

# IGBT – Power, Co-PAK N-Channel, Field Stop VII (FS7), Non SCR, TO247-3L 1200 V, 1.7 V, 40 A

## FGHL40T120SWD

### Description

Using the novel field stop 7th generation IGBT technology and the Gen7 Diode in TO247 3-lead package, FGHL40T120SWD offers the optimum performance with low switching and conduction losses for high efficiency operations in various applications like Solar, UPS and ESS.

### Features

- Maximum Junction Temperature –  $T_J = 175^{\circ}\text{C}$
- Positive Temperature Coefficient for Easy Parallel Operation
- High Current Capability
- Smooth and Optimized Switching
- Low Switching Loss
- RoHS Compliant

### Applications

- Boost and Inverter in Solar Applications
- UPS
- Energy Storage System

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

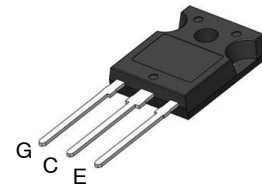
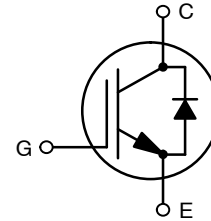
| Parameter                                        |                                                                      | Symbol         | Value       | Unit               |
|--------------------------------------------------|----------------------------------------------------------------------|----------------|-------------|--------------------|
| Collector-to-Emitter Voltage                     |                                                                      | $V_{CES}$      | 1200        | V                  |
| Gate-to-Emitter Voltage                          |                                                                      | $V_{GES}$      | $\pm 20$    |                    |
| Transient Gate-to-Emitter Voltage                |                                                                      |                | $\pm 30$    |                    |
| Collector Current                                | $T_C = 25^{\circ}\text{C}$ (Note 1)                                  | $I_C$          | 70          | A                  |
|                                                  | $T_C = 100^{\circ}\text{C}$                                          |                | 40          |                    |
| Power Dissipation                                | $T_C = 25^{\circ}\text{C}$                                           | $P_D$          | 469         | W                  |
|                                                  | $T_C = 100^{\circ}\text{C}$                                          |                | 234         |                    |
| Pulsed Collector Current                         | $T_C = 25^{\circ}\text{C}$ (Note 2)<br>$t_p = 10\text{ }\mu\text{s}$ | $I_{CM}$       | 160         | A                  |
| Diode Forward Current                            | $T_C = 25^{\circ}\text{C}$ (Note 1)                                  | $I_F$          | 80          |                    |
|                                                  | $T_C = 100^{\circ}\text{C}$                                          |                | 40          |                    |
| Pulsed Diode Maximum Forward Current             | $T_C = 25^{\circ}\text{C}$ ,<br>$t_p = 10\text{ }\mu\text{s}$        | $I_{FM}$       | 160         |                    |
| Operating Junction and Storage Temperature Range |                                                                      | $T_J, T_{stg}$ | -55 to +175 | $^{\circ}\text{C}$ |
| Lead Temperature for Soldering Purposes          |                                                                      | $T_L$          | 260         |                    |

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. Value limit by bond wire
2. Repetitive rating: Pulse width limited by max. junction temperature

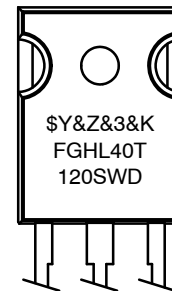
|            |               |       |
|------------|---------------|-------|
| $BV_{CES}$ | $V_{CE(SAT)}$ | $I_C$ |
| 1200 V     | 1.7 V         | 40 A  |

### PIN CONNECTIONS



TO-247-3LD  
CASE 340CX

### MARKING DIAGRAM



$\$Y$  = onsemi Logo  
 $\&Z$  = Assembly Plant Code  
 $\&3$  = 3-Digit Date Code  
 $\&K$  = 2-Digit Lot Traceability Code  
 FGHL40T120SWD = Specific Device Code

### ORDERING INFORMATION

| Device        | Package             | Shipping        |
|---------------|---------------------|-----------------|
| FGHL40T120SWD | TO-247<br>(Pb-Free) | 30 Units / Tube |

# FGHL40T120SWD

## THERMAL CHARACTERISTICS

| Parameter                                      | Symbol           | Value | Unit |
|------------------------------------------------|------------------|-------|------|
| Thermal Resistance, Junction-to-Case for IGBT  | $R_{\theta JC}$  | 0.32  | °C/W |
| Thermal Resistance, Junction-to-Case for Diode | $R_{\theta JCD}$ | 0.57  |      |
| Thermal Resistance, Junction-to-Ambient        | $R_{\theta JA}$  | 40    |      |

