

# IGBT - Ultra Field Stop

## 1200 V, 40 A, $V_{CE(Sat)} = 1.55V$ , TO247 4L

### FGH4L40T120LQD

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 motor driver 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:  $T_J = 175^{\circ}C$
- Fast and Soft Reverse Recovery Diode
- Optimized for Low  $V_{CE(Sat)}$

#### Typical Applications

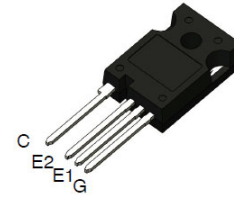
- Solar Inverter and UPS
- Industrial Switching
- Welding

#### MAXIMUM RATINGS

| Rating                                                                            | Symbol         | Value                | Unit        |
|-----------------------------------------------------------------------------------|----------------|----------------------|-------------|
| Collector-Emitter Voltage                                                         | $V_{CE}$       | 1200                 | V           |
| Gate-Emitter Voltage<br>Transient Gate-Emitter Voltage                            | $V_{GE}$       | $\pm 20$<br>$\pm 30$ | V           |
| Collector Current @ $T_C = 25^{\circ}C$ (Note 1)<br>@ $T_C = 100^{\circ}C$        | $I_C$          | 80<br>40             | A           |
| Pulsed Collector Current (Note 2)                                                 | $I_{LM}$       | 160                  | A           |
| Pulsed Collector Current (Note 3)                                                 | $I_{CM}$       | 160                  | A           |
| Diode Forward Current<br>@ $T_C = 25^{\circ}C$ (Note 1)<br>@ $T_C = 100^{\circ}C$ | $I_F$          | 80<br>40             | A           |
| Maximum Power Dissipation<br>@ $T_C = 25^{\circ}C$<br>@ $T_C = 100^{\circ}C$      | $P_D$          | 306<br>153           | W           |
| Operating Junction and Storage Temperature Range                                  | $T_J, T_{STG}$ | -55 to +175          | $^{\circ}C$ |
| Maximum Lead Temp. for Soldering Purposes (1/8" from case for 5 s)                | $T_L$          | 260                  | $^{\circ}C$ |

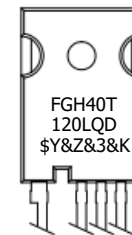
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

- Value limit by bond wire
- $V_{CC} = 600V$ ,  $V_{GE} = 15V$ ,  $I_C = 160A$ ,  $R_G = 15\Omega$ , Inductive Load, 100% Tested
- Repetitive rating: Pulse width limited by max. junction temperature



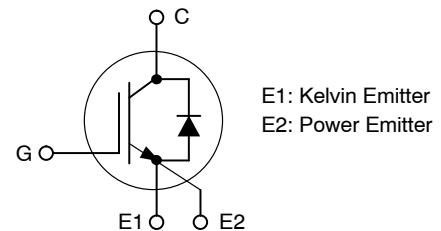
TO-247-4LD  
CASE 340CJ

#### MARKING DIAGRAM



FGH40T120LQD = Specific Device Code  
 $\$Y$  = onsemi Logo  
 $\&Z$  = Assembly Plant Code  
 $\&3$  = 3-Digit Date Code  
 $\&K$  = 2-Digit Lot Traceability Code

#### PIN CONNECTIONS



#### ORDERING INFORMATION

| Device         | Package | Shipping        |
|----------------|---------|-----------------|
| FGH4L40T120LQD | TO-247  | 30 Units / Rail |

# FGH4L40T120LQD

## THERMAL CHARACTERISTICS

| Rating                                         | Symbol          | Min | Typ  | Max  | Unit |
|------------------------------------------------|-----------------|-----|------|------|------|
| Thermal resistance junction-to-case, for IGBT  | $R_{\theta JC}$ | –   | 0.38 | 0.49 | °C/W |
| Thermal resistance junction-to-case, for Diode | $R_{\theta JC}$ | –   | 0.64 | 0.84 | °C/W |
| Thermal resistance junction-to-ambient         | $R_{\theta JA}$ | –   | –    | 40   | °C/W |

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

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

### OFF CHARACTERISTIC

|                                              |                                               |                                |      |          |         |               |
|----------------------------------------------|-----------------------------------------------|--------------------------------|------|----------|---------|---------------|
| Collector-Emitter Breakdown Voltage          | $V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$      | $BV_{CES}$                     | 1200 | –        | –       | V             |
| Temperature Coefficient of Breakdown Voltage | $V_{GE} = 0\text{ V}, I_C = 1\text{ mA}$      | $\Delta BV_{CES} / \Delta T_J$ | –    | 1.3      | –       | V/°C          |
| Collector-Emitter Cut-Off Current            | $V_{GE} = 0\text{ V}, V_{CE} = 1200\text{ V}$ | $I_{CES}$                      | –    | –<br>500 | 40<br>– | $\mu\text{A}$ |
| Gate Leakage Current                         | $V_{GE} = 20\text{ V}, V_{CE} = 0\text{ V}$   | $I_{GES}$                      | –    | –        | 200     | nA            |

### ON CHARACTERISTIC

|                                      |                                                                    |               |     |      |      |   |
|--------------------------------------|--------------------------------------------------------------------|---------------|-----|------|------|---|
| Gate-Emitter Threshold Voltage       | $V_{GE} = V_{CE}, I_C = 40\text{ mA}$                              | $V_{GE(th)}$  | 5.5 | 6.5  | 7.5  | V |
| Collector-Emitter Saturation Voltage | $V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 25^\circ\text{C}$  | $V_{CE(sat)}$ | –   | 1.55 | 1.80 | V |
|                                      | $V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_J = 175^\circ\text{C}$ |               | –   | 2    | –    |   |

