

### Feature

- 650V/6A  
 $V_{CE(sat)} = 1.63 \text{ V (typ.) @ } I_C = 6 \text{ A}$
- Positive temperature coefficient
- Fast Switching
- Low  $V_{CE(sat)}$
- Reliable and Rugged
- Halogen Free and Green Devices Available  
(RoHS Compliant)

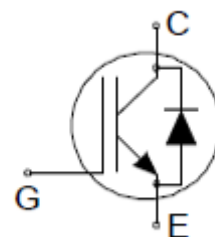
### Pin Description



TO-252-2L

### Applications

- Motor Drives, Home Appliance Applications
- Fan, Pumps, Vacuum Cleaner
- Other Hard Switching Applications



### Ordering and Marking Information

|                                                                                                                                                          |                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
|  <div style="text-align: center;"> D<br/> HYG06T65<br/> XYMXXX </div> | <div>Package Code</div> D:TO-252-2L<br><br><div>Date Code</div> XYMXXX |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|

Note: HUAYI halogen free products contain molding compounds and 100% matte tin plate Termination finish; which are fully compliant with RoHS. HUAYI halogen free products meet or exceed the halogen free requirements of IPC/JEDEC J-STD-020 for MSL classification at halogen free peak reflow temperature. HUAYI defines "Green" to mean halogen free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

HUAYI reserves the right to make changes, corrections, enhancements, modifications, and improvements to this product and/or to this document at any time without notice.

## Absolute Maximum Ratings

| Symbol                                          | Parameter                                    |          | Rating     | Unit |
|-------------------------------------------------|----------------------------------------------|----------|------------|------|
| Common Ratings (Tc=25°C Unless Otherwise Noted) |                                              |          |            |      |
| V <sub>CES</sub>                                | Collector-Emitter Voltage                    |          | 650        | V    |
| V <sub>GES</sub>                                | Gate-Emitter Voltage                         |          | ± 30       | V    |
| T <sub>J</sub>                                  | Junction Temperature Range                   |          | -55 to 175 | °C   |
| T <sub>STG</sub>                                | Storage Temperature Range                    |          |            | °C   |
| Mounted on Large Heat Sink                      |                                              |          |            |      |
| I <sub>CM</sub>                                 | Pulsed Collector Current *                   | Tc=25°C  | 18         | A    |
| I <sub>C</sub>                                  | Continuous Drain Current                     | Tc=25°C  | 12         | A    |
|                                                 |                                              | Tc=100°C | 6          | A    |
| I <sub>FM</sub>                                 | Diode Maximum Forward Current *              | Tc=25°C  | 18         | A    |
| I <sub>F</sub>                                  | Diode Continuous Forward Current             | Tc=25°C  | 12         | A    |
|                                                 |                                              | Tc=100°C | 6          | A    |
| P <sub>D</sub>                                  | Power Dissipation @TC=25°C                   |          | 83         | W    |
| R <sub>θJC</sub>                                | Thermal Resistance, Junction-to-Case (IGBT)  |          | 1.80       | °C/W |
| R <sub>θJC</sub>                                | Thermal Resistance, Junction-to-Case (Diode) |          | 2.20       | °C/W |
| R <sub>θJA</sub>                                | Thermal Resistance, Junction-to-Ambient      |          | 62.5       | °C/W |

Note: \* Repetitive rating: pulse width limited by max. junction temperature.

## Electrical Characteristics(Tc =25°C Unless Otherwise Noted)

| Symbol                  | Parameter                            | Test Conditions                                                   | HYG06T65F1DHD |      |      | Unit |
|-------------------------|--------------------------------------|-------------------------------------------------------------------|---------------|------|------|------|
|                         |                                      |                                                                   | Min           | Typ. | Max  |      |
| Static Characteristics* |                                      |                                                                   |               |      |      |      |
| BV <sub>CES</sub>       | Collector-Emitter Breakdown Voltage  | V <sub>GE</sub> =0V, I <sub>C</sub> =250uA                        | 650           | -    | -    | V    |
| I <sub>CES</sub>        | Collector-Emitter Leakage Current    | V <sub>CE</sub> =650V, V <sub>GE</sub> =0V                        | -             | -    | 10   | μA   |
| V <sub>GE(th)</sub>     | Gate Threshold Voltage               | V <sub>CE</sub> =V <sub>GE</sub> , I <sub>C</sub> =1mA            | 4.3           | 5.3  | 6.3  | V    |
| I <sub>GES</sub>        | Gate-Emitter Leakage Current         | V <sub>GE</sub> =± 20V, V <sub>CE</sub> =0V                       | -             | -    | ±200 | nA   |
| V <sub>CE(sat)</sub>    | Collector-Emitter Saturation Voltage | V <sub>GE</sub> =15V, I <sub>C</sub> =6A<br>T <sub>J</sub> =25°C  | -             | 1.63 | 1.98 | V    |
|                         |                                      | V <sub>GE</sub> =15V, I <sub>C</sub> =6A<br>T <sub>J</sub> =125°C | -             | 1.97 | -    | V    |
|                         |                                      | V <sub>GE</sub> =15V, I <sub>C</sub> =6A<br>T <sub>J</sub> =175°C | -             | 2.14 | -    | V    |
| V <sub>F</sub>          | Diode Forward Voltage                | I <sub>F</sub> =6A, T <sub>J</sub> =25°C                          | -             | 1.35 | 1.75 | V    |
|                         |                                      | I <sub>F</sub> =6A, T <sub>J</sub> =125°C                         | -             | 1.29 | -    | V    |
|                         |                                      | I <sub>F</sub> =6A, T <sub>J</sub> =175°C                         | -             | 1.24 | -    | V    |

