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**GA400TD60S**

Vishay Semiconductors

## Dual INT-A-PAK Low Profile “Half Bridge” (Standard Speed IGBT), 400 A




Dual INT-A-PAK Low Profile



**RoHS**  
COMPLIANT

### FEATURES

- Gen 4 IGBT technology
- Standard: optimized for hard switching speed
- Low  $V_{CE(on)}$
- Square RBSOA
- HEXFRED® antiparallel diode with ultrasoft reverse recovery characteristics
- Industry standard package
- $Al_2O_3$  DBC
- UL approved file E78996 
- Designed for industrial level
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

### BENEFITS

- Increased operating efficiency
- Performance optimized as output inverter stage for TIG welding machines
- Direct mounting on heatsink
- Very low junction to case thermal resistance

PRODUCT SUMMARY	
$V_{CES}$	600 V
$I_C$ DC at $T_C = 25\text{ }^\circ\text{C}$	750 A
$V_{CE(on)}$ (typical) at 400 A, $25\text{ }^\circ\text{C}$	1.24 V
Speed	DC to 1 kHz
Package	DIAP low profile
Circuit	Half bridge

ABSOLUTE MAXIMUM RATINGS				
PARAMETER	SYMBOL	TEST CONDITIONS	MAX.	UNITS
Collector to emitter voltage	$V_{CES}$		600	V
Continuous collector current	$I_C$ <sup>(1)</sup>	$T_C = 25\text{ }^\circ\text{C}$	750	A
		$T_C = 80\text{ }^\circ\text{C}$	525	
Pulsed collector current	$I_{CM}$		1000	
Clamped inductive load current	$I_{LM}$		1000	
Diode continuous forward current	$I_F$	$T_C = 25\text{ }^\circ\text{C}$	219	
		$T_C = 80\text{ }^\circ\text{C}$	145	
Gate to emitter voltage	$V_{GE}$		$\pm 20$	V
Maximum power dissipation (IGBT)	$P_D$	$T_C = 25\text{ }^\circ\text{C}$	1563	W
		$T_C = 80\text{ }^\circ\text{C}$	875	
RMS isolation voltage	$V_{ISOL}$	Any terminal to case ( $V_{RMS} t = 1\text{ s}$ , $T_J = 25\text{ }^\circ\text{C}$ )	3500	V

### Note

<sup>(1)</sup> Maximum continuous collector current must be limited to 500 A to do not exceed the maximum temperature of terminals



<b>ELECTRICAL SPECIFICATIONS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Collector to emitter breakdown voltage	$V_{BR(CEs)}$	$V_{GE} = 0\text{ V}, I_C = 500\text{ }\mu\text{A}$	600	-	-	V
Collector to emitter voltage	$V_{CE(on)}$	$V_{GE} = 15\text{ V}, I_C = 300\text{ A}$	-	1.14	1.35	
		$V_{GE} = 15\text{ V}, I_C = 400\text{ A}$	-	1.24	1.52	
		$V_{GE} = 15\text{ V}, I_C = 300\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.08	1.29	
		$V_{GE} = 15\text{ V}, I_C = 400\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.21	1.5	
Gate threshold voltage	$V_{GE(th)}$	$V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$	3.0	4.6	6.3	
Collector to emitter leakage current	$I_{CES}$	$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}$	-	0.075	1	mA
		$V_{GE} = 0\text{ V}, V_{CE} = 600\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	1.8	10	
Diode forward voltage drop	$V_{FM}$	$I_{FM} = 300\text{ A}$	-	1.48	1.75	V
		$I_{FM} = 400\text{ A}$	-	1.63	1.98	
		$I_{FM} = 300\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.50	1.77	
		$I_{FM} = 400\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	1.70	2.04	
Gate to emitter leakage current	$I_{GES}$	$V_{GE} = \pm 20\text{ V}$	-	-	$\pm 200$	nA

