

# IGBT – Power, Co-PAK N-Channel, Field Stop VII (FS7), TO247-4L 1200 V, 1.7 V, 140 A FGY4L140T120SWD

## Description

Using the novel field stop 7th generation IGBT technology and the Gen7 Diode in TO247 4-lead package, FGY4L140T120SWD offers the optimum performance with low switching and conduction losses for high-efficiency operations in various applications like Solar Inverter, 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

- Solar Inverter
- UPS
- Energy Storage System

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

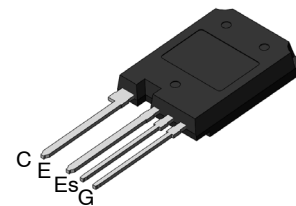
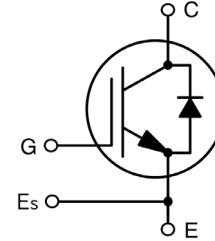
| Parameter                                        | Symbol         | Value                                                           | Unit               |
|--------------------------------------------------|----------------|-----------------------------------------------------------------|--------------------|
| Collector-to-Emitter Voltage                     | $V_{CE}$       | 1200                                                            | V                  |
| Gate-to-Emitter Voltage                          | $V_{GE}$       | $\pm 20$                                                        |                    |
| Transient Gate-to-Emitter Voltage                |                | $\pm 30$                                                        |                    |
| Collector Current                                | $I_C$          | $T_C = 25^{\circ}\text{C}$ (Note 1)                             | A                  |
|                                                  |                | $T_C = 100^{\circ}\text{C}$                                     |                    |
| Power Dissipation                                | $P_D$          | $T_C = 25^{\circ}\text{C}$                                      | W                  |
|                                                  |                | $T_C = 100^{\circ}\text{C}$                                     |                    |
| Pulsed Collector Current                         | $I_{CM}$       | $T_C = 25^{\circ}\text{C}$ ,<br>$t_p = 10 \mu\text{s}$ (Note 2) | A                  |
|                                                  |                |                                                                 |                    |
| Diode Forward Current                            | $I_F$          | $T_C = 25^{\circ}\text{C}$ (Note 1)                             | A                  |
|                                                  |                | $T_C = 100^{\circ}\text{C}$                                     |                    |
| Pulsed Diode Forward Current                     | $I_{FM}$       | $T_C = 25^{\circ}\text{C}$ ,<br>$t_p = 10 \mu\text{s}$ (Note 2) | A                  |
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$ | $-55$ to $+175$                                                 | $^{\circ}\text{C}$ |
| Lead Temperature for Soldering Purposes          | $T_L$          | 265                                                             |                    |

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.

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

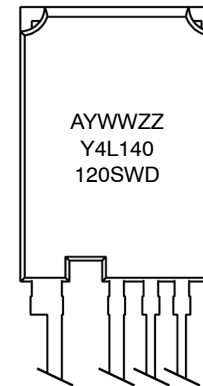
| $BV_{CES}$ | $V_{CE(SAT\_TYP)}$ | $I_C$ |
|------------|--------------------|-------|
| 1200 V     | 1.7 V              | 140 A |

## PIN CONNECTIONS



TO-247-4LD  
CASE 340BW

## MARKING DIAGRAM



A = Assembly Location  
YWW = Date code (Year & week)  
ZZ = Assembly Lot  
Y4L140120SWD = Specific Device Code

## ORDERING INFORMATION

| Device          | Package                 | Shipping           |
|-----------------|-------------------------|--------------------|
| FGY4L140T120SWD | TO-247-4LD<br>(Pb-Free) | 30 Units /<br>Tube |

# FGY4L140T120SWD

## THERMAL CHARACTERISTICS

| Parameter                                      | Symbol           | Value |      |      | Unit |
|------------------------------------------------|------------------|-------|------|------|------|
|                                                |                  | Min   | Typ  | Max  |      |
| Thermal Resistance, Junction-to-Case for IGBT  | $R_{\theta JC}$  | –     | 0.09 | 0.12 | °C/W |
| Thermal Resistance, Junction-to-Case for Diode | $R_{\theta JCD}$ | –     | 0.15 | 0.2  |      |
| Thermal Resistance, Junction-to-Ambient        | $R_{\theta JA}$  | –     | –    | 40   |      |

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

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

### OFF CHARACTERISTICS

|                                           |                                      |                                                 |      |      |      |       |
|-------------------------------------------|--------------------------------------|-------------------------------------------------|------|------|------|-------|
| Collector-to-Emitter Breakdown Voltage    | $BV_{CES}$                           | $V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$        | 1200 | –    | –    | V     |
| Breakdown Voltage Temperature Coefficient | $\frac{\Delta BV_{CES}}{\Delta T_J}$ | $V_{GE} = 0\text{ V}, I_C = 9.99\text{ mA}$     | –    | 1256 | –    | mV/°C |
| Collector-to-Emitter Cut-Off Current      | $I_{CES}$                            | $V_{GE} = 0\text{ V}, V_{CE} = V_{CES}$         | –    | –    | 40   | μA    |
| Gate-to-Emitter Leakage Current           | $I_{GES}$                            | $V_{GE} = \pm 20\text{ V}, V_{CE} = 0\text{ V}$ | –    | –    | ±400 | nA    |

