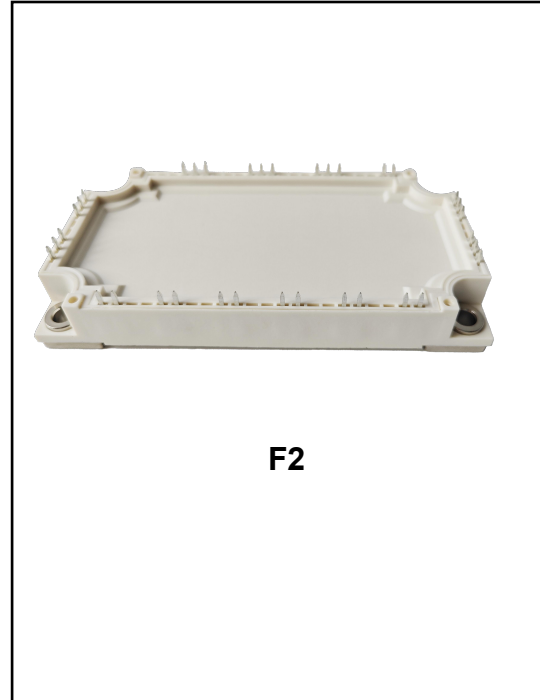


F2 PACK module with Gen.7 Trench/Fieldstop IGBT and Emitter Controlled diode and NTC

## Features

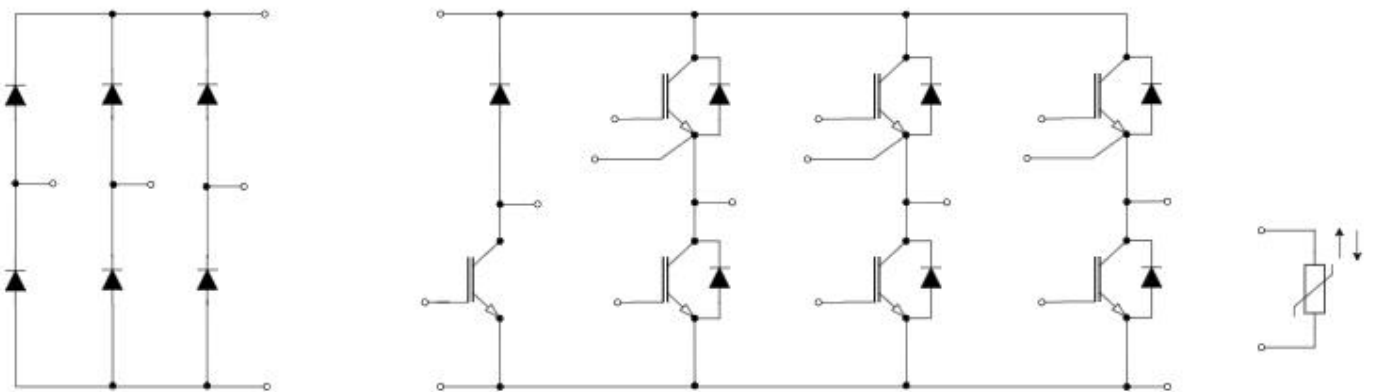
- Electrical features
  - $V_{CES} = 1200\text{ V}$
  - $I_C \text{ nom} = 75\text{ A} / I_{CRM} = 150\text{ A}$
  - Low  $V_{CEsat}$
  - Overload operation up to  $175^\circ\text{C}$
- Mechanical features
  - High power and thermal cycling capability
  - Integrated NTC temperature sensor
  - Copper base plate
  - $\text{Al}_2\text{O}_3$  substrate with low thermal resistance



