# Dual INT-A-PAK Low Profile 3-Level Half Bridge Inverter Stage, 300 A

| PRIMARY CHARACTERISTICS | |
|---|---|
| $V_{CES}$ | 600 V |
| $V_{CE(on)}$ typical at $I_C$ = 300 A | 1.72 V |
| $I_C$ at $T_C$ = 25 °C | 379 A |
| Speed | 8 kHz to 30 kHz |
| Package | Dual INT-A-PAK low profile |
| Circuit configuration | 3-level half bridge inverter stage |

## FEATURES

- Trench plus Field Stop IGBT technology
- FRED Pt® antiparallel and clamping diodes
- Short circuit capability
- Low stray internal inductances
- Low switching loss
- UL approved file E78996
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free
RoHS
COMPLIANT

## APPLICATION

- Solar converters
- Uninterruptible power supplies

## BENEFITS

- Direct mounting on heatsink
- Low junction to case thermal resistance
- Easy paralleling due to positive $T_C$ of $V_{CE(sat)}$

| ABSOLUTE MAXIMUM RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MAX.** | **UNITS** |
| Operating junction temperature | $T_J$ | | 175 | °C |
| Storage temperature range | $T_{Stg}$ | | -40 to +175 | |
| RMS isolation voltage | $V_{ISOL}$ | $T_J$ = 25 °C, all terminals shorted, f = 50 Hz, t = 1 s | 3500 | V |
| Collector to emitter voltage | $V_{CES}$ | | 600 | |
| Gate to emitter voltage | $V_{GES}$ | | 20 | |
| Pulsed collector current | $I_{CM}$ | | 650 | A |
| Clamped inductive load current | $I_{LM}$ | | 650 | |
| Continuous collector current | $I_C$ | $T_C$ = 25 °C | 379 | |
| | | $T_C$ = 80 °C | 288 | |
| Power dissipation | $P_D$ | $T_C$ = 25 °C | 1250 | W |
| | | $T_C$ = 80 °C | 792 | |
| **D5 - D6 CLAMPING DIODE** | | | | |
| Repetitive peak reverse voltage | $V_{RRM}$ | | 600 | V |
| Single pulse forward current | $I_{FSM}$ | 10 ms sine or 6 ms rectangular pulse, $T_J$ = 25 °C | 800 | A |
| Diode continuous forward current | $I_F$ | $T_C$ = 25 °C | 215 | |
| | | $T_C$ = 80 °C | 161 | |
| Power dissipation | $P_D$ | $T_C$ = 25 °C | 500 | W |
| | | $T_C$ = 80 °C | 317 | |
| **D - D2 - D3 - D4 AP DIODE** | | | | |
| Single pulse forward current | $I_{FSM}$ | 10 ms sine or 6 ms rectangular pulse, $T_J$ = 25 °C | 800 | A |
| Diode continuous forward current | $I_F$ | $T_C$ = 25 °C | 215 | |
| | | $T_C$ = 80 °C | 161 | |
| Power dissipation | $P_D$ | $T_C$ = 25 °C | 500 | W |
| | | $T_C$ = 80 °C | 317 | |

**Note**

- Absolute Maximum Ratings indicate sustained limits beyond which damage to the device may occur

| **ELECTRICAL SPECIFICATIONS** ($T_J$ = 25 °C unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| **Q1 - Q2 - Q3 - Q4 TRENCH IGBT** | | | | | | |
| Collector to emitter breakdown voltage | $BV_{CES}$ | $V_{GE}$ = 0 V, $I_C$ = 500 μA | 600 | - | - | V |
| Collector to emitter voltage | $V_{CE(on)}$ | $V_{GE}$ = 15 V, $I_C$ = 300 A | - | 1.72 | 2.5 | V |
| | | $V_{GE}$ = 15 V, $I_C$ = 300 A, $T_J$ = 125 °C | - | 1.93 | - | V |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 16.8 mA | 2.9 | 4.8 | 7.5 | V |
| Temperature coefficient of threshold voltage | $\Delta V_{GE(th)}/\Delta T_J$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 1 mA (25 °C to 125 °C) | - | -17.8 | - | mV/°C |
| Forward transconductance | $g_{fe}$ | $V_{CE}$ = 20 V, $I_C$ = 300 A | - | 315 | - | S |
| Transfer characteristics | $V_{GE}$ | $V_{CE}$ = 20 V, $I_C$ = 300 A | - | 7.9 | - | V |
| Zero gate voltage collector current | $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V | - | 0.4 | 250 | μA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V, $T_J$ = 125 °C | - | 300 | - | μA |
| Gate to emitter leakage current | $I_{GES}$ | $V_{GE}$ = ± 20 V, $V_{CE}$ = 0 V | - | - | ± 500 | nA |
| **D5 - D6 CLAMPING DIODE** | | | | | | |
| Cathode to anode blocking voltage | $V_{BR}$ | $I_R$ = 100 μA | 600 | - | - | V |
| Forward voltage drop | $V_{FM}$ | $I_F$ = 150 A | - | 2.17 | 2.7 | V |
| | | $I_F$ = 150 A, $T_J$ = 125 °C | - | 1.61 | - | V |
| Reverse leakage current | $I_{RM}$ | $V_R$ = 600 V | - | 0.25 | 200 | μA |
| | | $V_R$ = 600 V, $T_J$ = 125 °C | - | 140 | - | μA |
| **D1 - D2 - D3 - D4 AP DIODE** | | | | | | |
| Forward voltage drop | $V_{FM}$ | $I_F$ = 150 A | - | 2.17 | 2.7 | V |
| | | $I_F$ = 150 A, $T_J$ = 125 °C | - | 1.61 | - | V |

