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Bulletin I27503 08/97

# International **IOR** Rectifier

## MT..KB SERIES

### THREE PHASE CONTROLLED BRIDGE

### Power Modules

#### Features

- Package fully compatible with the industry standard INT-A-pak power modules series
- High thermal conductivity package, electrically insulated case
- Outstanding number of power encapsulated components
- Excellent power volume ratio
- 4000 V<sub>RMS</sub> isolating voltage
- UL E78996 approved 

55 A  
90 A  
110 A

#### Description

A range of extremely compact, encapsulated three phase controlled bridge rectifiers offering efficient and reliable operation. They are intended for use in general purpose and heavy duty applications.

#### Major Ratings and Characteristics

| Parameters                         | 53MT.KB<br>52MT.KB<br>51MT.KB | 93MT.KB<br>92MT.KB<br>91MT.KB | 113MT.KB<br>112MT.KB<br>111MT.KB | Units             |
|------------------------------------|-------------------------------|-------------------------------|----------------------------------|-------------------|
| I <sub>O</sub>                     | 55                            | 90                            | 110                              | A                 |
| @ T <sub>C</sub>                   | 85                            | 85                            | 85                               | °C                |
| I <sub>FSM</sub> @ 50Hz            | 390                           | 950                           | 1130                             | A                 |
| @ 60Hz                             | 410                           | 1000                          | 1180                             | A                 |
| I <sup>2</sup> <sub>t</sub> @ 50Hz | 770                           | 4525                          | 6380                             | A <sup>2</sup> s  |
| @ 60Hz                             | 700                           | 4130                          | 5830                             | A <sup>2</sup> s  |
| I <sup>2</sup> √t                  | 7700                          | 45250                         | 63800                            | A <sup>2</sup> √s |
| V <sub>RRM</sub> range             | 800 to 1600                   |                               |                                  | V                 |
| T <sub>STG</sub> range             | -40 to 125                    |                               |                                  | °C                |
| T <sub>J</sub> range               | -40 to 125                    |                               |                                  | °C                |

## 53-93-113MT.KB Series

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### ELECTRICAL SPECIFICATIONS

#### Voltage Ratings

| Type number                         | Voltage Code | $V_{RRM}$ , maximum repetitive peak reverse voltage<br>V | $V_{RSM}$ , maximum non-repetitive peak reverse voltage<br>V | $V_{DRM}$ , max. repetitive peak off-state voltage gate open circuit<br>V | $I_{RRM}/I_{DRM}$ max.<br>@ $T_J = 125^\circ\text{C}$<br>mA |
|-------------------------------------|--------------|----------------------------------------------------------|--------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------|
| 53/52/51MT..KB                      | 80           | 800                                                      | 900                                                          | 800                                                                       | 10                                                          |
|                                     | 100          | 1000                                                     | 1100                                                         | 1000                                                                      |                                                             |
|                                     | 120          | 1200                                                     | 1300                                                         | 1200                                                                      |                                                             |
|                                     | 140          | 1400                                                     | 1500                                                         | 1400                                                                      |                                                             |
|                                     | 160          | 1600                                                     | 1700                                                         | 1600                                                                      |                                                             |
| 93/92/91MT..KB<br>113/112/111MT..KB | 80           | 800                                                      | 900                                                          | 800                                                                       | 20                                                          |
|                                     | 100          | 1000                                                     | 1100                                                         | 1000                                                                      |                                                             |
|                                     | 120          | 1200                                                     | 1300                                                         | 1200                                                                      |                                                             |
|                                     | 140          | 1400                                                     | 1500                                                         | 1400                                                                      |                                                             |
|                                     | 160          | 1600                                                     | 1700                                                         | 1600                                                                      |                                                             |