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

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

### OFF CHARACTERISTICS

|                                                                |                                      |                                             |      |      |      |       |
|----------------------------------------------------------------|--------------------------------------|---------------------------------------------|------|------|------|-------|
| Collector-to-Emitter Breakdown Voltage                         | $BV_{CES}$                           | $V_{GE} = 0\text{ V}, I_C = 5\text{ mA}$    | 1200 | –    | –    | V     |
| Collector-to-Emitter Breakdown Voltage Temperature Coefficient | $\frac{\Delta BV_{CES}}{\Delta T_J}$ | $V_{GE} = 0\text{ V}, I_C = 5\text{ mA}$    | –    | 1226 | –    | mV/°C |
| Zero Gate Voltage Collector Current                            | $I_{CES}$                            | $V_{GE} = 0\text{ V}, V_{CE} = V_{CES}$     | –    | –    | 40   | μA    |
| Gate-to-Emitter Leakage Current                                | $I_{GES}$                            | $V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$ | –    | –    | ±400 | nA    |

### ON CHARACTERISTICS

|                                         |               |                                                                    |      |      |     |   |
|-----------------------------------------|---------------|--------------------------------------------------------------------|------|------|-----|---|
| Gate Threshold Voltage                  | $V_{GE(th)}$  | $V_{GE} = V_{CE}, I_C = 40\text{ mA}$                              | 5.6  | 6.55 | 7.4 | V |
| Collector-to-Emitter Saturation Voltage | $V_{CE(sat)}$ | $V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 25^\circ\text{C}$  | 1.35 | 1.68 | 2.0 | V |
|                                         |               | $V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 175^\circ\text{C}$ | –    | 2.26 | –   |   |

### DYNAMIC CHARACTERISTICS

|                              |           |                                                                  |   |      |   |    |
|------------------------------|-----------|------------------------------------------------------------------|---|------|---|----|
| Input Capacitance            | $C_{ies}$ | $V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$    | – | 3384 | – | pF |
| Output Capacitance           | $C_{oes}$ |                                                                  | – | 139  | – |    |
| Reverse Transfer Capacitance | $C_{res}$ |                                                                  | – | 16.2 | – |    |
| Gate Charge Total            | $Q_g$     | $V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 40\text{ A}$ | – | 118  | – | nC |
| Gate-to-Emitter Charge       | $Q_{ge}$  |                                                                  | – | 28.8 | – |    |
| Gate-to-Collector Charge     | $Q_{gc}$  |                                                                  | – | 45.4 | – |    |

### SWITCHING CHARACTERISTICS

|                         |              |                                                                                                               |   |      |   |    |
|-------------------------|--------------|---------------------------------------------------------------------------------------------------------------|---|------|---|----|
| Turn-on Delay Time      | $t_{d(on)}$  | $V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}, I_C = 20\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$ | – | 22.4 | – | ns |
| Turn-off Delay Time     | $t_{d(off)}$ |                                                                                                               | – | 160  | – |    |
| Rise Time               | $t_r$        |                                                                                                               | – | 14.4 | – |    |
| Fall Time               | $t_f$        |                                                                                                               | – | 78.4 | – |    |
| Turn-on Switching Loss  | $E_{on}$     | $V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}, I_C = 40\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$ | – | 1.1  | – | mJ |
| Turn-off Switching Loss | $E_{off}$    |                                                                                                               | – | 0.7  | – |    |
| Total Switching Loss    | $E_{ts}$     |                                                                                                               | – | 1.8  | – |    |
| Turn-on Delay Time      | $t_{d(on)}$  | $V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}, I_C = 40\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$ | – | 24.0 | – | ns |
| Turn-off Delay Time     | $t_{d(off)}$ |                                                                                                               | – | 118  | – |    |
| Rise Time               | $t_r$        |                                                                                                               | – | 35.2 | – |    |
| Fall Time               | $t_f$        |                                                                                                               | – | 67.4 | – |    |
| Turn-on Switching Loss  | $E_{on}$     |                                                                                                               | – | 2.4  | – | mJ |
| Turn-off Switching Loss | $E_{off}$    |                                                                                                               | – | 1.1  | – |    |
| Total Switching Loss    | $E_{ts}$     |                                                                                                               | – | 3.5  | – |    |

