# ANTREX Electronics

Electronic Components Sourcing Information

## Product Reference Information

| | |
|---|---|
| **Part Number:** | VS-40MT060WFHT |
| **Manufacturer:** | Vishay General Semiconductor - Diodes Division |
| **Package:** | 12-MTP Module |
| **Availability:** | Please confirm with sales |

**Product Page:**

https://antrexco.com/product/details/vishay-general-semiconductor-diodes-division vs-40mt060wfht.html

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**Note:**

This PDF includes an ANTREX product reference cover page.

The original manufacturer datasheet follows from the next page.

# Full Bridge IGBT and MOSFET MTP Power Module

MTP

| PRODUCT SUMMARY | |
|---|---|
| **HALF BRIDGE POWER MOSFET** | |
| $V_{DSS}$ | 650 V |
| $R_{DS(on)}$ typical at $I_D$ = 40 A | 35 mΩ |
| $I_D$ at $T_C$ = 80 °C | 41 A |
| **HALF BRIDGE WARP IGBT** | |
| $V_{CES}$ | 600 V |
| $V_{CE(on)}$ typical at $I_C$ = 25 A | 2.18 V |
| $I_C$ at $T_C$ = 80 °C | 46 A |

## FEATURES

- Generation 4 warp speed IGBT and power MOSFET technology
- HEXFRED® antiparallel diodes with ultrasoft reverse recovery
- Very low conduction and switching losses
- Operating frequency up to 100 kHz
- Designed and qualified for industrial level
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912

Pb-free
RoHS
COMPLIANT

## BENEFITS

- Optimized for welding, UPS and SMPS applications
- Low EMI, requires less snubbing
- Direct mounting to heatsink
- PCB solderable terminals
- Very low stray inductance design for high speed operation

**ABSOLUTE MAXIMUM RATINGS**

| PARAMETER | SYMBOL | TEST CONDITIONS | MAX. | UNITS |
|---|---|---|---|---|
| Operating junction temperature | $T_J$ | | 150 | °C |
| Storage temperature range | $T_{Stg}$ | | - 40 to 150 | |
| $V_{RMS}$ Insulation voltage | $V_{ISOL}$ | AC 1.2 s | 3500 | V |
| **Q1, Q2 POWER MOSFET** | | | | |
| Drain to source voltage | $V_{DSS}$ | | 650 | V |
| Gate to source voltage | $V_{GS}$ | | 25 | |
| Pulsed drain current | $I_{DM}$ (1) | | 270 | A |
| Single pulse avalanche energy | $E_{AS}$ | $T_C$ = 25 °C; $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V | 2000 | mJ |
| Avalanche current repetitive | $I_{AR}$ | pulsed width limited by $T_J$ max. | 15 | A |
| Peak diode recovery voltage slope | dV/dt (2) | | 15 | V/µs |
| Continuous drain current | $I_D$ | $T_C$ = 25 °C, $V_{GS}$ = 10 V | 52 | A |
| | | $T_C$ = 80 °C | 41 | |
| Power dissipation | $P_D$ | $T_C$ = 25 °C | 284 | W |
| | | $T_C$ = 80 °C | 159 | |
| **Q3, Q4 WARP IGBT** | | | | |
| Collector to emitter voltage | $V_{CES}$ | | 600 | V |
| Gate to emitter voltage | $V_{GES}$ | | 20 | |
| Pulsed collector current | $I_{CM}$ | | 200 | A |
| Clamped inductive load current | $I_{LM}$ | | 200 | |
| Continuous collector current | $I_C$ | $T_C$ = 25 °C | 67 | |
| | | $T_C$ = 80 °C | 43 | |
| Power dissipation | $P_D$ | $T_C$ = 25 °C | 211 | W |
| | | $T_C$ = 80 °C | 118 | |


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| ABSOLUTE MAXIMUM RATINGS | | | | |
|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MAX.** | **UNITS** |
| **D1, D2, AP DIODE OF WARP IGBT** | | | | |
| Repetitive peak reverse voltage | $V_{RRM}$ | | 600 | V |
| Diode continuous forward current | $I_F$ | $T_C$ = 25 °C | 73 | A |
| | | $T_C$ = 80 °C | 48 | |
| Peak diode forward current | $I_{FSM}$ | $T_C$ = 25 °C | 260 | |
| Power dissipation | $P_D$ | $T_C$ = 25 °C | 143 | W |
| | | $T_C$ = 80 °C | 80 | |
| **SOURCE DRAIN (MOSFET BODY DIODE)** | | | | |
| Continuous source current | $I_S$ | $T_C$ = 25 °C | 52 | A |
| Pulsed source current | $I_{SM}$ | $T_C$ = 25 °C | 360 | |