#### Forward Conduction

| Parameter           |                                                                              | 53MT.KB<br>52MT.KB<br>51MT.KB | 93MT.KB<br>92MT.KB<br>91MT.KB | 113MT.KB<br>112MT.KB<br>111MT.KB | Units             | Conditions                                                                                                                                                             |                       |                                                 |                                      |
|---------------------|------------------------------------------------------------------------------|-------------------------------|-------------------------------|----------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------|--------------------------------------|
| I <sub>O</sub>      | Maximum DC output current<br>@ Case temperature                              | 55                            | 90                            | 110                              | A                 | 120° Rect conduction angle                                                                                                                                             |                       |                                                 |                                      |
|                     |                                                                              | 85                            | 85                            | 85                               | °C                |                                                                                                                                                                        |                       |                                                 |                                      |
| I <sub>TSM</sub>    | Maximum peak, one-cycle<br>forward, non-repetitive<br>on state surge current | 390                           | 950                           | 1130                             | A                 | t = 10ms                                                                                                                                                               | No voltage            | Initial<br>T <sub>J</sub> = T <sub>J</sub> max. |                                      |
|                     |                                                                              | 410                           | 1000                          | 1180                             |                   | t = 8.3ms                                                                                                                                                              | reapplied             |                                                 |                                      |
|                     |                                                                              | 330                           | 800                           | 950                              |                   | t = 10ms                                                                                                                                                               | 100% V <sub>RRM</sub> |                                                 |                                      |
|                     |                                                                              | 345                           | 840                           | 1000                             |                   | t = 8.3ms                                                                                                                                                              | reapplied             |                                                 |                                      |
| I <sup>2</sup> t    | Maximum I <sup>2</sup> t for fusing                                          | 770                           | 4525                          | 6380                             | A <sup>2</sup> s  | t = 10ms                                                                                                                                                               | No voltage            |                                                 | T <sub>J</sub> = T <sub>J</sub> max. |
|                     |                                                                              | 700                           | 4130                          | 5830                             |                   | t = 8.3ms                                                                                                                                                              | reapplied             |                                                 |                                      |
|                     |                                                                              | 540                           | 3200                          | 4510                             |                   | t = 10ms                                                                                                                                                               | 100% V <sub>RRM</sub> |                                                 |                                      |
|                     |                                                                              | 500                           | 2920                          | 4120                             |                   | t = 8.3ms                                                                                                                                                              | reapplied             |                                                 |                                      |
| I <sup>2</sup> √t   | Maximum I <sup>2</sup> √t for fusing                                         | 7700                          | 45250                         | 63800                            | A <sup>2</sup> √s | t = 0.1 to 10ms, no voltage reapplied                                                                                                                                  |                       |                                                 |                                      |
| V <sub>T(TO)1</sub> | Low level value of threshold<br>voltage                                      | 1.17                          | 1.09                          | 1.04                             | V                 | (16.7% × π × I <sub>T(AV)</sub> ) < I < π × I <sub>T(AV)</sub> , @ T <sub>J</sub> max.                                                                                 |                       |                                                 |                                      |
| V <sub>T(TO)2</sub> | High level value of threshold<br>voltage                                     | 1.45                          | 1.27                          | 1.27                             |                   | (I > π × I <sub>T(AV)</sub> ), @ T <sub>J</sub> max.                                                                                                                   |                       |                                                 |                                      |
| r <sub>t1</sub>     | Low level value on-state<br>slope resistance                                 | 12.40                         | 4.10                          | 3.93                             | mΩ                | (16.7% × π × I <sub>T(AV)</sub> ) < I < π × I <sub>T(AV)</sub> , @ T <sub>J</sub> max.                                                                                 |                       |                                                 |                                      |
| r <sub>t2</sub>     | High level value on-state<br>slope resistance                                | 11.04                         | 3.59                          | 3.37                             |                   | (I > π × I <sub>T(AV)</sub> ), @ T <sub>J</sub> max.                                                                                                                   |                       |                                                 |                                      |
| V <sub>TM</sub>     | Maximum on-state voltage drop                                                | 2.68                          | 1.65                          | 1.57                             | V                 | I <sub>pk</sub> = 150A, T <sub>J</sub> = 25°C<br>t <sub>p</sub> = 400μs single junction                                                                                |                       |                                                 |                                      |
| di/dt               | Max. non-repetitive rate<br>of rise of turned on current                     | 150                           |                               |                                  | A/μs              | T <sub>J</sub> = 25°C, from 0.67 V <sub>DRM</sub> , I <sub>TM</sub> = π × I <sub>T(AV)</sub><br>I <sub>g</sub> = 500mA, t <sub>r</sub> < 0.5 μs, t <sub>p</sub> > 6 μs |                       |                                                 |                                      |
| I <sub>H</sub>      | Max. holding current                                                         | 200                           |                               |                                  | mA                | T <sub>J</sub> = 25°C, anode supply = 6V,<br>resistive load, gate open circuit                                                                                         |                       |                                                 |                                      |
| I <sub>L</sub>      | Max. latching current                                                        | 400                           |                               |                                  |                   | T <sub>J</sub> = 25°C, anode supply = 6V, resistive load                                                                                                               |                       |                                                 |                                      |

