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

Dual INT-A-PAK Low Profile

## FEATURES

- Generation 4 IGBT technology
- Standard: Optimized for hard switching speed DC to 1 kHz
- 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
- Compliant to RoHS Directive 2002/95/EC
- Designed for industrial level

RoHS COMPLIANT

| PRODUCT SUMMARY | |
|---|---|
| $V_{CES}$ | 600 V |
| $I_C$ DC at $T_C$ = 25 °C | 750 A |
| $V_{CE(on)}$ (typical) at 400 A, 25 °C | 1.24 V |

## 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

**ABSOLUTE MAXIMUM RATINGS**

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

**Note**

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



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

| **SWITCHING CHARACTERISTICS** ($T_J$ = 25 °C unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 400 A, $V_{CC}$ = 360 V, $V_{GE}$ = 15 V, $R_g$ = 1.5 Ω, L = 500 μH, $T_J$ = 25 °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 A, $V_{CC}$ = 360 V, $V_{GE}$ = 15 V, $R_g$ = 1.5 Ω, L = 500 μH, $T_J$ = 125 °C | - | 21 | - | |
| 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 °C, $I_C$ = 1000 A, $V_{CC}$ = 400 V, $V_P$ = 600 V, $R_g$ = 22 Ω, $V_{GE}$ = 15 V to 0 V, L = 500 μH | Fullsquare | | | |
| Diode reverse recovery time | $t_{rr}$ | $I_F$ = 300 A, $dI_F/dt$ = 500 A/μs, $V_{CC}$ = 400 V, $T_J$ = 25 °C | - | 150 | 179 | ns |
| Diode peak reverse current | $I_{rr}$ | | - | 43 | 59 | A |
| Diode recovery charge | $Q_{rr}$ | | - | 3.9 | 6.3 | μC |
| Diode reverse recovery time | $t_{rr}$ | $I_F$ = 300 A, $dI_F/dt$ = 500 A/μs, $V_{CC}$ = 400 V, $T_J$ = 125 °C | - | 236 | 265 | ns |
| Diode peak reverse current | $I_{rr}$ | | - | 64 | 80 | A |
| Diode recovery charge | $Q_{rr}$ | | - | 8.6 | 11.1 | μC |


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| 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 | $R_{thJC}$ | - | - | 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 |

