

# IGBT - Field Stop, Trench

## 1200 V, 40 A

### FGH40T120SMD, FGH40T120SMD-F155

#### Description

Using innovative field stop trench IGBT technology, ON Semiconductor's new series of field stop trench IGBTs offer the optimum performance for hard switching application such as solar inverter, UPS, welder and PFC applications.

#### Features

- FS Trench Technology, Positive Temperature Coefficient
- High Speed Switching
- Low Saturation Voltage:  $V_{CE(sat)} = 1.8 \text{ V @ } I_C = 40 \text{ A}$
- 100% of the Parts tested for  $I_{LM}(1)$
- High Input Impedance
- These Devices are Pb-Free and are RoHS Compliant

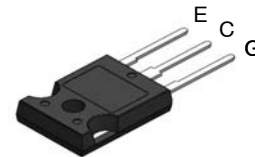
#### Applications

- Solar Inverter, Welder, UPS & PFC applications



ON Semiconductor®

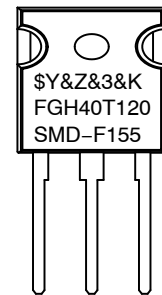
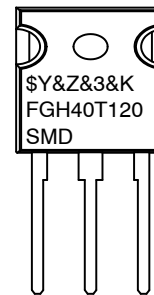
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TO-247-3LD  
CASE 340CK

TO-247-3LD  
CASE 340CH

#### MARKING DIAGRAMS



|  |                         |
|--|-------------------------|
| \$Y                                      | = ON Semiconductor Logo |
| &Z                                       | = Assembly Plant Code   |
| &3                                       | = Numeric Date Code     |
| &K                                       | = Lot Code              |
| FGH40T120SMD,                            |                         |
| FGH40T120SMD-F155 = Specific Device Code |                         |

#### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

# FGH40T120SMD, FGH40T120SMD-F155

## ABSOLUTE MAXIMUM RATINGS (T<sub>C</sub> = 25°C unless otherwise noted)

| Description   |                        | Symbol                   | Ratings     | Unit |
|---|------------------------|--------------------------|-------------|------|
| Collector to Emitter Voltage  |                        | V <sub>CES</sub>         | 1200        | V    |
| Gate to Emitter Voltage   |                        | V <sub>GES</sub>         | ±25         | V    |
| Transient Gate to Emitter Voltage                                       |                        |                          | ±30         | V    |
| Collector Current   | T <sub>C</sub> = 25°C  | I <sub>C</sub>           | 80          | A    |
| Collector Current   | T <sub>C</sub> = 100°C |                          | 40          | A    |
| Clamped Inductive Load Current  | T <sub>C</sub> = 25°C  | I <sub>LM</sub> (Note 1) | 160         | A    |
| Pulsed Collector Current  |                        | I <sub>CM</sub> (Note 2) | 160         | A    |
| Diode Continuous Forward Current  | T <sub>C</sub> = 25°C  | I <sub>F</sub>           | 80          | A    |
| Diode Continuous Forward Current  | T <sub>C</sub> = 100°C |                          | 40          | A    |
| Diode Maximum Forward Current   |                        | I <sub>FM</sub>          | 240         | A    |
| Maximum Power Dissipation   | T <sub>C</sub> = 25°C  | P <sub>D</sub>           | 555         | W    |
| Maximum Power Dissipation   | T <sub>C</sub> = 100°C |                          | 277         | W    |
| Operating Junction Temperature  |                        | T <sub>J</sub>           | –55 to +175 | °C   |
| Storage Temperature Range   |                        | T <sub>stg</sub>         | –55 to +175 | °C   |
| Maximum Lead Temp. for soldering Purposes, 1/8" from case for 5 seconds |                        | T <sub>L</sub>           | 300         | °C   |

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. V<sub>CC</sub> = 600 V, V<sub>GE</sub> = 15 V, I<sub>C</sub> = 160 A, R<sub>G</sub> = 10 W, Inductive Load
2. Limited by T<sub>jmax</sub>

## THERMAL CHARACTERISTICS

| Parameter                               | Symbol                   | Typ | Max  | Unit |
|---|--------------------------|-----|------|------|
| Thermal Resistance, Junction to Case    | R <sub>θJC</sub> (IGBT)  | –   | 0.27 | °C/W |
| Thermal Resistance, Junction to Case    | R <sub>θJC</sub> (Diode) | –   | 0.89 | °C/W |
| Thermal Resistance, Junction to Ambient | R <sub>θJA</sub>         | –   | 40   | °C/W |

## PACKAGE MARKING AND ORDERING INFORMATION

| Device Marking | Device            | Package               | Reel Size | Tape Width | Quantity |
|----------------|-------------------|-----------------------|-----------|------------|----------|
| FGH40T120SMD   | FGH40T120SMD      | TO-247-3<br>(PB-Free) | –         | –          | 30       |
| FGH40T120SMD   | FGH40T120SMD-F155 | TO-247-3<br>(Pb-Free) | –         | –          | 30       |

