

# 1200V 40A Insulated Gate Bipolar Transistor

## AKBK2A040WHH

### Description:

Gen 2 IGBT with soft, fast recovery full current rated anti-parallel Emitter Controlled diode, providing ultra-low conduction loss . They are designed for applications such as UPS, inverters, etc.

### Features:

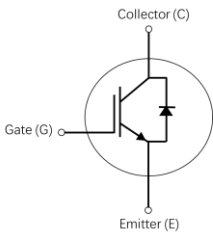
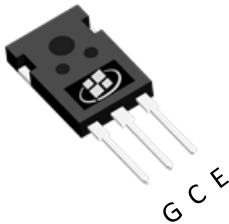
- 10μsec short circuit withstand time at  $T_{VJ}=175^{\circ}\text{C}$
- Easy paralleling capability due to positive temperature coefficient in  $V_{CEsat}$
- Low EMI
- Low Gate Charge  $Q_G$
- Very soft, fast recovery full current anti-parallel diode
- Maximum junction temperature  $T_{VJMAX}=175^{\circ}\text{C}$
- RoHS compliant <sup>(Note 1)</sup>
- Halogen-free <sup>(Note 1)</sup>

### Applications:

- Industrial UPS
- Charger
- Energy Storage
- Three-phase Solar String Inverter

### Key Performance Parameters:

| Parameter                                | Value | Unit |
|------------------------------------------|-------|------|
| $V_{CE}$                                 | 1200  | V    |
| $V_{CESAT}, T_{VJ} = 25^{\circ}\text{C}$ | 1.9   | V    |
| $I_C$                                    | 40    | A    |



### Ordering Information:

| Ordering Code | Package Type | Marking Code | Form | Packing |
|---------------|--------------|--------------|------|---------|
| AKBK2A040WHH  | TO247-3L     | BK2A040WHH   | Tube | 300PCS  |

### Notes:

1. Contact ALKAIDSEMI sales for detail information

## Maximum Ratings ( $T_A = 25^\circ\text{C}$ unless otherwise noted)

| Symbol    | Parameter                                                                        | Value       | Units            |
|-----------|----------------------------------------------------------------------------------|-------------|------------------|
| $V_{CE}$  | Collector-Emitter Voltage                                                        | 1200        | V                |
| $I_C$     | Collector Current - Continuous ( $T_C = 25^\circ\text{C}$ ) <sup>(Note 1)</sup>  | 80          | A                |
|           | Collector Current - Continuous ( $T_C = 100^\circ\text{C}$ )                     | 40          |                  |
| $I_{CM}$  | Collector Current - Pulsed <sup>(Note 2)</sup>                                   | 160         | A                |
| $I_F$     | Diode Forward Current, Limited by $T_{VJmax}$ ( $T_C = 25^\circ\text{C}$ )       | 80          | A                |
|           | Diode Forward Current, Limited by $T_{VJmax}$ ( $T_C = 100^\circ\text{C}$ )      | 40          |                  |
| $I_{FM}$  | Diode Pulsed Current, - Pulsed <sup>(Note 2)</sup>                               | 160         | A                |
| $V_{GE}$  | Gate-Emitter Voltage                                                             | $\pm 20$    | V                |
|           | Transient Gate-Emitter Voltage ( $t_p \leq 10\mu\text{s}$ , $D < 0.010$ )        | $\pm 30$    |                  |
| $T_{SC}$  | Short Circuit Withstand Time $V_{GE} = 15.0\text{V}$ , $V_{CC} \leq 400\text{V}$ | 10          | $\mu\text{s}$    |
| $P_D$     | Power Dissipation ( $T_C = 25^\circ\text{C}$ )                                   | 417         | W                |
|           | Power Dissipation ( $T_C = 100^\circ\text{C}$ )                                  | 208         | W                |
| $T_J$     | Operating Junction Temperature Range                                             | -40 to +175 | $^\circ\text{C}$ |
| $T_{STG}$ | Storage Temperature Range                                                        | -55 to +150 | $^\circ\text{C}$ |

## Thermal Characteristics

| Symbol          | Parameter                                                | Value | Units              |
|-----------------|----------------------------------------------------------|-------|--------------------|
| $R_{\theta JC}$ | IGBT Thermal Resistance, Junction-to-Case, Steady-State  | 0.36  | $^\circ\text{C/W}$ |
| $R_{\theta JC}$ | Diode Thermal Resistance, Junction-to-Case, Steady-State | 0.45  | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient Steady State     | 40    | $^\circ\text{C/W}$ |

### Notes:

1. The max collector current rating is package limited
2. Repetitive Rating: Pulse width limited by maximum junction temperature

