frequency**



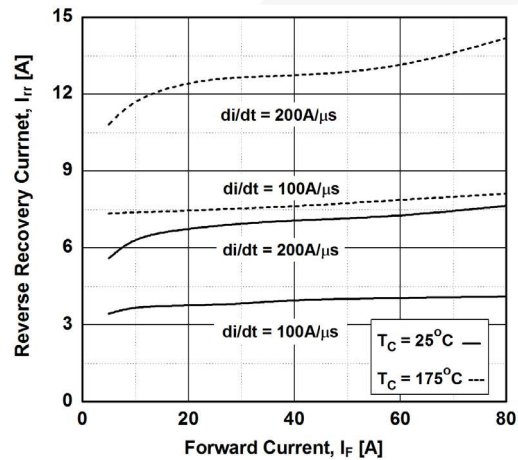
**Figure 16. SOA Characteristics**



**Figure 17. Forward Characteristics**



**Figure 18. Reverse Recovery Current**





## Typical Performance Characteristics

Figure 19. Reverse Recovery Time

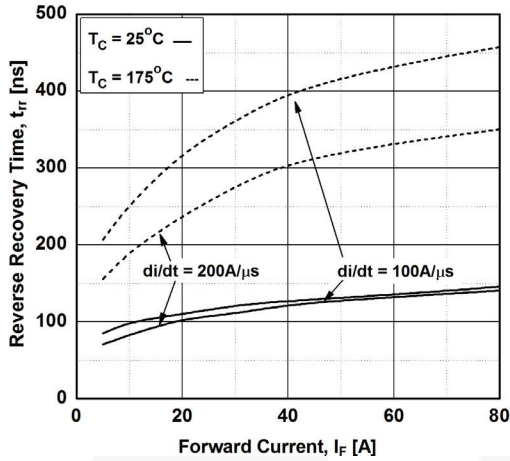


Figure 20. Stored Charge

