

## Description

MLG20T65FUL is obtained by advanced Trench Field Stop (T-FS) technology which is characteristic with low  $V_{CE(sat)}$ , optimized switching performance and low gate charge  $Q_g$ . The IGBT is suitable device for BLDC, UPS, and low  $V_{CE(sat)}$  applications.

## KEY CHARACTERISTICS

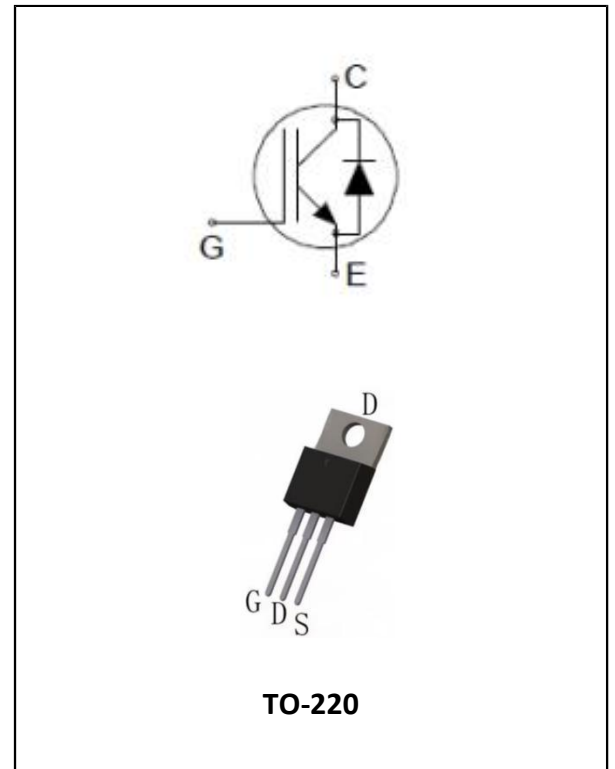
| Parameter         | Value | Unit |
|-------------------|-------|------|
| $V_{CES}$         | 650   | V    |
| $I_c$             | 20    | A    |
| $V_{CE(sat).typ}$ | 1.55  | V    |

## FEATURES

- ① Fast Switching
- ② Low  $V_{CE(sat)}$
- ③ Positive temperature coefficient
- ④ Very soft, fast recovery anti-parallel diode
- ⑤ RoHS product

## APPLICATIONS

- ① UPS
- ② Motor drives
- ③ PFC
- ④ Portable power station



## ORDERING INFORMATION

| Ordering Codes | Package | Product Code | Packing |
|----------------|---------|--------------|---------|
| MLG20T65FUL    | TO-220  | MLG20T65FUL  | Tube    |

## ABSOLUTE RATINGS

| Symbol    | Parameter                                          | TO-220 | TO-220F | Units |
|-----------|----------------------------------------------------|--------|---------|-------|
| $V_{CES}$ | Collector-Emitter Voltage                          | 650    | 650     | V     |
| $I_c$     | Collector Current @ $T_c=25^{\circ}C$              | 40     | 40      | A     |
|           | Collector Current @ $T_c=100^{\circ}C$             | 20     | 20      | A     |
| $I_{CM}$  | Pulsed Collector Current, tp limited by $T_{Jmax}$ | 80     | 80      | A     |

|                                      |                                                                                                                                                                               |                 |     |    |
|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----|----|
| I <sub>F</sub>                       | Diode Continuous Forward Current @T <sub>C</sub> =25°C                                                                                                                        | 40              | 40  | A  |
|                                      | Diode Continuous Forward Current @T <sub>C</sub> =100°C                                                                                                                       | 20              | 20  | A  |
| I <sub>FM</sub>                      | Diode Maximum Forward Current, limited by T <sub>Jmax</sub>                                                                                                                   | 40              | 40  | A  |
| V <sub>GES</sub>                     | Gate-Emitter Voltage                                                                                                                                                          | ±30             | ±30 | V  |
| t <sub>SC</sub>                      | Short circuit withstand time V <sub>GE</sub> =15V, V <sub>CC</sub> ≤400V, Allowed number of short circuits<1000, Times between short circuits: ≥ 1.0s, T <sub>J</sub> ≤ 175°C | 3.0             |     | us |
| P <sub>D</sub>                       | Power Dissipation @T <sub>C</sub> =25°C                                                                                                                                       | 136             | 39  | W  |
| T <sub>Jmax</sub> , T <sub>stg</sub> | Operating Junction and Storage Temperature Range                                                                                                                              | 175, -55 to 175 |     | °C |
| T <sub>L</sub>                       | Maximum Temperature for Soldering                                                                                                                                             | 260             |     | °C |

### Thermal characteristics

| Symbol           | Parameter                | TO-220 | TO-220F | Units |
|------------------|--------------------------|--------|---------|-------|
| R <sub>θJC</sub> | Junction-to-Case (IGBT)  | 1.1    | 3.8     | °C/W  |
| R <sub>θJC</sub> | Junction-to-Case (Diode) | 2.4    | 6.8     | °C/W  |
| R <sub>θJA</sub> | Junction-to-Ambient      | 62.5   | 78      | °C/W  |