### ON CHARACTERISTICS

|                                         |               |                                                                     |     |     |     |   |
|-----------------------------------------|---------------|---------------------------------------------------------------------|-----|-----|-----|---|
| Gate-to-Emitter Threshold Voltage       | $V_{GE(th)}$  | $V_{GE} = V_{CE}, I_C = 140\text{ mA}$                              | 5.6 | 6.5 | 7.4 | V |
| Collector-to-Emitter Saturation Voltage | $V_{CE(sat)}$ | $V_{GE} = 15\text{ V}, I_C = 140\text{ A}, T_J = 25^\circ\text{C}$  | –   | 1.7 | 2.0 |   |
|                                         |               | $V_{GE} = 15\text{ V}, I_C = 140\text{ A}, T_J = 175^\circ\text{C}$ | –   | 2.4 | –   |   |

### DYNAMIC CHARACTERISTICS

|                              |           |                                                                   |   |       |   |    |
|------------------------------|-----------|-------------------------------------------------------------------|---|-------|---|----|
| Input Capacitance            | $C_{ies}$ | $V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$     | – | 13600 | – | pF |
| Output Capacitance           | $C_{oes}$ |                                                                   | – | 389   | – |    |
| Reverse Transfer Capacitance | $C_{res}$ |                                                                   | – | 53.2  | – |    |
| Total Gate Charge            | $Q_g$     | $V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 140\text{ A}$ | – | 426   | – | nC |
| Gate-to-Emitter Charge       | $Q_{ge}$  |                                                                   | – | 114   | – |    |
| Gate-to-Collector Charge     | $Q_{gc}$  |                                                                   | – | 148   | – |    |

### SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

|                         |              |                                                                                                              |   |       |   |    |
|-------------------------|--------------|--------------------------------------------------------------------------------------------------------------|---|-------|---|----|
| Turn-on Delay Time      | $t_{d(on)}$  | $V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 70\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$  | – | 56    | – | ns |
| Rise Time               | $t_r$        |                                                                                                              | – | 16    | – |    |
| Turn-off Delay Time     | $t_{d(off)}$ |                                                                                                              | – | 254.4 | – |    |
| Fall Time               | $t_f$        |                                                                                                              | – | 65.6  | – |    |
| Turn-on Switching Loss  | $E_{on}$     | $V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 140\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$ | – | 2.2   | – | mJ |
| Turn-off Switching Loss | $E_{off}$    |                                                                                                              | – | 2.1   | – |    |
| Total Switching Loss    | $E_{ts}$     |                                                                                                              | – | 4.2   | – |    |
| Turn-on Delay Time      | $t_{d(on)}$  |                                                                                                              | – | 60.8  | – | ns |
| Rise Time               | $t_r$        |                                                                                                              | – | 27.2  | – |    |
| Turn-off Delay Time     | $t_{d(off)}$ |                                                                                                              | – | 232   | – |    |
| Fall Time               | $t_f$        |                                                                                                              | – | 57.6  | – |    |
| Turn-on Switching Loss  | $E_{on}$     | $V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}, I_C = 140\text{ A}, R_G = 4.7\ \Omega, T_J = 25^\circ\text{C}$ | – | 3.9   | – | mJ |
| Turn-off Switching Loss | $E_{off}$    |                                                                                                              | – | 4.6   | – |    |
| Total Switching Loss    | $E_{ts}$     |                                                                                                              | – | 8.5   | – |    |

# FGY4L140T120SWD

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

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

### SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

|                         |              |                                                                                                                   |   |       |   |    |
|-------------------------|--------------|-------------------------------------------------------------------------------------------------------------------|---|-------|---|----|
| Turn-on Delay Time      | $t_{d(on)}$  | $V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}$<br>$I_C = 70\text{ A } R_G = 4.7\ \Omega, T_J = 175^\circ\text{C}$  | – | 49.6  | – | ns |
| Rise Time               | $t_r$        |                                                                                                                   | – | 22.4  | – |    |
| Turn-off Delay Time     | $t_{d(off)}$ |                                                                                                                   | – | 305.6 | – |    |
| Fall Time               | $t_f$        |                                                                                                                   | – | 107.2 | – |    |
| Turn-on Switching Loss  | $E_{on}$     | $V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}$<br>$I_C = 140\text{ A } R_G = 4.7\ \Omega, T_J = 175^\circ\text{C}$ | – | 4.8   | – | mJ |
| Turn-off Switching Loss | $E_{off}$    |                                                                                                                   | – | 3.0   | – |    |
| Total Switching Loss    | $E_{ts}$     |                                                                                                                   | – | 7.9   | – |    |
| Turn-on Delay Time      | $t_{d(on)}$  | $V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}$<br>$I_C = 140\text{ A } R_G = 4.7\ \Omega, T_J = 175^\circ\text{C}$ | – | 52.8  | – | ns |
| Rise Time               | $t_r$        |                                                                                                                   | – | 35.2  | – |    |
| Turn-off Delay Time     | $t_{d(off)}$ |                                                                                                                   | – | 280   | – |    |
| Fall Time               | $t_f$        |                                                                                                                   | – | 99.6  | – |    |
| Turn-on Switching Loss  | $E_{on}$     | $V_{CE} = 600\text{ V}, V_{GE} = 15\text{ V}$<br>$I_C = 140\text{ A } R_G = 4.7\ \Omega, T_J = 175^\circ\text{C}$ | – | 8.6   | – | mJ |
| Turn-off Switching Loss | $E_{off}$    |                                                                                                                   | – | 7.0   | – |    |
| Total Switching Loss    | $E_{ts}$     |                                                                                                                   | – | 15.5  | – |    |