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## 53-93-113MT..KB Series

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### Blocking

| Parameter                                                   | 53MT.KB<br>52MT.KB<br>51MT.KB | 93MT.KB<br>92MT.KB<br>91MT.KB | 113MT.KB<br>112MT.KB<br>111MT.KB | Units            | Conditions                                                                           |
|-------------------------------------------------------------|-------------------------------|-------------------------------|----------------------------------|------------------|--------------------------------------------------------------------------------------|
| $V_{INS}$ RMS isolation voltage                             | 4000                          |                               |                                  | V                | $T_J = 25^\circ\text{C}$ all terminal shorted<br>$f = 50\text{Hz}$ , $t = 1\text{s}$ |
| $dv/dt$ Max. critical rate of rise of off-state voltage (*) | 500                           |                               |                                  | V/ $\mu\text{s}$ | $T_J = T_J \text{ max.}$ , linear to $0.67 V_{DRM}$ ,<br>gate open circuit           |

(\*) Available with  $dv/dt = 1000\text{V/ms}$ , to complete code add S90 i.e. 113MT160KBS90.

### Triggering

| Parameter                                         | 53MT.KB<br>52MT.KB<br>51MT.KB | 93MT.KB<br>92MT.KB<br>91MT.KB | 113MT.KB<br>112MT.KB<br>111MT.KB | Units | Conditions                                           |                                   |
|---------------------------------------------------|-------------------------------|-------------------------------|----------------------------------|-------|------------------------------------------------------|-----------------------------------|
| $P_{GM}$ Max. peak gate power                     | 10                            |                               |                                  | W     | $T_J = T_J \text{ max.}$                             |                                   |
| $P_{G(AV)}$ Max. average gate power               | 2.5                           |                               |                                  |       |                                                      |                                   |
| $I_{GM}$ Max. peak gate current                   | 2.5                           |                               |                                  | A     |                                                      |                                   |
| $-V_{GT}$ Max. peak negative gate voltage         | 10                            |                               |                                  | V     |                                                      |                                   |
| $V_{GT}$ Max. required DC gate voltage to trigger | 4.0                           |                               |                                  | V     | $T_J = -40^{\circ}\text{C}$                          | Anode supply = 6V, resistive load |
|                                                   | 2.5                           |                               |                                  |       | $T_J = 25^{\circ}\text{C}$                           |                                   |
|                                                   | 1.7                           |                               |                                  |       | $T_J = 125^{\circ}\text{C}$                          |                                   |
| $I_{GT}$ Max. required DC gate current to trigger | 270                           |                               |                                  | mA    | $T_J = -40^{\circ}\text{C}$                          | Anode supply = 6V, resistive load |
|                                                   | 150                           |                               |                                  |       | $T_J = 25^{\circ}\text{C}$                           |                                   |
|                                                   | 80                            |                               |                                  |       | $T_J = 125^{\circ}\text{C}$                          |                                   |
| $V_{GD}$ Max. gate voltage that will not trigger  | 0.25                          |                               |                                  | V     | @ $T_J = T_J \text{ max.}$ , rated $V_{DRM}$ applied |                                   |
| $I_{GD}$ Max. gate current that will not trigger  | 6                             |                               |                                  | mA    |                                                      |                                   |

### Thermal and Mechanical Specifications

| Parameter         |                                           | 53MT.KB<br>52MT.KB<br>51MT.KB | 93MT.KB<br>92MT.KB<br>91MT.KB | 113MT.KB<br>112MT.KB<br>111MT.KB | Units | Conditions                                                                                                                                                   |
|-------------------|-------------------------------------------|-------------------------------|-------------------------------|----------------------------------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| T <sub>j</sub>    | Max. junction operating temperature range | -40 to 125                    |                               |                                  | °C    |                                                                                                                                                              |
| T <sub>stg</sub>  | Max. storage temperature range            | -40 to 125                    |                               |                                  | °C    |                                                                                                                                                              |
| R <sub>thJC</sub> | Max. thermal resistance, junction to case | 0.18                          | 0.14                          | 0.12                             | K/W   | DC operation per module                                                                                                                                      |
|                   |                                           | 1.07                          | 0.86                          | 0.70                             |       | DC operation per junction                                                                                                                                    |
|                   |                                           | 0.19                          | 0.15                          | 0.12                             |       | 120° Rect conduction angle per module                                                                                                                        |
|                   |                                           | 1.17                          | 0.91                          | 0.74                             |       | 120° Rect conduction angle per junction                                                                                                                      |
| R <sub>thCS</sub> | Max. thermal resistance, case to heatsink | 0.03                          |                               |                                  | K/W   | Per module<br>Mounting surface smooth, flat an greased                                                                                                       |
| T                 | Mounting torque ± 10%                     | 4 to 6                        |                               |                                  | Nm    | A mounting compound is recommended and the torque should be rechecked after a period of 3 hours to allow for the spread of the compound. Lubricated threads. |
|                   | to heatsink<br>to terminal                | 3 to 4                        |                               |                                  |       |                                                                                                                                                              |
| wt                | Approximate weight                        | 225                           |                               |                                  | g     |                                                                                                                                                              |