### Electrical Characteristics at TC = 25°C, unless otherwise specified

### Static Characteristics

| Symbol               | Parameter                            | Test Conditions                                                     | Values |      |      | Units |
|----------------------|--------------------------------------|---------------------------------------------------------------------|--------|------|------|-------|
|                      |                                      |                                                                     | Min.   | Typ. | Max. |       |
| V <sub>CES</sub>     | Collector-Emitter Breakdown Voltage  | V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA                        | 650    | --   | --   | V     |
| V <sub>CE(sat)</sub> | Collector-Emitter Saturation Voltage | V <sub>GE</sub> = 15V, I <sub>C</sub> = 20A<br>T <sub>J</sub> =25°C | --     | 1.55 | 1.95 | V     |
|                      |                                      | T <sub>J</sub> =125°C T <sub>J</sub> =175°C                         | --     | 1.80 | --   |       |
|                      |                                      |                                                                     | --     | 1.90 | --   |       |
| V <sub>GE(TH)</sub>  | Gate Threshold Voltage               | V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1mA            | 5.1    | 5.8  | 6.5  | V     |
| V <sub>F</sub>       | Diode Forward Voltage                | I <sub>F</sub> =10A T <sub>J</sub> =25°C                            | --     | 1.60 | 2.20 | V     |
|                      |                                      | T <sub>J</sub> =125°C T <sub>J</sub> =175°C                         | --     | 1.40 | --   |       |
|                      |                                      |                                                                     | --     | 1.30 | --   |       |
| V <sub>F</sub>       | Diode Forward Voltage                | I <sub>F</sub> =20A T <sub>J</sub> =25°C                            | --     | 1.90 | 2.50 | V     |
|                      |                                      | T <sub>J</sub> =125°C T <sub>J</sub> =175°C                         | --     | 1.75 | --   |       |
|                      |                                      |                                                                     | --     | 1.65 | --   |       |
| I <sub>CES</sub>     | Collector-Emitter Leakage Current    | V <sub>CE</sub> = 650V, V <sub>GE</sub> = 0V                        | --     | --   | 4    | μA    |
| I <sub>GES(F)</sub>  | Gate-Emitter Leakage Current         | V <sub>GE</sub> = +30V                                              | --     | --   | 200  | nA    |
| I <sub>GES(R)</sub>  | Gate-Emitter Reverse Leakage         | V <sub>GE</sub> = -30V                                              | --     | --   | -200 | nA    |

Pulse width  $t_p \leq 300\mu s$ ,  $\delta \leq 2\%$

### Dynamic Characteristics

| Symbol      | Parameter                                                                                                   | Test Conditions                                                                        | Values |      |      | Units |
|-------------|-------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|--------|------|------|-------|
|             |                                                                                                             |                                                                                        | Min.   | Typ. | Max. |       |
| $C_{iss}$   | Input Capacitance                                                                                           | $V_{GE}=0V$ $V_{CE}=25V$<br>$f=1.0MHz$                                                 | --     | 892  | --   | pF    |
| $C_{oss}$   | Output Capacitance                                                                                          |                                                                                        | --     | 43   | --   |       |
| $C_{rss}$   | Reverse Transfer Capacitance                                                                                |                                                                                        | --     | 10   | --   |       |
| $Q_G$       | Gate charge                                                                                                 | $V_{CC}=520V$ $I_{CE}=20A$<br>$V_{GE}=15V$                                             | --     | 44   | --   | nC    |
| $Q_{GE}$    | Gate-emitter charge                                                                                         |                                                                                        | --     | 13   | --   |       |
| $Q_{GC}$    | Gate-collector charge                                                                                       |                                                                                        | --     | 18   | --   |       |
| $I_{C(SC)}$ | Short circuit collector current<br>Max.1000 short circuits, Times<br>between short circuits:<br>$\geq 1.0s$ | $V_{GE}=15.0V$ , $V_{CC} \leq 400V$ ,<br>$t_{SC} \leq 3\mu s$ , $T_J \leq 175^\circ C$ |        | 110  |      | A     |

### IGBT Switching Characteristics, at $T_J=25^\circ C$

| Symbol       | Parameter               | Test Conditions                                                                                    | Values |      |      | Units |
|--------------|-------------------------|----------------------------------------------------------------------------------------------------|--------|------|------|-------|
|              |                         |                                                                                                    | Min.   | Typ. | Max. |       |
| $t_{d(on)}$  | Turn-on Delay Time      | $I_C=20A$<br>$V_{CE}=400V$<br>$V_{GE}=15V$<br>$R_G=10\Omega$<br>$T_J=25^\circ C$<br>Inductive Load | --     | 15   | --   | ns    |
| $t_r$        | Rise Time               |                                                                                                    | --     | 24   | --   |       |
| $t_{d(off)}$ | Turn-Off Delay Time     |                                                                                                    | --     | 75   | --   |       |
| $t_f$        | Fall Time               |                                                                                                    | --     | 86   | --   |       |
| $E_{on}$     | Turn-On Switching Loss  |                                                                                                    |        | --   | 0.50 | --    |
| $E_{off}$    | Turn-Off Switching Loss |                                                                                                    | --     | 0.27 | --   |       |
| $E_{ts}$     | Total Switching Loss    |                                                                                                    | --     | 0.77 | --   |       |

### IGBT Switching Characteristics, at $T_J=175^\circ C$

| Symbol       | Parameter               | Test Conditions                                                                                     | Values |      |      | Units |    |
|--------------|-------------------------|-----------------------------------------------------------------------------------------------------|--------|------|------|-------|----|
|              |                         |                                                                                                     | Min.   | Typ. | Max. |       |    |
| $t_{d(on)}$  | Turn-on Delay Time      | $I_C=20A$<br>$V_{CE}=400V$<br>$V_{GE}=15V$<br>$R_G=10\Omega$<br>$T_J=175^\circ C$<br>Inductive Load | --     | 14   | --   | ns    |    |
| $t_r$        | Rise Time               |                                                                                                     | --     | 23   | --   |       |    |
| $t_{d(off)}$ | Turn-Off Delay Time     |                                                                                                     | --     | 96   | --   |       |    |
| $t_f$        | Fall Time               |                                                                                                     | --     | 128  | --   |       |    |
| $E_{on}$     | Turn-On Switching Loss  |                                                                                                     |        | --   | 0.54 | --    | mJ |
| $E_{off}$    | Turn-Off Switching Loss |                                                                                                     |        | --   | 0.49 | --    |    |
| $E_{ts}$     | Total Switching Loss    |                                                                                                     |        | --   | 1.03 | --    |    |