| **SWITCHING CHARACTERISTICS** ($T_J$ = 25 °C unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| **Q1 - Q2 - Q3 - Q4 TRENCH IGBT** | | | | | | |
| Total gate charge (turn-on) | $Q_g$ | $I_C$ = 300 A<br>$V_{CC}$ = 400 V<br>$V_{GE}$ = 15 V | - | 750 | - | nC |
| Gate to emitter charge (turn-on) | $Q_{ge}$ | | - | 210 | - | nC |
| Gate to collector charge (turn-on) | $Q_{gc}$ | | - | 300 | - | nC |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 150 A, $V_{CC}$ = 300 V<br>$V_{GE}$ = 15 V, $R_g$ = 10 Ω<br>L = 500 μH, $T_J$ = 25 °C | - | 2.1 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | - | 3.1 | - | mJ |
| Total switching loss | $E_{tot}$ | | - | 5.2 | - | mJ |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 300 A, $V_{CC}$ = 300 V<br>$V_{GE}$ = 15 V, $R_g$ = 22 Ω<br>L = 500 μH, $T_J$ = 25 °C | - | 8.6 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | - | 15.4 | - | mJ |
| Total switching loss | $E_{tot}$ | | - | 24 | - | mJ |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 150 A<br>$V_{CC}$ = 300 V<br>$V_{GE}$ = 15 V<br>$R_g$ = 10 Ω<br>L = 500 μH<br>$T_J$ = 125 °C | - | 2.6 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | - | 3.7 | - | mJ |
| Total switching loss | $E_{tot}$ | | - | 6.3 | - | mJ |
| Turn-on delay time | $t_{d(on)}$ | | - | 453 | - | ns |
| Rise time | $t_r$ | | - | 120 | - | ns |
| Turn-off delay time | $t_{d(off)}$ | | - | 366 | - | ns |
| Fall time | $t_f$ | | - | 119 | - | ns |

| **SWITCHING CHARACTERISTICS** ($T_J$ = 25 °C unless otherwise noted) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| **Q1 - Q2 - Q3 - Q4 TRENCH IGBT** | | | | | | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 300 A<br>$V_{CC}$ = 300 V<br>$V_{GE}$ = 15 V<br>$R_g$ = 22 Ω<br>L = 500 µH<br>$T_J$ = 125 °C | - | 10.7 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | - | 15.6 | - | |
| Total switching loss | $E_{tot}$ | | - | 26.3 | - | |
| Turn-on delay time | $t_{d(on)}$ | | - | 840 | - | ns |
| Rise time | $t_r$ | | - | 279 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 566 | - | |
| Fall time | $t_f$ | | - | 129 | - | |
| Input capacitance | $C_{ies}$ | $V_{GE}$ = 0 V<br>$V_{CC}$ = 30 V<br>f = 1 MHz | - | 23.3 | - | nF |
| Output capacitance | $C_{oes}$ | | - | 1.7 | - | |
| Reverse transfer capacitance | $C_{res}$ | | - | 0.7 | - | |
| Reverse bias safe operating area | RBSOA | $T_J$ = 175 °C, $I_C$ = 650 A<br>$V_{CC}$ = 270 V, $V_P$ = 600 V<br>$R_g$ = 22 Ω, $V_{GE}$ = 15 V to 0 V | | | | |
| Short circuit safe operating area | SCSOA | $V_{CC}$ = 400 V, $V_p$ = 600 V<br>$R_g$ = 10 Ω, $V_{GE}$ = 15 V to 0 V | - | - | 5.0 | µs |
| **D5 - D6 CLAMPING DIODE** | | | | | | |
| Diode reverse recovery time | $t_{rr}$ | $V_R$ = 200 V<br>$I_F$ = 50 A<br>dI/dt = 500 A/µs | - | 105 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | - | 13.5 | - | A |
| Diode recovery charge | $Q_{rr}$ | | - | 712 | - | nC |
| Diode reverse recovery time | $t_{rr}$ | $V_R$ = 200 V<br>$I_F$ = 50 A<br>dI/dt = 500 A/µs, $T_J$ = 125 °C | - | 166 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | - | 24.5 | - | A |
| Diode recovery charge | $Q_{rr}$ | | - | 2050 | - | nC |
| **D1 - D2 - D3 - D4 AP DIODE** | | | | | | |
| Diode reverse recovery time | $t_{rr}$ | $V_R$ = 200 V<br>$I_F$ = 50 A<br>dI/dt = 500 A/µs | - | 105 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | - | 13.5 | - | A |
| Diode recovery charge | $Q_{rr}$ | | - | 712 | - | nC |
| Diode reverse recovery time | $t_{rr}$ | $V_R$ = 200 V<br>$I_F$ = 50 A<br>dI/dt = 500 A/µs, $T_J$ = 125 °C | - | 166 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | - | 24.5 | - | A |
| Diode recovery charge | $Q_{rr}$ | | - | 2050 | - | nC |

| **THERMAL AND MECHANICAL SPECIFICATIONS** | | | | | |
|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| Junction to case IGBT thermal resistance (per switch) | $R_{thJC}$ | - | - | 0.12 | °C/W |
| Junction to case diode thermal resistance (per diode) | | - | - | 0.3 | |
| Case to sink, flat, greased surface (per module) | $R_{thCS}$ | - | 0.05 | - | |
| Mounting torque, case to heatsink: M6 screw | | 4 | - | 6 | Nm |
| Mounting torque, case to terminal: 1, 2, 3, 4: M5 screw | | 2 | - | 5 | |
| Weight | | - | 270 | - | g |

