## Features

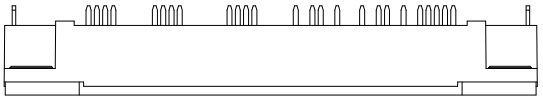
- Low Switching Losses
- Low $V_{ce(sat)}$ with Positive Temperature Coefficient
- Including Fast & Soft Recovery Anti-parallel FWD
- Low Inductance Case
- High Short Circuit Capability(10μs)
- Maximum Junction Temperature 175°C
- Epoxy Meets UL 94 V-0 Flammability Rating
- Lead Free Finish/RoHS Compliant ("P" Suffix Designates RoHS Compliant. See Ordering Information)

# IGBT Modules
# 1200V 50A

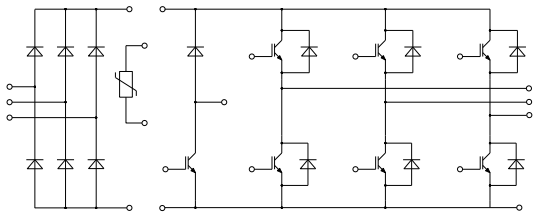
## Applications

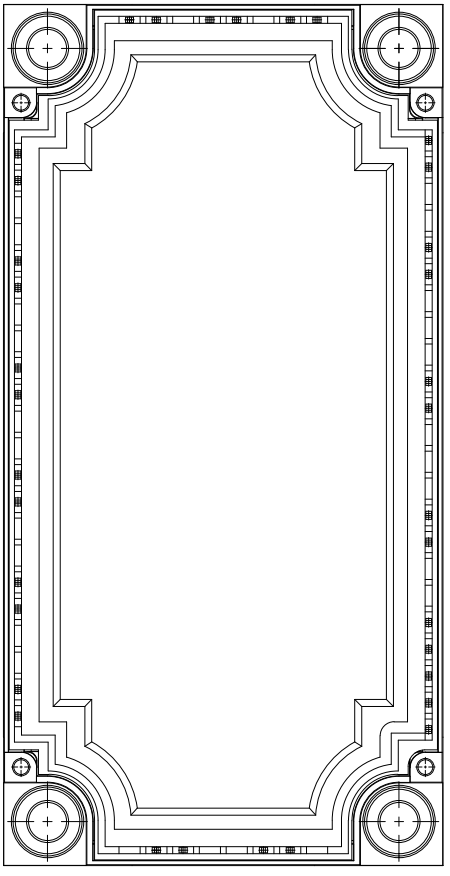
- Motor Drivers
- AC and DC Servo Drive Amplifier
- UPS (Uninterruptible Power Supplies)

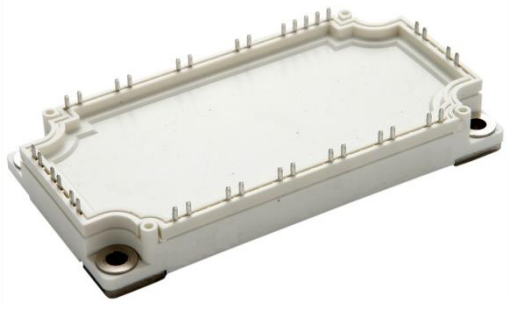
E2A



## Circuit Diagram







## ● IGBT- Inverter

### Maximum Ratings

| Parameter | Symbol | Test Conditions | Rating | Unit |
|---|---|---|---|---|
| Collector-Emitter Voltage | $V_{CES}$ | $V_{GE}$=0V, $I_C$=1mA, $T_{vj}$=25°C | 1200 | V |
| Continuous Collector Current | $I_C$ | $T_C$=80°C, $T_{vjmax}$=150°C | 50 | A |
| Repetitive Peak Collector Current | $I_{CRM}$ | $t_p$=1ms | 100 | A |
| Gate-Emitter Voltage | $V_{GES}$ | $T_{vj}$=25°C | ±20 | V |
| Total Power Dissipation | $P_{tot}$ | $T_C$=25°C, $T_{vjmax}$=150°C | 368 | W |