## 53-93-113MT.KB Series

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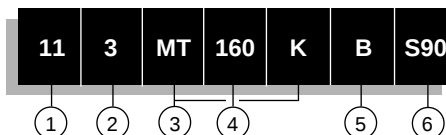
### $\Delta R$ Conduction (per Junction)

(The following table shows the increment of thermal resistance  $R_{thJC}$  when devices operate at different conduction angles than DC)

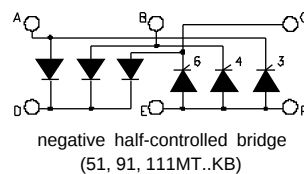
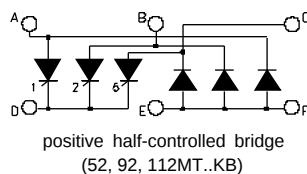
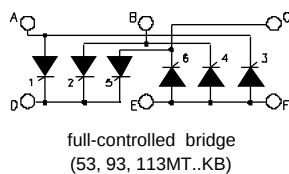
| Devices          | Sinusoidal conduction @ $T_j$ max. |       |       |       |       | Rectangular conduction @ $T_j$ max. |       |       |       |       | Units |
|------------------|------------------------------------|-------|-------|-------|-------|-------------------------------------|-------|-------|-------|-------|-------|
|                  | 180°                               | 120°  | 90°   | 60°   | 30°   | 180°                                | 120°  | 90°   | 60°   | 30°   |       |
| 53/52/51MT.KB    | 0.072                              | 0.085 | 0.108 | 0.152 | 0.233 | 0.055                               | 0.091 | 0.117 | 0.157 | 0.236 | K/W   |
| 93/92/91MT.KB    | 0.033                              | 0.039 | 0.051 | 0.069 | 0.099 | 0.027                               | 0.044 | 0.055 | 0.071 | 0.100 |       |
| 113/112/111MT.KB | 0.027                              | 0.033 | 0.042 | 0.057 | 0.081 | 0.023                               | 0.037 | 0.046 | 0.059 | 0.082 |       |

### Ordering Information Table

#### Device Code



- 1** - Current rating code: 5 = 55 A (Avg)  
9 = 90 A (Avg)  
11 = 110 A (Avg)
- 2** - Circuit configuration code: 3 = Full-controlled bridge  
2 = Positive half-controlled bridge  
1 = Negative half-controlled bridge
- 3** - Essential part number
- 4** - Voltage code: Code x 10 =  $V_{RRM}$  (See Voltage Ratings Table)
- 5** - Generation II
- 6** - Critical dv/dt: None = 500V/ $\mu$ s (Standard value)  
S90 = 1000V/ $\mu$ s (Special selection)



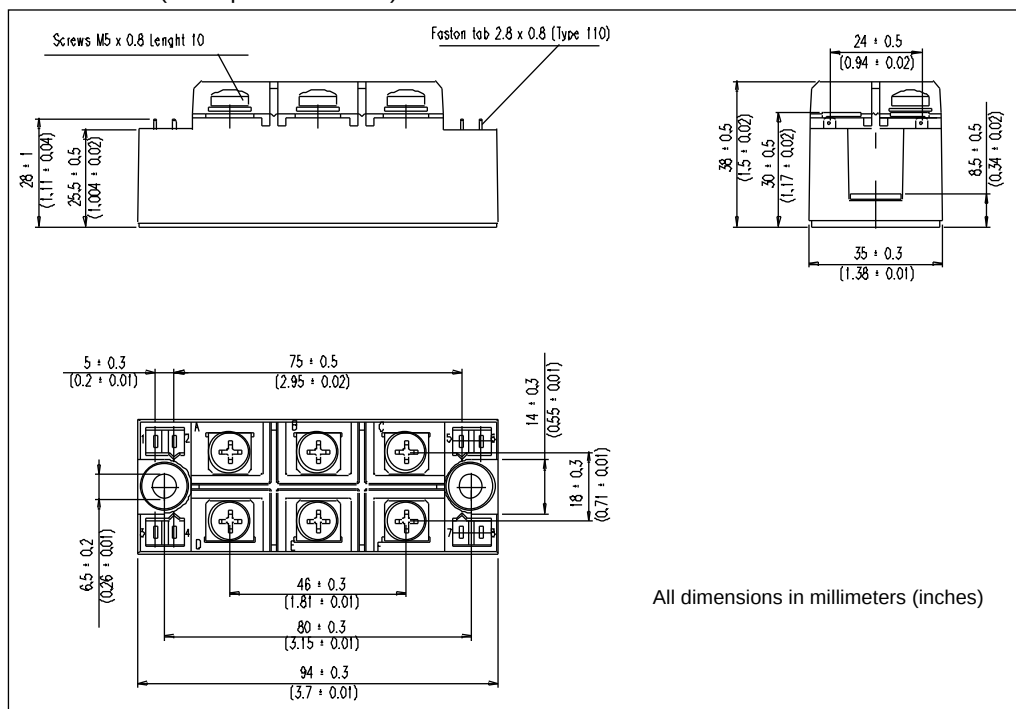
**NOTE: To order the Optional Hardware see Bulletin I27900**