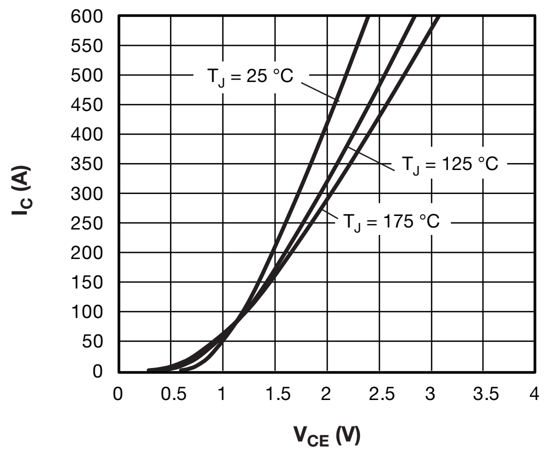



Fig. 1 - Typical Trench IGBT Output Characteristics, $V_{GE}$ = 15 V

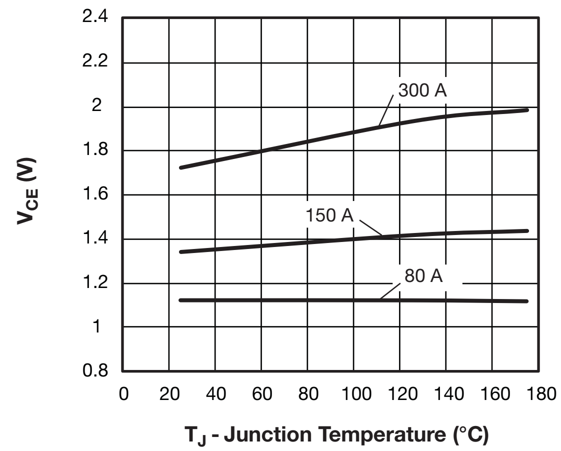



Fig. 4 - Typical Trench IGBT Collector to Emitter Voltage vs. Junction Temperature, $V_{GE}$ = 15 V

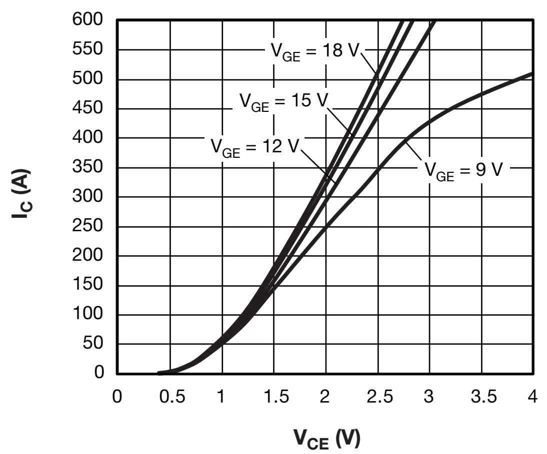



Fig. 2 - Typical Trench IGBT Output Characteristics, $T_J$ = 125 °C

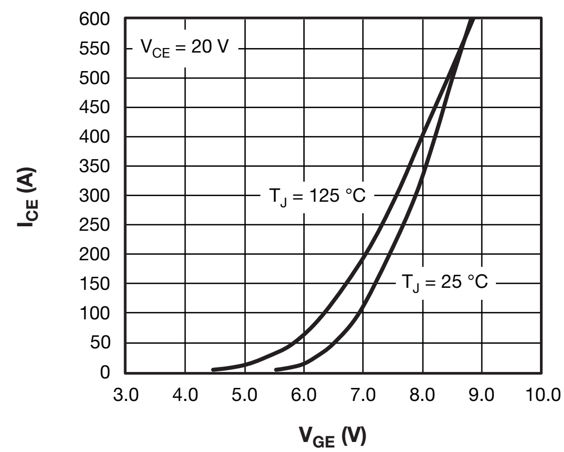



Fig. 5 - Typical Trench IGBT Transfer Characteristics

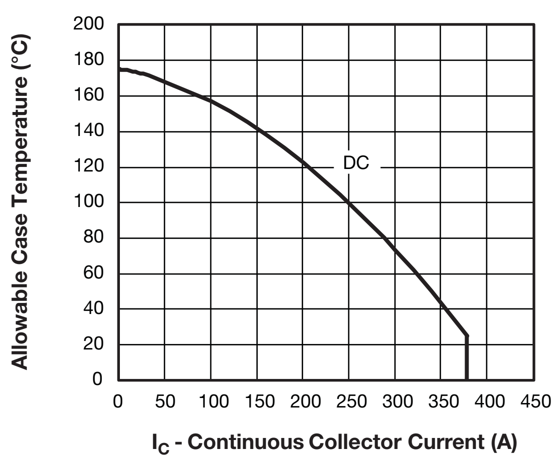



Fig. 3 - Maximum Trench IGBT Continuous Collector Current vs. Case Temperature (per switch)