### Electrical Characteristics

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Gate-Emitter Threshold Voltage | $V_{GE(th)}$ | $V_{GE}$=$V_{CE}$, $I_C$=2mA,$T_{vj}$=25°C | 5 | 5.8 | 6.5 | V |
| Collector-Emitter Cut-off Current | $I_{CES}$ | $V_{CE}$=1200V,$V_{GE}$=0V, Tvj=25°C | | | 1 | mA |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C$=50A,$V_{GE}$=15V, $T_{vj}$=25°C | | 1.95 | 2.25 | V |
| | | $I_C$=50A,$V_{GE}$=15V, $T_{vj}$=125°C | | 2.15 | | V |
| | | $I_C$=50A,$V_{GE}$=15V, $T_{vj}$=150°C | | 2.2 | | V |
| Gate Charge | $Q_g$ | | | 0.6 | | µC |
| Input Capacitance | $C_{ies}$ | $V_{CE}$=25V,$V_{GE}$=0V,f=1MHz | | 3.8 | | nF |
| Reverse Transfer Capacitance | $C_{res}$ | | | 0.26 | | |
| Internal Gate Resistance | $R_{gint}$ | | | 2.5 | | Ω |
| Gate-Emitter leakage current | $I_{GES}$ | $V_{CE}$=0V, $V_{GE}$=20V, $T_{vj}$=25°C | | | 400 | nA |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{CE}$=600V, $I_C$=50A, $V_{GE}$=± 15V, $R_G$=15Ω, $T_{vj}$=25°C | | 40 | | ns |
| Rise Time | $t_r$ | | | 65 | | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | 390 | | |
| Fall Time | $t_f$ | | | 36 | | |
| Turn-On Energy | $E_{on}$ | | | 6.05 | | mJ |
| Turn-Off Energy | $E_{off}$ | | | 3.3 | | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{CE}$=600V, $I_C$=50A, $V_{GE}$=± 15V, $R_G$=15Ω, $T_{vj}$=125°C | | 45 | | ns |
| Rise Time | $t_r$ | | | 70 | | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | 440 | | |
| Fall Time | $t_f$ | | | 41 | | |
| Turn-On Energy | $E_{on}$ | | | 8 | | mJ |
| Turn-Off Energy | $E_{off}$ | | | 5.5 | | |
| SC Data | $I_{SC}$ | $T_p$≤10µs,$V_{GE}$=15V,$T_{vj}$=150°C, $V_{CC}$=900V,$V_{CEM}$≤1200V | | 320 | | A |

## ● Diode- Inverter

### Maximum Ratings

| Parameter | Symbol | Test Conditions | Rating | Unit |
|---|---|---|---|---|
| Repetitive Peak Reverse Voltage | $V_{RRM}$ | $T_{vj}$=25°C | 1200 | V |
| Continuous DC Forward Current | $I_F$ | | 50 | A |
| Repetitive Peak Forward Current | $I_{FRM}$ | $t_p$=1ms | 100 | A |

### Electrical Characteristics

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | $I_F$=50A, $T_{vj}$=25°C | | 1.95 | 2.25 | V |
| | | $I_F$=50A, $T_{vj}$=125°C | | 2.05 | | V |
| | | $I_F$=50A, $T_{vj}$=150°C | | 2.1 | | V |
| Recovered Charge | $Q_{rr}$ | $I_F$=50A, $V_R$=600V, -$di_F$/dt=900A/μs, $T_{vj}$=25°C | | 3.5 | | μC |
| Peak Reverse Recovery Current | $I_{rr}$ | | | 40 | | A |
| Reverse Recovery Energy | $E_{rec}$ | | | 1.35 | | mJ |
| Recovered Charge | $Q_{rr}$ | $I_F$=50A, $V_R$=600V, -$di_F$/dt=900A/μs, $T_{vj}$=125°C | | 6.5 | | μC |
| Peak Reverse Recovery Current | $I_{rr}$ | | | 50 | | A |
| Reverse Recovery Energy | $E_{rec}$ | | | 2 | | mJ |

## ● IGBT- Brake-chopper

### Maximum Ratings

| Parameter | Symbol | Test Conditions | Rating | Unit |
|---|---|---|---|---|
| Collector-Emitter Voltage | $V_{CES}$ | $V_{GE}$=0V, $I_C$=1mA, $T_{vj}$=25°C | 1200 | V |
| Continuous Collector Current | $I_C$ | $T_C$=100°C, $T_{vjmax}$=175°C | 40 | A |
| Repetitive Peak Collector Current | $I_{CRM}$ | $t_p$=1ms | 80 | A |
| Gate-Emitter Voltage | $V_{GES}$ | $T_{vj}$=25°C | ±20 | V |
| Total Power Dissipation | $P_{tot}$ | $T_C$=25°C, $T_{vjmax}$=175°C | 300 | W |