<b>SWITCHING CHARACTERISTICS</b> ( $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNITS
Turn-on switching loss	$E_{on}$	$I_C = 400\text{ A}, V_{CC} = 360\text{ V}, V_{GE} = 15\text{ V}, R_g = 1.5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 25\text{ }^\circ\text{C}$	-	8.5	-	mJ
Turn-off switching loss	$E_{off}$		-	113	-	
Total switching loss	$E_{tot}$		-	121.5	-	
Turn-on switching loss	$E_{on}$	$I_C = 400\text{ A}, V_{CC} = 360\text{ V}, V_{GE} = 15\text{ V}, R_g = 1.5\text{ }\Omega, L = 500\text{ }\mu\text{H}, T_J = 125\text{ }^\circ\text{C}$	-	21	-	ns
Turn-off switching loss	$E_{off}$		-	163	-	
Total switching loss	$E_{tot}$		-	184	-	
Turn-on delay time	$t_{d(on)}$		-	532	-	ns
Rise time	$t_r$		-	377	-	
Turn-off delay time	$t_{d(off)}$		-	496	-	
Fall time	$t_f$	-	1303	-		
Reverse bias safe operating area	RBSOA	$T_J = 150\text{ }^\circ\text{C}, I_C = 1000\text{ A}, V_{CC} = 400\text{ V}, V_P = 600\text{ V}, R_g = 22\text{ }\Omega, V_{GE} = 15\text{ V to } 0\text{ V}, L = 500\text{ }\mu\text{H}$	Fullsquare			
Diode reverse recovery time	$t_{rr}$	$I_F = 300\text{ A}, di_F/dt = 500\text{ A}/\mu\text{s}, V_{CC} = 400\text{ V}, T_J = 25\text{ }^\circ\text{C}$	-	150	179	ns
Diode peak reverse current	$I_{rr}$		-	43	59	A
Diode recovery charge	$Q_{rr}$		-	3.9	6.3	$\mu\text{C}$
Diode reverse recovery time	$t_{rr}$	$I_F = 300\text{ A}, di_F/dt = 500\text{ A}/\mu\text{s}, V_{CC} = 400\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	236	265	ns
Diode peak reverse current	$I_{rr}$		-	64	80	A
Diode recovery charge	$Q_{rr}$		-	8.6	11.1	$\mu\text{C}$



THERMAL AND MECHANICAL SPECIFICATIONS					
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
Operating junction and storage temperature range	$T_J, T_{Stg}$	-40	-	150	°C
Junction to case per leg	IGBT	-	-	0.08	°C/W
	Diode	-	-	0.4	
Case to sink per module	$R_{thCS}$	-	0.05	-	
Mounting torque	case to heatsink: M6 screw	4	-	6	Nm
	case to terminal 1, 2, 3: M5 screw	2	-	4	
Weight		-	270	-	g

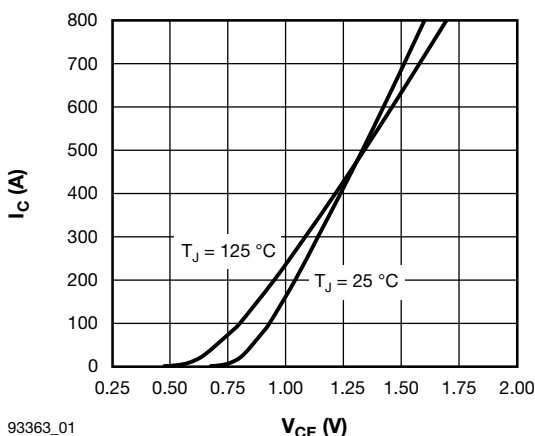


Fig. 1 - Typical Output Characteristics,  $T_J = 25\text{ }^\circ\text{C}$ ,  $V_{GE} = 15\text{ V}$

