

# IGBT - Ultra Field Stop 1200 V, 60 A

## FGY60T120SQDN

### General Description

This Insulated Gate Bipolar Transistor (IGBT) features a robust and cost effective Ultra Field Stop Trench construction, and provides superior performance in demanding switching applications, offering both low on-state voltage and minimal switching loss. The IGBT is well suited for UPS and solar applications. Incorporated into the device is a soft and fast co-packaged free wheeling diode with a low forward voltage.

### Features

- Extremely Efficient Trench with Field Stop Technology
- Maximum Junction Temperature  $T_J = 175^{\circ}\text{C}$
- Low Saturation Voltage:  $V_{CE(sat)} = 1.7\text{ V (Typ.) @ } I_C = 60\text{ A}$
- 100% of the Parts Tested for  $I_{LM}$  (Note 1)
- Soft Fast Reverse Recovery Diode
- Optimized for High Speed Switching
- RoHS Compliant

### Applications

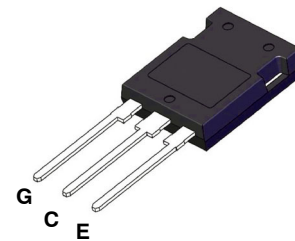
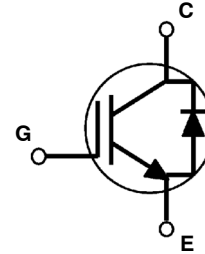
- Solar Inverter, UPS

### ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^{\circ}\text{C}$ unless otherwise noted)

| Symbol      | Description                                                                                        | Value           | Unit               |
|-------------|----------------------------------------------------------------------------------------------------|-----------------|--------------------|
| $V_{CES}$   | Collector to Emitter Voltage                                                                       | 1200            | V                  |
| $V_{GES}$   | Gate to Emitter Voltage                                                                            | $\pm 25$        | V                  |
|             | Transient Gate to Emitter Voltage                                                                  | $\pm 30$        | V                  |
| $I_C$       | Collector Current @ ( $T_C = 25^{\circ}\text{C}$ )                                                 | 120             | A                  |
|             | Collector Current @ ( $T_C = 100^{\circ}\text{C}$ )                                                | 60              | A                  |
| $I_{LM}(1)$ | Pulsed Collector Current @ ( $T_C = 25^{\circ}\text{C}$ )                                          | 240             | A                  |
| $I_{CM}(2)$ | Pulsed Collector Current                                                                           | 240             | A                  |
| $I_F$       | Diode Forward Current @ ( $T_C = 25^{\circ}\text{C}$ )                                             | 120             | A                  |
|             | Diode Forward Current @ ( $T_C = 100^{\circ}\text{C}$ )                                            | 60              | A                  |
| $I_{FM}$    | Pulsed Diode Max. Forward Current                                                                  | 240             | A                  |
| $P_D$       | Maximum Power Dissipation<br>@ ( $T_C = 25^{\circ}\text{C}$ )<br>@ ( $T_C = 100^{\circ}\text{C}$ ) |                 | W                  |
|             |                                                                                                    | 517             |                    |
|             |                                                                                                    | 259             | W                  |
| $T_J$       | Operating Junction Temperature                                                                     | $-55$ to $+175$ | $^{\circ}\text{C}$ |
| $T_{stg}$   | Storage Temperature Range                                                                          | $-55$ to $+175$ | $^{\circ}\text{C}$ |
| $T_L$       | Maximum Lead Temp. For soldering<br>Purposes, 1/8" from case for 5 seconds                         | 300             | $^{\circ}\text{C}$ |

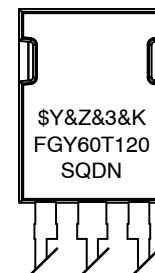
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

- $V_{CC} = 800\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_C = 240\text{ A}$ ,  $R_G = 68\ \Omega$ , Inductive Load
- Repetitive rating; Pulse width limited by max. Junction temperature



Power TO247  
(TO-247H03)

### MARKING DIAGRAM



&Y = onsemi Logo  
&3 = Data Code (Year & Week)  
&K = Lot  
FGY60T120SQDN = Specific Device Code

### ORDERING INFORMATION

See detailed ordering and shipping information on page 3 of this data sheet.

