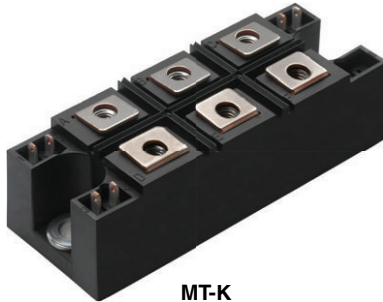




## Three Phase Controlled Bridge (Power Modules), 55 A to 110 A



MT-K

### FEATURES

- Package fully compatible with the industry standard INT-A-PAK power modules series
- High thermal conductivity package, electrically insulated case
- Excellent power volume ratio
- 4000 V<sub>RMS</sub> isolating voltage
- UL E78996 approved 
- Designed and qualified for industrial level
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)


RoHS  
COMPLIANT

### PRODUCT SUMMARY

|                  |                    |
|------------------|--------------------|
| I <sub>O</sub>   | 55 A to 110 A      |
| V <sub>RRM</sub> | 800 V to 1600 V    |
| Package          | MT-K               |
| Circuit          | Three phase bridge |

### 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

| SYMBOL            | CHARACTERISTICS | VALUES<br>5.MT...K | VALUES<br>9.MT...K | VALUES<br>11.MT...K | UNITS             |
|-------------------|-----------------|--------------------|--------------------|---------------------|-------------------|
| I <sub>O</sub>    |                 | 55                 | 90                 | 110                 | A                 |
|                   | T <sub>C</sub>  | 85                 | 85                 | 85                  | °C                |
| I <sub>FSM</sub>  | 50 Hz           | 390                | 950                | 1130                | A                 |
|                   | 60 Hz           | 410                | 1000               | 1180                |                   |
| I <sup>2</sup> t  | 50 Hz           | 770                | 4525               | 6380                | A <sup>2</sup> s  |
|                   | 60 Hz           | 700                | 4130               | 5830                |                   |
| I <sup>2</sup> √t |                 | 7700               | 45 250             | 63 800              | 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                |

### ELECTRICAL SPECIFICATIONS

#### VOLTAGE RATINGS

| TYPE<br>NUMBER              | VOLTAGE<br>CODE | V <sub>RRM</sub> , MAXIMUM<br>REPETITIVE PEAK<br>REVERSE VOLTAGE<br>V | V <sub>RSM</sub> , MAXIMUM<br>NON-REPETITIVE PEAK<br>REVERSE VOLTAGE<br>V | V <sub>DRM</sub> , MAXIMUM<br>REPETITIVE PEAK<br>OFF-STATE VOLTAGE,<br>GATE OPEN CIRCUIT<br>V | I <sub>RRM</sub> /I <sub>DRM</sub> ,<br>MAXIMUM<br>AT T <sub>J</sub> = 125 °C<br>mA |
|-----------------------------|-----------------|-----------------------------------------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| VS-5.MT...K                 | 80              | 800                                                                   | 900                                                                       | 800                                                                                           | 10                                                                                  |
|                             | 100             | 1000                                                                  | 1100                                                                      | 1000                                                                                          |                                                                                     |
|                             | 120             | 1200                                                                  | 1300                                                                      | 1200                                                                                          |                                                                                     |
|                             | 140             | 1400                                                                  | 1500                                                                      | 1400                                                                                          |                                                                                     |
|                             | 160             | 1600                                                                  | 1700                                                                      | 1600                                                                                          |                                                                                     |
| VS-9.MT...K<br>VS-11.MT...K | 80              | 800                                                                   | 900                                                                       | 800                                                                                           | 20                                                                                  |
|                             | 100             | 1000                                                                  | 1100                                                                      | 1000                                                                                          |                                                                                     |
|                             | 120             | 1200                                                                  | 1300                                                                      | 1200                                                                                          |                                                                                     |
|                             | 140             | 1400                                                                  | 1500                                                                      | 1400                                                                                          |                                                                                     |
|                             | 160             | 1600                                                                  | 1700                                                                      | 1600                                                                                          |                                                                                     |