| Dynamic Characteristics                                  |                                                                                                     |                                                                                                                                      |   |      |   |    |
|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|---|------|---|----|
| C <sub>ies</sub>                                         | Input Capacitance                                                                                   | V <sub>GE</sub> =0V                                                                                                                  | - | 246  | - | pF |
| C <sub>oes</sub>                                         | Output Capacitance                                                                                  | V <sub>CE</sub> =25V                                                                                                                 | - | 33   | - |    |
| C <sub>res</sub>                                         | Reverse Transfer Capacitance                                                                        | Frequency=1MHz                                                                                                                       | - | 3.8  | - |    |
| Q <sub>g</sub>                                           | Total Gate Charge                                                                                   | V <sub>CC</sub> =520V                                                                                                                | - | 9.0  | - | nC |
| Q <sub>ge</sub>                                          | Gate- Emitter Charge                                                                                | I <sub>C</sub> =6A                                                                                                                   | - | 3.0  | - |    |
| Q <sub>gc</sub>                                          | Gate- Collector Charge                                                                              | V <sub>GE</sub> =15V                                                                                                                 | - | 3.2  | - |    |
| t <sub>(SC)</sub>                                        | Short circuit collector current<br>Max.1000 short circuits, times<br>between short circuits: ≥ 1.0s | V <sub>GE</sub> =15V, V <sub>CC</sub> ≤400V<br>T <sub>J</sub> ≤175°C                                                                 | - | 15   | - | μs |
| IGBT Switching Characteristics, at T <sub>J</sub> =25°C  |                                                                                                     |                                                                                                                                      |   |      |   |    |
| t <sub>d(ON)</sub>                                       | Turn-on Delay Time                                                                                  | I <sub>C</sub> =6A<br>V <sub>CC</sub> =400V<br>V <sub>GE</sub> =15V<br>R <sub>g</sub> =5Ω<br>T <sub>J</sub> =25°C<br>Inductive Load  | - | 9    | - | ns |
| t <sub>r</sub>                                           | Turn-on Rise Time                                                                                   |                                                                                                                                      | - | 12   | - |    |
| t <sub>d(OFF)</sub>                                      | Turn-off Delay Time                                                                                 |                                                                                                                                      | - | 39   | - |    |
| t <sub>f</sub>                                           | Turn-off Fall Time                                                                                  |                                                                                                                                      | - | 135  | - |    |
| E <sub>on</sub>                                          | Turn-On Switching Loss                                                                              |                                                                                                                                      | - | 0.08 | - | mJ |
| E <sub>off</sub>                                         | Turn-Off Switching Loss                                                                             |                                                                                                                                      | - | 0.16 | - |    |
| E <sub>ts</sub>                                          | Total Switching Loss                                                                                |                                                                                                                                      | - | 0.24 | - |    |
| IGBT Switching Characteristics, at T <sub>J</sub> =175°C |                                                                                                     |                                                                                                                                      |   |      |   |    |
| t <sub>d(ON)</sub>                                       | Turn-on Delay Time                                                                                  | I <sub>C</sub> =6A<br>V <sub>CC</sub> =400V<br>V <sub>GE</sub> =15V<br>R <sub>g</sub> =5Ω<br>T <sub>J</sub> =175°C<br>Inductive Load | - | 10   | - | ns |
| t <sub>r</sub>                                           | Turn-on Rise Time                                                                                   |                                                                                                                                      | - | 33   | - |    |
| t <sub>d(OFF)</sub>                                      | Turn-off Delay Time                                                                                 |                                                                                                                                      | - | 57   | - |    |
| t <sub>f</sub>                                           | Turn-off Fall Time                                                                                  |                                                                                                                                      | - | 180  | - |    |
| E <sub>on</sub>                                          | Turn-On Switching Loss                                                                              |                                                                                                                                      | - | 0.11 | - | mJ |
| E <sub>off</sub>                                         | Turn-Off Switching Loss                                                                             |                                                                                                                                      | - | 0.23 | - |    |
| E <sub>ts</sub>                                          | Total Switching Loss                                                                                |                                                                                                                                      | - | 0.34 | - |    |
| Diode Characteristics, at T <sub>J</sub> =25°C           |                                                                                                     |                                                                                                                                      |   |      |   |    |
| t <sub>rr</sub>                                          | Reverse Recovery Time                                                                               | I <sub>F</sub> =6A, V <sub>CC</sub> =400V<br>di/dt=200A/μs                                                                           | - | 42   | - | ns |
| Q <sub>rr</sub>                                          | Reverse Recovery Charge                                                                             |                                                                                                                                      | - | 88   | - | nC |
| I <sub>rrm</sub>                                         | Reverse Recovery Current                                                                            |                                                                                                                                      | - | 4.4  | - | A  |
| Diode Characteristics, at T <sub>J</sub> =175°C          |                                                                                                     |                                                                                                                                      |   |      |   |    |
| t <sub>rr</sub>                                          | Reverse Recovery Time                                                                               | I <sub>F</sub> =6A, V <sub>CC</sub> =400V<br>di/dt=200A/μs                                                                           | - | 68   | - | ns |
| Q <sub>rr</sub>                                          | Reverse Recovery Charge                                                                             |                                                                                                                                      | - | 103  | - | nC |
| I <sub>rrm</sub>                                         | Reverse Recovery Current                                                                            |                                                                                                                                      | - | 6.2  | - | A  |