# FGHL40T120SWD

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

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

### SWITCHING CHARACTERISTICS

|                         |              |                                                                                                                    |   |      |   |    |
|-------------------------|--------------|--------------------------------------------------------------------------------------------------------------------|---|------|---|----|
| Turn-on Delay Time      | $t_{d(on)}$  | $V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}$<br>$I_C = 20\text{ A } R_G = 4.7\ \Omega, T_J = 175^\circ\text{C}$ | – | 19.2 | – | ns |
| Turn-off Delay Time     | $t_{d(off)}$ |                                                                                                                    | – | 197  | – |    |
| Rise Time               | $t_r$        |                                                                                                                    | – | 16.0 | – |    |
| Fall Time               | $t_f$        |                                                                                                                    | – | 126  | – |    |
| Turn-on Switching Loss  | $E_{on}$     |                                                                                                                    | – | 1.8  | – | mJ |
| Turn-off Switching Loss | $E_{off}$    |                                                                                                                    | – | 1.1  | – |    |
| Total Switching Loss    | $E_{ts}$     |                                                                                                                    | – | 3.0  | – |    |
| Turn-on Delay Time      | $t_{d(on)}$  | $V_{CE} = 600\text{ V}, V_{GE} = 0/15\text{ V}$<br>$I_C = 40\text{ A } R_G = 4.7\ \Omega, T_J = 175^\circ\text{C}$ | – | 20.8 | – | ns |
| Turn-off Delay Time     | $t_{d(off)}$ |                                                                                                                    | – | 138  | – |    |
| Rise Time               | $t_r$        |                                                                                                                    | – | 35.2 | – |    |
| Fall Time               | $t_f$        |                                                                                                                    | – | 99.6 | – |    |
| Turn-on Switching Loss  | $E_{on}$     |                                                                                                                    | – | 3.6  | – | mJ |
| Turn-off Switching Loss | $E_{off}$    |                                                                                                                    | – | 1.5  | – |    |
| Total Switching Loss    | $E_{ts}$     |                                                                                                                    | – | 5.2  | – |    |

### DIODE CHARACTERISTICS

|                 |       |                                              |      |      |      |   |
|-----------------|-------|----------------------------------------------|------|------|------|---|
| Forward Voltage | $V_F$ | $I_F = 40\text{ A}, T_J = 25^\circ\text{C}$  | 1.62 | 1.87 | 2.22 | V |
|                 |       | $I_F = 40\text{ A}, T_J = 175^\circ\text{C}$ | –    | 1.84 | –    |   |

### DIODE SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

|                               |           |                                                                                                            |   |      |   |    |
|-------------------------------|-----------|------------------------------------------------------------------------------------------------------------|---|------|---|----|
| Reverse Recovery Time         | $t_{rr}$  | $V_R = 600\text{ V}, I_F = 20\text{ A},$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 25^\circ\text{C}$  | – | 113  | – | ns |
| Reverse Recovery Charge       | $Q_{rr}$  |                                                                                                            | – | 1433 | – | nC |
| Reverse Recovery Energy       | $E_{REC}$ |                                                                                                            | – | 0.4  | – | mJ |
| Peak Reverse Recovery Current | $I_{RRM}$ |                                                                                                            | – | 25.3 | – | A  |
| Reverse Recovery Time         | $t_{rr}$  | $V_R = 600\text{ V}, I_F = 40\text{ A},$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 25^\circ\text{C}$  | – | 185  | – | ns |
| Reverse Recovery Charge       | $Q_{rr}$  |                                                                                                            | – | 2512 | – | nC |
| Reverse Recovery Energy       | $E_{REC}$ |                                                                                                            | – | 0.7  | – | mJ |
| Peak Reverse Recovery Current | $I_{RRM}$ |                                                                                                            | – | 26.9 | – | A  |
| Reverse Recovery Time         | $t_{rr}$  | $V_R = 600\text{ V}, I_F = 20\text{ A},$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$ | – | 193  | – | ns |
| Reverse Recovery Charge       | $Q_{rr}$  |                                                                                                            | – | 3258 | – | nC |
| Reverse Recovery Energy       | $E_{REC}$ |                                                                                                            | – | 1.0  | – | mJ |
| Peak Reverse Recovery Current | $I_{RRM}$ |                                                                                                            | – | 33.6 | – | A  |
| Reverse Recovery Time         | $t_{rr}$  | $V_R = 600\text{ V}, I_F = 40\text{ A},$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$ | – | 275  | – | ns |
| Reverse Recovery Charge       | $Q_{rr}$  |                                                                                                            | – | 5211 | – | nC |
| Reverse Recovery Energy       | $E_{REC}$ |                                                                                                            | – | 1.7  | – | mJ |
| Peak Reverse Recovery Current | $I_{RRM}$ |                                                                                                            | – | 37.9 | – | A  |

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.