## ELECTRICAL CHARACTERISTICS OF THE IGBT (T<sub>C</sub> = 25°C unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|-----------|--------|-----------------|-----|-----|-----|------|
|-----------|--------|-----------------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|  |                   |  |      |   |      |    |
|--|-------------------|--|------|---|------|----|
| Collector to Emitter Breakdown Voltage | BV <sub>CES</sub> | V <sub>GE</sub> = 0 V, I <sub>C</sub> = 250 μA             | 1200 | – | –    | V  |
| Collector Cut-Off Current              | I <sub>CES</sub>  | V <sub>CE</sub> = V <sub>CES</sub> , V <sub>GE</sub> = 0 V | –    | – | 250  | μA |
| G–E Leakage Current                    | I <sub>GES</sub>  | V <sub>GE</sub> = V <sub>GES</sub> , V <sub>CE</sub> = 0 V | –    | – | ±400 | nA |

### ON CHARACTERISTICS

|   |                      |   |     |     |     |   |
|---|----------------------|---|-----|-----|-----|---|
| G–E Threshold Voltage                   | V <sub>GE(th)</sub>  | I <sub>C</sub> = 40 mA, V <sub>CE</sub> = V <sub>GE</sub>             | 4.9 | 6.2 | 7.5 | V |
| Collector to Emitter Saturation Voltage | V <sub>CE(sat)</sub> | I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V, T <sub>C</sub> = 25°C  | –   | 1.8 | 2.4 | V |
|   |                      | I <sub>C</sub> = 40 A, V <sub>GE</sub> = 15 V, T <sub>C</sub> = 175°C | –   | 2.0 | –   | V |

# FGH40T120SMD, FGH40T120SMD-F155

## ELECTRICAL CHARACTERISTICS OF THE IGBT ( $T_C = 25^\circ\text{C}$ unless otherwise noted) (continued)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|-----------|--------|-----------------|-----|-----|-----|------|
|-----------|--------|-----------------|-----|-----|-----|------|

### DYNAMIC CHARACTERISTICS

|                              |           |   |   |      |   |    |
|------------------------------|-----------|---|---|------|---|----|
| Input Capacitance            | $C_{ies}$ | $V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$ | – | 4300 | – | pF |
| Output Capacitance           | $C_{oes}$ |   | – | 180  | – | pF |
| Reverse Transfer Capacitance | $C_{res}$ |   | – | 100  | – | pF |

### SWITCHING CHARACTERISTICS

|                          |              |   |   |     |   |    |
|--------------------------|--------------|---|---|-----|---|----|
| Turn-On Delay Time       | $t_{d(on)}$  | $V_{CC} = 600\text{ V}, I_C = 40\text{ A},$<br>$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$<br>Inductive Load, $T_C = 25^\circ\text{C}$  | – | 40  | – | ns |
| Rise Time                | $t_r$        |   | – | 47  | – | ns |
| Turn-Off Delay Time      | $t_{d(off)}$ |   | – | 475 | – | ns |
| Fall Time                | $t_f$        |   | – | 10  | – | ns |
| Turn-On Switching Loss   | $E_{on}$     |   | – | 2.7 | – | mJ |
| Turn-Off Switching Loss  | $E_{off}$    |   | – | 1.1 | – | mJ |
| Total Switching Loss     | $E_{ts}$     |   | – | 3.8 | – | mJ |
| Turn-On Delay Time       | $t_{d(on)}$  | $V_{CC} = 600\text{ V}, I_C = 40\text{ A},$<br>$R_G = 10\ \Omega, V_{GE} = 15\text{ V},$<br>Inductive Load, $T_C = 175^\circ\text{C}$ | – | 40  | – | ns |
| Rise Time                | $t_r$        |   | – | 55  | – | ns |
| Turn-Off Delay Time      | $t_{d(off)}$ |   | – | 520 | – | ns |
| Fall Time                | $t_f$        |   | – | 50  | – | ns |
| Turn-On Switching Loss   | $E_{on}$     |   | – | 3.4 | – | mJ |
| Turn-Off Switching Loss  | $E_{off}$    |   | – | 2.5 | – | mJ |
| Total Switching Loss     | $E_{ts}$     |   | – | 5.9 | – | mJ |
| Total Gate Charge        | $Q_g$        | $V_{CE} = 600\text{ V}, I_C = 40\text{ A}, V_{GE} = 15\text{ V}$  | – | 370 | – | nC |
| Gate to Emitter Charge   | $Q_{ge}$     |   | – | 23  | – | nC |
| Gate to Collector Charge | $Q_{gc}$     |   | – | 210 | – | nC |

