

### Product Summary

| $V_{(BR)CES}$ | $V_{CE(SAT)MAX}$ | $I_C(100^{\circ}C)$ |
|---------------|------------------|---------------------|
| 650V          | 2.1V@15V         | 40A                 |

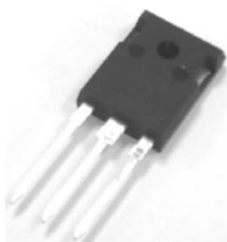
### Feature

- Low switching losses
- Maximum junction temperature 175°C
- Positive temperature coefficient
- High ruggedness, temperature stable
- High short circuit capability (5us)

### Application

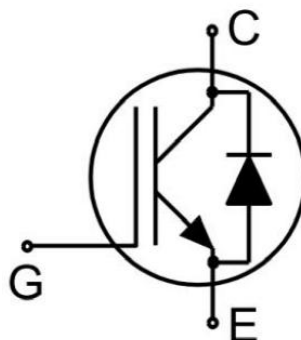
- AC and DC servo drive amplifier
- Uninterruptible power supply
- Motion/servo control

### Package

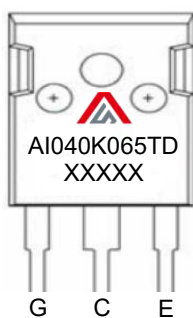


TO-247AB

### Circuit diagram



### Marking



### Absolute maximum ratings ( $T_C=25^{\circ}\text{C}$ unless otherwise noted)

| Parameter                                                                                                 | Symbol                     | Value           | Unit                 |
|-----------------------------------------------------------------------------------------------------------|----------------------------|-----------------|----------------------|
| Collector-Emitter Voltage                                                                                 | $V_{CES}$                  | 650             | V                    |
| Continuous Gate- Emitter Voltage                                                                          | $V_{GE}$                   | $\pm 20$        | V                    |
| Transient Gate-Emitter Voltage ( $t_p \leq 10\mu\text{s}, D < 0.01$ )                                     | $V_{GE}$                   | $\pm 30$        | V                    |
| Collector Current, limited by $T_{jmax}$                                                                  | $I_C$                      | 80              | A                    |
| Collector Current, limited by $T_{jmax}$ ( $T_C = 100^{\circ}\text{C}$ )                                  | $I_C(100^{\circ}\text{C})$ | 40              | A                    |
| Pulsed Collector Current, $t_p$ limited by $T_{jmax}$ ( $V_{GE} = 15\text{V}$ )                           | $I_{CM}$                   | 120             | A                    |
| Diode Continuous Forward Current, limited by $T_{jmax}$                                                   | $I_F$                      | 80              | A                    |
| Diode Continuous Forward Current, limited by $T_{jmax}$ ( $T_C = 100^{\circ}\text{C}$ )                   | $I_F(100^{\circ}\text{C})$ | 40              | A                    |
| Diode Pulsed Current, $t_p$ limited by $T_{jmax}$                                                         | $I_{Fpuls}$                | 120             | A                    |
| Turn off Safe Operating Area ( $V_{CE} \leq 650\text{V}, T_J \leq 150^{\circ}\text{C}$ )                  | -                          | 120             | A                    |
| Short Circuit Withstand Time<br>( $V_{GE} = 15\text{V}, V_{CC} = 400\text{V}, V_{CEM} \leq 650\text{V}$ ) | $T_{SC}$                   | 5               | $\mu\text{s}$        |
| Power Dissipation ( $T_J = 175^{\circ}\text{C}$ )                                                         | $P_D$                      | 187             | W                    |
| Thermal Resistance, Junction to case for Diode                                                            | $R_{\theta JC}$            | 1.05            | $^{\circ}\text{C/W}$ |
| Thermal Resistance, Junction to case for IGBT                                                             | $R_{\theta JC}$            | 0.8             | $^{\circ}\text{C/W}$ |
| Operating junction temperature range                                                                      | $T_J$                      | $-40 \sim +175$ | $^{\circ}\text{C}$   |
| Storage Temperature Range                                                                                 | $T_{STG}$                  | $-55 \sim +175$ | $^{\circ}\text{C}$   |