**Electrical Characteristics** ( $T_{VJ} = 25^{\circ}\text{C}$  unless otherwise noted)

| Symbol                                                                             | Parameter                            | Test Conditions                                                                                                               | Min  | Typ   | Max       | Units         |
|------------------------------------------------------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|------|-------|-----------|---------------|
| <b>Static Characteristics</b>                                                      |                                      |                                                                                                                               |      |       |           |               |
| $V_{(BR)CES}$                                                                      | Collector-Emitter Breakdown Voltage  | $V_{GE} = 0\text{ V}, I_C = 0.5\text{ mA}$                                                                                    | 1200 |       |           | V             |
| $V_{CESAT}$                                                                        | Collector-Emitter Saturation Voltage | $V_{GE} = 15\text{ V}, I_C = 40\text{ A}$                                                                                     | 1.6  | 1.9   | 2.3       | V             |
|                                                                                    |                                      | $V_{GE} = 15\text{ V}, I_C = 40\text{ A}, T_{VJ} = 175^{\circ}\text{C}$                                                       |      | 2.9   |           |               |
| $V_F$                                                                              | Diode Forward Voltage                | $V_{GE} = 0\text{ V}, I_F = 40\text{ A}$                                                                                      | 1.7  | 1.9   | 2.1       | V             |
|                                                                                    |                                      | $V_{GE} = 0\text{ V}, I_F = 40\text{ A}, T_{VJ} = 175^{\circ}\text{C}$                                                        |      | 1.95  |           |               |
| $V_{GE(TH)}$                                                                       | Gate-Emitter Threshold Voltage       | $V_{CE} = V_{GE}, I_C = 1.5\text{ mA}$                                                                                        | 5.1  | 5.8   | 6.5       | V             |
| $I_{CES}$                                                                          | Zero Gate Voltage Collector Current  | $V_{CE} = 1200\text{ V}, V_{GE} = 0\text{ V}$                                                                                 |      |       | 250       | $\mu\text{A}$ |
|                                                                                    |                                      | $V_{CE} = 1200\text{ V}, V_{GE} = 0\text{ V}, T_{VJ} = 175^{\circ}\text{C}$                                                   |      | 3000  |           |               |
| $I_{GES}$                                                                          | Gate-Emitter Leakage Current         | $V_{GE} = \pm 20\text{ V}, V = 0\text{ V}$                                                                                    |      |       | $\pm 100$ | nA            |
| $G_{FS}$                                                                           | Transconductance                     | $V_{GE} = 20\text{ V}, I_C = 40\text{ A}$                                                                                     |      | 28    |           | S             |
| <b>Dynamic Characteristics</b>                                                     |                                      |                                                                                                                               |      |       |           |               |
| $C_{IES}$                                                                          | Input Capacitance                    | $V_{CE} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$F = 1\text{ MHz}$                                                            |      | 5047  |           | pF            |
| $C_{OES}$                                                                          | Output Capacitance                   |                                                                                                                               |      | 161   |           | pF            |
| $C_{RES}$                                                                          | Reverse Transfer Capacitance         |                                                                                                                               |      | 35    |           | pF            |
| $Q_G$                                                                              | Total Gate Charge                    | $V_{CC} = 960\text{ V}, I_C = 40\text{ A},$<br>$V_{GE} = 15\text{ V}$                                                         |      | 170   |           | nC            |
| $Q_{GE}$                                                                           | Gate-Emitter Charge                  |                                                                                                                               |      | 37.5  |           | nC            |
| $Q_{GC}$                                                                           | Gate-Collector Charge                |                                                                                                                               |      | 68    |           | nC            |
| $L_E$                                                                              | Internal Emitter Inductance          |                                                                                                                               |      | 8     |           | nH            |
| <b>Switching Characteristics, Inductive Load</b> ( $T_{VJ} = 25^{\circ}\text{C}$ ) |                                      |                                                                                                                               |      |       |           |               |
| $T_{D(ON)}$                                                                        | Turn On Delay Time                   | $V_{CC} = 600\text{ V}$<br>$I_C = 40\text{ A}$<br>$V_{GE} = 15\text{ V}$<br>$R_{Gon} = 12\ \Omega$<br>$R_{Goff} = 12\ \Omega$ |      | 46    |           | nS            |
| $T_R$                                                                              | Rise Time                            |                                                                                                                               |      | 48    |           | nS            |
| $T_{D(OFF)}$                                                                       | Turn Off Delay Time                  |                                                                                                                               |      | 194.4 |           | nS            |
| $T_F$                                                                              | Fall Time                            |                                                                                                                               |      | 99    |           | nS            |
| $E_{ON}$                                                                           | Turn On Energy                       |                                                                                                                               |      | 2.62  |           | mJ            |
| $E_{OFF}$                                                                          | Turn Off Energy                      |                                                                                                                               |      | 1.55  |           | mJ            |
| $E_{TOTAL}$                                                                        | Total Switching Energy               |                                                                                                                               |      | 4.17  |           | mJ            |

### Drain-Source Diode Characteristics

|              |                                                     |                                                                                |  |       |  |                  |
|--------------|-----------------------------------------------------|--------------------------------------------------------------------------------|--|-------|--|------------------|
| $T_{RR}$     | Reverse recovery time                               | $V_R = 600\text{ V}, I_R = 40\text{ A},$<br>$di/dt = 600\text{ A}/\mu\text{S}$ |  | 270.8 |  | nS               |
| $Q_{RR}$     | Reverse recovery charge                             |                                                                                |  | 1.7   |  | $\mu\text{C}$    |
| $I_{RRM}$    | Peak Reverse Recovery Current                       |                                                                                |  | 19.2  |  | A                |
| $di_{rr}/dt$ | Diode Peak Rate of Fall of Reverse Recovery Current |                                                                                |  | -74.5 |  | A/ $\mu\text{s}$ |