**FORWARD CONDUCTION**

| PARAMETER                                                              | SYMBOL              | TEST CONDITIONS                                                                                                                                                         |                                   |                                              | VALUES<br>5.MT...K | VALUES<br>9.MT...K | VALUES<br>11.MT...K | UNITS             |
|------------------------------------------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|----------------------------------------------|--------------------|--------------------|---------------------|-------------------|
| Maximum DC output current at case temperature                          | I <sub>O</sub>      | 120° rect. conduction angle                                                                                                                                             |                                   |                                              | 55                 | 90                 | 110                 | A                 |
|                                                                        |                     |                                                                                                                                                                         |                                   |                                              | 85                 | 85                 | 85                  | °C                |
| Maximum peak, one-cycle forward, non-repetitive on state surge current | I <sub>TSM</sub>    | t = 10 ms                                                                                                                                                               | No voltage reappplied             | Initial T <sub>J</sub> = T <sub>J</sub> max. | 390                | 950                | 1130                | A                 |
|                                                                        |                     | t = 8.3 ms                                                                                                                                                              |                                   |                                              | 410                | 1000               | 1180                |                   |
|                                                                        |                     | t = 10 ms                                                                                                                                                               | 100 % V <sub>RRM</sub> reappplied |                                              | 330                | 800                | 950                 |                   |
|                                                                        |                     | t = 8.3 ms                                                                                                                                                              |                                   |                                              | 345                | 840                | 1000                |                   |
| Maximum I <sup>2</sup> t for fusing                                    | I <sup>2</sup> t    | t = 10 ms                                                                                                                                                               | No voltage reappplied             |                                              | 770                | 4525               | 6380                | A <sup>2</sup> s  |
|                                                                        |                     | t = 8.3 ms                                                                                                                                                              |                                   |                                              | 700                | 4130               | 5830                |                   |
|                                                                        |                     | t = 10 ms                                                                                                                                                               | 100 % V <sub>RRM</sub> reappplied |                                              | 540                | 3200               | 4510                |                   |
|                                                                        |                     | t = 8.3 ms                                                                                                                                                              |                                   |                                              | 500                | 2920               | 4120                |                   |
| Maximum I <sup>2</sup> √t for fusing                                   | I <sup>2</sup> √t   | t = 0.1 ms to 10 ms, no voltage reappplied                                                                                                                              |                                   |                                              | 7700               | 45 250             | 63 800              | A <sup>2</sup> √s |
| Low level value of threshold voltage                                   | V <sub>T(TO)1</sub> | (16.7 % × π × I <sub>T(AV)</sub> < I < π × I <sub>T(AV)</sub> ), T <sub>J</sub> maximum                                                                                 |                                   |                                              | 1.17               | 1.09               | 1.04                | V                 |
| High level value of threshold voltage                                  | V <sub>T(TO)2</sub> | (I > π × I <sub>T(AV)</sub> ), T <sub>J</sub> maximum                                                                                                                   |                                   |                                              | 1.45               | 1.27               | 1.27                |                   |
| Low level value on-state slope resistance                              | r <sub>t1</sub>     | (16.7 % × π × I <sub>T(AV)</sub> < I < π × I <sub>T(AV)</sub> ), T <sub>J</sub> maximum                                                                                 |                                   |                                              | 12.40              | 4.10               | 3.93                | mΩ                |
| High level value on-state slope resistance                             | r <sub>t2</sub>     | (I > π × I <sub>T(AV)</sub> ), T <sub>J</sub> maximum                                                                                                                   |                                   |                                              | 11.04              | 3.59               | 3.37                |                   |
| Maximum on-state voltage drop                                          | V <sub>TM</sub>     | I <sub>pk</sub> = 150 A, T <sub>J</sub> = 25 °C, t <sub>p</sub> = 400 μs single junction                                                                                |                                   |                                              | 2.68               | 1.65               | 1.57                | V                 |
| Maximum non-repetitive rate of rise of turned on current               | di/dt               | T <sub>J</sub> = 25 °C, from 0.67 V <sub>DRM</sub> , I <sub>TM</sub> = π × I <sub>T(AV)</sub> , I <sub>g</sub> = 500 mA, t <sub>r</sub> < 0.5 μs, t <sub>p</sub> > 6 μs |                                   |                                              | 150                |                    |                     | A/μs              |
| Maximum holding current                                                | I <sub>H</sub>      | T <sub>J</sub> = 25 °C, anode supply = 6 V, resistive load, gate open circuit                                                                                           |                                   |                                              | 200                |                    |                     | mA                |
| Maximum latching current                                               | I <sub>L</sub>      | T <sub>J</sub> = 25 °C, anode supply = 6 V, resistive load                                                                                                              |                                   |                                              | 400                |                    |                     |                   |

**BLOCKING**

| PARAMETER                                          | SYMBOL        | TEST CONDITIONS                                                                  | 5.MT...K | 9.MT...K | 11.MT...K | UNITS |
|----------------------------------------------------|---------------|----------------------------------------------------------------------------------|----------|----------|-----------|-------|
| RMS isolation voltage                              | $V_{ISOL}$    | $T_J = 25\text{ °C}$ all terminal shorted, $f = 50\text{ Hz}$ , $t = 1\text{ s}$ | 4000     |          |           | V     |
| Maximum critical rate of rise of off-state voltage | $dV/dt^{(1)}$ | $T_J = T_J$ maximum, linear to $0.67 V_{DRM}$ , gate open circuit                | 500      |          |           | V/μs  |

**Note**

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

**TRIGGERING**

| PARAMETER                                   | SYMBOL             | TEST CONDITIONS                                                         |                                       | 5.MT...K | 9.MT...K | 11.MT...K | UNITS |
|---------------------------------------------|--------------------|-------------------------------------------------------------------------|---------------------------------------|----------|----------|-----------|-------|
| Maximum peak gate power                     | P <sub>GM</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum                                 |                                       | 10       |          |           | W     |
| Maximum average gate power                  | P <sub>G(AV)</sub> |                                                                         |                                       | 2.5      |          |           |       |
| Maximum peak gate current                   | I <sub>GM</sub>    |                                                                         |                                       | 2.5      |          |           | A     |
| Maximum peak negative gate voltage          | - V <sub>GT</sub>  |                                                                         |                                       | 10       |          |           | V     |
| Maximum required DC gate voltage to trigger | V <sub>GT</sub>    | T <sub>J</sub> = - 40 °C                                                | Anode supply = 6 V,<br>resistive load | 4.0      |          |           |       |
|                                             |                    | T <sub>J</sub> = 25 °C                                                  |                                       | 2.5      |          |           |       |
|                                             |                    | T <sub>J</sub> = 125 °C                                                 |                                       | 1.7      |          |           |       |
| Maximum required DC gate current to trigger | I <sub>GT</sub>    | T <sub>J</sub> = - 40 °C                                                |                                       | 270      |          | mA        |       |
|                                             |                    | T <sub>J</sub> = 25 °C                                                  |                                       | 150      |          |           |       |
|                                             |                    | T <sub>J</sub> = 125 °C                                                 |                                       | 80       |          |           |       |
| Maximum gate voltage that will not trigger  | V <sub>GD</sub>    | T <sub>J</sub> = T <sub>J</sub> maximum, rated V <sub>DRM</sub> applied |                                       | 0.25     |          | V         |       |
| Maximum gate current that will not trigger  | I <sub>GD</sub>    |                                                                         |                                       | 6        |          | mA        |       |