### Electrical characteristics of the IGBT ( $T_J=25^{\circ}\text{C}$ unless otherwise noted)

| Parameter                            | Symbol        | Test Condition                                                         | Min. | Typ. | Max. | Unit    |
|--------------------------------------|---------------|------------------------------------------------------------------------|------|------|------|---------|
| Static Characteristics               |               |                                                                        |      |      |      |         |
| Collector-Emitter Breakdown Voltage  | $V_{(BR)CES}$ | $V_{GE}=0V, I_C=250\mu A$                                              | 650  |      |      | V       |
| Collector-Emitter Leakage Current    | $I_{CES}$     | $V_{GE}=0V, V_{CE}=650V$                                               |      |      | 0.25 | mA      |
|                                      |               | $V_{GE}=0V, V_{CE}=650V, T_J=150^{\circ}C$                             |      |      | 4    |         |
| Gate to Emitter Leakage Current      | $I_{GES}$     | $V_{GE}=20V, V_{CE}=0V$                                                |      |      | 100  | nA      |
| Gate Threshold Voltage               | $V_{GE(th)}$  | $V_{GE}=V_{CE}, I_C=250\mu A$                                          | 4    | 5    | 6.5  | V       |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $V_{GE}=15V, I_C=40A$                                                  |      | 1.8  | 2.1  | V       |
|                                      |               | $V_{GE}=15V, I_C=40A, T_J=125^{\circ}C$                                |      | 2.2  |      |         |
|                                      |               | $V_{GE}=15V, I_C=40A, T_J=150^{\circ}C$                                |      | 2.35 |      |         |
| Dynamic characteristics              |               |                                                                        |      |      |      |         |
| Input Capacitance                    | $C_{ies}$     | $V_{CE}=25V, V_{GE}=0V, f=1MHz$                                        |      | 1.56 |      | nF      |
| Reverse Transfer Capacitance         | $C_{res}$     |                                                                        |      | 0.05 |      |         |
| Total Gate Charge                    | $Q_g$         | $V_{CC}=400V, V_{GE}=15V, I_C=40A$                                     |      | 0.16 |      | $\mu C$ |
| Short Circuit Collector Current      | $I_{SC}$      | $V_{CC}=400V, V_{GE}=15V, t_{sc}\leq 5\mu s$<br>$T_J\leq 150^{\circ}C$ |      | 185  |      | A       |
| Turn-on delay time                   | $t_{d(on)}$   | $V_{CC}=400V, V_{GE}=-5V\sim 15V$<br>$I_C=40A, R_G=20\Omega$           |      | 51   |      | nS      |
| Turn-on rise time                    | $t_r$         |                                                                        |      | 78   |      |         |
| Turn-off delay time                  | $t_{d(off)}$  |                                                                        |      | 81   |      |         |
| Turn-off fall time                   | $t_f$         |                                                                        |      | 88   |      |         |
| Turn-On Switching Loss               | $E_{on}$      |                                                                        |      | 2.11 |      | mJ      |
| Turn-Off Switching Loss              | $E_{off}$     |                                                                        |      | 0.82 |      |         |

| Parameter                      | Symbol       | Test Condition                                                                    | Min. | Typ. | Max. | Unit |
|--------------------------------|--------------|-----------------------------------------------------------------------------------|------|------|------|------|
| <b>Dynamic characteristics</b> |              |                                                                                   |      |      |      |      |
| Turn-on delay time             | $t_{d(on)}$  | $V_{CC}=400V, V_{GE}=-5V\sim 15V$<br>$I_C=40A, R_G=20\Omega$<br>$T_J=125^\circ C$ |      | 53   |      | nS   |
| Turn-on rise time              | $t_r$        |                                                                                   |      | 88   |      |      |
| Turn-off delay time            | $t_{d(off)}$ |                                                                                   |      | 85   |      |      |
| Turn-off fall time             | $t_f$        |                                                                                   |      | 109  |      |      |
| Turn-On Switching Loss         | $E_{on}$     | $V_{CC}=400V, V_{GE}=-5V\sim 15V$<br>$I_C=40A, R_G=20\Omega$<br>$T_J=150^\circ C$ |      | 2.19 |      | mJ   |
| Turn-Off Switching Loss        | $E_{off}$    |                                                                                   |      | 1.03 |      |      |
| Turn-on delay time             | $t_{d(on)}$  |                                                                                   |      | 56   |      | nS   |
| Turn-on rise time              | $t_r$        |                                                                                   |      | 104  |      |      |
| Turn-off delay time            | $t_{d(off)}$ |                                                                                   |      | 94   |      |      |
| Turn-off fall time             | $t_f$        |                                                                                   |      | 118  |      |      |
| Turn-On Switching Loss         | $E_{on}$     |                                                                                   |      | 2.24 |      | mJ   |
| Turn-Off Switching Loss        | $E_{off}$    |                                                                                   |      | 1.09 |      |      |