**Notes**

(1) Pulse width limited by safe operating area

(2) $I_{SD}$ < 69 A, dI/dt = 400 A/μs, peak $V_{SD}$ < $V_{(BR)DSS}$

| ELECTRICAL SPECIFICATIONS ($T_J$ = 25 °C unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | **MIN.** | **TYP.** | **MAX.** | **UNITS** |
| **Q1, Q2 POWER MOSFET** | | | | | | |
| Drain to source breakdown voltage | $V_{(BR)DSS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 μA | 650 | - | - | V |
| Static drain to source on resistance | $R_{DS(on)}$ | $V_{GS}$ = 10 V, $I_D$ = 50 A | - | 35 | 44 | mΩ |
| | | $V_{GS}$ = 10 V, $I_D$ = 50 A, $T_J$ = 150 °C | - | - | 104 | mΩ |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{GE}$ = $V_{GS}$, $I_D$ = 0.25 mA | 2.8 | 4 | 5.4 | V |
| Drain to source leakage current | $I_{DSS}$ | $V_{DS}$ = 650 V, $V_{GS}$ = 0 V | - | - | 50 | μA |
| | | $V_{DS}$ = 650 V, $V_{GS}$ = 0 V, $T_J$ = 150 °C | - | - | 5.0 | mA |
| Gate to source forward leakage | $I_{GSS}$ | $V_{GS}$ = 25 V | - | - | 100 | nA |
| Gate to source reverse leakage | | $V_{GS}$ = - 25 V | - | - | - 100 | |
| Intrinsic gate resistance | $R_g$ | f = 1 MHz, open drain | - | 1.2 | - | Ω |
| Total gate charge | $Q_g$ | $I_D$ = 35 A | - | 200 | - | nC |
| Gate to source charge | $Q_{gs}$ | $V_{DD}$ = 520 V | - | 60 | - | |
| Gate to drain (Miller) charge | $Q_{gd}$ | $V_{GS}$ = 10 V | - | 70 | - | |
| Turn-on delay time | $t_{d(on)}$ | $V_{DD}$ = 325 V<br>L = 500 μH, $I_D$ = 40 A<br>$R_g$ = 5 Ω, $V_{GS}$ = 10 V, $T_J$ = 125 °C | - | 165 | - | ns |
| Rise time | $t_r$ | | - | 44 | - | |
| Turn-off delay time | $t_{d(off)}$ | | - | 148 | - | |
| Fall time | $t_f$ | | - | 30 | - | |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0 V | - | 9800 | - | pF |
| Output capacitance | $C_{oss}$ | $V_{DS}$ = 100 V, f = 1 MHz | - | 200 | - | |
| **SOURCE DRAIN (MOSFET BODY DIODE)** | | | | | | |
| Forward voltage | $V_{SD}$ | $I_S$ = 34 A, $V_{GS}$ = 0 V | - | - | 1.0 | V |
| **Q3, Q4 WARP IGBT** | | | | | | |
| Collector to emitter breakdown voltage | $V_{(BR)CES}$ | $V_{GE}$ = 0 V, $I_C$ = 250 μA | 600 | - | - | V |
| Collector to emitter voltage | $V_{CE(on)}$ | $V_{GE}$ = 15 V, $I_D$ = 25 A | - | 2.18 | 2.83 | |
| | | $V_{GE}$ = 15 V, $I_C$ = 25 A $T_J$ = 150 °C | - | 1.75 | 2.34 | |
| Gate threshold voltage | $V_{GE(th)}$ | $V_{CE}$ = $V_{GE}$, $I_C$ = 0.25 mA | 2.8 | 4.9 | 6.2 | 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) | - | - 12 | - | mV/°C |
| Forward transconductance | $g_{fe}$ | $V_{CE}$ = 20 V, $I_C$ = 25 A | - | 49 | - | S |
| Zero gate voltage collector current | $I_{CES}$ | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V | - | - | 250 | μA |
| | | $V_{GE}$ = 0 V, $V_{CE}$ = 600 V, $T_J$ = 125 °C | - | - | 5.0 | mA |
| Gate to emitter leakage current | $I_{GES}$ | $V_{GE}$ = ± 20 V, $V_{CE}$ = 0 V | - | - | ± 100 | nA |
| **D1, D2, AP DIODE OF WARP IGBT** | | | | | | |
| Forward voltage drop | $V_{FM}$ | $I_F$ = 25 A | - | 1.3 | 1.41 | V |
| | | $I_F$ = 25 A, $T_J$ = 150 °C | - | 1.11 | 1.29 | |


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| SWITCHING CHARACTERISTICS ($T_J$ = 25 °C unless otherwise specified) | | | | | | |
|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNITS |
| **Q3, Q4 WARP IGBT** | | | | | | |
| Total gate charge (turn-on) | $Q_g$ | $I_C$ = 25 A<br>$V_{CC}$ = 400 V<br>$V_{GE}$ = 15 V | - | 175 | - | nC |
| Gate to emitter charge (turn-on) | $Q_{ge}$ | | - | 27 | - | |
| Gate to collector charge (turn-on) | $Q_{gc}$ | | - | 71 | - | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 25 A<br>$V_{CC}$ = 400 V, $V_{GE}$ = 15 V<br>$R_g$ = 5 Ω , L = 500 μH | - | 0.21 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | - | 0.15 | - | |
| Total switching loss | $E_{tot}$ | | - | 0.36 | - | |
| Turn-on switching loss | $E_{on}$ | $I_C$ = 25 A<br>$V_{CC}$ = 400 V, $V_{GE}$ = 15 V<br>$R_g$ = 5 Ω , $T_J$ = 125 °C , L = 500 μH | - | 0.33 | - | mJ |
| Turn-off switching loss | $E_{off}$ | | - | 0.36 | - | |
| Total switching loss | $E_{tot}$ | | - | 0.69 | - | |
| **D1, D2, AP DIODE OF WARP IGBT** | | | | | | |
| Diode reverse recovery time | $t_{rr}$ | $V_{RR}$ = 400 V<br>$I_F$ = 25 A, $T_J$ = 125 °C<br>dI/dt = 200 A/μs | - | 118 | - | ns |
| Diode peak reverse current | $I_{rr}$ | | - | 13.5 | - | A |
| Diode recovery charge | $Q_{rr}$ | | - | 760 | - | nC |
| **SOURCE DRAIN (MOSFET BODY DIODE)** | | | | | | |
| Diode reverse recovery time | $t_{rr}$ | $I_{SD}$ = 34.5 A<br>$V_{DD}$ = 100 V<br>dI/dt = 100 A/μs | - | 563 | - | ns |
| Diode reverse current | $I_{rr}$ | | - | 35 | - | A |
| Diode recovery charge | $Q_{rr}$ | | - | 9500 | - | nC |

| THERMISTOR ELECTRICAL CHARACTERISTICS ($T_J$ = 25 °C unless otherwise specified) | | | | |
|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | TYP. | UNITS |
| Resistance | R | $T_J$ = 25 °C | 5000 | Ω |
| B Value | B | $T_J$ = 125 °C/50 °C | 3375 | K |

| MECHANICAL SPECIFICATIONS | | | | | |
|---|---|---|---|---|---|
| PARAMETER | SYMBOL | MIN. | TYP. | MAX. | UNITS |
| Junction to case Q1, Q2 POWER MOSFET thermal resistance (per switch) | $R_{thJC}$ | - | - | 0.44 | °C/W |
| Junction to case Q3, Q4 WARP IGBT thermal resistance (per switch) | | - | - | 0.59 | |
| Junction to case D1, D2, AP diode of WARP IGBT thermal resistance (per diode) | | - | - | 0.87 | |
| Case to sink, flat, greased surface (per module) | $R_{thCS}$ | - | 0.05 | - | |
| Mounting torque ± 10 % to heatsink (1) | | - | - | 4 | Nm |
| Weight | | - | 65 | - | g |

**Note**

(1) A mounting compound is recommended and the torque should be rechecked after a period of 3 hours to allow for the spread of the compound. Lubricated threads.