### Electrical Characteristics

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Gate-Emitter Threshold Voltage | $V_{GE(th)}$ | $V_{GE}$=$V_{CE}$, $I_C$=1.2mA,$T_{vj}$=25°C | 5.8 | 6.7 | 7.2 | V |
| Collector-Emitter Cut-off Current | $I_{CES}$ | $V_{CE}$=1200V,$V_{GE}$=0V, Tvj=25°C | | | 1 | mA |
| Collector-Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C$=40A,$V_{GE}$=15V, $T_{vj}$=25°C | | 1.95 | 2.35 | V |
| | | $I_C$=40A,$V_{GE}$=15V, $T_{vj}$=125°C | | 2.3 | | V |
| | | $I_C$=40A,$V_{GE}$=15V, $T_{vj}$=150°C | | 2.4 | | V |
| Gate Charge | $Q_g$ | | | 0.27 | | µC |
| Input Capacitance | $C_{ies}$ | $V_{CE}$=25V,$V_{GE}$=0V,f=1MHz | | 2 | | nF |
| Reverse Transfer Capacitance | $C_{res}$ | | | 0.07 | | |
| Gate-Emitter leakage current | $I_{GES}$ | $V_{CE}$=0V, $V_{GE}$=20V, $T_{vj}$=25°C | | | 400 | nA |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{CE}$=600V, $I_C$=40A, $V_{GE}$=± 15V, $R_G$=12Ω, $T_{vj}$=25°C | | 28 | | ns |
| Rise Time | $t_r$ | | | 16 | | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | 26 | | |
| Fall Time | $t_f$ | | | 125 | | |
| Turn-On Energy | $E_{on}$ | | | 2.4 | | mJ |
| Turn-Off Energy | $E_{off}$ | | | 2.25 | | |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{CE}$=600V, $I_C$=40A, $V_{GE}$=± 15V, $R_G$=12Ω, $T_{vj}$=125°C | | 28 | | ns |
| Rise Time | $t_r$ | | | 18 | | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | 310 | | |
| Fall Time | $t_f$ | | | 190 | | |
| Turn-On Energy | $E_{on}$ | | | 3.6 | | mJ |
| Turn-Off Energy | $E_{off}$ | | | 3.2 | | |
| SC Data | $I_{SC}$ | $T_p$≤10µs,$V_{GE}$=15V,$T_{vj}$=150°C, $V_{CC}$=900V,$V_{CEM}$≤1200V | | 130 | | A |

## ● Diode- Brake-chopper

### Maximum Ratings

| Parameter | Symbol | Test Conditions | Rating | Unit |
|---|---|---|---|---|
| Repetitive Peak Reverse Voltage | $V_{RRM}$ | $T_{vj}$=25°C | 1200 | V |
| Continuous DC Forward Current | $I_F$ | | 40 | A |
| Repetitive Peak Forward Current | $I_{FRM}$ | $t_p$=1ms | 80 | A |
| $I^2t$-value | $I^2t$ | $V_R$=0,$t_p$=10ms,$T_{vj}$=125°C | 240 | $A^2s$ |
| | | $V_R$=0,$t_p$=10ms,$T_{vj}$=150°C | 220 | |

### Electrical Characteristics

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | $I_F$=40A, $T_{vj}$=25°C | | 1.75 | 2.25 | V |
| | | $I_F$=40A, $T_{vj}$=125°C | | 1.75 | | V |
| | | $I_F$=40A, $T_{vj}$=150°C | | 1.75 | | V |
| Recovered Charge | $Q_{rr}$ | $I_F$=40A, $V_R$=600V, -$di_F/dt$=1600A/μs, $T_{vj}$=25°C | | 4.15 | | μC |
| Peak Reverse Recovery Current | $I_{rr}$ | | | 42 | | A |
| Reverse Recovery Energy | $E_{rec}$ | | | 1.3 | | mJ |
| Recovered Charge | $Q_{rr}$ | $I_F$=40A, $V_R$=600V, -$di_F/dt$=1600A/μs, $T_{vj}$=125°C | | 8 | | μC |
| Peak Reverse Recovery Current | $I_{rr}$ | | | 46 | | A |
| Reverse Recovery Energy | $E_{rec}$ | | | 2.38 | | mJ |

## ● Diode- Rectifier

### Maximum Ratings

| Parameter | Symbol | Test Conditions | Rating | Unit |
|---|---|---|---|---|
| Repetitive Peak Reverse Voltage | $V_{RRM}$ | $T_j$=25°C | 1600 | V |
| Average On-state Current 50/60Hz, sine wave | $I_{F(AV)}$ | $T_C$=100°C | 65 | A |
| Maximum RMS Current at Rectifier Output | $I_{RMSM}$ | $T_C$=100°C | 110 | A |
| Surge Forward Current | $I_{FSM}$ | $V_R$=0,$t_p$=10ms,$T_j$=45°C | 850 | A |
| $I^2t$-value | $I^2t$ | $V_R$=0,$t_p$=10ms,$T_j$=45°C | 3610 | $A^2s$ |

### Electrical Characteristics

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Diode Forward Voltage | $V_F$ | $I_F$=50A,$T_j$=150°C | | 1 | | V |
| Reverse Current | $I_r$ | $T_j$=125°C,$V_R$=1600V | | | 1.5 | mA |

## ● NTC-Thermistor

### Electrical Characteristics

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Rated Resistance | $R_{25}$ | | | 5 | | kΩ |
| Deviation of R100 | ΔR/R | $T_C$=100,$R_{100}$=493.3Ω | -5 | | 5 | % |
| Power Dissipation | $P_{25}$ | | | 20 | | mW |
| B-value | $B_{25/50}$ | $R_2=R_{25}\exp[B_{25/50}(1/T_2-1/(298.15K))]$ | | 3375 | | K |