Note: \*Pulse test, pulse width  $\leq 300\mu s$ , duty cycle  $\leq 2\%$

## Typical Operating Characteristics

Figure 1: Power Dissipation

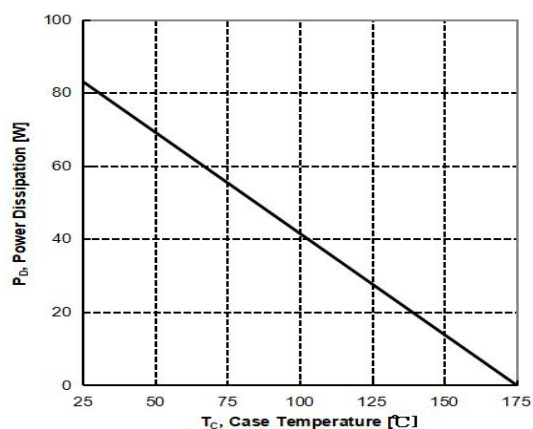


Figure 2: Collector Current vs. Case Temperature

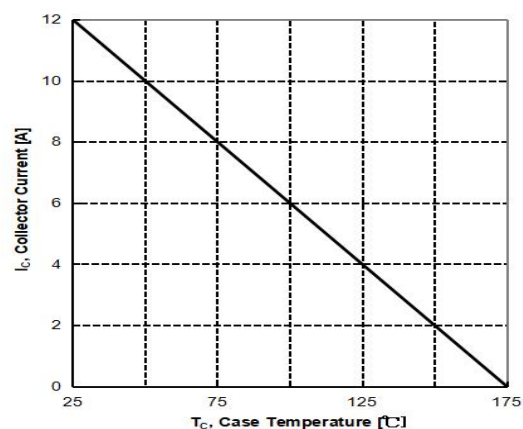


Figure 3: Safe Operation Area

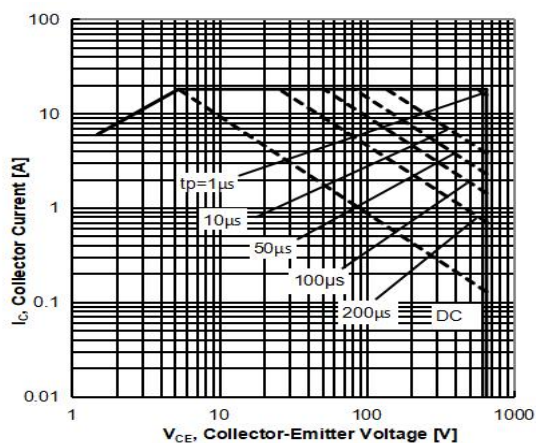


Figure 4: Typical Transfer Characteristics

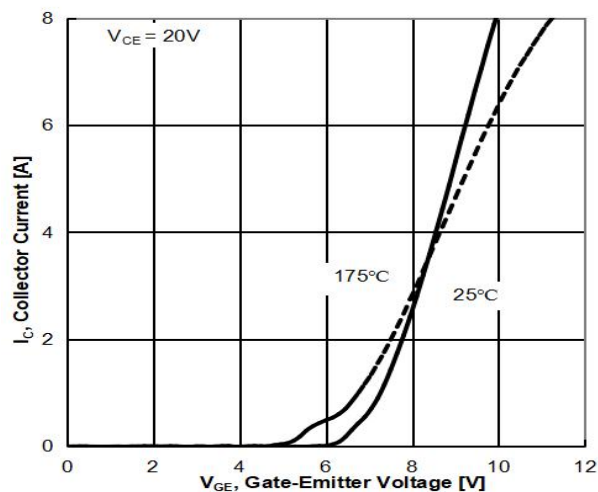


Figure 5: Typical Output Characteristics

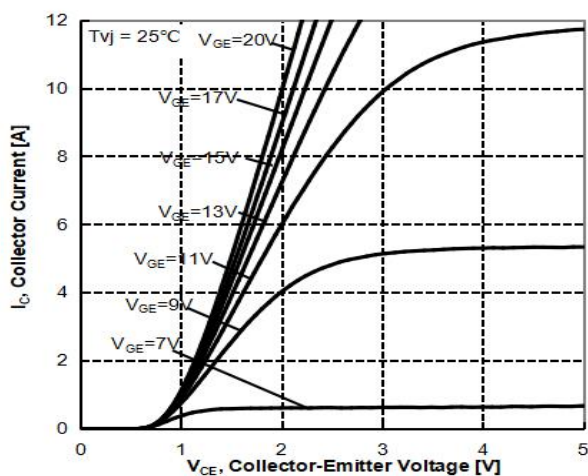
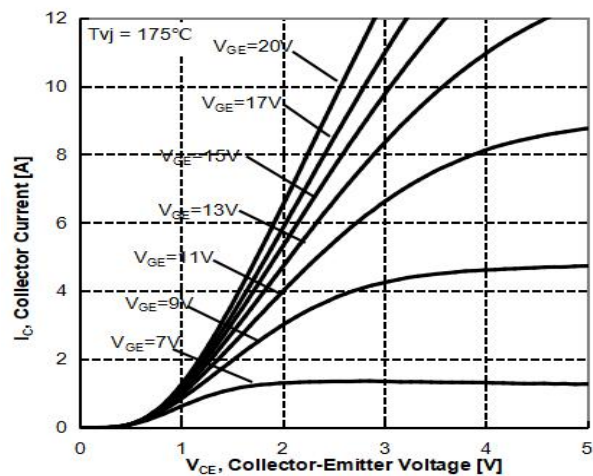
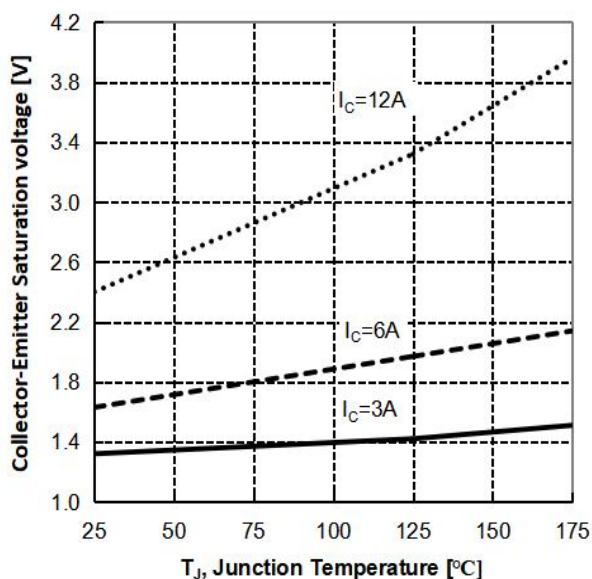


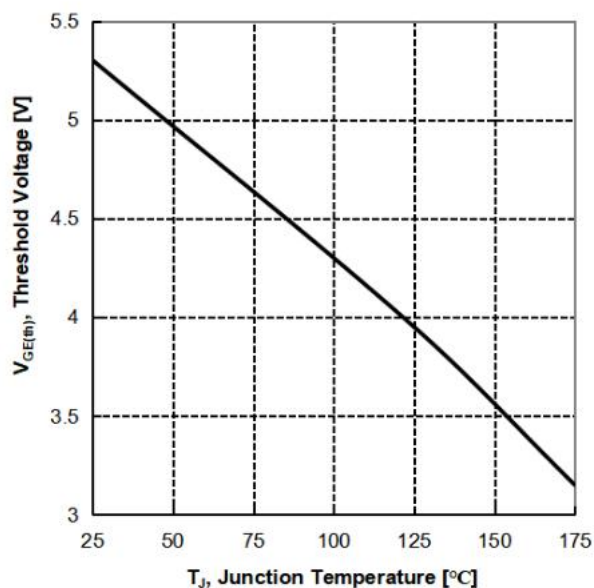
Figure 6: Typical Output Characteristics



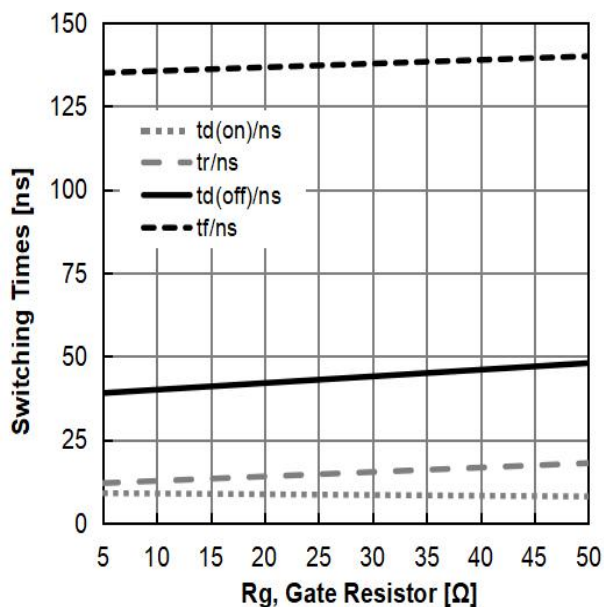
**Figure 7: Typical Collector-Emitter Saturation Voltage vs. Junction Temperature**