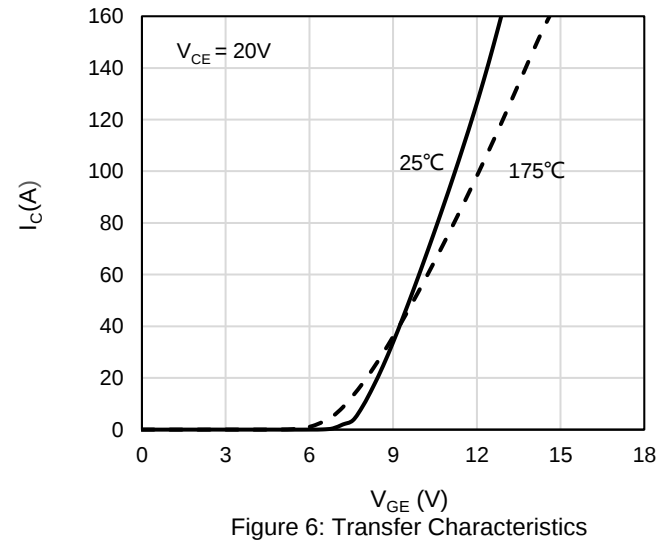
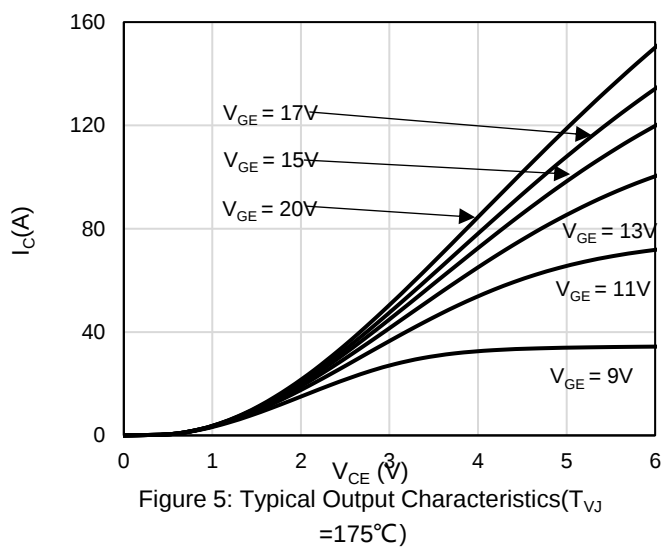
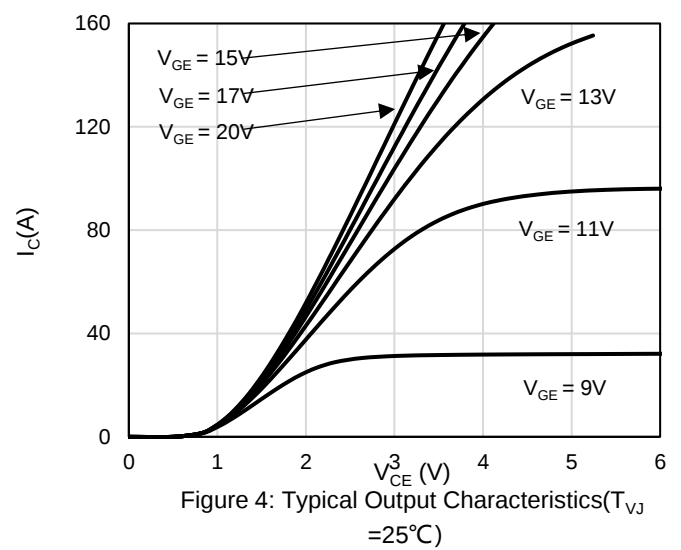
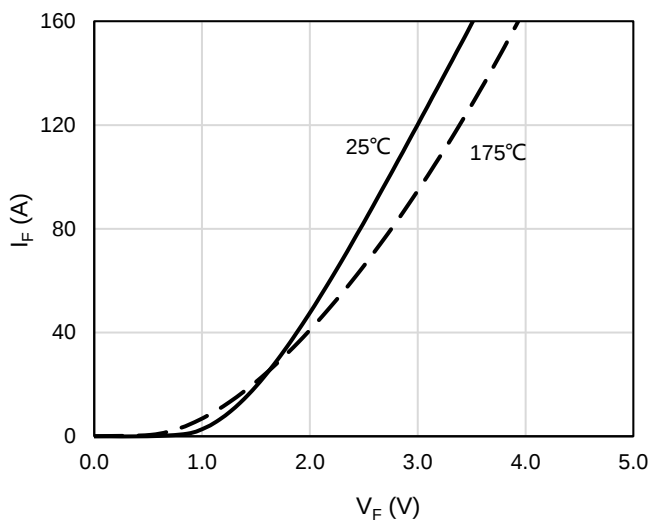
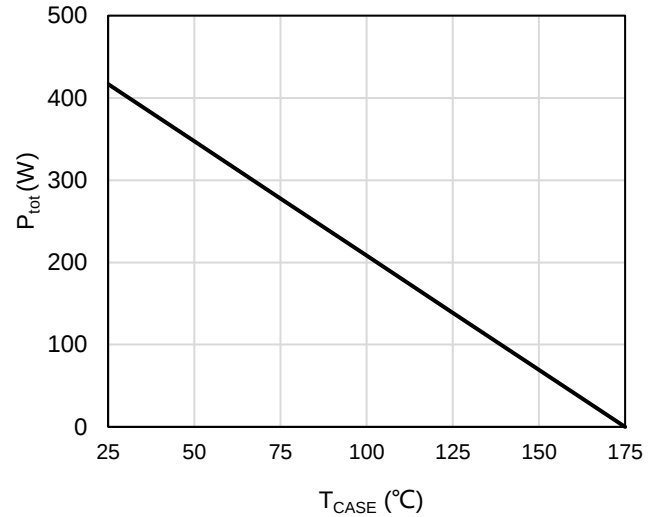
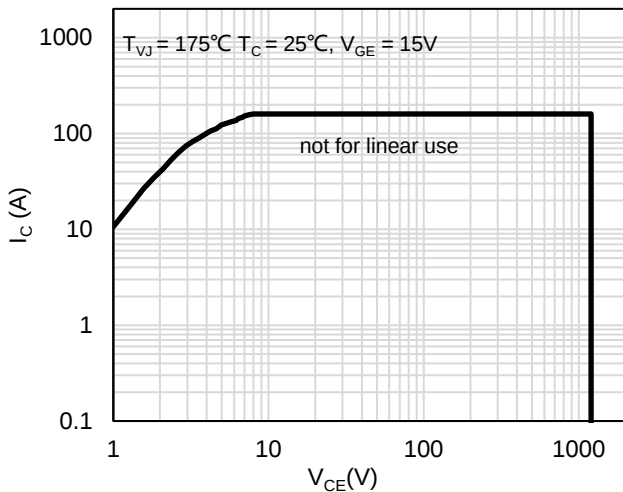
### Switching Characteristics, Inductive Load ( $T_{VJ} = 175^\circ\text{C}$ )

|              |                        |                                                                                                                               |  |       |  |    |
|--------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------|--|-------|--|----|
| $T_{D(ON)}$  | Turn On Delay Time     | $V_{CC} = 600\text{ V}$<br>$I_C = 40\text{ A}$<br>$V_{GE} = 15\text{ V}$<br>$R_{Gon} = 12\ \Omega$<br>$R_{Goff} = 12\ \Omega$ |  | 45    |  | nS |
| $T_R$        | Rise Time              |                                                                                                                               |  | 51    |  | nS |
| $T_{D(OFF)}$ | Turn Off Delay Time    |                                                                                                                               |  | 223.5 |  | nS |
| $T_F$        | Fall Time              |                                                                                                                               |  | 141   |  | nS |
| $E_{ON}$     | Turn On Energy         |                                                                                                                               |  | 4.7   |  | mJ |
| $E_{OFF}$    | Turn Off Energy        |                                                                                                                               |  | 2.3   |  | mJ |
| $E_{TOTAL}$  | Total Switching Energy |                                                                                                                               |  | 7     |  | mJ |