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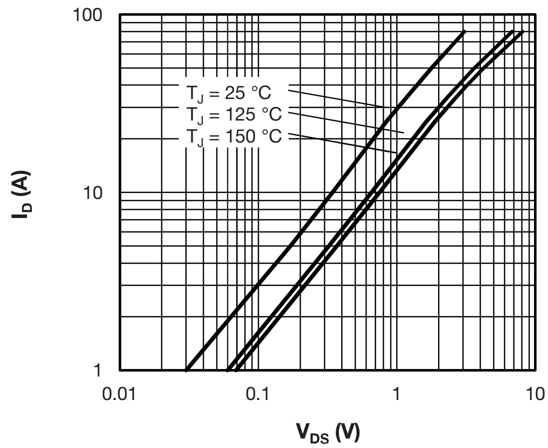


Fig. 1 - Power MOSFET Q1 - Q2 Typical Output Characteristics, $V_{GS}$ = 10 V

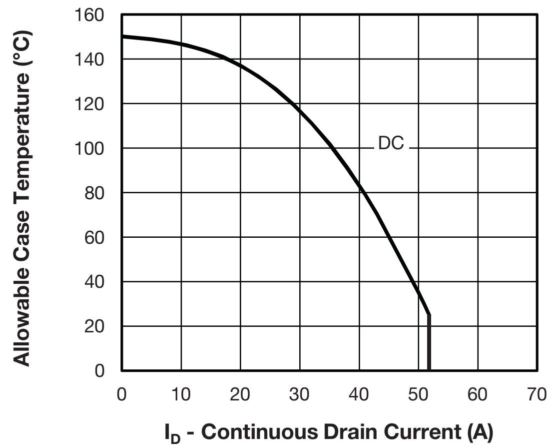


Fig. 4 - Power MOSFET Q1 - Q2 Maximum Continuous Drain Current vs. Case Temperature, $V_{GS}$ = 10 V

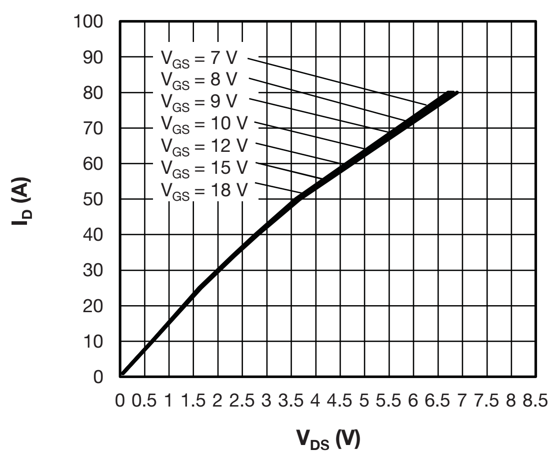


Fig. 2 - Power MOSFET Q1 - Q2 Typical Output Characteristics, $T_J$ = 125 °C

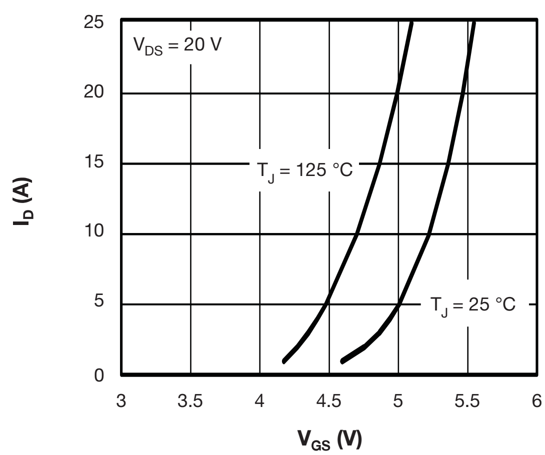


Fig. 5 - Power MOSFET Q1 - Q2 Typical Transfer Characteristics

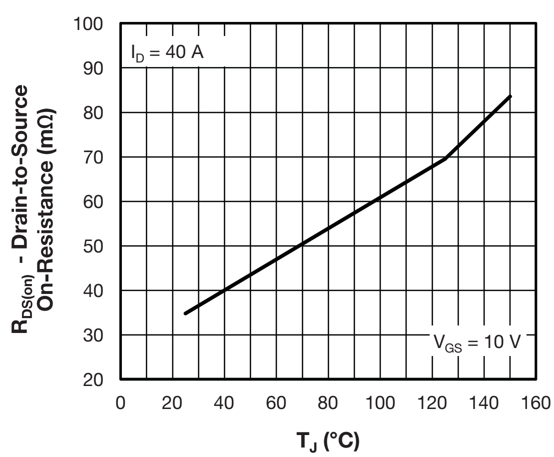


Fig. 3 - Power MOSFET Q1 - Q2 Typical Drain-to-Source On-Resistance vs. Temperature

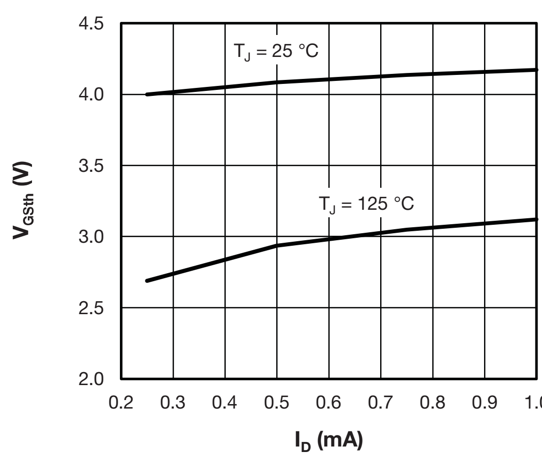


Fig. 6 - Power MOSFET Q1 - Q2 Typical Gate Threshold Voltage


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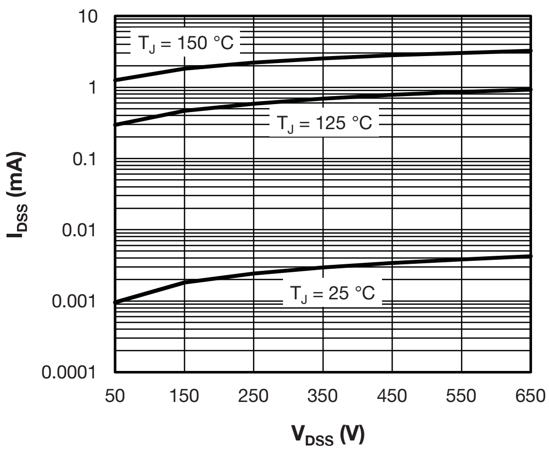