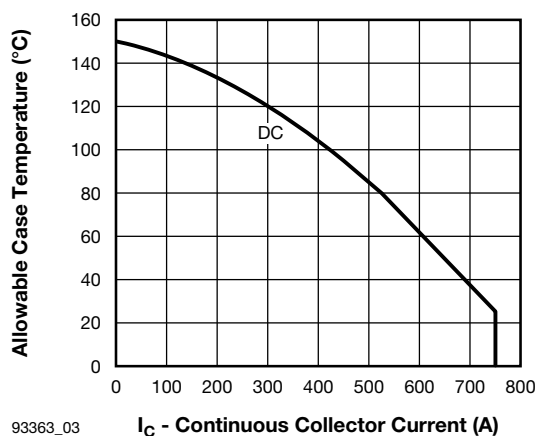


Fig. 3 - Maximum DC IGBT Collector Current vs. Case Temperature

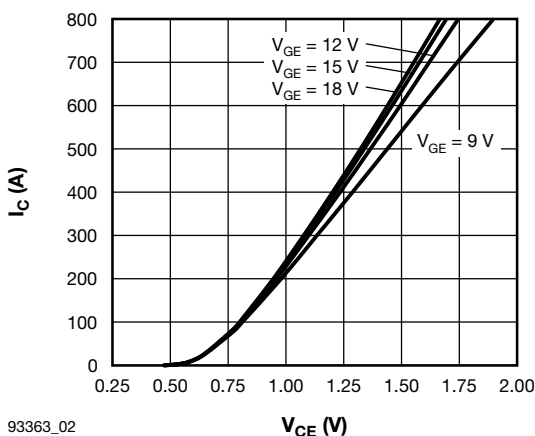


Fig. 2 - Typical Output Characteristics,  $T_J = 125\text{ }^\circ\text{C}$

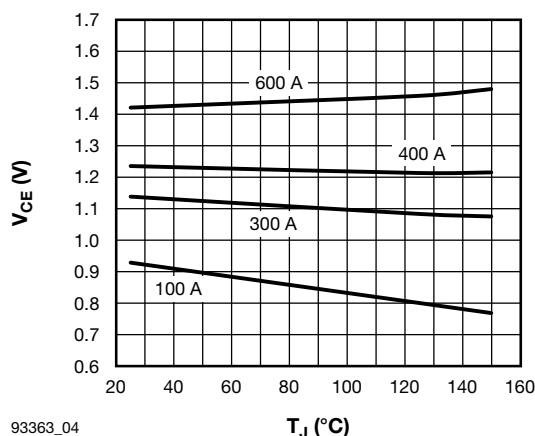


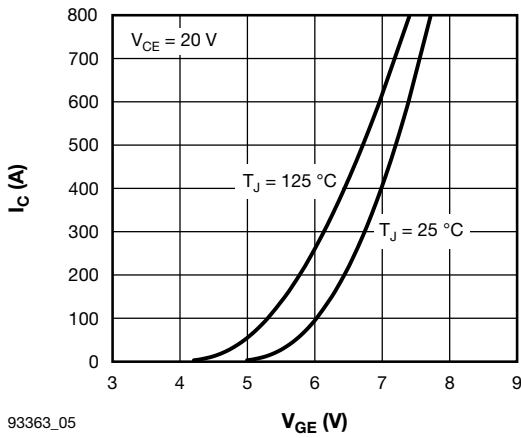
Fig. 4 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature,  $V_{GE} = 15\text{ V}$