### DIODE CHARACTERISTICS

|                 |       |                                               |      |      |      |   |
|-----------------|-------|-----------------------------------------------|------|------|------|---|
| Forward Voltage | $V_F$ | $I_F = 140\text{ A}, T_J = 25^\circ\text{C}$  | 1.74 | 2.04 | 2.34 | V |
|                 |       | $I_F = 140\text{ A}, T_J = 175^\circ\text{C}$ | –    | 2.2  | –    |   |

### DIODE SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

|                               |           |                                                                                                             |   |       |   |               |
|-------------------------------|-----------|-------------------------------------------------------------------------------------------------------------|---|-------|---|---------------|
| Reverse Recovery Time         | $t_{rr}$  | $V_R = 600\text{ V}, I_F = 70\text{ A},$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 25^\circ\text{C}$   | – | 192.4 | – | ns            |
| Reverse Recovery Charge       | $Q_{rr}$  |                                                                                                             | – | 4.4   | – | $\mu\text{C}$ |
| Reverse Recovery Energy       | $E_{REC}$ |                                                                                                             | – | 1.5   | – | mJ            |
| Peak Reverse Recovery Current | $I_{RRM}$ |                                                                                                             | – | 45.9  | – | A             |
| Reverse Recovery Time         | $t_{rr}$  | $V_R = 600\text{ V}, I_F = 140\text{ A},$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 25^\circ\text{C}$  | – | 266.9 | – | ns            |
| Reverse Recovery Charge       | $Q_{rr}$  |                                                                                                             | – | 6.95  | – | $\mu\text{C}$ |
| Reverse Recovery Energy       | $E_{REC}$ |                                                                                                             | – | 2.4   | – | mJ            |
| Peak Reverse Recovery Current | $I_{RRM}$ |                                                                                                             | – | 52.4  | – | A             |
| Reverse Recovery Time         | $t_{rr}$  | $V_R = 600\text{ V}, I_F = 70\text{ A},$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$  | – | 304.6 | – | ns            |
| Reverse Recovery Charge       | $Q_{rr}$  |                                                                                                             | – | 10.6  | – | $\mu\text{C}$ |
| Reverse Recovery Energy       | $E_{REC}$ |                                                                                                             | – | 3.9   | – | mJ            |
| Peak Reverse Recovery Current | $I_{RRM}$ |                                                                                                             | – | 68.7  | – | A             |
| Reverse Recovery Time         | $t_{rr}$  | $V_R = 600\text{ V}, I_F = 140\text{ A},$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}, T_J = 175^\circ\text{C}$ | – | 431.9 | – | ns            |
| Reverse Recovery Charge       | $Q_{rr}$  |                                                                                                             | – | 16.3  | – | $\mu\text{C}$ |
| Reverse Recovery Energy       | $E_{REC}$ |                                                                                                             | – | 6.1   | – | mJ            |
| Peak Reverse Recovery Current | $I_{RRM}$ |                                                                                                             | – | 76.6  | – | 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.

