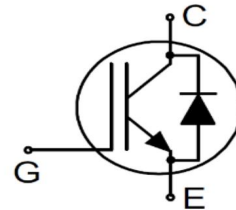




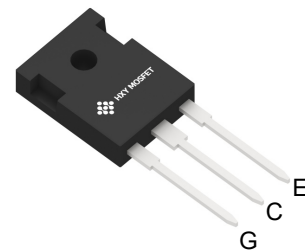
## Features

- 650V, 40A IGBT
- Easy paralleling capability due to positive temperature coefficient in  $V_{CE(SAT)}$
- Low EMI
- Low Gate Charge
- Low Saturation Voltage  $V_{CE(SAT)}$
- Maximum junction temperature  $T_{VJmax}=175^{\circ}C$



## Application

- UPS
- EV-Charger
- Solar String Inverter
- Energy Storage Inverter



## Key Performance and Package Parameters

| Device        | $V_{CE}$ | $I_C$<br>( $T_C = 25^{\circ}C$ ) | $V_{CE(SAT)}$<br>( $T_{VJ} = 25^{\circ}C$ ,<br>$V_{GE} = 15V$ ) | $V_F$<br>( $T_{VJ} = 25^{\circ}C$ ,<br>$I_F = 40A$ ) | Package | Packing |
|---------------|----------|----------------------------------|-----------------------------------------------------------------|------------------------------------------------------|---------|---------|
| AFGHL40T65SPD | 650V     | 40A                              | 1.6 V                                                           | 1.8V                                                 | TO-247  | 30PCS   |

## Absolute Maximum Ratings (@ $T_{VJ} = 25^{\circ}C$ unless otherwise specified)

| Symbol    | Parameter                                                              |                        | Value       | Units       |
|-----------|------------------------------------------------------------------------|------------------------|-------------|-------------|
| $V_{CE}$  | Collector emitter voltage                                              |                        | 650         | V           |
| $I_C$     | DC collector current <sup>(1)</sup>                                    | $T_C = 25^{\circ}C$    | 70          | A           |
|           |                                                                        | $T_C = 100^{\circ}C$   | 40          | A           |
| $I_{CM}$  | Pulsed collector current                                               | $T_C = 25^{\circ}C$    | 160         | A           |
| $I_F$     | Maximum Diode forward current <sup>(1)</sup>                           | $T_C = 25^{\circ}C$    | 70          | A           |
|           |                                                                        | $T_C = 100^{\circ}C$   | 40          | A           |
| $I_{FM}$  | Diode pulsed current                                                   | $T_C = 25^{\circ}C$    | 160         | A           |
| $V_{GE}$  | Gate-Emitter voltage                                                   | $T_{VJ} = 25^{\circ}C$ | $\pm 20$    | V           |
|           | Transient Gate-Emitter Voltage<br>( $t_p \leq 10\mu s$ , $D < 0.010$ ) | $T_{VJ} = 25^{\circ}C$ | $\pm 30$    | V           |
| $P_{tot}$ | Power Dissipation                                                      | $T_C = 25^{\circ}C$    | 250         | W           |
|           |                                                                        | $T_C = 100^{\circ}C$   | 125         | W           |
| $T_{VJ}$  | Operating Junction Temperature Range                                   |                        | -40 to +175 | $^{\circ}C$ |
| $T_{STG}$ | Storage Temperature Range                                              |                        | -55 to +150 | $^{\circ}C$ |



## Thermal Resistance

| Symbol          | Parameter                                 | Conditions | Max. | Unit                 |
|-----------------|-------------------------------------------|------------|------|----------------------|
| $R_{\theta JA}$ | Thermal resistance: junction - ambient    |            | 40   | $^{\circ}\text{C/W}$ |
| $R_{\theta JC}$ | IGBT Thermal resistance: junction - case  | IGBT       | 0.6  | $^{\circ}\text{C/W}$ |
| $R_{\theta JC}$ | Diode Thermal resistance: junction - case | Diode      | 0.65 | $^{\circ}\text{C/W}$ |