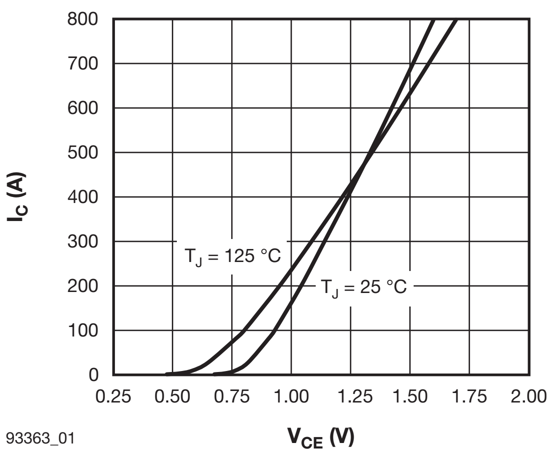


Fig. 1 - Typical Output Characteristics, $T_J$ = 25 °C, $V_{GE}$ = 15 V

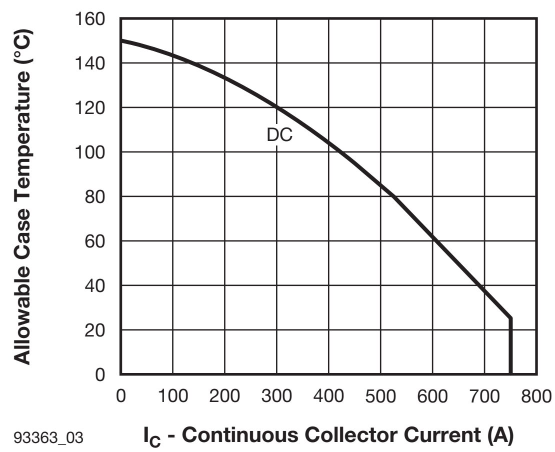


Fig. 3 - Maximum DC IGBT Collector Current vs. Case Temperature

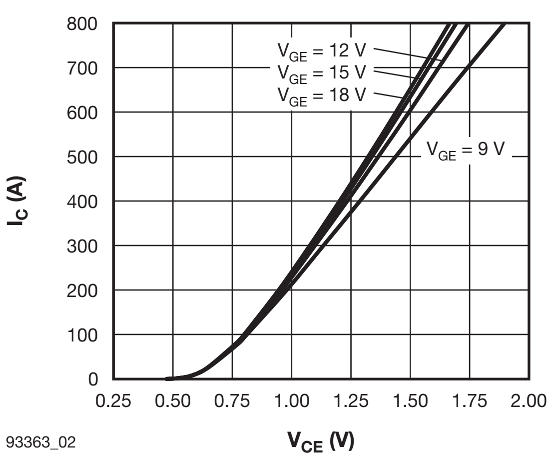


Fig. 2 - Typical Output Characteristics, $T_J$ = 125 °C

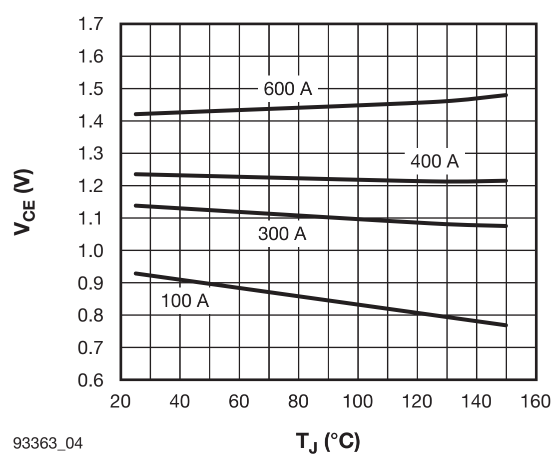


Fig. 4 - Typical IGBT Collector to Emitter Voltage vs. Junction Temperature, $V_{GE}$ = 15 V



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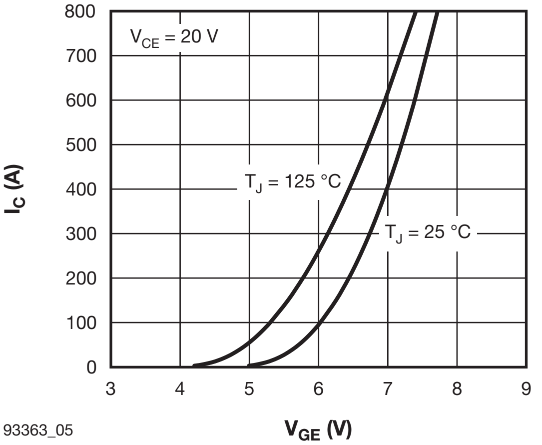