### DYNAMIC CHARACTERISTIC

|                              |                                                                  |           |   |      |   |    |
|------------------------------|------------------------------------------------------------------|-----------|---|------|---|----|
| Input Capacitance            | $V_{CE} = 30\text{ V}, V_{GE} = 0\text{ V}, f = 1\text{ MHz}$    | $C_{ies}$ | – | 5079 | – | pF |
| Output Capacitance           |                                                                  | $C_{oes}$ | – | 113  | – |    |
| Reverse Transfer Capacitance |                                                                  | $C_{res}$ | – | 62   | – |    |
| Gate Charge Total            | $V_{CC} = 600\text{ V}, I_C = 40\text{ A}, V_{GE} = 15\text{ V}$ | $Q_g$     | – | 227  | – | nC |
| Gate-to-Emitter Charge       |                                                                  | $Q_{ge}$  | – | 40   | – |    |
| Gate-to-Collector Charge     |                                                                  | $Q_{gc}$  | – | 108  | – |    |

### SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

|                         |                                                                                                                                          |              |   |      |   |    |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------|--------------|---|------|---|----|
| Turn-on Delay Time      | $T_J = 25^\circ\text{C}$<br>$V_{CC} = 600\text{ V}, I_C = 20\text{ A}$<br>$R_g = 10\ \Omega$<br>$V_{GE} = 15\text{ V}$<br>Inductive Load | $t_{d(on)}$  | – | 38   | – | ns |
| Rise Time               |                                                                                                                                          | $t_r$        | – | 13   | – |    |
| Turn-off Delay Time     |                                                                                                                                          | $t_{d(off)}$ | – | 227  | – |    |
| Fall Time               |                                                                                                                                          | $t_f$        | – | 51   | – |    |
| Turn-on Switching Loss  |                                                                                                                                          | $E_{on}$     | – | 0.63 | – | mJ |
| Turn-off Switching Loss |                                                                                                                                          | $E_{off}$    | – | 0.77 | – |    |
| Total Switching Loss    |                                                                                                                                          | $E_{ts}$     | – | 1.40 | – |    |
| Turn-on Delay Time      | $T_J = 25^\circ\text{C}$<br>$V_{CC} = 600\text{ V}, I_C = 40\text{ A}$<br>$R_g = 10\ \Omega$<br>$V_{GE} = 15\text{ V}$<br>Inductive Load | $t_{d(on)}$  | – | 42   | – | ns |
| Rise Time               |                                                                                                                                          | $t_r$        | – | 19   | – |    |
| Turn-off Delay Time     |                                                                                                                                          | $t_{d(off)}$ | – | 218  | – |    |
| Fall Time               |                                                                                                                                          | $t_f$        | – | 80   | – |    |
| Turn-on Switching Loss  |                                                                                                                                          | $E_{on}$     | – | 1.04 | – | mJ |
| Turn-off Switching Loss |                                                                                                                                          | $E_{off}$    | – | 1.35 | – |    |
| Total Switching Loss    |                                                                                                                                          | $E_{ts}$     | – | 2.39 | – |    |

# FGH4L40T120LQD

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

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

### SWITCHING CHARACTERISTIC, INDUCTIVE LOAD

|                         |                                                                                                                                           |              |   |      |   |    |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|--------------|---|------|---|----|
| Turn-on Delay Time      | $T_J = 175^\circ\text{C}$<br>$V_{CC} = 600\text{ V}, I_C = 20\text{ A}$<br>$R_g = 10\ \Omega$<br>$V_{GE} = 15\text{ V}$<br>Inductive Load | $t_{d(on)}$  | – | 32   | – | ns |
| Rise Time               |                                                                                                                                           | $t_r$        | – | 12   | – |    |
| Turn-off Delay Time     |                                                                                                                                           | $t_{d(off)}$ | – | 264  | – |    |
| Fall Time               |                                                                                                                                           | $t_f$        | – | 156  | – |    |
| Turn-on Switching Loss  |                                                                                                                                           | $E_{on}$     | – | 1.05 | – | mJ |
| Turn-off Switching Loss |                                                                                                                                           | $E_{off}$    | – | 1.62 | – |    |
| Total Switching Loss    |                                                                                                                                           | $E_{ts}$     | – | 2.67 | – |    |
| Turn-on Delay Time      | $T_J = 175^\circ\text{C}$<br>$V_{CC} = 600\text{ V}, I_C = 40\text{ A}$<br>$R_g = 10\ \Omega$<br>$V_{GE} = 15\text{ V}$<br>Inductive Load | $t_{d(on)}$  | – | 36   | – | ns |
| Rise Time               |                                                                                                                                           | $t_r$        | – | 20   | – |    |
| Turn-off Delay Time     |                                                                                                                                           | $t_{d(off)}$ | – | 236  | – |    |
| Fall Time               |                                                                                                                                           | $t_f$        | – | 204  | – |    |
| Turn-on Switching Loss  |                                                                                                                                           | $E_{on}$     | – | 1.62 | – | mJ |
| Turn-off Switching Loss |                                                                                                                                           | $E_{off}$    | – | 2.51 | – |    |
| Total Switching Loss    |                                                                                                                                           | $E_{ts}$     | – | 4.13 | – |    |

### DIODE CHARACTERISTIC

|                               |                                                                                                               |           |   |      |      |               |
|-------------------------------|---------------------------------------------------------------------------------------------------------------|-----------|---|------|------|---------------|
| Forward Voltage               | $V_{GE} = 0\text{ V}, I_F = 40\text{ A}, T_J = 25^\circ\text{C}$                                              | $V_F$     | – | 3.31 | 3.80 | V             |
|                               | $V_{GE} = 0\text{ V}, I_F = 40\text{ A}, T_J = 175^\circ\text{C}$                                             |           | – | 2.97 | –    |               |
| Reverse Recovery Energy       | $T_J = 25^\circ\text{C}$<br>$I_F = 40\text{ A}, V_R = 600\text{ V}$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}$  | $E_{REC}$ | – | 126  | –    | $\mu\text{J}$ |
| Diode Reverse Recovery Time   |                                                                                                               | $T_{rr}$  | – | 59   | –    | ns            |
| Diode Reverse Recovery Charge |                                                                                                               | $Q_{rr}$  | – | 804  | –    | nC            |
| Reverse Recovery Energy       | $T_J = 175^\circ\text{C}$<br>$I_F = 20\text{ A}, V_R = 600\text{ V}$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}$ | $E_{REC}$ | – | 540  | –    | $\mu\text{J}$ |
| Diode Reverse Recovery Time   |                                                                                                               | $T_{rr}$  | – | 115  | –    | ns            |
| Diode Reverse Recovery Charge |                                                                                                               | $Q_{rr}$  | – | 2090 | –    | nC            |
| Reverse Recovery Energy       | $T_J = 175^\circ\text{C}$<br>$I_F = 40\text{ A}, V_R = 600\text{ V}$<br>$di_F/dt = 1000\text{ A}/\mu\text{s}$ | $E_{REC}$ | – | 667  | –    | $\mu\text{J}$ |
| Diode Reverse Recovery Time   |                                                                                                               | $T_{rr}$  | – | 127  | –    | ns            |
| Diode Reverse Recovery Charge |                                                                                                               | $Q_{rr}$  | – | 2613 | –    | 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.