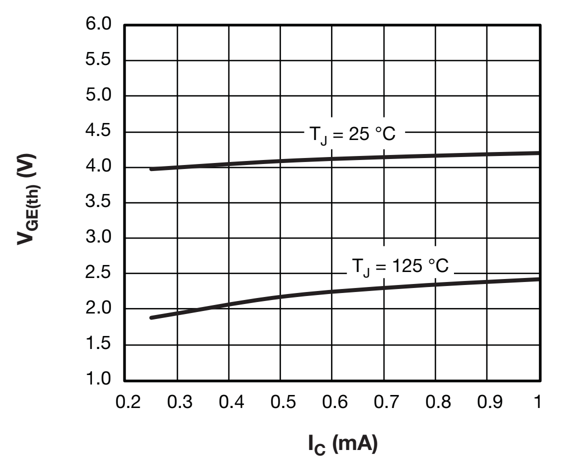



Fig. 6 - Typical Trench IGBT Gate Threshold Voltage

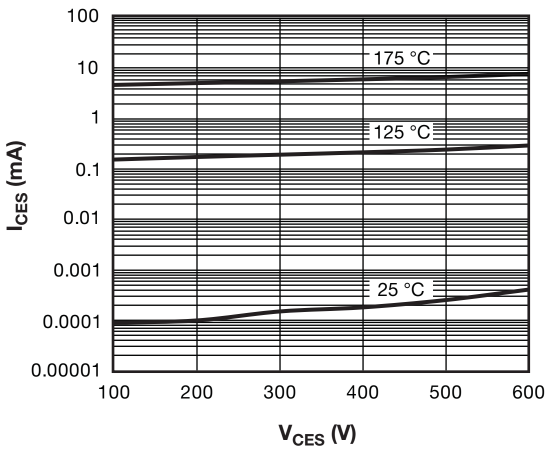



Fig. 7 - Typical Trench IGBT Zero Gate Voltage Collector Current

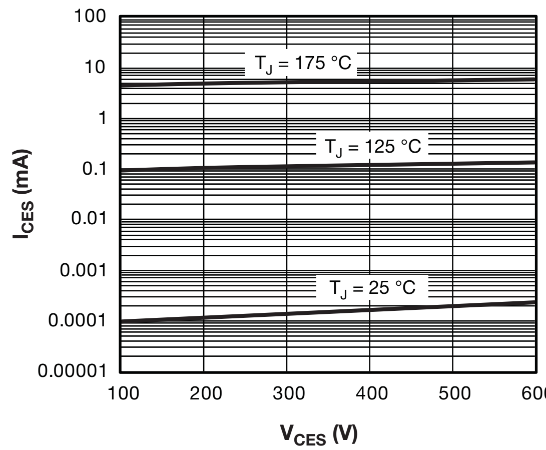



Fig. 10 - Typical Diode Reverse Leakage Current

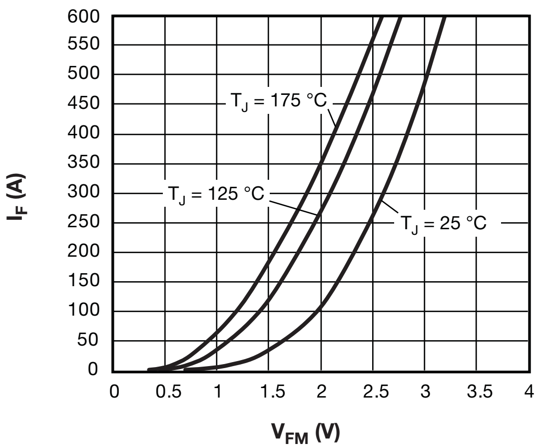



Fig. 8 - Typical Diode Forward Characteristics

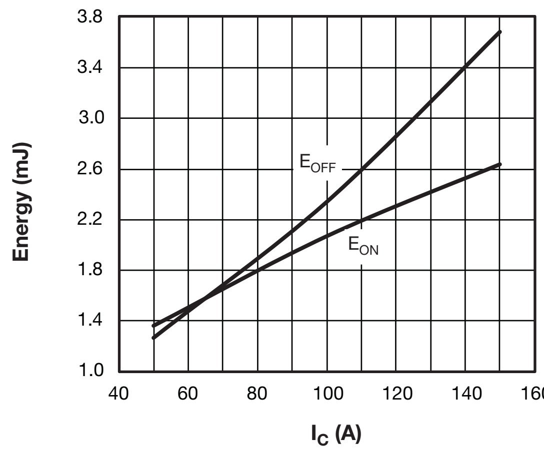



Fig. 11 - Typical Trench IGBT Energy Loss vs. $I_C$,
$T_J$ = 125 °C, $V_{CC}$ = 300 V, $R_g$ = 10 Ω, $V_{GE}$ = 15 V, L = 500 μH