# FGHL40T120SWD

## TYPICAL CHARACTERISTICS

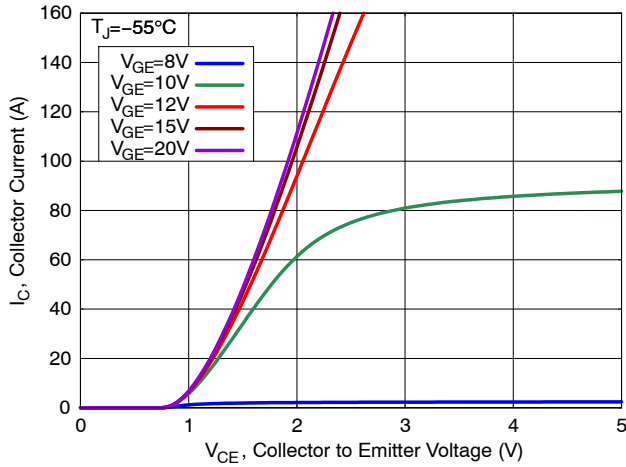


Figure 1. Output Characteristics

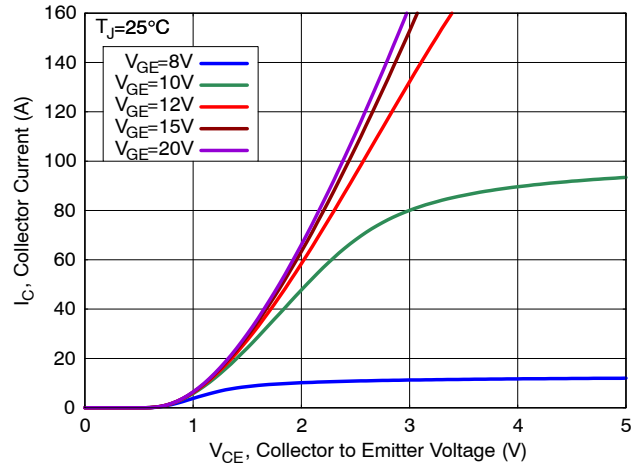


Figure 2. Output Characteristics

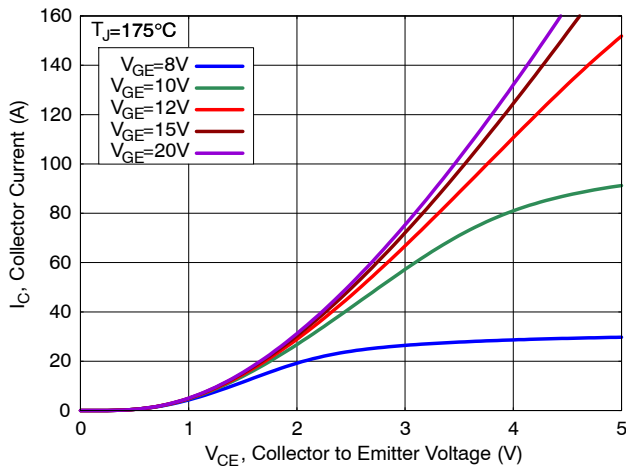


Figure 3. Output Characteristics

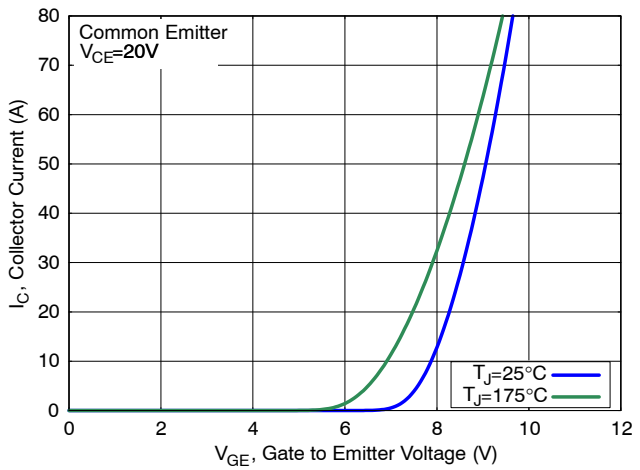


Figure 4. Transfer Characteristics

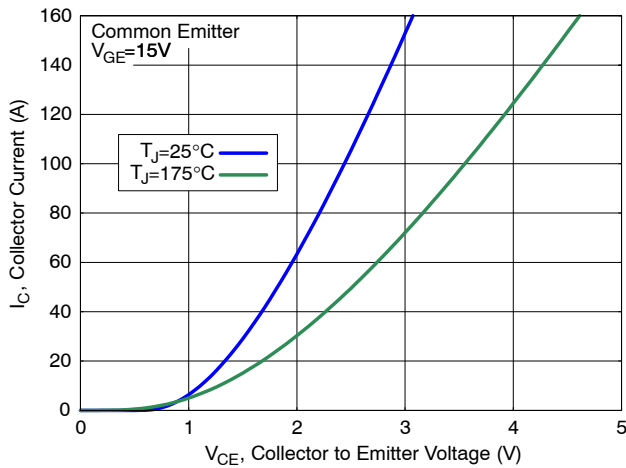


Figure 5. Saturation Characteristics

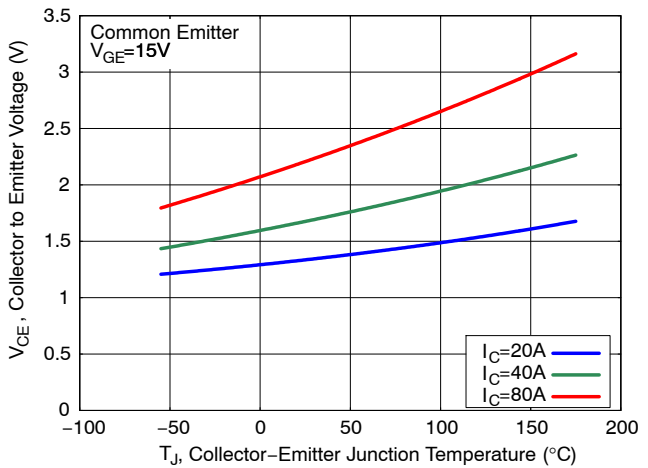


Figure 6. Saturation Voltage vs. Junction Temperature

TYPICAL CHARACTERISTICS