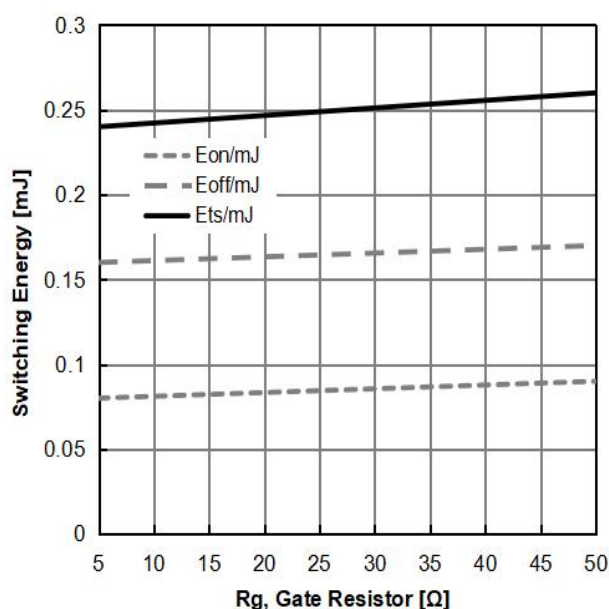
**Figure 8: Typical Gate-Emitter Threshold Voltage vs. Junction Temperature**



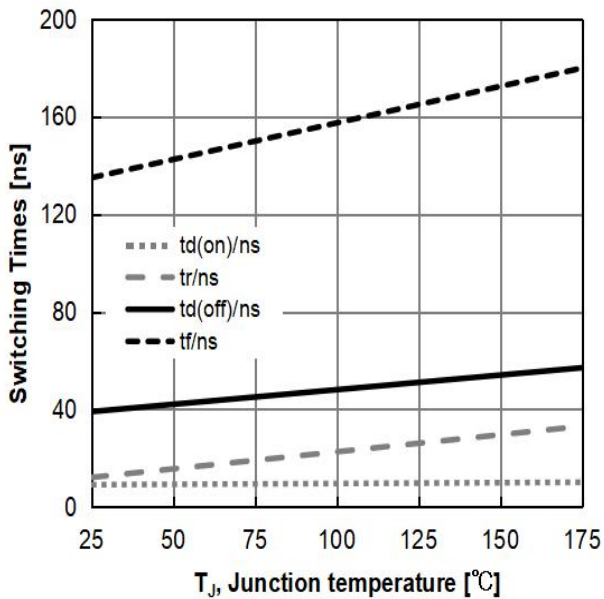
**Figure 9: Typical Switching Times vs. Gate Resistor ( $T_J=25^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15\text{V}$ ,  $I_C=6\text{A}$ )**



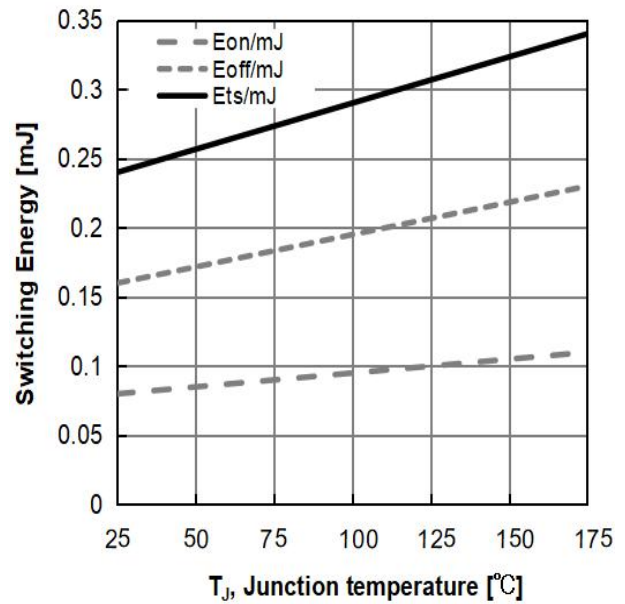
**Figure 10: Typical Switching Energy vs. Gate Resistor ( $T_J=25^\circ\text{C}$ ,  $V_{CE}=400\text{V}$ ,  $V_{GE}=15\text{V}$ ,  $I_C=6\text{A}$ )**



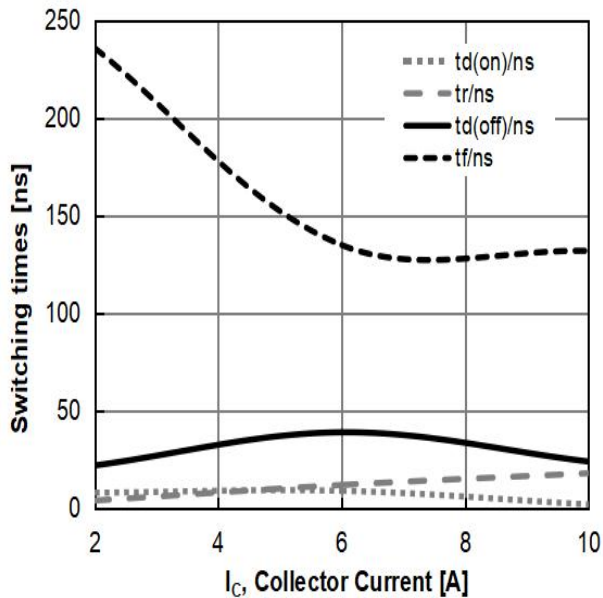
**Figure 11: Typical Switching Times vs. Junction Temperature ( $V_{CE}=400V$ ,  $V_{GE}=15V$ ,  $I_C=6A$ ,  $R_g=5\Omega$ )**