TYPICAL CHARACTERISTICS

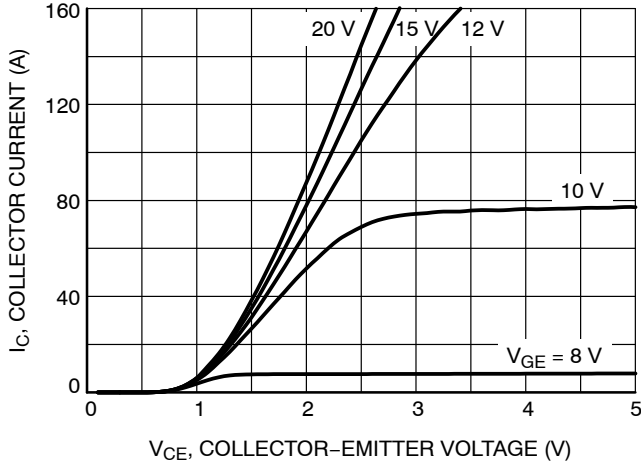


Figure 1. Typical Output Characteristics  
( $T_J = 25^\circ\text{C}$ )

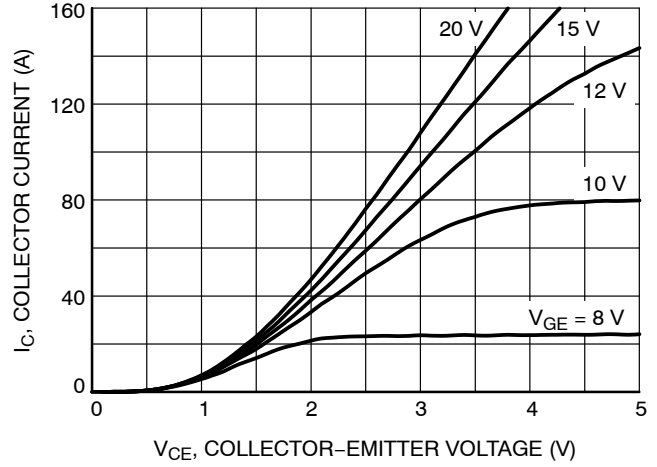


Figure 2. Typical Output Characteristics  
( $T_J = 175^\circ\text{C}$ )

