

# 3-Level NPC Inverter Module

## NXH450N65L4Q2F2

The NXH450N65L4Q2F2 is a power module containing a I- type neutral point clamped three-level inverter. The integrated field stop trench IGBTs and FRDs provide lower conduction losses and switching losses, enabling designers to achieve high efficiency and superior reliability.

### Features

- Neutral Point Clamped Three-Level Inverter Module
- 650 V Field Stop 4 IGBTs
- Low Inductive Layout
- Solderable Pins
- Thermistor

### Typical Applications

- Solar Inverters
- Uninterruptable Power Supplies Systems

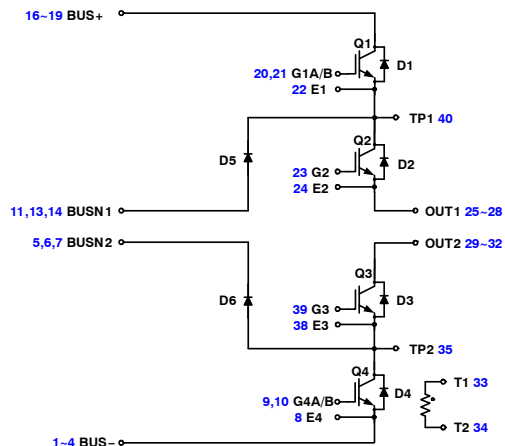
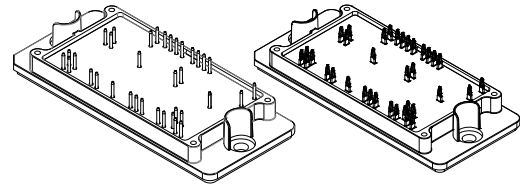


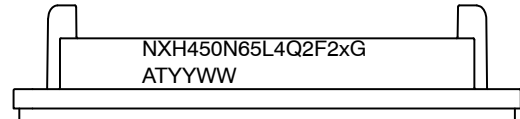
Figure 1. Schematic Diagram



PIM40, Q2PACK  
CASE 180BE

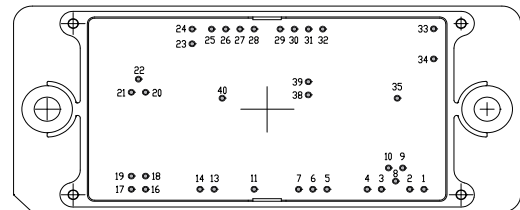
PIM36, Q2PACK  
CASE 180CD

### MARKING DIAGRAM



NXH450N65L4Q2F2x = Specific Device Code  
 G = Pb-Free Package  
 AT = Assembly & Test Site Code  
 YYWW = Year and Work Week Code

### PIN ASSIGNMENTS



### ORDERING INFORMATION

See detailed ordering and shipping information in the dimensions section on page 5 of this data sheet.

# NXH450N65L4Q2F2

**Table 1. MAXIMUM RATINGS** (Note 1)

| Rating | Symbol | Value | Unit |
|--------|--------|-------|------|
|--------|--------|-------|------|

**OUTER IGBT (Q1-1, Q1-2, Q4-1, Q4-2)**

|  |              |                |            |
|--|--------------|----------------|------------|
| Collector-Emitter Voltage  | $V_{CES}$    | 650            | V          |
| Gate-Emitter Voltage<br>Positive Transient Gate-Emitter Voltage ( $t_{pulse} = 5 \mu s$ , $D < 0.10$ ) | $V_{GE}$     | $\pm 20$<br>30 | V          |
| Continuous Collector Current @ $T_c = 80^\circ C$ ( $T_J = 175^\circ C$ )                              | $I_C$        | 167            | A          |
| Pulsed Collector Current ( $T_J = 175^\circ C$ )   | $I_{Cpulse}$ | 501            | A          |
| Maximum Power Dissipation ( $T_J = 175^\circ C$ )  | $P_{tot}$    | 365            | W          |
| Maximum Operating Junction Temperature   | $T_{JMAX}$   | 150            | $^\circ C$ |

**INNER IGBT (Q2, Q3)**

|  |              |                |            |
|--|--------------|----------------|------------|
| Collector-Emitter Voltage  | $V_{CES}$    | 650            | V          |
| Gate-Emitter Voltage<br>Positive Transient Gate-Emitter Voltage ( $t_{pulse} = 5 \mu s$ , $D < 0.10$ ) | $V_{GE}$     | $\pm 20$<br>30 | V          |
| Continuous Collector Current @ $T_c = 80^\circ C$ ( $T_J = 175^\circ C$ )                              | $I_C$        | 280            | A          |
| Pulsed Collector Current ( $T_J = 175^\circ C$ )   | $I_{Cpulse}$ | 840            | A          |
| Maximum Power Dissipation ( $T_J = 175^\circ C$ )  | $P_{tot}$    | 633            | W          |
| Maximum Operating Junction Temperature   | $T_{JMAX}$   | 150            | $^\circ C$ |

**NEUTRAL POINT DIODE (D5, D6)**

|   |            |     |            |
|---|------------|-----|------------|
| Peak Repetitive Reverse Voltage   | $V_{RRM}$  | 650 | V          |
| Continuous Forward Current @ $T_c = 80^\circ C$ ( $T_J = 175^\circ C$ ) | $I_F$      | 271 | A          |
| Repetitive Peak Forward Current ( $T_J = 175^\circ C$ )                 | $I_{FRM}$  | 813 | A          |
| Maximum Power Dissipation ( $T_J = 175^\circ C$ )                       | $P_{tot}$  | 559 | W          |
| Maximum Operating Junction Temperature                                  | $T_{JMAX}$ | 150 | $^\circ C$ |

**INVERSE DIODES (D1, D2, D3, D4)**

|   |            |     |            |
|---|------------|-----|------------|
| Peak Repetitive Reverse Voltage   | $V_{RRM}$  | 650 | V          |
| Continuous Forward Current @ $T_c = 80^\circ C$ ( $T_J = 175^\circ C$ ) | $I_F$      | 131 | A          |
| Repetitive Peak Forward Current ( $t_p = 1 ms$ )                        | $I_{FRM}$  | 450 | A          |
| Maximum Power Dissipation ( $T_J = 175^\circ C$ )                       | $P_{tot}$  | 288 | W          |
| Maximum Operating Junction Temperature                                  | $T_{JMAX}$ | 150 | $^\circ C$ |

**THERMAL PROPERTIES**

|                           |           |            |            |
|---------------------------|-----------|------------|------------|
| Storage Temperature Range | $T_{stg}$ | -40 to 150 | $^\circ C$ |
|---------------------------|-----------|------------|------------|

**INSULATION PROPERTIES**

|   |          |      |           |
|---|----------|------|-----------|
| Isolation Test Voltage, $t = 1 s$ , 50 Hz | $V_{is}$ | 4000 | $V_{RMS}$ |
| Creepage Distance                         |          | 12.7 | mm        |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Refer to ELECTRICAL CHARACTERISTICS, RECOMMENDED OPERATING RANGES and/or APPLICATION INFORMATION for Safe Operating parameters.

**Table 2. RECOMMENDED OPERATING RANGES**

| Rating                                | Symbol | Min | Max        | Unit       |
|---------------------------------------|--------|-----|------------|------------|
| Module Operating Junction Temperature | $T_J$  | -40 | $T_{JMAX}$ | $^\circ C$ |

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

# NXH450N65L4Q2F2

**Table 3. ELECTRICAL CHARACTERISTICS** ( $T_J = 25^\circ\text{C}$  unless otherwise noted)

| Parameter                             | Test Conditions  | Symbol  | Min         | Typ   | Max   | Unit               |
|---------------------------------------|--|---|-------------|-------|-------|--------------------|
| OUTER IGBT (Q1-1, Q1-2, Q4-1, Q4-2)   |  |   |             |       |       |                    |
| Collector-Emitter Cutoff Current      | $V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$   | $I_{CES}$   | —           | —     | 300   | $\mu\text{A}$      |
| Collector-Emitter Saturation Voltage  | $V_{GE} = 15\text{ V}, I_C = 225\text{ A}, T_J = 25^\circ\text{C}$   | $V_{CE(sat)}$   | —           | 1.49  | 2.2   | V                  |
|                                       | $V_{GE} = 15\text{ V}, I_C = 225\text{ A}, T_J = 150^\circ\text{C}$  |   | —           | 1.70  | —     |                    |
| Gate-Emitter Threshold Voltage        | $V_{GE} = V_{CE}, I_C = 2.25\text{ mA}$  | $V_{GE(TH)}$  | 3.1         | 4.0   | 5.2   | V                  |
| Gate Leakage Current                  | $V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$  | $I_{GES}$   | —           | —     | 600   | nA                 |
| Turn-on Delay Time                    | $T_J = 25^\circ\text{C}$<br>$V_{CE} = 400\text{ V}, I_C = 100\text{ A}$<br>$V_{GE} = -5\text{ V to } +15\text{ V}, R_{G(on)} = 15\ \Omega,$<br>$R_{G(off)} = 15\ \Omega$ | $t_{d(on)}$   | —           | 163   | —     | ns                 |
| Rise Time                             |  | $t_r$   | —           | 45    | —     |                    |
| Turn-off Delay Time                   |  | $t_{d(off)}$  | —           | 831   | —     |                    |
| Fall Time                             |  | $t_f$   | —           | 61    | —     |                    |
| Turn-on Switching Loss per Pulse      |  | $E_{on}$  | —           | 2.344 | —     | mJ                 |
| Turn off Switching Loss per Pulse     |  | $E_{off}$   | —           | 3.125 | —     |                    |
| Turn-on Delay Time                    |  | $T_J = 125^\circ\text{C}$<br>$V_{CE} = 400\text{ V}, I_C = 100\text{ A}$<br>$V_{GE} = -5\text{ V to } +15\text{ V}, R_{G(on)} = 15\ \Omega,$<br>$R_{G(off)} = 15\ \Omega$ | $t_{d(on)}$ | —     | 141   | —                  |
| Rise Time                             | $t_r$  |   | —           | 51    | —     |                    |
| Turn-off Delay Time                   | $t_{d(off)}$   |   | —           | 898   | —     |                    |
| Fall Time                             | $t_f$  |   | —           | 80    | —     |                    |
| Turn-on Switching Loss per Pulse      | $E_{on}$   |   | —           | 3.75  | —     | mJ                 |
| Turn off Switching Loss per Pulse     | $E_{off}$  |   | —           | 2.97  | —     |                    |
| Input Capacitance                     | $V_{CE} = 20\text{ V}, V_{GE} = 0\text{ V}, f = 10\text{ kHz}$   |   | $C_{ies}$   | —     | 14630 | —                  |
| Output Capacitance                    |  | $C_{oes}$   | —           | 230   | —     |                    |
| Reverse Transfer Capacitance          |  | $C_{res}$   | —           | 64    | —     |                    |
| Total Gate Charge                     | $V_{CE} = 480\text{ V}, I_C = 225\text{ A}, V_{GE} = 0 \sim +15\text{ V}$  | $Q_g$   | —           | 452   | —     | nC                 |
| Thermal Resistance – Chip-to-Heatsink | Thermal grease,<br>Thickness = 2 Mil $\pm 2\%$ , $\lambda = 2.8\text{ W/mK}$   | $R_{thJH}$  | —           | 0.45  | —     | $^\circ\text{C/W}$ |
| Thermal Resistance – Chip-to-Case     |  | $R_{thJC}$  | —           | 0.26  | —     | $^\circ\text{C/W}$ |
| NEUTRAL POINT DIODE (D5, D6)          |  |   |             |       |       |                    |
| Diode Forward Voltage                 | $I_F = 375\text{ A}, T_J = 25^\circ\text{C}$   | $V_F$   | —           | 1.80  | 2.3   | V                  |
|                                       | $I_F = 375\text{ A}, T_J = 150^\circ\text{C}$  |   | —           | 1.77  | —     |                    |
| Reverse Recovery Time                 | $T_J = 25^\circ\text{C}$<br>$V_{CE} = 400\text{ V}, I_C = 100\text{ A}$<br>$V_{GE} = -5\text{ V to } +15\text{ V}, R_G = 15\ \Omega$                                     | $t_{rr}$  | —           | 46    | —     | ns                 |
| Reverse Recovery Charge               |  | $Q_{rr}$  | —           | 1.5   | —     | $\mu\text{C}$      |
| Peak Reverse Recovery Current         |  | $I_{RRM}$   | —           | 53    | —     | A                  |
| Peak Rate of Fall of Recovery Current |  | $di/dt$   | —           | 2541  | —     | A/ $\mu\text{s}$   |
| Reverse Recovery Energy               |  | $E_{rr}$  | —           | 0.3   | —     | mJ                 |
| Reverse Recovery Time                 | $T_J = 125^\circ\text{C}$<br>$V_{CE} = 400\text{ V}, I_C = 100\text{ A}$<br>$V_{GE} = -5\text{ V to } +15\text{ V}, R_G = 15\ \Omega$                                    | $t_{rr}$  | —           | 75    | —     | ns                 |
| Reverse Recovery Charge               |  | $Q_{rr}$  | —           | 4     | —     | $\mu\text{C}$      |
| Peak Reverse Recovery Current         |  | $I_{RRM}$   | —           | 96    | —     | A                  |
| Peak Rate of Fall of Recovery Current |  | $di/dt$   | —           | 2500  | —     | A/ $\mu\text{s}$   |
| Reverse Recovery Energy               |  | $E_{rr}$  | —           | 0.83  | —     | mJ                 |
| Thermal Resistance – Chip-to-Heatsink | Thermal grease,<br>Thickness = 2 Mil $\pm 2\%$ , $\lambda = 2.8\text{ W/mK}$   | $R_{thJH}$  | —           | 0.37  | —     | $^\circ\text{C/W}$ |
| Thermal Resistance – Chip-to-Case     |  | $R_{thJC}$  | —           | 0.17  | —     | $^\circ\text{C/W}$ |