### Diode Characteristics, at $T_J=25^\circ C$

| Symbol | Parameter | Test Conditions | Values |      |      | Units |
|--------|-----------|-----------------|--------|------|------|-------|
|        |           |                 | Min.   | Typ. | Max. |       |



|           |                          |                                               |    |     |    |    |
|-----------|--------------------------|-----------------------------------------------|----|-----|----|----|
| $T_{rr}$  | Reverse Recovery Time    | $I_F=10A,$<br>$di/dt=200A/us, T_J=25^\circ C$ | -- | 66  | -- | ns |
| $Q_{rr}$  | Reverse Recovery Charge  |                                               | -- | 182 | -- | nC |
| $I_{rrm}$ | Reverse Recovery Current |                                               | -- | 4.5 | -- | A  |
| $T_{rr}$  | Reverse Recovery Time    | $I_F=20A,$<br>$di/dt=200A/us, T_J=25^\circ C$ | -- | 75  | -- | ns |
| $Q_{rr}$  | Reverse Recovery Charge  |                                               | -- | 236 | -- | nC |
| $I_{rrm}$ | Reverse Recovery Current |                                               | -- | 5.4 | -- | A  |

Diode Characteristics, at  $T_J=175^\circ C$

| Symbol    | Parameter                | Test Conditions                                | Values |      |      | Units |
|-----------|--------------------------|------------------------------------------------|--------|------|------|-------|
|           |                          |                                                | Min.   | Typ. | Max. |       |
| $T_{rr}$  | Reverse Recovery Time    | $I_F=10A,$<br>$di/dt=200A/us, T_J=175^\circ C$ | --     | 122  | --   | ns    |
| $Q_{rr}$  | Reverse Recovery Charge  |                                                | --     | 690  | --   | nC    |
| $I_{rrm}$ | Reverse Recovery Current |                                                | --     | 10.0 | --   | A     |
| $T_{rr}$  | Reverse Recovery Time    | $I_F=20A,$<br>$di/dt=200A/us, T_J=175^\circ C$ | --     | 150  | --   | ns    |
| $Q_{rr}$  | Reverse Recovery Charge  |                                                | --     | 910  | --   | nC    |
| $I_{rrm}$ | Reverse Recovery Current |                                                | --     | 11.0 | --   | A     |