### Drain-Source Diode Characteristics

|              |                                                     |                                                                                |  |      |  |                  |
|--------------|-----------------------------------------------------|--------------------------------------------------------------------------------|--|------|--|------------------|
| $T_{RR}$     | Reverse recovery time                               | $V_R = 600\text{ V}, I_R = 40\text{ A},$<br>$di/dt = 600\text{ A}/\mu\text{S}$ |  | 418  |  | nS               |
| $Q_{RR}$     | Reverse recovery charge                             |                                                                                |  | 5    |  | $\mu\text{C}$    |
| $I_{RRM}$    | Peak Reverse Recovery Current                       |                                                                                |  | 30.5 |  | A                |
| $di_{rr}/dt$ | Diode Peak Rate of Fall of Reverse Recovery Current |                                                                                |  | -74  |  | A/ $\mu\text{s}$ |

## Electrical Characteristics Diagrams



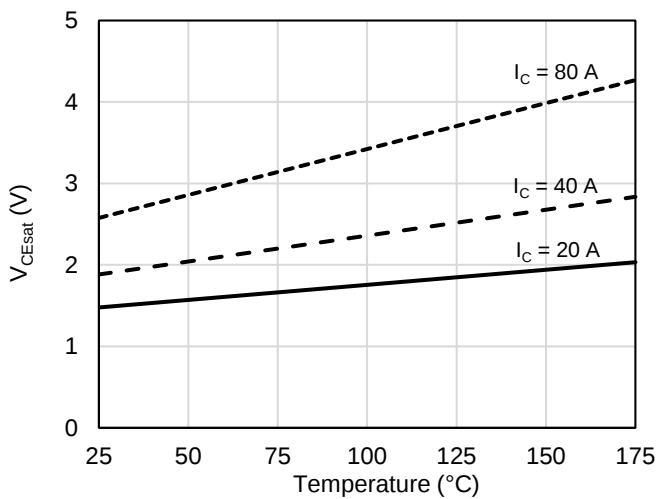


Figure 7: Collect-emitter Saturation Voltage vs. Junction Temperature

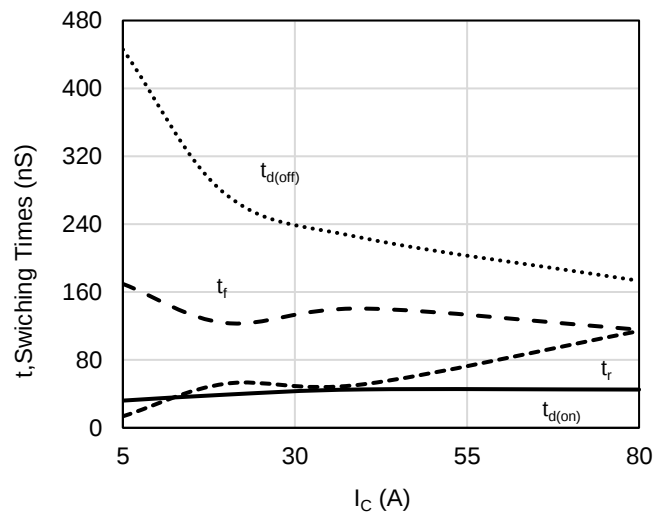


Figure 8: Switching Times vs. Collector Current

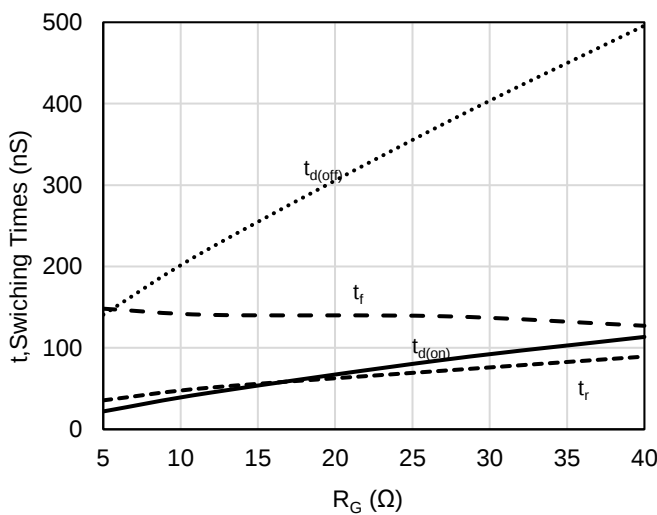


Figure 9: Switching Times vs. Gate Resistor

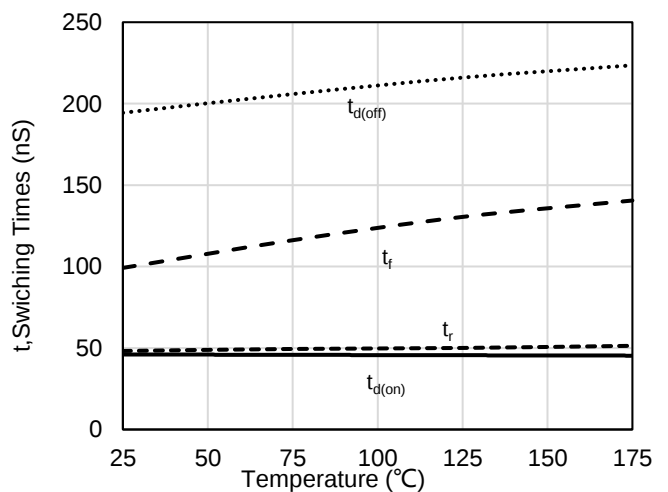