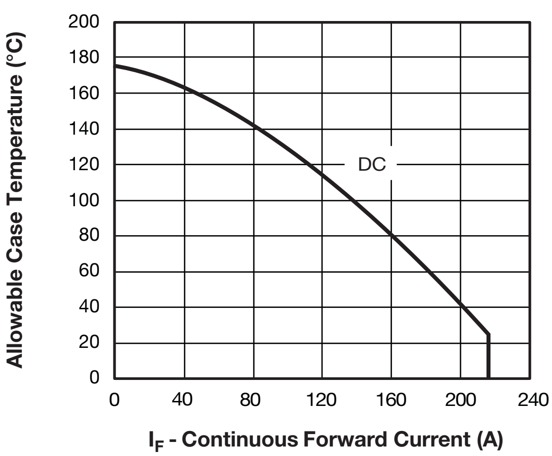



Fig. 9 - Maximum Diode Forward Current vs. Case Temperature

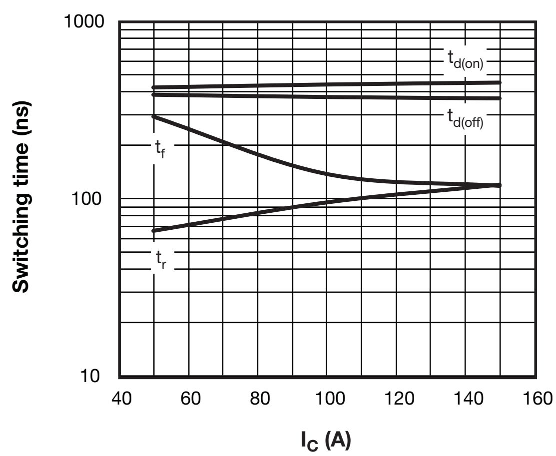



Fig. 12 - Typical IGBT Switching Time vs. $I_C$,
$T_J$ = 125 °C, $V_{CC}$ = 300 V, $R_g$ = 10 Ω, $V_{GE}$ = 15 V, L = 500 μH

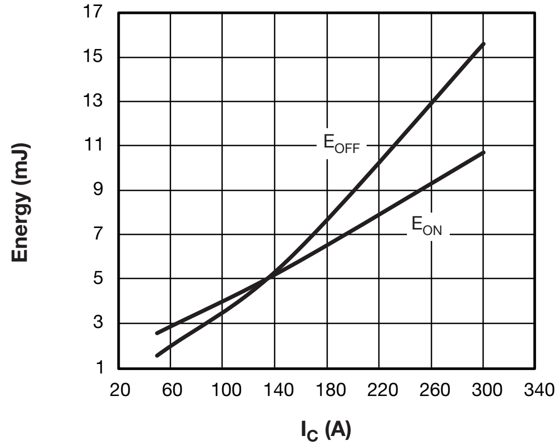



Fig. 13 - Typical Trench IGBT Energy Loss vs. $I_C$,
$T_J$ = 125 °C, $V_{CC}$ = 300 V, $R_g$ = 22 Ω, $V_{GE}$ = 15 V, L = 500 μH

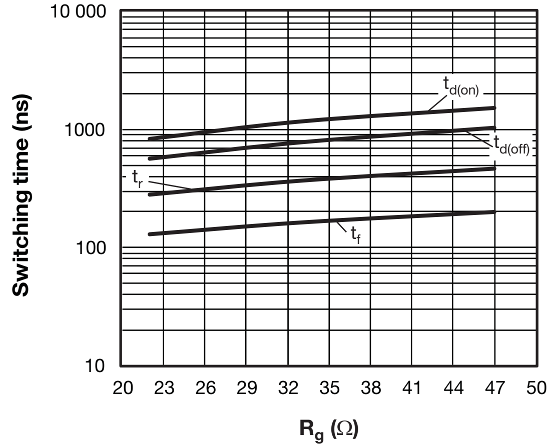



Fig. 16 - Typical Trench IGBT Switching Time vs. $R_g$,
$T_J$ = 125 °C, $V_{CC}$ = 300 V, $I_C$ = 300 A, $V_{GE}$ = 15 V, L = 500 μH

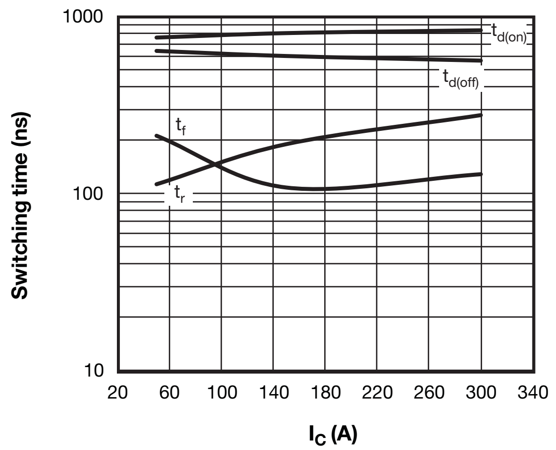



Fig. 14 - Typical IGBT Switching Time vs. $I_C$,
$T_J$ = 125 °C, $V_{CC}$ = 300 V, $R_g$ = 22 Ω, $V_{GE}$ = 15 V, L = 500 μH

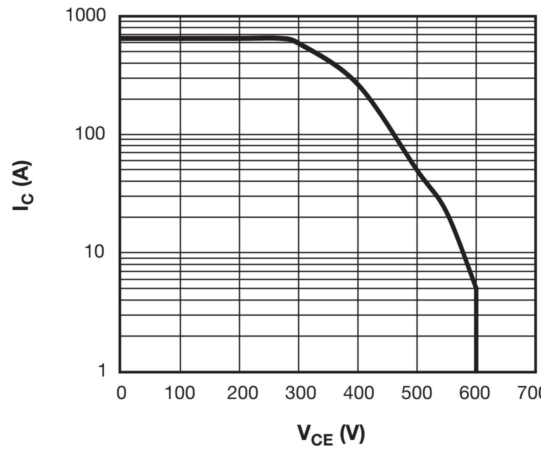



Fig. 17 - Trench IGBT Reverse Bias SOA
$T_J$ = 175 °C, $V_{GE}$ = 15 V, $R_g$ = 22 Ω