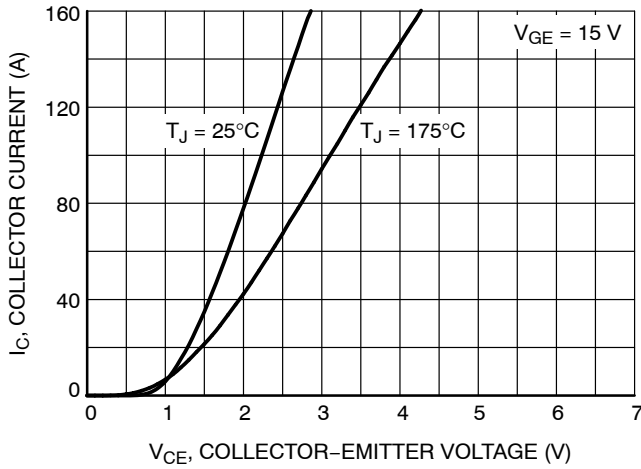


Figure 3. Typical Saturation Voltage  
Characteristics

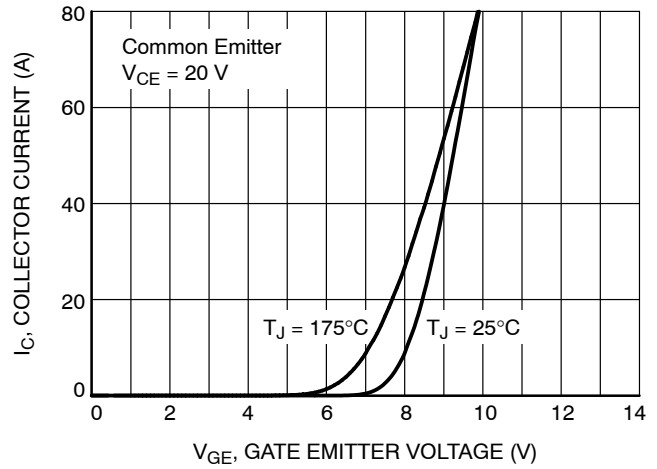


Figure 4. Typical Transfer Characteristics

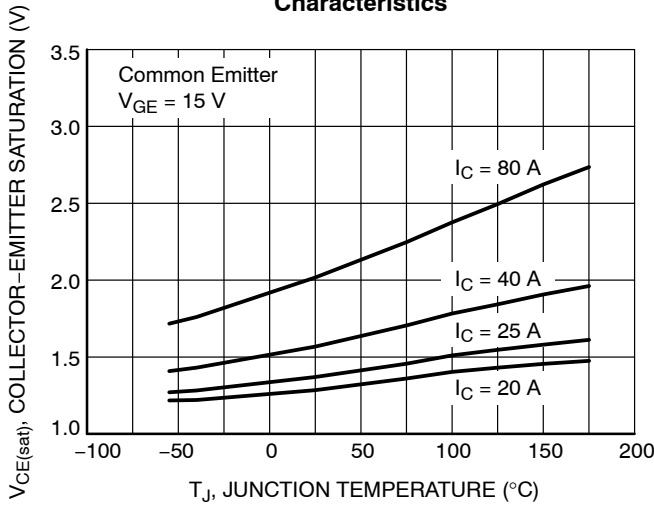


Figure 5. Saturation Voltage vs. Junction  
Temperature

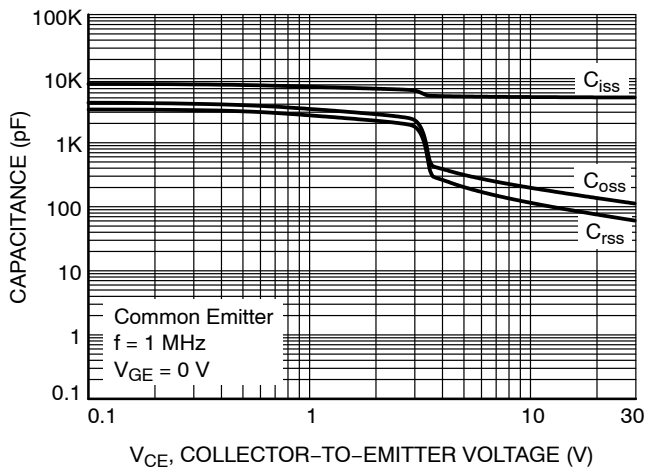


Figure 6. Capacitances Characteristics

TYPICAL CHARACTERISTICS

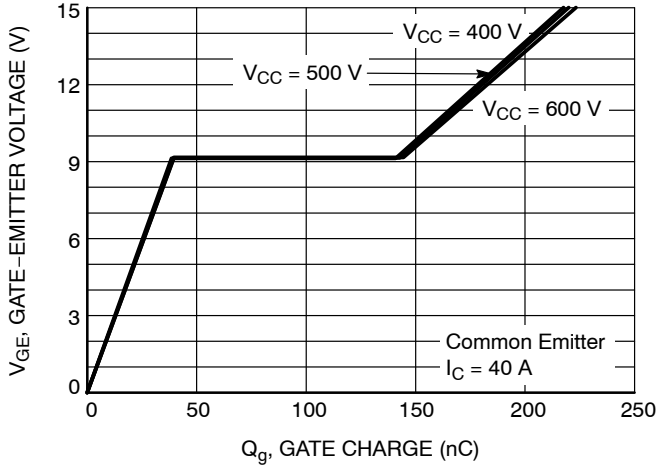


Figure 7. Gate Charge Characteristics

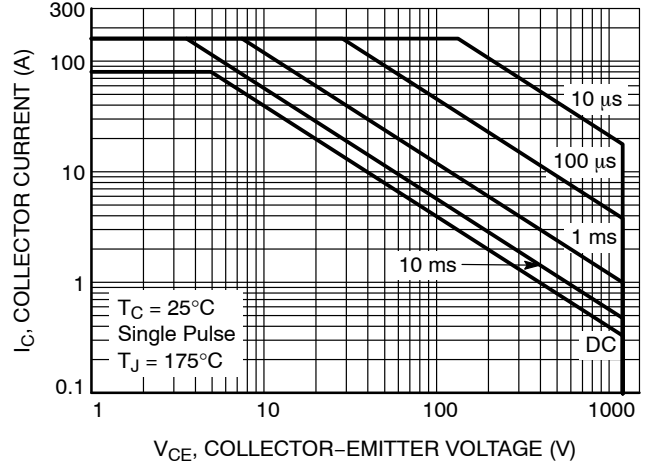


Figure 8. SOA Characteristics (FBSOA)