### Electrical characteristics of the Diode ( $T_J=25^\circ C$ unless otherwise noted)

| Parameter                | Symbol    | Test Condition                                                  | Min. | Typ. | Max. | Unit |
|--------------------------|-----------|-----------------------------------------------------------------|------|------|------|------|
| Diode Forward Voltage    | $V_F$     | $I_F=40A$                                                       |      | 2.1  | 2.6  | V    |
|                          |           | $I_F=40A, T_J=125^\circ C$                                      |      | 1.85 |      |      |
|                          |           | $I_F=40A, T_J=150^\circ C$                                      |      | 1.75 |      |      |
| Reverse Recovery Current | $I_{rrm}$ | $V_R=400V, I_F=40A$<br>$di/dt=-350A/\mu s$                      |      | 7    |      | A    |
| Reverse Recovery Charge  | $Q_{rr}$  |                                                                 |      | 0.17 |      | uC   |
| Reverse Recovery Time    | $t_{rr}$  |                                                                 |      | 48   |      | nS   |
| Reverse Recovery Energy  | $E_{rec}$ |                                                                 |      | 0.08 |      | mJ   |
| Reverse Recovery Current | $I_{rrm}$ | $V_R=400V, I_F=40A$<br>$di/dt=-350A/\mu s$<br>$T_J=125^\circ C$ |      | 14   |      | A    |
| Reverse Recovery Charge  | $Q_{rr}$  |                                                                 |      | 0.96 |      | uC   |
| Reverse Recovery Time    | $t_{rr}$  |                                                                 |      | 156  |      | nS   |
| Reverse Recovery Energy  | $E_{rec}$ |                                                                 |      | 0.17 |      | mJ   |
| Reverse Recovery Current | $I_{rrm}$ | $V_R=400V, I_F=40A$<br>$di/dt=-350A/\mu s$<br>$T_J=150^\circ C$ |      | 15   |      | A    |
| Reverse Recovery Charge  | $Q_{rr}$  |                                                                 |      | 1.28 |      | uC   |
| Reverse Recovery Time    | $t_{rr}$  |                                                                 |      | 165  |      | nS   |
| Reverse Recovery Energy  | $E_{rec}$ |                                                                 |      | 0.24 |      | mJ   |

### Typical Characteristics

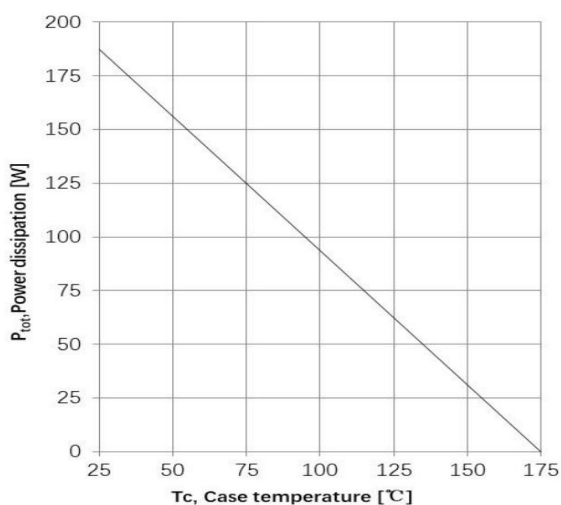


Fig1. Power dissipation as a function of case temperature ( $T_j < 175^\circ\text{C}$ )