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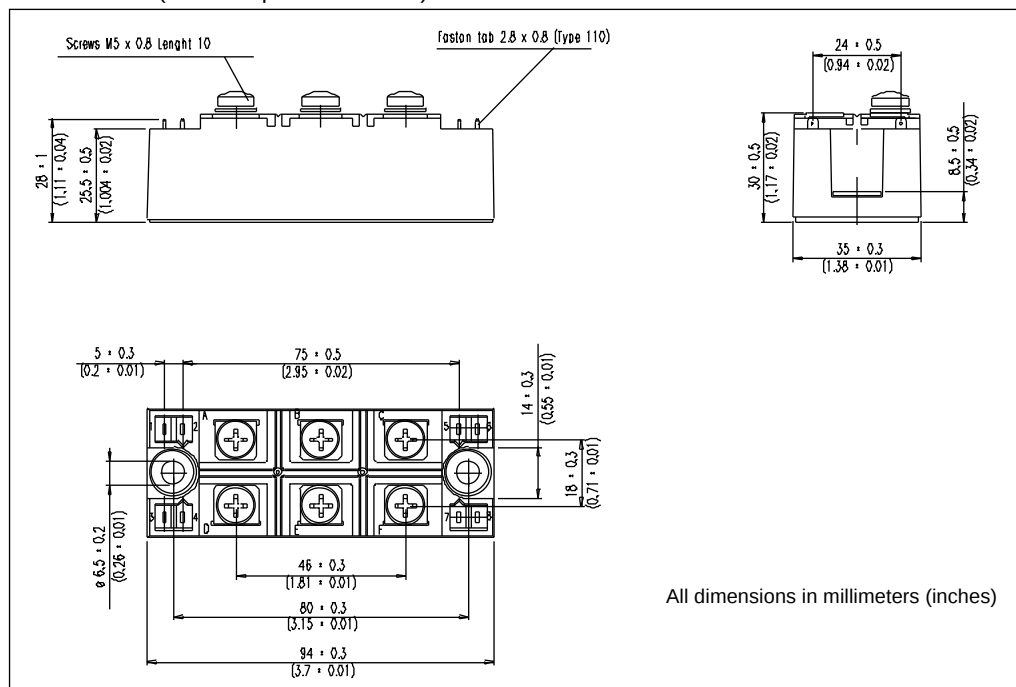
**53-93-113MT..KB Series**

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Outline Table (with optional barriers)



Outline Table (without optional barriers)