## ELECTRICAL CHARACTERISTICS OF THE DIODE ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Parameter                           | Symbol   | Test Conditions   | Min | Typ  | Max | Unit |
|-------------------------------------|----------|---|-----|------|-----|------|
| Diode Forward Voltage               | $V_{FM}$ | $I_F = 40\text{ A}, T_C = 25^\circ\text{C}$   | –   | 3.8  | 4.8 | V    |
|                                     |          | $I_F = 40\text{ A}, T_C = 175^\circ\text{C}$  | –   | 2.7  | –   | V    |
| Diode Reverse Recovery Time         | $t_{rr}$ | $V_R = 600\text{ V}, I_F = 40\text{ A},$<br>$di_F/dt = 200\text{ A}/\mu\text{s}, T_C = 25^\circ\text{C}$  | –   | 65   | –   | ns   |
| Diode Peak Reverse Recovery Current | $I_{rr}$ |   | –   | 7.2  | –   | A    |
| Diode Reverse Recovery Charge       | $Q_{rr}$ |   | –   | 234  | –   | nC   |
| Diode Reverse Recovery Time         | $t_{rr}$ | $V_R = 600\text{ V}, I_F = 40\text{ A},$<br>$di_F/dt = 200\text{ A}/\mu\text{s}, T_C = 175^\circ\text{C}$ | –   | 200  | –   | ns   |
| Diode Peak Reverse Recovery Current | $I_{rr}$ |   | –   | 18.0 | –   | A    |
| Diode Reverse Recovery Charge       | $Q_{rr}$ |   | –   | 1800 | –   | nC   |