# NXH450N65L4Q2F2

**Table 3. ELECTRICAL CHARACTERISTICS** ( $T_J = 25^\circ\text{C}$  unless otherwise noted) (continued)

| Parameter                             | Test Conditions   | Symbol        | Min | Typ   | Max  | Unit               |
|---------------------------------------|---|---------------|-----|-------|------|--------------------|
| INNER IGBT (Q2, Q3)                   |   |               |     |       |      |                    |
| Collector–Emitter Cutoff Current      | $V_{GE} = 0\text{ V}, V_{CE} = 650\text{ V}$  | $I_{CES}$     | –   | –     | 300  | $\mu\text{A}$      |
| Collector–Emitter Saturation Voltage  | $V_{GE} = 15\text{ V}, I_C = 375\text{ A}, T_J = 25^\circ\text{C}$  | $V_{CE(sat)}$ | –   | 1.49  | 2.2  | V                  |
|                                       | $V_{GE} = 15\text{ V}, I_C = 375\text{ A}, T_J = 150^\circ\text{C}$   |               | –   | 1.72  | –    |                    |
| Gate–Emitter Threshold Voltage        | $V_{GE} = V_{CE}, I_C = 3.75\text{ mA}$   | $V_{GE(TH)}$  | 3.1 | 4.1   | 5.2  | V                  |
| Gate Leakage Current                  | $V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$   | $I_{GES}$     | –   | –     | 1000 | nA                 |
| Turn–on Delay Time                    | $T_J = 25^\circ\text{C}$<br>$V_{CE} = 400\text{ V}, I_C = 100\text{ A}$<br>$V_{GE} = -5\text{ V to } +15\text{ V}, R_{G(on)} = 15\ \Omega,$<br>$R_{G(off)} = 15\ \Omega$  | $t_{d(on)}$   | –   | 134   | –    | ns                 |
| Rise Time                             |   | $t_r$         | –   | 47    | –    |                    |
| Turn–off Delay Time                   |   | $t_{d(off)}$  | –   | 709   | –    |                    |
| Fall Time                             |   | $t_f$         | –   | 32    | –    |                    |
| Turn–on Switching Loss per Pulse      |   | $E_{on}$      | –   | 1.72  | –    | mJ                 |
| Turn off Switching Loss per Pulse     |   | $E_{off}$     | –   | 2.65  | –    |                    |
| Turn–on Delay Time                    | $T_J = 125^\circ\text{C}$<br>$V_{CE} = 400\text{ V}, I_C = 100\text{ A}$<br>$V_{GE} = -5\text{ V to } +15\text{ V}, R_{G(on)} = 15\ \Omega,$<br>$R_{G(off)} = 15\ \Omega$ | $t_{d(on)}$   | –   | 118   | –    | ns                 |
| Rise Time                             |   | $t_r$         | –   | 52    | –    |                    |
| Turn–off Delay Time                   |   | $t_{d(off)}$  | –   | 765   | –    |                    |
| Fall Time                             |   | $t_f$         | –   | 29    | –    |                    |
| Turn–on Switching Loss per Pulse      |   | $E_{on}$      | –   | 2.34  | –    | mJ                 |
| Turn off Switching Loss per Pulse     |   | $E_{off}$     | –   | 2.89  | –    |                    |
| Input Capacitance                     | $V_{CE} = 20\text{ V}, V_{GE} = 0\text{ V}, f = 10\text{ kHz}$  | $C_{ies}$     | –   | 24383 | –    | pF                 |
| Output Capacitance                    |   | $C_{oes}$     | –   | 383   | –    |                    |
| Reverse Transfer Capacitance          |   | $C_{res}$     | –   | 105   | –    |                    |
| Total Gate Charge                     | $V_{CE} = 480\text{ V}, I_C = 375\text{ A}, V_{GE} = 0 \sim +15\text{ V}$   | $Q_g$         | –   | 753   | –    | nC                 |
| Thermal Resistance – Chip–to–Heatsink | Thermal grease,<br>Thickness = 2 Mil $\pm 2\%$ , $\lambda = 2.8\text{ W/mK}$  | $R_{thJH}$    | –   | 0.31  | –    | $^\circ\text{C/W}$ |
| Thermal Resistance – Chip–to–Case     |   | $R_{thJC}$    | –   | 0.15  | –    | $^\circ\text{C/W}$ |
| INVERSE DIODES (D1, D2, D3, D4)       |   |               |     |       |      |                    |
| Diode Forward Voltage                 | $I_F = 150\text{ A}, T_J = 25^\circ\text{C}$  | $V_F$         | –   | 1.78  | 2.3  | V                  |
|                                       | $I_F = 150\text{ A}, T_J = 150^\circ\text{C}$   |               | –   | 1.77  | –    |                    |
| Reverse Recovery Time                 | $T_J = 25^\circ\text{C}$<br>$V_{CE} = 400\text{ V}, I_C = 100\text{ A}$<br>$V_{GE} = -5\text{ V to } +15\text{ V}, R_G = 15\ \Omega$                                      | $t_{rr}$      | –   | 43    | –    | ns                 |
| Reverse Recovery Charge               |   | $Q_{rr}$      | –   | 1.14  | –    | $\mu\text{C}$      |
| Peak Reverse Recovery Current         |   | $I_{RRM}$     | –   | 46    | –    | A                  |
| Peak Rate of Fall of Recovery Current |   | $di/dt$       | –   | 2473  | –    | A/ $\mu\text{s}$   |
| Reverse Recovery Energy               |   | $E_{rr}$      | –   | 0.313 | –    | mJ                 |
| Reverse Recovery Time                 | $T_J = 125^\circ\text{C}$<br>$V_{CE} = 400\text{ V}, I_C = 100\text{ A}$<br>$V_{GE} = -5\text{ V to } +15\text{ V}, R_G = 15\ \Omega$                                     | $t_{rr}$      | –   | 67    | –    | ns                 |
| Reverse Recovery Charge               |   | $Q_{rr}$      | –   | 2.5   | –    | $\mu\text{C}$      |
| Peak Reverse Recovery Current         |   | $I_{RRM}$     | –   | 66    | –    | A                  |
| Peak Rate of Fall of Recovery Current |   | $di/dt$       | –   | 2317  | –    | A/ $\mu\text{s}$   |
| Reverse Recovery Energy               |   | $E_{rr}$      | –   | 0.625 | –    | mJ                 |
| Thermal Resistance – Chip–to–Heatsink | Thermal grease,<br>Thickness = 2 Mil $\pm 2\%$ , $\lambda = 2.8\text{ W/mK}$  | $R_{thJH}$    | –   | 0.58  | –    | $^\circ\text{C/W}$ |
| Thermal Resistance – Chip–to–Case     |   | $R_{thJC}$    | –   | 0.33  | –    | $^\circ\text{C/W}$ |

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**Table 3. ELECTRICAL CHARACTERISTICS** ( $T_J = 25^\circ\text{C}$  unless otherwise noted) (continued)

| Parameter                         | Test Conditions                   | Symbol       | Min | Typ  | Max | Unit      |
|-----------------------------------|-----------------------------------|--------------|-----|------|-----|-----------|
| <b>THERMISTOR CHARACTERISTICS</b> |                                   |              |     |      |     |           |
| Nominal Resistance                | $T = 25^\circ\text{C}$            | $R_{25}$     | —   | 22   | —   | $k\Omega$ |
| Nominal Resistance                | $T = 100^\circ\text{C}$           | $R_{100}$    | —   | 1486 | —   | $\Omega$  |
| Deviation of $R_{25}$             |                                   | $\Delta R/R$ | -5  | —    | 5   | %         |
| Power Dissipation                 |                                   | $P_D$        | —   | 200  | —   | mW        |
| Power Dissipation Constant        |                                   |              | —   | 2    | —   | mW/K      |
| B-value                           | $B(25/50)$ , tolerance $\pm 3\%$  |              | —   | 3950 | —   | K         |
| B-value                           | $B(25/100)$ , tolerance $\pm 3\%$ |              | —   | 3998 | —   | K         |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

## ORDERING INFORMATION

| Orderable Part Number | Marking           | Package                                    | Shipping                |
|-----------------------|-------------------|--|-------------------------|
| NXH450N65L4Q2F2SG     | NXH450N65L4Q2F2SG | PIM40, Q2PACK<br>(Pb-Free and Halide-Free) | 12 Units / Blister Tray |
| NXH450N65L4Q2F2PG     | NXH450N65L4Q2F2PG | PIM436 Q2PACK<br>(Pb-Free and Halide-Free) | 12 Units / Blister Tray |