## Typical Applications

- Auxiliary inverters
- Motor drives
- Servo drives

## Description



## Package Insulation coordination

| Parameter                                  | Symbol             | Note or test condition               | Values                         | Unit |
|--------------------------------------------|--------------------|--------------------------------------|--------------------------------|------|
| Isolation test voltage                     | V <sub>ISOL</sub>  | RMS, f=50Hz, t=60s                   | 2.5                            | kV   |
| Internal isolation                         |                    | basic insulation(class 1, IEC 61140) | Al <sub>2</sub> O <sub>3</sub> |      |
| Creepage distance                          | d <sub>creep</sub> | terminal to heatsink                 | 10.0                           | mm   |
| Clearance                                  | d <sub>clear</sub> | terminal to heatsink                 | 7.5                            | mm   |
| Comparative tracking index<br>(electrical) | CTI                |                                      | >200                           |      |
| RTI Elec.                                  | RTI                | housing                              | 140                            | °C   |

## Package Characteristic values

| Parameter                                | Symbol               | Note or test condition           | Values |      |      | Unit |
|------------------------------------------|----------------------|----------------------------------|--------|------|------|------|
|                                          |                      |                                  | Min.   | Typ. | Max. |      |
| Stray Inductance                         | LCE                  |                                  | --     | 35   | --   | nH   |
| Module Lead Resistance, Terminal to Chip | R <sub>AA'+CC'</sub> | T <sub>c</sub> =25°C, per switch | --     | 2.9  | --   | mΩ   |
| Module Lead Resistance, Terminal to Chip | R <sub>CC'+EE'</sub> | T <sub>c</sub> =25°C, per switch | --     | 3.9  | --   | mΩ   |
| Storage Temperature Range                | T <sub>STG</sub>     |                                  | -40    |      | 125  | °C   |
| Mounting Torque, Screw M5                | M                    | M5, Screw                        | 3      |      | 6    | N.m  |
| Weight                                   | G                    |                                  | --     | 300  | --   | g    |

## IGBT, Inverter

### Absolute Maximum Ratings (T<sub>C</sub> = 25°C unless otherwise noted)

| Symbol           | Description                                  | Value | Unit |
|------------------|----------------------------------------------|-------|------|
| V <sub>CES</sub> | Collector-Emitter Voltage                    | 1200  | V    |
| V <sub>GES</sub> | Gate-Emitter Voltage                         | ±30   | V    |
| I <sub>C</sub>   | Collector Current @ T <sub>C</sub> =25°C     | 150   | A    |
|                  | Collector Current @ T <sub>C</sub> =80°C     | 75    | A    |
| I <sub>CM</sub>  | Pulsed Collector Current, t <sub>p</sub> =1S | 225   | A    |