Characteristics Curves

Figure 1. Forward Bias Safe Operating Area for TO220

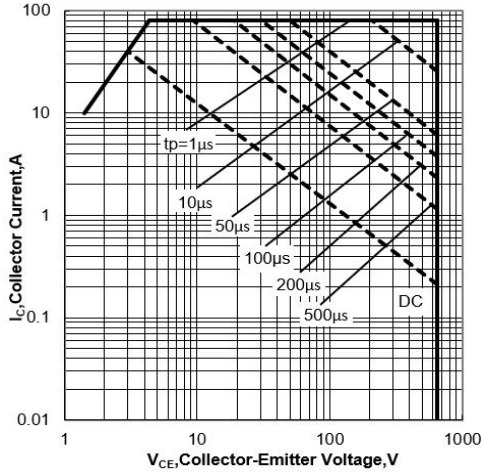


Figure 2. Forward Bias Safe Operating Area for TO220F

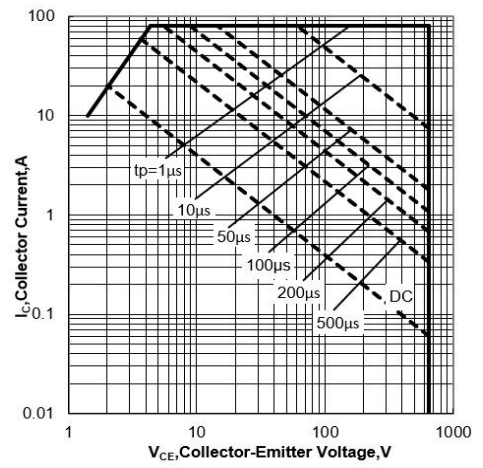


Figure 3. Power Dissipation vs Case Temperature for TO220

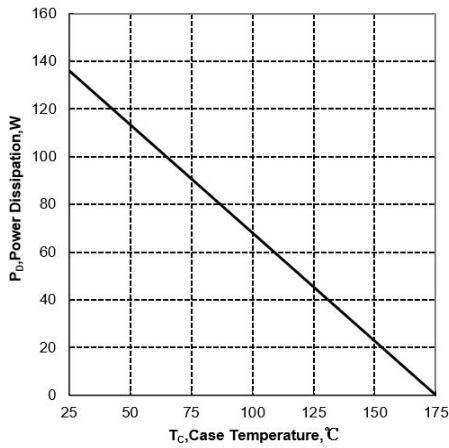


Figure 4. Power Dissipation vs Case Temperature for TO220F

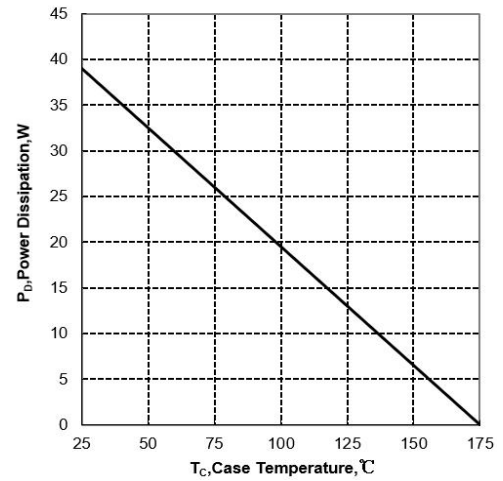


Figure 5. Collector Current vs Case Temperature

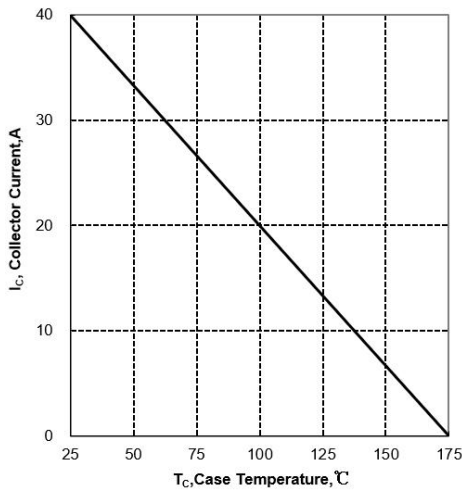


Figure 6. Typical Transfer Characteristics

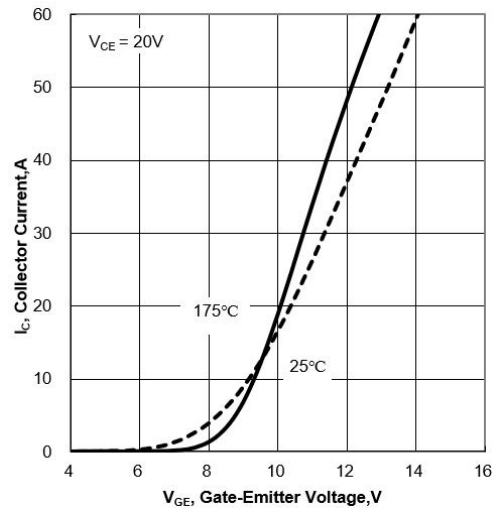


Figure 7. Typical Output Characteristics ( $T_C=25^\circ\text{C}$ )

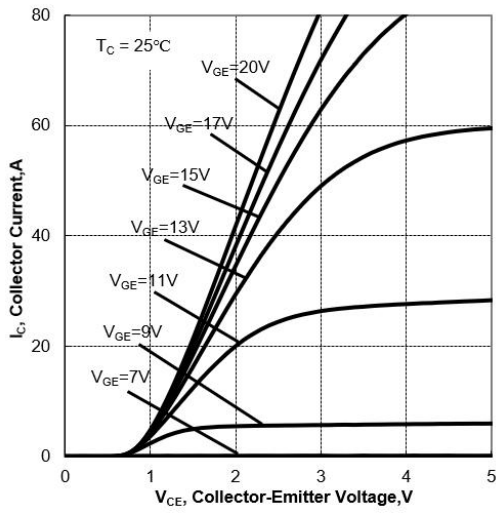


Figure 8. Typical Output Characteristics ( $T_C=175^\circ\text{C}$ )

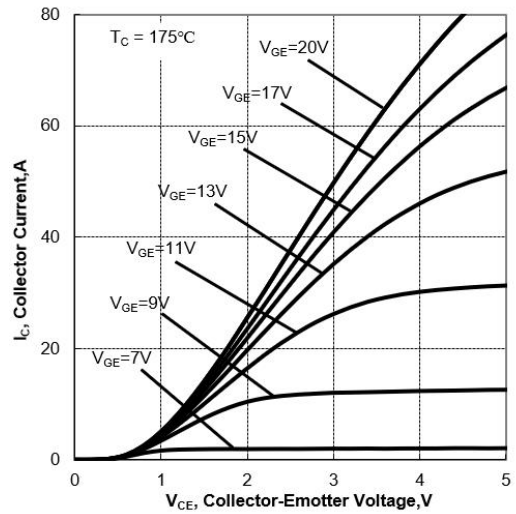


Figure 9. Typical Collector-Emitter Saturation Voltage vs Case Temperature

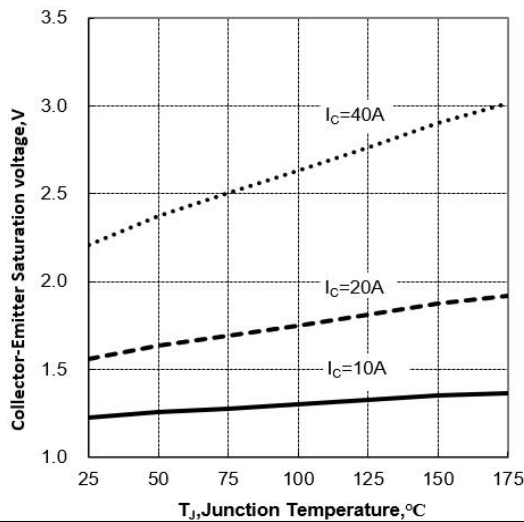


Figure 10. Typical Gate-Emitter Threshold Voltage vs Case Temperature

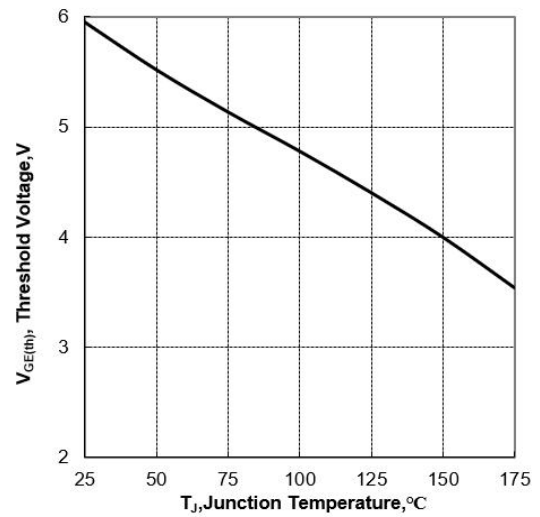


Figure 11. Typical Switching Times vs Gate Resistor ( $T_J=25^\circ\text{C}$ ,  $V_{ce}=400\text{V}$ ,  $V_{ge}=15/0\text{V}$ ,  $I_c=20\text{A}$ )