Fig. 7 - Power MOSFET Q1 - Q2 Typical Zero Gate Voltage Drain Current

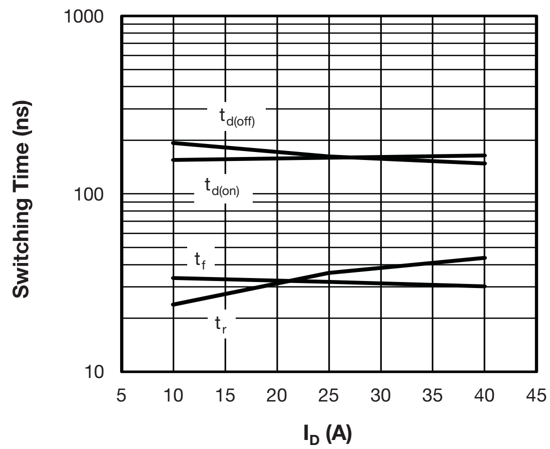


Fig. 9 - Power MOSFET Q1 - Q2 Typical Switching Time vs. $I_D$ (with freewheeling diode 15ETH06), $T_J$ = 125 °C, $V_{DD}$ = 325 V, $R_g$ = 5 Ω, $V_{GS}$ = 10 V, L = 500 µH

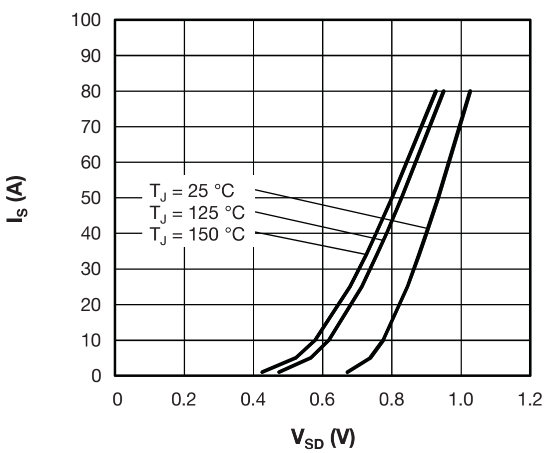


Fig. 8 - Power MOSFET Q1 - Q2 Typical Bodydiode Source-to-Drain Current Characteristics

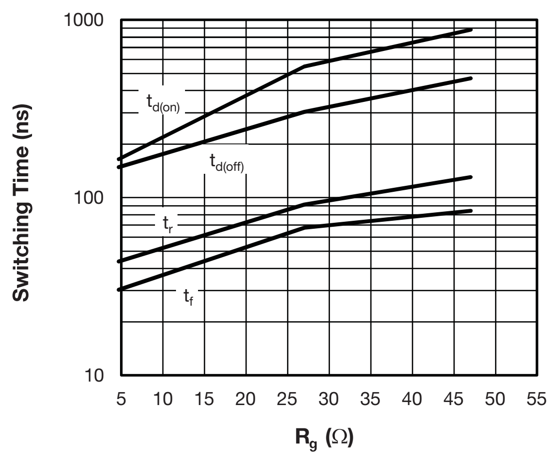


Fig. 10 - Power MOSFET Q1 - Q2 Typical Switching Time vs. $R_g$ (with freewheeling diode 15ETH06), $T_J$ = 125 °C, $V_{DD}$ = 325 V, $I_D$ = 40 A, $V_{GS}$ = 10 V, L = 500 µH

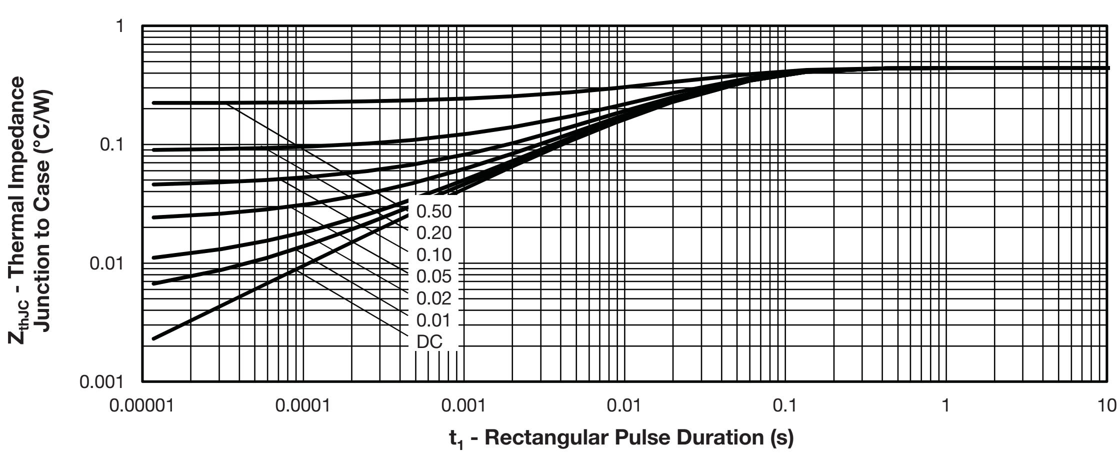


Fig. 11 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics (Q1 - Q2 Power MOSFET)


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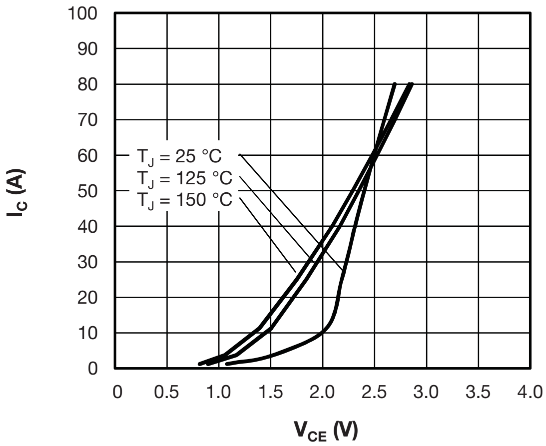