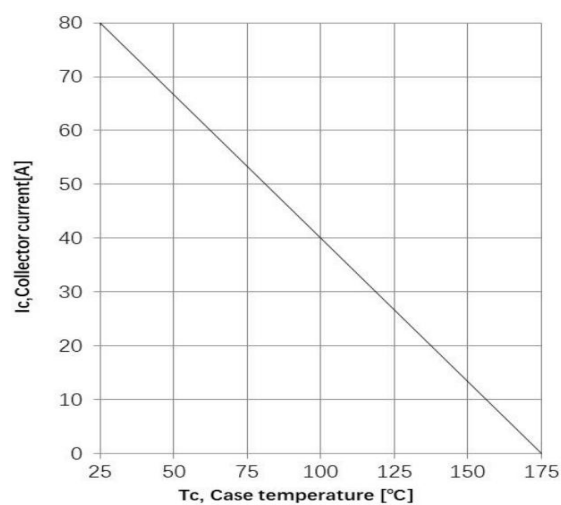


Fig2. Collector current as a function of case temperature ( $V_{ge} > 15\text{V}$ ,  $T_j < 175^\circ\text{C}$ )

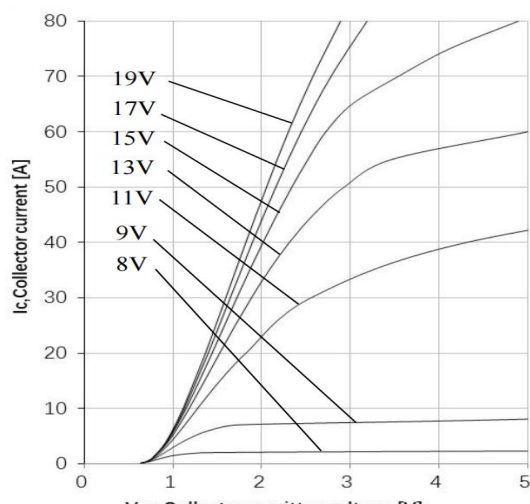


Fig3. Typical output characteristic ( $T_j = 25^\circ\text{C}$ )

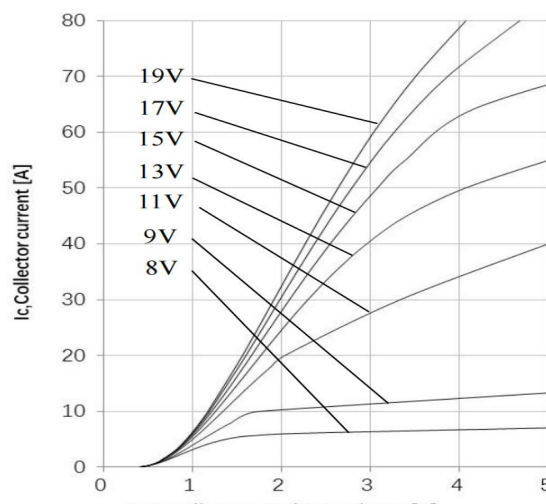


Fig4. Typical output characteristic ( $T_j = 150^\circ\text{C}$ )

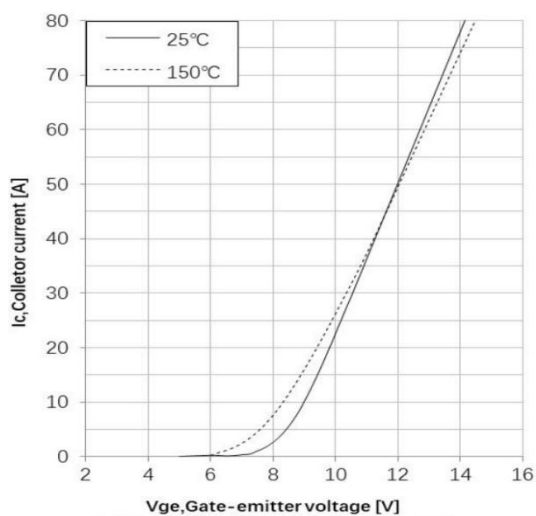


Fig5. Typical transfer characteristic ( $V_{ce} = 20\text{V}$ )