## ● Module Characteristics($T_C$=25°C unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Isolation voltage | $V_{isol}$ | t=1min,f=50Hz | 2500 | | | V |
| Maximum Junction Temperature | $T_{jmax}$ | Inverter, brake | | | 175 | °C |
| | | rectifier | | | 150 | |
| Operating Junction Temperature | $T_{vj\ op}$ | | -40 | | 150 | °C |
| Operating Junction Temperature | $T_{stg}$ | | -40 | | 125 | °C |
| Stray Inductance | $L_{CE}$ | | | 60 | | nH |
| Module Lead Resistance , Terminal to Chip | $R_{cc'+EE'}$ | TC=25°C, per switch | | 4 | | mΩ |
| | $R_{AA'+CC'}$ | | | 2 | | |
| Thermal Resistance Junction to Case | $R_{\theta jc}$ | per IGBT-inverter | | | 0.339 | K/W |
| | | per Diode-inverter | | | 0.619 | |
| | | per IGBT-brake-chopper | | | 0.5 | |
| | | per Diode-chopper | | | 1.266 | |
| | | per Diode-rectifier | | | 0.635 | |
| Thermal Resistance Case to Sink | $R_{\theta CS}$ | per IGBT-inverter | | 0.121 | | K/W |
| | | per Diode-inverter | | 0.221 | | |
| | | per IGBT-brake-chopper | | 0.18 | | |
| | | per Diode-chopper | | 0.452 | | |
| | | per Diode-rectifier | | 0.227 | | |
| | | per Module | | 0.02 | | |
| Module-to-Sink Torque | $M_S$ | | 3 | | 6 | N·m |
| Weight of Module | G | | | 300 | | g |