Fig. 12 - Q3 - Q4 IGBT Typical Output Characteristics, $V_{GE}$ = 15 V

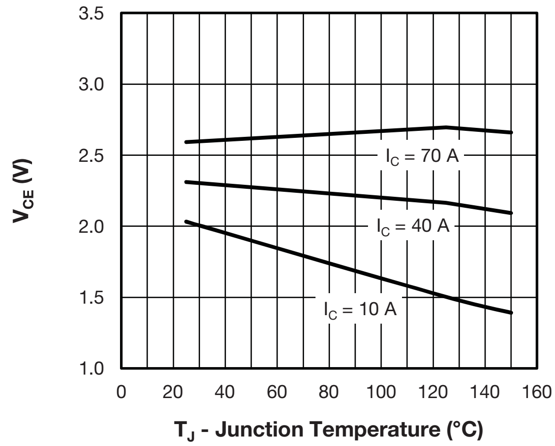


Fig. 15 - Q3 - Q4 IGBT Typical Collector to Emitter Voltage vs. Junction Temperature, $V_{GE}$ = 15 V

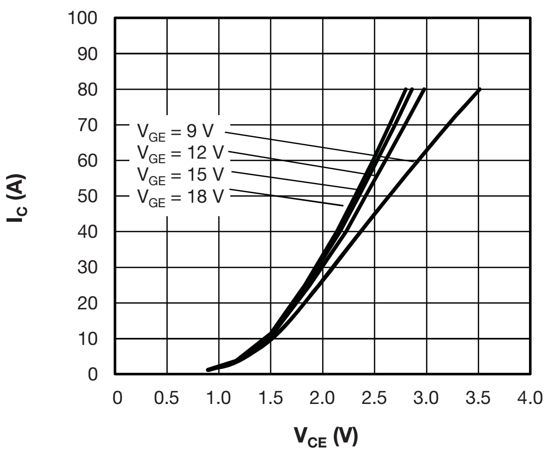


Fig. 13 - Q3 - Q4 IGBT Typical Output Characteristics, $T_J$ = 125 °C

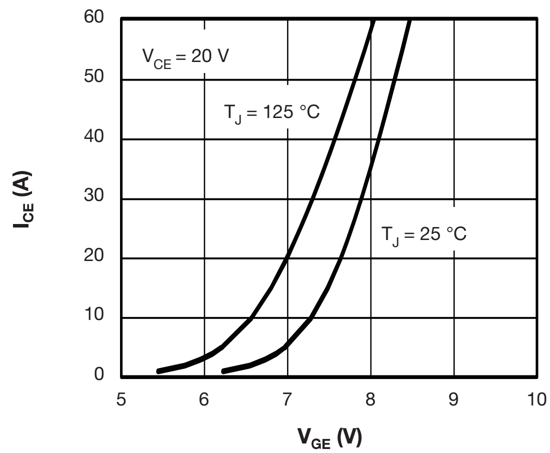


Fig. 16 - Q3 - Q4 IGBT Typical Transfer Characteristics

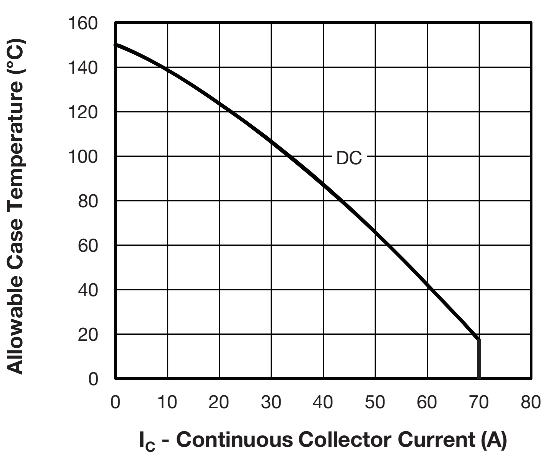


Fig. 14 - Q3 - Q4 IGBT Maximum Continuous Collector Current vs. Case Temperature

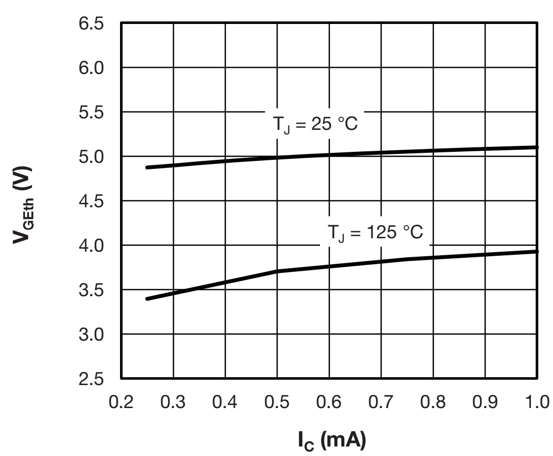


Fig. 17 - Q3 - Q4 IGBT Typical Gate Threshold Voltage


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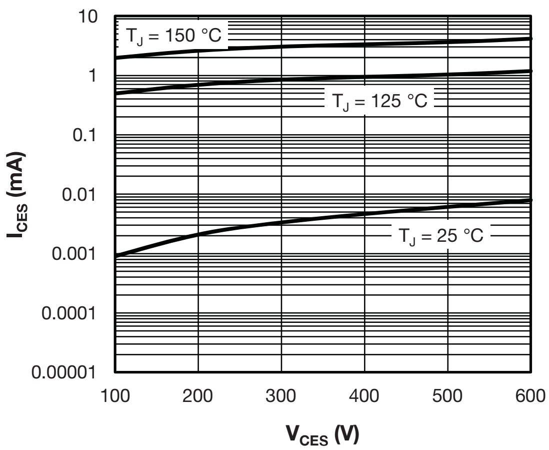