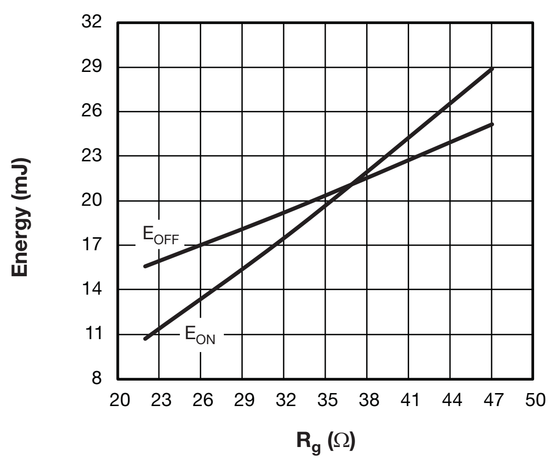



Fig. 15 - Typical Trench IGBT Energy Loss vs. $R_g$,
$T_J$ = 125 °C, $V_{CC}$ = 300 V, $I_C$ = 300 A, $V_{GE}$ = 15 V, L = 500 μH

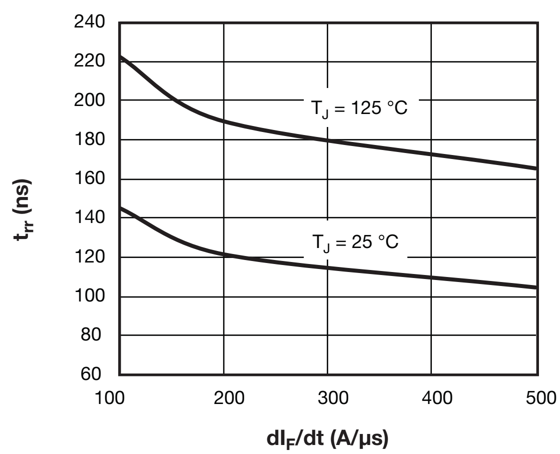



Fig. 18 - Typical Diode Reverse Recovery Time vs. $dI_F/dt$,
$V_{rr}$ = 200 V, $I_F$ = 50 A

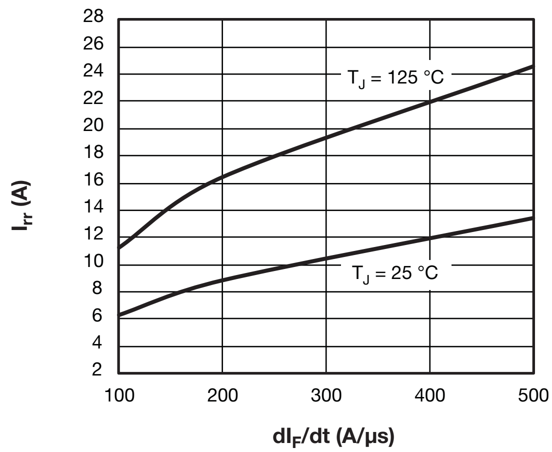



Fig. 19 - Typical Diode Reverse Recovery Current vs. $dI_F/dt$, $V_{rr}$ = 200 V, $I_F$ = 50 A

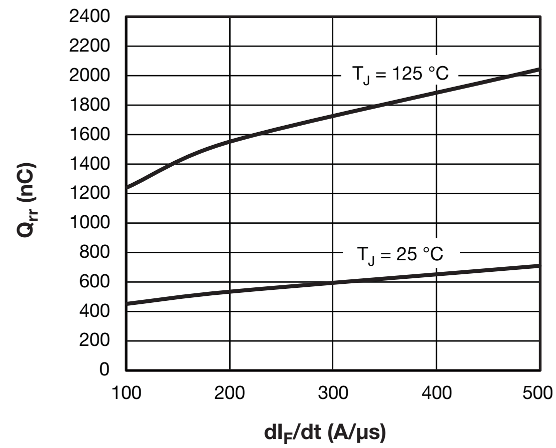



Fig. 20 - Typical Diode Reverse Recovery Charge vs. $dI_F/dt$, $V_{rr}$ = 200 V, $I_F$ = 50 A

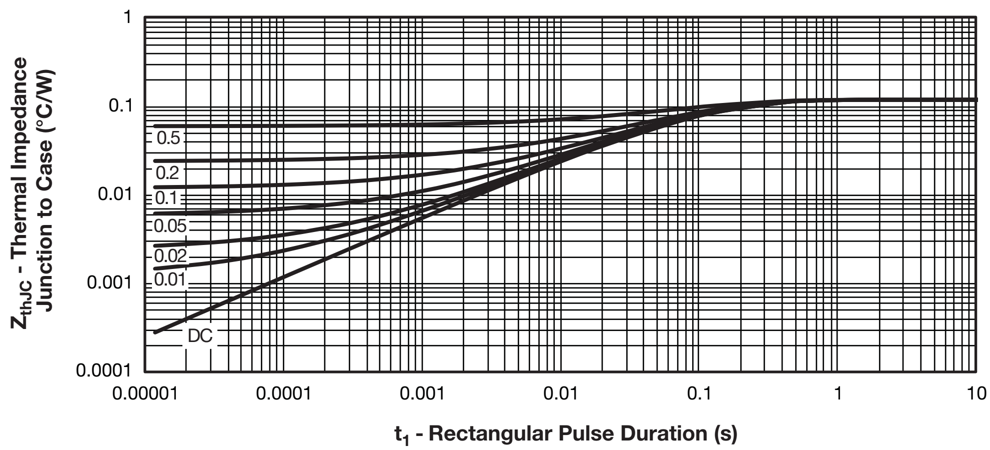



Fig. 21 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics (Trench IGBT)