## 53-93-113MT..KB Series

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**IR** Rectifier

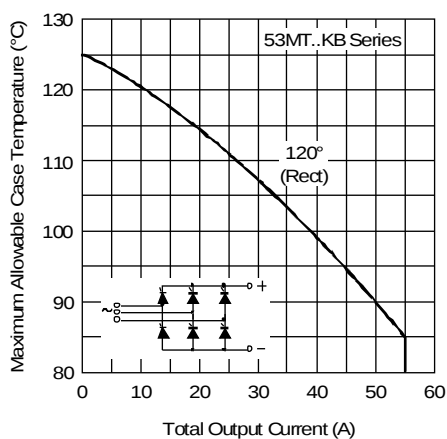


Fig. 1 - Current Ratings Characteristic

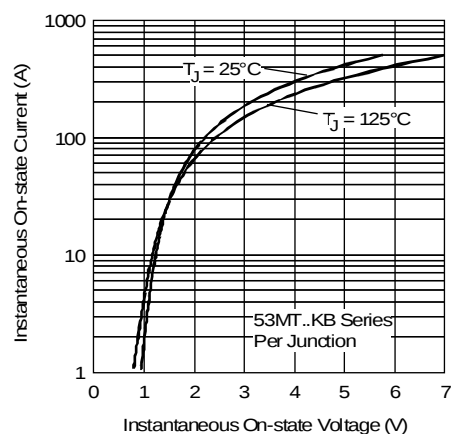


Fig. 2 - Forward Voltage Drop Characteristics

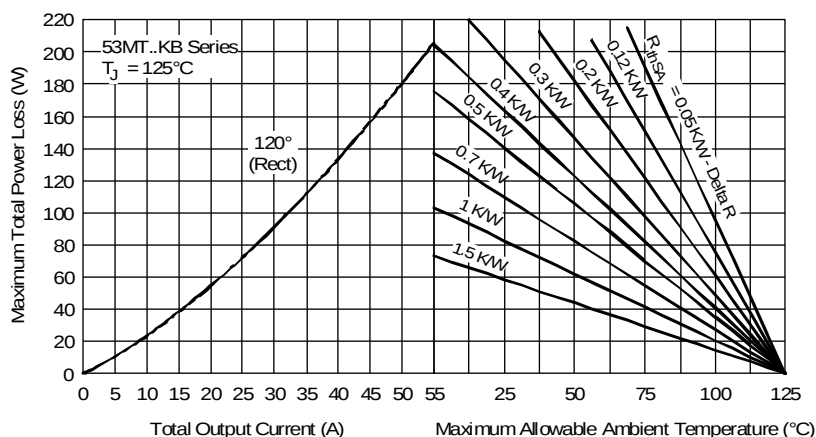


Fig. 3 - Total Power Loss Characteristics

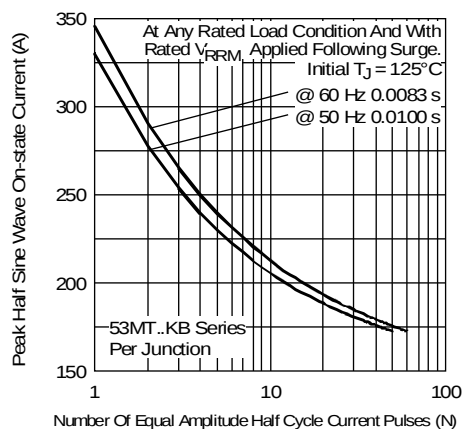


Fig. 4 - Maximum Non-Repetitive Surge Current

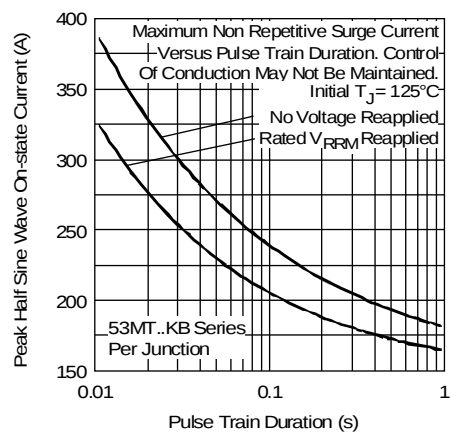


Fig. 5 - Maximum Non-Repetitive Surge Current

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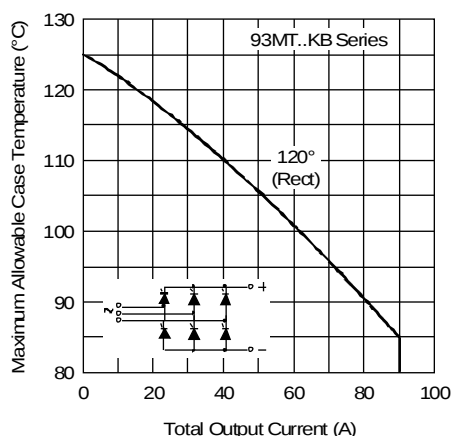