## Electrical Characteristics (@ $T_{VJ} = 25^{\circ}\text{C}$ unless otherwise specified)

| Symbol                         | Parameter                              | Conditions                                                                                                              | Min. | Typ. | Max. | Unit |
|--------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| Static Characteristics         |                                        |                                                                                                                         |      |      |      |      |
| V <sub>(BR)CES</sub>           | Collector - Emitter Breakdown Voltage  | V <sub>GE</sub> = 0V , I <sub>C</sub> = 0.5mA                                                                           | 650  | -    | -    | V    |
| V <sub>CESAT</sub>             | Collector - Emitter Saturation Voltage | V <sub>GE</sub> = 15V , I <sub>C</sub> = 40A                                                                            | -    | 1.6  | 2.1  | V    |
|                                |                                        | V <sub>GE</sub> = 15V , I <sub>C</sub> = 40A ,T <sub>VJ</sub> = 125°C                                                   | -    | 1.85 | -    | V    |
|                                |                                        | V <sub>GE</sub> = 15V , I <sub>C</sub> = 40A ,T <sub>VJ</sub> = 175°C                                                   | -    | 1.95 | -    | V    |
|                                |                                        |                                                                                                                         |      |      |      |      |
| V <sub>F</sub>                 | Diode forward voltage                  | V <sub>GE</sub> = 0V , I <sub>C</sub> =40A                                                                              | -    | 1.8  | -    | V    |
|                                |                                        | V <sub>GE</sub> = 0V , I <sub>C</sub> =40A ,T <sub>VJ</sub> = 125°C                                                     | -    | 1.5  | -    | V    |
|                                |                                        | V <sub>GE</sub> = 0V , I <sub>C</sub> = 40A ,T <sub>VJ</sub> = 175°C                                                    | -    | 1.35 | -    | V    |
| V <sub>GE(th)</sub>            | Gate-Emitter threshold voltage         | V <sub>GE</sub> = V <sub>CE</sub> , I <sub>C</sub> = 250μA                                                              | 3.2  | 4    | 4.8  | V    |
| I <sub>CES</sub>               | Zero Gate voltage Collector current    | V <sub>CE</sub> = 650V , V <sub>GE</sub> = 0V                                                                           | -    | -    | 40   | μA   |
| I <sub>GES</sub>               | Gate-Emitter leakage current           | V <sub>GE</sub> = ±20V , V <sub>CE</sub> = 0V                                                                           | -    | -    | ±100 | nA   |
| g <sub>fs</sub>                | Transconductance                       | V <sub>GE</sub> =15V, I <sub>C</sub> = 40A                                                                              | -    | 55   | -    | S    |
| Dynamic Characteristics        |                                        |                                                                                                                         |      |      |      |      |
| C <sub>ies</sub>               | Input Capacitance                      | V <sub>GE</sub> = 0V, V <sub>CE</sub> = 25V,<br>f = 1MHz                                                                | -    | 1520 | -    | pF   |
| C <sub>oes</sub>               | Output Capacitance                     |                                                                                                                         | -    | 110  | -    | pF   |
| C <sub>res</sub>               | Reverse Transfer Capacitance           |                                                                                                                         | -    | 11   | -    | pF   |
| Q <sub>g</sub>                 | Gate Charge                            | V <sub>GE</sub> = 0 to 15V<br>V <sub>CE</sub> = 520V, I <sub>C</sub> = 40A                                              | -    | 57   | -    | nC   |
| Q <sub>ge</sub>                | Gate to Emitter charge                 |                                                                                                                         | -    | 6.5  | -    | nC   |
| Q <sub>gc</sub>                | Gate to Collector charge               |                                                                                                                         | -    | 17.5 | -    | nC   |
| Switching Characteristics      |                                        |                                                                                                                         |      |      |      |      |
| t <sub>d(on)</sub>             | Turn-On DelayTime                      | V <sub>GE</sub> = 15V, V <sub>CC</sub> = 400V<br>I <sub>C</sub> = 40A, R <sub>G(on)</sub> =15Ω,RG <sub>(off)</sub> =15Ω | -    | 26   | -    | ns   |
| t <sub>r</sub>                 | Turn-On Rise Time                      |                                                                                                                         | -    | 28   | -    | ns   |
| t <sub>d(off)</sub>            | Turn-Off DelayTime                     |                                                                                                                         | -    | 136  | -    | ns   |
| t <sub>f</sub>                 | Turn-Off Fall Time                     |                                                                                                                         | -    | 34   | -    | ns   |
| E <sub>on</sub>                | Turn-on energy                         |                                                                                                                         | -    | 0.9  | -    | mJ   |
| E <sub>off</sub>               | Turn-off energy                        |                                                                                                                         | -    | 0.43 | -    | mJ   |
| E <sub>ts</sub>                | Total switching energy                 |                                                                                                                         | -    | 1.33 | -    | mJ   |
| Diode Recovery Characteristics |                                        |                                                                                                                         |      |      |      |      |
| T <sub>rr</sub>                | Reverse recovery time                  | V <sub>R</sub> = 400 V, I <sub>F</sub> = 40 A,<br>di/dt = 400 A/μS                                                      | -    | 56   | -    | ns   |
| Q <sub>rr</sub>                | Reverse recovery charge                |                                                                                                                         | -    | 0.27 | -    | μC   |
| I <sub>rrm</sub>               | Peak reverse recovery current          |                                                                                                                         | -    | 8.0  | -    | A    |