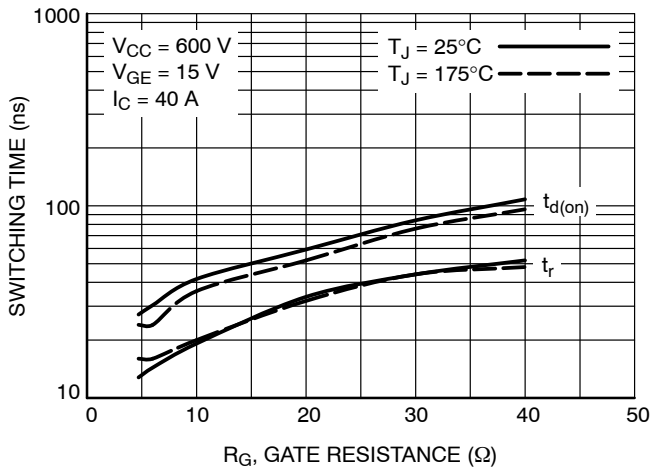


Figure 9. Turn-on Characteristics vs. Gate Resistance

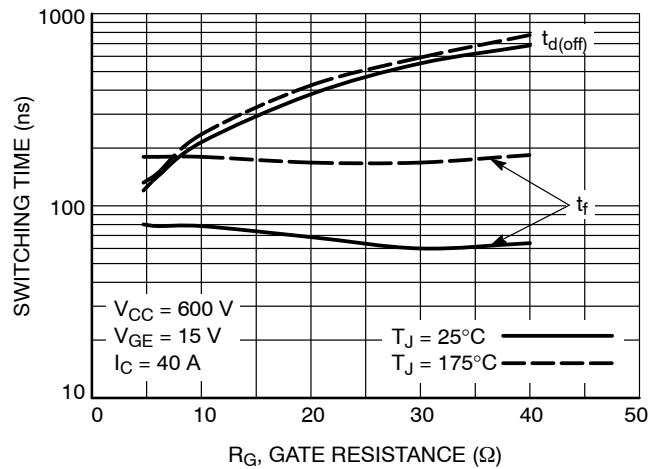


Figure 10. Turn-off Characteristics vs. Gate Resistance

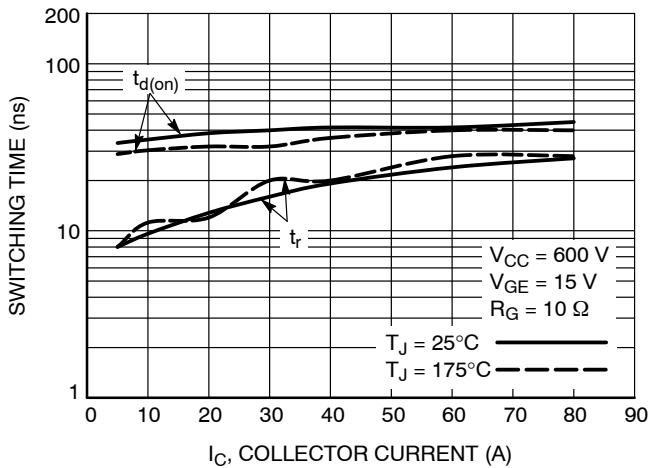


Figure 11. Turn-on Characteristics vs. Collector Current

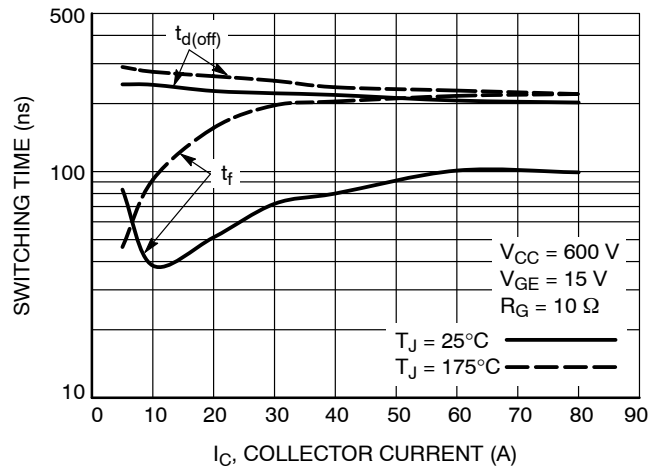


Figure 12. Turn-off Characteristics vs. Collector Current

# FGH4L40T120LQD

## TYPICAL CHARACTERISTICS

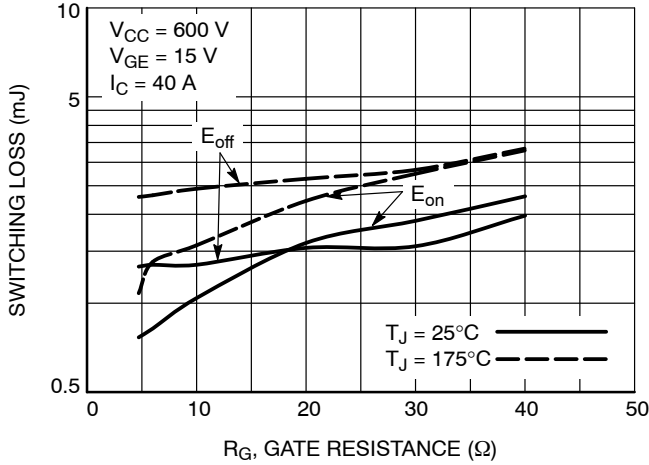


Figure 13. Switching Loss vs. Gate Resistance

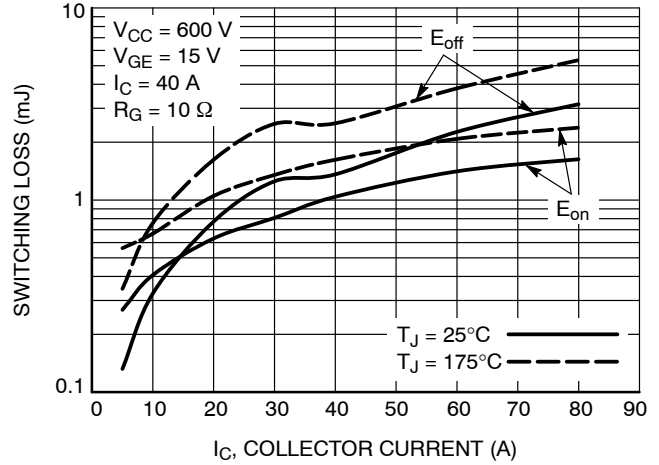


Figure 14. Switching Loss vs. Collector Current

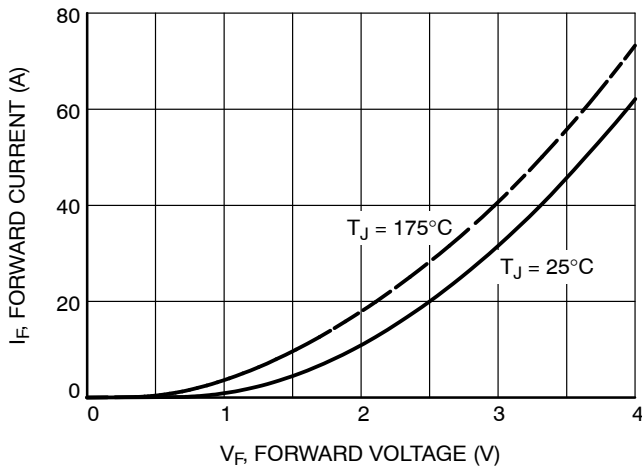


Figure 15. (Diode) Forward Characteristics

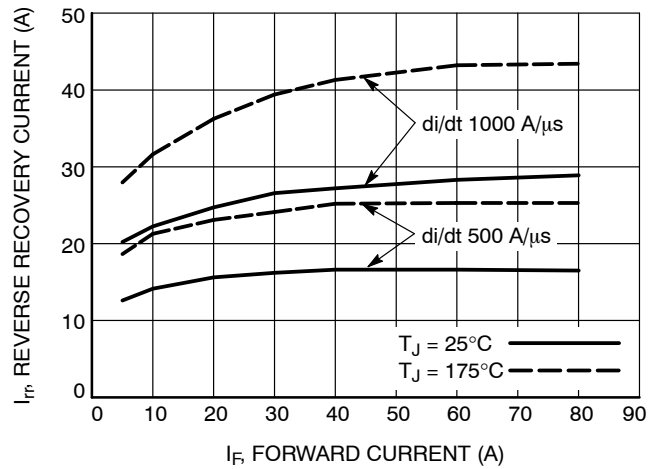