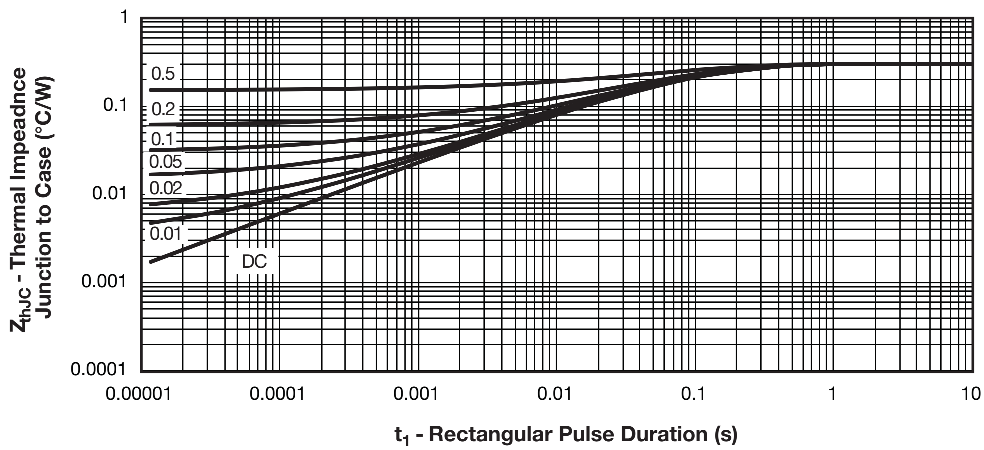


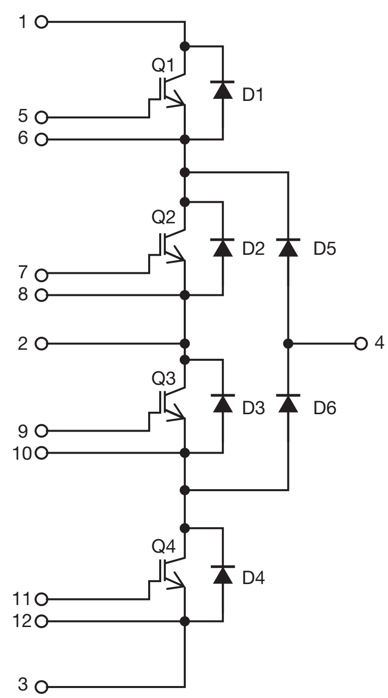

Fig. 22 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics (Diode)

## ORDERING INFORMATION TABLE

| Device code | VS- | G | T | 300 | F | D | 060 | N |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

| | | |
|---|---|---|
| 1 | - | Vishay Semiconductors product |
| 2 | - | Insulated gate bipolar transistor |
| 3 | - | T = trench IGBT |
| 4 | - | Current rating (300 = 300 A) |
| 5 | - | F = 3-level circuit configuration |
| 6 | - | Package indicator D = dual INT-A-PAK low profile |
| 7 | - | Voltage rating (060 = 600 V) |
| 8 | - | N = ultrafast |