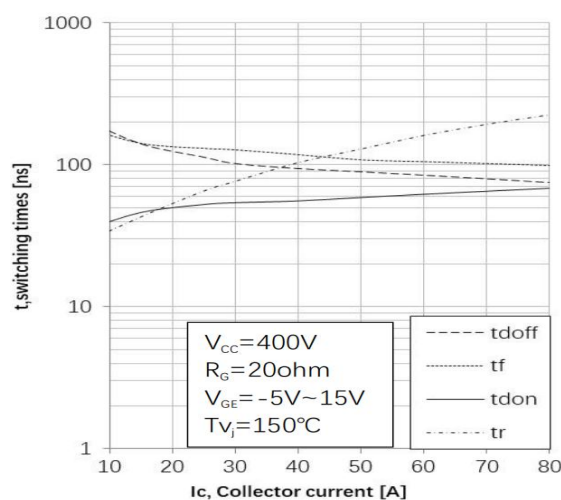


Fig6. Typical switching times as a function of collector current

### Typical Characteristics

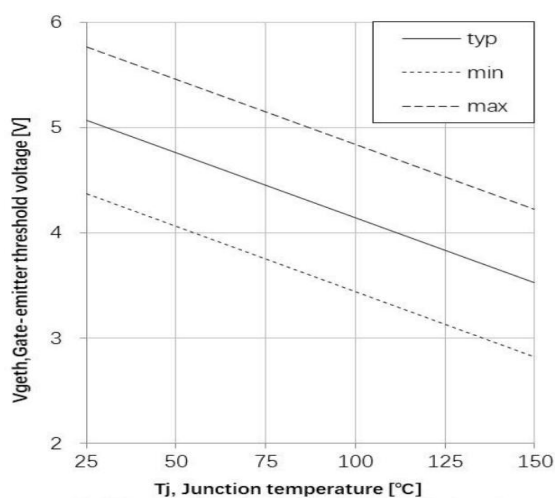


Fig7. Gate-emitter threshold voltage as a function of junction temperature ( $I_c=250\mu A$ )