Notes: 1. The max Collector current rating is package limited



## Typical Performance Characteristics

Fig.1 Typical Output characteristics (25°C)

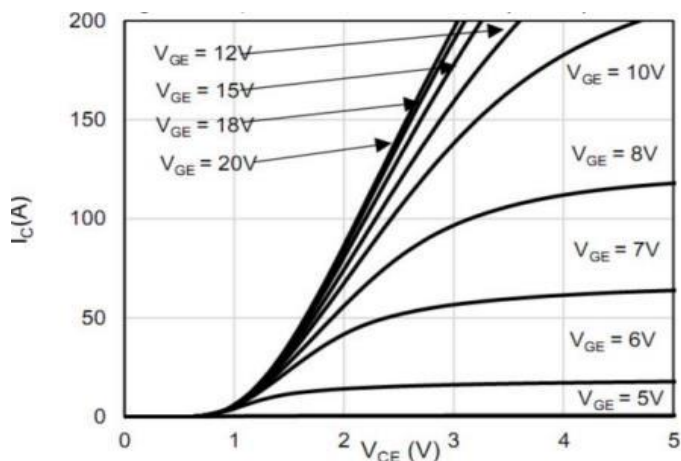


Fig.2 Typical Output characteristics (150°C)

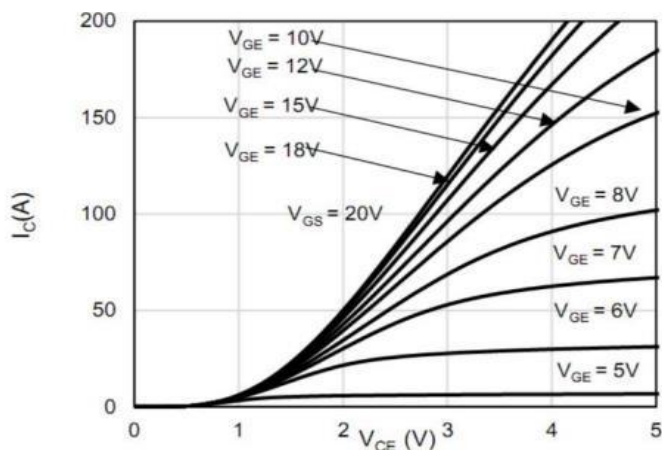