Fig. 6 - Current Ratings Characteristic

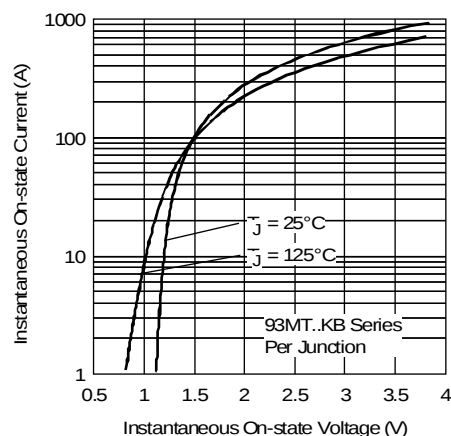


Fig. 7 - Forward Voltage Drop Characteristics

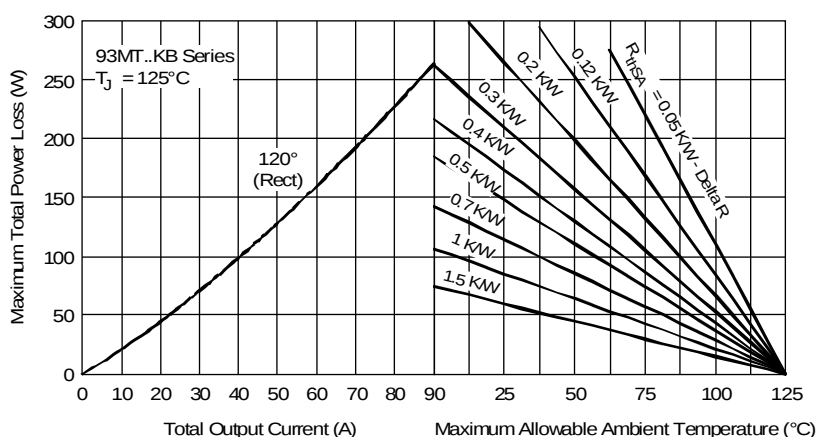


Fig. 8 - Total Power Loss Characteristics

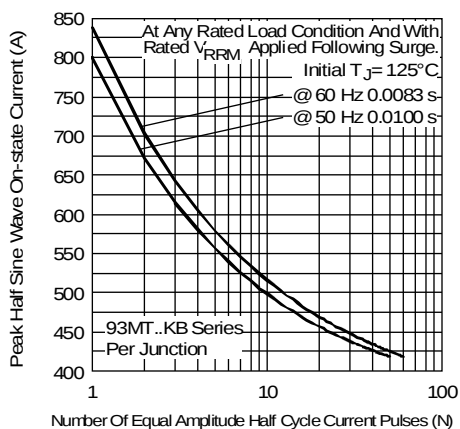


Fig. 9 - Maximum Non-Repetitive Surge Current

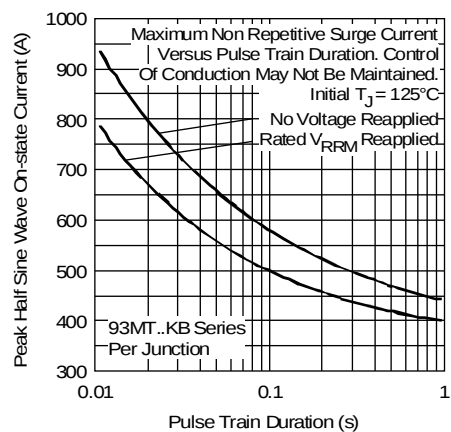


Fig. 10 - Maximum Non-Repetitive Surge Current

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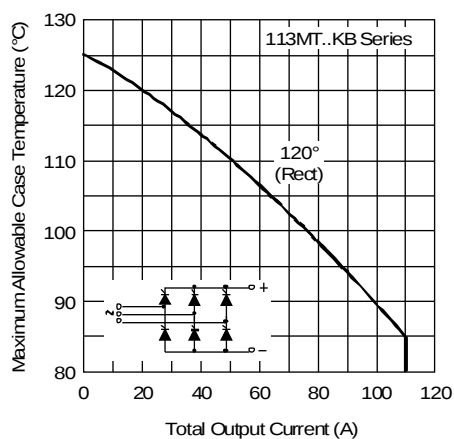