### Characteristics (T<sub>C</sub> = 25°C unless otherwise noted)

| Symbol               | Parameter                            | Test Condition                                                                                                                                                          |                          | Min                                                                                                                                                                        | Typ  | Max  | Unit |                   |     |
|----------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|-------------------|-----|
| V <sub>CE(sat)</sub> | Collector–Emitter Saturation Voltage | I <sub>C</sub> =75A, V <sub>GE</sub> =15V                                                                                                                               | T <sub>vj</sub> =25°C    | --                                                                                                                                                                         | 1.65 | 2.50 | V    |                   |     |
|                      |                                      |                                                                                                                                                                         | T <sub>vj</sub> = 175 °C | --                                                                                                                                                                         | 1.95 | --   |      |                   |     |
| V <sub>GE(th)</sub>  | Gate Threshold Voltage               | I <sub>C</sub> =1mA,V <sub>CE</sub> =V <sub>GE</sub>                                                                                                                    |                          | 5.0                                                                                                                                                                        | 6.0  | 7.0  | V    |                   |     |
| I <sub>CES</sub>     | Collector-Emitter Leakage Current    | V <sub>GE</sub> =0V,V <sub>CE</sub> =1200V                                                                                                                              |                          | --                                                                                                                                                                         | --   | 100  | uA   |                   |     |
| I <sub>GES</sub>     | Gate-Emitter Leakage Current         | V <sub>GE</sub> =30V,V <sub>CE</sub> =0V                                                                                                                                |                          | --                                                                                                                                                                         | --   | 200  | nA   |                   |     |
| R <sub>Gint</sub>    | Internal Gate Resistance             | f=1MHz                                                                                                                                                                  |                          | --                                                                                                                                                                         | 0.5  | --   | Ω    |                   |     |
| C <sub>ies</sub>     | Input Capacitance                    | V <sub>CE</sub> =25V,V <sub>GE</sub> =0V,<br>f=1MHz                                                                                                                     |                          | --                                                                                                                                                                         | 7.7  | --   | nF   |                   |     |
| C <sub>oes</sub>     | Out Capacitance                      |                                                                                                                                                                         |                          | --                                                                                                                                                                         | 0.17 | --   | nF   |                   |     |
| C <sub>res</sub>     | Reverse Transfer                     |                                                                                                                                                                         |                          | --                                                                                                                                                                         | 0.04 | --   | nF   |                   |     |
| Q <sub>G</sub>       | Gate Charge                          | V <sub>CE</sub> =600V, I <sub>C</sub> =50A,V <sub>GE</sub> =15V                                                                                                         |                          | --                                                                                                                                                                         | 0.36 | --   | μC   |                   |     |
| t <sub>d(on)</sub>   | Turn–On Delay Time                   | V <sub>CC</sub> = 600 V, I <sub>C</sub> = 75 A,<br>R <sub>Gon</sub> = 10Ω,R <sub>Goff</sub> = 15Ω<br>V <sub>GE</sub> =±15V<br>Inductive Load<br>T <sub>vj</sub> = 25°C  |                          | --                                                                                                                                                                         | 90   | --   | ns   |                   |     |
| t <sub>r</sub>       | Rise Time                            |                                                                                                                                                                         |                          | --                                                                                                                                                                         | 61   | --   |      |                   |     |
