



High power cycling capability  
Low on-state and switching losses  
Designed for traction and industrial applications

## Phase Control Thyristor Type T143-630-18

|                                         |            |     |     |     |     |     |                  |      |      |                                 |      |      |      |      |  |  |
|-----------------------------------------|------------|-----|-----|-----|-----|-----|------------------|------|------|---------------------------------|------|------|------|------|--|--|
| Mean on-state current                   |            |     |     |     |     |     | I <sub>TAV</sub> |      |      | 630 A                           |      |      |      |      |  |  |
| Repetitive peak off-state voltage       |            |     |     |     |     |     | V <sub>DRM</sub> |      |      | 400...1800 V                    |      |      |      |      |  |  |
| Repetitive peak reverse voltage         |            |     |     |     |     |     | V <sub>RRM</sub> |      |      |                                 |      |      |      |      |  |  |
| Turn-off time                           |            |     |     |     |     |     | t <sub>q</sub>   |      |      | 160, 200, 250, 320, 400, 500 μs |      |      |      |      |  |  |
| V <sub>DRM</sub> , V <sub>RRM</sub> , V | 400        | 500 | 600 | 700 | 800 | 900 | 1000             | 1100 | 1200 | 1300                            | 1400 | 1500 | 1600 | 1800 |  |  |
| Voltage code                            | 4          | 5   | 6   | 7   | 8   | 9   | 10               | 11   | 12   | 13                              | 14   | 15   | 16   | 18   |  |  |
| T <sub>j</sub> , °C                     | -60...+125 |     |     |     |     |     |                  |      |      |                                 |      |      |      |      |  |  |

### MAXIMUM ALLOWABLE RATINGS

| Symbols and parameters              |                                                                           | Units                            | Values                                       | Test conditions                                                                                                      |                                                                                                                                                                                                 |
|-------------------------------------|---------------------------------------------------------------------------|----------------------------------|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ON-STATE                            |                                                                           |                                  |                                              |                                                                                                                      |                                                                                                                                                                                                 |
| I <sub>TAV</sub>                    | Maximum allowable mean on-state current                                   | A                                | 630<br>761                                   | T <sub>c</sub> =94 °C, Double side cooled<br>T <sub>c</sub> =85 °C, Double side cooled<br>180° half-sine wave; 50 Hz |                                                                                                                                                                                                 |
| I <sub>TRMS</sub>                   | RMS on-state current                                                      | A                                | 989                                          | T <sub>c</sub> =94 °C, Double side cooled<br>180° half-sine wave; 50 Hz                                              |                                                                                                                                                                                                 |
| I <sub>TSM</sub>                    | Surge on-state current                                                    | kA                               | 13.5<br>16.0                                 | T <sub>j</sub> =T <sub>j max</sub><br>T <sub>j</sub> =25 °C                                                          | 180° half-sine wave;<br>t <sub>p</sub> =10 ms; single pulse;<br>V <sub>D</sub> =V <sub>R</sub> =0 V;<br>Gate pulse: I <sub>G</sub> =2 A;<br>t <sub>GP</sub> =50 μs; di <sub>G</sub> /dt≥1 A/μs  |
|                                     |                                                                           |                                  | 14.0<br>16.0                                 | T <sub>j</sub> =T <sub>j max</sub><br>T <sub>j</sub> =25 °C                                                          | 180° half-sine wave;<br>t <sub>p</sub> =8.3 ms; single pulse;<br>V <sub>D</sub> =V <sub>R</sub> =0 V;<br>Gate pulse: I <sub>G</sub> =2 A;<br>t <sub>GP</sub> =50 μs; di <sub>G</sub> /dt≥1 A/μs |
| I <sup>2</sup> t                    | Safety factor                                                             | A <sup>2</sup> s·10 <sup>3</sup> | 910<br>1280                                  | T <sub>j</sub> =T <sub>j max</sub><br>T <sub>j</sub> =25 °C                                                          | 180° half-sine wave;<br>t <sub>p</sub> =10 ms; single pulse;<br>V <sub>D</sub> =V <sub>R</sub> =0 V;<br>Gate pulse: I <sub>G</sub> =2 A;<br>t <sub>GP</sub> =50 μs; di <sub>G</sub> /dt≥1 A/μs  |
|                                     |                                                                           |                                  | 810<br>1060                                  | T <sub>j</sub> =T <sub>j max</sub><br>T <sub>j</sub> =25 °C                                                          | 180° half-sine wave;<br>t <sub>p</sub> =8.3 ms; single pulse;<br>V <sub>D</sub> =V <sub>R</sub> =0 V;<br>Gate pulse: I <sub>G</sub> =2 A;<br>t <sub>GP</sub> =50 μs; di <sub>G</sub> /dt≥1 A/μs |
| BLOCKING                            |                                                                           |                                  |                                              |                                                                                                                      |                                                                                                                                                                                                 |
| V <sub>DRM</sub> , V <sub>RRM</sub> | Repetitive peak off-state and<br>Repetitive peak reverse voltages         | V                                | 400...1800                                   | T <sub>j min</sub> < T <sub>j</sub> < T <sub>j max</sub> ;<br>180° half-sine wave; 50 Hz;<br>Gate open               |                                                                                                                                                                                                 |
| V <sub>DSM</sub> , V <sub>RSM</sub> | Non-repetitive peak off-state and<br>Non-repetitive peak reverse voltages | V                                | 500...1900                                   | T <sub>j min</sub> < T <sub>j</sub> < T <sub>j max</sub> ;<br>180° half-sine wave; single pulse;<br>Gate open        |                                                                                                                                                                                                 |
| V <sub>D</sub> , V <sub>R</sub>     | Direct off-state and<br>Direct reverse voltages                           | V                                | 0.6·V <sub>DRM</sub><br>0.6·V <sub>RRM</sub> | T <sub>j</sub> =T <sub>j max</sub> ;<br>Gate open                                                                    |                                                                                                                                                                                                 |