Fig. 11 - Current Ratings Characteristic

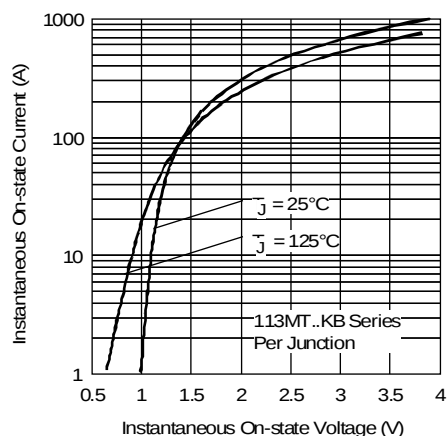


Fig. 12 - Forward Voltage Drop Characteristics

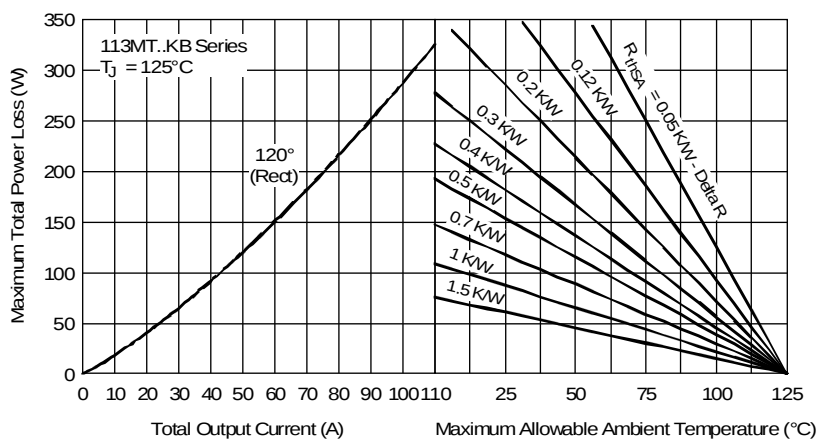


Fig. 13 - Total Power Loss Characteristics

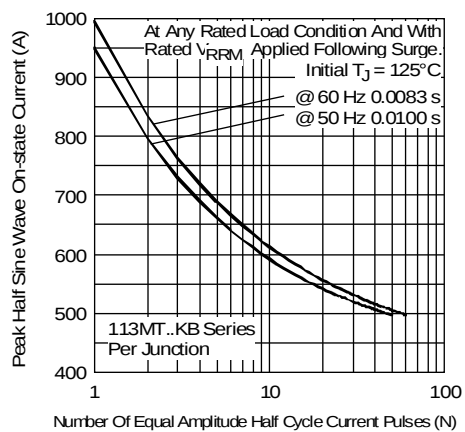


Fig. 14 - Maximum Non-Repetitive Surge Current

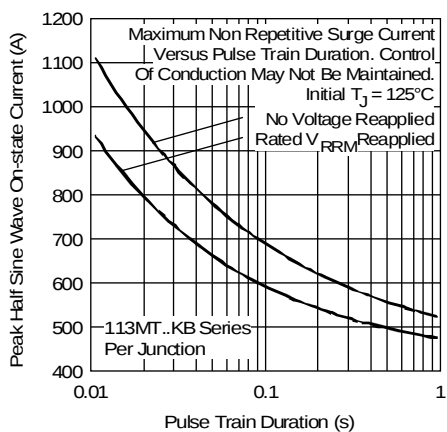


Fig. 15 - Maximum Non-Repetitive Surge Current

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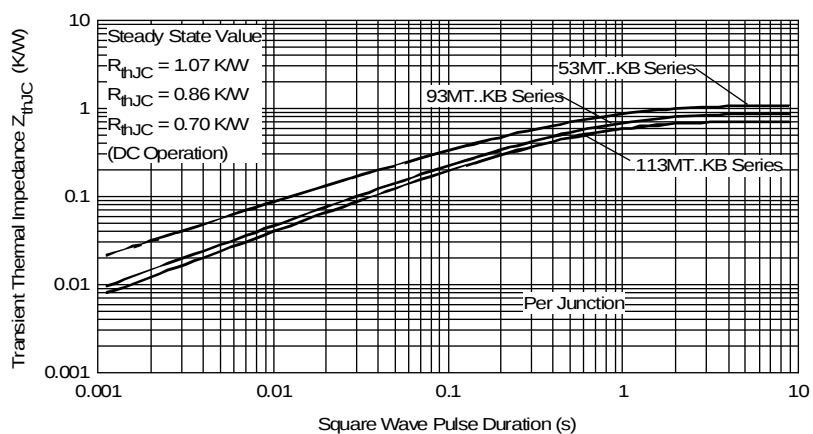


Fig. 16 - Thermal Impedance  $Z_{thJC}$  Characteristics

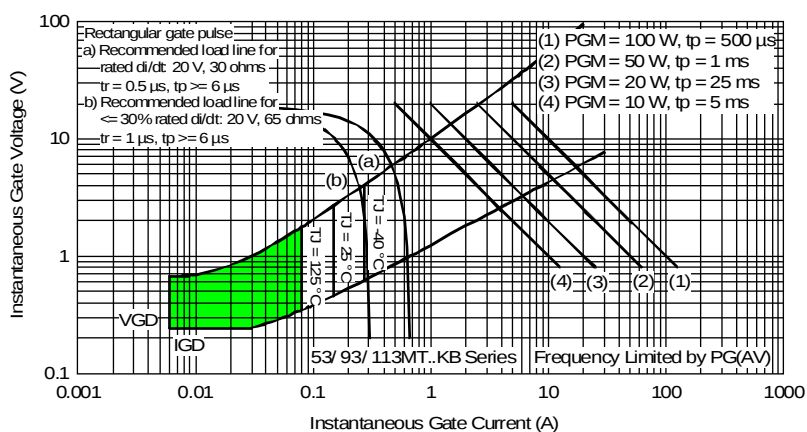


Fig. 17 - Gate Characteristics