Fig. 18 - Q3 - Q4 IGBT Typical Trench Zero Gate Voltage Collector Current

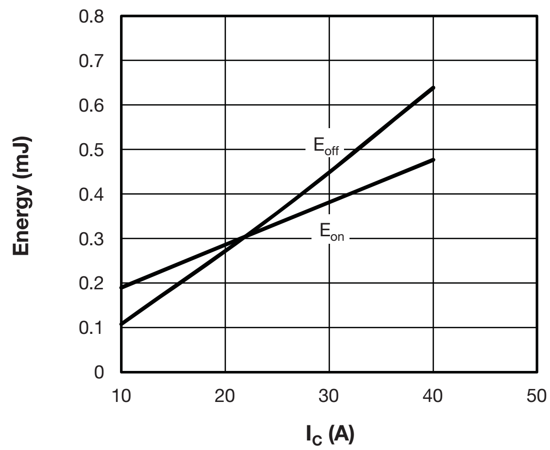


Fig. 21 - Q3 - Q4 IGBT Typical Energy Loss vs. $I_C$ (with freewheeling D1 - D2 antiparallel diode), $T_J$ = 125 °C, $V_{CC}$ = 400 V, $R_g$ = 5 $\Omega$, $V_{GE}$ = 15 V, L = 500 µH

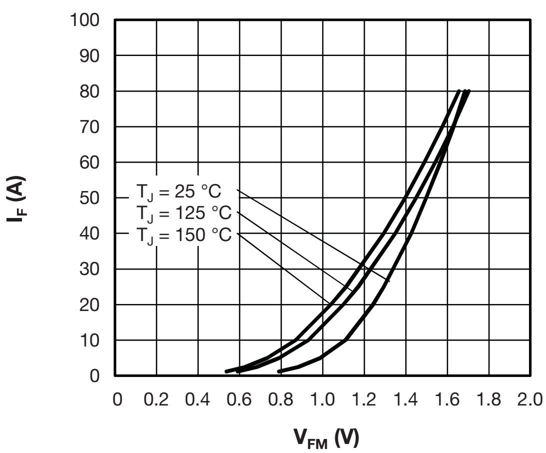


Fig. 19 - D1 - D2 Antiparallel Diode Typical Forward Characteristics

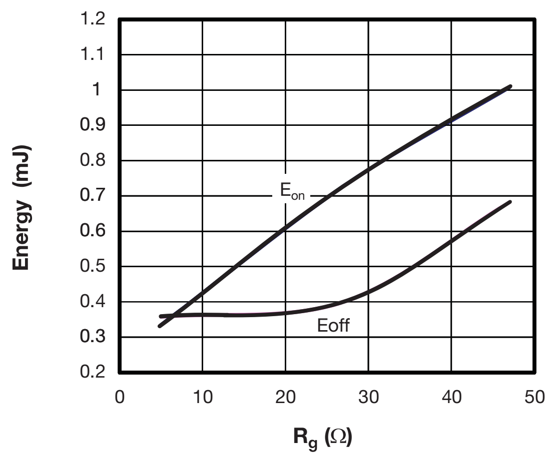


Fig. 22 - Q3 - Q4 IGBT Typical Energy Loss vs. $R_g$ (with freewheeling D1 - D2 antiparallel diode), $T_J$ = 125 °C, $V_{CC}$ = 400 V, $V_{GE}$ = 15 V, L = 500 µH, $I_C$ = 25 A

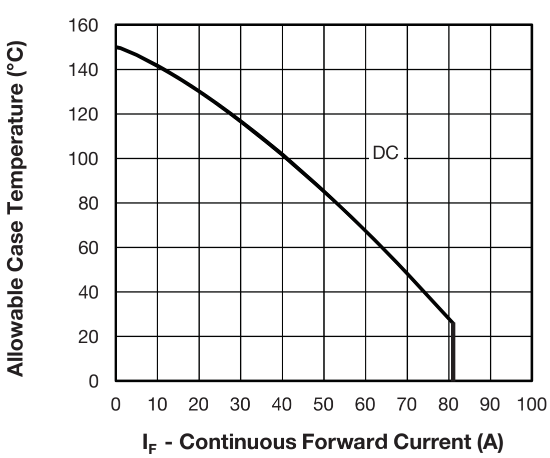


Fig. 20 - D1 - D2 Antiparallel Diode Maximum Forward Current vs. Case Temperature

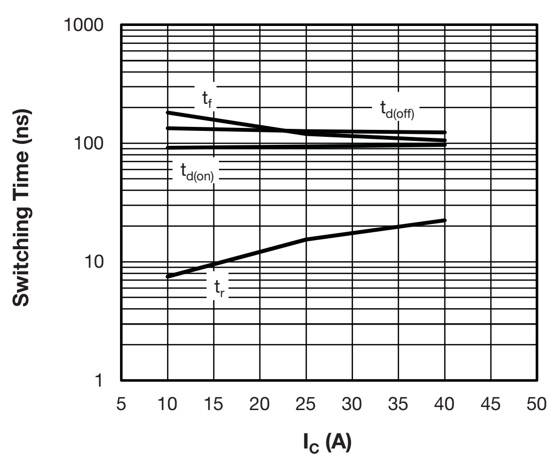


Fig. 23 - Q3 - Q4 IGBT Typical Switching Time vs. $I_C$ (with freewheeling D1 - D2 antiparallel diode), $T_J$ = 125 °C, $V_{CC}$ = 400 V, $R_g$ = 5 $\Omega$, $V_{GE}$ = 15 V, L = 500 µH



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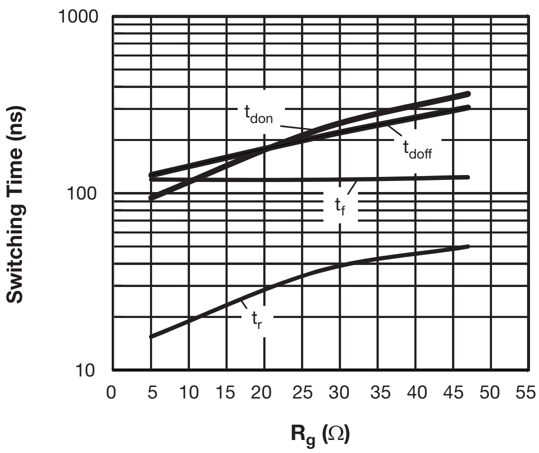