TYPICAL CHARACTERISTICS

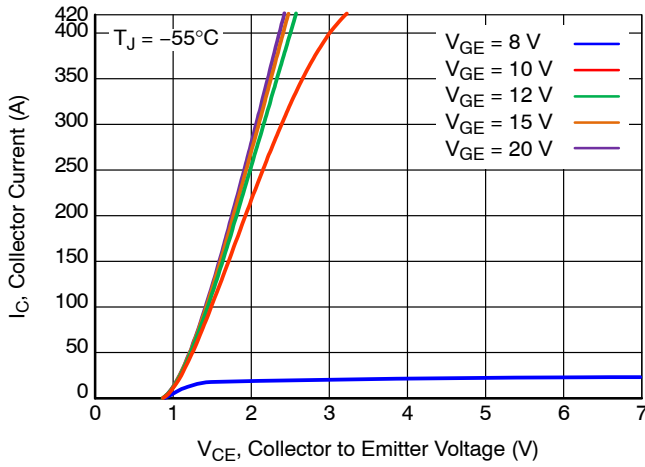


Figure 1. Output Characteristics

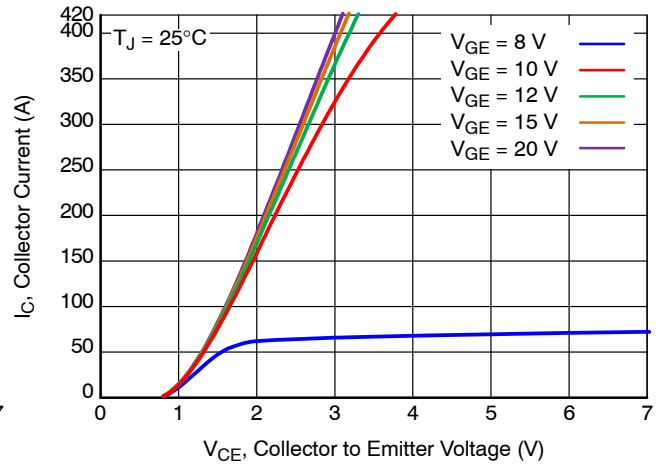


Figure 2. Output Characteristics

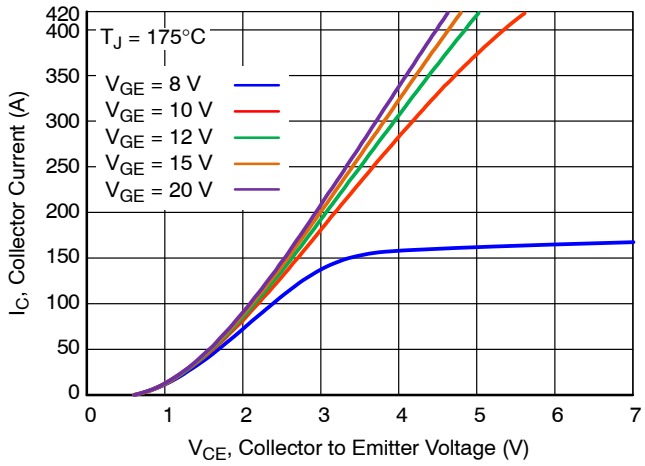


Figure 3. Output Characteristics

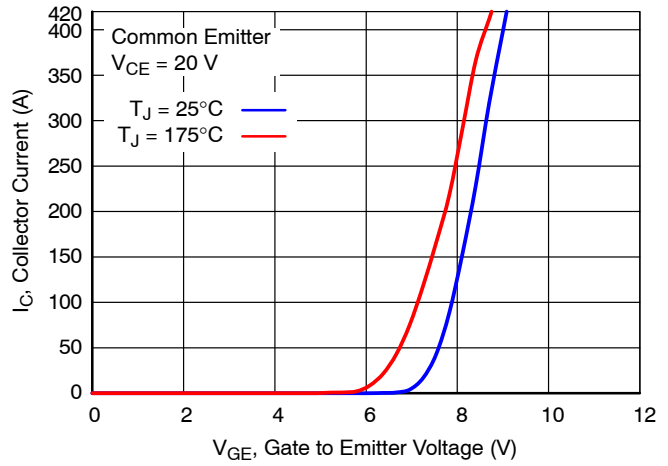


Figure 4. Transfer Characteristics

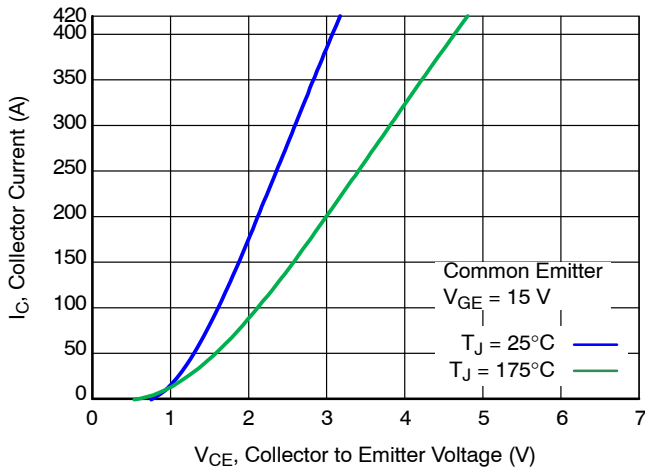


Figure 5. Saturation Characteristics

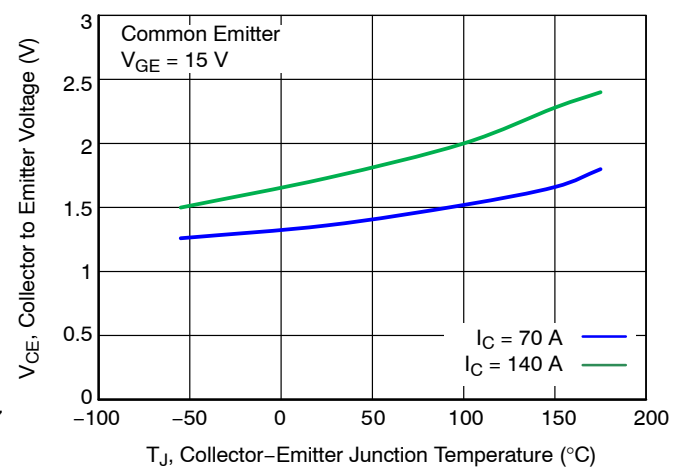


Figure 6. Saturation Voltage vs. Junction Temperature

TYPICAL CHARACTERISTICS

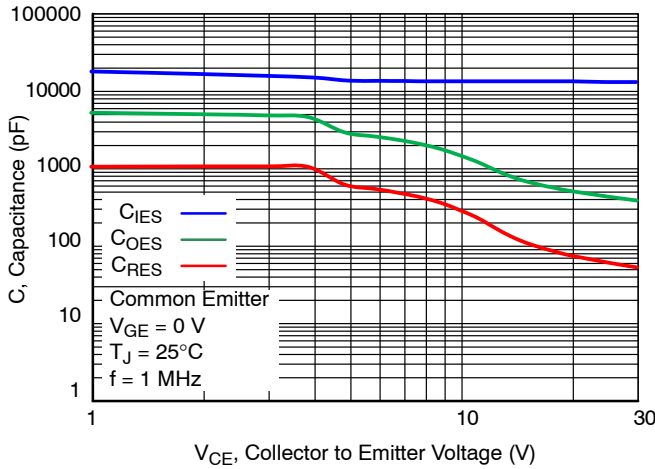


Figure 7. Capacitance Characteristics