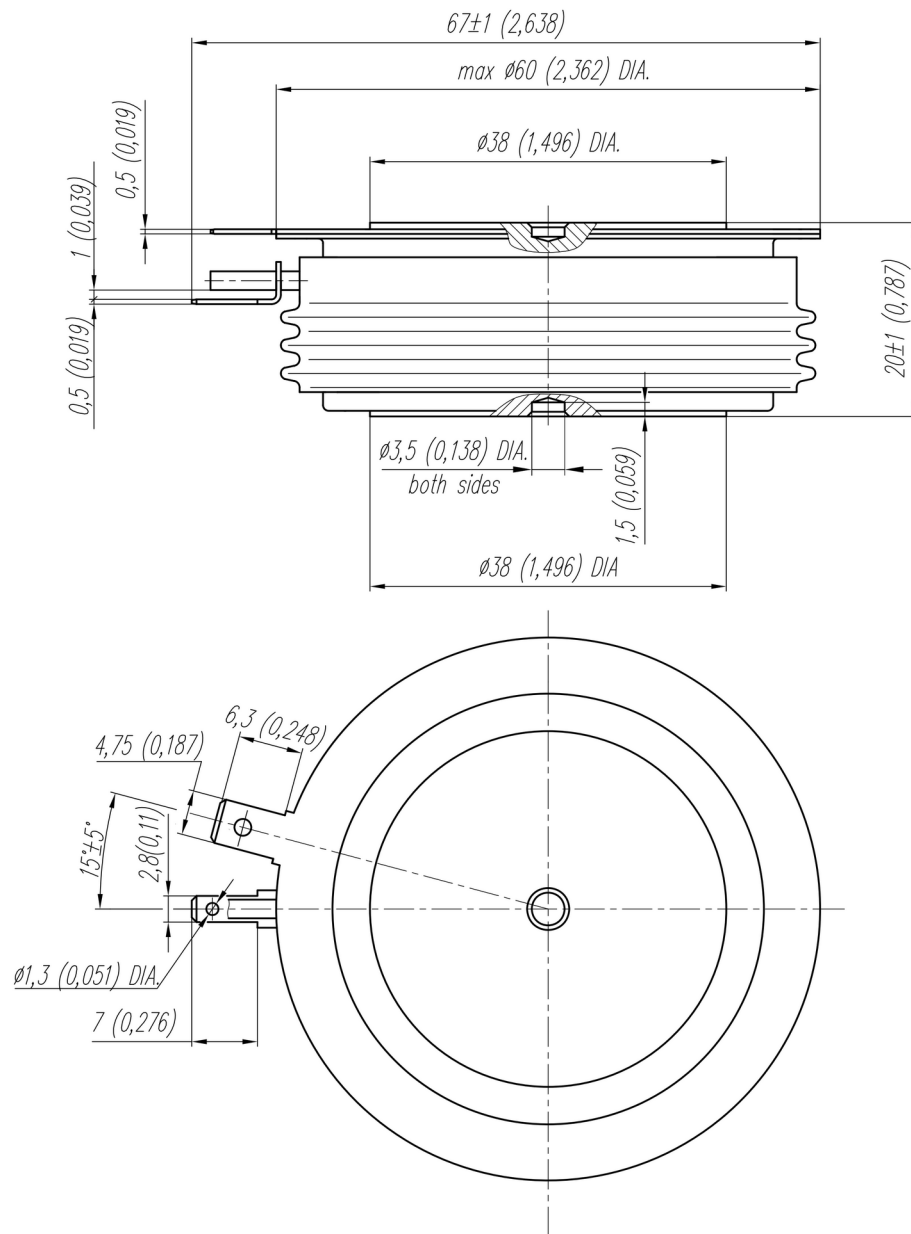
| TRIGGERING         |                                                                      |                  |             |                                                                                                                                                        |
|--------------------|----------------------------------------------------------------------|------------------|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_{FGM}$          | Peak forward gate current                                            | A                | 8           | $T_j = T_{j \max}$                                                                                                                                     |
| $V_{RGM}$          | Peak reverse gate voltage                                            | V                | 5           |                                                                                                                                                        |
| $P_G$              | Gate power dissipation                                               | W                | 4           | $T_j = T_{j \max}$ for DC gate current                                                                                                                 |
| SWITCHING          |                                                                      |                  |             |                                                                                                                                                        |
| $(di_T/dt)_{crit}$ | Critical rate of rise of on-state current non-repetitive ( $f=1$ Hz) | A/ $\mu$ s       | 1250        | $T_j = T_{j \max}$ ; $V_D = 0.67 \cdot V_{DRM}$ ; $I_{TM} = 2000$ A;<br>Gate pulse: $I_G = 2$ A;<br>$t_{GP} = 50$ $\mu$ s; $di_G/dt \geq 2$ A/ $\mu$ s |
| THERMAL            |                                                                      |                  |             |                                                                                                                                                        |
| $T_{stg}$          | Storage temperature                                                  | $^{\circ}$ C     | -60...+50   |                                                                                                                                                        |
| $T_j$              | Operating junction temperature                                       | $^{\circ}$ C     | -60...+125  |                                                                                                                                                        |
| MECHANICAL         |                                                                      |                  |             |                                                                                                                                                        |
| F                  | Mounting force                                                       | kN               | 14.0...16.0 |                                                                                                                                                        |
| a                  | Acceleration                                                         | m/s <sup>2</sup> | 50          | Device clamped                                                                                                                                         |