# NXH450N65L4Q2F2

## TYPICAL CHARACTERISTICS – IGBT Q1-1, Q1-2, Q4-1, Q4-2 AND DIODE D1, D4

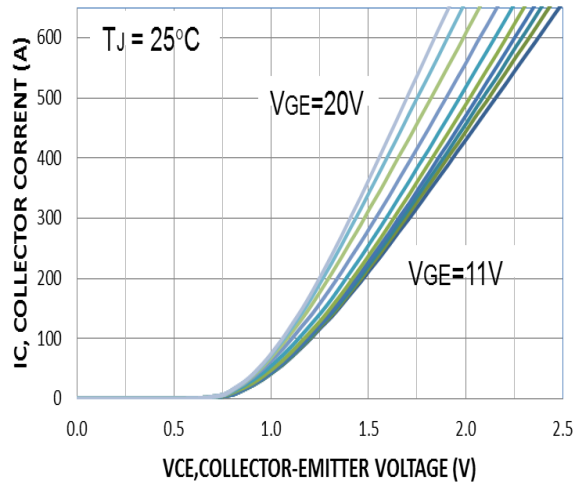


Figure 2. Typical Output Characteristics

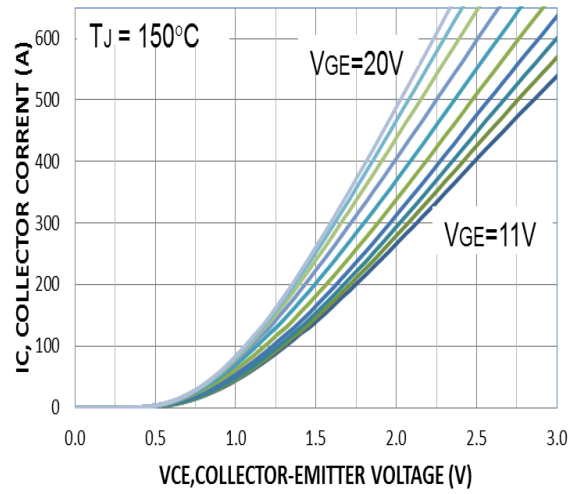


Figure 3. Typical Output Characteristics

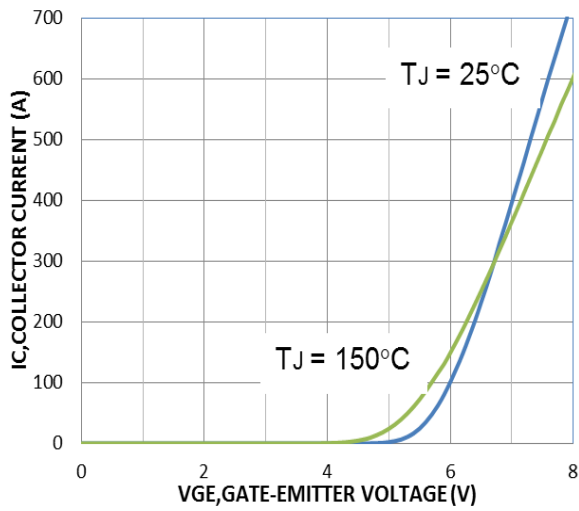


Figure 4. Typical Transfer Characteristics

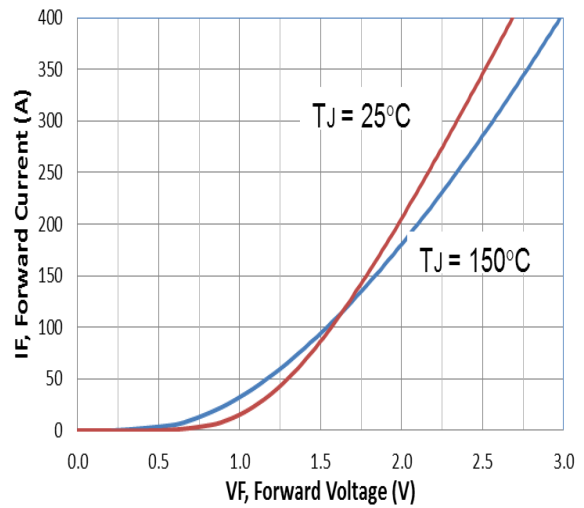


Figure 5. Typical Transfer Characteristics

# NXH450N65L4Q2F2

## TYPICAL CHARACTERISTICS – IGBT Q1–1, Q1–2, Q4–1, Q4–2 AND DIODE D1, D4

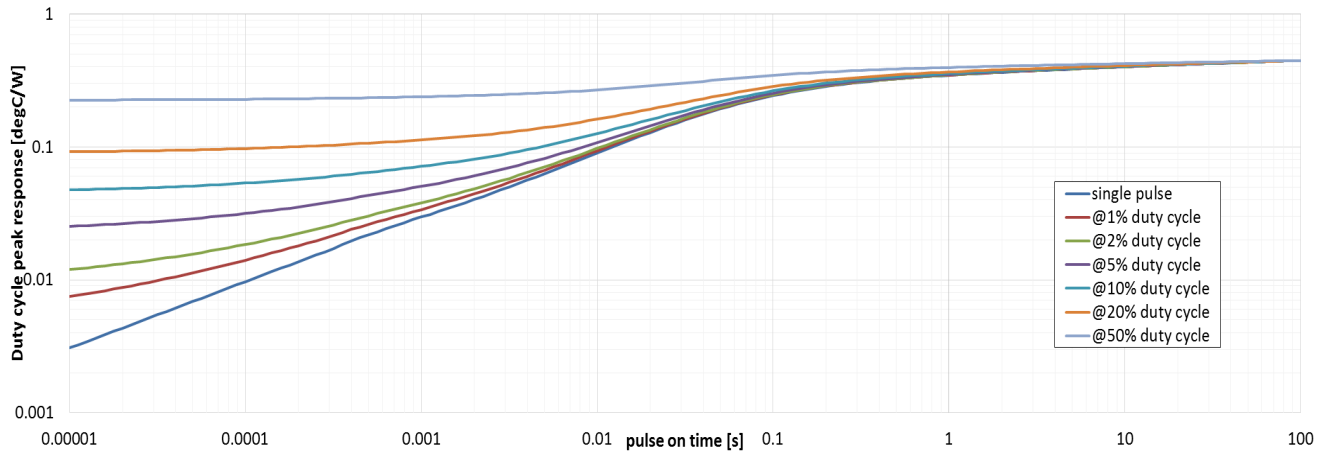


Figure 6. Transient Thermal Impedance (Q1–1, Q1–2, Q4–1, Q4–2)

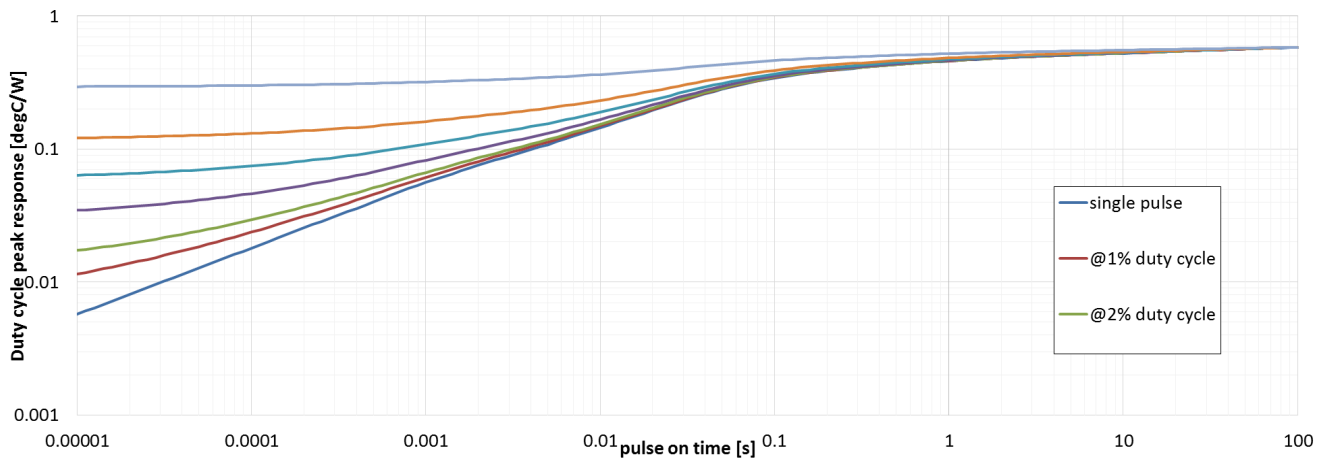


Figure 7. Transient Thermal Impedance (D1, D4)

# NXH450N65L4Q2F2

## TYPICAL CHARACTERISTICS – IGBT Q1-1, Q1-2, Q4-1, Q4-2 AND DIODE D1, D4

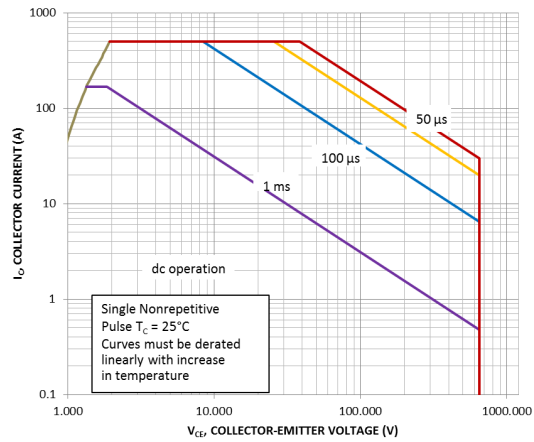


Figure 8. FBSOA (Q1-1, Q1-2, Q4-1, Q4-2)

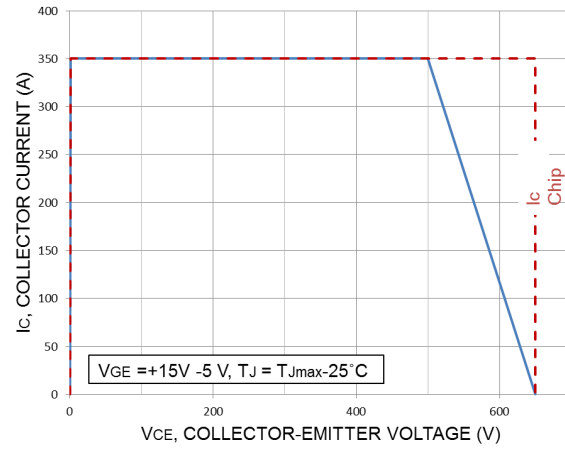


Figure 9. RBSOA (Q1-1, Q1-2, Q4-1, Q4-2)