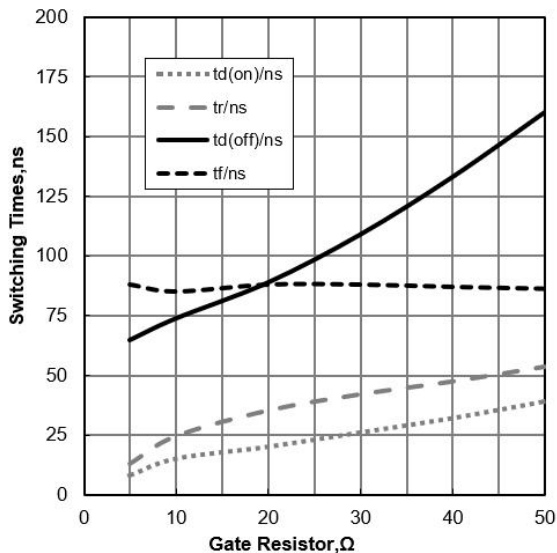


Figure 12. Typical Switching Energy vs Gate Resistor ( $T_J=25^\circ\text{C}$ ,  $V_{ce}=400\text{V}$ ,  $V_{ge}=15/0\text{V}$ ,  $I_c=20\text{A}$ )

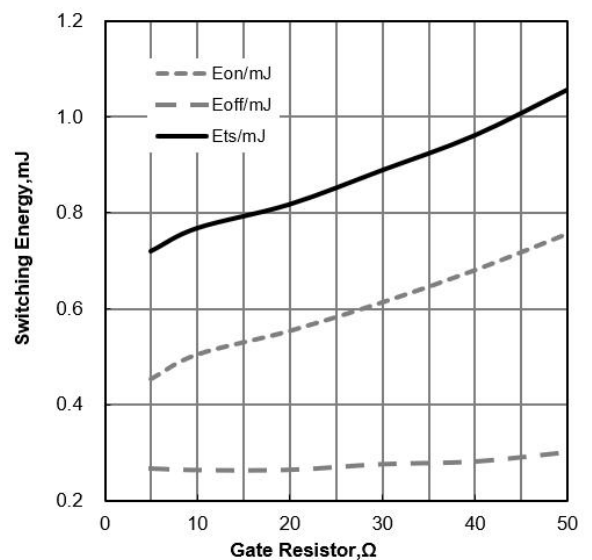


Figure 13. Typical Switching Times vs Case Temperature (  $V_{ce}=400V$ ,  $V_{ge}=15/0V$ ,  $I_c=20A$  )

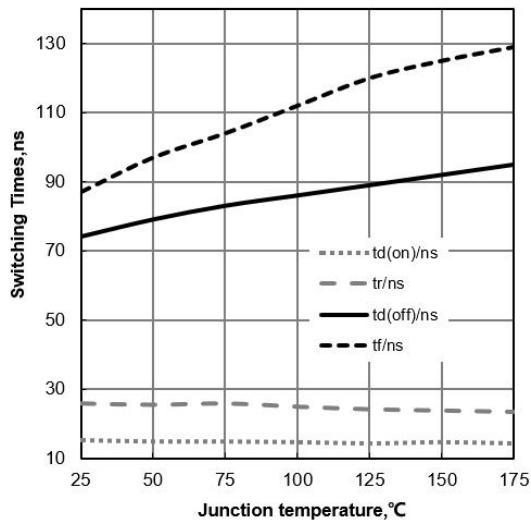


Figure 14. Typical Switching Energy vs Case Temperature (  $V_{ce}=400V$ ,  $V_{ge}=15/0V$ ,  $I_c=20A$  )

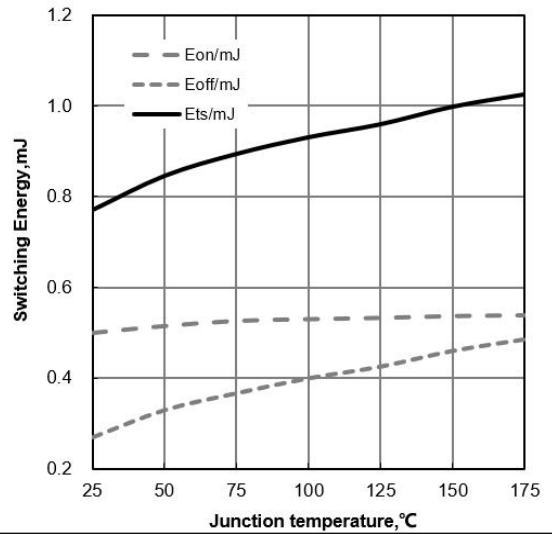


Figure 15. Typical Switching Times vs Collector Current (  $T_c=25^\circ C$ ,  $V_{ce}=400V$ ,  $V_{ge}=15/0V$  )

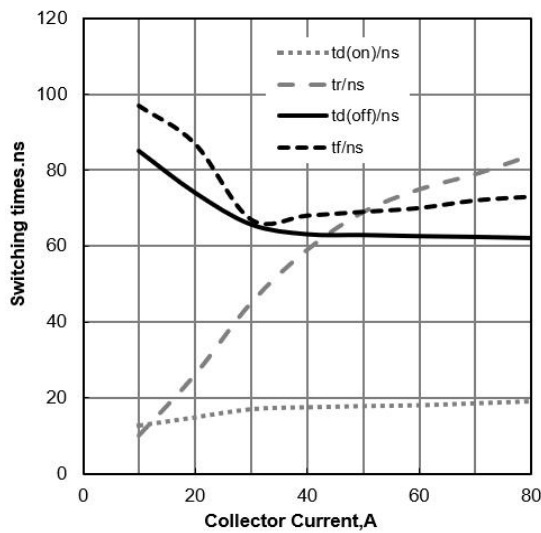


Figure 16. Typical Switching Energy vs Collector Current (  $T_c=25^\circ C$ ,  $V_{ce}=400V$ ,  $V_{ge}=15/0V$  )