| THERMAL AND MECHANICAL SPECIFICATIONS                    |                                   |                                                                                                                                                              |             |          |           |       |
|----------------------------------------------------------|-----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------|-----------|-------|
| PARAMETER                                                | SYMBOL                            | TEST CONDITIONS                                                                                                                                              | 5.MT...K    | 9.MT...K | 11.MT...K | UNITS |
| Maximum junction operating and storage temperature range | T <sub>J</sub> , T <sub>Stg</sub> |                                                                                                                                                              | - 40 to 125 |          |           | °C    |
| Maximum thermal resistance, junction to case             | R <sub>thJC</sub>                 | DC operation per module                                                                                                                                      | 0.18        | 0.14     | 0.12      | K/W   |
|                                                          |                                   | DC operation per junction                                                                                                                                    | 1.07        | 0.86     | 0.70      |       |
|                                                          |                                   | 120 °C rect. conduction angle per module                                                                                                                     | 0.19        | 0.15     | 0.12      |       |
|                                                          |                                   | 120 °C rect. conduction angle per junction                                                                                                                   | 1.17        | 0.91     | 0.74      |       |
| Maximum thermal resistance, case to heatsink per module  | R <sub>thCS</sub>                 | Mounting surface smooth, flat and grased                                                                                                                     | 0.03        |          |           |       |
| Mounting torque ± 10 %                                   | to heatsink<br>to terminal        | 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. | 4 to 6      |          |           | Nm    |
|                                                          |                                   |                                                                                                                                                              | 3 to 4      |          |           |       |
| Approximate weight                                       |                                   |                                                                                                                                                              | 225         |          |           | g     |

| $\Delta R$ CONDUCTION PER JUNCTION |                                        |       |       |       |       |                                         |       |       |       |       |       |
|------------------------------------|----------------------------------------|-------|-------|-------|-------|-----------------------------------------|-------|-------|-------|-------|-------|
| DEVICES                            | SINUSOIDAL CONDUCTION AT $T_J$ MAXIMUM |       |       |       |       | RECTANGULAR CONDUCTION AT $T_J$ MAXIMUM |       |       |       |       | UNITS |
|                                    | 180°                                   | 120°  | 90°   | 60°   | 30°   | 180°                                    | 120°  | 90°   | 60°   | 30°   |       |
| 5.MT...K                           | 0.072                                  | 0.085 | 0.108 | 0.152 | 0.233 | 0.055                                   | 0.091 | 0.117 | 0.157 | 0.236 | K/W   |
| 9.MT...K                           | 0.033                                  | 0.039 | 0.051 | 0.069 | 0.099 | 0.027                                   | 0.044 | 0.055 | 0.071 | 0.100 |       |
| 11.MT...K                          | 0.027                                  | 0.033 | 0.042 | 0.057 | 0.081 | 0.023                                   | 0.037 | 0.046 | 0.059 | 0.082 |       |

## Note

- Table shows the increment of thermal resistance  $R_{thJC}$  when devices operate at different conduction angles than DC