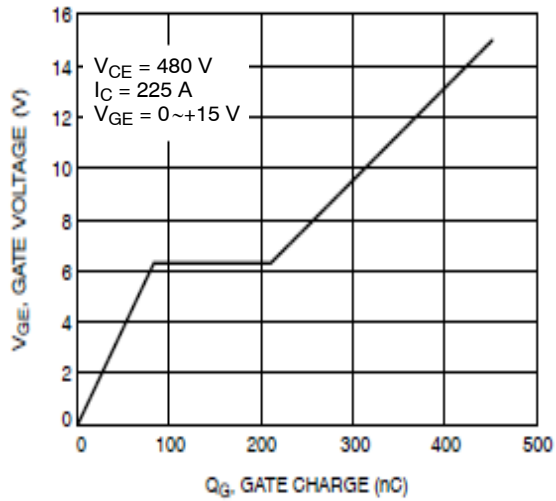


Figure 10. Gate Voltage vs. Gate Charge



# NXH450N65L4Q2F2

## TYPICAL CHARACTERISTICS – IGBT Q2, Q3 AND DIODE D2, D3

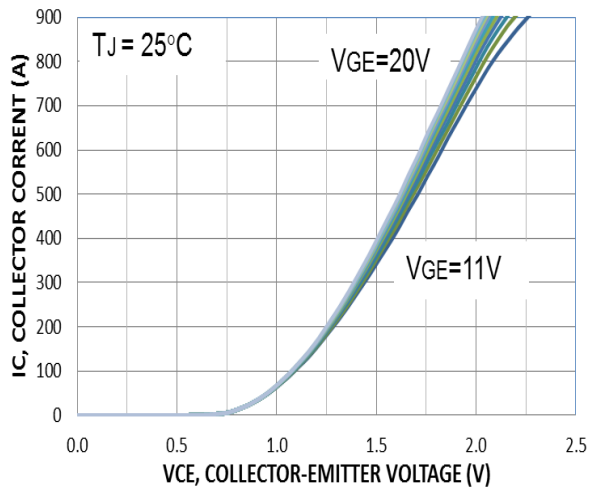


Figure 11. Typical Output Characteristics

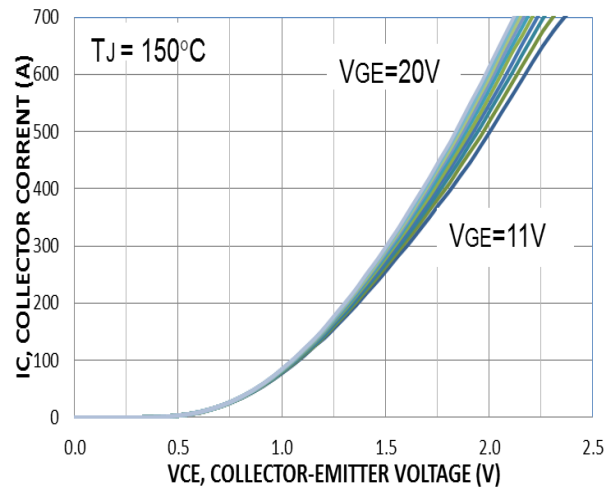


Figure 12. Typical Output Characteristics

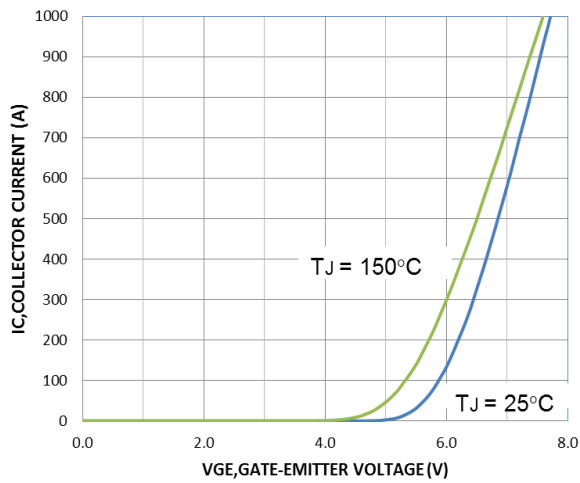


Figure 13. Typical Transfer Characteristics

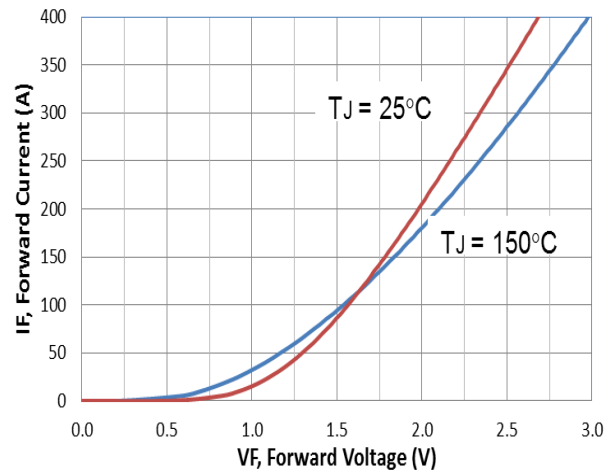


Figure 14. Typical Transfer Characteristics

# NXH450N65L4Q2F2

## TYPICAL CHARACTERISTICS – IGBT Q2, Q3 AND DIODE D2, D3

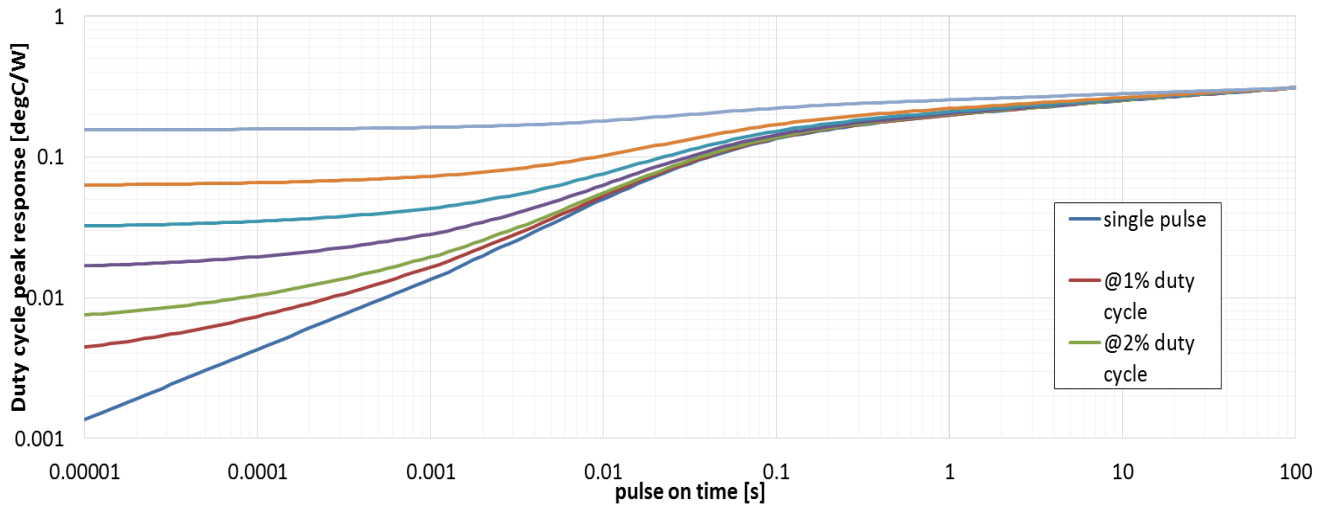


Figure 15. Transient Thermal Impedance (Q2, Q3)

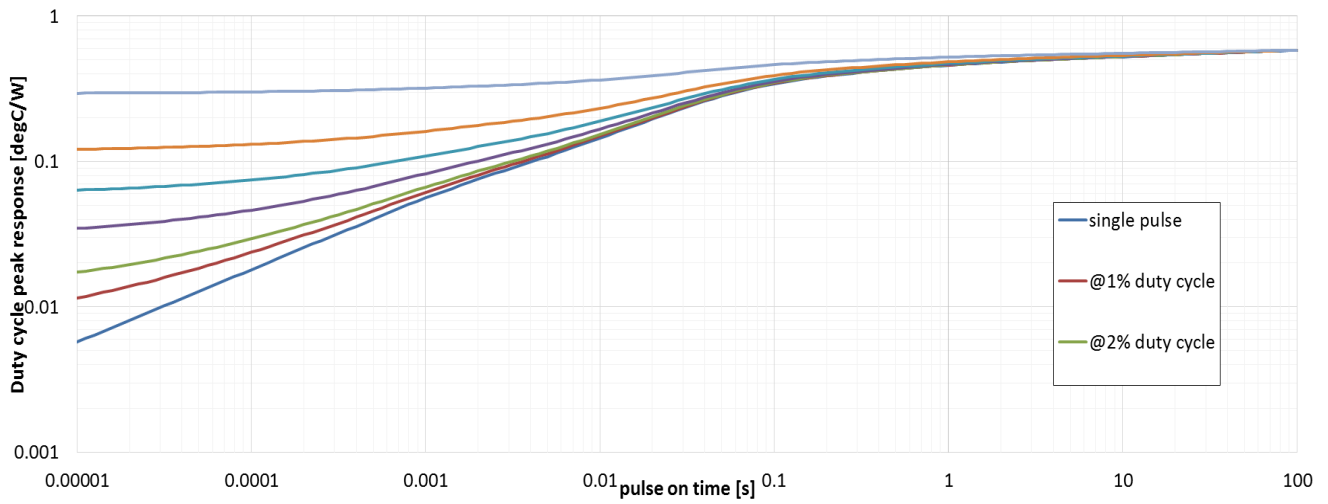


Figure 16. Transient Thermal Impedance (D2, D3)

# NXH450N65L4Q2F2

## TYPICAL CHARACTERISTICS – IGBT Q2, Q3 AND DIODE D2, D3

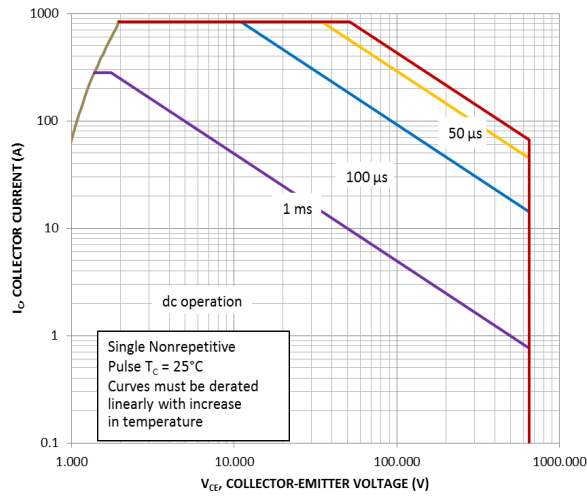


Figure 17. FBSOA (Q2, Q3)

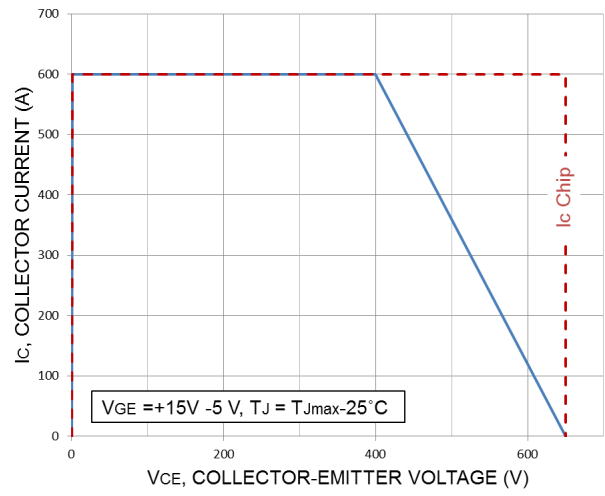


Figure 18. RBSOA (Q2, Q3)

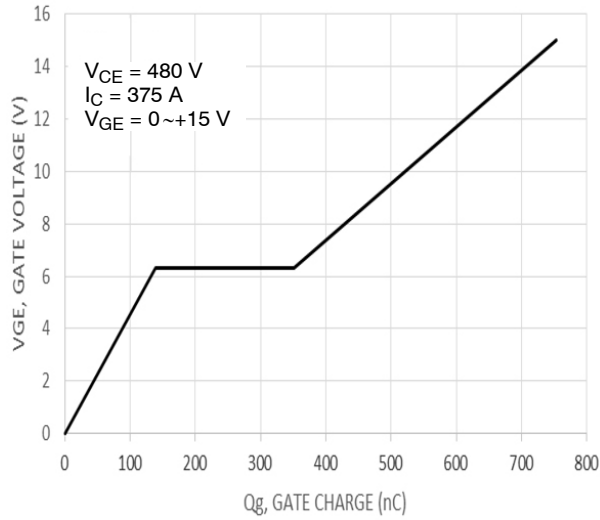


Figure 19. Gate Voltage vs. Gate Charge

# NXH450N65L4Q2F2

## TYPICAL CHARACTERISTICS – DIODE D5, D6

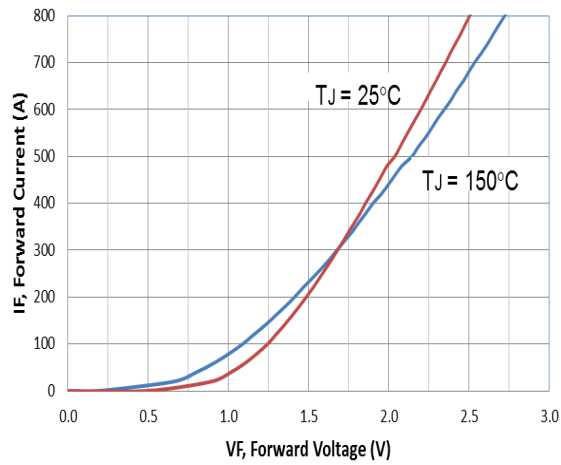


Figure 20. Diode Forward Characteristics

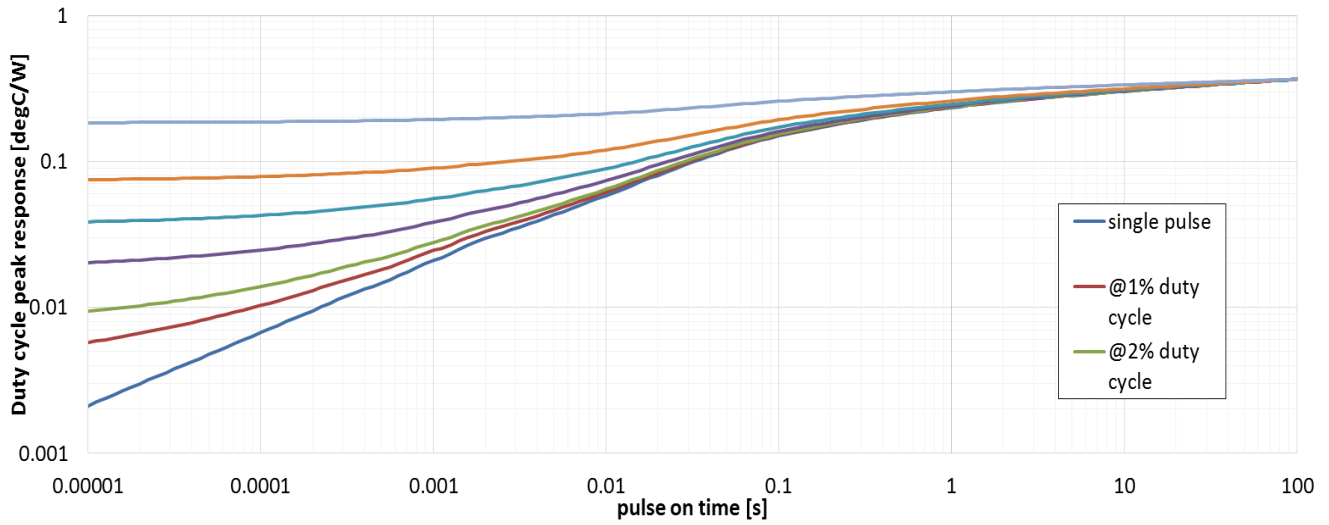


Figure 21. Transient Thermal Impedance (D5, D6)