Figure 10: Switching Times vs. Junction Temperature

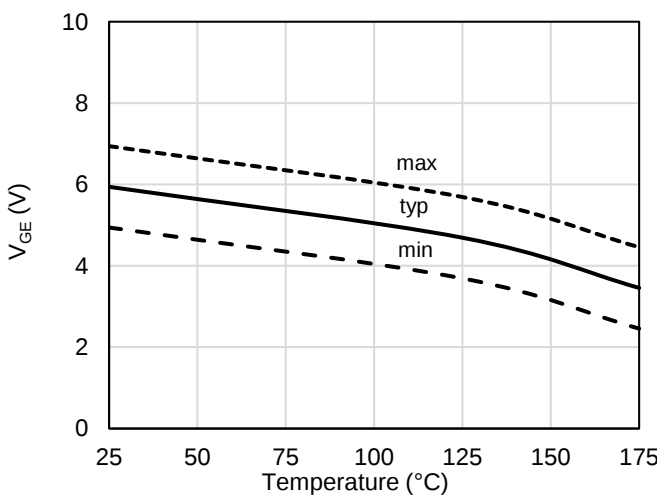


Figure 11: Threshold voltage vs. Junction Temperature

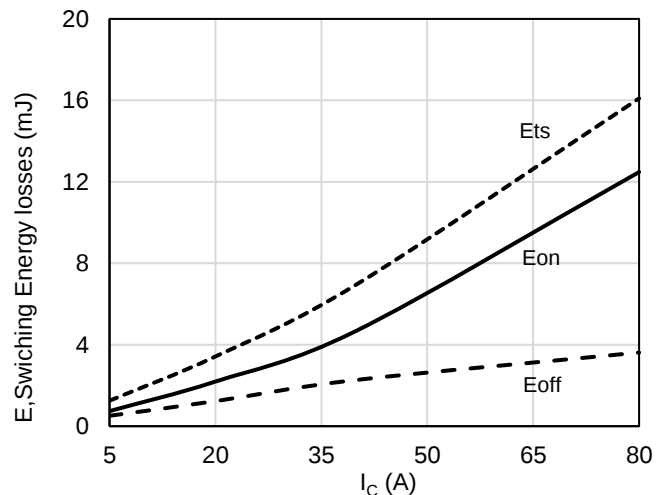


Figure 12: Switching Energy losses vs. Collector Current

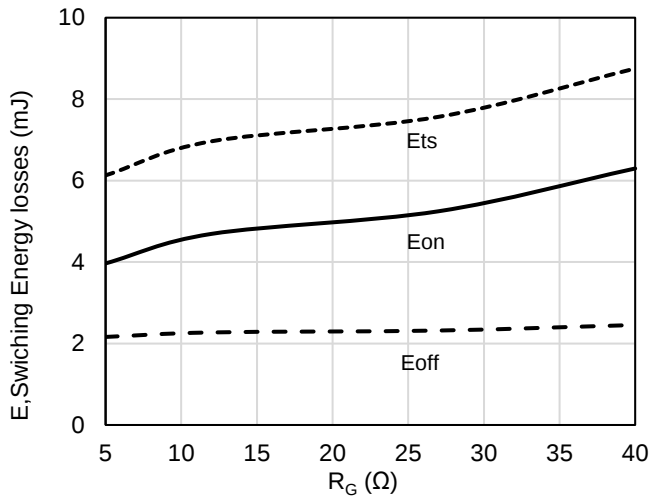


Figure 13: Switching Energy losses vs. Gate Voltage

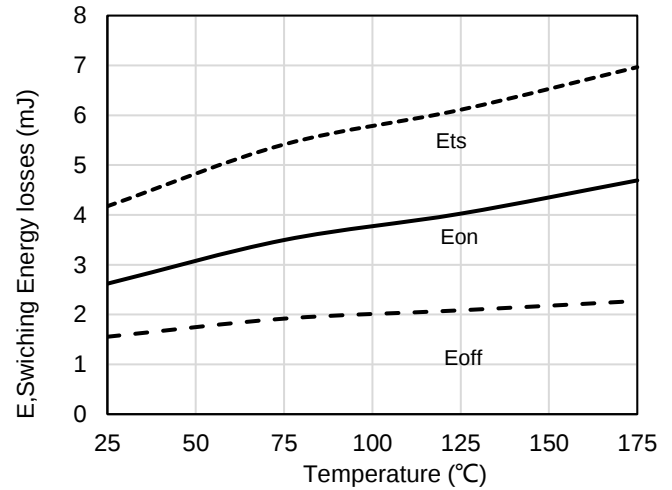


Figure 14: Switching Energy losses vs. Junction Temperature

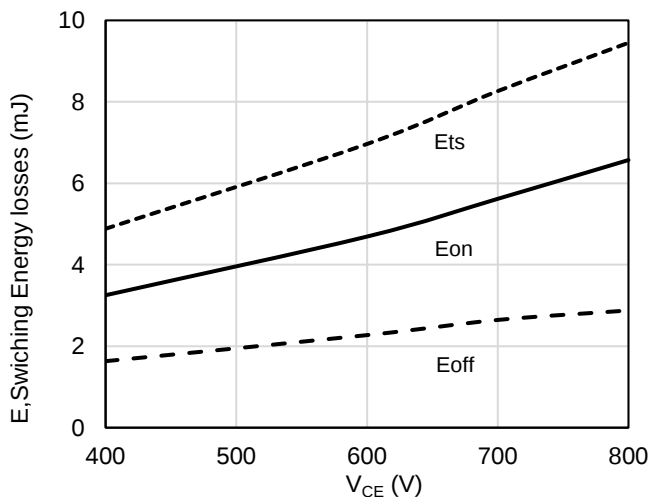


Figure 15: Switching Energy losses vs. Collector Emitter Voltage

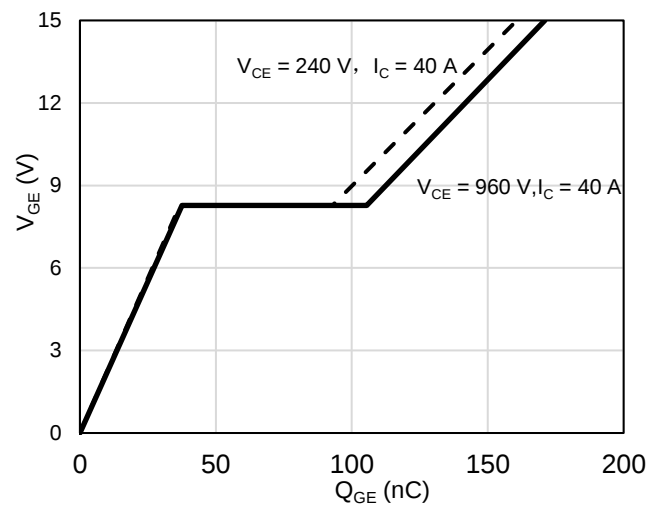


Figure 16: Gate-Charge Characteristics

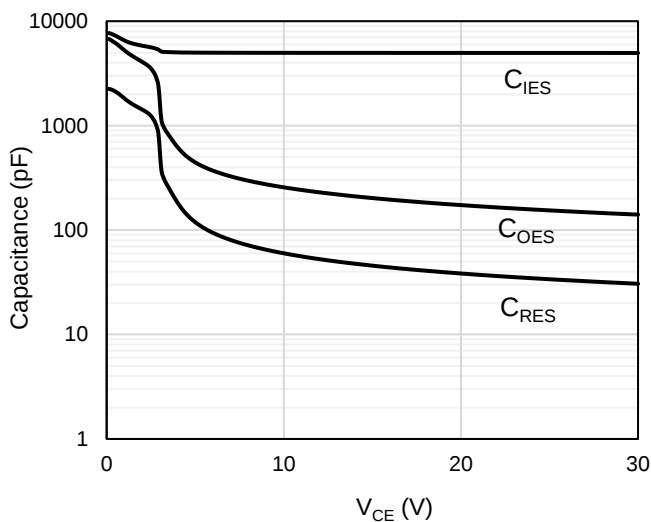


Figure 17: Capacitance Characteristics