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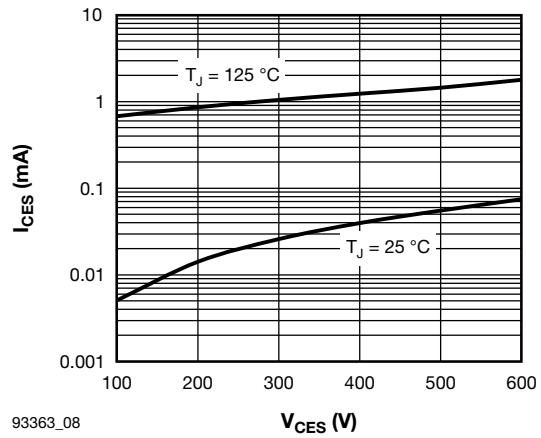
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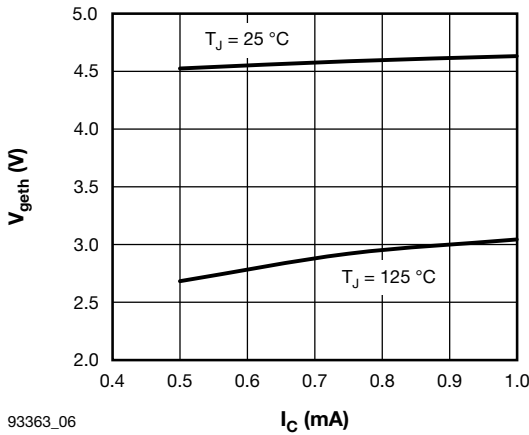
93363\_05

Fig. 5 - Typical IGBT Transfer Characteristics



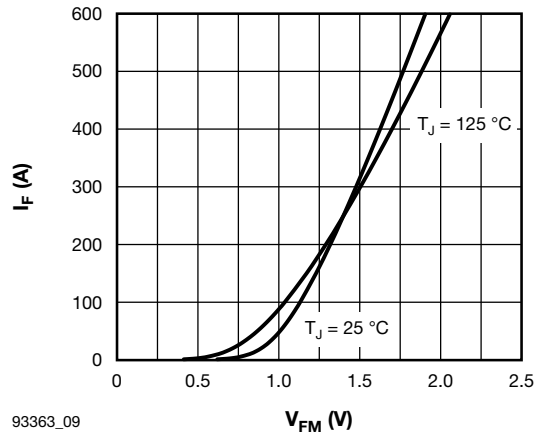
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Fig. 8 - Typical IGBT Zero Gate Voltage Collector Current



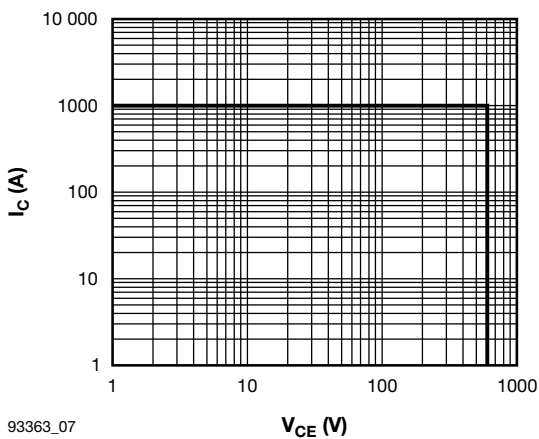
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Fig. 6 - Typical IGBT Gate Threshold Voltage



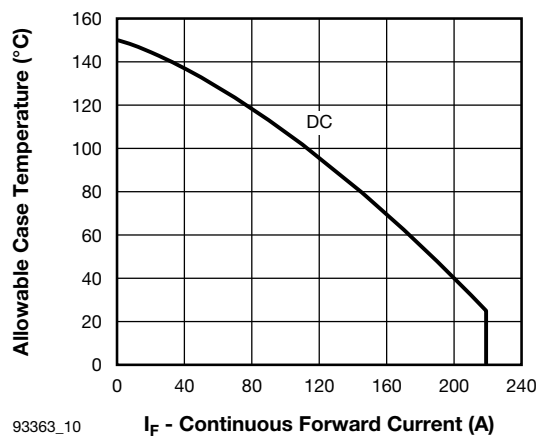
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Fig. 9 - Typical Diode Forward Characteristics



93363\_07

Fig. 7 - IGBT Reverse Bias SOA,  
 $T_J = 150\text{ }^\circ\text{C}$ ,  $V_{GE} = 15\text{ V}$ ,  $R_g = 22\text{ }\Omega$