## CHARACTERISTICS

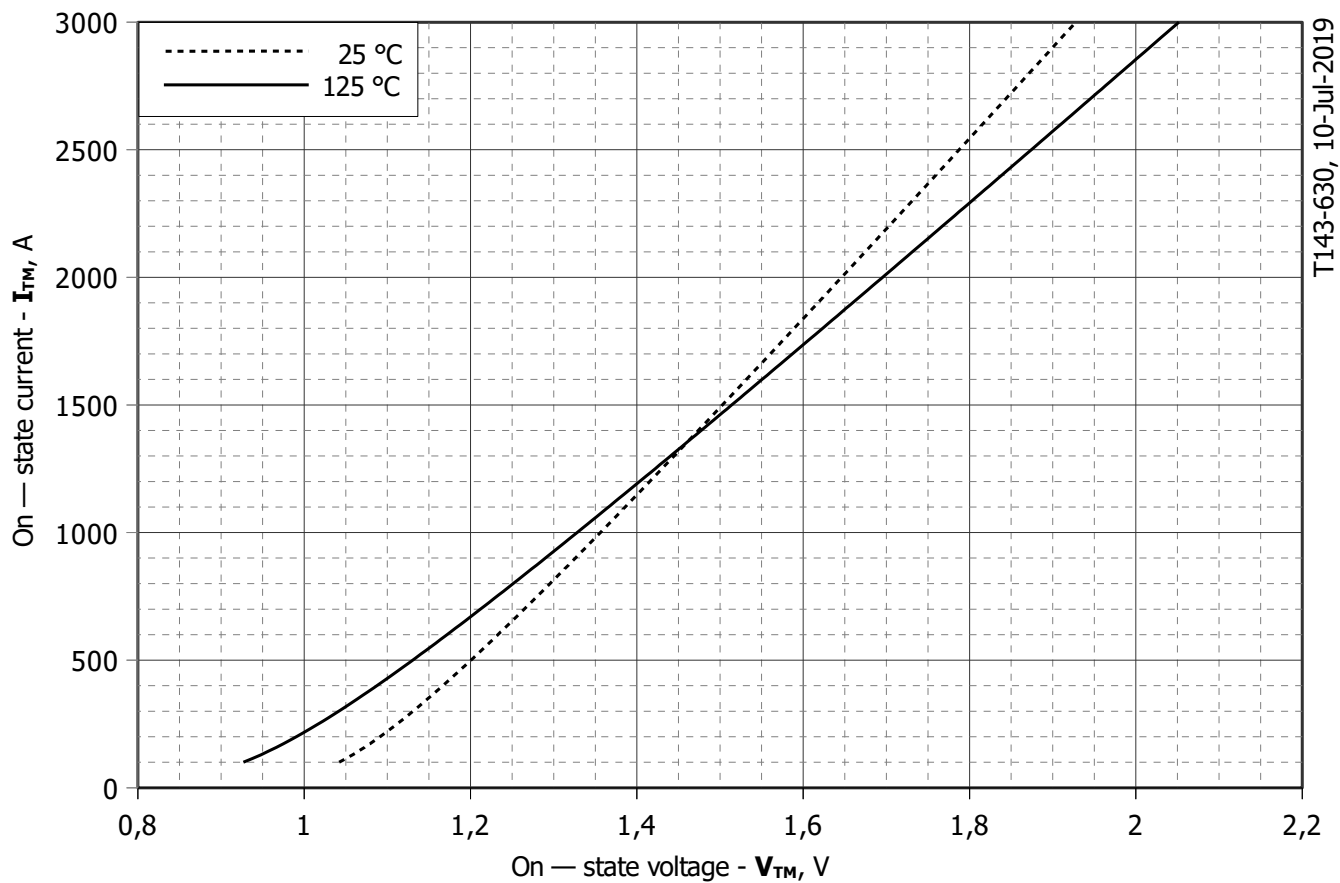
| Symbols and parameters                |                                                                        | Units | Values                                         | Conditions                                                                                                                                                                                             |                                                                   |
|---------------------------------------|------------------------------------------------------------------------|-------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|
| ON-STATE                              |                                                                        |       |                                                |                                                                                                                                                                                                        |                                                                   |
| V <sub>TM</sub>                       | Peak on-state voltage, max                                             | V     | 1.65                                           | T <sub>j</sub> =25 °C; I <sub>TM</sub> =1978 A                                                                                                                                                         |                                                                   |
| V <sub>T(TO)</sub>                    | On-state threshold voltage, max                                        | V     | 0.966                                          | T <sub>j</sub> =T <sub>j max</sub> ;                                                                                                                                                                   |                                                                   |
| r <sub>T</sub>                        | On-state slope resistance, max                                         | mΩ    | 0.362                                          | 0.5 π I <sub>TAV</sub> < I <sub>T</sub> < 1.5 π I <sub>TAV</sub>                                                                                                                                       |                                                                   |
| I <sub>L</sub>                        | Latching current, max                                                  | mA    | 1000                                           | T <sub>j</sub> =25 °C; V <sub>D</sub> =12 V;<br>Gate pulse: I <sub>G</sub> =2 A;<br>t <sub>GP</sub> =50 μs; di <sub>G</sub> /dt≥1 A/μs                                                                 |                                                                   |
| I <sub>H</sub>                        | Holding current, max                                                   | mA    | 300                                            | T <sub>j</sub> =25 °C;<br>V <sub>D</sub> =12 V; Gate open                                                                                                                                              |                                                                   |
| BLOCKING                              |                                                                        |       |                                                |                                                                                                                                                                                                        |                                                                   |
| I <sub>DRM</sub> , I <sub>RRM</sub>   | Repetitive peak off-state and<br>Repetitive peak reverse currents, max | mA    | 100                                            | T <sub>j</sub> =T <sub>j max</sub> ;<br>V <sub>D</sub> =V <sub>DRM</sub> ; V <sub>R</sub> =V <sub>RRM</sub>                                                                                            |                                                                   |
| (dv <sub>D</sub> /dt) <sub>crit</sub> | Critical rate of rise of<br>off-state voltage <sup>1)</sup> , min      | V/μs  | 200, 320,<br>500, 1000,<br>1600, 2000,<br>2500 | T <sub>j</sub> =T <sub>j max</sub> ;<br>V <sub>D</sub> =0.67·V <sub>DRM</sub> ; Gate open                                                                                                              |                                                                   |
| TRIGGERING                            |                                                                        |       |                                                |                                                                                                                                                                                                        |                                                                   |