Fig. 24 - Q3 - Q4 IGBT Typical Switching Time vs. $R_g$ (with freewheeling D1 - D2 antiparallel diode), $T_J$ = 125 °C, $V_{CC}$ = 400 V, $V_{GE}$ = 15 V, L = 500 μH, $I_C$ = 25 A

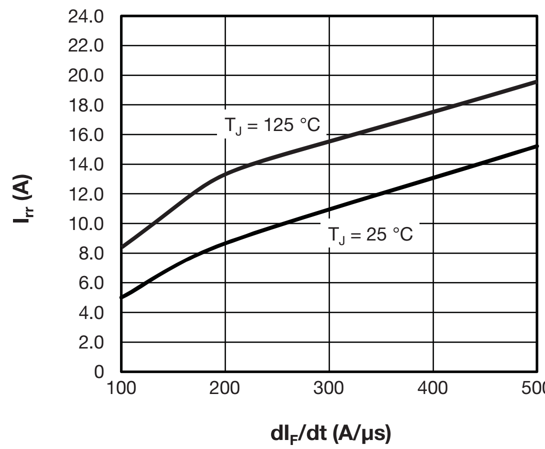


Fig. 26 - D1 - D2 Antiparallel Diode Typical Reverse Recovery Current vs. $dI_F/dt$, $V_{RR}$ = 400 V, $I_F$ = 25 A

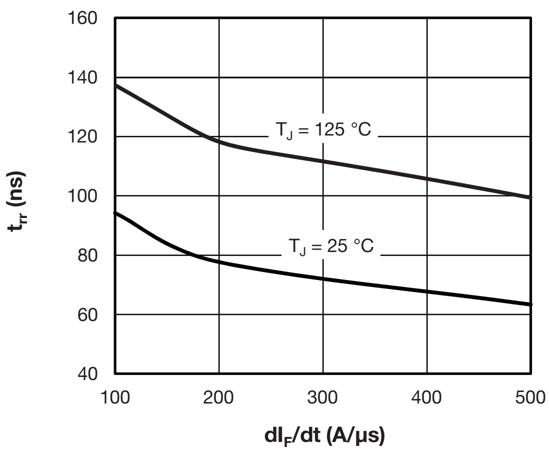


Fig. 25 - D1 - D2 Antiparallel Diode Typical Reverse Recovery Time vs. $dI_F/dt$, $V_{RR}$ = 400 V, $I_F$ = 25 A

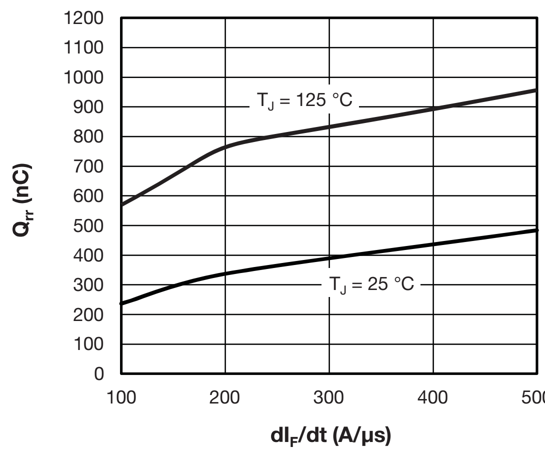


Fig. 27 - D1 - D2 Antiparallel Diode Typical Reverse Recovery Charge vs. $dI_F/dt$, $V_{RR}$ = 400 V, $I_F$ = 25 A

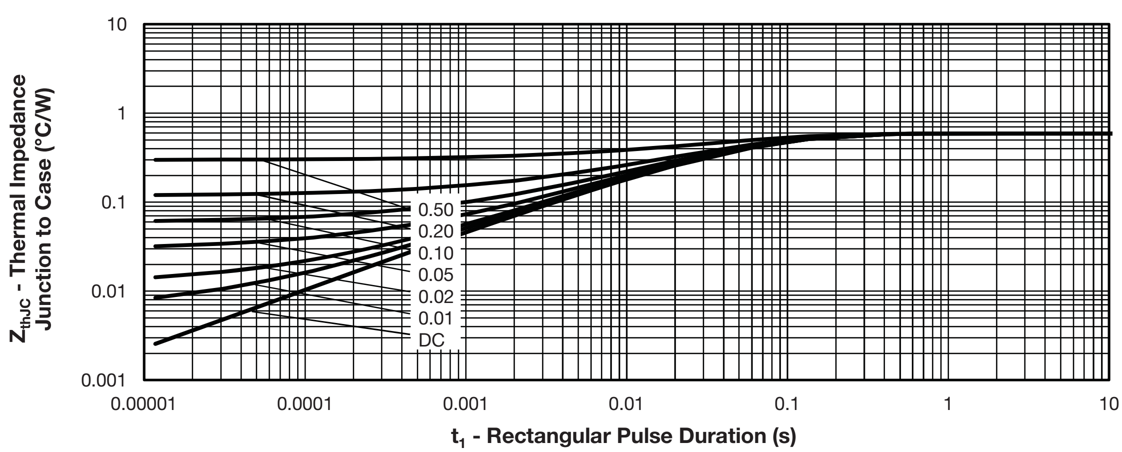


Fig. 28 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics (Q1 - Q2 WARP IGBT)