93363\_10

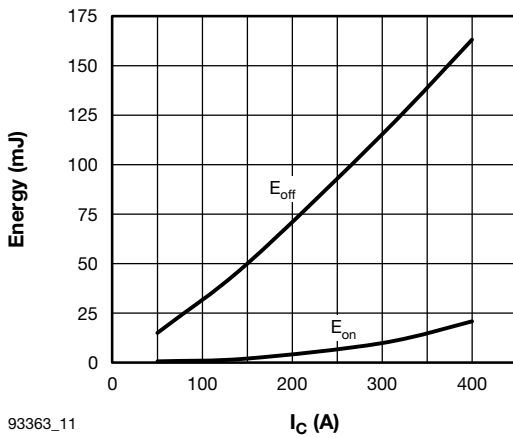
Fig. 10 - Maximum DC Forward Current vs. Case Temperature



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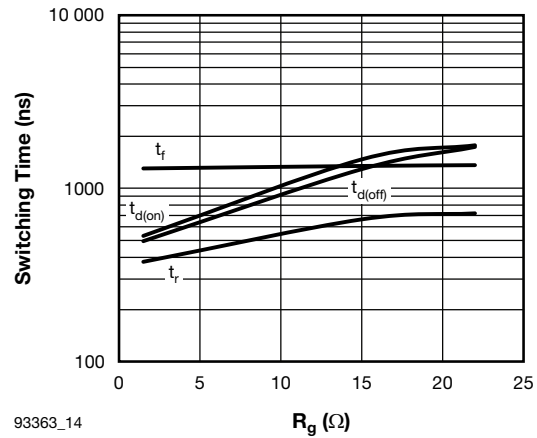
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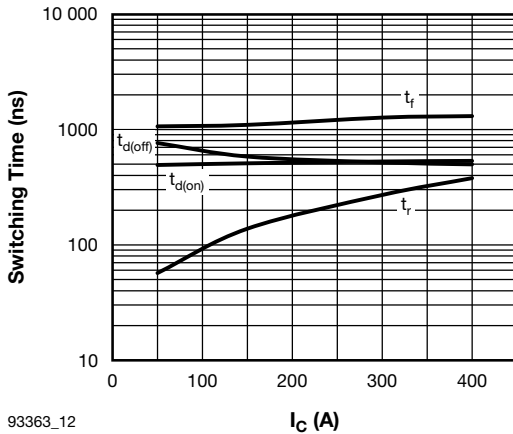
93363\_11

Fig. 11 - Typical IGBT Energy Loss vs.  $I_C$ ,  
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 360\text{ V}$ ,  $R_g = 1.5\ \Omega$ ,  
 $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$



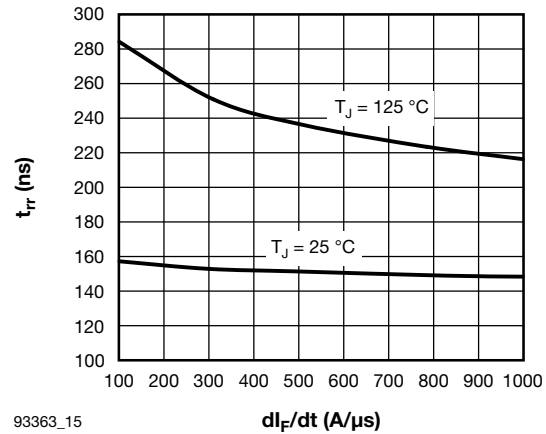
93363\_14

Fig. 14 - Typical IGBT Switching Time vs.  $R_g$ ,  
 $T_J = 125\text{ }^\circ\text{C}$ ,  $I_C = 400\text{ A}$ ,  $V_{CC} = 360\text{ V}$ ,  
 $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$