# FGH40T120SMD, FGH40T120SMD-F155

## TYPICAL PERFORMANCE CHARACTERISTICS

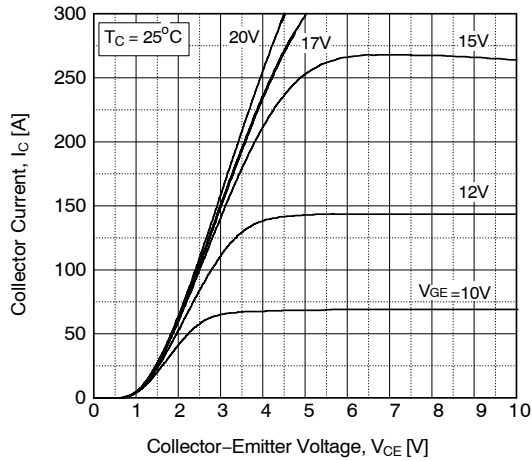


Figure 1. Typical Output Characteristics

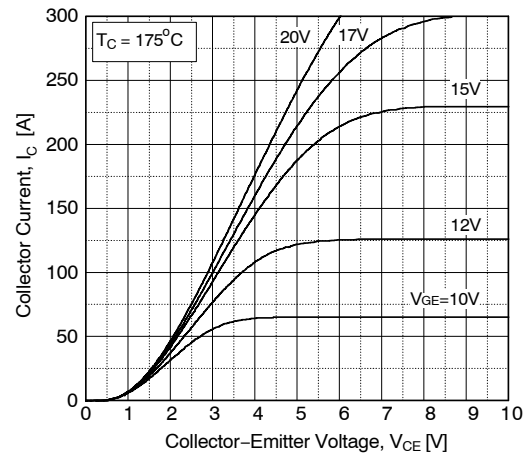


Figure 2. Typical Output Characteristics

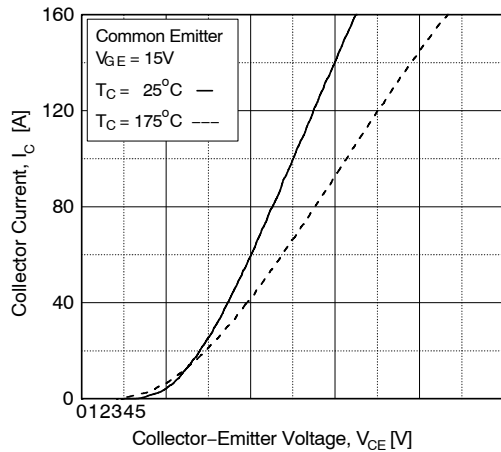


Figure 3. Typical Saturation Voltage Characteristics

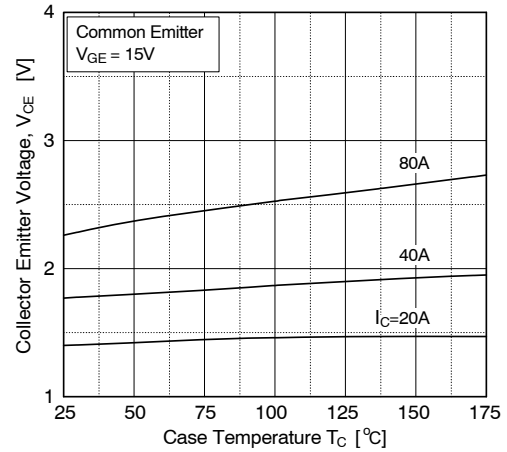


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

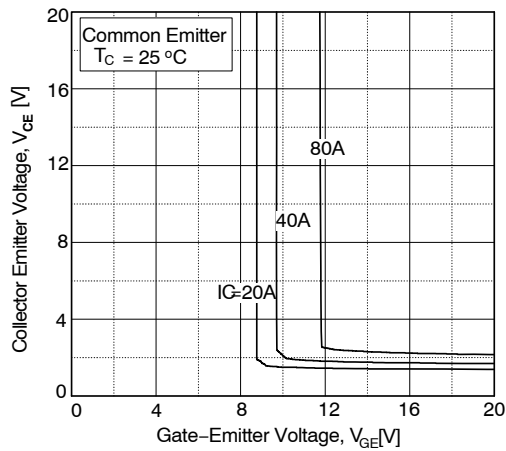


Figure 5. Saturation Voltage vs  $V_{GE}$

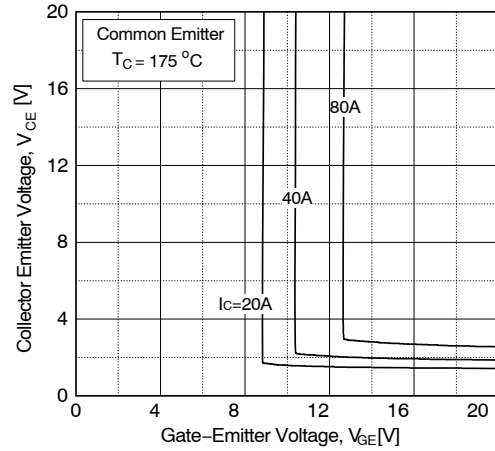


Figure 6. Saturation Voltage vs  $V_{GE}$

# FGH40T120SMD, FGH40T120SMD-F155

## TYPICAL PERFORMANCE CHARACTERISTICS

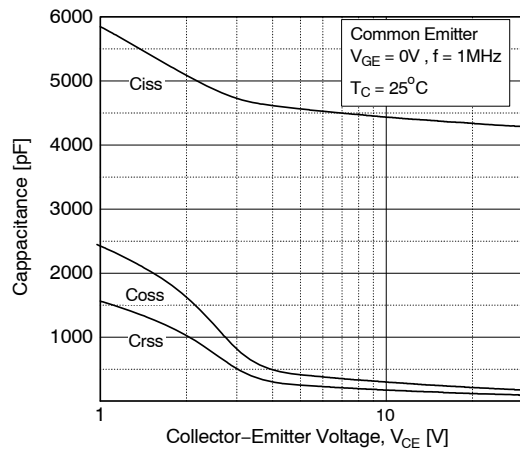


Figure 7. Capacitance Characteristics

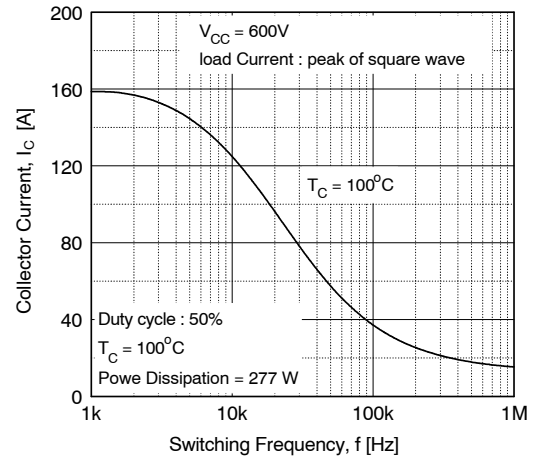


Figure 8. Load Current vs. Frequency