| t <sub>d(off)</sub>  | Turn–off Delay Time                  |                                                                                                                                                                         |                          | --                                                                                                                                                                         | 304  | --   |      |                   |     |
| t <sub>f</sub>       | Fall Time                            |                                                                                                                                                                         |                          | --                                                                                                                                                                         | 45   | --   |      |                   |     |
| E <sub>on</sub>      | Turn–On Switching Loss per Pulse     |                                                                                                                                                                         |                          | V <sub>CC</sub> = 600 V, I <sub>C</sub> = 75 A,<br>R <sub>Gon</sub> = 10Ω,R <sub>Goff</sub> = 15Ω<br>V <sub>GE</sub> =±15V<br>Inductive Load<br>T <sub>vj</sub> = 175°C    |      | --   | 4.17 | --                | mJ  |
| E <sub>off</sub>     | Turn Off Switching Loss per Pulse    | --                                                                                                                                                                      | 2.1                      |                                                                                                                                                                            |      | --   |      |                   |     |
| t <sub>d(on)</sub>   | Turn–On Delay Time                   | --                                                                                                                                                                      | TBD                      |                                                                                                                                                                            |      | --   | ns   |                   |     |
| t <sub>r</sub>       | Rise Time                            | --                                                                                                                                                                      | TBD                      |                                                                                                                                                                            |      | --   |      |                   |     |
| t <sub>d(off)</sub>  | Turn–off Delay Time                  | --                                                                                                                                                                      | TBD                      |                                                                                                                                                                            |      | --   |      |                   |     |
| t <sub>f</sub>       | Fall Time                            | --                                                                                                                                                                      | TBD                      | --                                                                                                                                                                         |      |      |      |                   |     |
| E <sub>on</sub>      | Turn–on Switching Loss per Pulse     | V <sub>CC</sub> = 600 V, I <sub>C</sub> = 75 A,<br>R <sub>Gon</sub> = 10Ω,R <sub>Goff</sub> = 15Ω<br>V <sub>GE</sub> =±15V<br>Inductive Load<br>T <sub>vj</sub> = 175°C |                          | --                                                                                                                                                                         | TBD  | --   | mJ   |                   |     |
| E <sub>off</sub>     | Turn Off Switching Loss per Pulse    |                                                                                                                                                                         |                          | --                                                                                                                                                                         | TBD  | --   |      |                   |     |
| I <sub>SC</sub>      | SC Data                              |                                                                                                                                                                         |                          | t <sub>p</sub> ≤10μs,V <sub>GE</sub> ≤15V,<br>T <sub>vj</sub> ≤150°C,V <sub>CC</sub> =800V,<br>V <sub>CEmax</sub> =V <sub>CES</sub> -L <sub>s</sub> C <sub>GE</sub> ·di/dt |      |      | 330  |                   | A   |
| R <sub>thJC</sub>    | Thermal resistance                   |                                                                                                                                                                         |                          | Junction-to-Case (per IGBT)                                                                                                                                                |      |      | 0.42 |                   | K/W |
| T <sub>vj op</sub>   |                                      |                                                                                                                                                                         |                          | Temperature under switching conditions                                                                                                                                     |      | -40  |      | 175 <sup>1)</sup> | °C  |