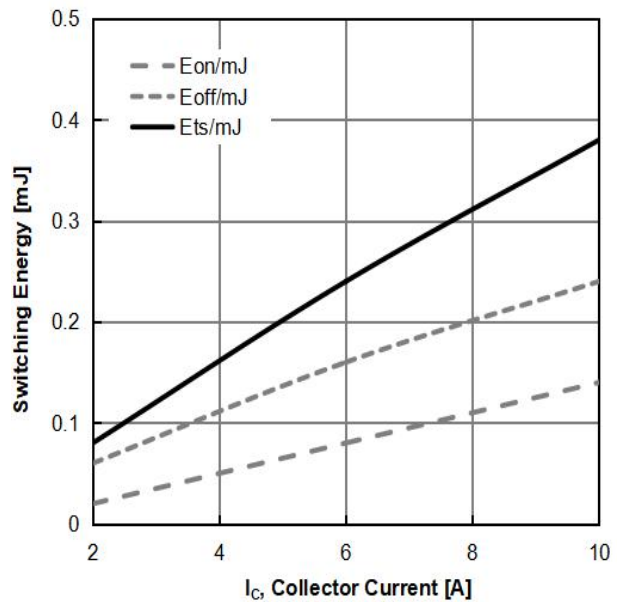
**Figure 12: Typical Switching Energy vs. Junction Temperature ( $V_{CE}=400V$ ,  $V_{GE}=15V$ ,  $I_C=6A$ ,  $R_g=5\Omega$ )**



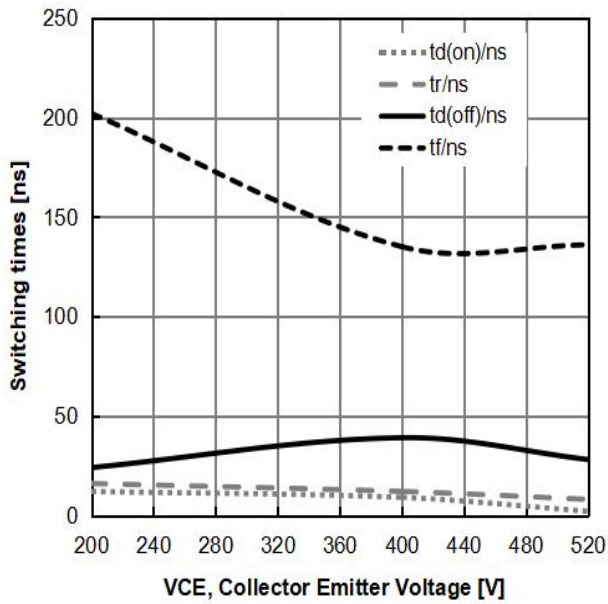
**Figure 13: Typical Switching Times vs. Collector Current ( $T_J=25^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15V$ ,  $R_g=5\Omega$ )**



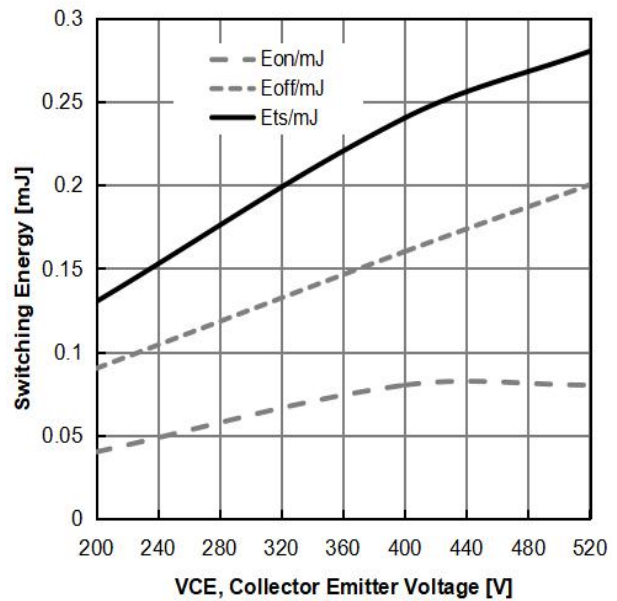
**Figure 14: Typical Switching Energy vs. Collector Current ( $T_J=25^\circ C$ ,  $V_{CE}=400V$ ,  $V_{GE}=15V$ ,  $R_g=5\Omega$ )**



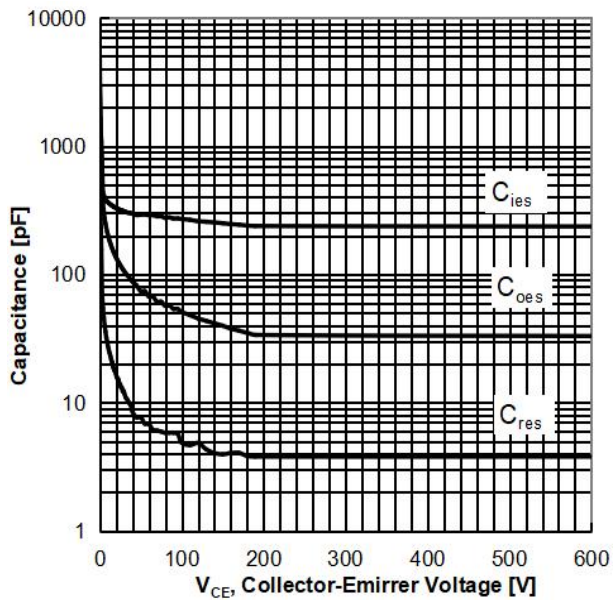
**Figure 15: Typical Switching Times vs. VCE (  $T_J=25^{\circ}\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $I_C=6\text{A}$ ,  $R_g=5\Omega$  )**



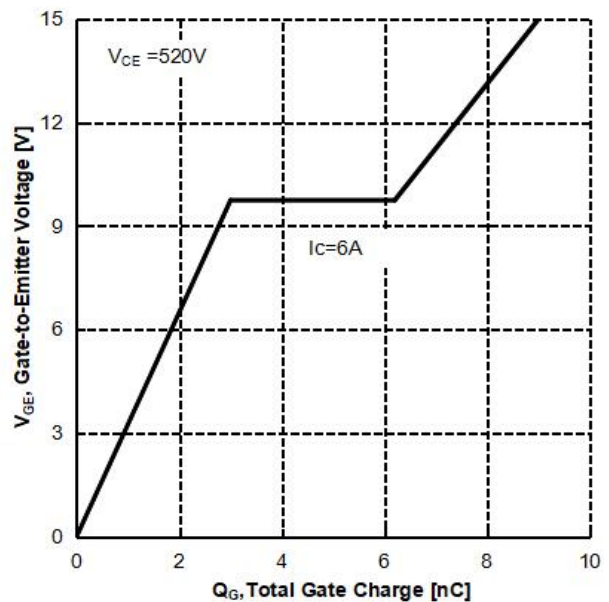
**Figure 16: Typical Switching Energy vs. VCE (  $T_J=25^{\circ}\text{C}$ ,  $V_{GE}=15\text{V}$ ,  $I_C=6\text{A}$ ,  $R_g=5\Omega$  )**