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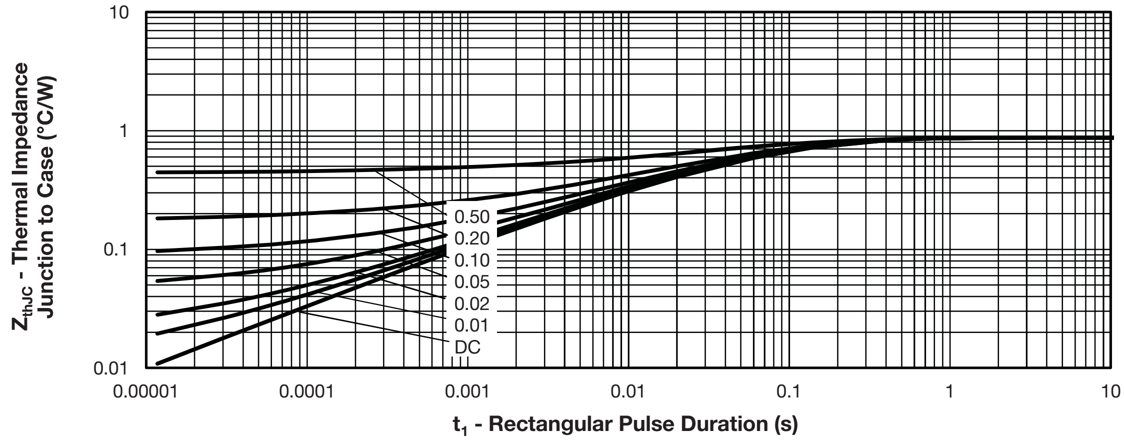
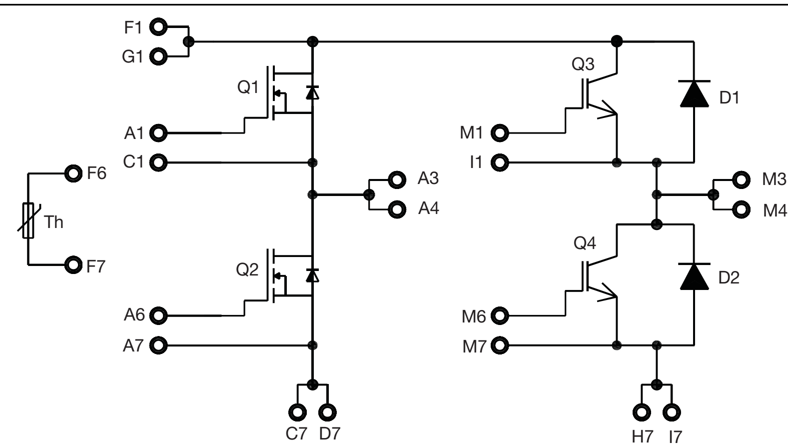



Fig. 29 - Maximum Thermal Impedance $Z_{thJC}$ Characteristics (D1 - D2 Antiparallel Diode)

## ORDERING INFORMATION TABLE

| Device code | VS- | 40 | MT | 060 | W | FH | T |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

- 1 - Vishay Semiconductors Product
- 2 - Current rating (40 = 40 A)
- 3 - MTP package
- 4 - Voltage code (060 = 600 V)
- 5 - Speed/type (W = Warp IGBT)
- 6 - Circuit configuration (FH = Full bridge MOSFET, IGBT)
- 7 - Thermistor

| CIRCUIT CONFIGURATION | | |
|---|---|---|
| **CIRCUIT** | **CIRCUIT CONFIGURATION CODE** | **CIRCUIT DRAWING** |
| Full bridge MOSFET, IGBT | FH |  |





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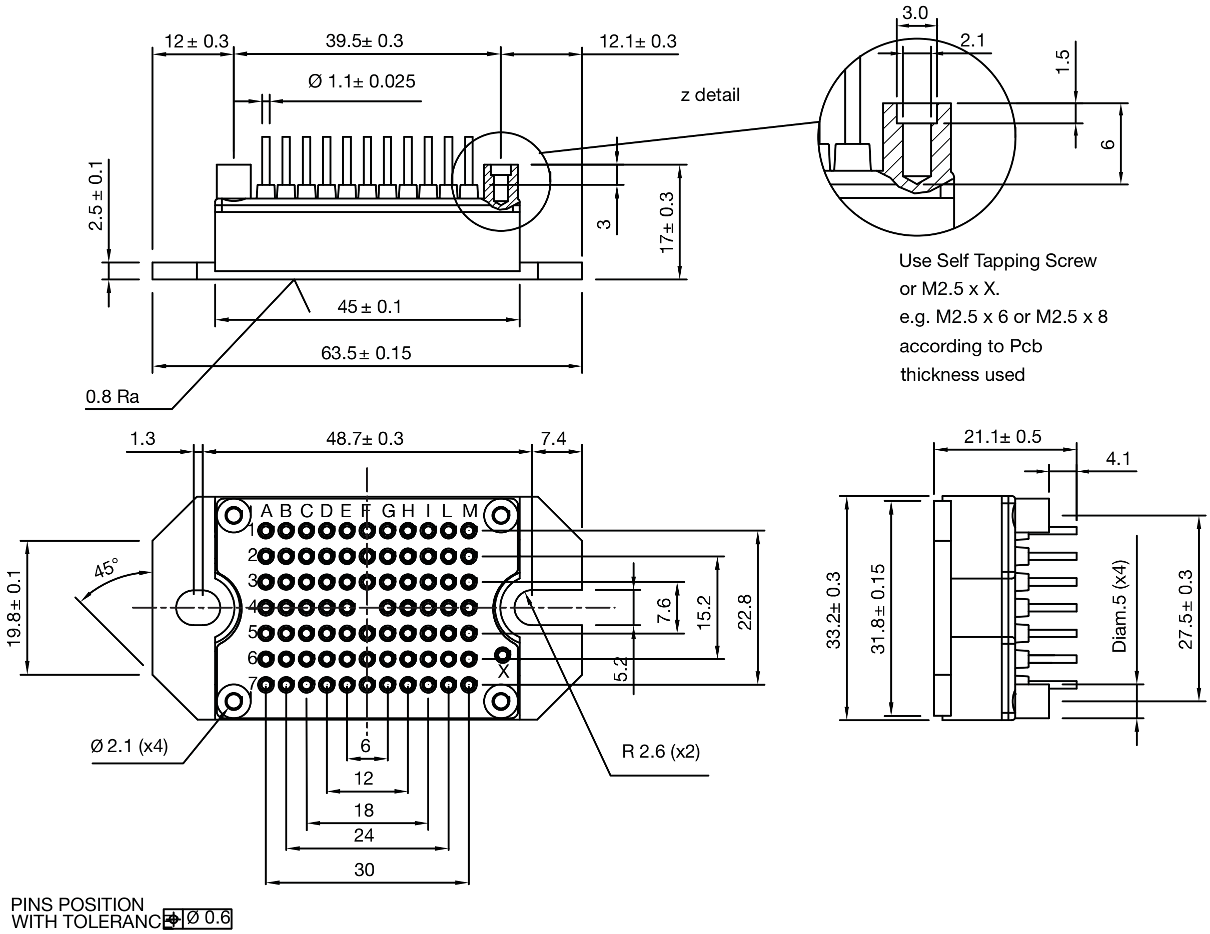
**DIMENSIONS** in millimeters



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