Figure 16. (Diode) Reverse Recover Current vs. Forward Current

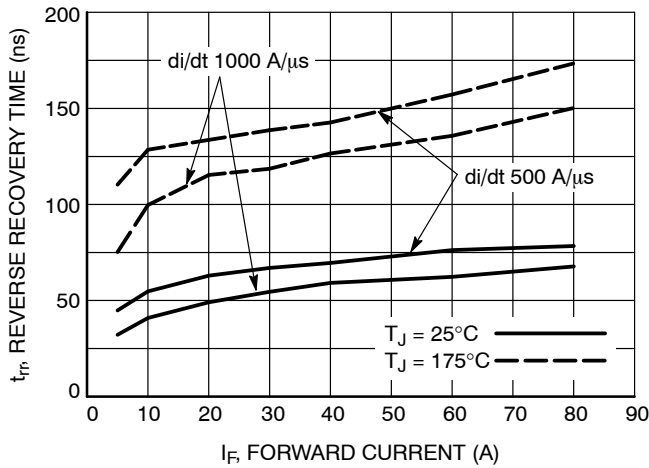


Figure 17. (Diode) Reverse Recovery Time

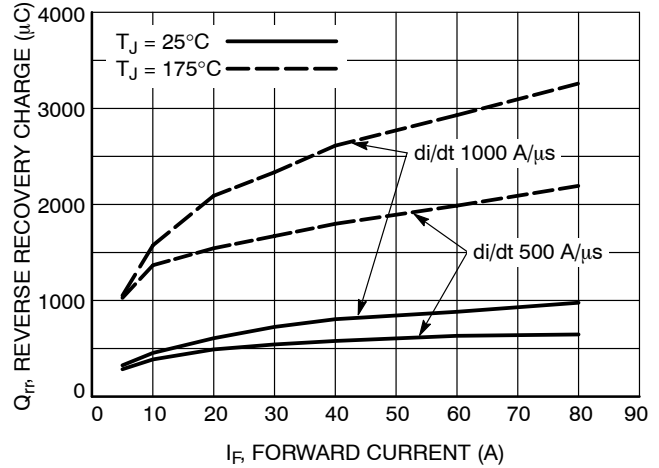


Figure 18. (Diode) Stored Charge

# FGH4L40T120LQD

## TYPICAL CHARACTERISTICS

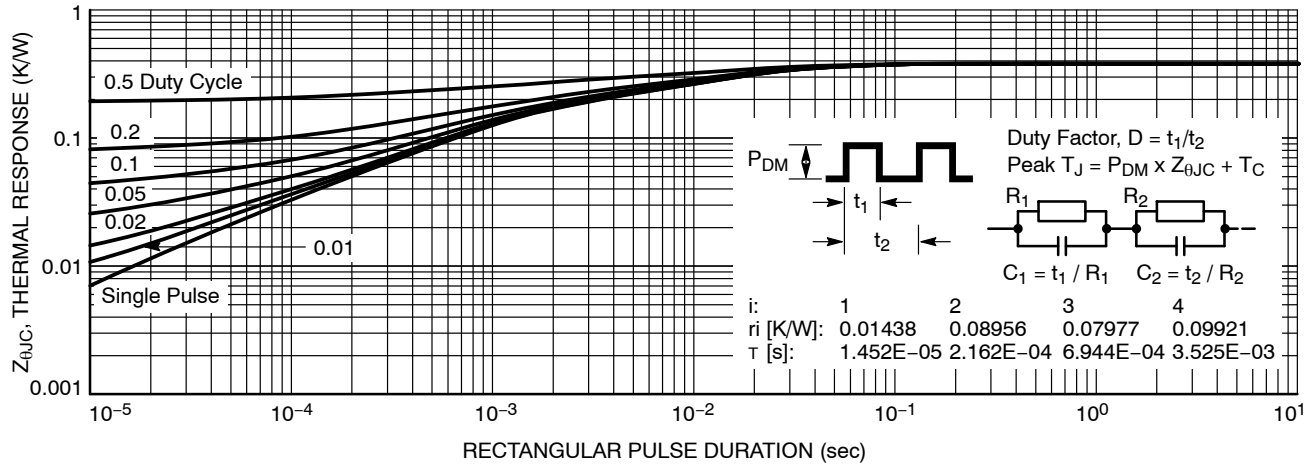


Figure 19. Transient Thermal Impedance of IGBT

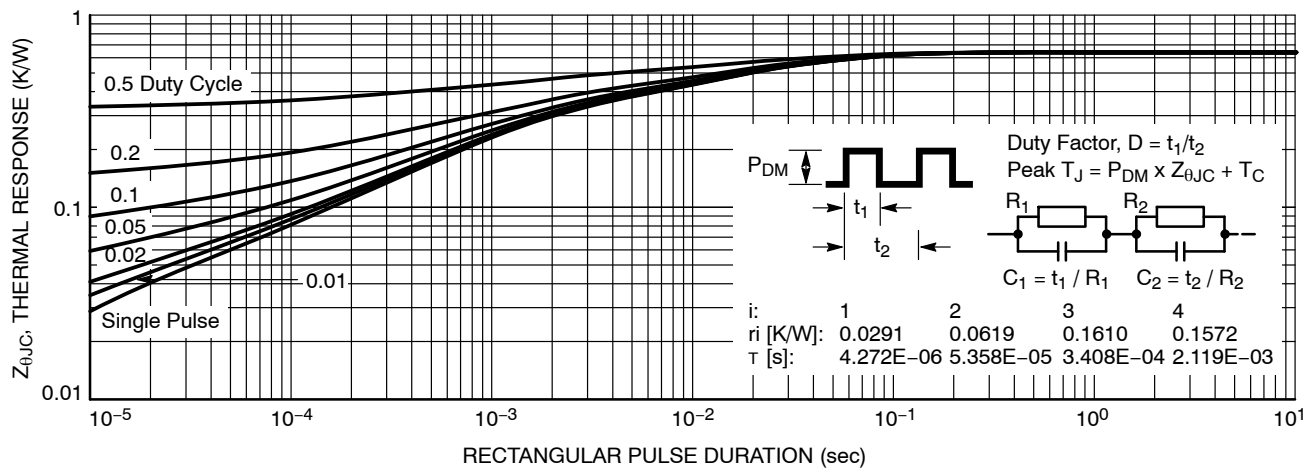


Figure 20. Transient Thermal Impedance of Diode

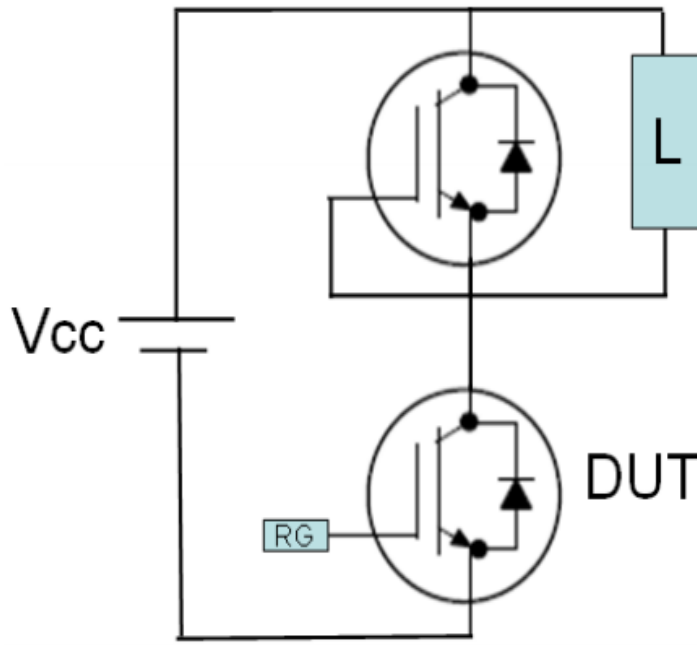


Figure 21. Test Circuits for Switching Characteristics

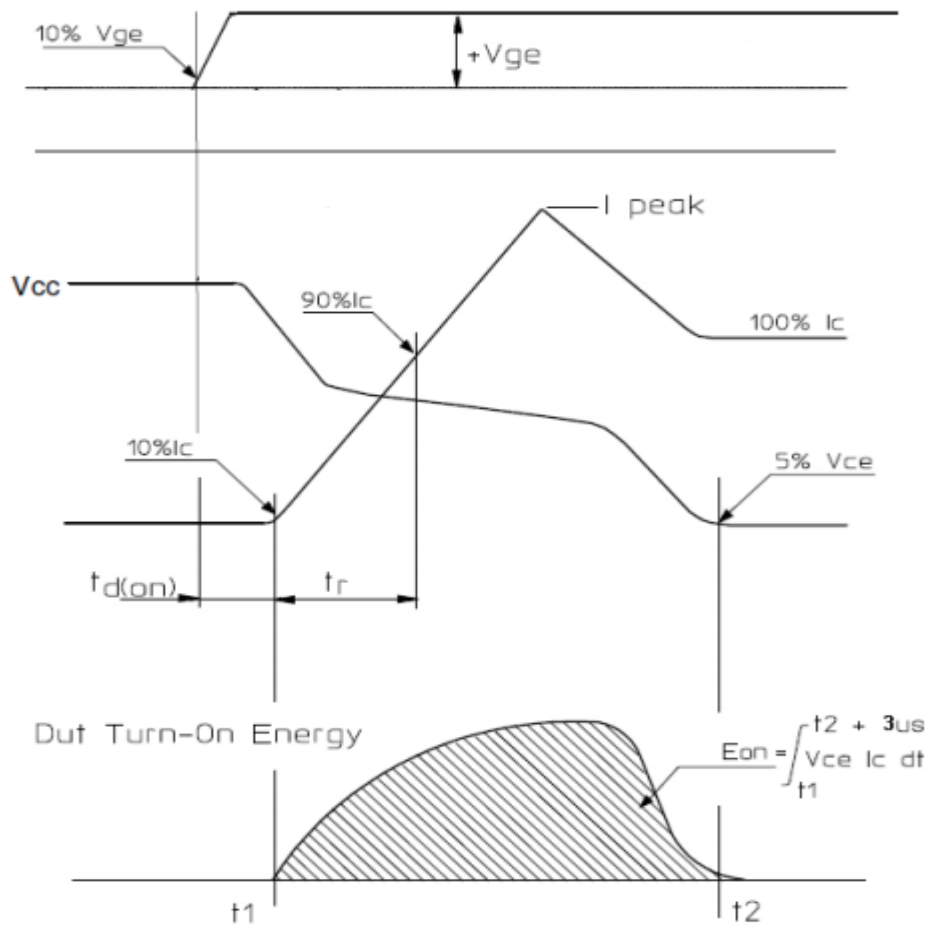


Figure 22. Definition of Turn-On Waveforms

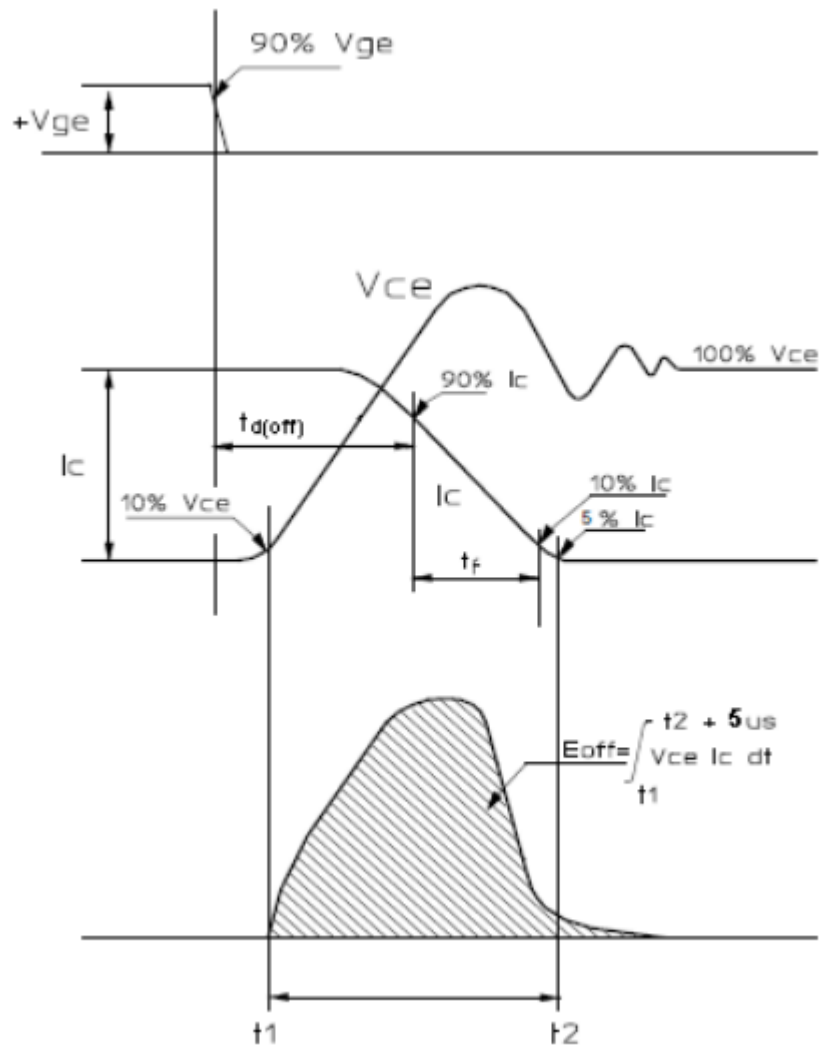
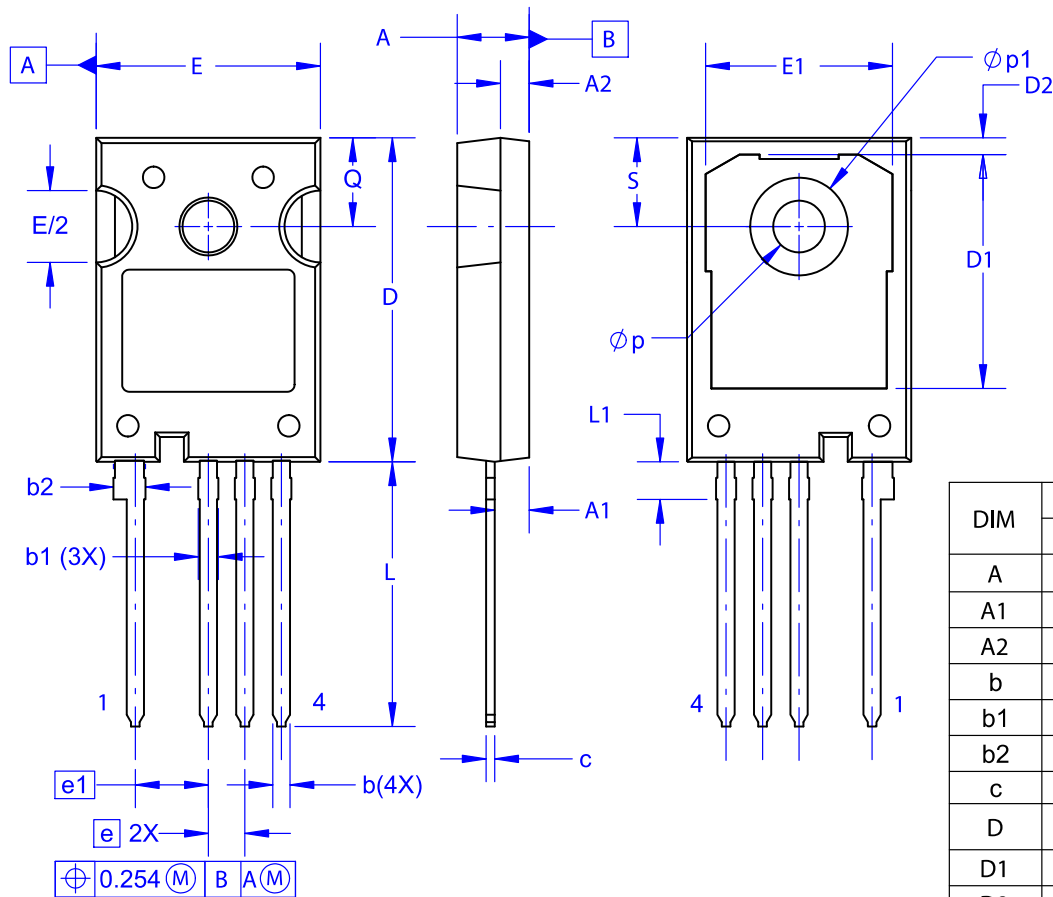


Figure 23. Definition of Turn-Off Waveforms

**TO-247-4LD**  
**CASE 340CJ**  
**ISSUE A**

DATE 16 SEP 2019