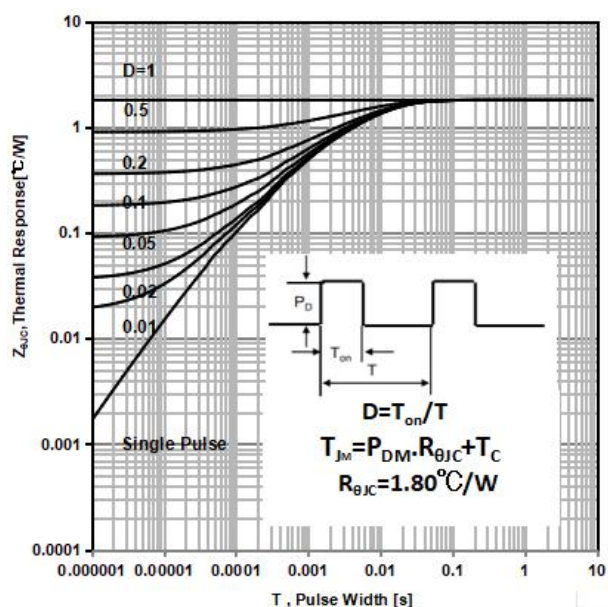
**Figure 17: Typical Capacitance vs. Collector- Emitter Voltage**



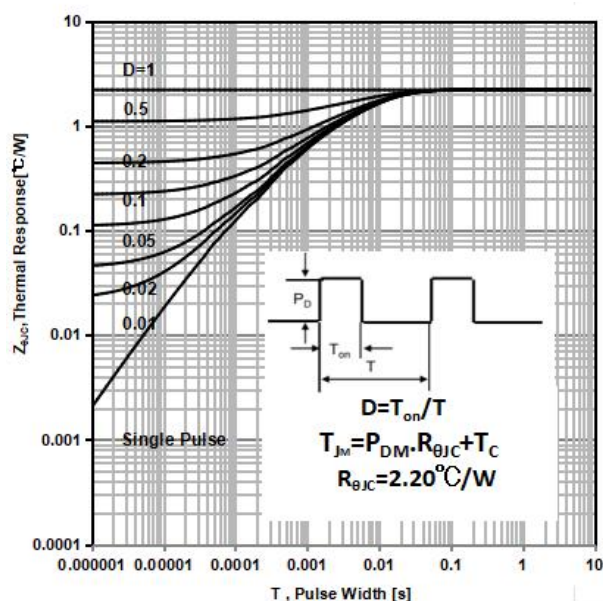
**Figure 17: Typical Gate Charge**



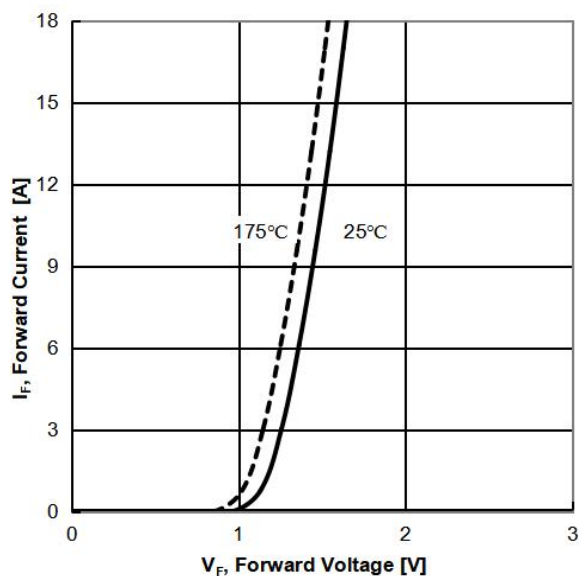
**Figure 19: IGBT Transient Thermal Impedance vs. Pulse Width**



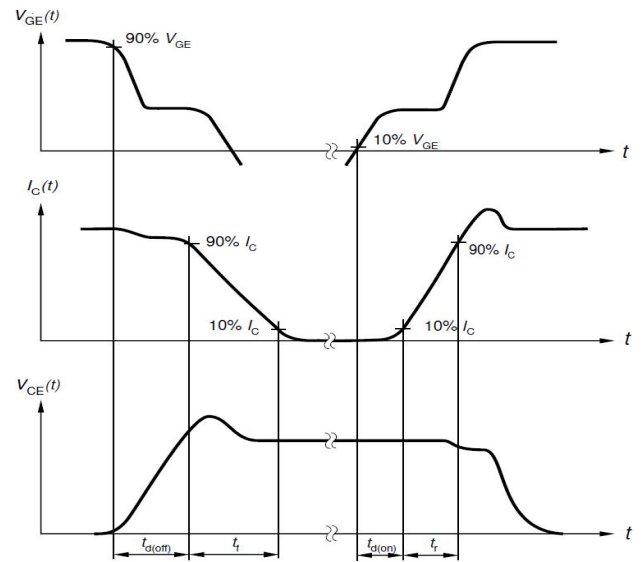
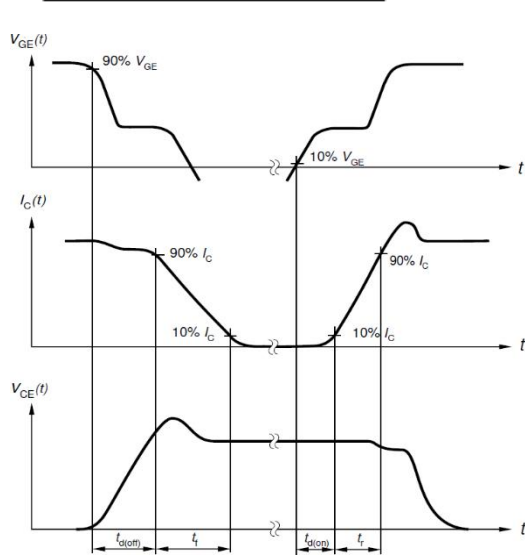
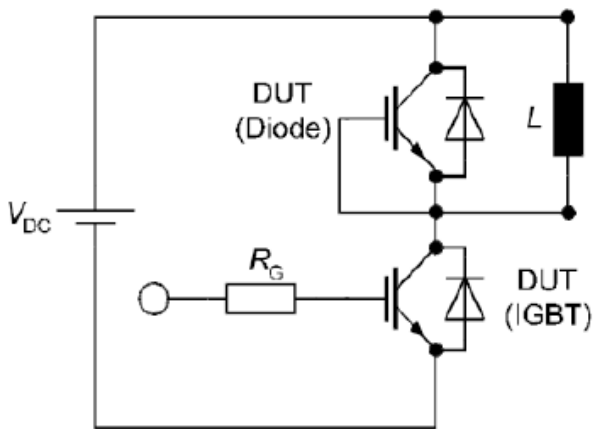
**Figure 20: Diode Transient Thermal Impedance vs. Pulse Width**