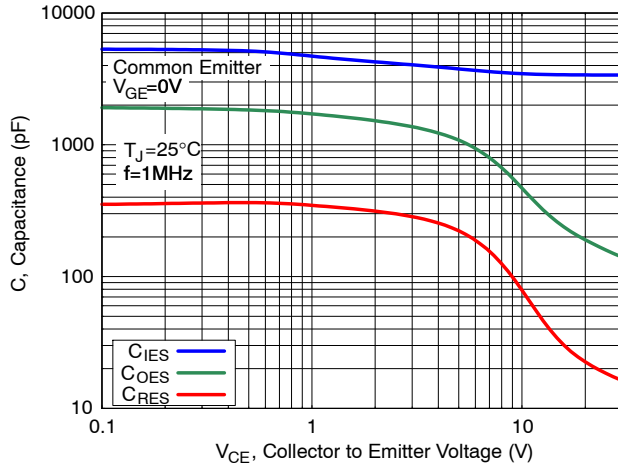


Figure 7. Capacitance Characteristics

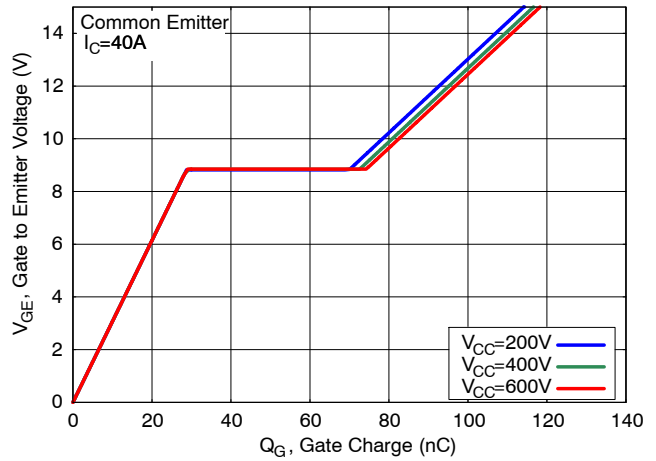


Figure 8. Gate Charge Characteristics

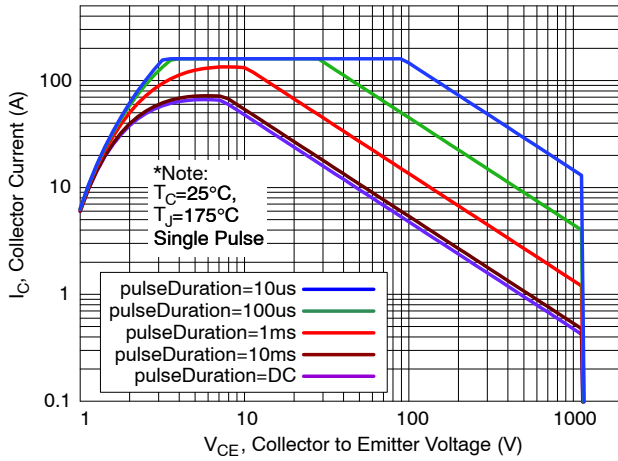


Figure 9. SOA Characteristics

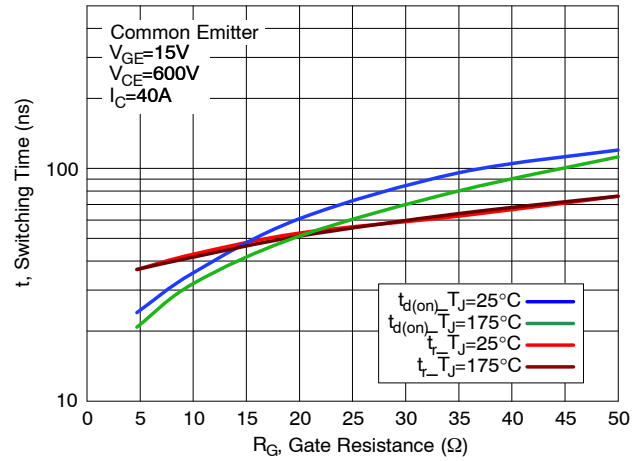


Figure 10. Turn-On Switching Time vs. Gate Resistance

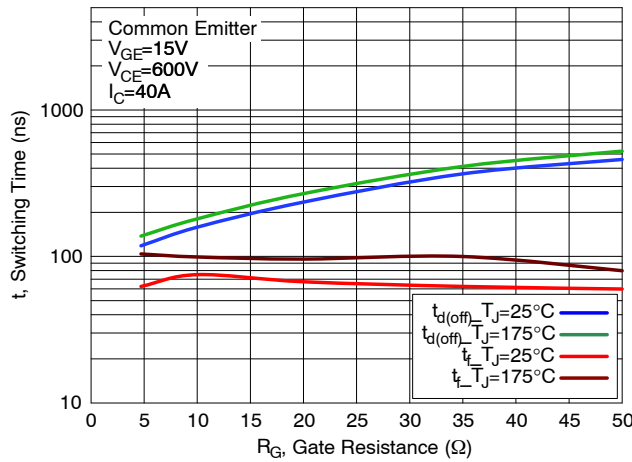


Figure 11. Turn-Off Switching Time vs. Gate Resistance

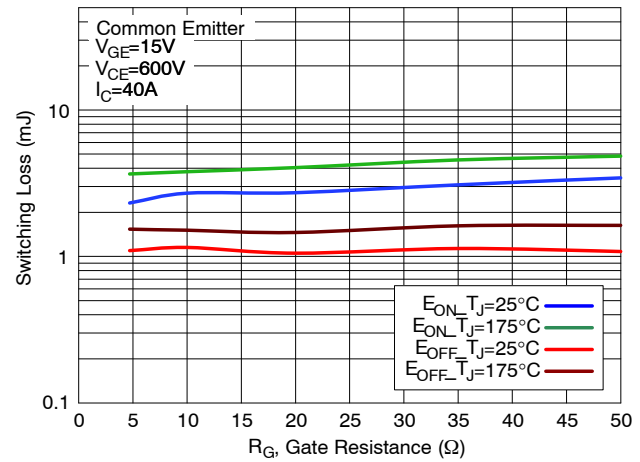


Figure 12. Switching Loss vs. Gate Resistance

TYPICAL CHARACTERISTICS

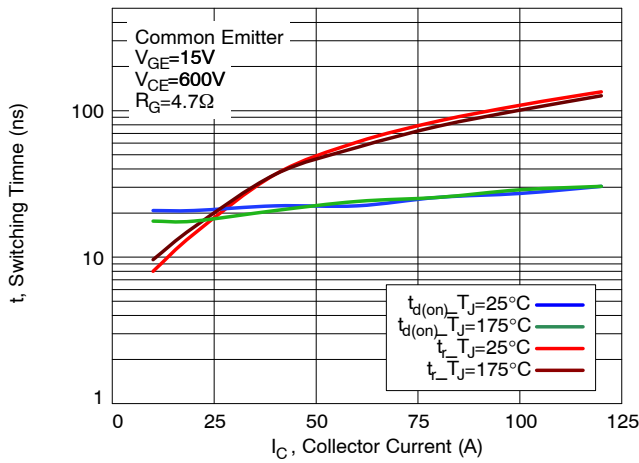