| V <sub>GT</sub>                       | Gate trigger direct voltage, max                                       | V     | 3.00<br>2.50<br>1.50                           | T <sub>j</sub> = T <sub>j min</sub><br>T <sub>j</sub> =25 °C<br>T <sub>j</sub> = T <sub>j max</sub>                                                                                                    | V <sub>D</sub> =12 V; I <sub>D</sub> =3 A;<br>Direct gate current |
| I <sub>GT</sub>                       | Gate trigger direct current, max                                       | mA    | 400<br>250<br>150                              | T <sub>j</sub> = T <sub>j min</sub><br>T <sub>j</sub> = 25 °C<br>T <sub>j</sub> = T <sub>j max</sub>                                                                                                   |                                                                   |
| V <sub>GD</sub>                       | Gate non-trigger direct voltage, min                                   | V     | 0.30                                           | T <sub>j</sub> =T <sub>j max</sub> ;<br>V <sub>D</sub> =0.67·V <sub>DRM</sub> ;                                                                                                                        |                                                                   |
| I <sub>GD</sub>                       | Gate non-trigger direct current, min                                   | mA    | 35.00                                          | Direct gate current                                                                                                                                                                                    |                                                                   |
| SWITCHING                             |                                                                        |       |                                                |                                                                                                                                                                                                        |                                                                   |
| t <sub>gd</sub>                       | Delay time, max                                                        | μs    | 0.80                                           | T <sub>j</sub> =25 °C; V <sub>D</sub> =1000 V; I <sub>TM</sub> =I <sub>TAV</sub> ;<br>di/dt=200 A/μs;                                                                                                  |                                                                   |
| t <sub>gt</sub>                       | Turn-on time, max                                                      | μs    | 3.00                                           | Gate pulse: I <sub>G</sub> =2 A; V <sub>G</sub> =20 V;<br>t <sub>GP</sub> =50 μs; di <sub>G</sub> /dt=2 A/μs                                                                                           |                                                                   |
| t <sub>q</sub>                        | Turn-off time <sup>2)</sup> , max                                      | μs    | 160, 200,<br>250, 320,<br>400, 500             | dv <sub>D</sub> /dt=50 V/μs; T <sub>j</sub> =T <sub>j max</sub> ; I <sub>TM</sub> = I <sub>TAV</sub> ;<br>di <sub>R</sub> /dt=-10 A/μs; V <sub>R</sub> =100V;<br>V <sub>D</sub> =0.67·V <sub>DRM</sub> |                                                                   |
| Q <sub>rr</sub>                       | Recovered charge, max                                                  | μC    | 1890                                           | T <sub>j</sub> =T <sub>j max</sub> ; I <sub>TM</sub> =630 A;                                                                                                                                           |                                                                   |
| t <sub>rr</sub>                       | Reverse recovery time, max                                             | μs    | 25                                             | di <sub>R</sub> /dt=-10 A/μs;                                                                                                                                                                          |                                                                   |
| I <sub>rr</sub>                       | Reverse recovery current, max                                          | A     | 151                                            | V <sub>R</sub> =100 V                                                                                                                                                                                  |                                                                   |