# NXH450N65L4Q2F2

## TYPICAL CHARACTERISTICS – Q1/Q4 IGBT COMUTATES D5/D6 DIODE

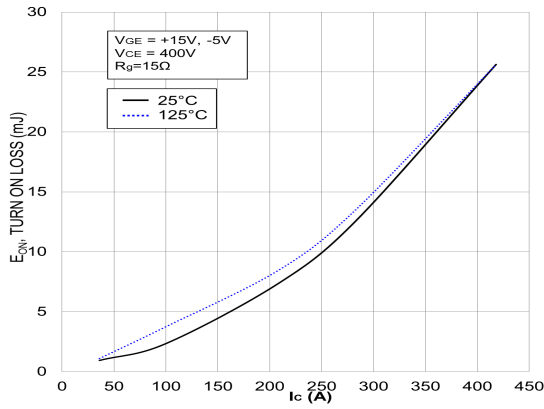


Figure 22. Typical Switching Loss Eon vs. IC

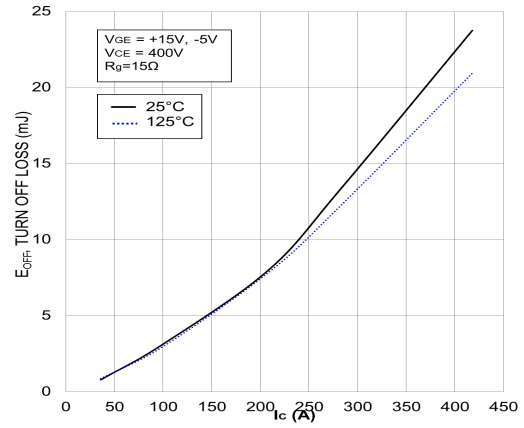


Figure 23. Typical Switching Loss Eoff vs. IC

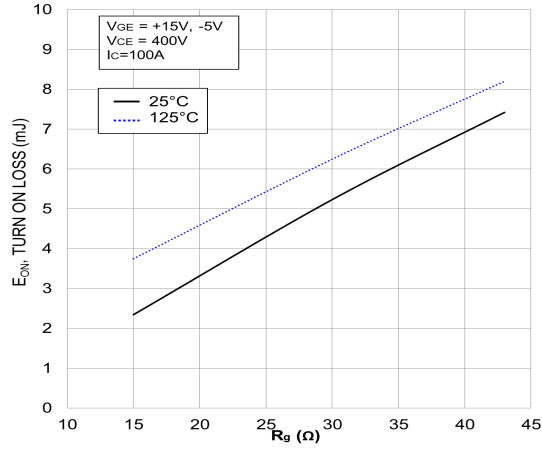


Figure 24. Typical Switching Loss Eon vs. R<sub>G</sub>

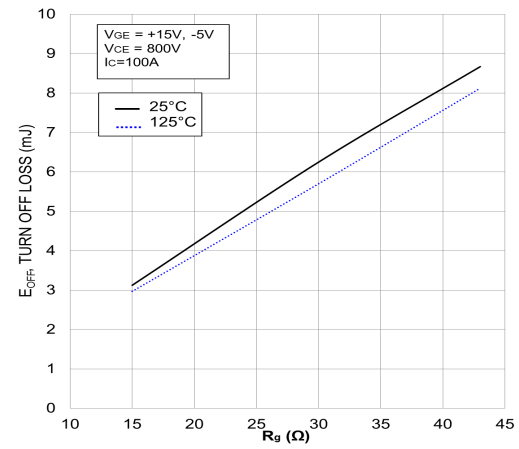


Figure 25. Typical Switching Loss Eoff vs. R<sub>G</sub>

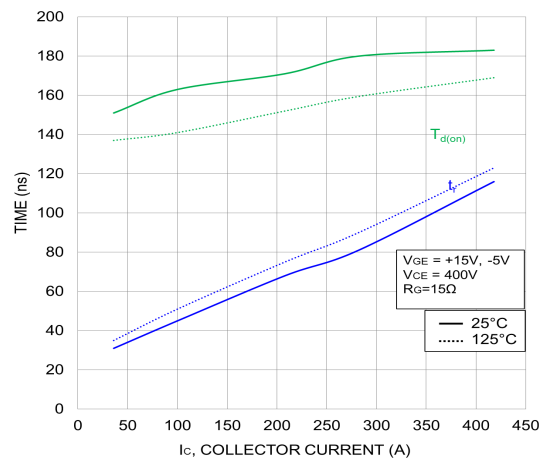


Figure 26. Typical Switching Time Tdon vs. IC

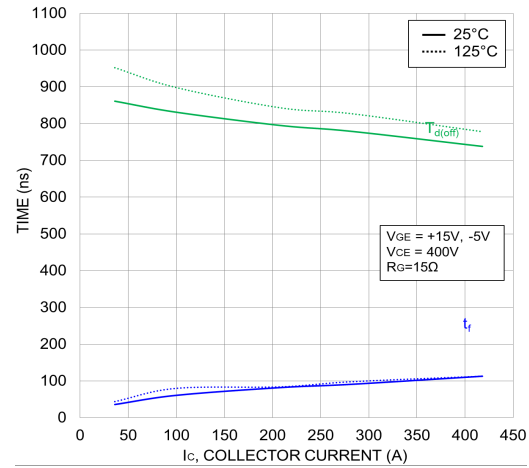


Figure 27. Typical Switching Time Tdoff vs. IC

TYPICAL CHARACTERISTICS – Q1/Q4 IGBT COMUTATES D5/D6 DIODE

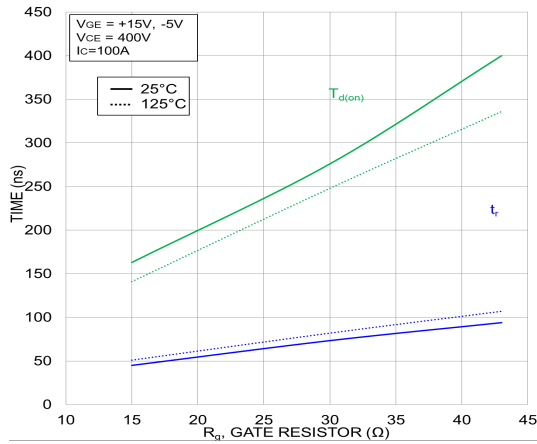


Figure 28. Typical Switching Time  $T_{don}$  vs.  $R_G$

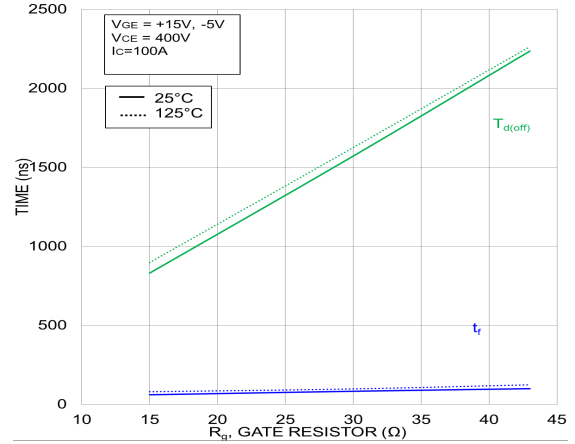


Figure 29. Typical Switching Time  $T_{doff}$  vs.  $R_G$

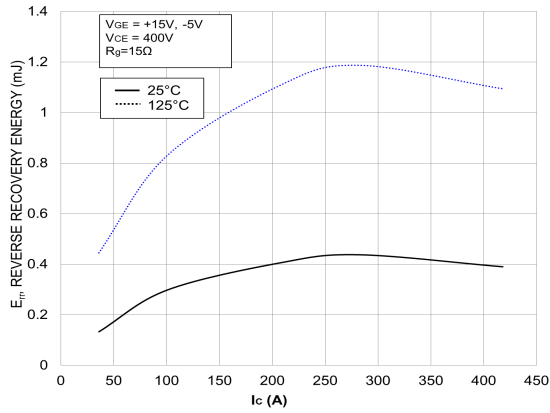


Figure 30. Typical Reverse Recovery Energy vs.  $I_C$

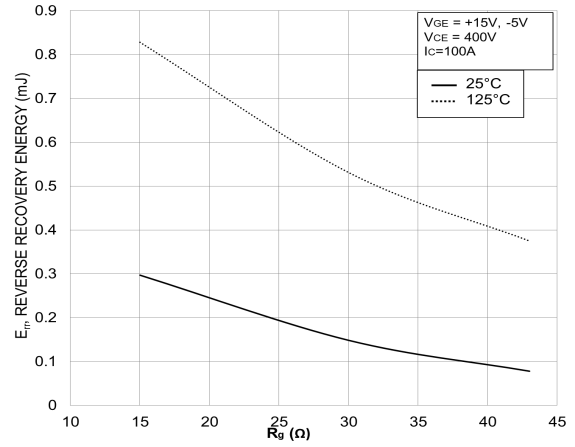


Figure 31. Typical Reverse Recovery Energy vs.  $R_G$

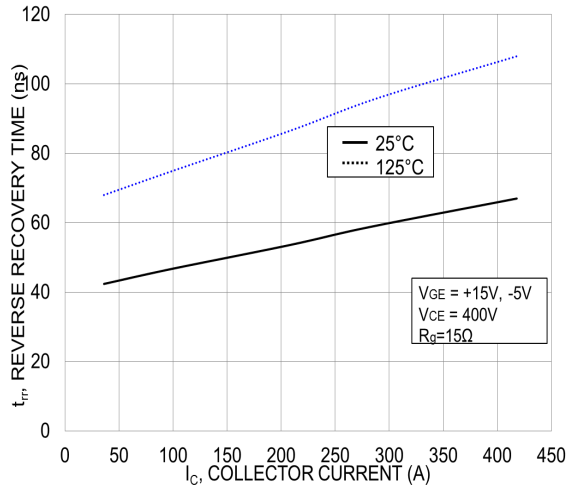


Figure 32. Typical Reverse Recovery Time vs.  $I_C$

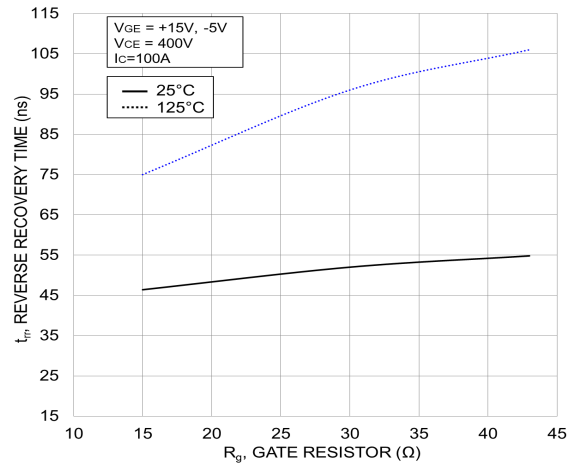


Figure 33. Typical Reverse Recovery Time vs.  $R_G$