Figure 13. Turn-On Switching Time vs. Collector Current

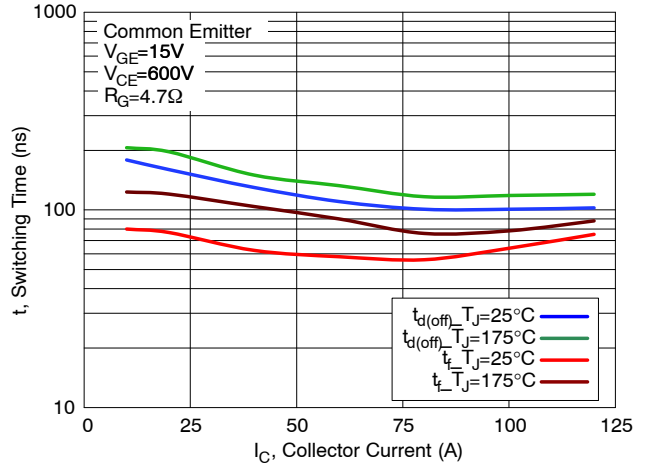


Figure 14. Turn-Off Switching Time vs. Collector Current

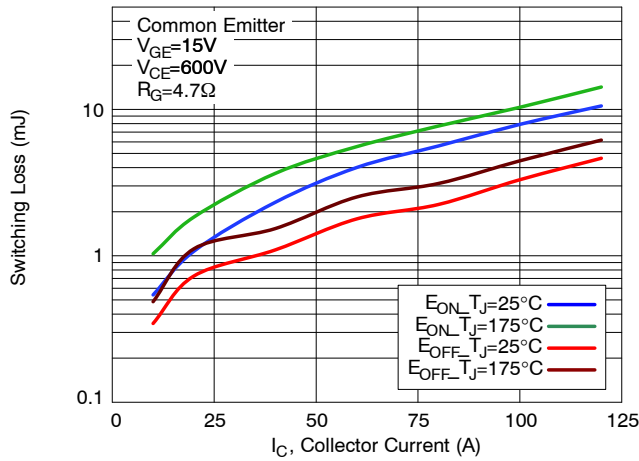


Figure 15. Switching Loss vs. Collector Current

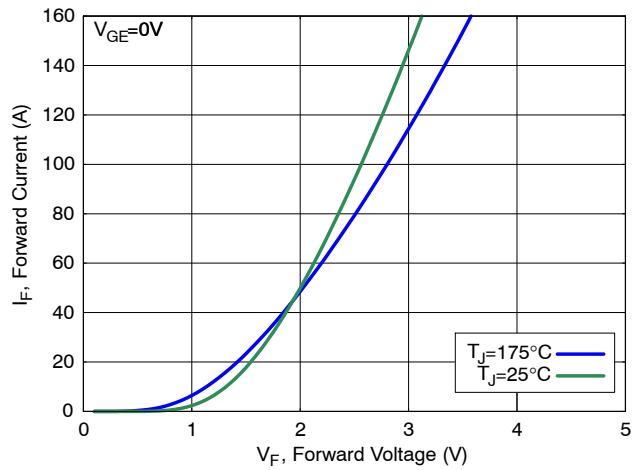


Figure 16. Diode Forward Characteristics

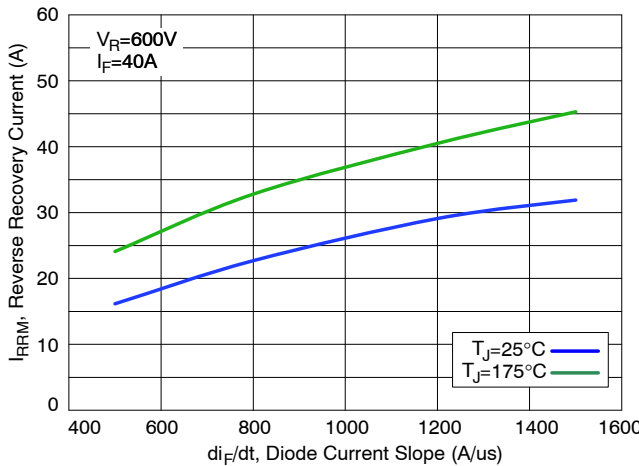


Figure 17. Diode Reverse Recovery Current

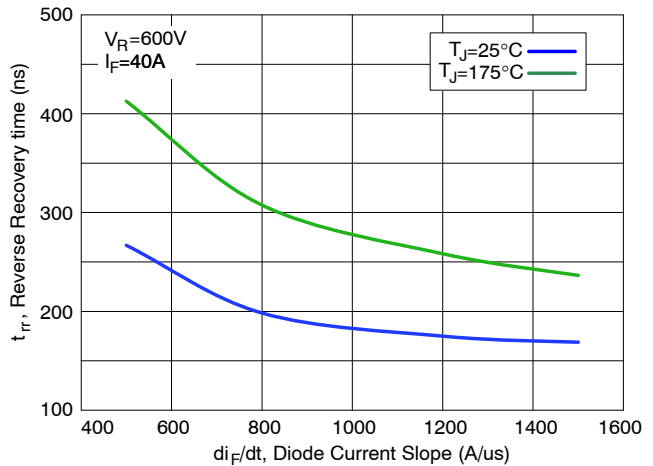


Figure 18. Diode Reverse Recovery Time

# FGHL40T120SWD

## TYPICAL CHARACTERISTICS

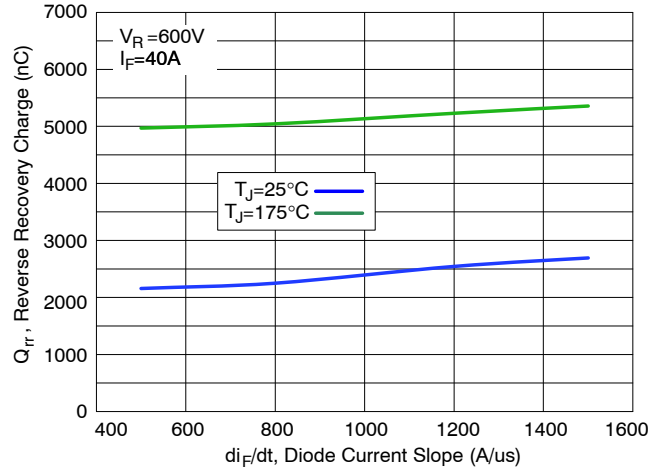