<sup>1)</sup>T<sub>Vj op</sub> > 150°C is only allowed for operation at overload conditions.

## Diode, Inverter

### Absolute Maximum Ratings (T<sub>c</sub> = 25°C unless otherwise noted)

| Symbol           | Description                                       | Value | Unit |
|------------------|---------------------------------------------------|-------|------|
| V <sub>RRM</sub> | Repetitive Peak Reverse Voltage                   | 1200  | V    |
| I <sub>F</sub>   | Diode Continuous Forward Current                  | 75    | A    |
| I <sub>FM</sub>  | Diode Maximum Forward Current t <sub>p</sub> =1ms | 225   | A    |

### Characteristics (T<sub>c</sub>=25°C unless otherwise noted)

| Symbol             | Parameter                     | Test Condition                                                     | Min | Typ                   | Max               | Unit |
|--------------------|-------------------------------|--------------------------------------------------------------------|-----|-----------------------|-------------------|------|
| V <sub>F</sub>     | Diode Forward Voltage         | I <sub>F</sub> =75A                                                |     | T <sub>J</sub> =25°C  | --                | V    |
|                    |                               |                                                                    |     | T <sub>J</sub> =175°C | --                |      |
| Q <sub>r</sub>     | Recovered Charge              | I <sub>F</sub> =75A, R <sub>g</sub> =25Ω,<br>T <sub>J</sub> =25°C  | --  | 1.24                  | --                | μC   |
| I <sub>RM</sub>    | Peak Reverse Recovery Current |                                                                    | --  | 27                    | --                | A    |
| T <sub>rr</sub>    | Reverse Recovery Time         |                                                                    | --  | 175                   | --                | ns   |
| E <sub>rec</sub>   | Reverse Recovery Energy       |                                                                    | --  | 1.23                  | --                | mJ   |
| Q <sub>r</sub>     | Recovered Charge              | I <sub>F</sub> =75A, R <sub>g</sub> =25Ω,<br>T <sub>J</sub> =175°C | --  | TBD                   | --                | μC   |
| I <sub>RM</sub>    | Peak Reverse Recovery Current |                                                                    | --  | TBD                   | --                | A    |
| T <sub>rr</sub>    | Reverse Recovery Time         |                                                                    | --  | TBD                   | --                | ns   |
| E <sub>rec</sub>   | Reverse Recovery Energy       |                                                                    | --  | TBD                   | --                | mJ   |
| R <sub>thJC</sub>  | Thermal resistance            | Junction-to-Case (per diode)                                       |     | 0.65                  |                   | K/W  |
| T <sub>vj op</sub> |                               | Temperature under switching conditions                             | -40 |                       | 175 <sup>2)</sup> | °C   |

<sup>2)</sup>T<sub>vj op</sub> > 150°C is only allowed for operation at overload conditions.

## Diode, Rectifier

### Absolute Maximum Ratings (T<sub>c</sub> = 25°C unless otherwise noted)

| Symbol           | Description                                       | Value | Unit |
|------------------|---------------------------------------------------|-------|------|
| V <sub>RRM</sub> | Repetitive Peak Reverse Voltage                   | 1600  | V    |
| I <sub>F</sub>   | Diode Continuous Forward Current                  | 75    | A    |
| I <sub>FM</sub>  | Diode Maximum Forward Current t <sub>p</sub> =1ms | 150   | A    |