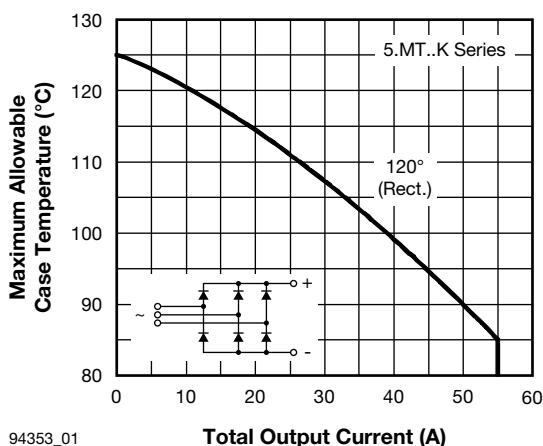


Fig. 1 - Current Ratings Characteristic

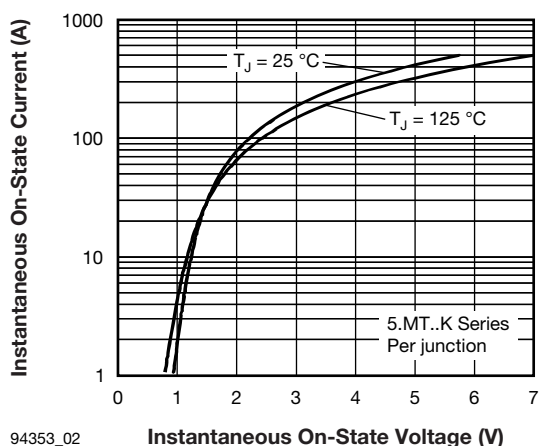
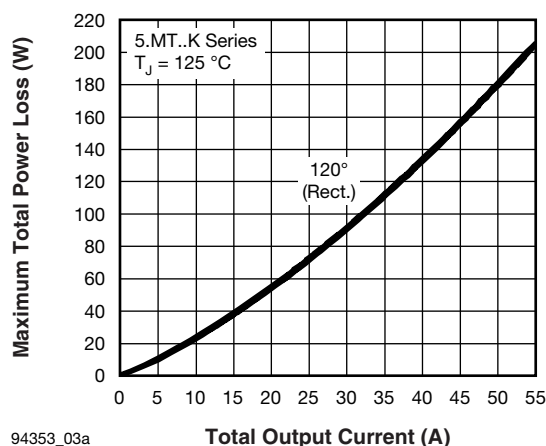
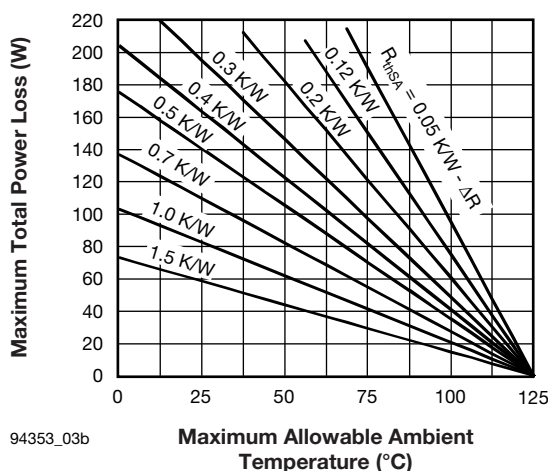