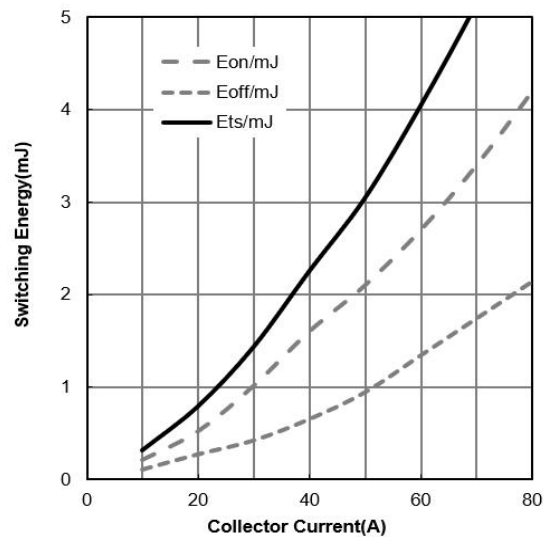


Figure 17. Typical Switching Times vs  $V_{CE}$  (  $T_c=25^\circ C$ ,  $V_{ge}=15/0V$ ,  $I_c=20A$  )

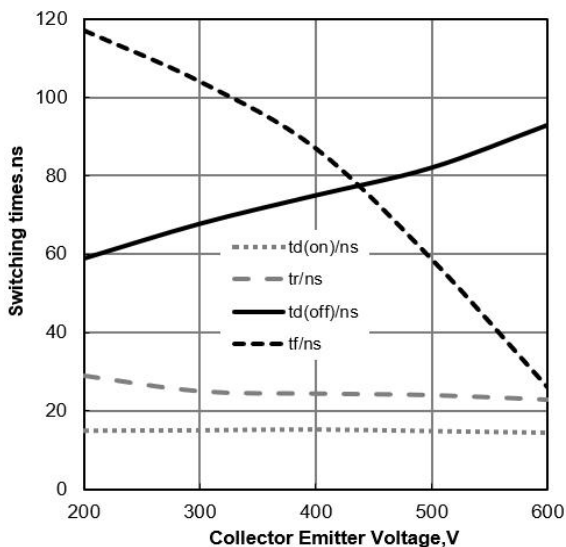


Figure 18. Typical Switching Energy vs  $V_{CE}$  (  $T_c=25^\circ C$ ,  $V_{ge}=15/0V$ ,  $I_c=20A$  )

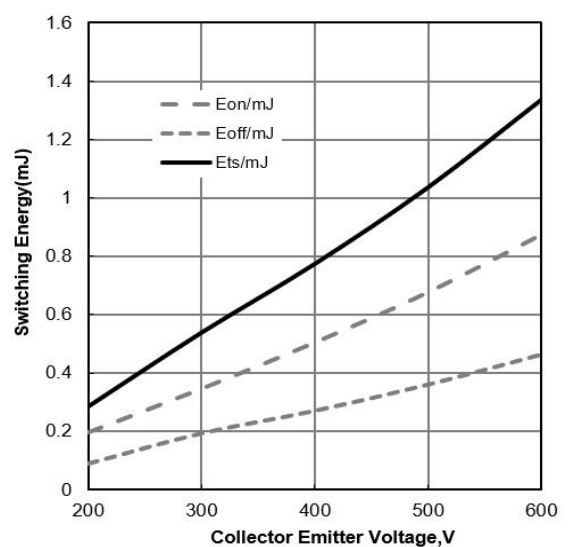




Figure 19. Typical Gate Charge

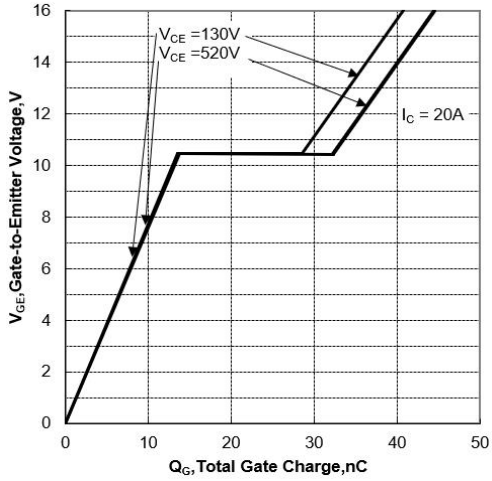


Figure 20. Typical Capacitance vs Collector-Emitter Voltage

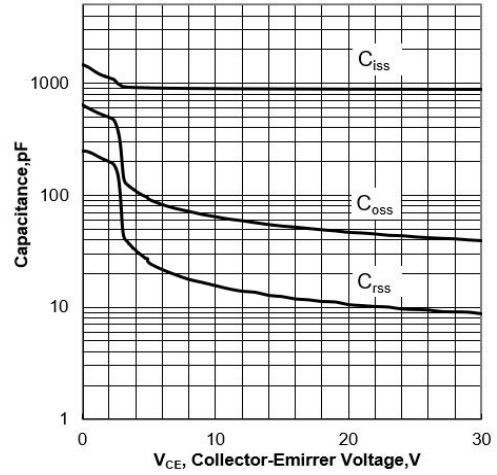


Figure 21. IGBT Transient Thermal Impedance vs Pulse Width(TO220)