# FGY60T120SQDN

## THERMAL CHARACTERISTICS

| Symbol                  | Parameter                                     | FGY60T120SQDN | Unit |
|-------------------------|-----------------------------------------------|---------------|------|
| $R_{\theta JC}$ (IGBT)  | Thermal Resistance, Junction to Case, Max.    | 0.29          | °C/W |
| $R_{\theta JC}$ (Diode) | Thermal Resistance, Junction to Case, Max.    | 0.42          |      |
| $R_{\theta JA}$         | Thermal Resistance, Junction to Ambient, Max. | 40            | °C/W |

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

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|--------|-----------|----------------|------|------|------|------|
|--------|-----------|----------------|------|------|------|------|

### OFF CHARACTERISTICS

|            |                                        |                                                    |      |   |           |               |
|------------|----------------------------------------|----------------------------------------------------|------|---|-----------|---------------|
| $BV_{CES}$ | Collector to Emitter Breakdown Voltage | $V_{GE} = 0\text{V}, I_C = 500\text{ }\mu\text{A}$ | 1200 | – | –         | V             |
| $I_{CES}$  | Collector Cut-Off Current              | $V_{CE} = V_{CES}, V_{GE} = 0\text{V}$             | –    | – | 400       | $\mu\text{A}$ |
| $I_{GES}$  | G-E Leakage Current                    | $V_{GE} = V_{GES}, V_{CE} = 0\text{V}$             | –    | – | $\pm 200$ | nA            |

### ON CHARACTERISTICS

|               |                                         |                                                                    |     |     |      |   |
|---------------|-----------------------------------------|--------------------------------------------------------------------|-----|-----|------|---|
| $V_{GE(th)}$  | G-E Threshold Voltage                   | $I_C = 400\text{ }\mu\text{A}, V_{CE} = V_{GE}$                    | 4.5 | 5.5 | 6.5  | V |
| $V_{CE(sat)}$ | Collector to Emitter Saturation Voltage | $I_C = 60\text{ A}, V_{GE} = 15\text{ V}$                          | –   | 1.7 | 1.95 | V |
|               |                                         | $I_C = 60\text{ A}, V_{GE} = 15\text{ V}, T_C = 175^\circ\text{C}$ | –   | 2.3 | –    | V |

### DYNAMIC CHARACTERISTICS

|           |                              |                                                                    |   |      |   |    |
|-----------|------------------------------|--------------------------------------------------------------------|---|------|---|----|
| $C_{ies}$ | Input Capacitance            | $V_{CE} = 20\text{ V}, V_{GE} = 0\text{ V},$<br>$f = 1\text{ MHz}$ | – | 7147 | – | pF |
| $C_{oes}$ | Output Capacitance           |                                                                    | – | 203  | – | pF |
| $C_{res}$ | Reverse Transfer Capacitance |                                                                    | – | 114  | – | pF |

### SWITCHING CHARACTERISTICS

|              |                          |                                                                                                                                             |   |       |   |    |
|--------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|---|-------|---|----|
| $t_{d(on)}$  | Turn-On Delay Time       | $V_{CC} = 600\text{ V}, I_C = 60\text{ A}, R_G = 10\text{ }\Omega,$<br>$V_{GE} = 15\text{ V},$<br>Inductive Load, $T_C = 25^\circ\text{C}$  | – | 52    | – | ns |
| $t_r$        | Rise Time                |                                                                                                                                             | – | 84    | – | ns |
| $t_{d(off)}$ | Turn-Off Delay Time      |                                                                                                                                             | – | 296   | – | ns |
| $t_f$        | Fall Time                |                                                                                                                                             | – | 56    | – | ns |
| $E_{on}$     | Turn-On Switching Loss   |                                                                                                                                             | – | 5.15  | – | mJ |
| $E_{off}$    | Turn-Off Switching Loss  |                                                                                                                                             | – | 1.82  | – | mJ |
| $E_{ts}$     | Total Switching Loss     |                                                                                                                                             | – | 6.97  | – | mJ |
| $t_{d(on)}$  | Turn-On Delay Time       | $V_{CC} = 600\text{ V}, I_C = 60\text{ A}, R_G = 10\text{ }\Omega,$<br>$V_{GE} = 15\text{ V},$<br>Inductive Load, $T_C = 175^\circ\text{C}$ | – | 40    | – | ns |
| $t_r$        | Rise Time                |                                                                                                                                             | – | 72    | – | ns |
| $t_{d(off)}$ | Turn-Off Delay Time      |                                                                                                                                             | – | 324   | – | ns |
| $t_f$        | Fall Time                |                                                                                                                                             | – | 144   | – | ns |
| $E_{on}$     | Turn-On Switching Loss   |                                                                                                                                             | – | 7.18  | – | mJ |
| $E_{off}$    | Turn-Off Switching Loss  |                                                                                                                                             | – | 3.1   | – | mJ |
| $E_{ts}$     | Total Switching Loss     |                                                                                                                                             | – | 10.28 | – | mJ |
| $Q_g$        | Total Gate Charge        | $V_{CE} = 600\text{ V}, I_C = 60\text{ A}, V_{GE} = 15\text{ V}$                                                                            | – | 311   | – | nC |
| $Q_{ge}$     | Gate to Emitter Charge   |                                                                                                                                             | – | 57    | – | nC |
| $Q_{gc}$     | Gate to Collector Charge |                                                                                                                                             | – | 153   | – | nC |