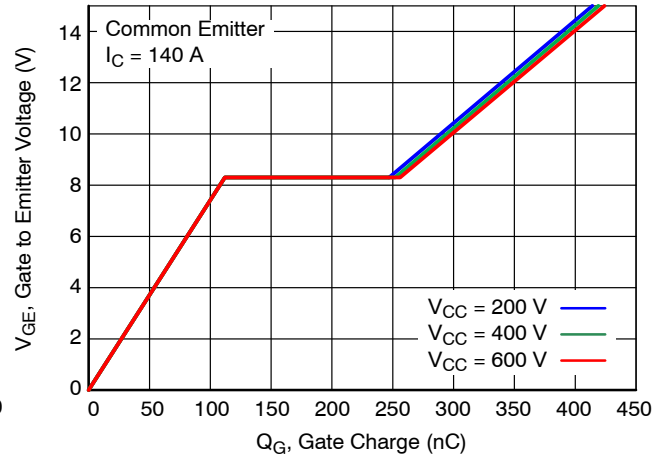


Figure 8. Gate Charge Characteristics

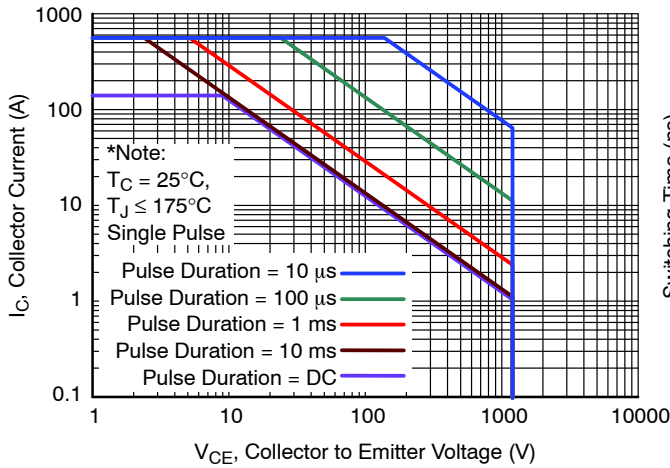


Figure 9. SOA Characteristics

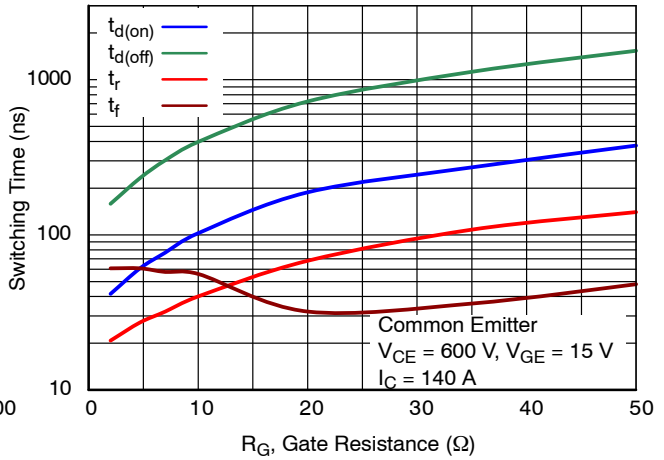


Figure 10. Switching Time vs. Gate Resistance ( $T_J = 25^\circ\text{C}$ )

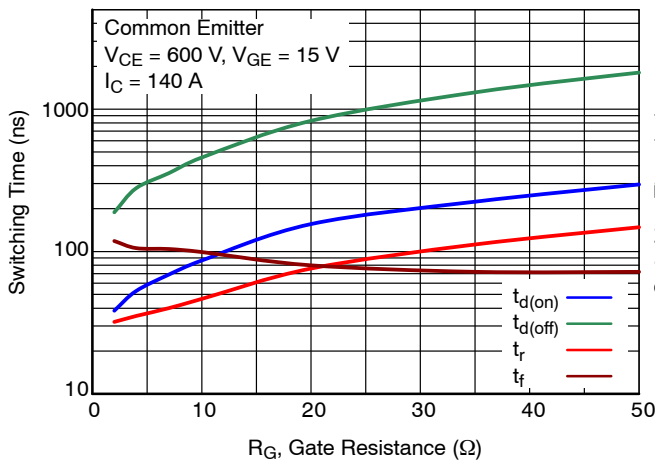


Figure 11. Switching Time vs. Gate Resistance ( $T_J = 175^\circ\text{C}$ )

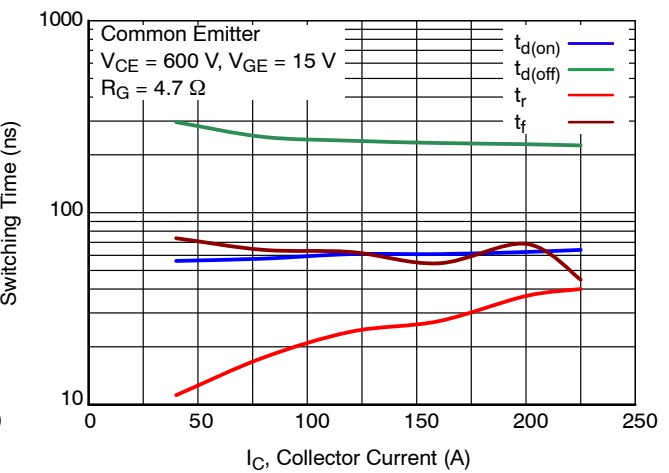


Figure 12. Switching Time vs. Collector Current ( $T_J = 25^\circ\text{C}$ )

TYPICAL CHARACTERISTICS

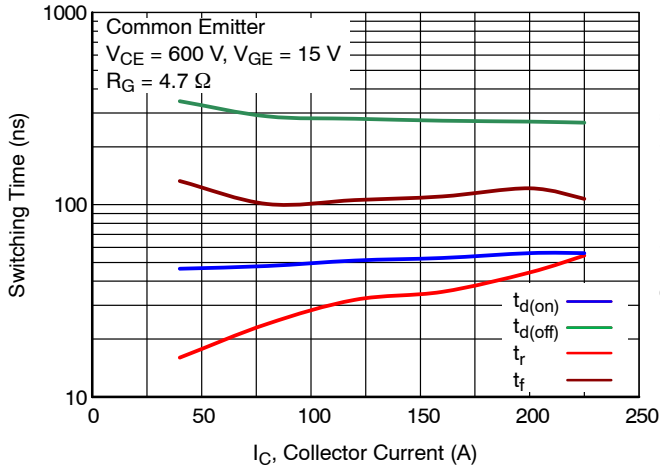


Figure 13. Switching Time vs. Collector Current ( $T_J = 175^\circ\text{C}$ )