### Characteristics (T<sub>c</sub>=25°C unless otherwise noted)

| Symbol             | Parameter             | Test Condition                                | Min | Typ  | Max               | Unit |
|--------------------|-----------------------|-----------------------------------------------|-----|------|-------------------|------|
| V <sub>F</sub>     | Diode Forward Voltage | I <sub>F</sub> = 75A, T <sub>J</sub> = 150 °C |     | 0.9  |                   | V    |
| I <sub>R</sub>     | Reverse Current       | T <sub>J</sub> =175 °C, V <sub>R</sub> =1600V |     | 1.0  |                   | mA   |
| R <sub>thJC</sub>  | Thermal resistance    | Junction-to-Case (per diode)                  |     | 0.35 |                   | K/W  |
| T <sub>vj op</sub> |                       | Temperature under switching conditions        | -40 |      | 175 <sup>3)</sup> | °C   |

<sup>3)</sup>T<sub>vj op</sub> > 150°C is only allowed for operation at overload conditions.

## IGBT, Chopper

### Absolute Maximum Ratings (T<sub>C</sub> = 25°C unless otherwise noted)

| Symbol           | Description                                  | Value | Unit |
|------------------|----------------------------------------------|-------|------|
| V <sub>CES</sub> | Collector-Emitter Voltage                    | 1200  | V    |
| V <sub>GES</sub> | Gate-Emitter Voltage                         | ±30   | V    |
| I <sub>C</sub>   | Collector Current @ T <sub>C</sub> =25°C     | 100   | A    |
|                  | Collector Current @ T <sub>C</sub> =80°C     | 50    | A    |
| I <sub>CM</sub>  | Pulsed Collector Current, t <sub>p</sub> =1S | 150   | A    |

### Characteristics (T<sub>C</sub> = 25°C unless otherwise noted)

| Symbol               | Parameter                            | Test Condition                                                                                                                 |                          | Min  | Typ   | Max               | Unit |
|----------------------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------------|------|-------|-------------------|------|
| V <sub>CE(sat)</sub> | Collector–Emitter Saturation Voltage | I <sub>C</sub> =50A, V <sub>GE</sub> =15V                                                                                      | T <sub>vj</sub> =25°C    | --   | 1.55  | 2.20              | V    |
|                      |                                      |                                                                                                                                | T <sub>vj</sub> = 175 °C | --   | 1.80  | --                |      |
| V <sub>GE(th)</sub>  | Gate Threshold Voltage               | I <sub>C</sub> =1mA, V <sub>CE</sub> =V <sub>GE</sub>                                                                          |                          | 5.5  | --    | 7.0               | V    |
| I <sub>CES</sub>     | Collector-Emitter Leakage Current    | V <sub>GE</sub> =0V, V <sub>CE</sub> =1200V                                                                                    |                          | --   | --    | 30                | uA   |
| I <sub>GES</sub>     | Gate-Emitter Leakage Current         | V <sub>GE</sub> =30V, V <sub>CE</sub> =0V                                                                                      |                          | --   | --    | 100               | nA   |
| R <sub>Gint</sub>    | Internal Gate Resistance             | f=1MHz                                                                                                                         |                          | --   | 0.6   | --                | Ω    |
| C <sub>ies</sub>     | Input Capacitance                    | V <sub>CE</sub> =25V, V <sub>GE</sub> =0V, f=1MHz                                                                              |                          | 4690 | 5632  | 6566              | nF   |
| C <sub>oes</sub>     | Out Capacitance                      |                                                                                                                                |                          | --   | 143.3 | --                | nF   |
| C <sub>res</sub>     | Reverse Transfer                     |                                                                                                                                |                          | --   | 32.1  | --                | nF   |
| Q <sub>G</sub>       | Gate Charge                          | V <sub>CE</sub> =960V, I <sub>C</sub> =50A, V <sub>GE</sub> =15V                                                               |                          | --   | 196   | --                | μC   |
| t <sub>d(on)</sub>   | Turn-On Delay Time                   | V <sub>CE</sub> =600V, I <sub>C</sub> =50A, V <sub>GE</sub> =0/15V, R <sub>g</sub> =25Ω, Inductive Load                        |                          | --   | 95    | --                | ns   |
| t <sub>r</sub>       | Rise Time                            |                                                                                                                                |                          | --   | 71    | --                |      |
| t <sub>d(off)</sub>  | Turn-off Delay Time                  |                                                                                                                                |                          | --   | 349   | --                |      |
| t <sub>f</sub>       | Fall Time                            |                                                                                                                                |                          | --   | 88    | --                |      |
| E <sub>on</sub>      | Turn-On Switching Loss per Pulse     |                                                                                                                                |                          | --   | 3.13  | --                | mJ   |
| E <sub>off</sub>     | Turn Off Switching Loss per Pulse    |                                                                                                                                |                          | --   | 1.92  | --                |      |
| t <sub>d(on)</sub>   | Turn-On Delay Time                   | V <sub>CE</sub> =600V, I <sub>C</sub> =50A, V <sub>GE</sub> =0/15V, R <sub>g</sub> =25Ω, Inductive Load, T <sub>j</sub> =175°C |                          | --   | TBD   | --                | ns   |
| t <sub>r</sub>       | Rise Time                            |                                                                                                                                |                          | --   | TBD   | --                |      |
| t <sub>d(off)</sub>  | Turn-off Delay Time                  |                                                                                                                                |                          | --   | TBD   | --                |      |
| t <sub>f</sub>       | Fall Time                            |                                                                                                                                |                          | --   | TBD   | --                |      |
| E <sub>on</sub>      | Turn-on Switching Loss per Pulse     |                                                                                                                                |                          | --   | 4.87  | --                | mJ   |
| E <sub>off</sub>     | Turn Off Switching Loss per Pulse    |                                                                                                                                |                          | --   | 2.68  | --                |      |
| I <sub>SC</sub>      | SC Data                              | V <sub>GE</sub> =15V, V <sub>CC</sub> ≤600V, t <sub>sc</sub> ≤10us, T <sub>j</sub> ≤150°C                                      |                          | --   | 220   | --                | A    |
| R <sub>thJC</sub>    | Thermal resistance                   | Junction-to-Case (per IGBT)                                                                                                    |                          | --   | 0.59  | --                | K/W  |
| T <sub>vj op</sub>   |                                      | Temperature under switching conditions                                                                                         |                          | -40  |       | 175 <sup>4)</sup> | °C   |