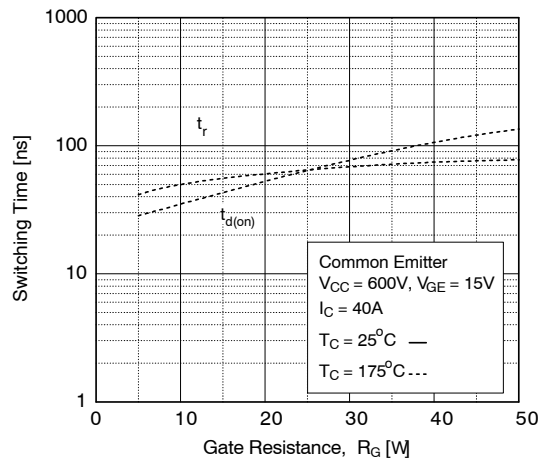


Figure 9. Turn-On Characteristics vs. Gate Resistance

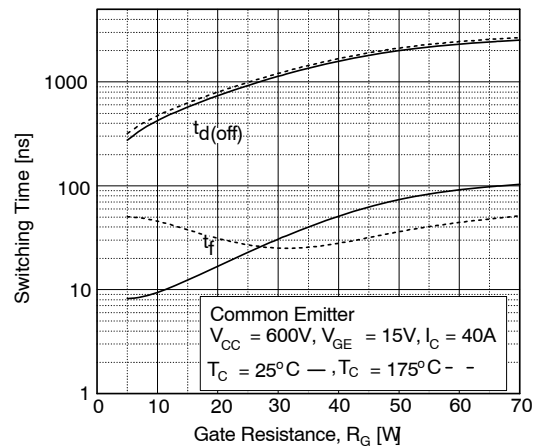


Figure 10. Turn-Off Characteristics vs. Collector Current

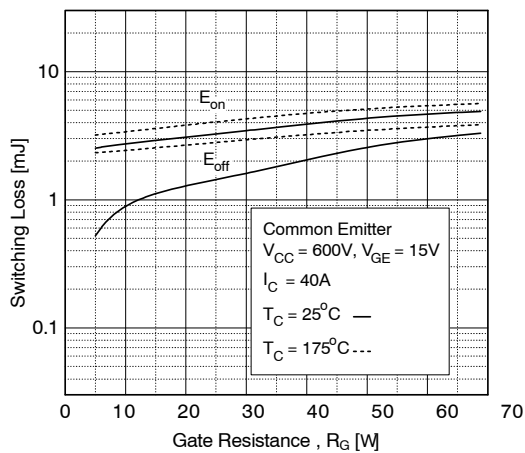


Figure 11. Switching Loss vs. Gate Resistance

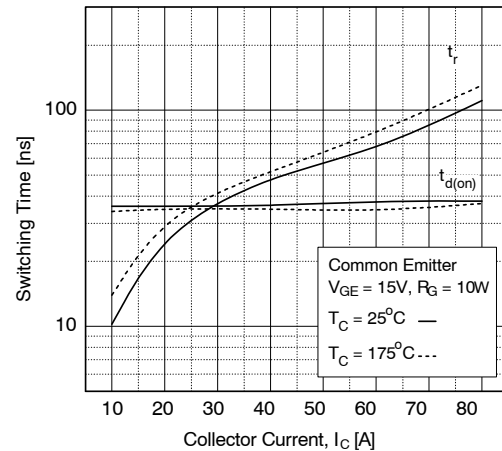


Figure 12. Turn-On Characteristics vs. Collector Current

TYPICAL PERFORMANCE CHARACTERISTICS

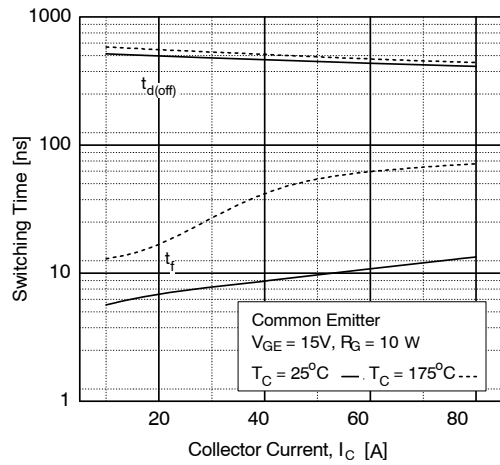


Figure 13. Turn-Off Characteristics vs. Collector Current

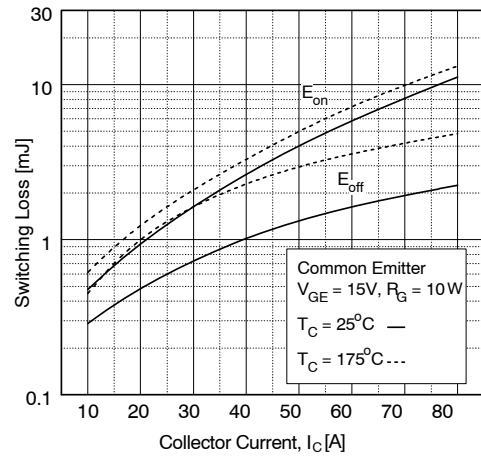


Figure 14. Switching Loss vs. Collector Current

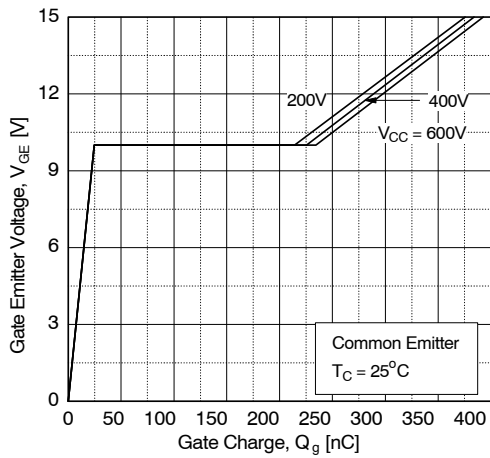


Figure 15. Gate Charge Characteristics

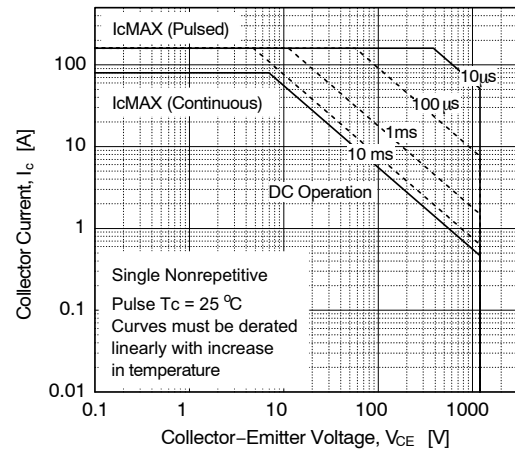


Figure 16. SOA Characteristics

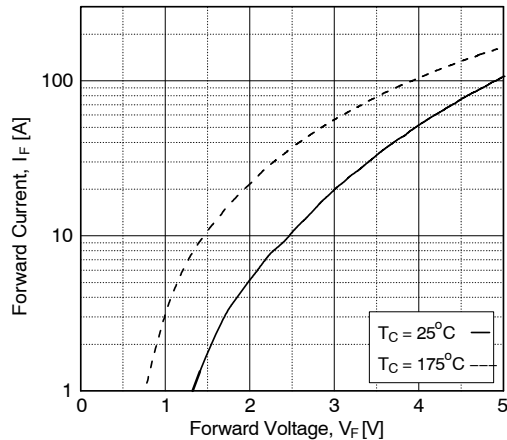


Figure 17. Forward Characteristics