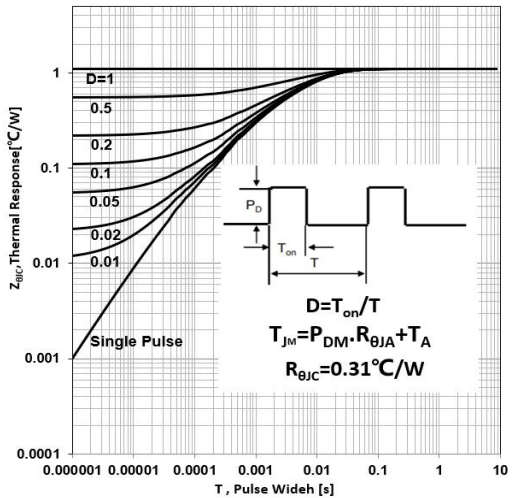


Figure 22. IGBT Transient Thermal Impedance vs Pulse Width(TO220F)

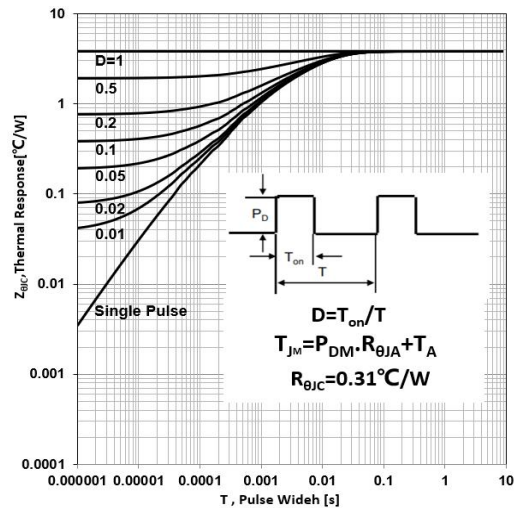


Figure 23. Diode Transient Thermal Impedance vs Pulse Width(TO220)

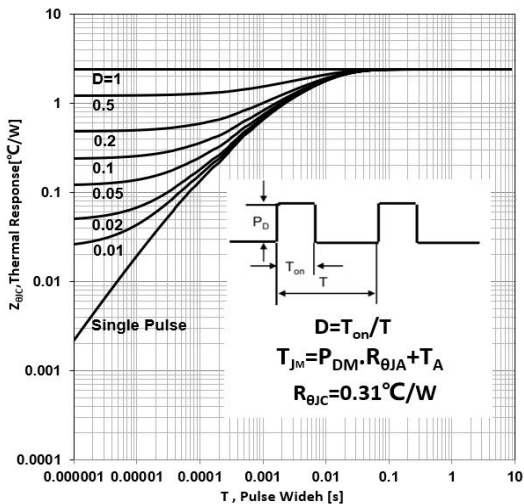


Figure 24. Diode Transient Thermal Impedance vs Pulse Width(TO220F)

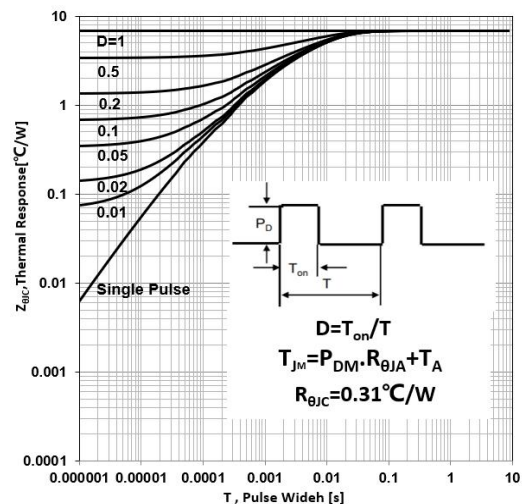
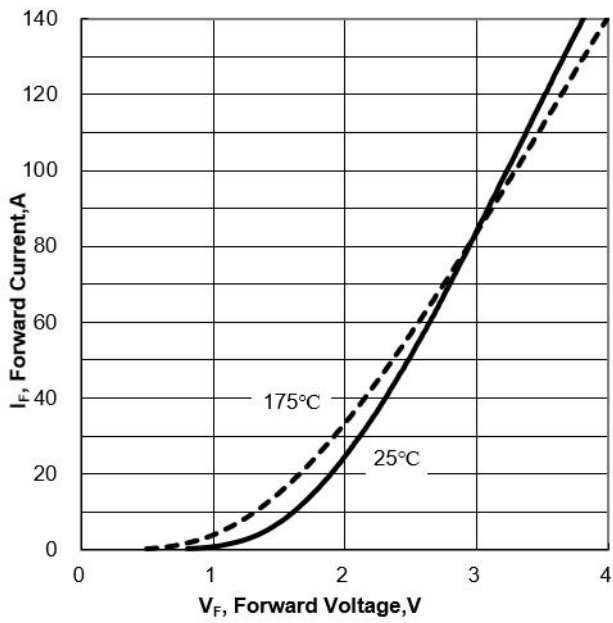