## Curve Characteristics

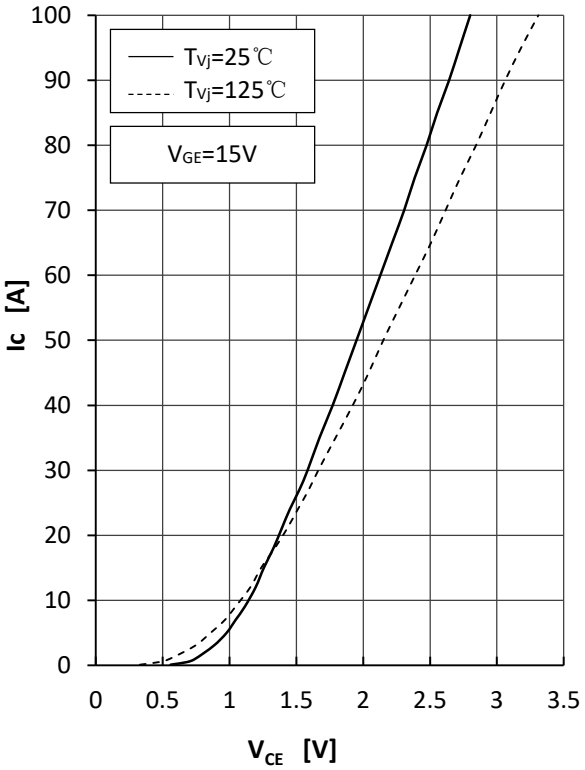



Fig1.IGBT Output Characteristics

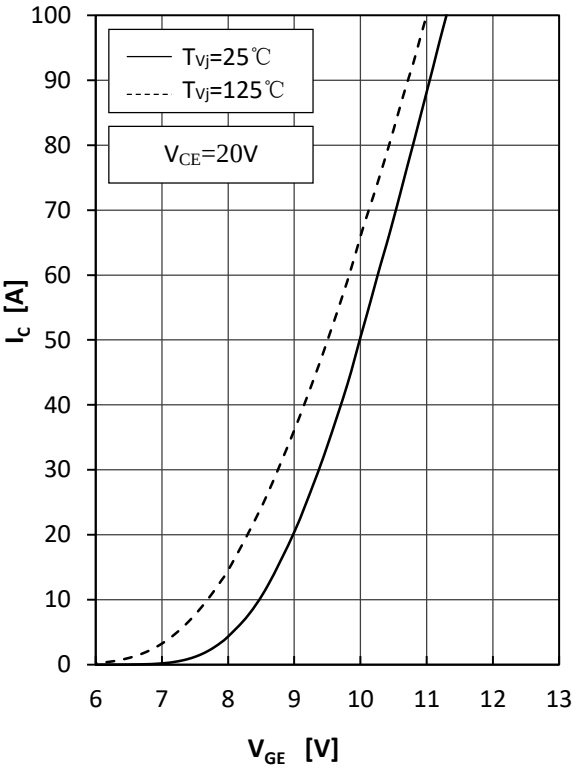



Fig2.IGBT Transfer Characteristics

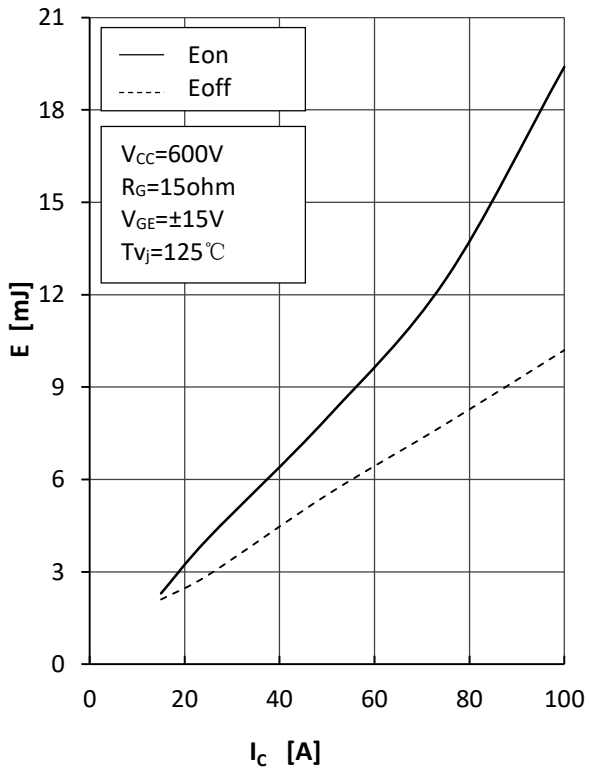



Fig3.IGBT Switching Loss vs.Ic

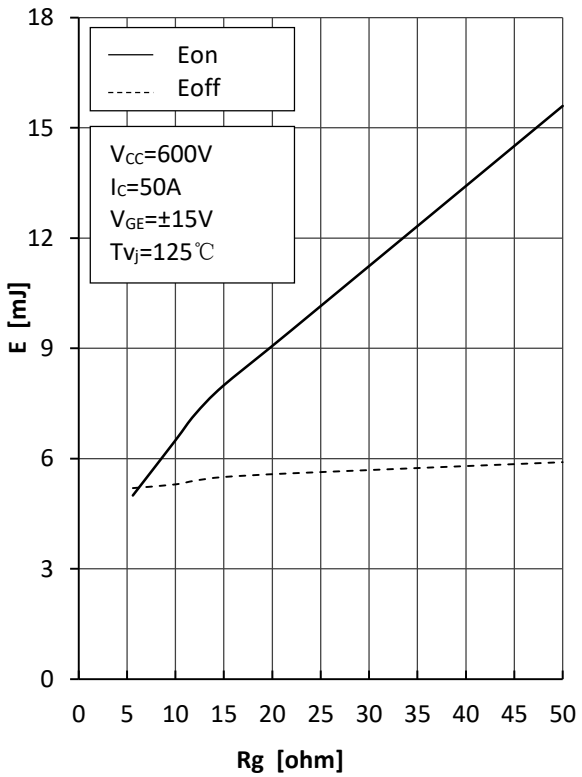