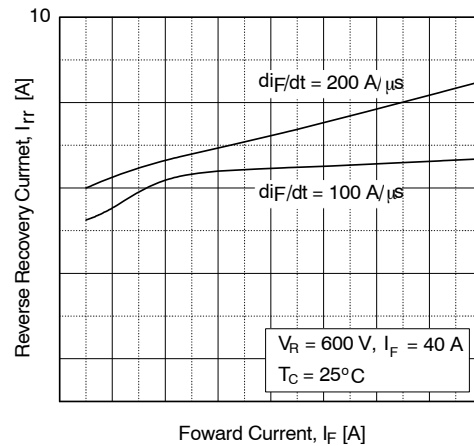


Figure 18. Reverse Recovery Current

TYPICAL PERFORMANCE CHARACTERISTICS

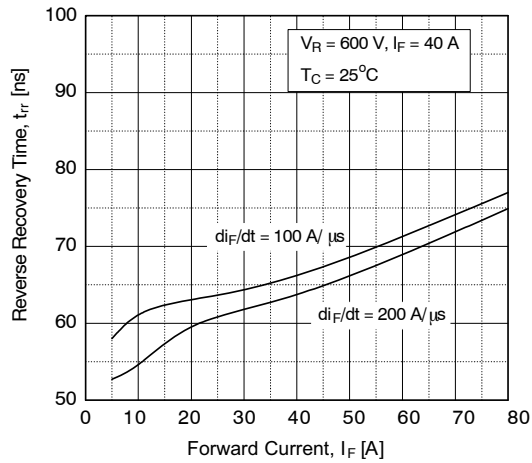


Figure 19. Reverse Recovery Time

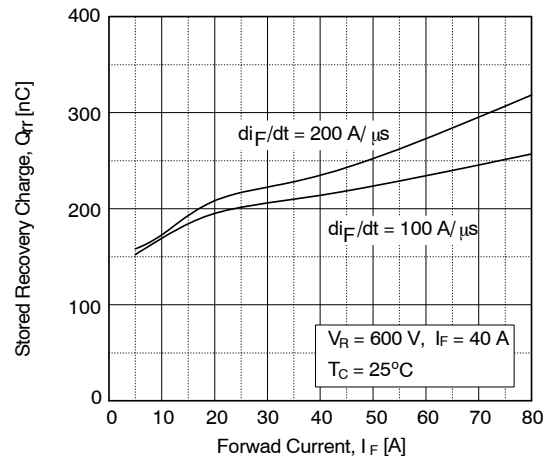


Figure 20. Stored Charge

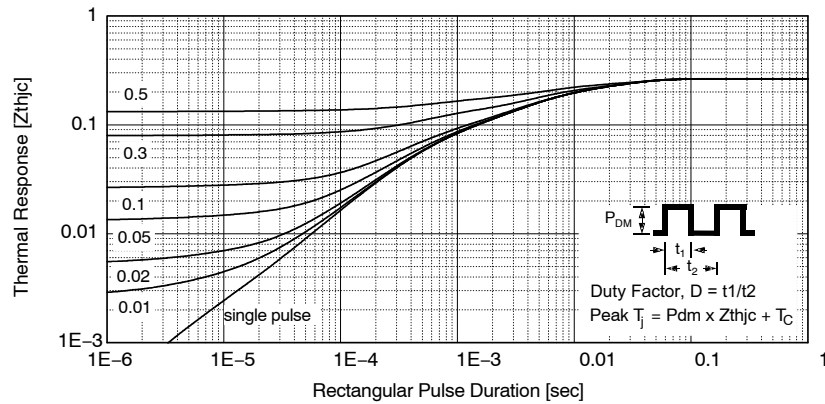
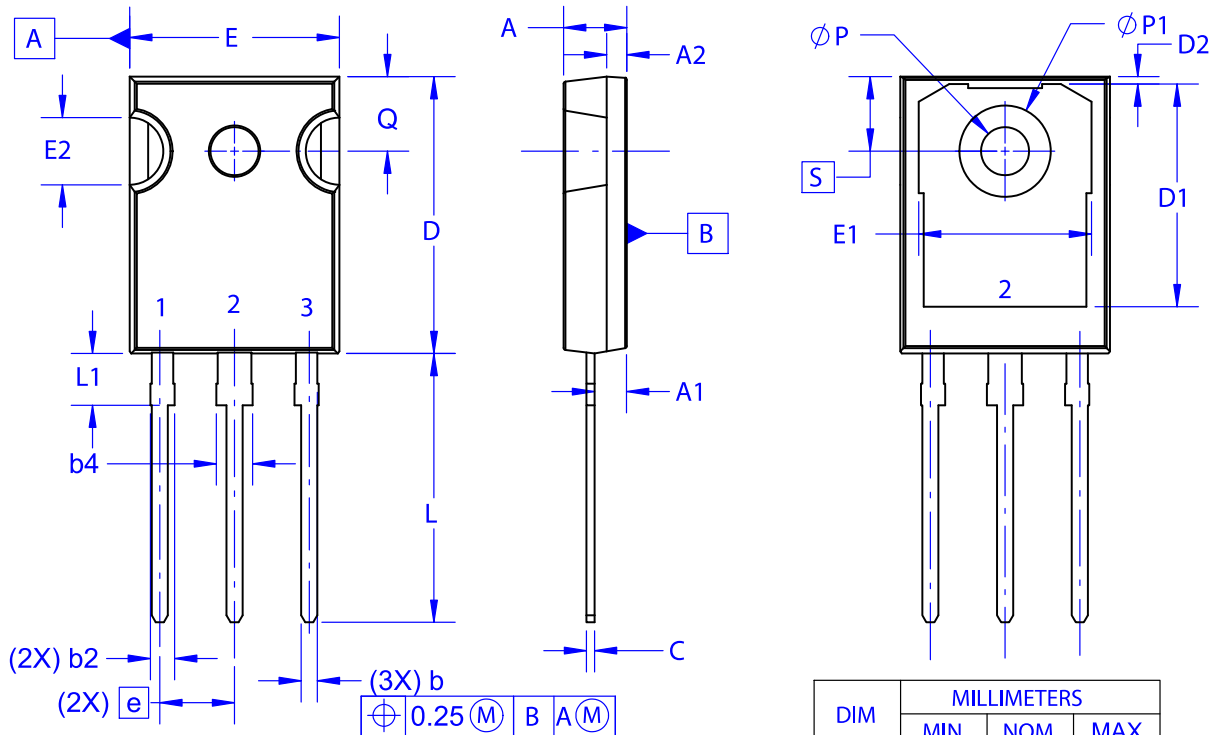


Figure 21. Transient Thermal Impedance of IGBT

### TO-247-3LD CASE 340CH ISSUE A

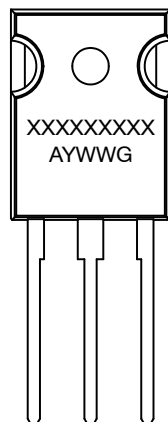
DATE 09 OCT 2019



NOTES: UNLESS OTHERWISE SPECIFIED.

- A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
- D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
- E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

#### GENERIC MARKING DIAGRAM\*



XXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

\*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.

| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN         | NOM   | MAX   |
| A   | 4.58        | 4.70  | 4.82  |
| A1  | 2.29        | 2.475 | 2.66  |
| A2  | 1.40        | 1.50  | 1.60  |
| D   | 20.32       | 20.57 | 20.82 |
| E   | 15.37       | 15.62 | 15.87 |
| E2  | 4.96        | 5.08  | 5.20  |
| e   | ~           | 5.56  | ~     |
| L   | 19.75       | 20.00 | 20.25 |
| L1  | 3.69        | 3.81  | 3.93  |
| ØP  | 3.51        | 3.58  | 3.65  |
| Q   | 5.34        | 5.46  | 5.58  |
| S   | 5.34        | 5.46  | 5.58  |
| b   | 1.17        | 1.26  | 1.35  |
| b2  | 1.53        | 1.65  | 1.77  |
| b4  | 2.42        | 2.54  | 2.66  |
| c   | 0.51        | 0.61  | 0.71  |
| D1  | 13.08       | ~     | ~     |
| D2  | 0.51        | 0.93  | 1.35  |
| E1  | 12.81       | ~     | ~     |
| ØP1 | 6.61        | 6.73  | 6.85  |