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.



# FGY60T120SQDN

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

| Symbol    | Parameter                      | Test Condition            | Min. | Typ. | Max. | Unit |
|-----------|--------------------------------|---------------------------|------|------|------|------|
| $V_{FM}$  | Diode Forward Voltage          | $T_C = 25^\circ\text{C}$  | –    | 3.4  | 4    | V    |
|           |                                | $T_C = 175^\circ\text{C}$ | –    | 3.2  | –    |      |
| $t_{rr}$  | Diode Reverse Recovery Time    | $T_C = 25^\circ\text{C}$  | –    | 91   | –    | ns   |
|           |                                | $T_C = 175^\circ\text{C}$ | –    | 309  | –    |      |
| $Q_{rr}$  | Diode Reverse Recovery Charge  | $T_C = 25^\circ\text{C}$  | –    | 860  | –    | nC   |
|           |                                | $T_C = 175^\circ\text{C}$ | –    | 4902 | –    |      |
| $I_{rrm}$ | Diode Reverse Recovery Current | $T_C = 25^\circ\text{C}$  | –    | 19   | –    | A    |
|           |                                | $T_C = 175^\circ\text{C}$ | –    | 32   | –    |      |

## PACKAGE MARKING AND ORDERING INFORMATION

| Part Number   | Top Marking   | Package                 | Quantity |
|---------------|---------------|-------------------------|----------|
| FGY60T120SQDN | FGY60T120SQDN | TO-247-3LD<br>(Pb-Free) | 30/Tube  |