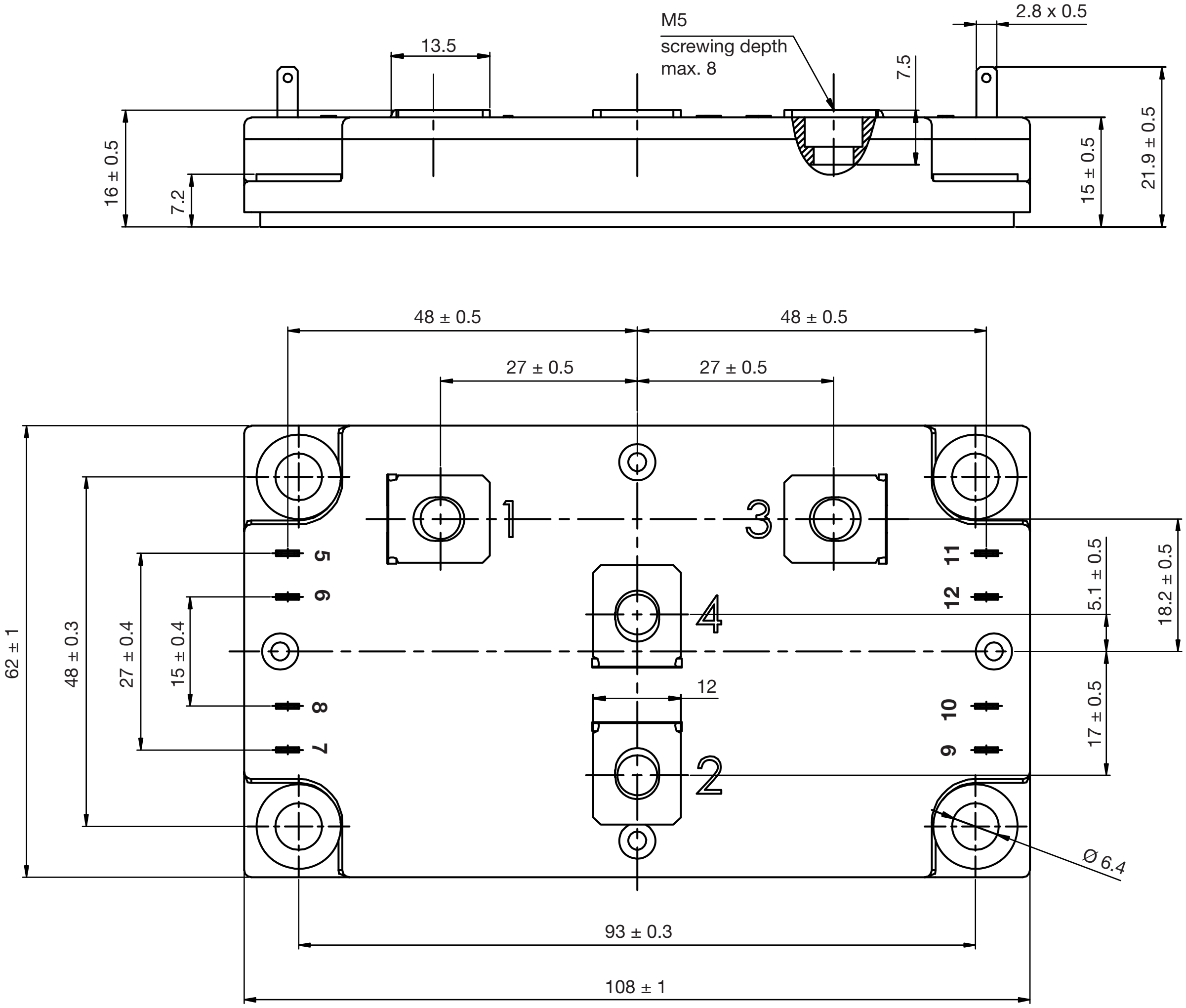
## CIRCUIT CONFIGURATION




| LINKS TO RELATED DOCUMENTS | |
|---|---|
| Dimensions | www.vishay.com/doc?95515 |

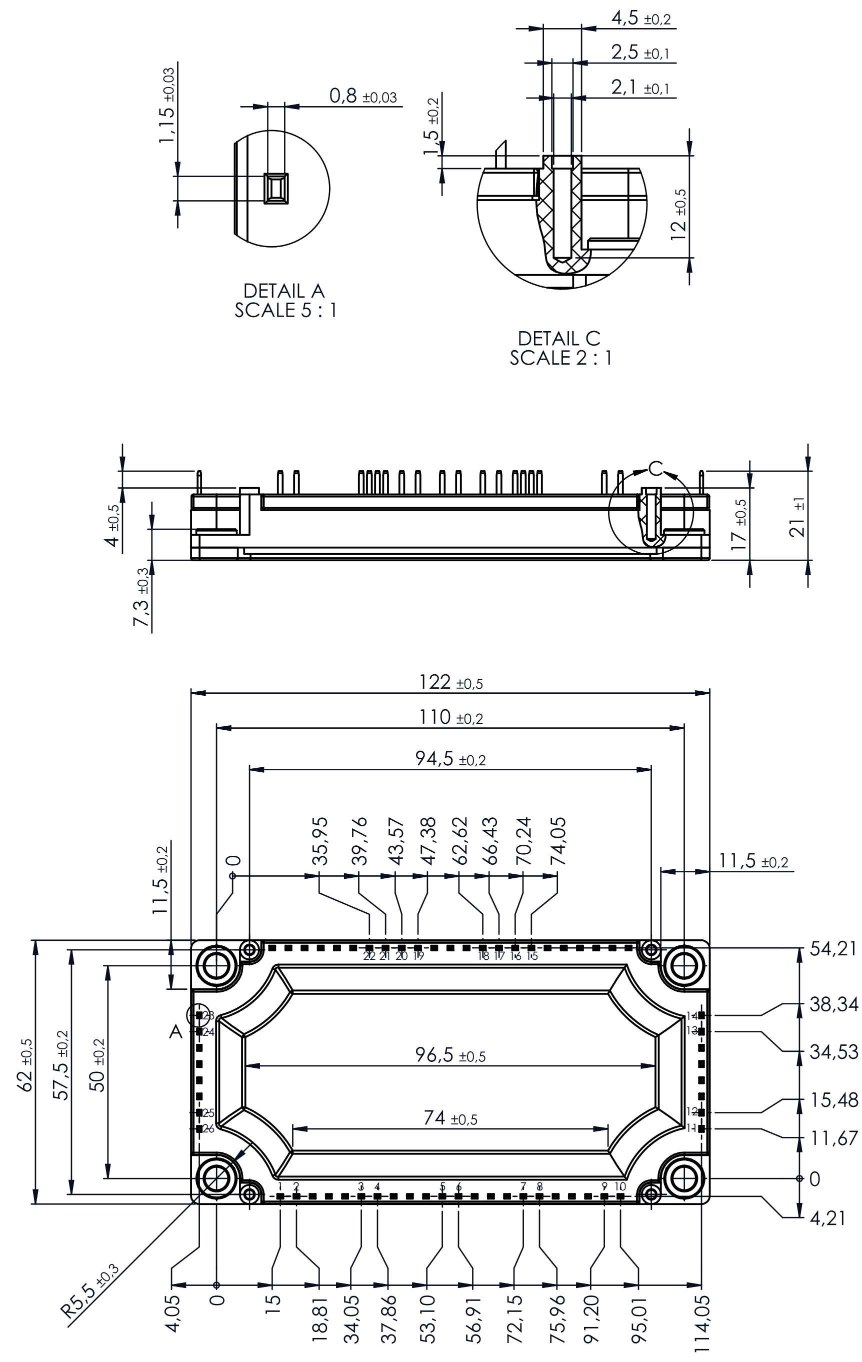
# DIAP Low Profile - 4 Leads

**DIMENSIONS** in millimeters



# ECONO3 4 Pack

**DIMENSIONS** in millimeters and inches




All pins position with tolerance of ⌖ ∅ 0.5

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