Fig. 5 - Typical IGBT Transfer Characteristics

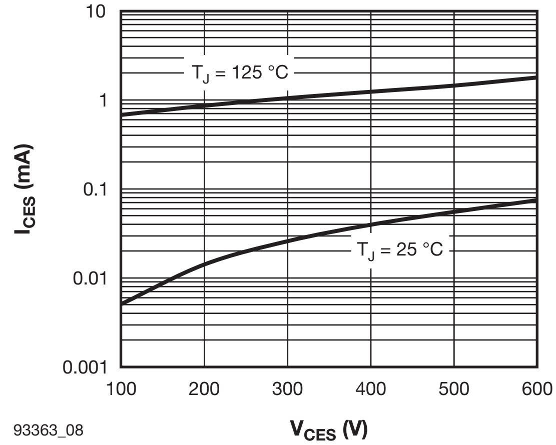


Fig. 8 - Typical IGBT Zero Gate Voltage Collector Current

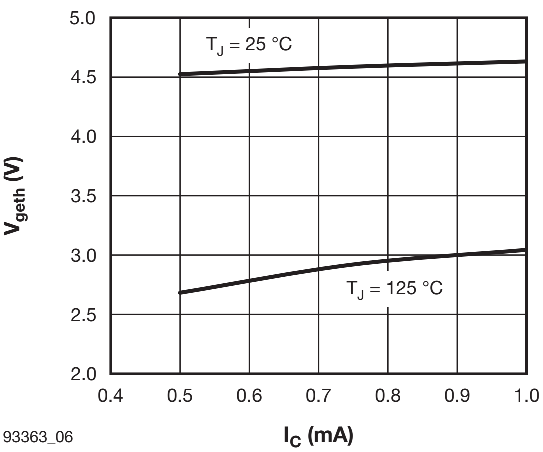


Fig. 6 - Typical IGBT Gate Threshold Voltage

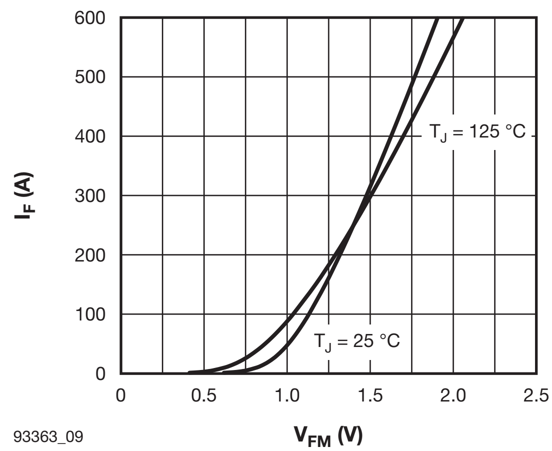


Fig. 9 - Typical Diode Forward Characteristics

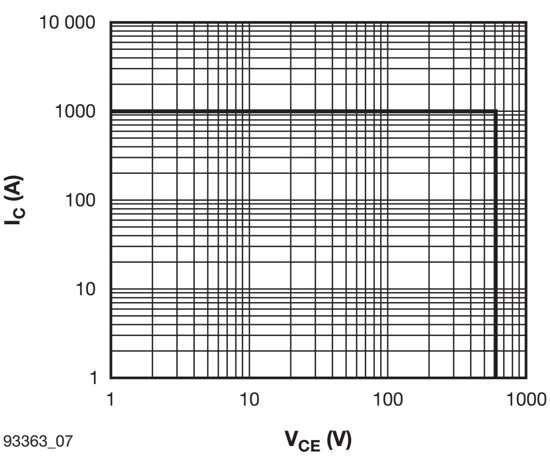


Fig. 7 - IGBT Reverse Bias SOA,
$T_J$ = 150 °C, $V_{GE}$ = 15 V, $R_g$ = 22 Ω

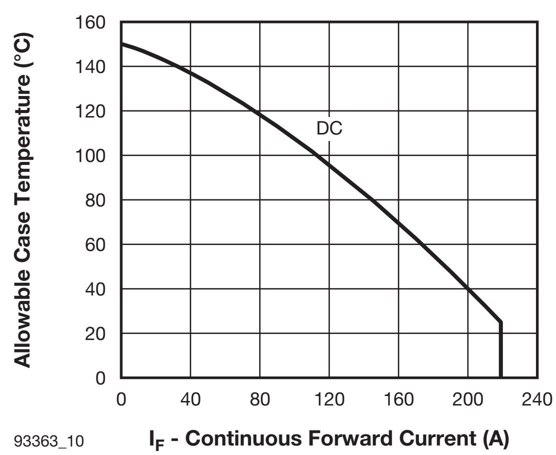


Fig. 10 - Maximum DC Forward Current vs. Case Temperature



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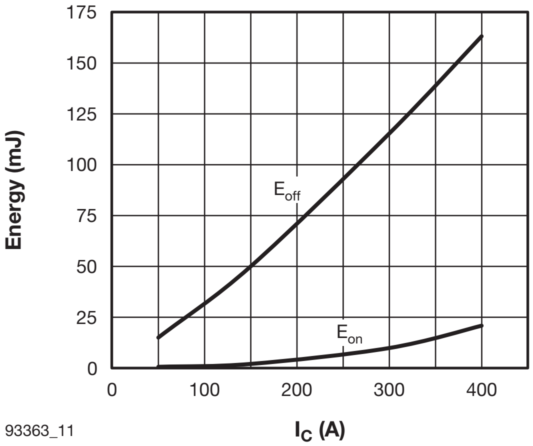


Fig. 11 - Typical IGBT Energy Loss vs. $I_C$, $T_J$ = 125 °C, $V_{CC}$ = 360 V, $R_g$ = 1.5 Ω, $V_{GE}$ = 15 V, L = 500 μH

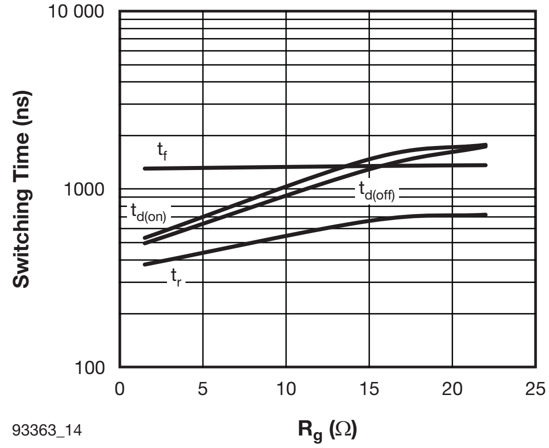


Fig. 14 - Typical IGBT Switching Time vs. $R_g$, $T_J$ = 125 °C, $I_C$ = 400 A, $V_{CC}$ = 360 V, $V_{GE}$ = 15 V, L = 500 μH