Fig4.IGBT Switching Loss vs.Rg

## Curve Characteristics

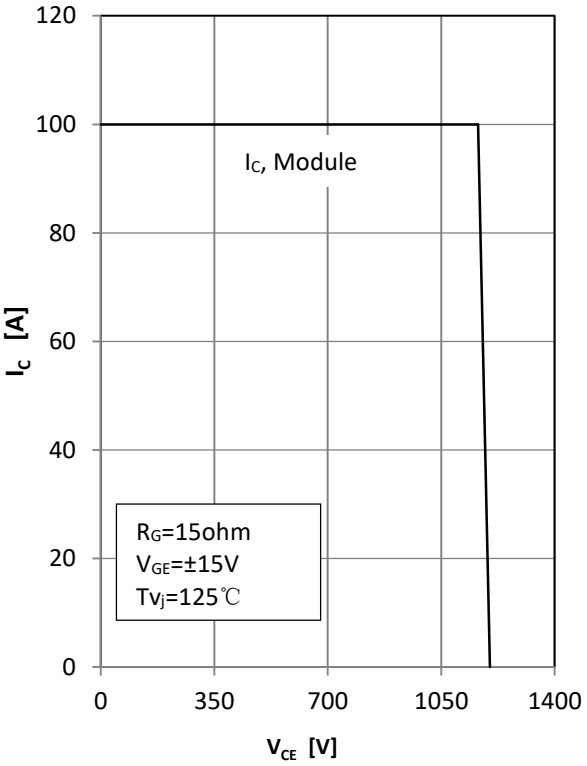



Fig5. RBSOA

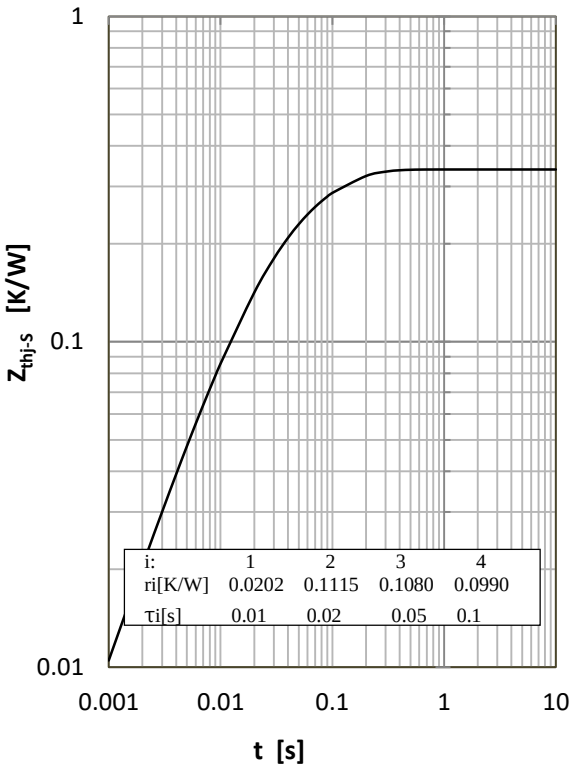



Fig 6. IGBT Transient Thermal Impedance

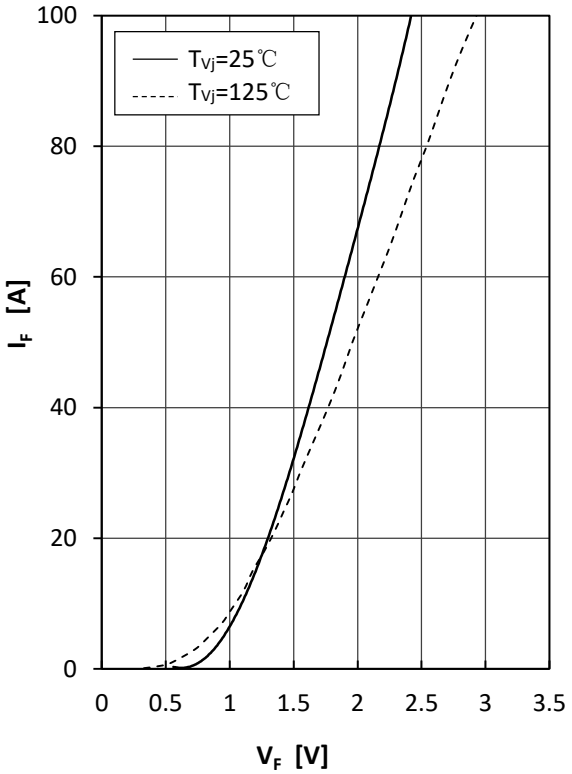



Fig7.Diode Foward Characteristics

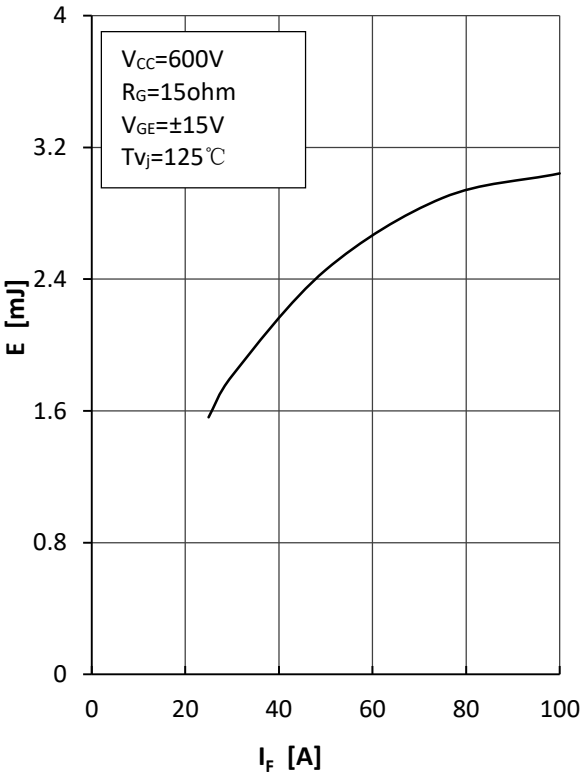