Fig.3 Forward Bias Safe Operating Area

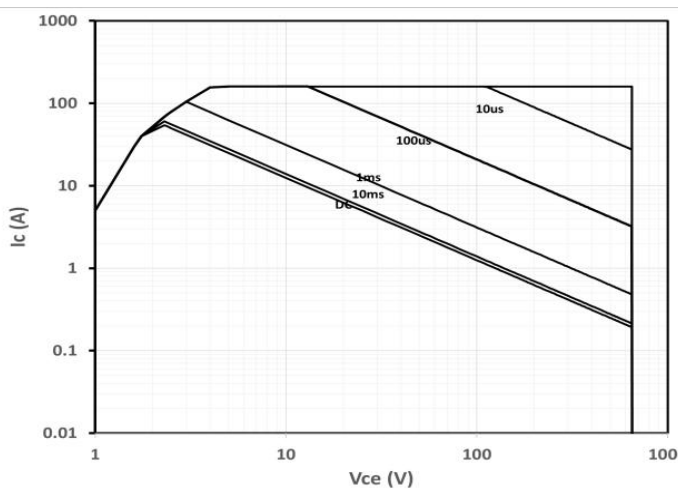


Fig.4 Transfer characteristics

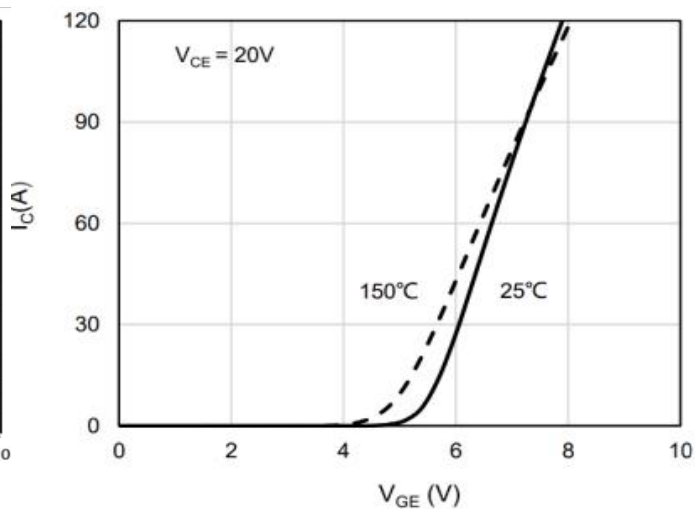


Fig.5 Gate charge characteristics

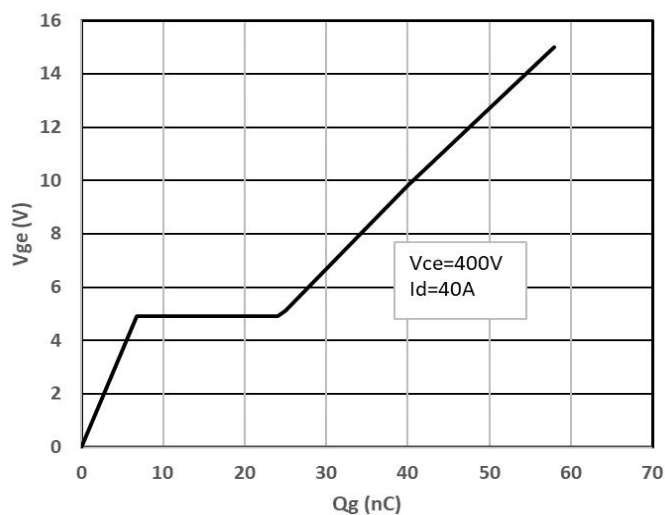


Fig.6 Typical capacitance characteristics