| THERMAL             |                                           |              |                  |                |                     |
|---------------------|-------------------------------------------|--------------|------------------|----------------|---------------------|
| R <sub>thjc</sub>   | Thermal resistance, junction to case, max | °C/W         | 0.0320           | Direct current | Double side cooled  |
| R <sub>thjc-A</sub> |                                           |              | 0.0704           |                | Anode side cooled   |
| R <sub>thjc-K</sub> |                                           |              | 0.0576           |                | Cathode side cooled |
| R <sub>thck</sub>   | Thermal resistance, case to heatsink, max | °C/W         | 0.0060           | Direct current |                     |
| MECHANICAL          |                                           |              |                  |                |                     |
| m                   | Weight, max                               | g            | 235              |                |                     |
| D <sub>s</sub>      | Surface creepage distance                 | mm<br>(inch) | 19.44<br>(0.765) |                |                     |
| D <sub>a</sub>      | Air strike distance                       | mm<br>(inch) | 12.10<br>(0.476) |                |                     |

| PART NUMBERING GUIDE                                                                                                                                                                                                                                                                                                      |     |     |     |      |      |      | NOTES                                                                                                                                                                                                                                                                                                                               |  |  |  |  |  |  |                 |    |    |    |    |    |    |               |                           |     |     |     |      |      |      |      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|------|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|-----------------|----|----|----|----|----|----|---------------|---------------------------|-----|-----|-----|------|------|------|------|
| T                                                                                                                                                                                                                                                                                                                         | 143 | 630 | 18  | A2   | E2   | N    | <div>1) Critical rate of rise of off-state voltage</div> <table><tr><td>Symbol of Group</td><td>P2</td><td>K2</td><td>E2</td><td>A2</td><td>T1</td><td>P1</td><td>M1</td></tr><tr><td><math>(dv_D/dt)_{crit}</math>, V/μs</td><td>200</td><td>320</td><td>500</td><td>1000</td><td>1600</td><td>2000</td><td>2500</td></tr></table> |  |  |  |  |  |  | Symbol of Group | P2 | K2 | E2 | A2 | T1 | P1 | M1            | $(dv_D/dt)_{crit}$ , V/μs | 200 | 320 | 500 | 1000 | 1600 | 2000 | 2500 |
| Symbol of Group                                                                                                                                                                                                                                                                                                           | P2  | K2  | E2  | A2   | T1   | P1   | M1                                                                                                                                                                                                                                                                                                                                  |  |  |  |  |  |  |                 |    |    |    |    |    |    |               |                           |     |     |     |      |      |      |      |
| $(dv_D/dt)_{crit}$ , V/μs                                                                                                                                                                                                                                                                                                 | 200 | 320 | 500 | 1000 | 1600 | 2000 | 2500                                                                                                                                                                                                                                                                                                                                |  |  |  |  |  |  |                 |    |    |    |    |    |    |               |                           |     |     |     |      |      |      |      |
| 1                                                                                                                                                                                                                                                                                                                         | 2   | 3   | 4   | 5    | 6    | 7    | <div>2) Turn-off time (<math>dv_D/dt=50</math> V/μs)</div> <table><tr><td>Symbol of Group</td><td>T2</td><td>P2</td><td>M2</td><td>K2</td><td>H2</td><td>E2</td></tr><tr><td><math>t_{qr}</math>, μs</td><td>160</td><td>200</td><td>250</td><td>320</td><td>400</td><td>500</td></tr></table>                                      |  |  |  |  |  |  | Symbol of Group | T2 | P2 | M2 | K2 | H2 | E2 | $t_{qr}$ , μs | 160                       | 200 | 250 | 320 | 400  | 500  |      |      |
| Symbol of Group                                                                                                                                                                                                                                                                                                           | T2  | P2  | M2  | K2   | H2   | E2   |                                                                                                                                                                                                                                                                                                                                     |  |  |  |  |  |  |                 |    |    |    |    |    |    |               |                           |     |     |     |      |      |      |      |
| $t_{qr}$ , μs                                                                                                                                                                                                                                                                                                             | 160 | 200 | 250 | 320  | 400  | 500  |                                                                                                                                                                                                                                                                                                                                     |  |  |  |  |  |  |                 |    |    |    |    |    |    |               |                           |     |     |     |      |      |      |      |
| <div>1. Phase Control Thyristor</div> <div>2. Design version</div> <div>3. Mean on-state current, A</div> <div>4. Voltage code</div> <div>5. Critical rate of rise of off-state voltage, V/μs</div> <div>6. Turn-off time (<math>dv_D/dt=50</math> V/μs)</div> <div>7. Ambient conditions: N – normal; T – tropical</div> |     |     |     |      |      |      |                                                                                                                                                                                                                                                                                                                                     |  |  |  |  |  |  |                 |    |    |    |    |    |    |               |                           |     |     |     |      |      |      |      |