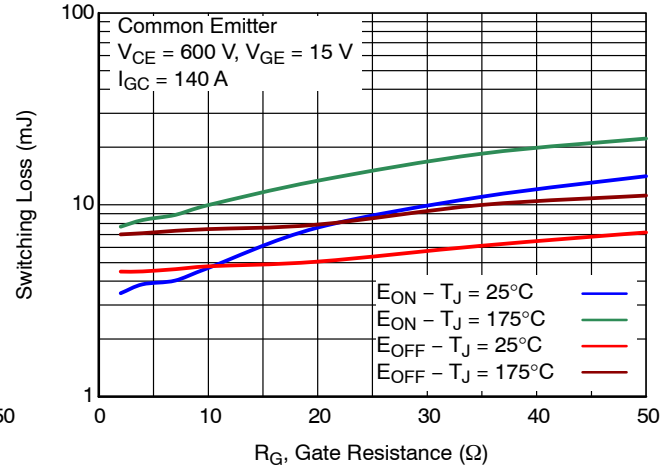


Figure 14. Switching Loss vs. Gate Resistance

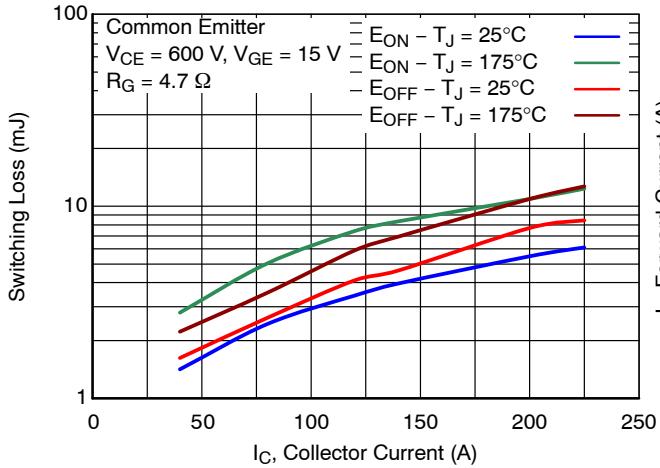


Figure 15. Switching Loss vs. Collector Current

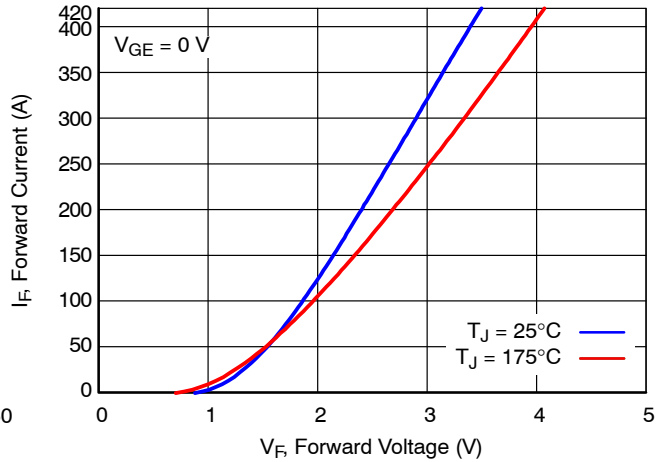


Figure 16. Diode Forward Characteristics

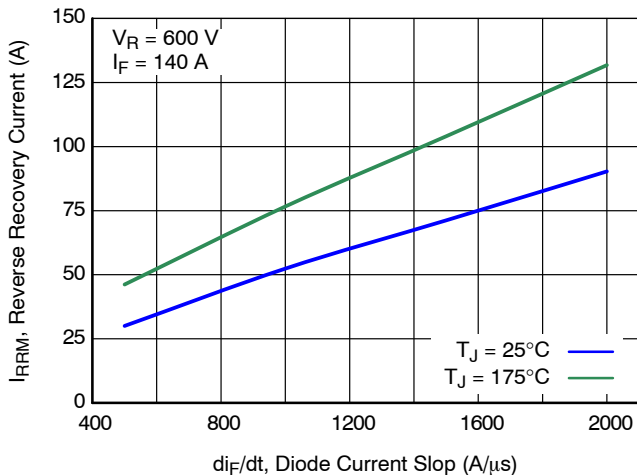


Figure 17. Diode Reverse Recovery Current