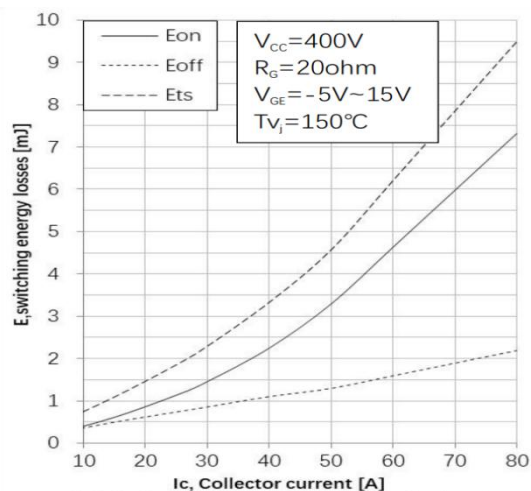


Fig8. Typical switching energy losses as a function of collector current

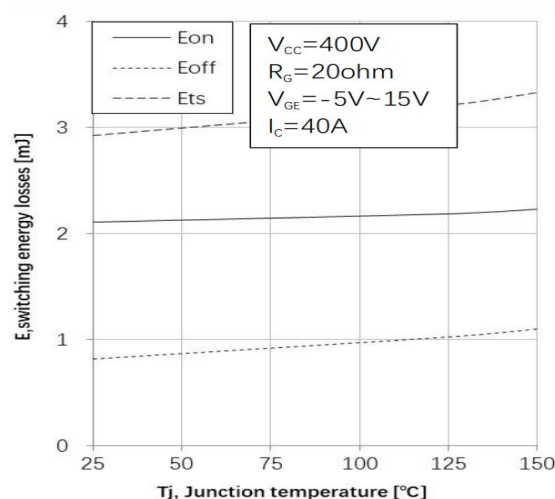


Fig9. Typical switching energy losses as a function of junction temperature

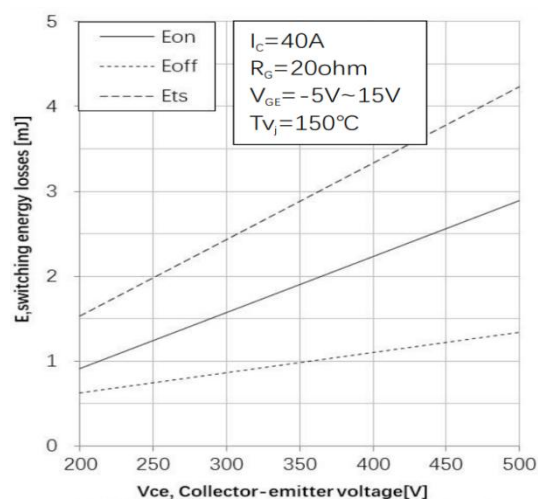


Fig10. Typical switching energy losses as a function of collector-emitter voltage