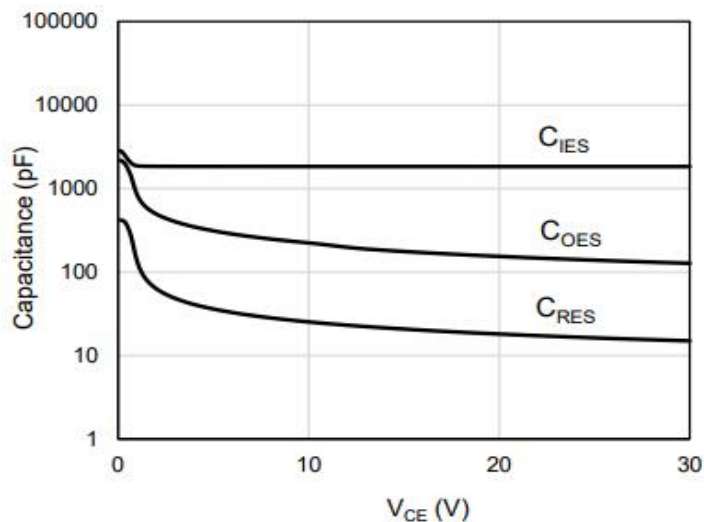




Fig.7 Vcesat vs. Junction Temperature

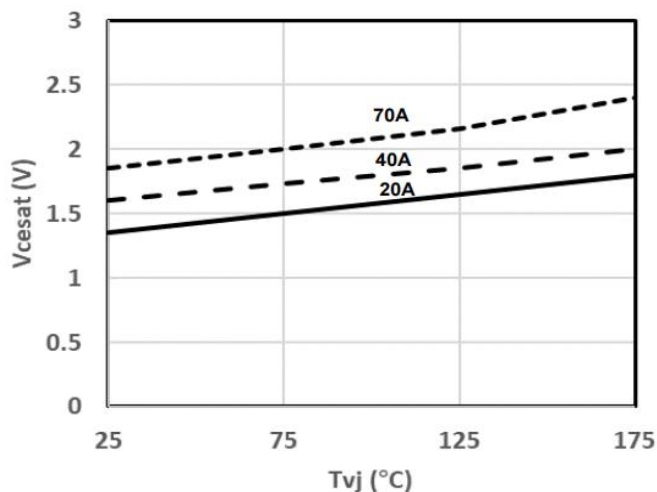


Fig.8 Typical diode VF vs. IF Characteristics

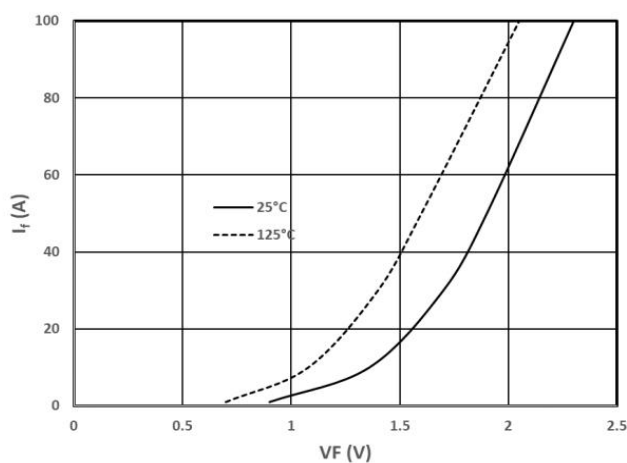


Fig.9 Threshold voltage vs. Junction temperature