TYPICAL PERFORMANCE CHARACTERISTICS

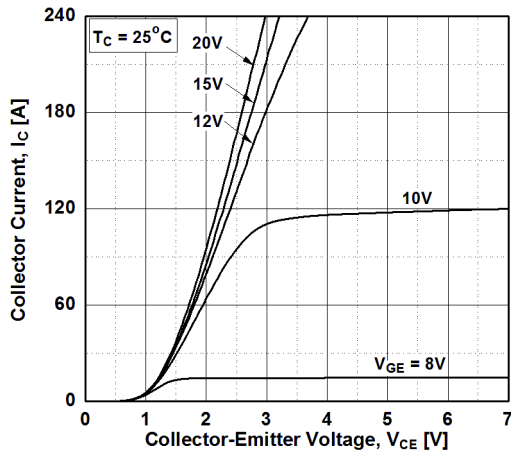


Figure 1. Typical Output Characteristics

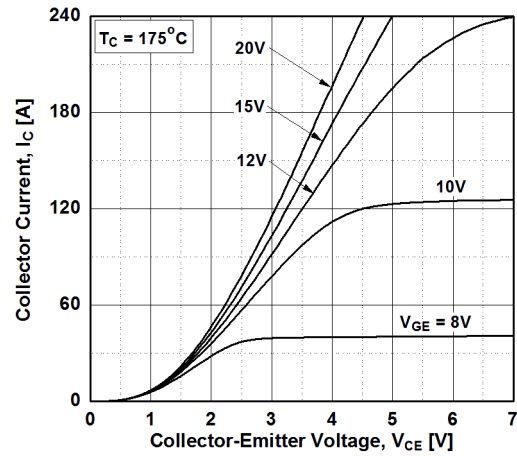


Figure 2. Typical Output Characteristics

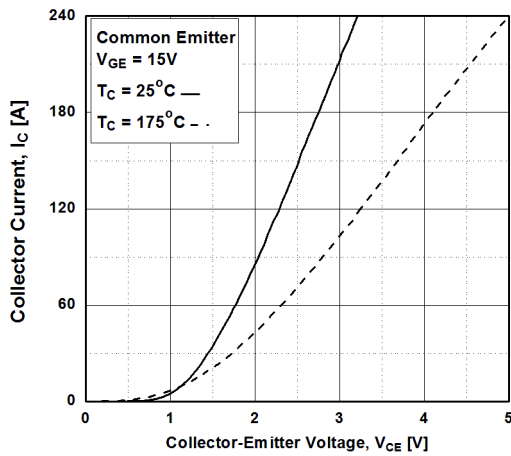


Figure 3. Typical Saturation Voltage Characteristics

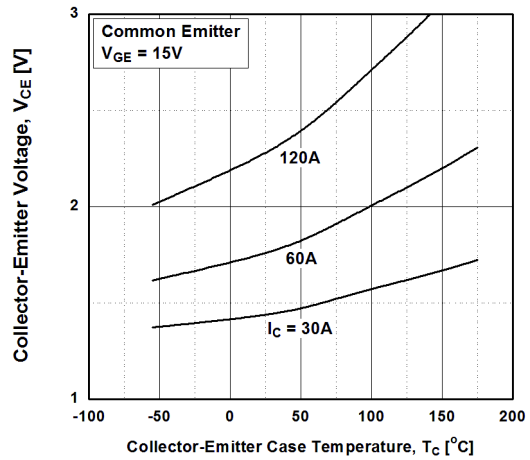


Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level

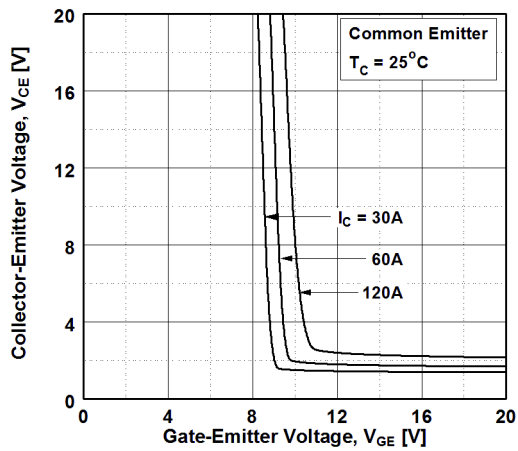


Figure 5. Saturation Voltage vs.  $V_{GE}$

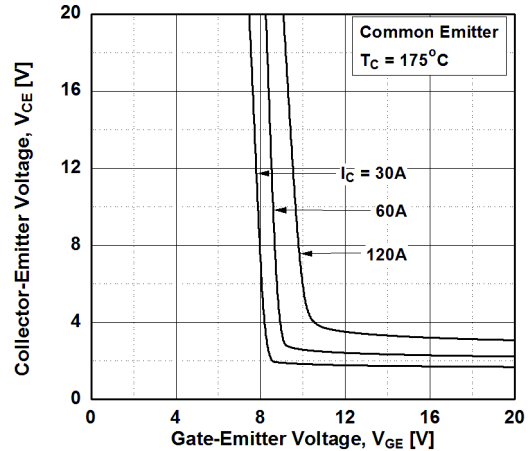


Figure 6. Saturation Voltage vs.  $V_{GE}$

TYPICAL PERFORMANCE CHARACTERISTICS

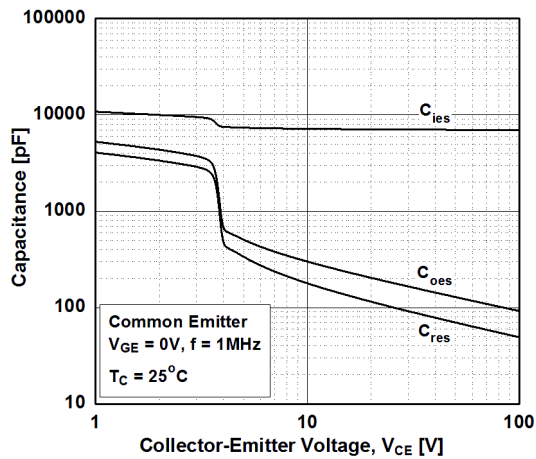


Figure 7. Capacitance Characteristics