Figure 25. Typical Diode Forward Current vs Forward Voltage



Test Circuit and Waveform

Figure 11. Inductive Switching Test Circuit

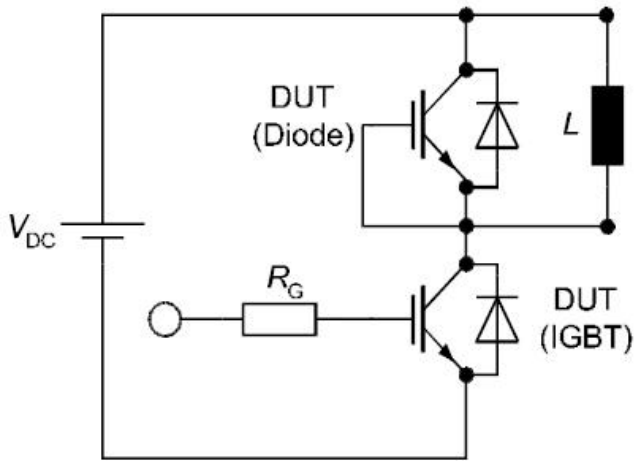


Figure 12. Definition of switching times

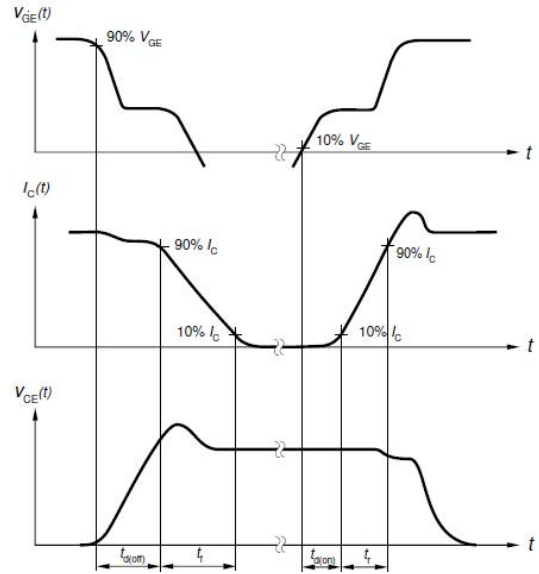


Figure 13. Definition of switching losses

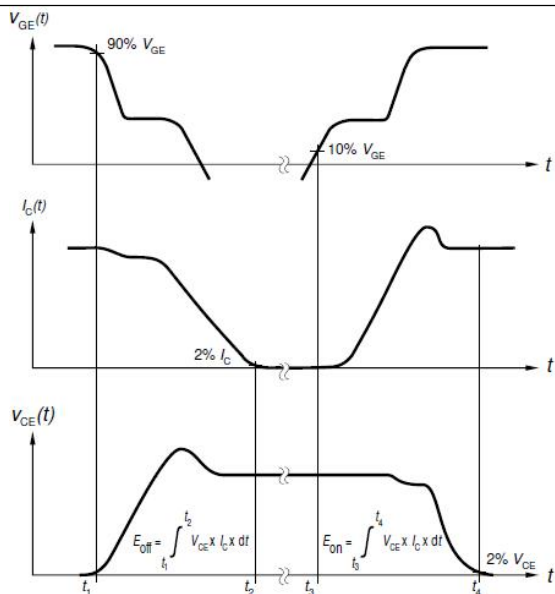
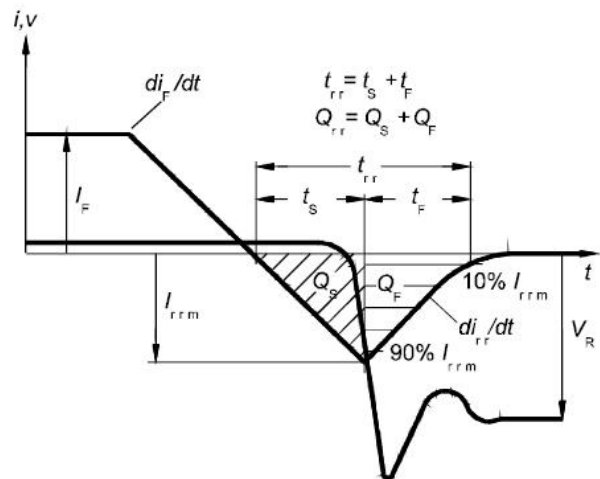
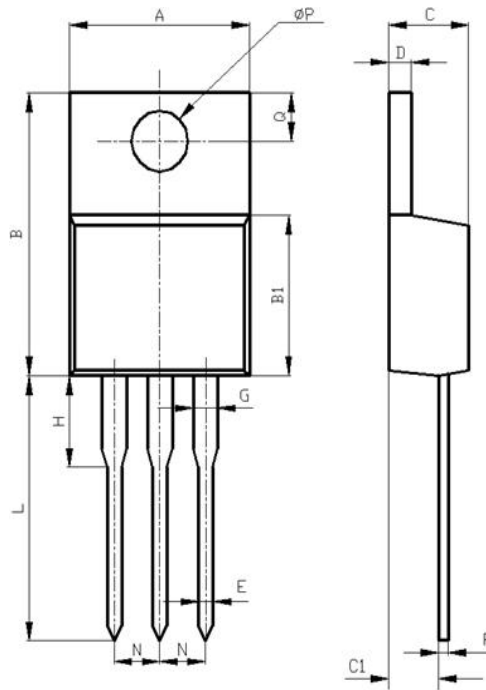


Figure 14. Definition of diode switching characteristics



Package Description



| Items    | Values(mm) |      |
|----------|------------|------|
|          | MIN        | MAX  |
| A        | 9.60       | 10.6 |
| B        | 15.0       | 16.0 |
| B1       | 8.90       | 9.50 |
| C        | 4.30       | 4.80 |
| C1       | 2.30       | 3.10 |
| D        | 1.20       | 1.40 |
| E        | 0.70       | 0.90 |
| F        | 0.30       | 0.60 |
| G        | 1.17       | 1.37 |
| H        | 2.70       | 3.80 |
| L        | 12.6       | 14.8 |
| N        | 2.34       | 2.74 |
| Q        | 2.40       | 3.00 |
| $\phi p$ | 3.50       | 3.90 |

TO-220 Package



**NOTE:**

1. Exceeding the maximum ratings of the device in performance may cause damage to the device, even the permanent failure, which may affect the dependability of the machine. Please do not exceed the absolute maximum ratings of the device when circuit designing.
2. When installing the heat sink, please pay attention to the torsional moment and the smoothness of the heat sink.
3. MOSFETs is the device which is sensitive to the static electricity, it is necessary to protect the device from being damaged by the static electricity when using it.
4. Shenzhen Minos reserves the right to make changes in this specification sheet and is subject to change without prior notice.

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