All dimensions in millimeters (inches)



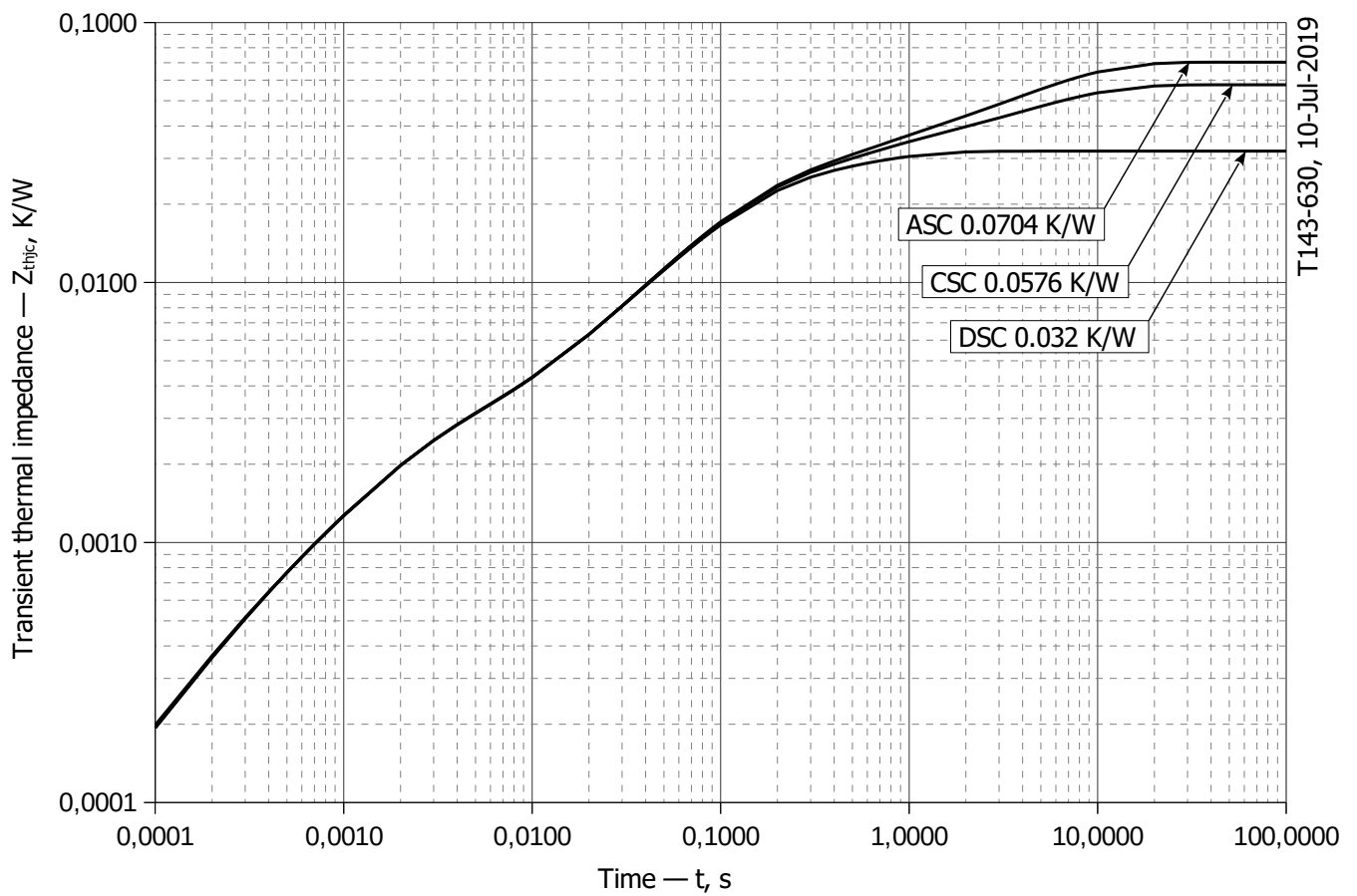
**Fig 1 – On-state characteristics of Limit device**