TYPICAL CHARACTERISTICS – Q1/Q4 IGBT COMUTATES D5/D6 DIODE

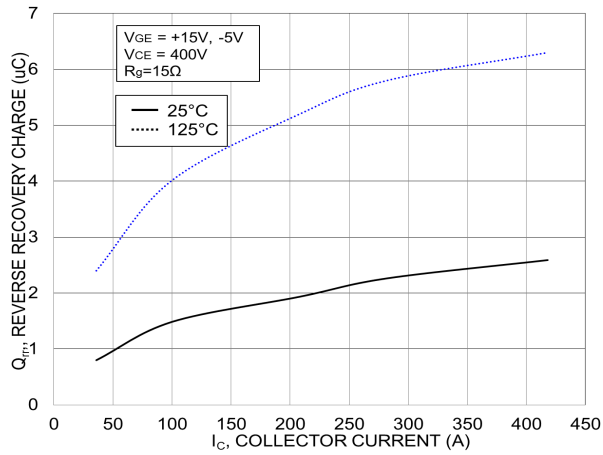


Figure 34. Typical Reverse Recovery Charge vs. IC

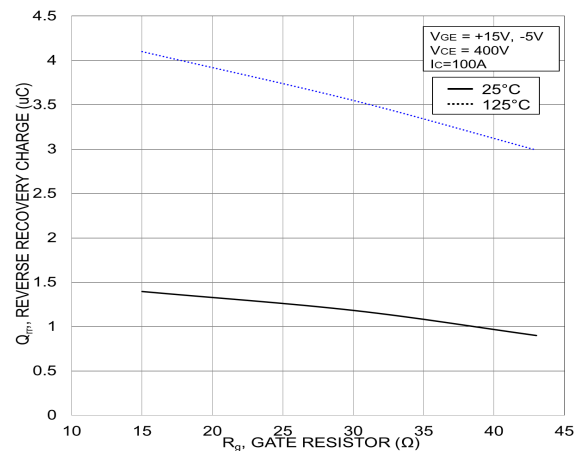


Figure 35. Typical Reverse Recovery Charge vs.  $R_G$

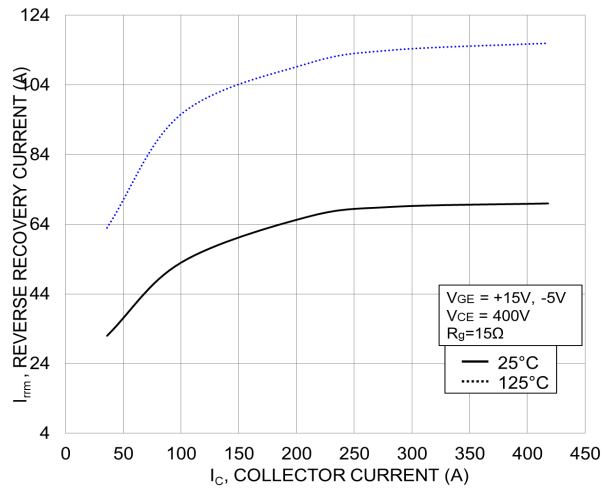


Figure 36. Typical Reverse Recovery Current vs. IC

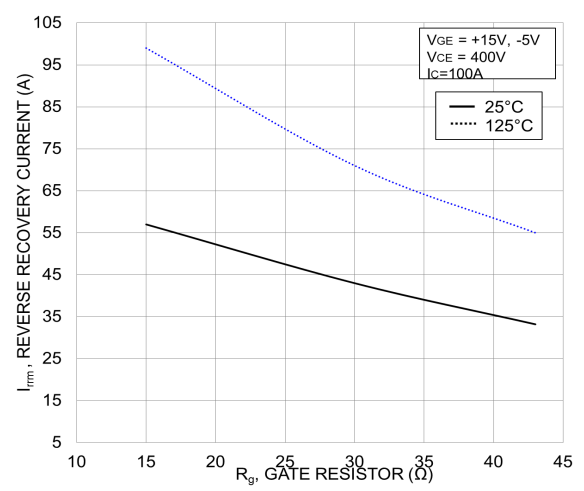


Figure 37. Typical Reverse Recovery Current vs.  $R_G$

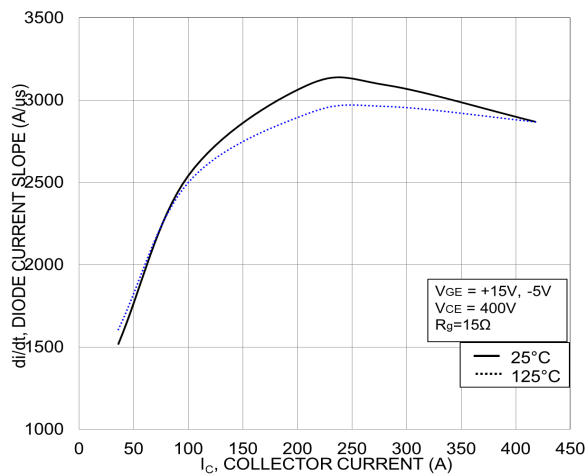


Figure 38. Typical di/dt vs. IC

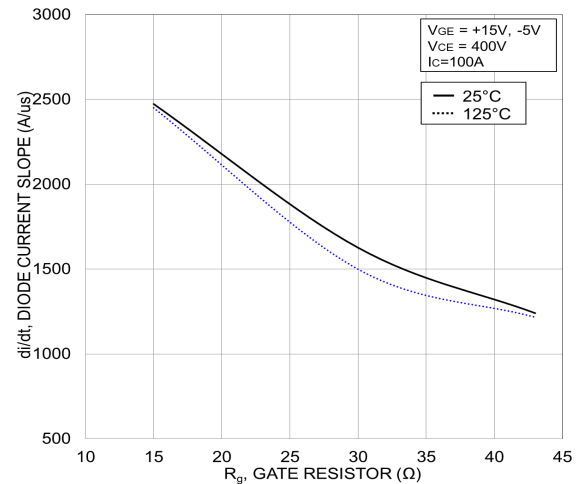


Figure 39. Typical di/dt vs.  $R_G$

TYPICAL CHARACTERISTICS – Q2/Q3 IGBT COMUTATES D1/D4 DIODE

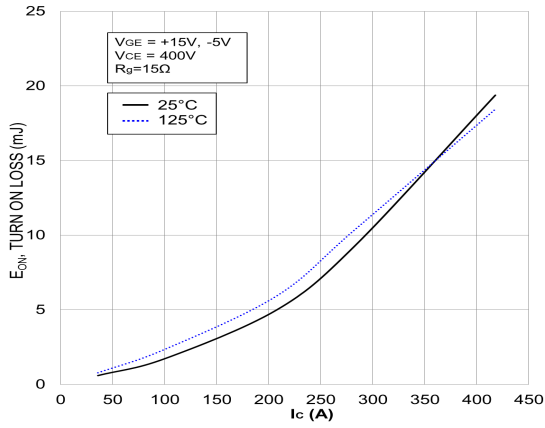


Figure 40. Typical Switching Loss Eon vs. IC

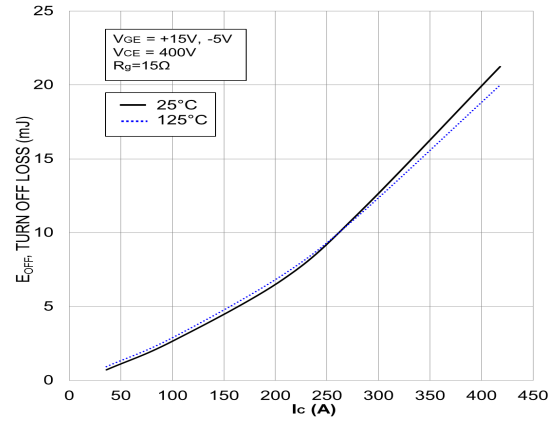


Figure 41. Typical Switching Loss Eoff vs. IC

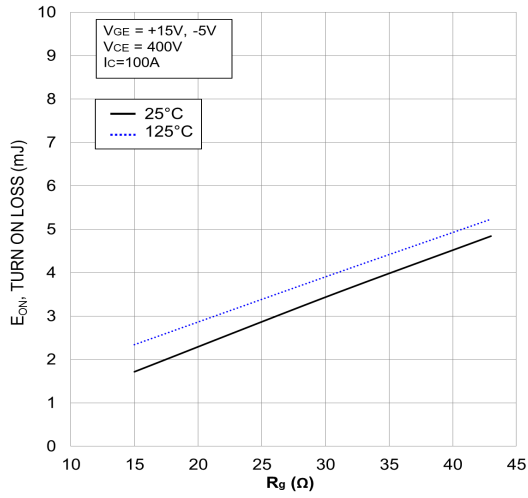


Figure 42. Typical Switching Loss Eon vs.  $R_G$

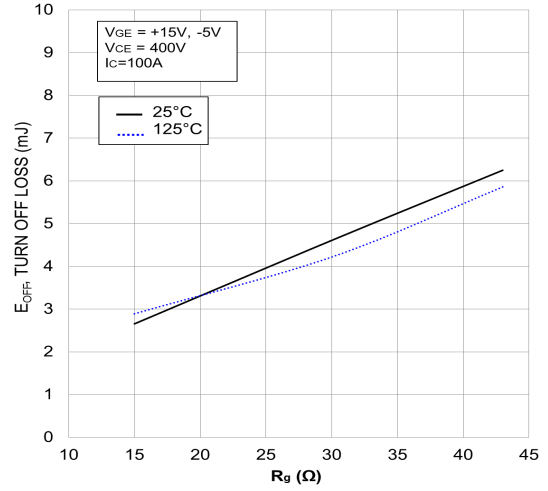


Figure 43. Typical Switching Loss Eoff vs.  $R_G$

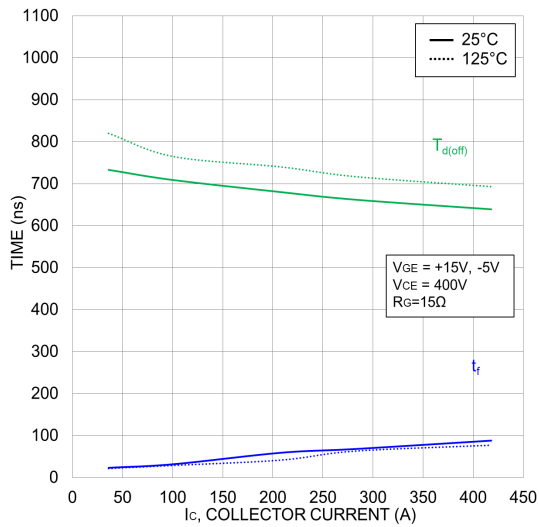


Figure 44. Typical Turn-On Switching Time vs. IC

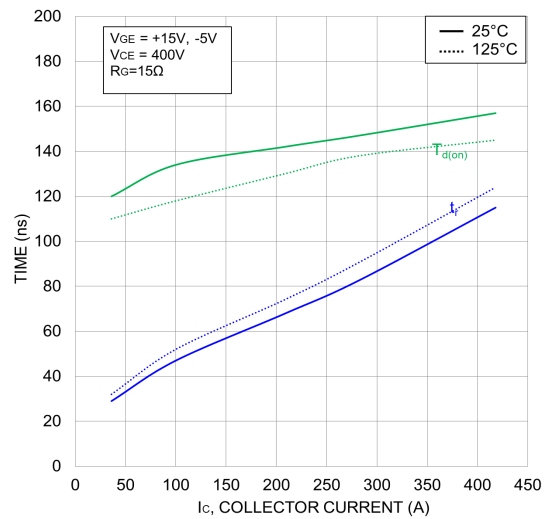


Figure 45. Typical Turn-Off Switching Time vs. IC