**NOTES:**

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

| DIM | MILLIMETERS |       |       |
|-----|-------------|-------|-------|
|     | MIN         | NOM   | MAX   |
| A   | 4.80        | 5.00  | 5.20  |
| A1  | 2.10        | 2.40  | 2.70  |
| A2  | 1.80        | 2.00  | 2.20  |
| b   | 1.07        | 1.20  | 1.33  |
| b1  | 1.20        | 1.40  | 1.60  |
| b2  | 2.02        | 2.22  | 2.42  |
| c   | 0.50        | 0.60  | 0.70  |
| D   | 22.34       | 22.54 | 22.74 |
| D1  | 16.00       | 16.25 | 16.50 |
| D2  | 0.97        | 1.17  | 1.37  |
| e   | 2.54 BSC    |       |       |
| e1  | 5.08 BSC    |       |       |
| E   | 15.40       | 15.60 | 15.80 |
| E1  | 12.80       | 13.00 | 13.20 |
| E/2 | 4.80        | 5.00  | 5.20  |
| L   | 18.22       | 18.42 | 18.62 |
| L1  | 2.42        | 2.62  | 2.82  |
| p   | 3.40        | 3.60  | 3.80  |
| p1  | 6.60        | 6.80  | 7.00  |
| Q   | 5.97        | 6.17  | 6.37  |
| S   | 5.97        | 6.17  | 6.37  |

|                         |                    |                                                                                                                                                                                     |
|-------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| <b>DESCRIPTION:</b>     | <b>TO-247-4LD</b>  | <b>PAGE 1 OF 1</b>                                                                                                                                                                  |

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