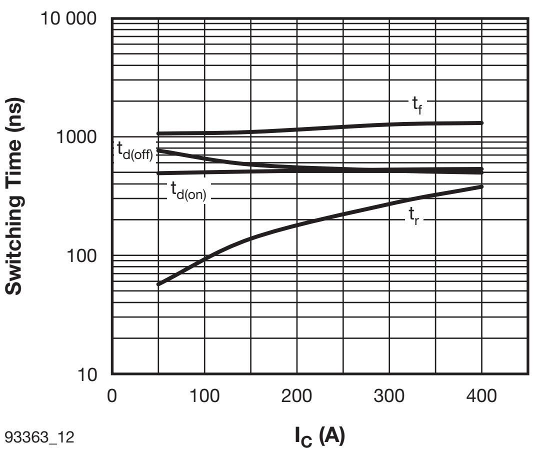


Fig. 12 - Typical IGBT Switching Time vs. $I_C$, $T_J$ = 125 °C, $V_{CC}$ = 360 V, $R_g$ = 1.5 Ω, $V_{GE}$ = 15 V, L = 500 μH

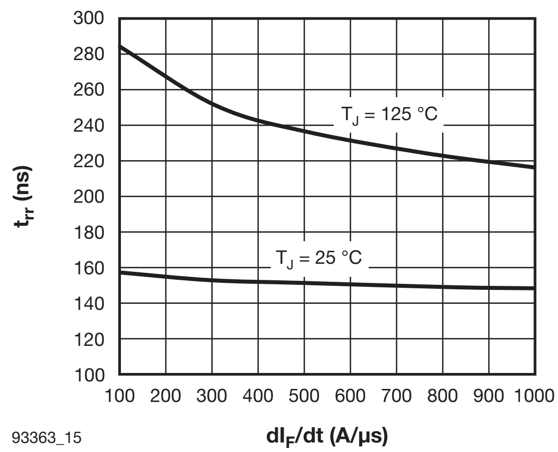


Fig. 15 - Typical Reverse Recovery Time vs. $dI_F/dt$, $V_{CC}$ = 400 V, $I_F$ = 300 A

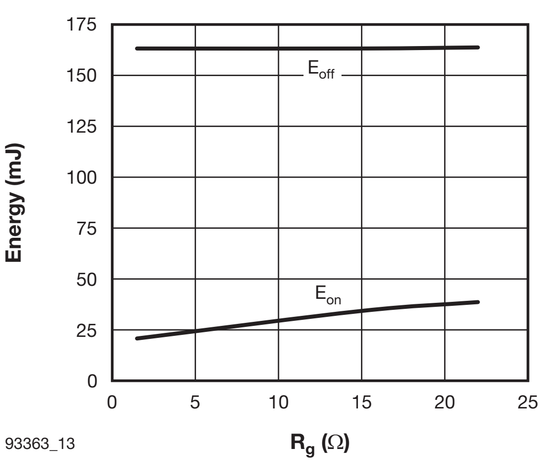


Fig. 13 - Typical IGBT Energy Loss vs. $R_g$, $T_J$ = 125 °C, $I_C$ = 400 A, $V_{CC}$ = 360 V, $V_{GE}$ = 15 V, L = 500 μH

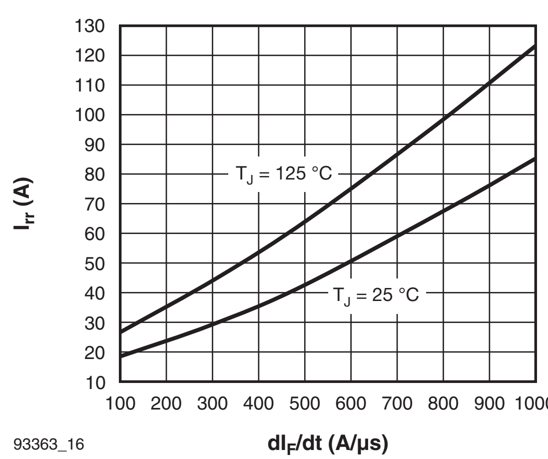


Fig. 16 - Typical Reverse Recovery Current vs. $dI_F/dt$, $V_{CC}$ = 400 V, $I_F$ = 300 A