TYPICAL CHARACTERISTICS – Q2/Q3 IGBT COMUTATES D1/D4 DIODE

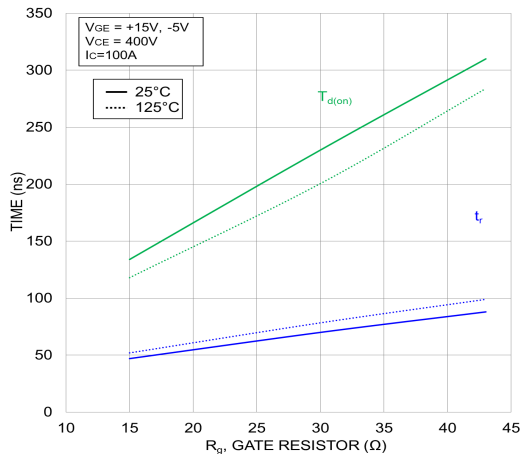


Figure 46. Typical Turn-On Switching Time vs.  $R_G$

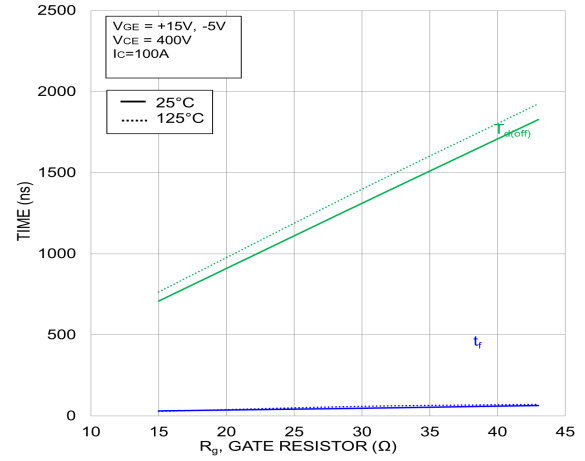


Figure 47. Typical Turn-Off Switching Time vs.  $R_G$

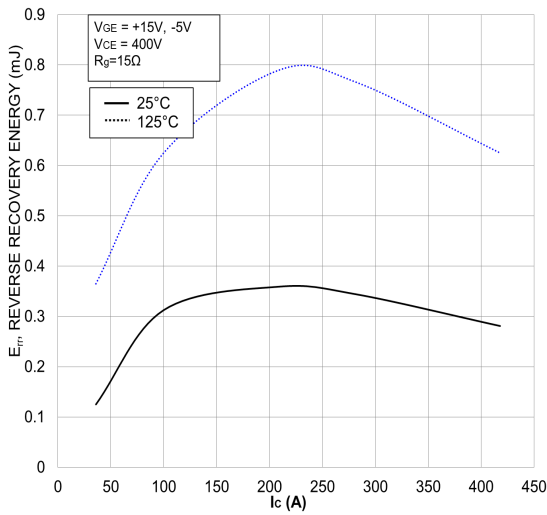


Figure 48. Typical Reverse Recovery Energy Loss vs.  $I_C$

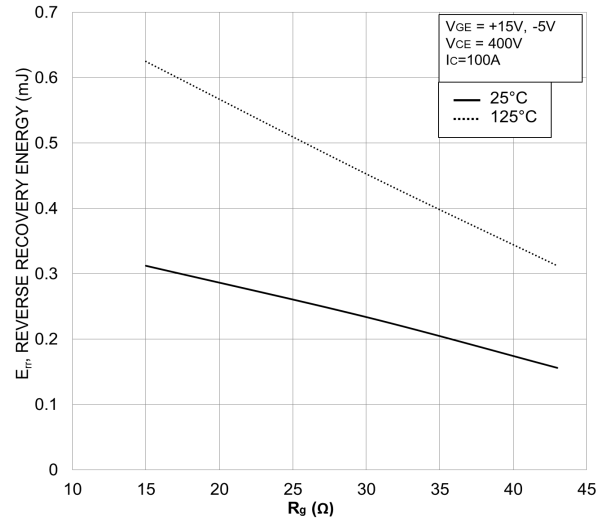


Figure 49. Typical Reverse Recovery Energy Loss vs.  $R_G$

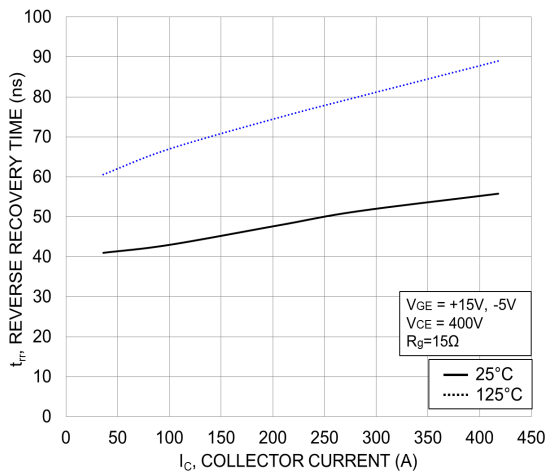


Figure 50. Typical Reverse Recovery Time vs.  $I_C$

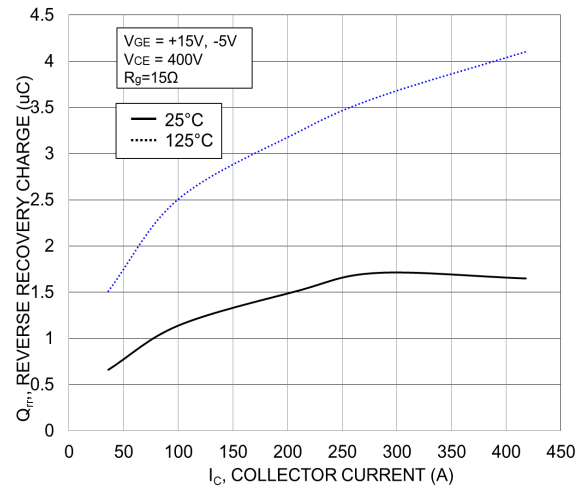


Figure 51. Typical Reverse Recovery Charge vs.  $I_C$

TYPICAL CHARACTERISTICS – Q2/Q3 IGBT COMUTATES D1/D4 DIODE

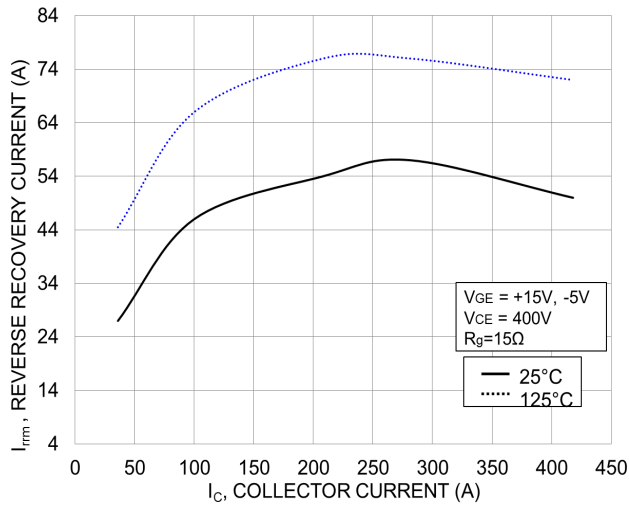


Figure 52. Typical Reverse Recovery Current vs.  $I_C$

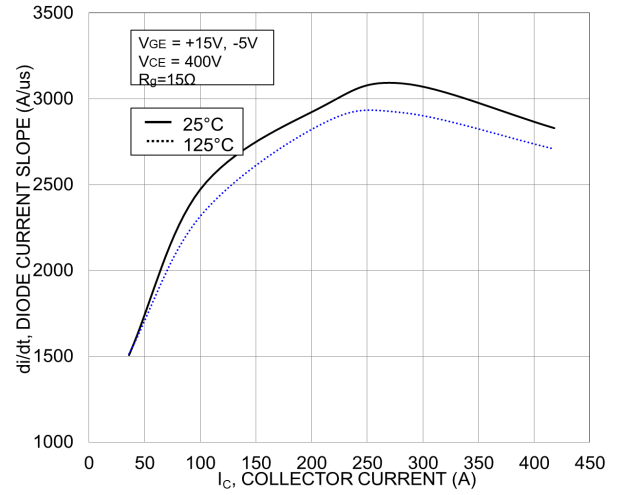


Figure 53. Typical  $di/dt$  Current Slope vs.  $I_C$

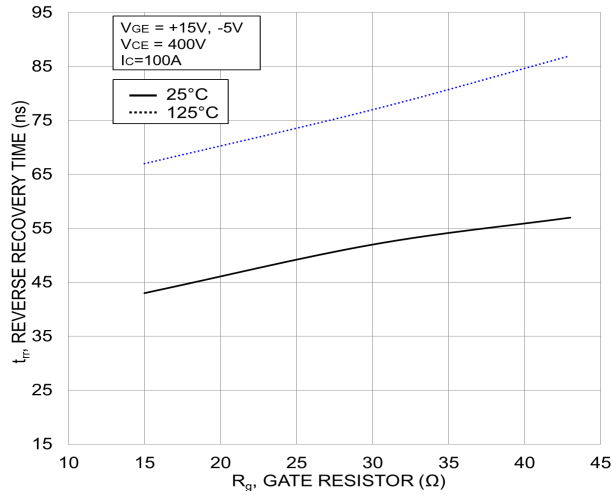


Figure 54. Typical Reverse Recovery Time vs.  $R_g$

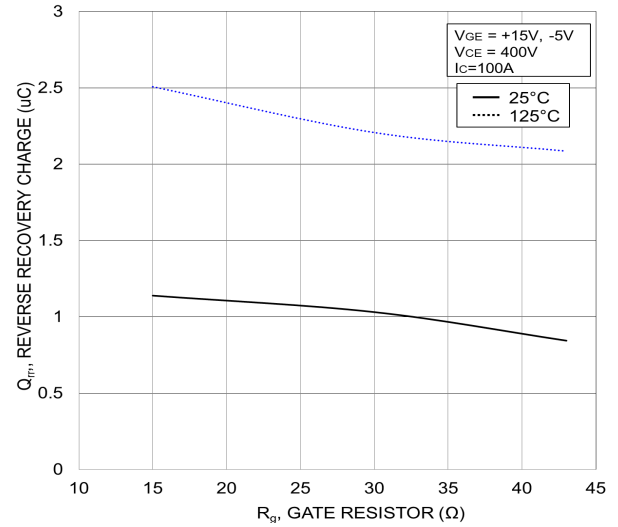


Figure 55. Typical Reverse Recovery Charge vs.  $R_g$

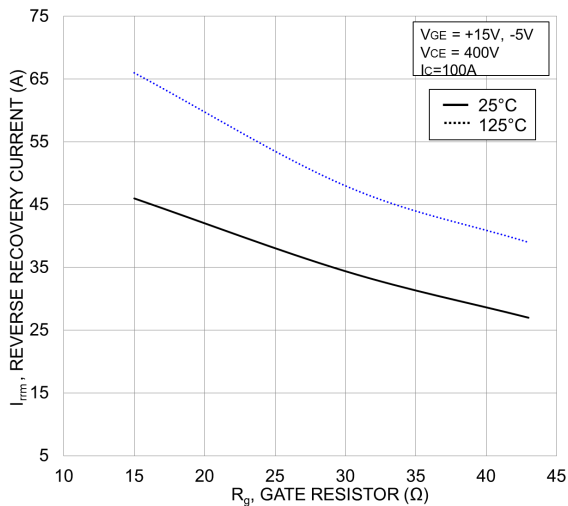


Figure 56. Typical Reverse Recovery Peak Current vs.  $R_g$

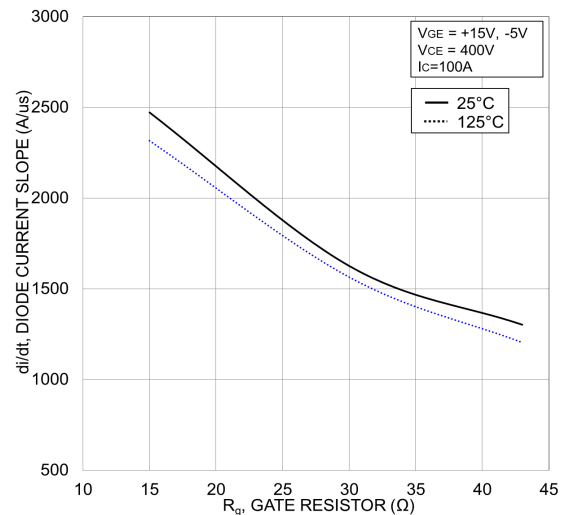
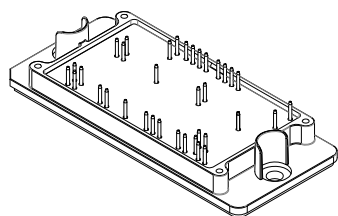