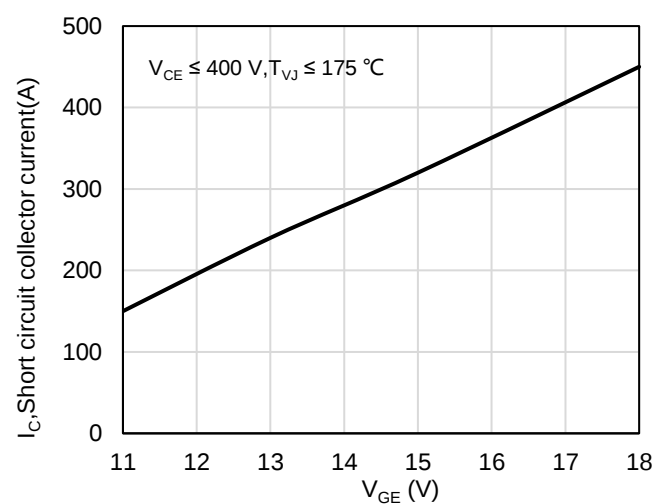


Figure 18: Short Circuit Collector Current vs. Gate Emitter Voltage

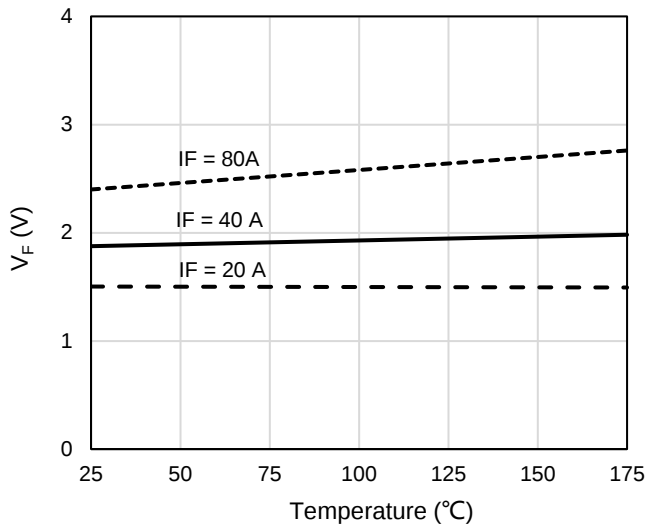


Figure 19: Diode Forward Voltage vs. Junction Temperature

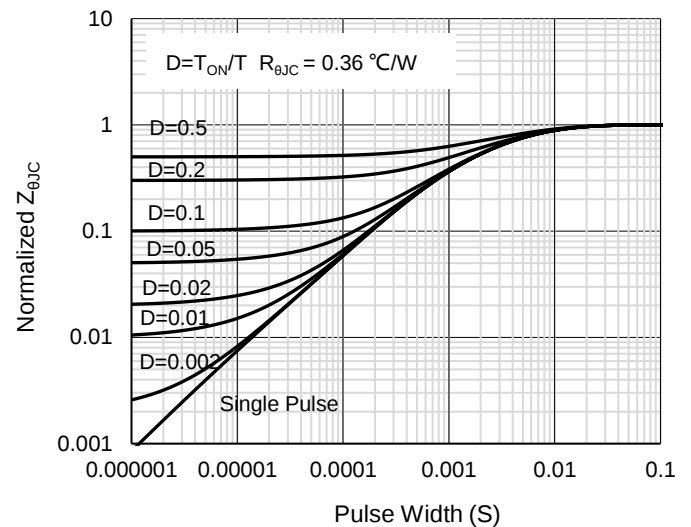


Figure 20: Normalized Maximum IGBT Transient Thermal Impedance

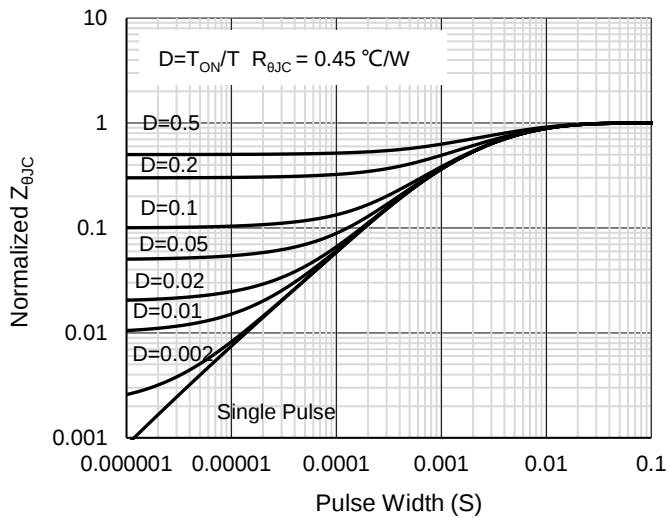


Figure 21: Normalized Maximum Diode Transient Thermal Impedance

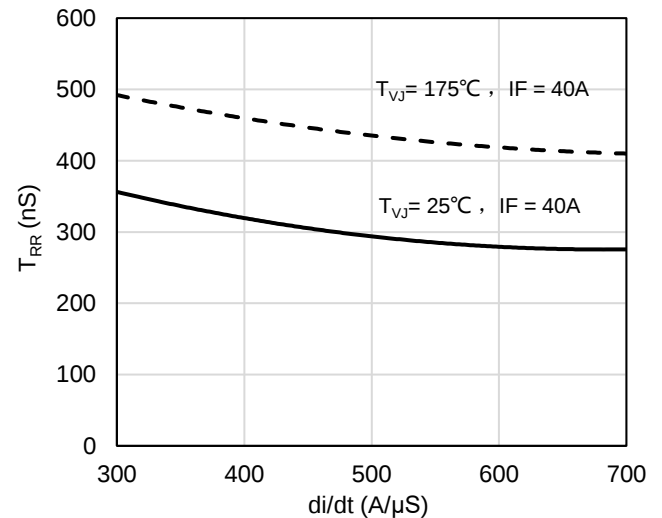


Figure 22: Reverse Recovery Time vs. Diode Current Slope

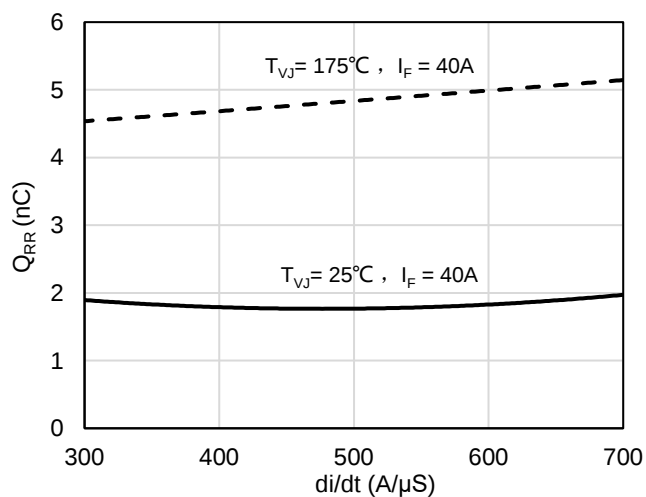


Figure 23: Reverse Recovery Charge vs. Diode Current Slope

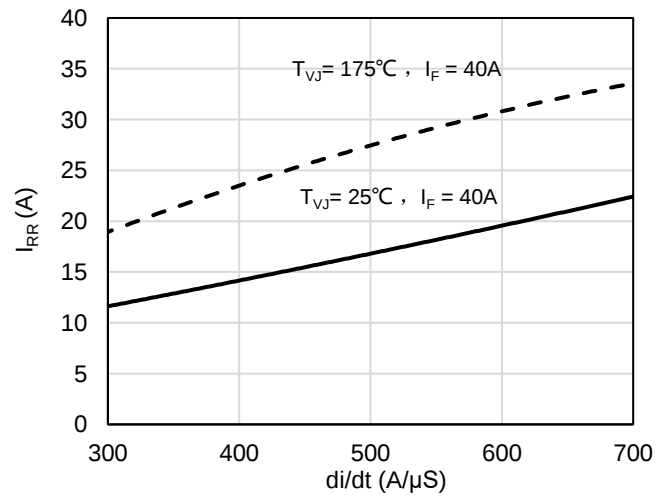
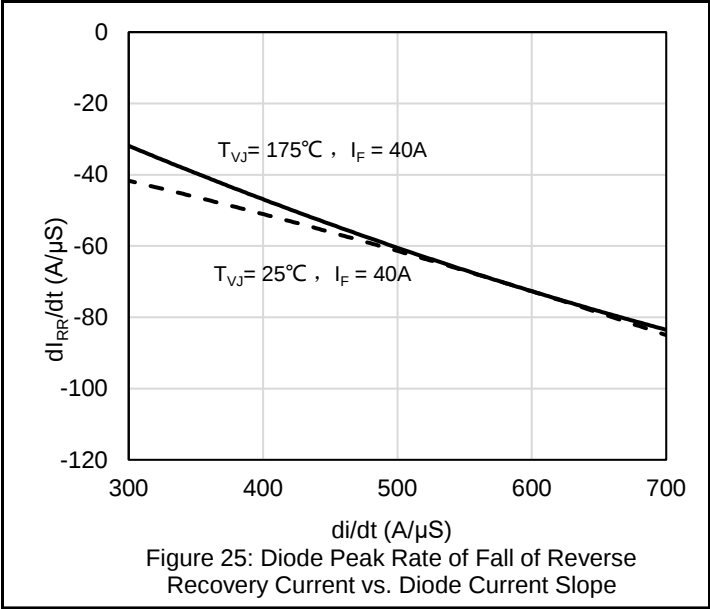
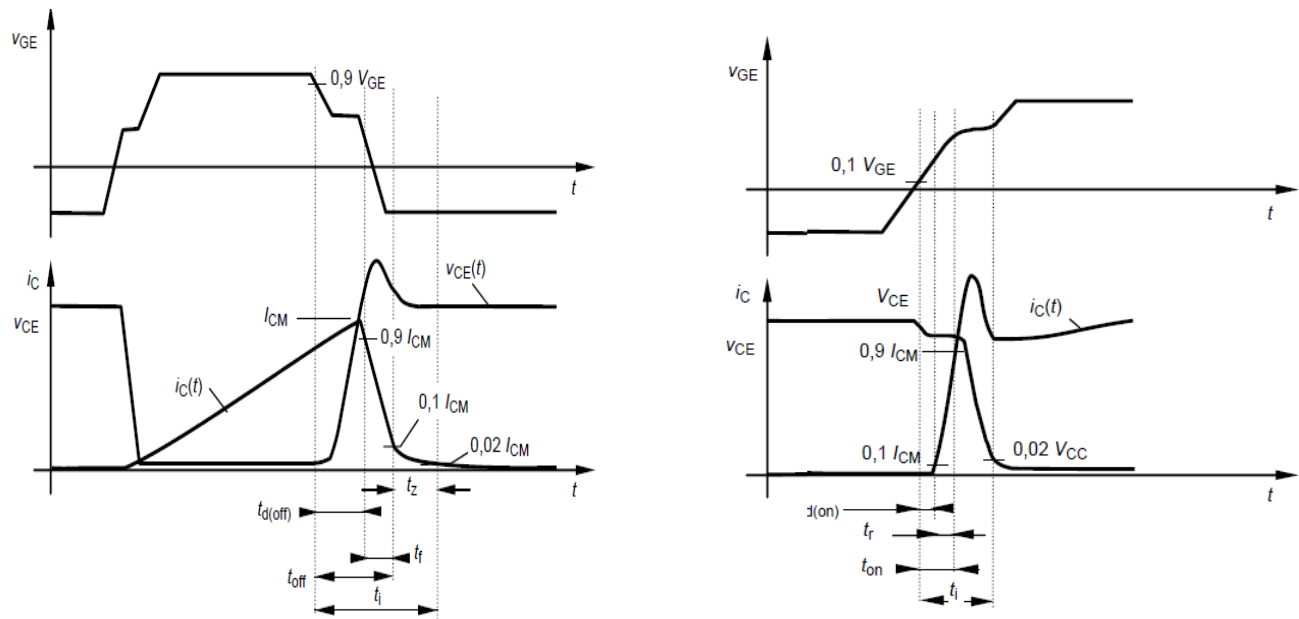