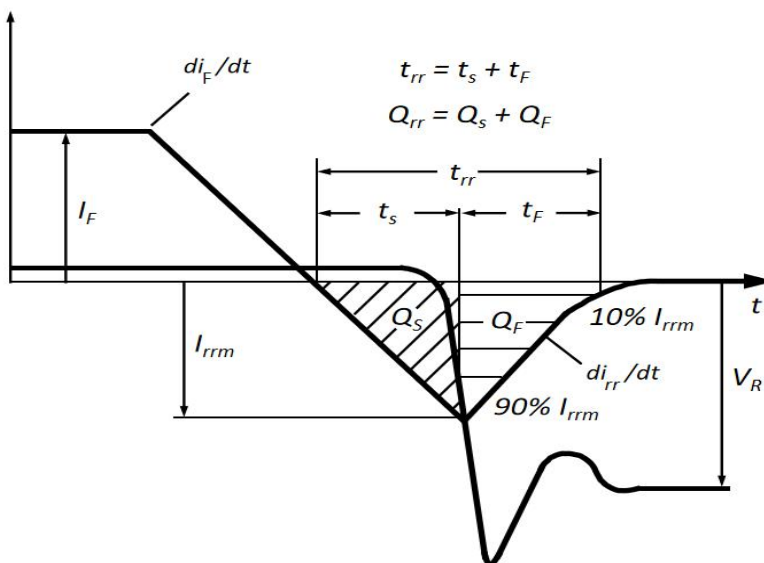
**Figure 21: Typical Diode Forward Current vs. Forward Voltage**



## Switching Time Test Circuit



## Definition of diode switching characteristics

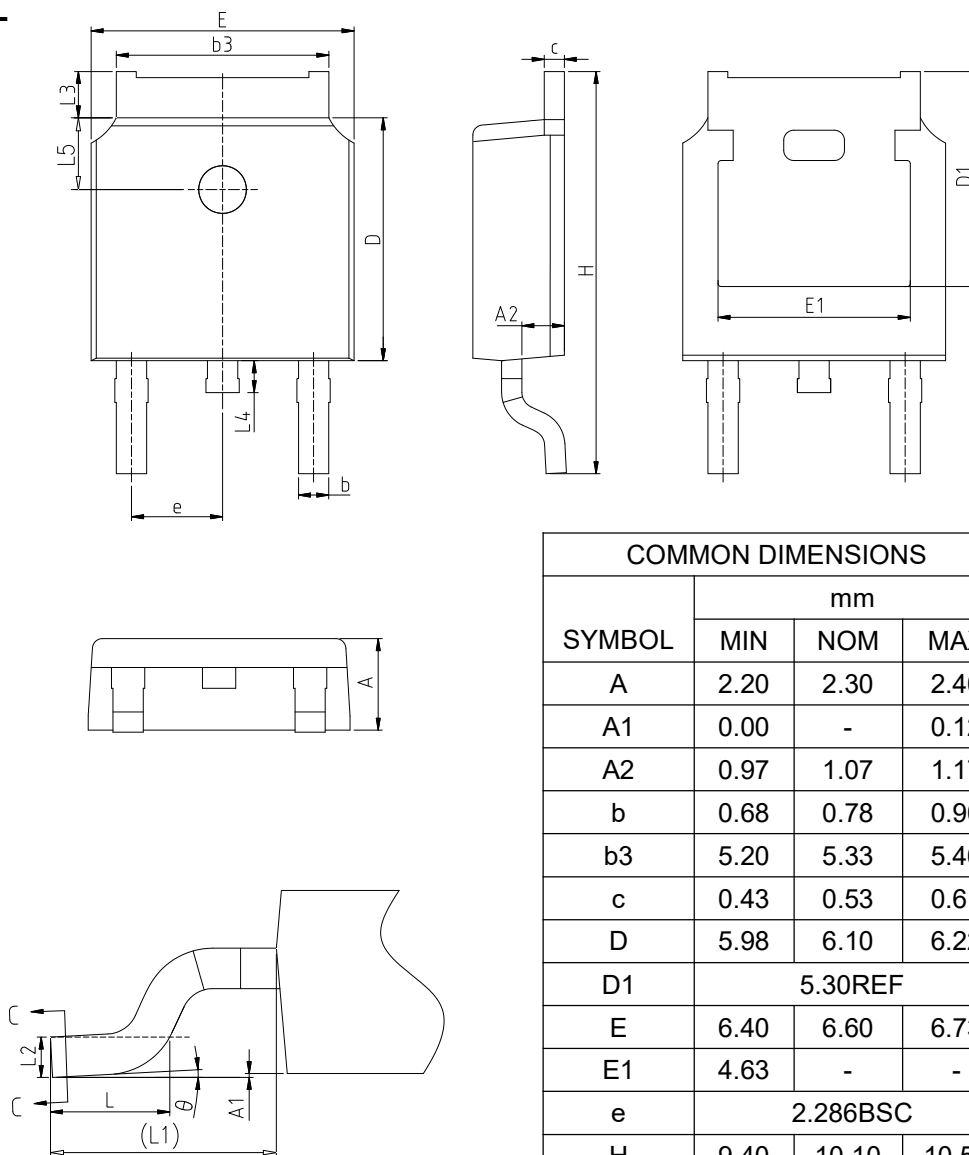


## Device Per Unit

| Package Type | Unit | Quantity |
|--------------|------|----------|
| TO-252-2L    | Tube | 75       |
| TO-252-2L    | Reel | 2500     |