Analytical function for On-state characteristic:

$$V_T = A + B \cdot i_T + C \cdot \ln(i_T + 1) + D \cdot \sqrt{i_T}$$

|          | Coefficients for max curves |                   |
|----------|-----------------------------|-------------------|
|          | $T_j = 25^\circ\text{C}$    | $T_j = T_{j\max}$ |
| <b>A</b> | 0.85846000                  | 0.68224000        |
| <b>B</b> | 0.00027309                  | 0.00034593        |
| <b>C</b> | 0.03507100                  | 0.04743500        |
| <b>D</b> | -0.00056132                 | -0.00087862       |

**On-state characteristic model (see Fig. 1)**



**Fig 2 – Transient thermal impedance  $Z_{thjc}$  vs. time  $t$**

Analytical function for Transient thermal impedance junction to case  $Z_{thjc}$  for DC:

$$Z_{thjc} = \sum_{i=1}^n R_i \left( 1 - e^{-\frac{t}{\tau_i}} \right)$$

Where  $i = 1$  to  $n$ ,  $n$  is the number of terms in the series.

$t$  = Duration of heating pulse in seconds.

$Z_{thjc}$  = Thermal resistance at time  $t$ .

$R_i$  = Amplitude of  $p_{th}$  term.

$\tau_i$  = Time constant of  $r_{th}$  term.

DC Double side cooled

| $i$          | 1           | 2       | 3       | 4         | 5        | 6         |
|--------------|-------------|---------|---------|-----------|----------|-----------|
| $R_i$ , K/W  | 0.000005619 | 0.01031 | 0.01922 | 0.0004148 | 0.001895 | 0.0001521 |
| $\tau_i$ , s | 7.790       | 0.5094  | 0.09719 | 0.01725   | 0.0016   | 0.0002257 |

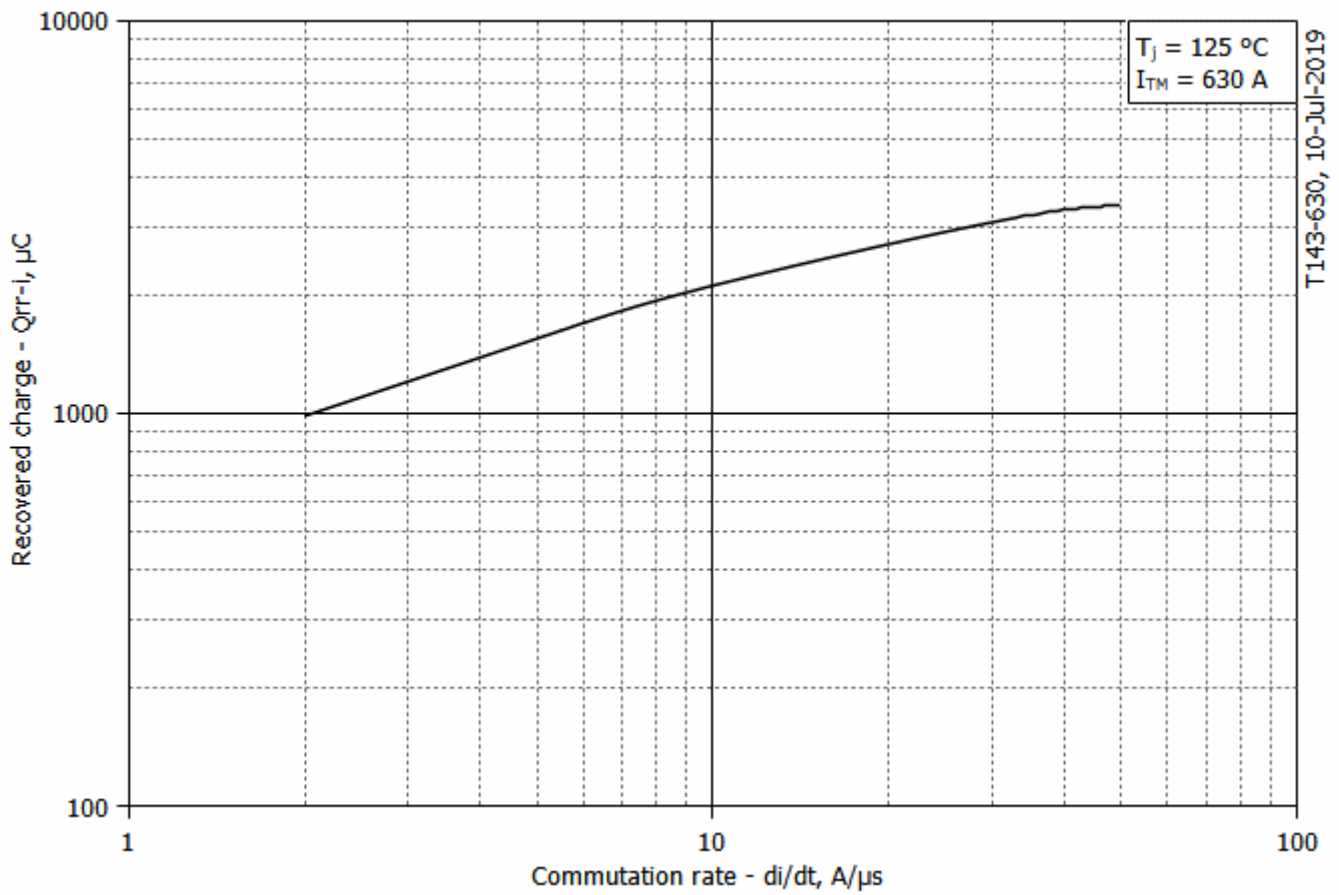
DC Anode side cooled

| $i$          | 1      | 2        | 3       | 4        | 5         | 6        |
|--------------|--------|----------|---------|----------|-----------|----------|
| $R_i$ , K/W  | 0.0381 | 0.008681 | 0.01867 | 0.001961 | 0.0001787 | 0.002771 |
| $\tau_i$ , s | 5.351  | 0.4584   | 0.09325 | 0.001734 | 0.0002174 | 0.9059   |