Figure 57. Typical  $di/dt$  vs.  $R_g$

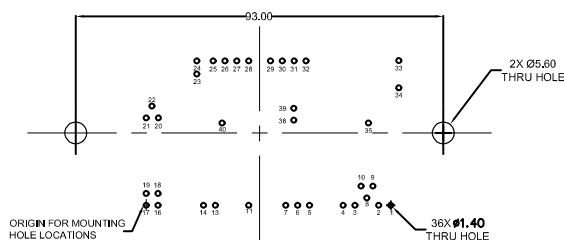
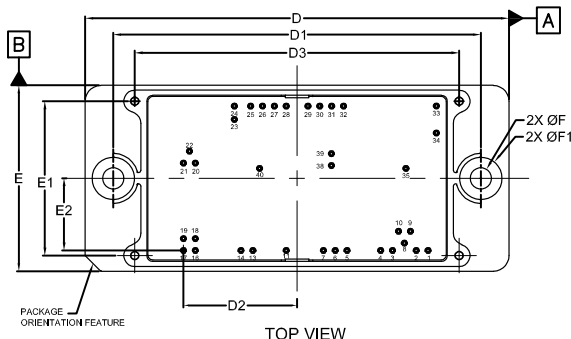
# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS



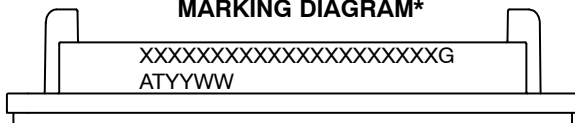
**PIM40, 107.2x47**  
CASE 180BE  
ISSUE C

DATE 27 JUL 2022



For additional information on our Pb-Free strategy and soldering details, please download the On Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

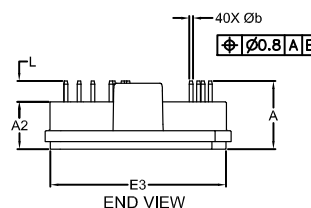
### GENERIC MARKING DIAGRAM\*



XXXXX = Specific Device Code  
G = Pb-Free Package  
AT = Assembly & Test Site Code  
YYWW = Year and Work Week Code

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

| MILLIMETERS |           |        |        |
|-------------|-----------|--------|--------|
| DIM         | MIN.      | NOM.   | MAX.   |
| A           | 16.63     | 17.23  | 17.83  |
| A1          | 4.50      | 4.70   | 4.90   |
| A2          | 11.60     | 12.00  | 12.40  |
| A3          | 16.40     | 16.70  | 17.00  |
| b           | 0.95      | 1.00   | 1.05   |
| D           | 106.80    | 107.20 | 107.60 |
| D1          | 92.90     | 93.00  | 93.10  |
| D2          | 28.40     | 28.70  | 29.00  |
| D3          | 81.80     | 82.00  | 82.20  |
| D4          | 104.35    | 104.75 | 105.15 |
| E           | 46.60     | 47.00  | 47.40  |
| E1          | 38.80     | 39.00  | 39.20  |
| E2          | 17.95     | 18.25  | 18.55  |
| E3          | 44.30     | 44.40  | 44.50  |
| F           | 5.40      | 5.50   | 5.60   |
| F1          | 10.70 REF |        |        |
| L           | 5.03      | 5.23   | 5.43   |



NOTE 4

| PIN | PIN POSITION |      | PIN | PIN POSITION |       |
|-----|--------------|------|-----|--------------|-------|
|     | X            | Y    |     | X            | Y     |
| 1   | 61.85        | 0.0  | 21  | 0.0          | 22.1  |
| 2   | 58.85        | 0.0  | 22  | 1.5          | 25.1  |
| 3   | 52.85        | 0.0  | 23  | 12.85        | 33.15 |
| 4   | 49.85        | 0.0  | 24  | 12.85        | 36.5  |
| 5   | 41.35        | 0.0  | 25  | 16.95        | 36.5  |
| 6   | 38.35        | 0.0  | 26  | 19.95        | 36.5  |
| 7   | 35.35        | 0.0  | 27  | 22.95        | 36.5  |
| 8   | 55.85        | 1.85 | 28  | 25.95        | 36.5  |
| 9   | 57.35        | 4.85 | 29  | 31.45        | 36.5  |
| 10  | 54.35        | 4.85 | 30  | 34.45        | 36.5  |
| 11  | 25.95        | 0.0  | 31  | 37.45        | 36.5  |
| 13  | 17.5         | 0.0  | 32  | 40.45        | 36.5  |
| 14  | 14.5         | 0.0  | 33  | 63.9         | 36.55 |
| 16  | 3.0          | 0.0  | 34  | 63.9         | 29.7  |
| 17  | 0.0          | 0.0  | 35  | 56.2         | 20.75 |
| 18  | 3.0          | 3.0  | 38  | 37.4         | 21.5  |
| 19  | 0.0          | 3.0  | 39  | 37.4         | 24.5  |
| 20  | 3.0          | 22.1 | 40  | 19.2         | 20.75 |

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME 7 14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSIONS b APPLY TO THE PLATED TERMINALS AND ARE MEASURED WHERE THE PIN EXITS THE PACKAGE BODY.
4. POSITION OF THE CENTER OF THE TERMINALS IS DETERMINED FROM PIN 17. POSITIONAL TOLERANCE, AS NOTED IN THE DRAWING, APPLIES TO EACH TERMINAL.

|                         |                        |  |
|-------------------------|------------------------|--|
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| <b>DESCRIPTION:</b>     | <b>PIM40, 107.2x47</b> | <b>PAGE 1 OF 1</b>   |

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# MECHANICAL CASE OUTLINE

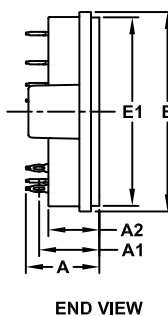
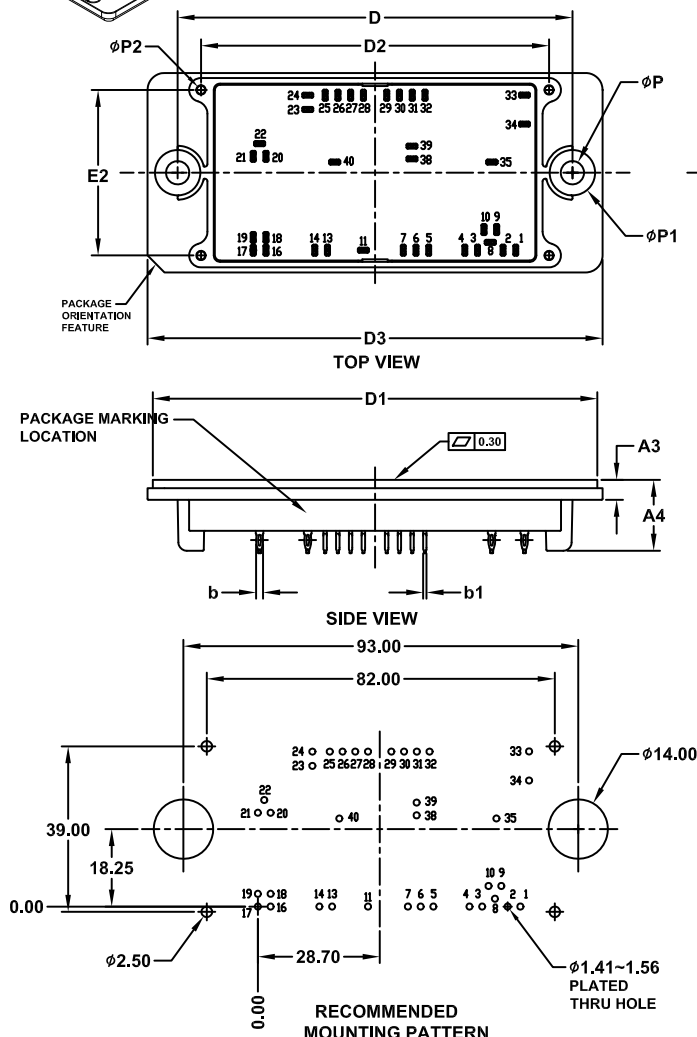
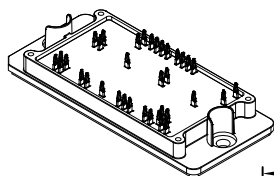
## PACKAGE DIMENSIONS

ON Semiconductor®

ON

### PIM36, 93x47 (PRESSFIT) CASE 180CD ISSUE O

DATE 24 APR 2020



| DIM | MILLIMETERS |        |        |
|-----|-------------|--------|--------|
|     | MIN.        | NOM.   | MAX.   |
| A   | 16.90       | 17.30  | 17.70  |
| A1  | 13.97       | 14.18  | 14.39  |
| A2  | 11.70       | 12.00  | 12.30  |
| A3  | 4.40        | 4.70   | 5.00   |
| A4  | 16.40       | 16.70  | 17.00  |
| b   | 1.61        | 1.66   | 1.71   |
| b1  | 0.75        | 0.80   | 0.85   |
| D   | 92.90       | 93.00  | 93.10  |
| D1  | 104.45      | 104.75 | 105.05 |
| D2  | 81.80       | 82.00  | 82.20  |
| D3  | 106.90      | 107.20 | 107.50 |
| E   | 46.70       | 47.00  | 47.30  |
| E1  | 44.10       | 44.40  | 44.70  |
| E2  | 38.80       | 39.00  | 39.20  |
| P   | 5.40        | 5.50   | 5.60   |
| P1  | 10.60       | 10.70  | 10.80  |
| P2  | 1.80        | 2.00   | 2.20   |

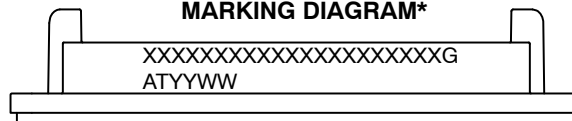
NOTE 4

| PIN | PIN POSITION |       | PIN | PIN POSITION |       |
|-----|--------------|-------|-----|--------------|-------|
|     | X            | Y     |     | X            | Y     |
| 1   | 61.85        | 0.00  | 21  | 0.00         | 22.10 |
| 2   | 58.85        | 0.00  | 22  | 1.50         | 25.10 |
| 3   | 52.85        | 0.00  | 23  | 12.85        | 33.15 |
| 4   | 49.85        | 0.00  | 24  | 12.85        | 36.50 |
| 5   | 41.35        | 0.00  | 25  | 16.95        | 36.50 |
| 6   | 38.35        | 0.00  | 26  | 19.95        | 36.50 |
| 7   | 35.35        | 0.00  | 27  | 22.95        | 36.50 |
| 8   | 55.85        | 1.85  | 28  | 25.95        | 36.50 |
| 9   | 57.35        | 4.85  | 29  | 31.45        | 36.50 |
| 10  | 54.35        | 4.85  | 30  | 34.45        | 36.50 |
| 11  | 25.95        | 0.00  | 31  | 37.45        | 36.50 |
| 13  | 17.50        | 0.00  | 32  | 40.45        | 36.50 |
| 14  | 14.50        | 0.00  | 33  | 63.90        | 36.55 |
| 16  | 3.00         | 0.00  | 34  | 63.90        | 29.70 |
| 17  | 0.00         | 0.00  | 35  | 56.20        | 20.75 |
| 18  | 3.00         | 3.00  | 38  | 37.40        | 21.50 |
| 19  | 0.00         | 3.00  | 39  | 37.40        | 24.50 |
| 20  | 3.00         | 22.10 | 40  | 19.20        | 20.75 |

#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009
2. CONTROLLING DIMENSION : MILLIMETERS
3. DIMENSIONS b AND b1 APPLY TO THE PLATED TERMINALS AND ARE MEASURED AT DIMENSION A1
4. PIN POSITION TOLERANCE IS  $\pm 0.4\text{mm}$
5. PACKAGE MARKING IS LOCATED AS SHOWN ON THE SIDE OPPOSITE THE PACKAGE ORIENTATION FEATURES

#### GENERIC MARKING DIAGRAM\*



XXXXXX = Specific Device Code

G = Pb-Free Package

AT = Assembly & Test Site Code

YYWW = Year and Work Week Code

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

|                  |                         |   |
|------------------|-------------------------|---|
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| DESCRIPTION:     | PIM36 93X47 (PRESS FIT) | PAGE 1 OF 1   |

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