Fig8.Diode Switching Loss vs.$I_F$

## Curve Characteristics

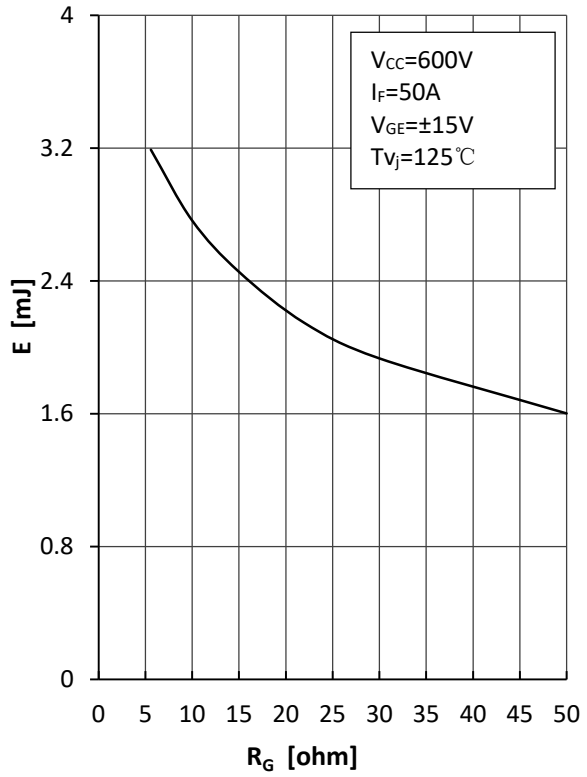



Fig9.Diode Switching Loss vs.Rg

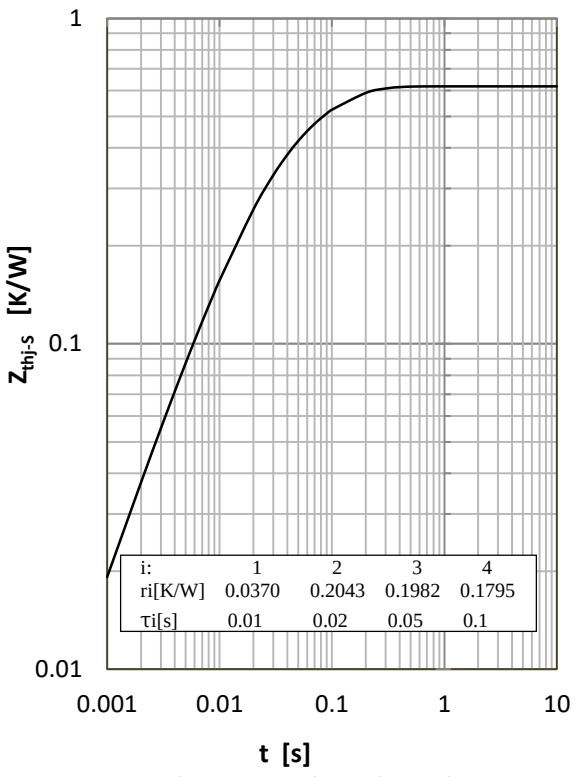



Fig10.Diode Transient Thermal Impedance

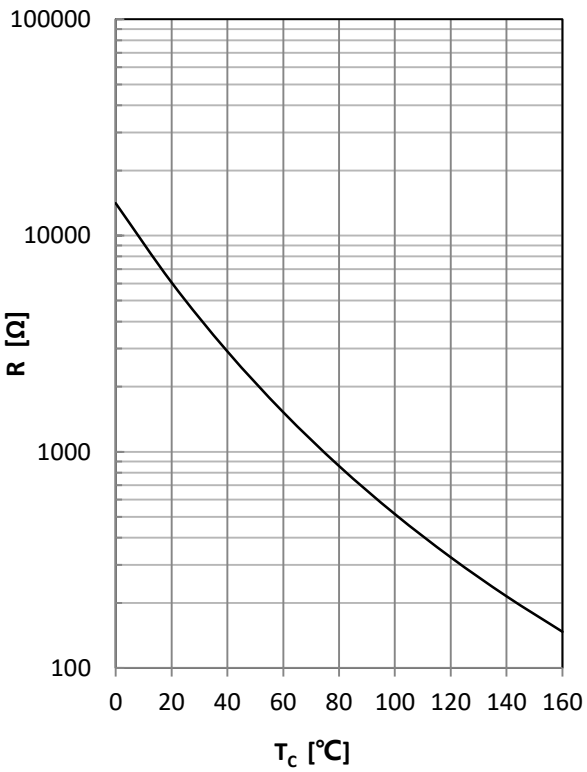
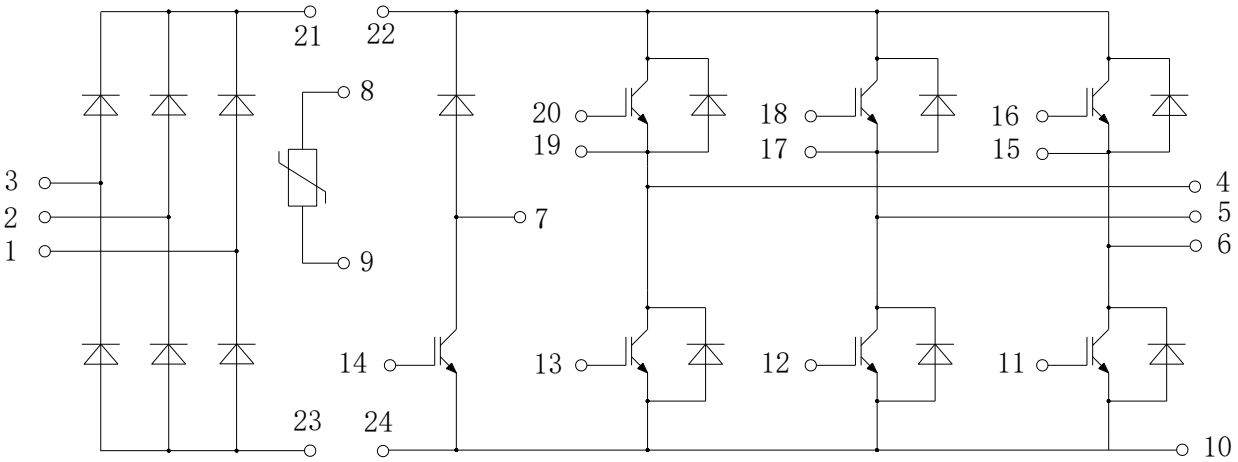