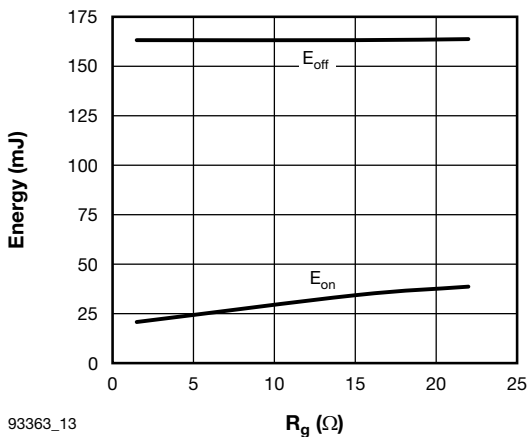
93363\_12

Fig. 12 - Typical IGBT Switching Time vs.  $I_C$ ,  
 $T_J = 125\text{ }^\circ\text{C}$ ,  $V_{CC} = 360\text{ V}$ ,  $R_g = 1.5\ \Omega$ ,  
 $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$



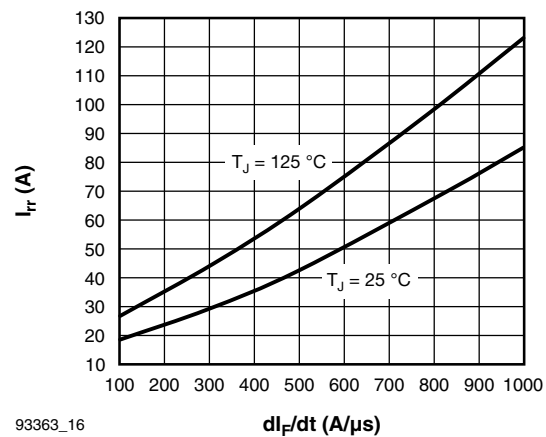
93363\_15

Fig. 15 - Typical Reverse Recovery Time vs.  $di_F/dt$ ,  
 $V_{CC} = 400\text{ V}$ ,  $I_F = 300\text{ A}$



93363\_13

Fig. 13 - Typical IGBT Energy Loss vs.  $R_g$ ,  
 $T_J = 125\text{ }^\circ\text{C}$ ,  $I_C = 400\text{ A}$ ,  $V_{CC} = 360\text{ V}$ ,  
 $V_{GE} = 15\text{ V}$ ,  $L = 500\ \mu\text{H}$



93363\_16

Fig. 16 - Typical Reverse Recovery Current vs.  $di_F/dt$ ,  
 $V_{CC} = 400\text{ V}$ ,  $I_F = 300\text{ A}$



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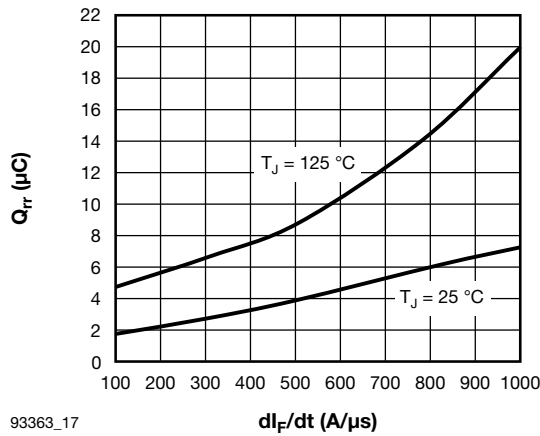


Fig. 17 - Typical Reverse Recovery Charge vs.  $di_F/dt$ ,  
 $V_{CC} = 400\text{ V}$ ,  $I_F = 300\text{ A}$