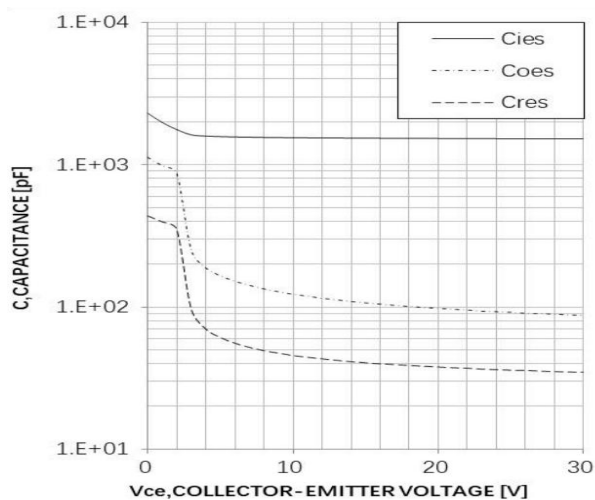


Fig11. Typical capacitance as a function of collector-emitter voltage

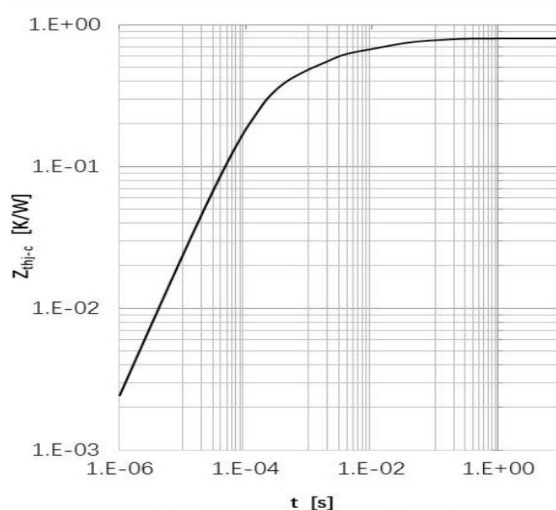


Fig 12. IGBT Transient Thermal Impedance

### Typical Characteristics

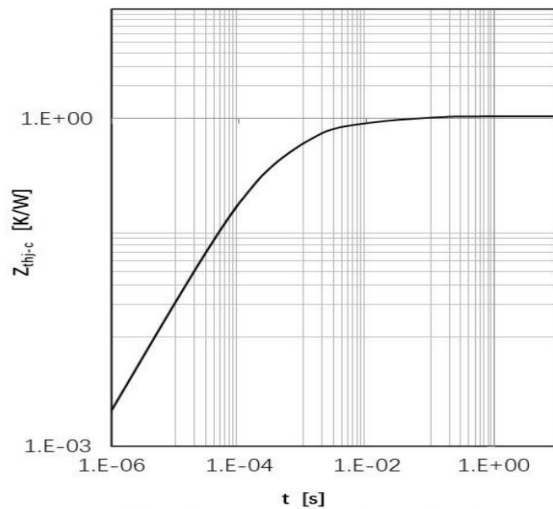


Fig 13. Diode Transient Thermal Impedance

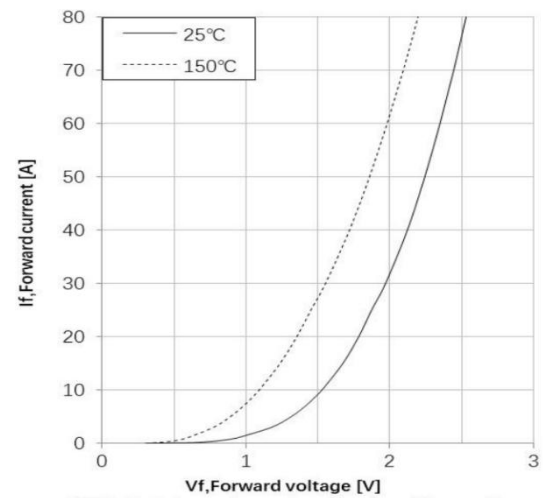
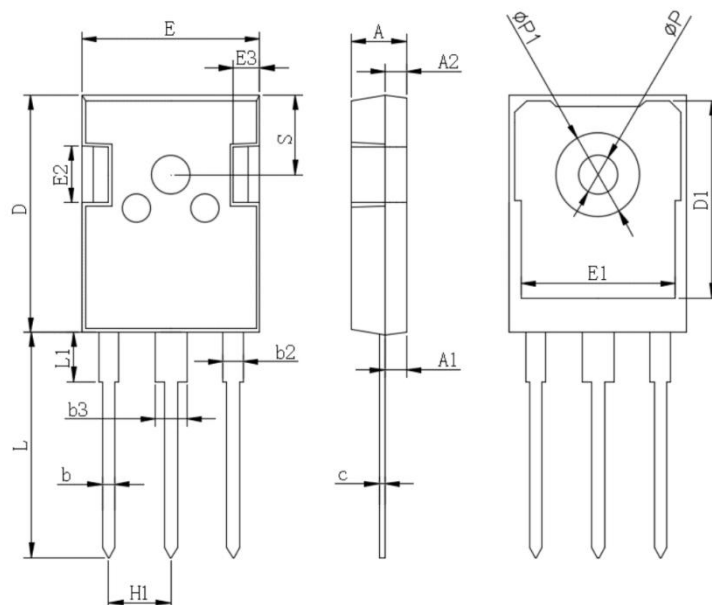


Fig14. Diode forward current as a function of forward voltage

## TO-247AB Package Information



| Symbol    | Dimensions In Millimeters |        | Dimensions In Inches |       |
|-----------|---------------------------|--------|----------------------|-------|
|           | Min.                      | Max.   | Min.                 | Max.  |
| A         | 4.800                     | 5.200  | 0.189                | 0.205 |
| A1        | 2.210                     | 2.610  | 0.087                | 0.103 |
| A2        | 1.850                     | 2.150  | 0.073                | 0.085 |
| b         | 1.000                     | 1.400  | 0.039                | 0.055 |
| b2        | 1.910                     | 2.210  | 0.075                | 0.087 |
| b3        | 2.800                     | 3.200  | 0.110                | 0.126 |
| C         | 0.500                     | 0.700  | 0.020                | 0.028 |
| D         | 20.700                    | 21.300 | 0.815                | 0.839 |
| D1        | 16.250                    | 16.850 | 0.640                | 0.663 |
| E         | 15.500                    | 16.100 | 0.610                | 0.634 |
| E1        | 13.000                    | 13.600 | 0.512                | 0.535 |
| E2        | 4.800                     | 5.200  | 0.189                | 0.205 |
| E3        | 2.300                     | 2.700  | 0.091                | 0.106 |
| L         | 19.620                    | 20.220 | 0.772                | 0.796 |
| L1        | -                         | 4.300  | -                    | 0.169 |
| $\phi P$  | 3.400                     | 3.800  | 0.134                | 0.150 |
| $\phi P1$ | -                         | 7.300  | -                    | 0.287 |
| S         | 6.150 TYP                 |        | 0.242 TYP            |       |
| H1        | 5.440 TYP                 |        | 0.214 TYP            |       |