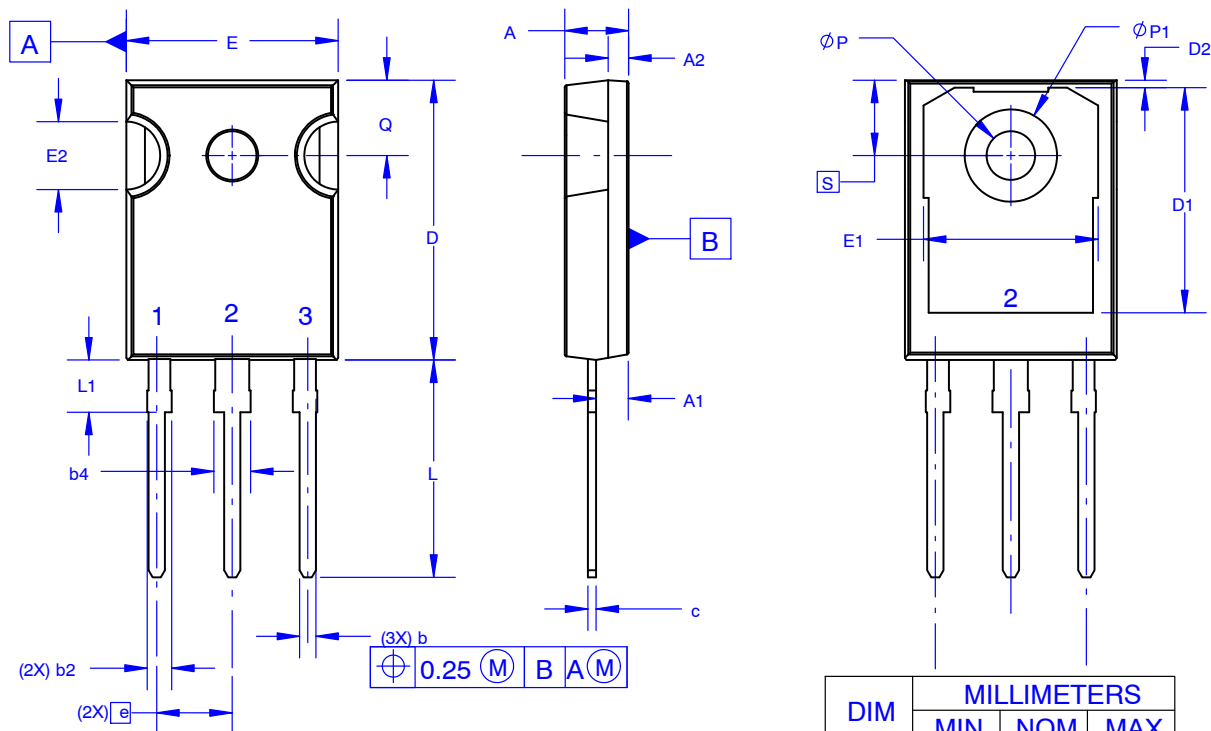
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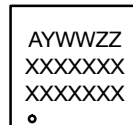
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#### GENERIC MARKING DIAGRAM\*



XXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
ZZ = Assembly Lot 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.

| DIM       | MILLIMETERS |       |       |
|-----------|-------------|-------|-------|
|           | MIN         | NOM   | MAX   |
| A         | 4.58        | 4.70  | 4.82  |
| A1        | 2.20        | 2.40  | 2.60  |
| A2        | 1.40        | 1.50  | 1.60  |
| b         | 1.17        | 1.26  | 1.35  |
| b2        | 1.53        | 1.65  | 1.77  |
| b4        | 2.42        | 2.54  | 2.66  |
| c         | 0.51        | 0.61  | 0.71  |
| D         | 20.32       | 20.57 | 20.82 |
| D1        | 13.08       | ~     | ~     |
| D2        | 0.51        | 0.93  | 1.35  |
| E         | 15.37       | 15.62 | 15.87 |
| E1        | 12.81       | ~     | ~     |
| E2        | 4.96        | 5.08  | 5.20  |
| e         | ~           | 5.56  | ~     |
| L         | 15.75       | 16.00 | 16.25 |
| L1        | 3.69        | 3.81  | 3.93  |
| $\phi P$  | 3.51        | 3.58  | 3.65  |
| $\phi P1$ | 6.60        | 6.80  | 7.00  |
| Q         | 5.34        | 5.46  | 5.58  |
| S         | 5.34        | 5.46  | 5.58  |

|                  |                       |   |
|------------------|-----------------------|---|
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