Fig. 2 - Forward Voltage Drop Characteristics

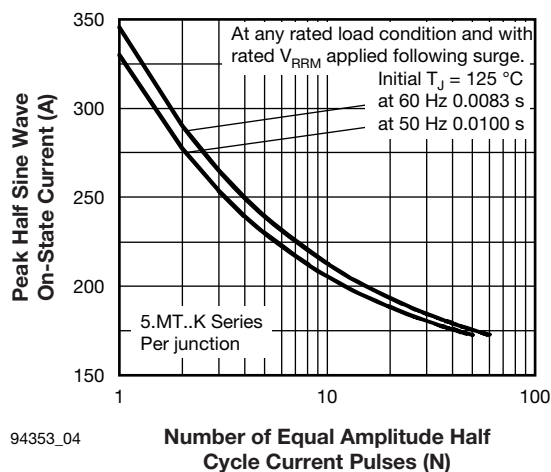


94353\_03a



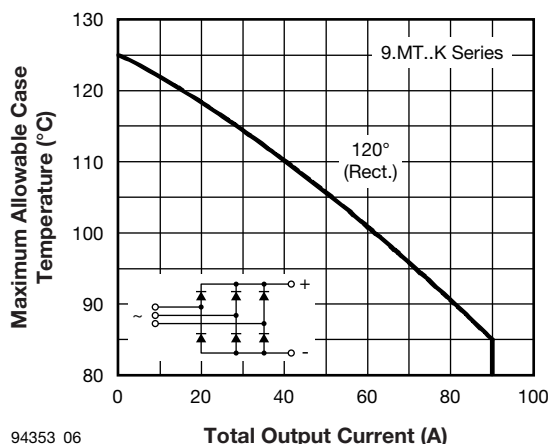
94353\_03b

Fig. 3 - Total Power Loss Characteristics



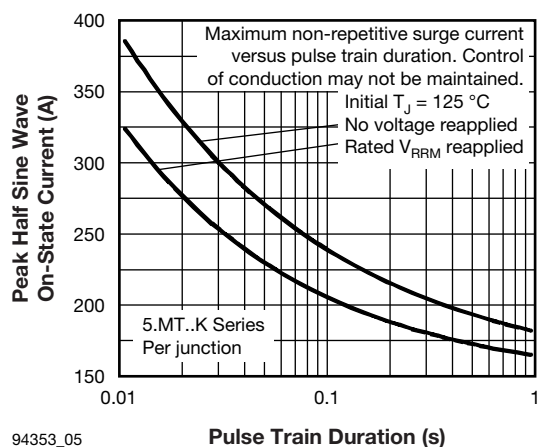
94353\_04

Fig. 4 - Maximum Non-Repetitive Surge Current



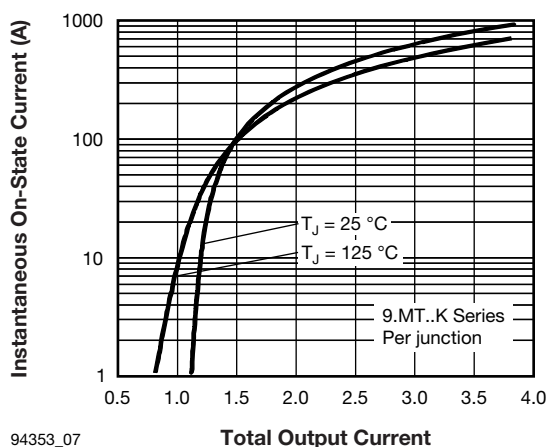
94353\_06

Fig. 6 - Current Ratings Characteristic



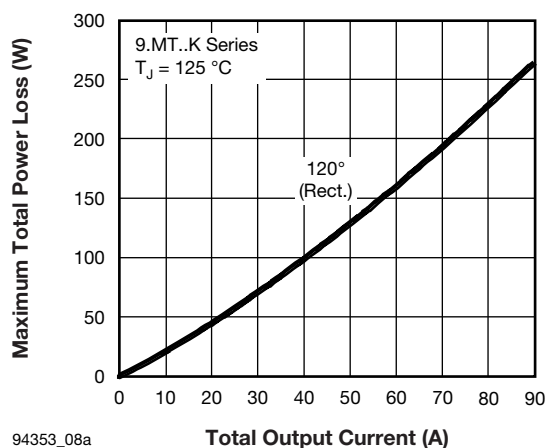
94353\_05

Fig. 5 - Maximum Non-Repetitive Surge Current

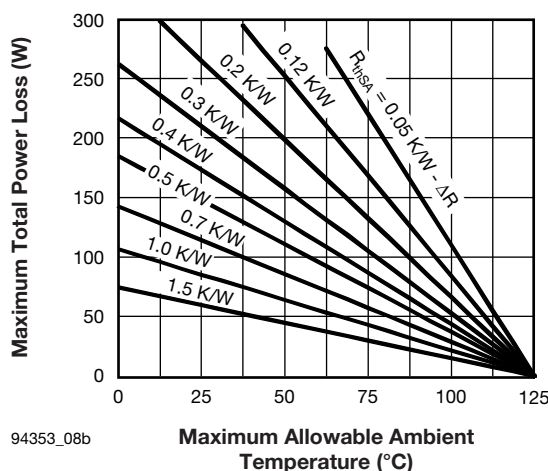


94353\_07

Fig. 7 - Forward Voltage Drop Characteristics

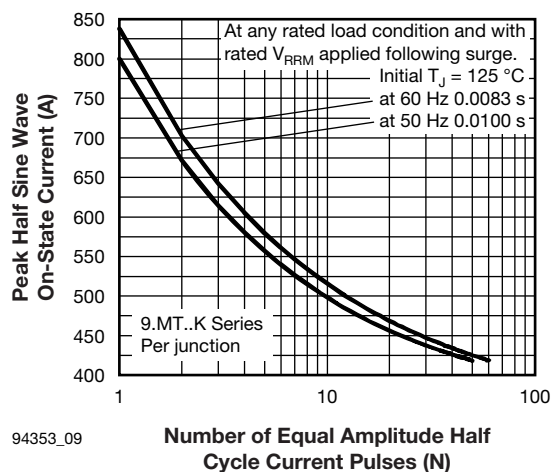


94353\_08a



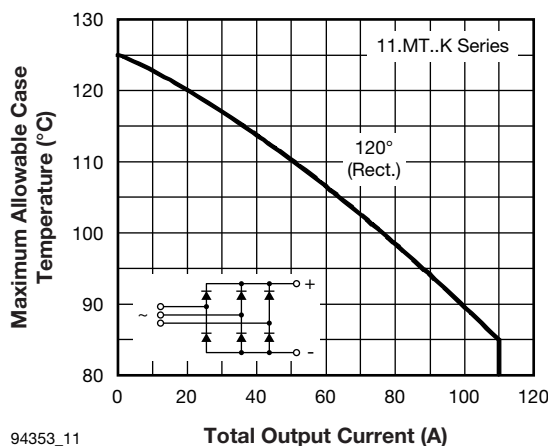
94353\_08b

Fig. 8 - Total Power Loss Characteristics



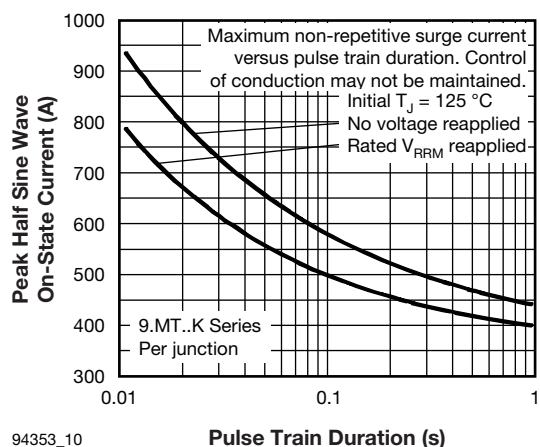
94353\_09

Fig. 9 - Maximum Non-Repetitive Surge Current