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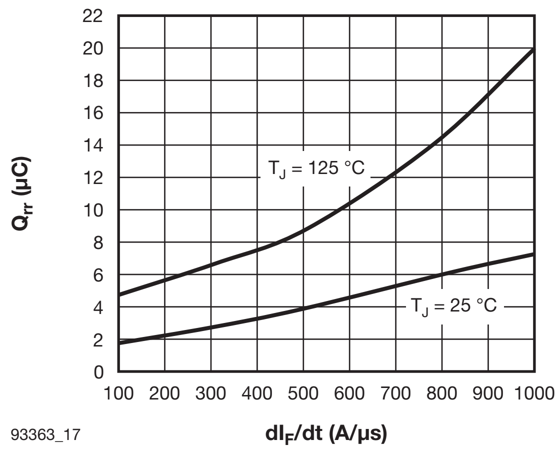


Fig. 17 - Typical Reverse Recovery Charge vs. $dI_F/dt$, $V_{CC}$ = 400 V, $I_F$ = 300 A

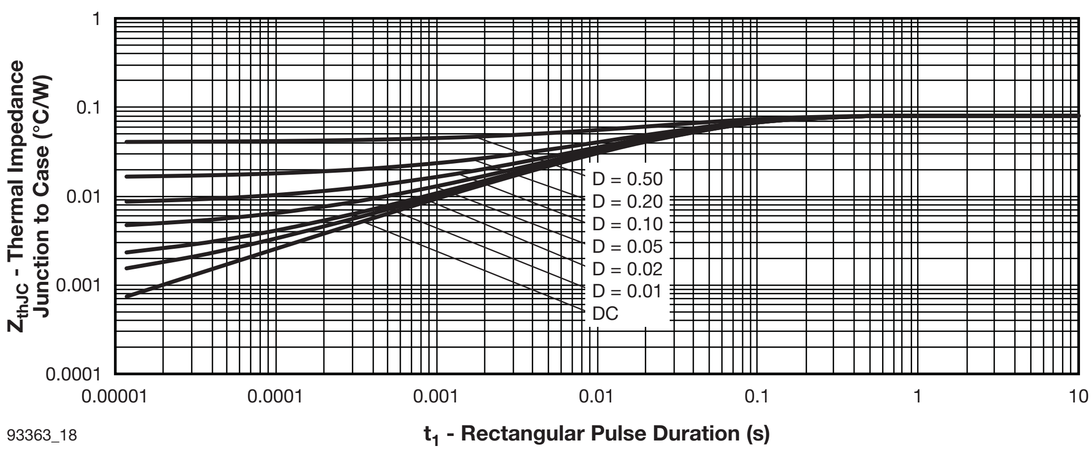


Fig. 18 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics (IGBT)

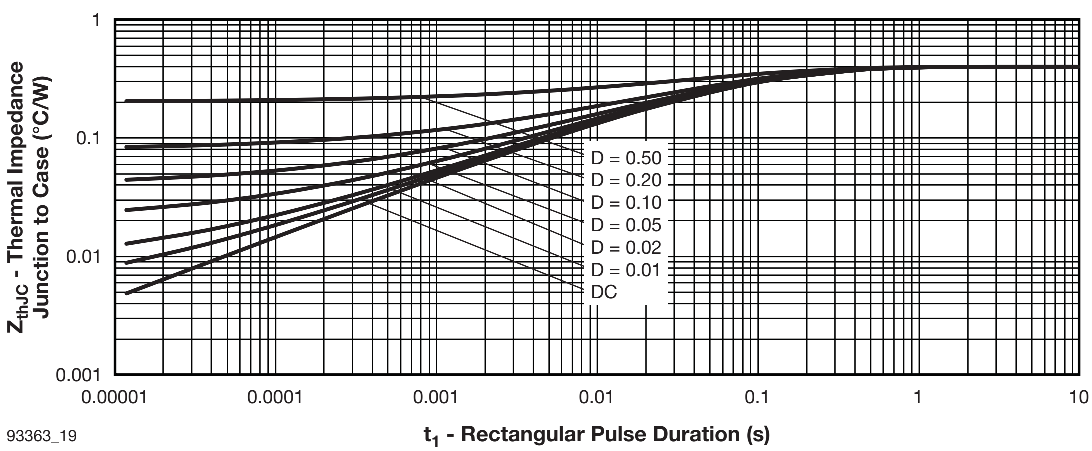


Fig. 19 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics (Diode)




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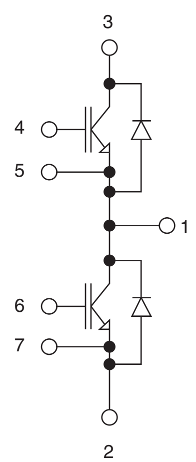
## ORDERING INFORMATION TABLE

| Device code | G | A | 400 | T | D | 60 | S |
|---|---|---|---|---|---|---|---|
| | 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 | www.vishay.com/doc?95435 |



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