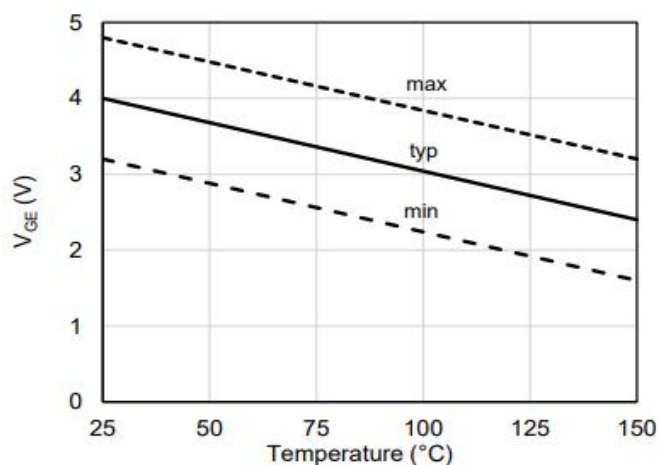


Fig.10 Transient Thermal Impedance IGBT

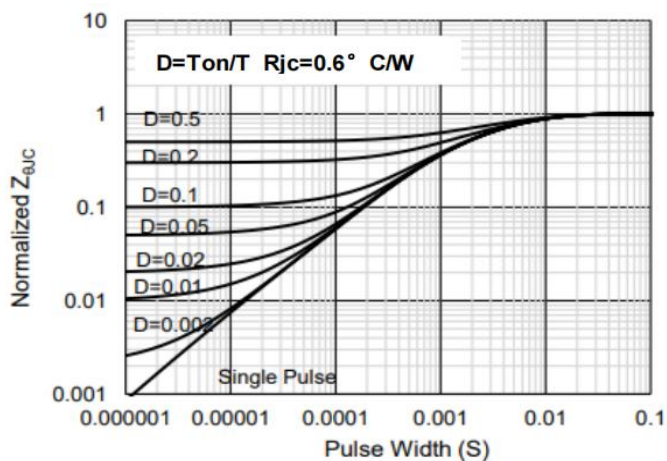
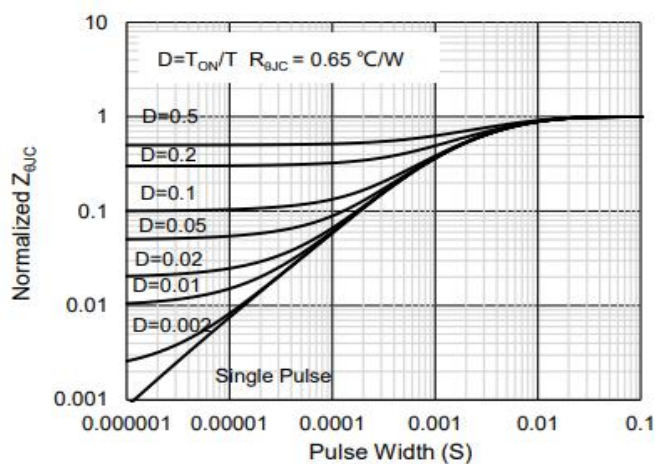


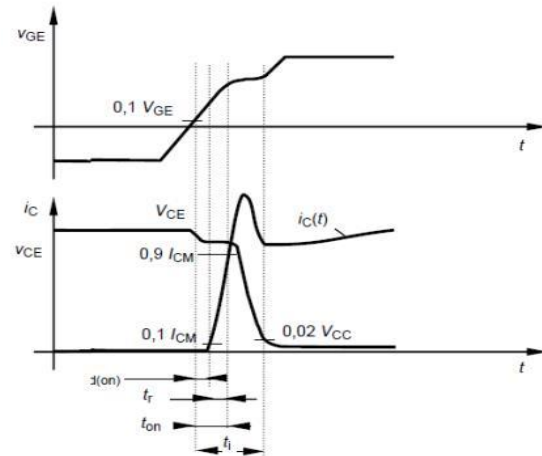
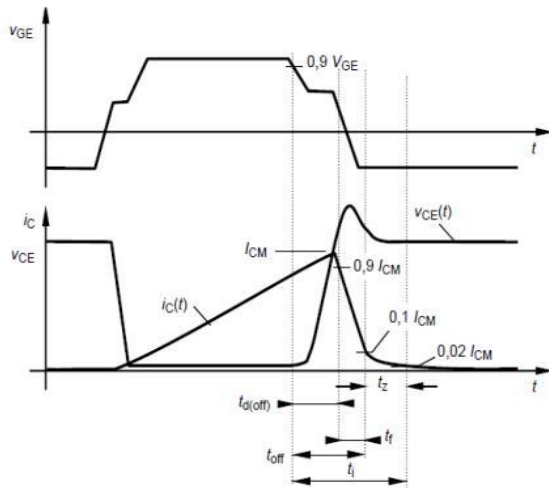
Fig.11 Transient Thermal Impedance Diode