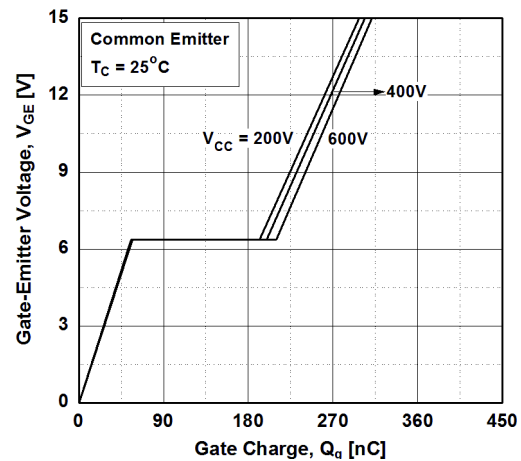


Figure 8. Gate charge Characteristics

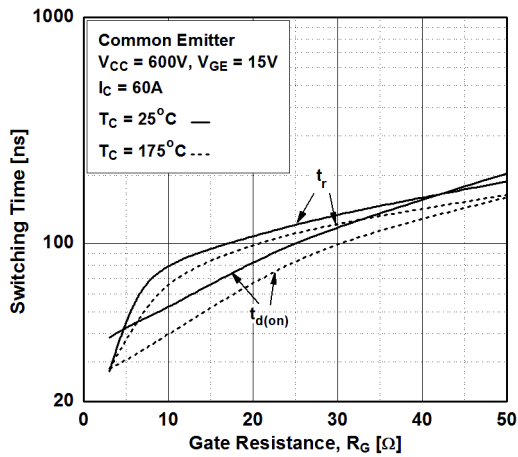


Figure 9. Turn-on Characteristics vs. Gate Resistance

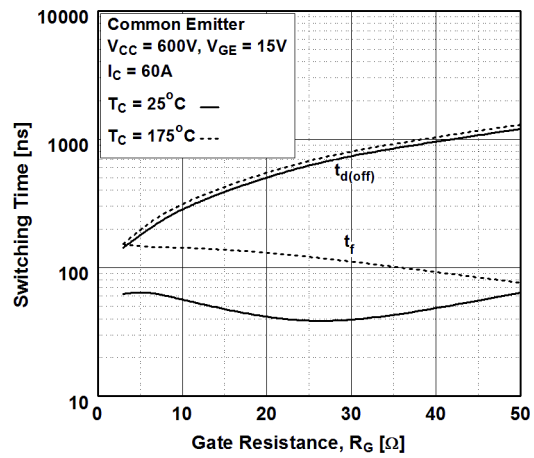


Figure 10. Turn-off Characteristics vs. Gate Resistance

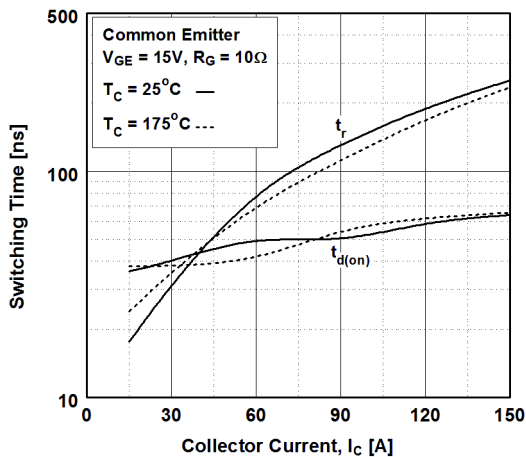


Figure 11. Turn-on Characteristics vs. Collector Current

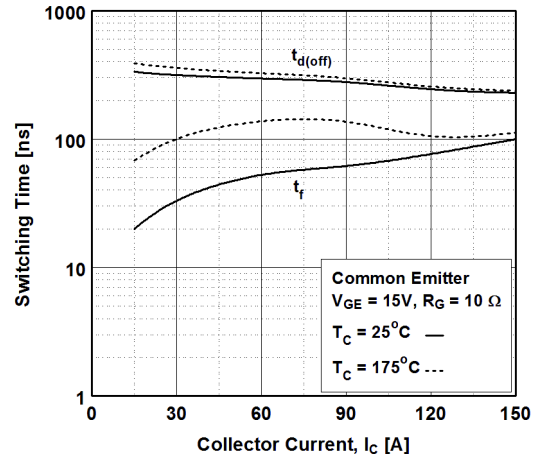


Figure 12. Turn-off Characteristics vs. Collector Current

TYPICAL PERFORMANCE CHARACTERISTICS

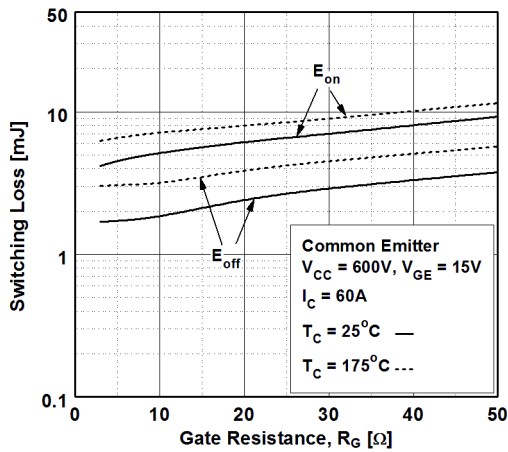


Figure 13. Switching Loss vs. Gate Resistance

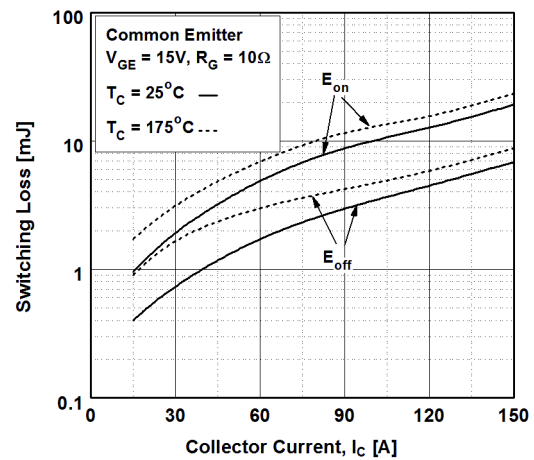