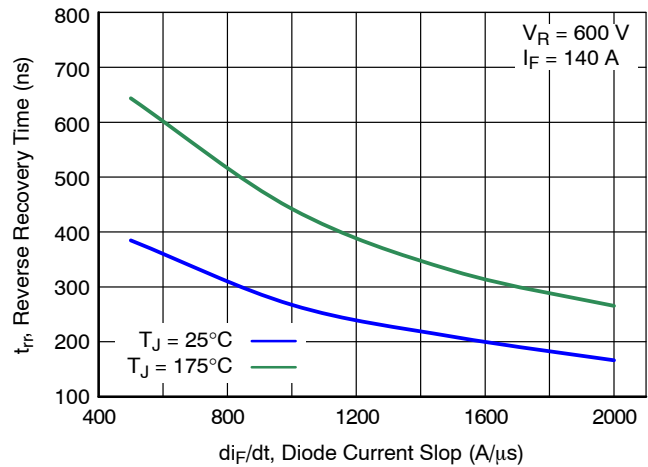


Figure 18. Diode Reverse Recovery Time

# FGY4L140T120SWD

## TYPICAL CHARACTERISTICS

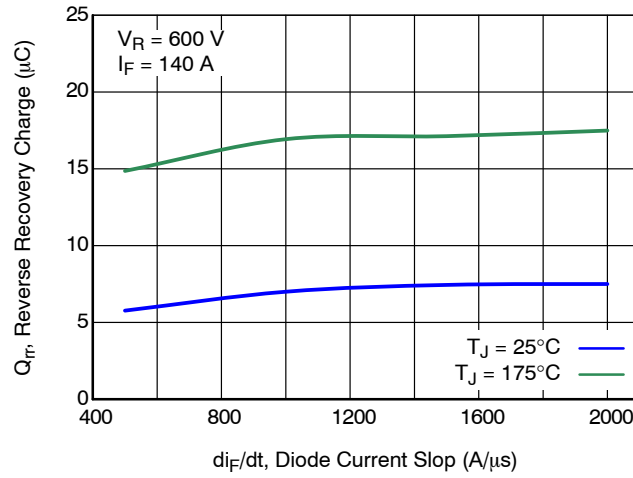


Figure 19. Diode Stored Charge

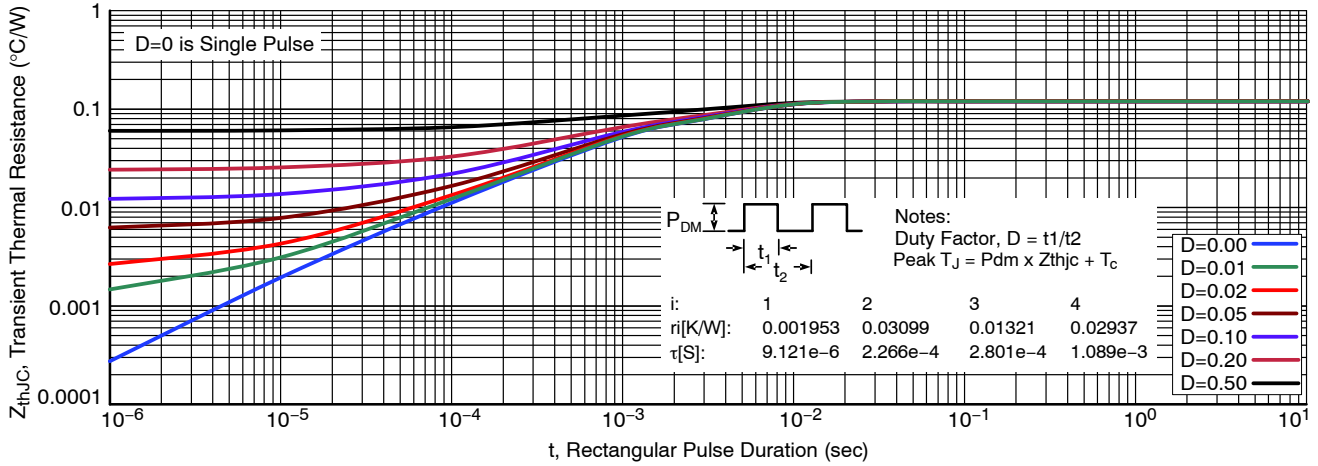


Figure 20. Max Transient Thermal Impedance of IGBT

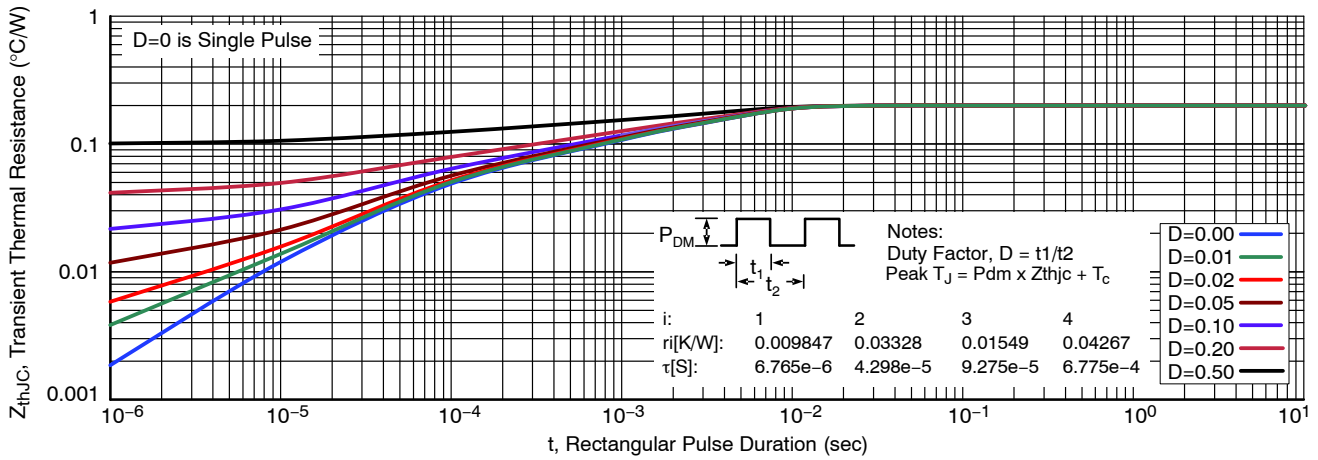
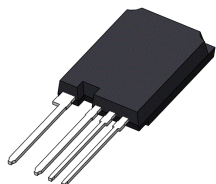