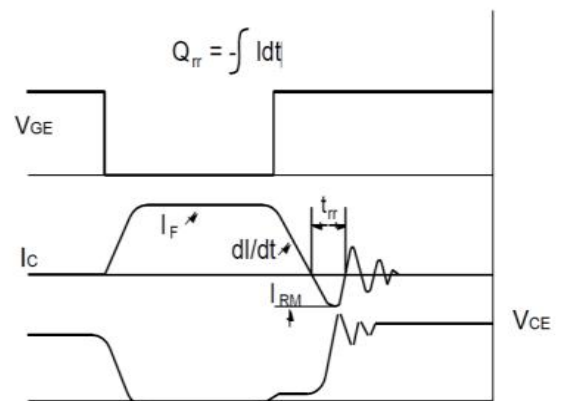
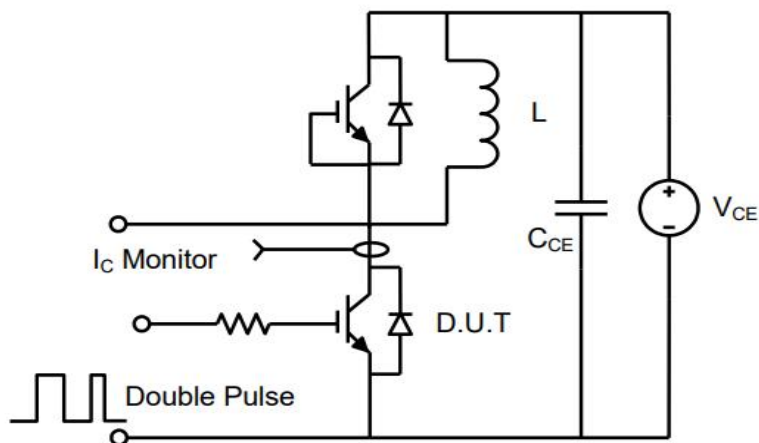


## Test Circuit

Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms





Package Mechanical Data(TO-247)



| SYMBOL | mm      |       |       |
|--------|---------|-------|-------|
|        | MIN     | NOM   | MAX   |
| A      | 4.80    | 5.00  | 5.20  |
| A1     | 2.21    | 2.41  | 2.59  |
| A2     | 1.85    | 2.00  | 2.15  |
| b      | 1.11    | 1.21  | 1.36  |
| b2     | 1.91    | 2.01  | 2.21  |
| b4     | 2.91    | 3.01  | 3.21  |
| c      | 0.51    | 0.61  | 0.75  |
| D      | 20.70   | 21.00 | 21.30 |
| D1     | 16.25   | 16.55 | 16.85 |
| E      | 15.50   | 15.80 | 16.10 |
| E1     | 13.00   | 13.30 | 13.60 |
| E2     | 4.80    | 5.00  | 5.20  |
| E3     | 2.30    | 2.50  | 2.70  |
| e      | 5.44BSC |       |       |
| L      | 19.62   | 19.92 | 20.22 |
| L1     | —       | —     | 4.30  |
| ΦP     | 3.40    | 3.60  | 3.80  |
| ΦP1    | —       | —     | 7.30  |
| S      | 6.15BSC |       |       |



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