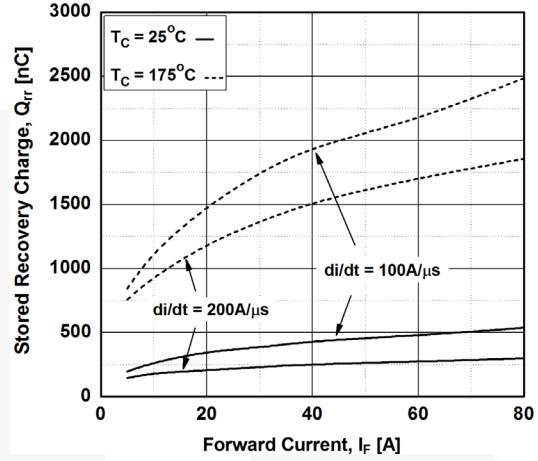


Figure 21. Transient Thermal Impedance of IGBT

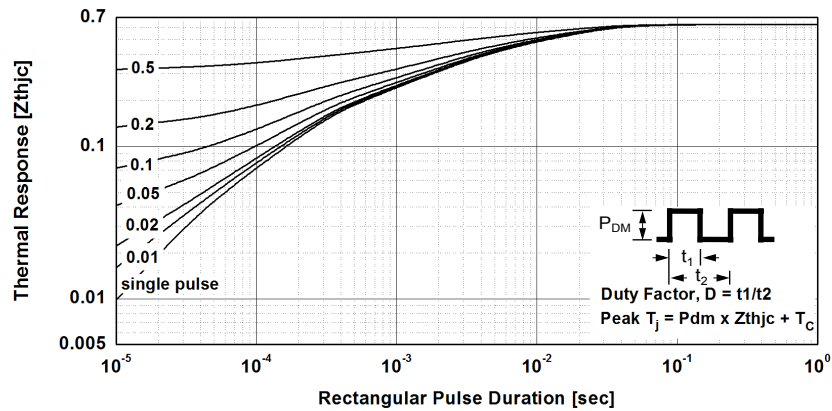
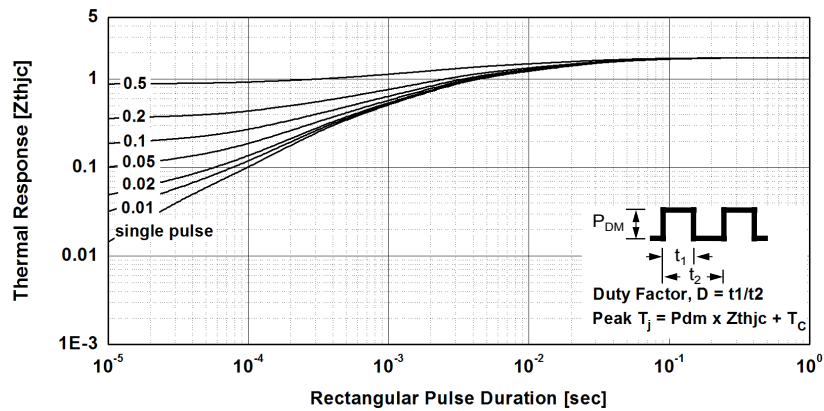
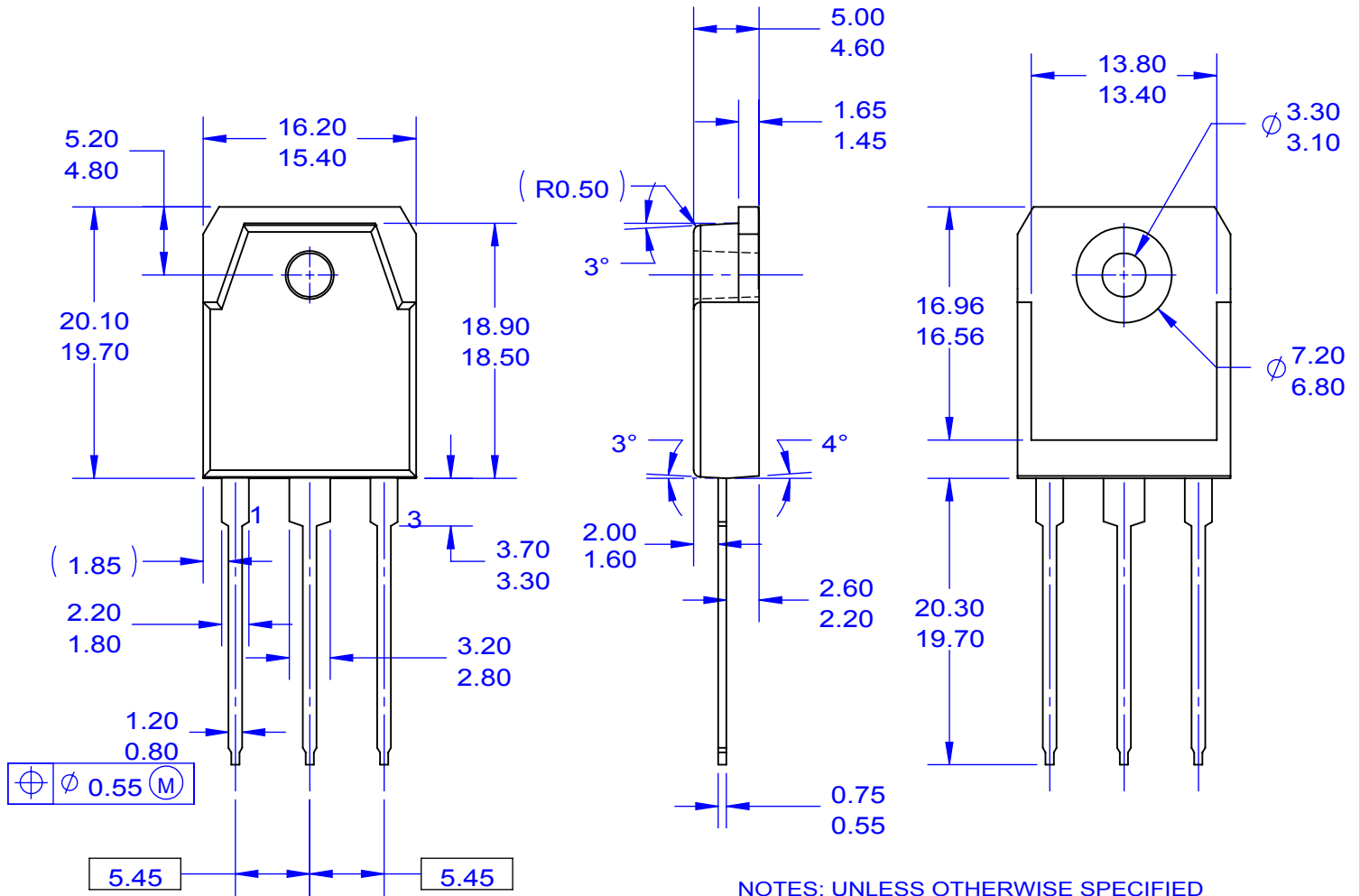


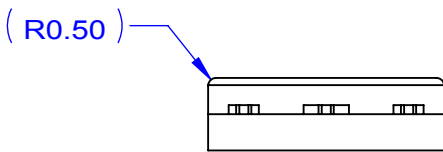
Figure 22. Transient Thermal Impedance of Diode





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