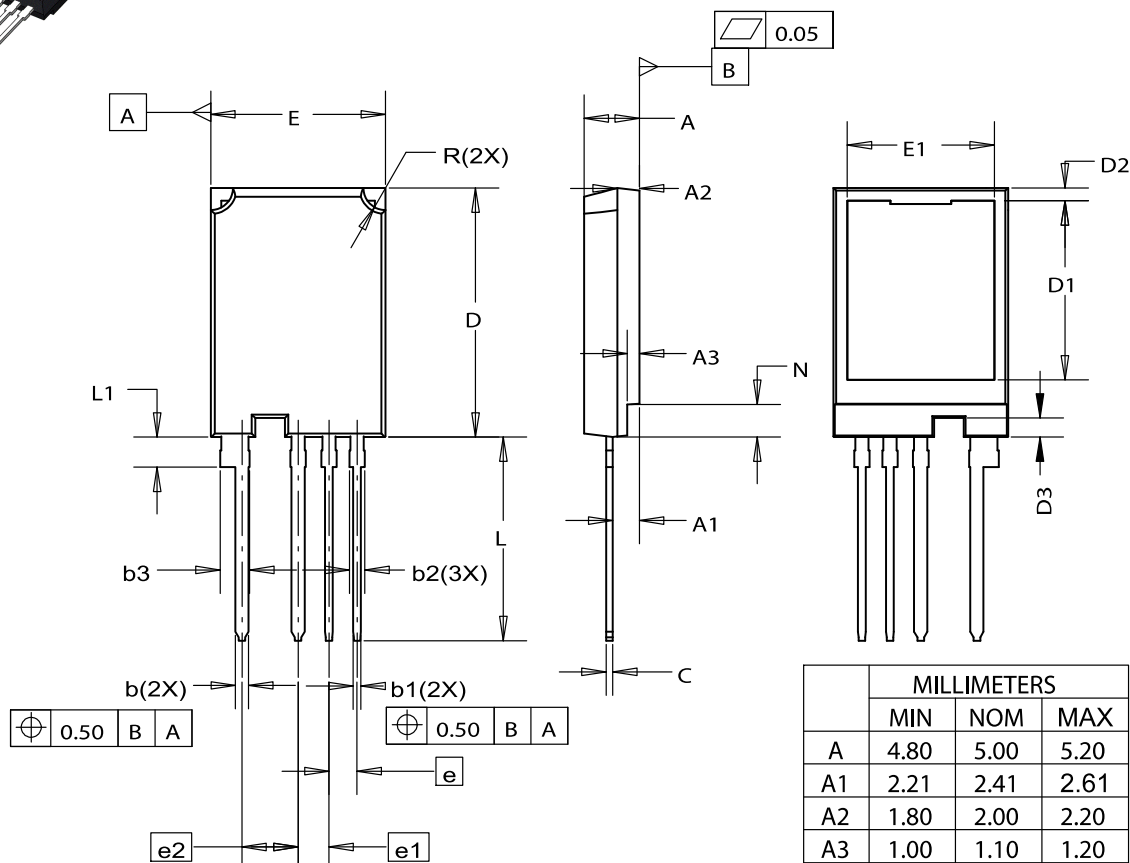
Figure 21. Max Transient Thermal Impedance of Diode

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



TO-247-PLUS-4L 15.80x22.54x5.00, 2.54P  
CASE 340BW  
ISSUE A

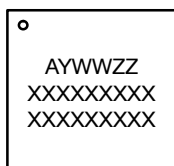
DATE 07 SEPT 2023



## NOTES:

- A. NO INDUSTRY STANDARDS APPLIES TO THIS PACKAGE.
- B. ALL DIMENSIONS ARE IN MILLIMETERS.
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR PROTRUSIONS.
- D. DRAWING CONFORMS TO ASME Y14.5-2009.

## 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.

|    | MILLIMETERS |       |       |
|----|-------------|-------|-------|
|    | MIN         | NOM   | MAX   |
| A  | 4.80        | 5.00  | 5.20  |
| A1 | 2.21        | 2.41  | 2.61  |
| A2 | 1.80        | 2.00  | 2.20  |
| A3 | 1.00        | 1.10  | 1.20  |
| b  | 1.07        | 1.20  | 1.33  |
| b1 | 0.57        | 0.70  | 0.83  |
| b2 | 1.20        | 1.40  | 1.60  |
| b3 | 2.47        | 2.67  | 2.87  |
| c  | 0.50        | 0.60  | 0.70  |
| D  | 22.34       | 22.54 | 22.74 |
| D1 | 16.00       | 16.20 | 16.40 |
| D2 | 0.96        | 1.16  | 1.36  |
| D3 | 1.52        | 1.72  | 1.92  |
| e  | 2.54BSC     |       |       |
| e1 | 2.79BSC     |       |       |
| e2 | 5.08BSC     |       |       |
| E  | 15.60       | 15.80 | 16.00 |
| E1 | 13.10       | 13.30 | 13.50 |
| L  | 18.12       | 18.42 | 18.72 |
| L1 | 2.52        | 2.72  | 2.92  |
| R  | 1.90        | 2.00  | 2.10  |
| N  | 2.75        | 2.95  | 3.15  |

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