<sup>4)</sup>T<sub>Vj op</sub> > 150°C is only allowed for operation at overload conditions.

## Diode, Chopper

### Absolute Maximum Ratings (T<sub>C</sub> = 25°C unless otherwise noted)

| Symbol           | Description                                       | Value | Unit |
|------------------|---------------------------------------------------|-------|------|
| V <sub>RRM</sub> | Repetitive Peak Reverse Voltage                   | 1200  | V    |
| I <sub>F</sub>   | Diode Continuous Forward Current                  | 25    | A    |
| I <sub>FM</sub>  | Diode Maximum Forward Current t <sub>p</sub> =1ms | 50    | A    |

## Characteristics (T<sub>c</sub>=25°C unless otherwise noted)

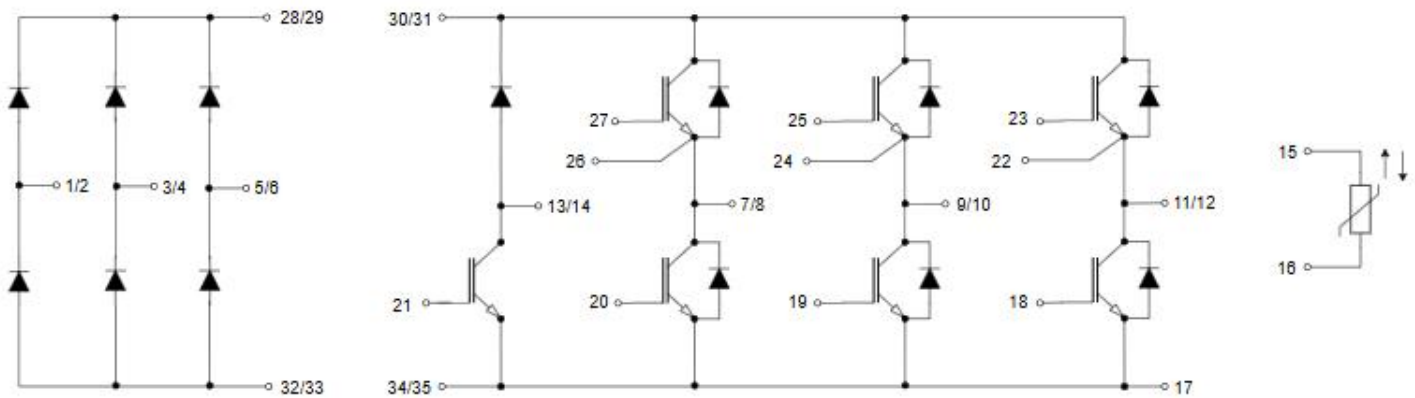
| Symbol             | Parameter                     | Test Condition                                                      |                        | Min | Typ  | Max               | Unit |
|--------------------|-------------------------------|---------------------------------------------------------------------|------------------------|-----|------|-------------------|------|
| V <sub>F</sub>     | Diode Forward Voltage         | I <sub>F</sub> =25A                                                 | T <sub>vj</sub> =25°C  | --  | 1.70 | 2.50              | V    |
|                    |                               |                                                                     | T <sub>vj</sub> =175°C | --  | 1.65 | --                |      |
| Q <sub>r</sub>     | Recovered Charge              | I <sub>F</sub> =25A, R <sub>g</sub> =25Ω,<br>T <sub>vj</sub> =25°C  |                        | --  | 0.47 | --                | μC   |
| I <sub>RM</sub>    | Peak Reverse Recovery Current |                                                                     |                        | --  | 18.2 | --                | A    |
| T <sub>rr</sub>    | Reverse Recovery Time         |                                                                     |                        | --  | 58   | --                | ns   |
| E <sub>rec</sub>   | Reverse Recovery Energy       |                                                                     |                        | --  | 0.19 | --                | mJ   |
| Q <sub>r</sub>     | Recovered Charge              | I <sub>F</sub> =25A, R <sub>g</sub> =25Ω,<br>T <sub>vj</sub> =175°C |                        | --  | TBD  | --                | μC   |
| I <sub>RM</sub>    | Peak Reverse Recovery Current |                                                                     |                        | --  | TBD  | --                | A    |
| T <sub>rr</sub>    | Reverse Recovery Time         |                                                                     |                        | --  | TBD  | --                | ns   |
| E <sub>rec</sub>   | Reverse Recovery Energy       |                                                                     |                        | --  | TBD  | --                | mJ   |
| R <sub>thJC</sub>  | Thermal resistance            | Junction-to-Case (per diode)                                        |                        | --  | 0.9  | --                | K/W  |
| T <sub>vj op</sub> |                               | Temperature under switching conditions                              |                        | -40 |      | 175 <sup>5)</sup> | °C   |

<sup>5)</sup>T<sub>vj op</sub> > 150°C is only allowed for operation at overload conditions.

## NTC Characteristics (T<sub>c</sub> = 25°C unless otherwise noted)

| Symbol              | Parameter         | Test Condition                                       | Min | Typ  | Max  | Unit |
|---------------------|-------------------|------------------------------------------------------|-----|------|------|------|
| R <sub>25</sub>     | Rated Resistance  |                                                      | --  | 5.0  | --   | kΩ   |
| ΔR/R                | Deviation of R100 | T <sub>c</sub> =100 °C, R <sub>100</sub> =493.3Ω     | -5  | --   | 5    | %    |
| P <sub>25</sub>     | Power Dissipation |                                                      | --  | --   | 20.0 | mW   |
| B <sub>25/50</sub>  | B-value           | $R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298.15K))]$  | --  | 3375 | --   | K    |
| B <sub>25/80</sub>  | B-value           | $R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298.15K))]$  | --  | 3411 | --   | K    |
| B <sub>25/100</sub> | B-value           | $R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298.15K))]$ | --  | 3433 | --   | K    |

## CIRCUIT DIAGRAM



## PACKAGE DIMENSION