Figure 19. Diode Stored Charge Characteristics

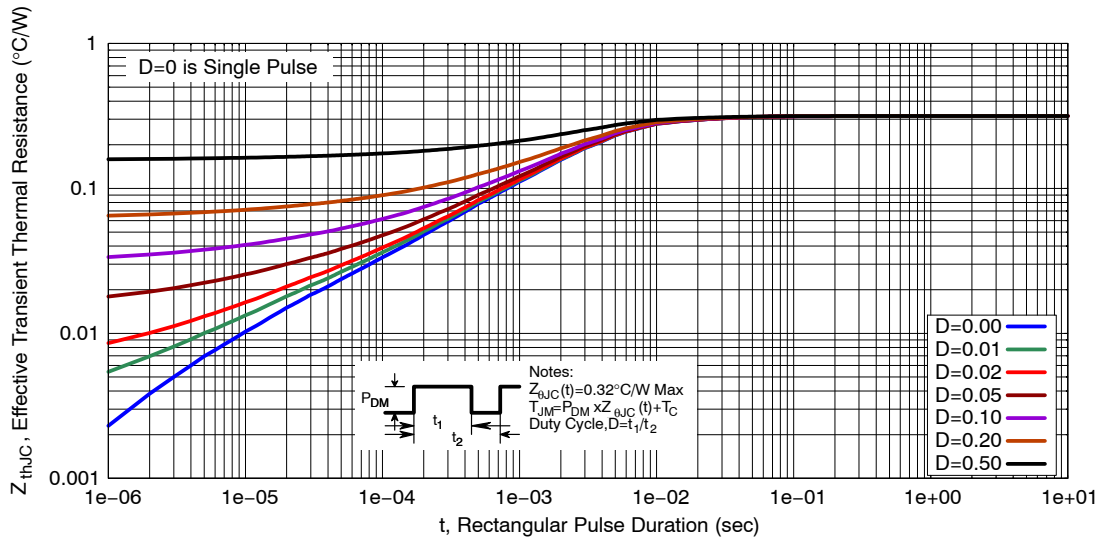


Figure 20. Transient Thermal Impedance of IGBT

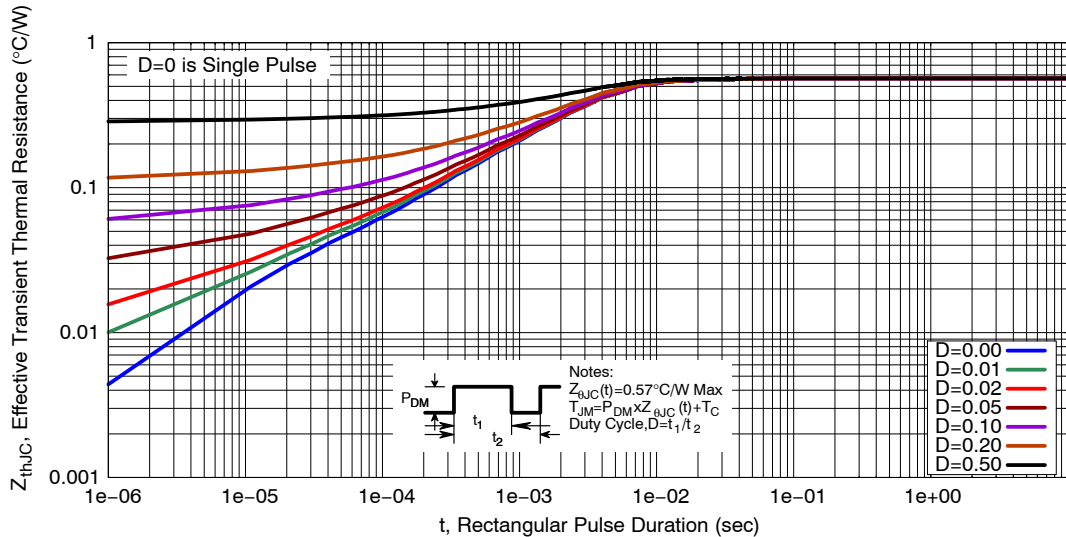


Figure 21. Transient Thermal Impedance of Diode

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

DATE 06 JUL 2020



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\***


XXXXX = 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  | 2.20        | 2.40  | 2.60  |
| 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 | 6.60        | 6.80  | 7.00  |

|                         |                    |                                                                                                                                                                                     |
|-------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| <b>DESCRIPTION:</b>     | <b>TO-247-3LD</b>  | <b>PAGE 1 OF 1</b>                                                                                                                                                                  |

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