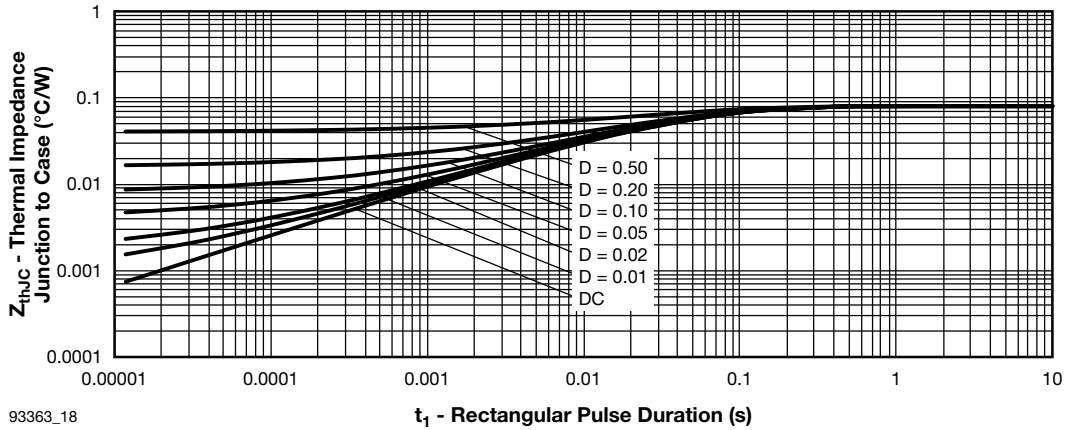


Fig. 18 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics (IGBT)

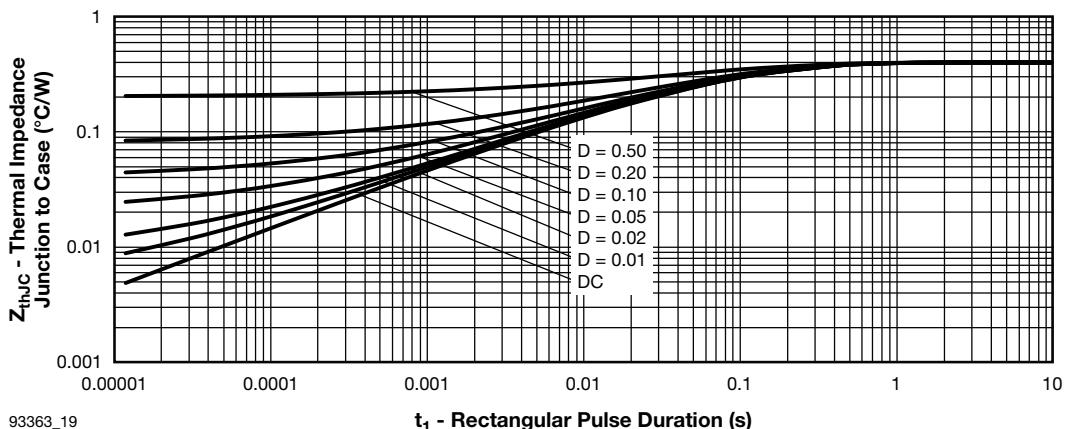


Fig. 19 - Maximum Thermal Impedance  $Z_{thJC}$  Characteristics (Diode)



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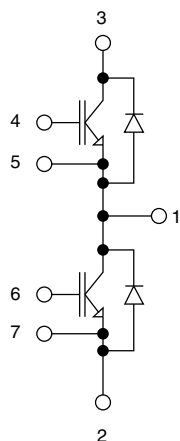
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## ORDERING INFORMATION TABLE

Device code	<b>G</b>	<b>A</b>	<b>400</b>	<b>T</b>	<b>D</b>	<b>60</b>	<b>S</b>
	①	②	③	④	⑤	⑥	⑦

- 1** - Insulated Gate Bipolar Transistor (IGBT)
- 2** - A = Generation 4 IGBT
- 3** - Current rating (400 = 400 A)
- 4** - Circuit configuration (T = Half-bridge)
- 5** - Package indicator (D = Dual INT-A-PAK Low Profile)
- 6** - Voltage rating (60 = 600 V)
- 7** - Speed/type (S = Standard Speed IGBT)

## CIRCUIT CONFIGURATION



LINKS TO RELATED DOCUMENTS	
Dimensions	<a href="http://www.vishay.com/doc?95435">www.vishay.com/doc?95435</a>





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