Figure 14. Switching Loss vs. Collector Current

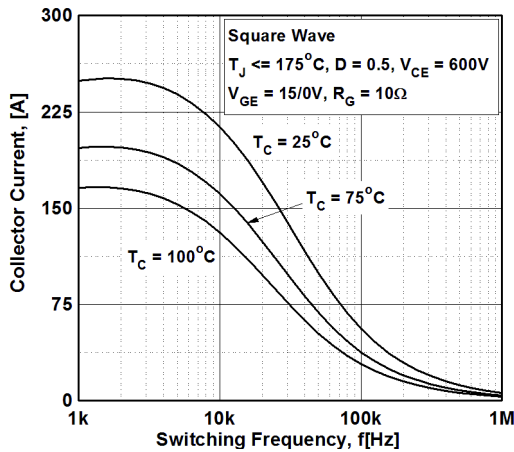


Figure 15. Load Current vs. Frequency

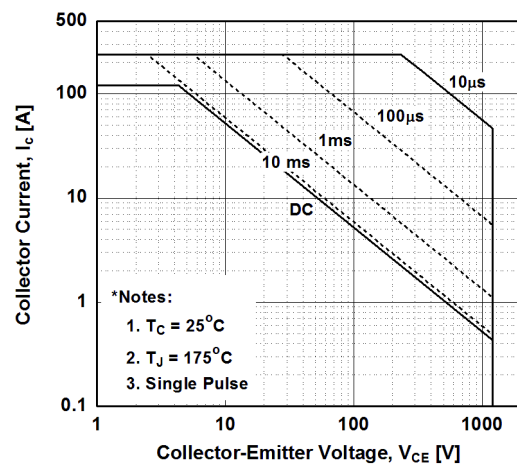


Figure 16. SOA Characteristics

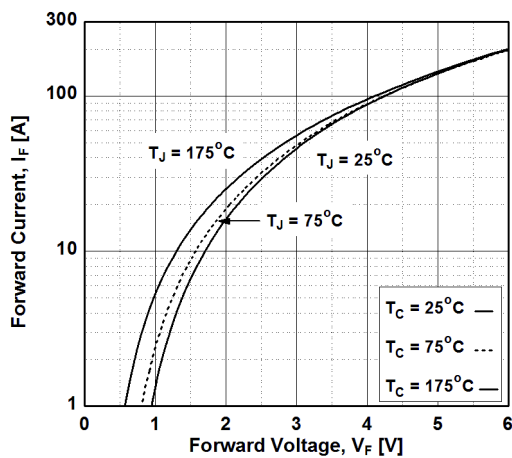


Figure 17. Forward Characteristics

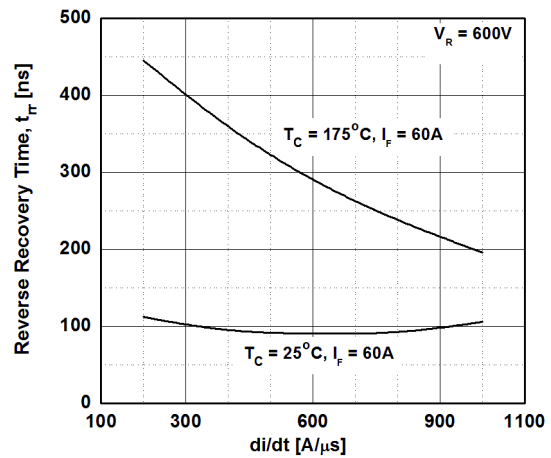


Figure 18. Reverse Recovery Time vs.  $di_F/dt$

# FGY60T120SQDN

## TYPICAL PERFORMANCE CHARACTERISTICS

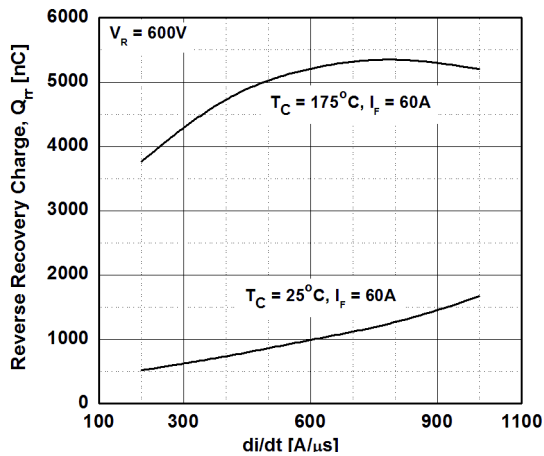


Figure 19. Reverse Recovery Charge vs.  $di_F/dt$

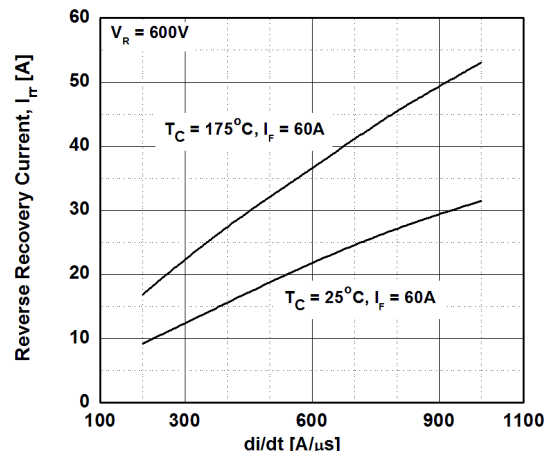


Figure 20. Reverse Recovery Current vs.  $di_F/dt$

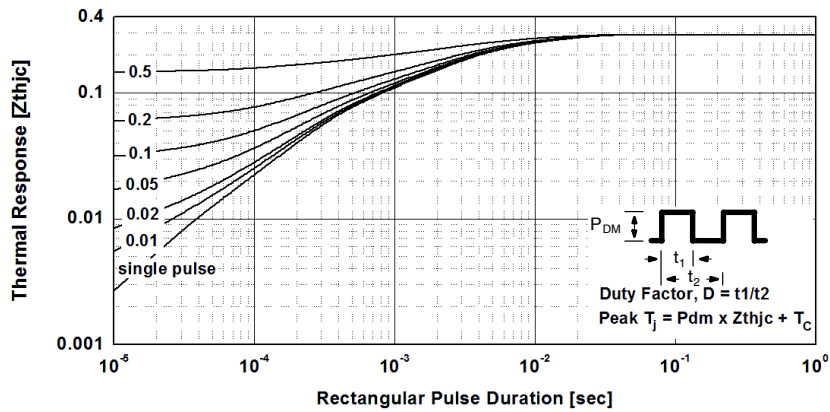


Figure 21. Transient Thermal Impedance if IGBT