Figure 24: Reverse Recovery Current vs. Diode Current Slope

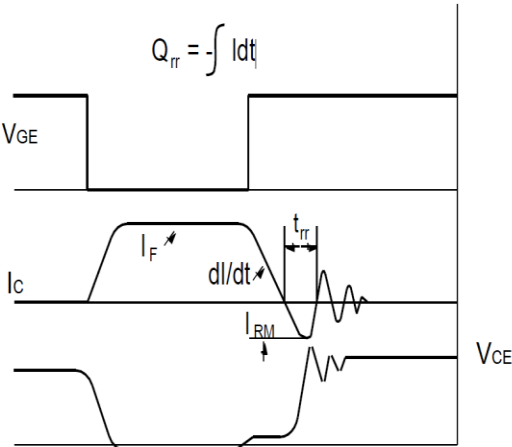
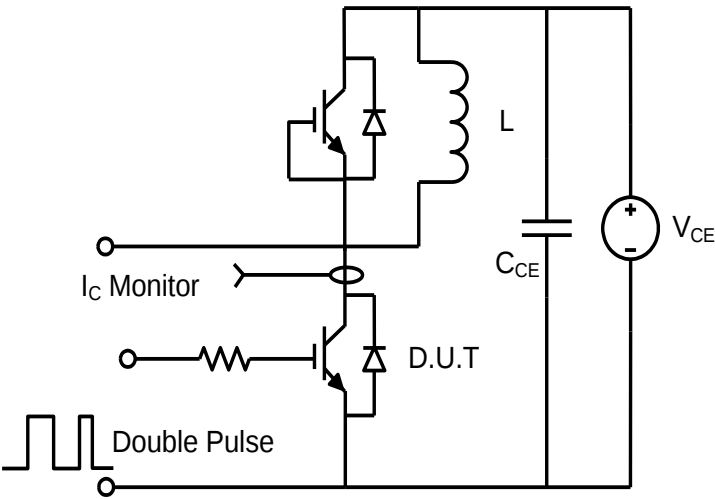


Test Circuit and Waveform

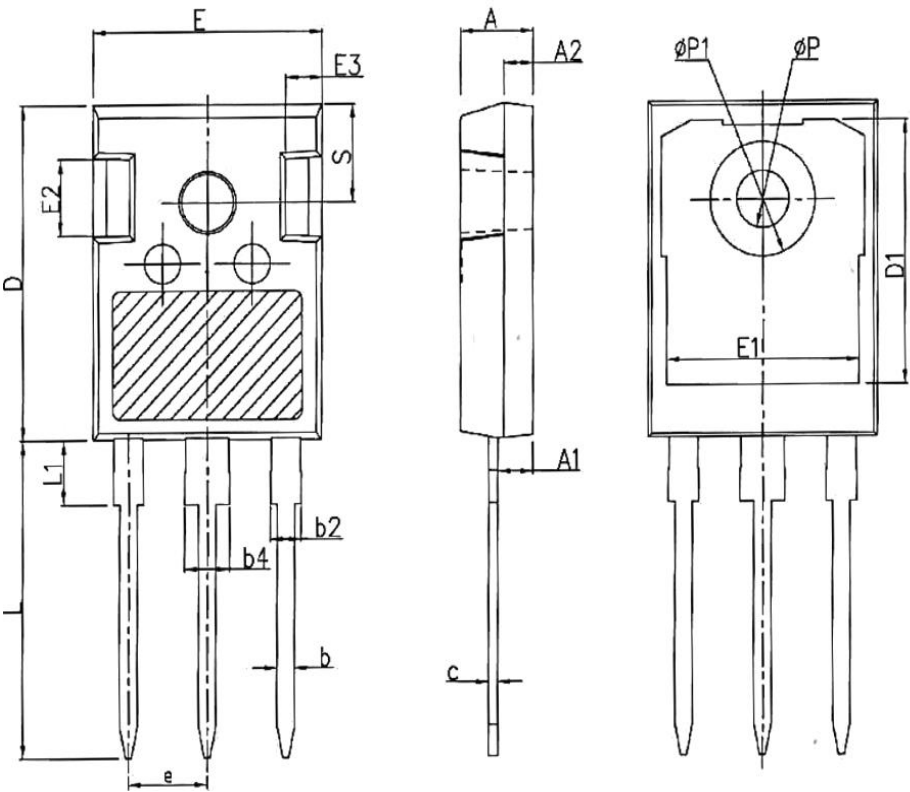
Switching Test Circuit & Waveforms



Diode Recovery Test Circuit & Waveforms



Package Outlines



| 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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## Marking Information



BK2A040WHH

XXXXXXX

Note:

BK2A040WHH = Product Name Code

XXXXXXX = Date code

Contact ALKAIDSEMI sales for detail information

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## Revision History

| Revision | Release Date | Remark |
|----------|--------------|--------|
| Rev.1.1  | 2023/2/10    |        |

## Disclaimer

The information given in this document describes the independent performance of the product, but similar performance is not guaranteed under other working conditions, and cannot be guaranteed when installed with other products or equipment. To achieve the required performance of the product in actual scenarios, the customer should conduct a complete application test to assess the functionality of the product.

Alkaidsemi assumes no responsibility for equipment failures result from using products at values that exceed the ratings, operating conditions, or other parameters listed in the product specifications.

The product described in this specification is not applicable for aerospace or other applications which requires high reliability. Customers using or selling these products for use in medical, life-saving, or life-sustaining applications do so at their own risk and agree to fully indemnify.

Due to product or technical improvements, the information described or contained herein may be changed without prior notice.