## Package Information

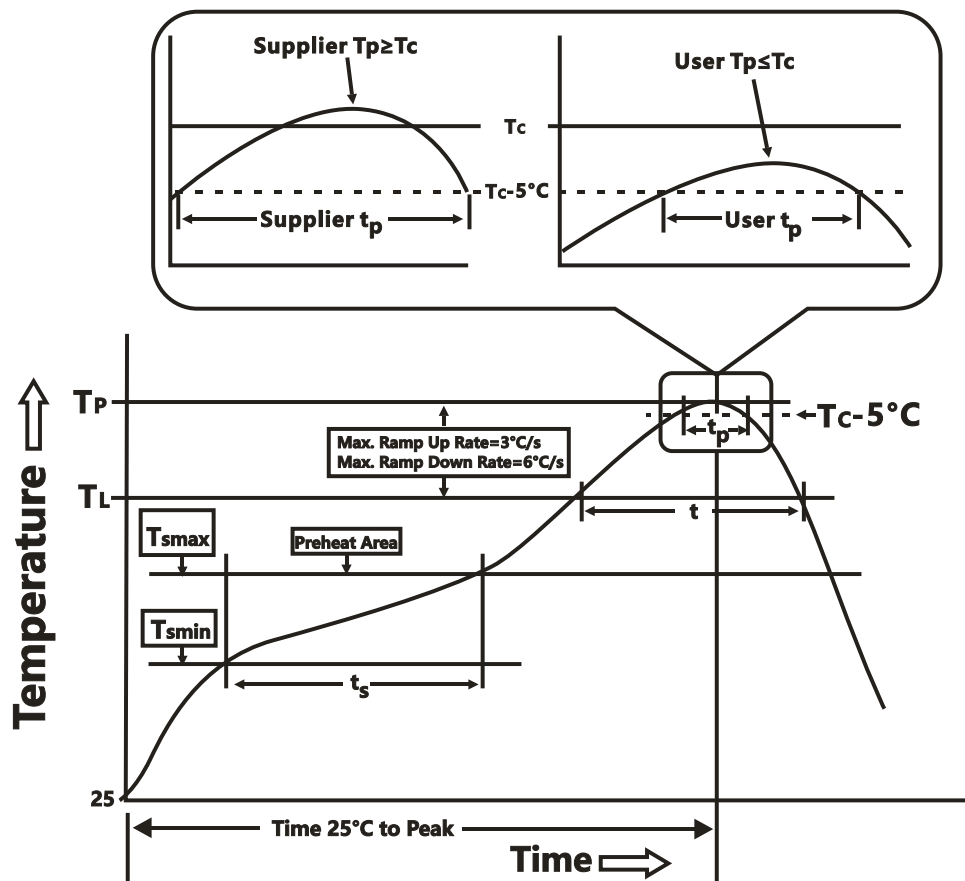
## TO-252-2L



COMMON DIMENSIONS

| SYMBOL   | mm       |       |       |
|----------|----------|-------|-------|
|          | MIN      | NOM   | MAX   |
| A        | 2.20     | 2.30  | 2.40  |
| A1       | 0.00     | -     | 0.12  |
| A2       | 0.97     | 1.07  | 1.17  |
| b        | 0.68     | 0.78  | 0.90  |
| b3       | 5.20     | 5.33  | 5.46  |
| c        | 0.43     | 0.53  | 0.61  |
| D        | 5.98     | 6.10  | 6.22  |
| D1       | 5.30REF  |       |       |
| E        | 6.40     | 6.60  | 6.73  |
| E1       | 4.63     | -     | -     |
| e        | 2.286BSC |       |       |
| H        | 9.40     | 10.10 | 10.50 |
| L        | 1.38     | 1.50  | 1.75  |
| L1       | 2.90REF  |       |       |
| L2       | 0.51BSC  |       |       |
| L3       | 0.88     | -     | 1.28  |
| L4       | 0.50     | -     | 1.00  |
| L5       | 1.65     | 1.80  | 1.95  |
| $\theta$ | 0°       | -     | 8°    |

## Classification Profile



## Classification Reflow Profiles

| Profile Feature                                                                      | Sn-Pb Eutectic Assembly            | Pb-Free Assembly                   |
|--------------------------------------------------------------------------------------|------------------------------------|------------------------------------|
| <b>Preheat &amp; Soak</b>                                                            |                                    |                                    |
| Temperature min ( $T_{smin}$ )                                                       | 100 °C                             | 150 °C                             |
| Temperature max ( $T_{smax}$ )                                                       | 150 °C                             | 200 °C                             |
| Time ( $T_{smin}$ to $T_{smax}$ ) ( $T_s$ )                                          | 60-120 seconds                     | 60-120 seconds                     |
| Average ramp-up rate<br>( $T_{smax}$ to $T_P$ )                                      | 3 °C/second max.                   | 3°C/second max.                    |
| Liquidous temperature ( $T_L$ )                                                      | 183 °C                             | 217 °C                             |
| Time at liquidous ( $t_L$ )                                                          | 60-150 seconds                     | 60-150 seconds                     |
| Peak package body temperature<br>( $T_P$ )*                                          | See Classification Temp in table 1 | See Classification Temp in table 2 |
| Time ( $t_p$ )** within 5°C of the specified<br>classification temperature ( $T_c$ ) | 20** seconds                       | 30** seconds                       |

|                                                                                                                  |                  |                  |
|------------------------------------------------------------------------------------------------------------------|------------------|------------------|
| Average ramp-down rate ( $T_p$ to $T_{smax}$ )                                                                   | 6 °C/second max. | 6 °C/second max. |
| Time 25°C to peak temperature                                                                                    | 6 minutes max.   | 8 minutes max.   |
| *Tolerance for peak profile Temperature ( $T_p$ ) is defined as a supplier minimum and a user maximum.           |                  |                  |
| ** Tolerance for time at peak profile temperature ( $t_p$ ) is defined as a supplier minimum and a user maximum. |                  |                  |

Table 1.Sn-Pb Eutectic Process – Classification Temperatures ( $T_c$ )

| Package Thickness | Volume mm <sup>3</sup><br><350 | Volume mm <sup>3</sup><br>≥350 |
|-------------------|--------------------------------|--------------------------------|
| <2.5 mm           | 235 °C                         | 220 °C                         |
| ≥2.5 mm           | 220 °C                         | 220 °C                         |

Table 2.Pb-free Process – Classification Temperatures ( $T_c$ )

| Package Thickness | Volume mm <sup>3</sup><br><350 | Volume mm <sup>3</sup><br>350-2000 | Volume mm <sup>3</sup><br>≥2000 |
|-------------------|--------------------------------|------------------------------------|---------------------------------|
| <1.6 mm           | 260 °C                         | 260 °C                             | 260 °C                          |
| 1.6 mm – 2.5 mm   | 260 °C                         | 250 °C                             | 245 °C                          |
| ≥2.5 mm           | 250 °C                         | 245 °C                             | 245 °C                          |

## Reliability Test Program

| Test item | Method        | Description                               |
|-----------|---------------|-------------------------------------------|
| HTRB      | JESD-22, A108 | 168/500 Hrs, Bias @ 150°C                 |
| HTGB      | JESD-22, A108 | 168 /500 Hrs, 100%V <sub>GE</sub> @ 150°C |
| PCT       | JESD-22, A102 | 96 Hrs, 100%RH, 2atm, 121°C               |
| TCT       | JESD-22, A104 | 250/500 Cycles, -55°C~150°C               |

## Revision History

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HYG06T65F1DHD

Revision:2024-11-15, Rev.1.1

| Revision | Date       | Change Information        |
|----------|------------|---------------------------|
| 1.0      | 2024-01-17 | Official version released |
| 1.1      | 2024-11-15 | Update template           |

## Customer Service

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