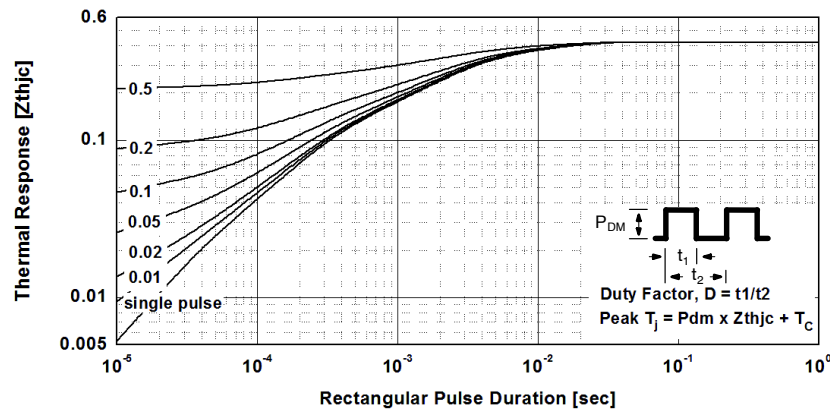
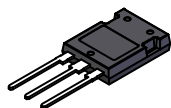


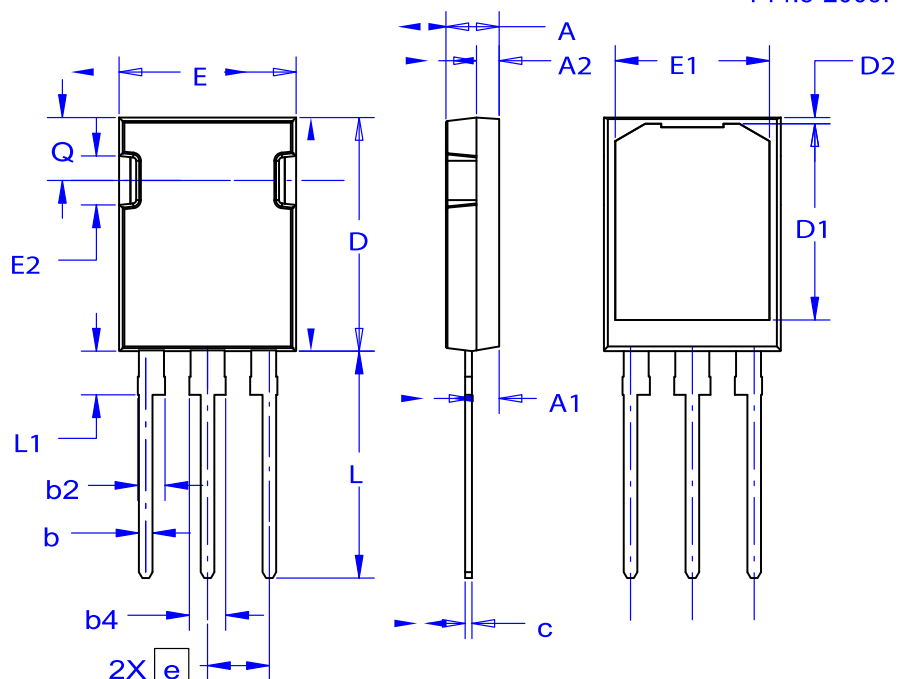
Figure 22. Transient Thermal Impedance if Diode


**TO-247-3LD**  
**CASE 340CD**  
**ISSUE A**

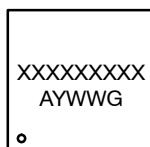
DATE 18 SEP 2018

**NOTES:**

- A. THIS PACKAGE DOES NOT CONFORM TO ANY STANDARDS.  
B. ALL DIMENSIONS ARE IN MILLIMETERS.  
C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.  
D. DIMENSION AND TOLERANCE AS PER ASME Y14.5-2009.



| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN         | NOM   | MAX   |
| A   | 4.58        | 4.70  | 4.82  |
| A1  | 2.20        | 2.40  | 2.60  |
| A2  | 1.80        | 2.00  | 2.20  |
| D   | 20.32       | 20.57 | 20.82 |
| E   | 15.37       | 15.62 | 15.87 |
| E2  | 4.12        | 4.32  | 4.52  |
| e   | ~           | 5.45  | ~     |
| L   | 19.90       | 20.00 | 20.10 |
| L1  | 3.69        | 3.81  | 3.93  |
| Q   | 5.34        | 5.46  | 5.58  |
| b   | 1.10        | 1.20  | 1.30  |
| b2  | 2.10        | 2.24  | 2.39  |
| b4  | 2.87        | 3.04  | 3.20  |
| c   | 0.51        | 0.61  | 0.71  |
| D1  | 16.63       | 16.83 | 17.03 |
| D2  | 0.51        | 0.93  | 1.35  |
| E1  | 13.40       | 13.60 | 13.80 |

**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.

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