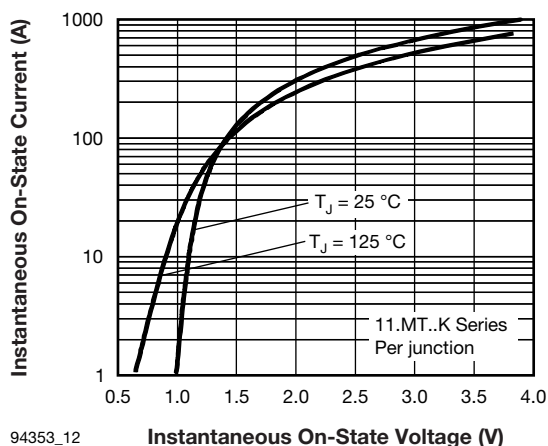
94353\_11

Fig. 11 - Current Ratings Characteristic



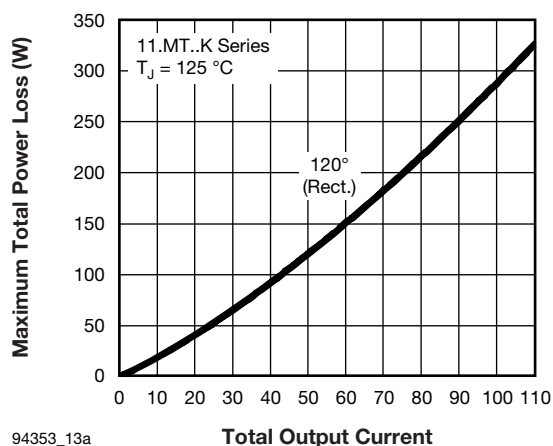
94353\_10

Fig. 10 - Maximum Non-Repetitive Surge Current

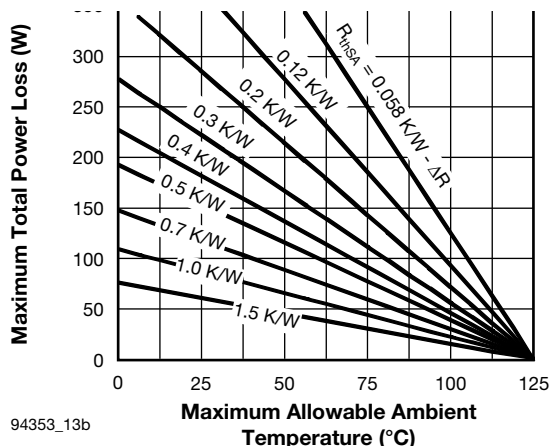


94353\_12

Fig. 12 - Forward Voltage Drop Characteristics

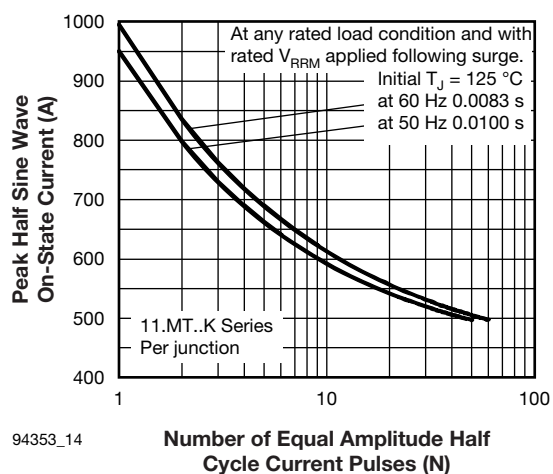


94353\_13a



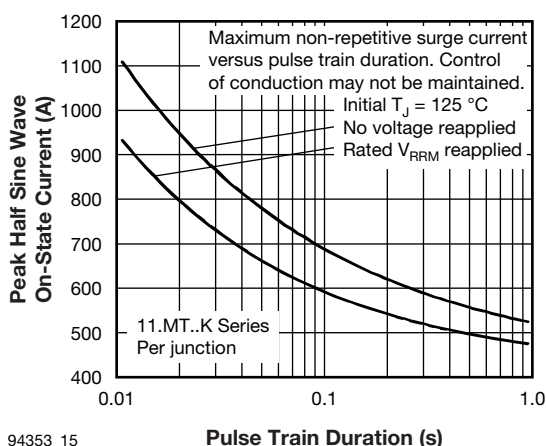
94353\_13b

Fig. 13 - Total Power Loss Characteristics



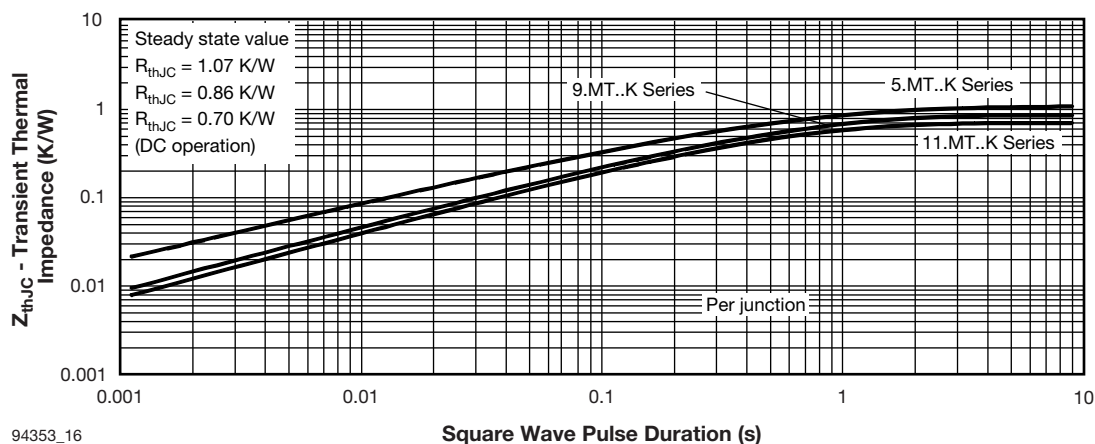
94353\_14

Fig. 14 - Maximum Non-Repetitive Surge Current



94353\_15

Fig. 15 - Maximum Non-Repetitive Surge Current



94353\_16

Fig. 16 - Thermal Impedance  $Z_{\theta JC}$  Characteristics

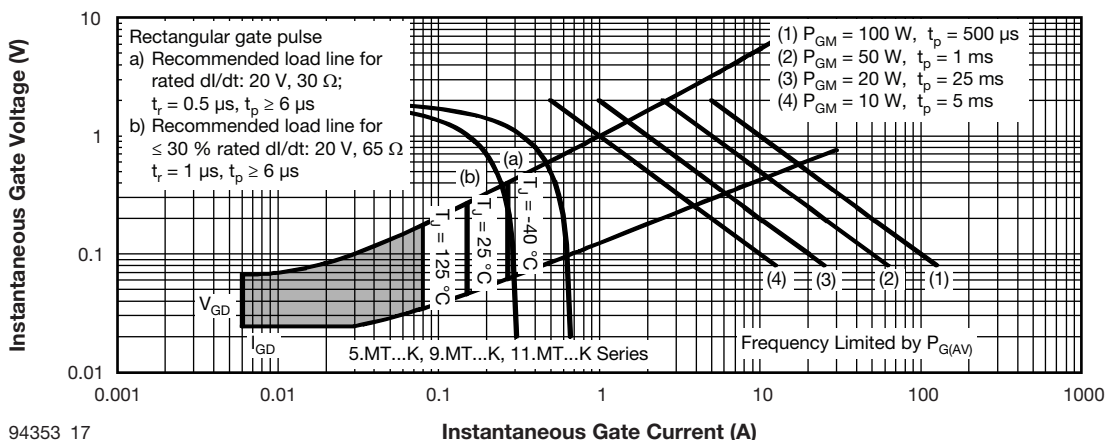


Fig. 17 - Gate Characteristics

## ORDERING INFORMATION TABLE

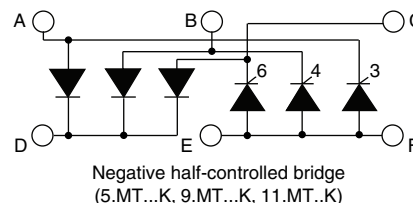
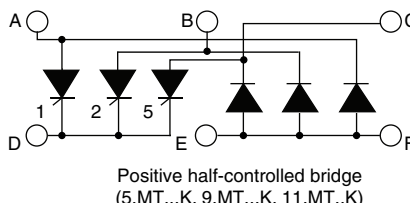