Fig 11. NTC Temperature Characteristic

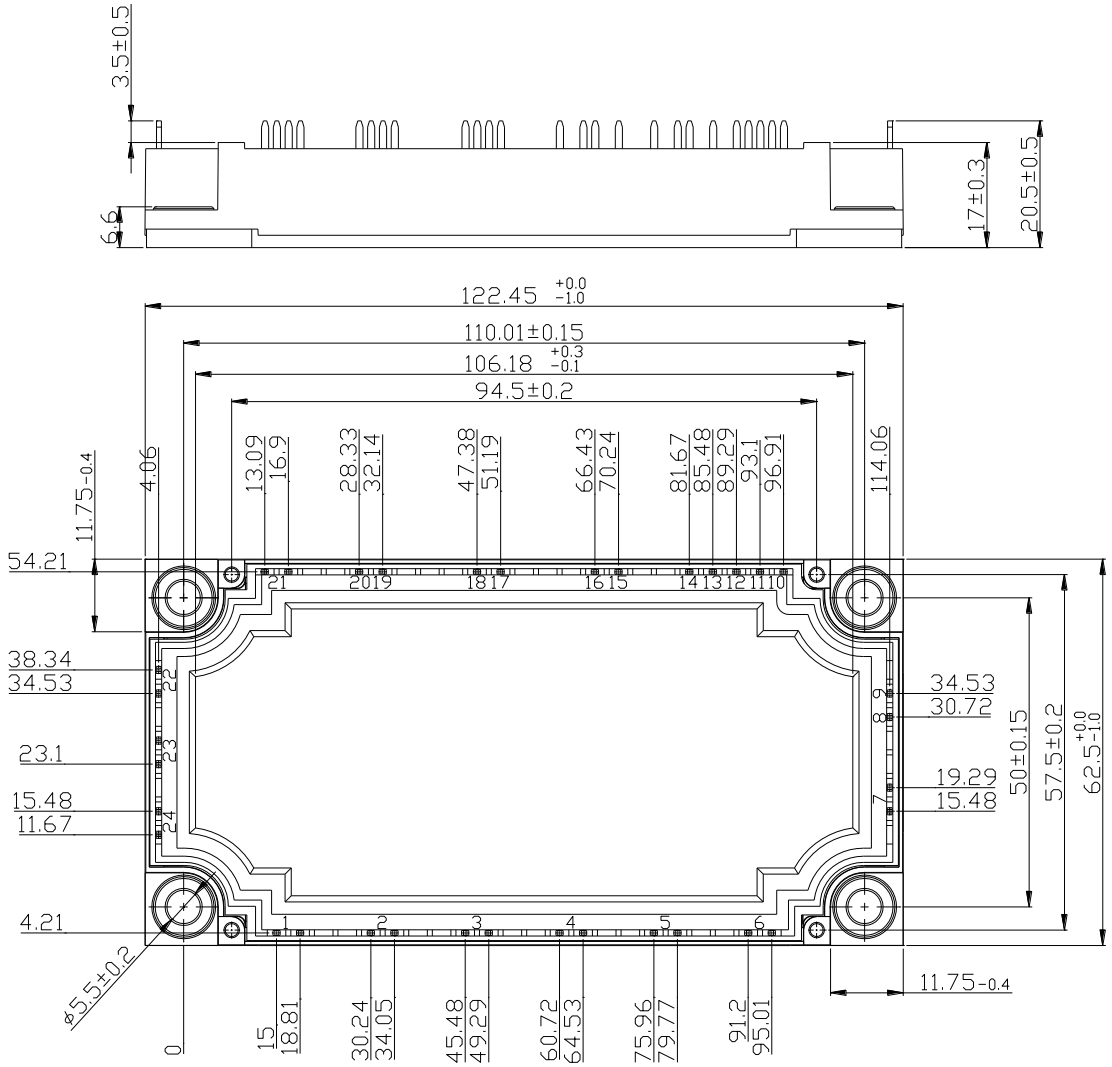
## Circuit Diagram




## Package Dimensions

**Dimensions in mm**

# E2A



## Ordering Information

| Device | Packing |
|---|---|
| Part Number-BP | Bulk: 6pcs/Box ; 42pcs/Ctn |