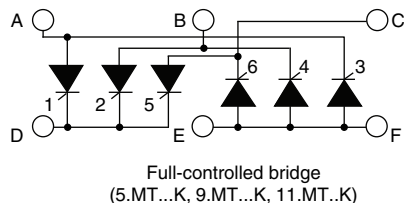
| Device code | VS- | 11 | 3 | MT | 160 | K | S90 | PbF |
|-------------|-----|----|---|----|-----|---|-----|-----|
|             | 1   | 2  | 3 | 4  | 5   | 6 | 7   |     |

- 1** - Vishay Semiconductors product
- 2** - Current rating code:
  - 5 = 55 A (average)
  - 9 = 90 A (average)
  - 11 = 110 A (average)
- 3** - Circuit configuration code:
  - 1 = Negative half-controlled bridge
  - 2 = Positive half-controlled bridge
  - 3 = Full-controlled bridge
- 4** - Essential part number
- 5** - Voltage code  $\times 10 = V_{RRM}$  (see Voltage Ratings table)
- 6** - Critical  $dV/dt$ :
  - None = 500 V/ $\mu s$  (standard value)
  - S90 = 1000 V/ $\mu s$  (special selection)
- 7** - PbF = Lead (Pb)-free

### Note

- To order the optional hardware go to [www.vishay.com/doc?95172](http://www.vishay.com/doc?95172)

## CIRCUIT CONFIGURATION



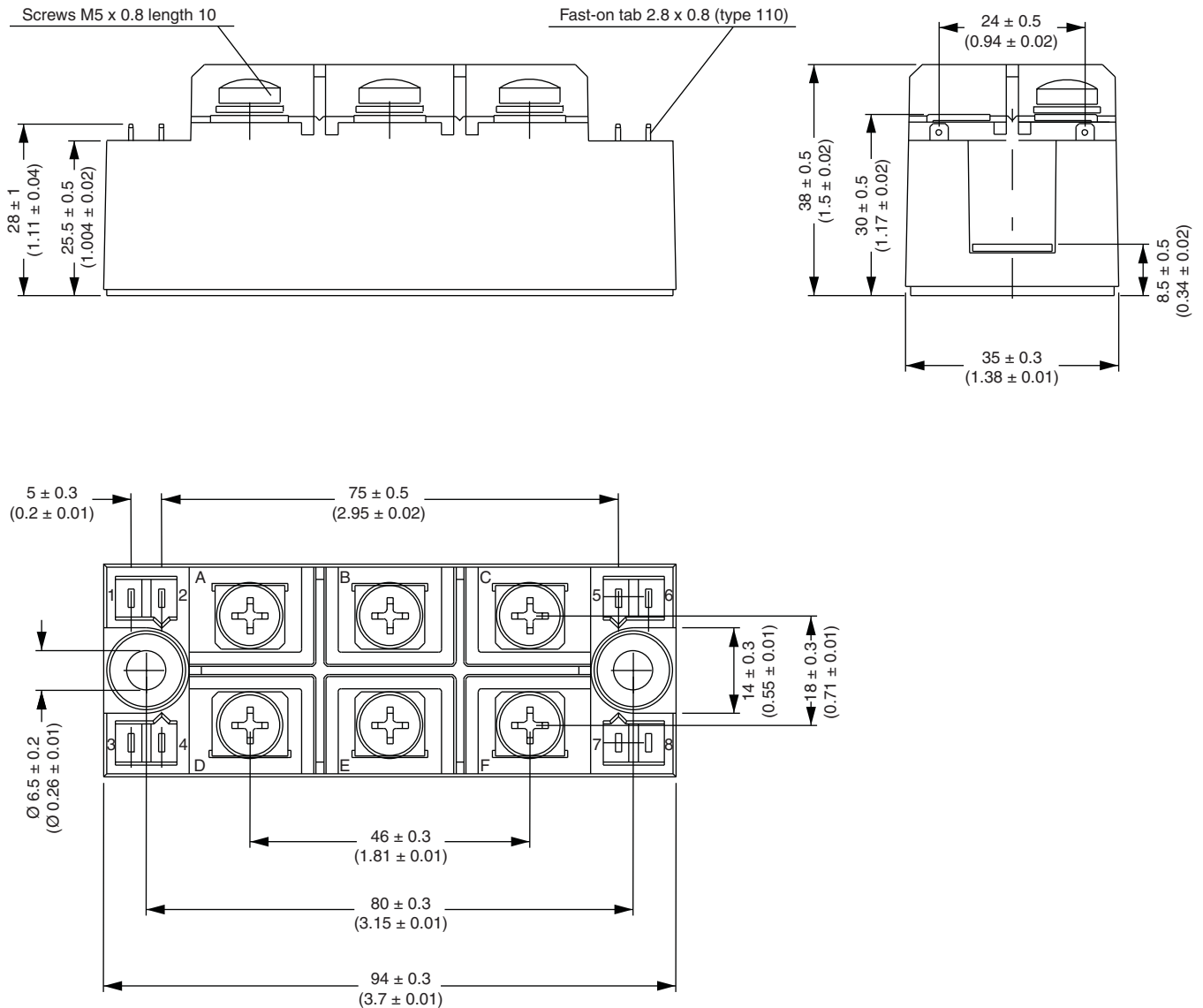
## LINKS TO RELATED DOCUMENTS

Dimensions

[www.vishay.com/doc?95004](http://www.vishay.com/doc?95004)

## MTK (with and without optional barrier)

### DIMENSIONS WITH OPTIONAL BARRIERS in millimeters (inches)



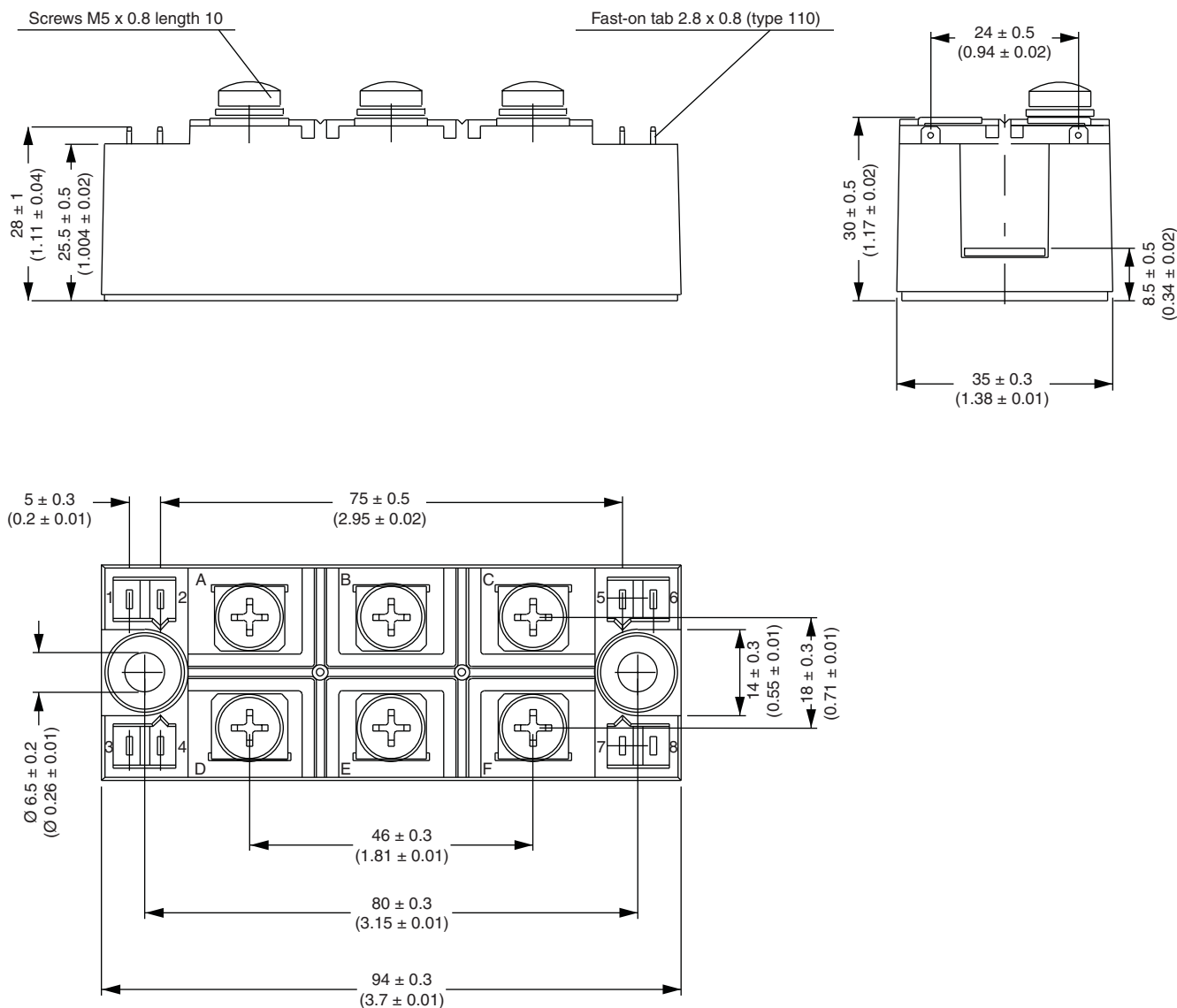


# Outline Dimensions

Vishay Semiconductors MTK (with and without optional barrier)



## DIMENSIONS WITHOUT OPTIONAL BARRIERS in millimeters (inches)





## Disclaimer

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