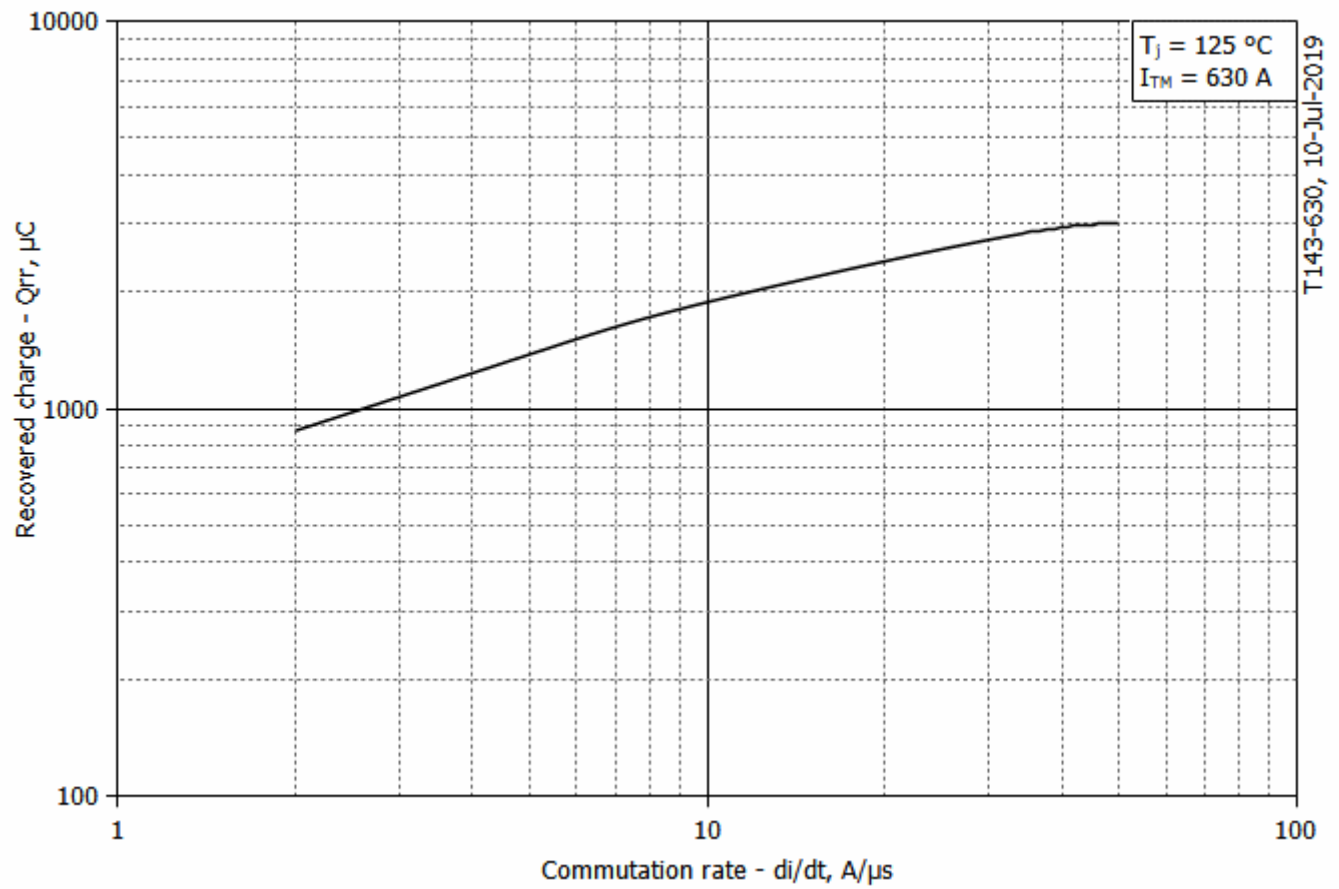
DC Cathode side cooled

| $i$          | 1       | 2        | 3       | 4        | 5         | 6       |
|--------------|---------|----------|---------|----------|-----------|---------|
| $R_i$ , K/W  | 0.02561 | 0.001472 | 0.01786 | 0.001926 | 0.0001928 | 0.01052 |
| $\tau_i$ , s | 5.328   | 0.1832   | 0.09031 | 0.001714 | 0.0002598 | 0.525   |

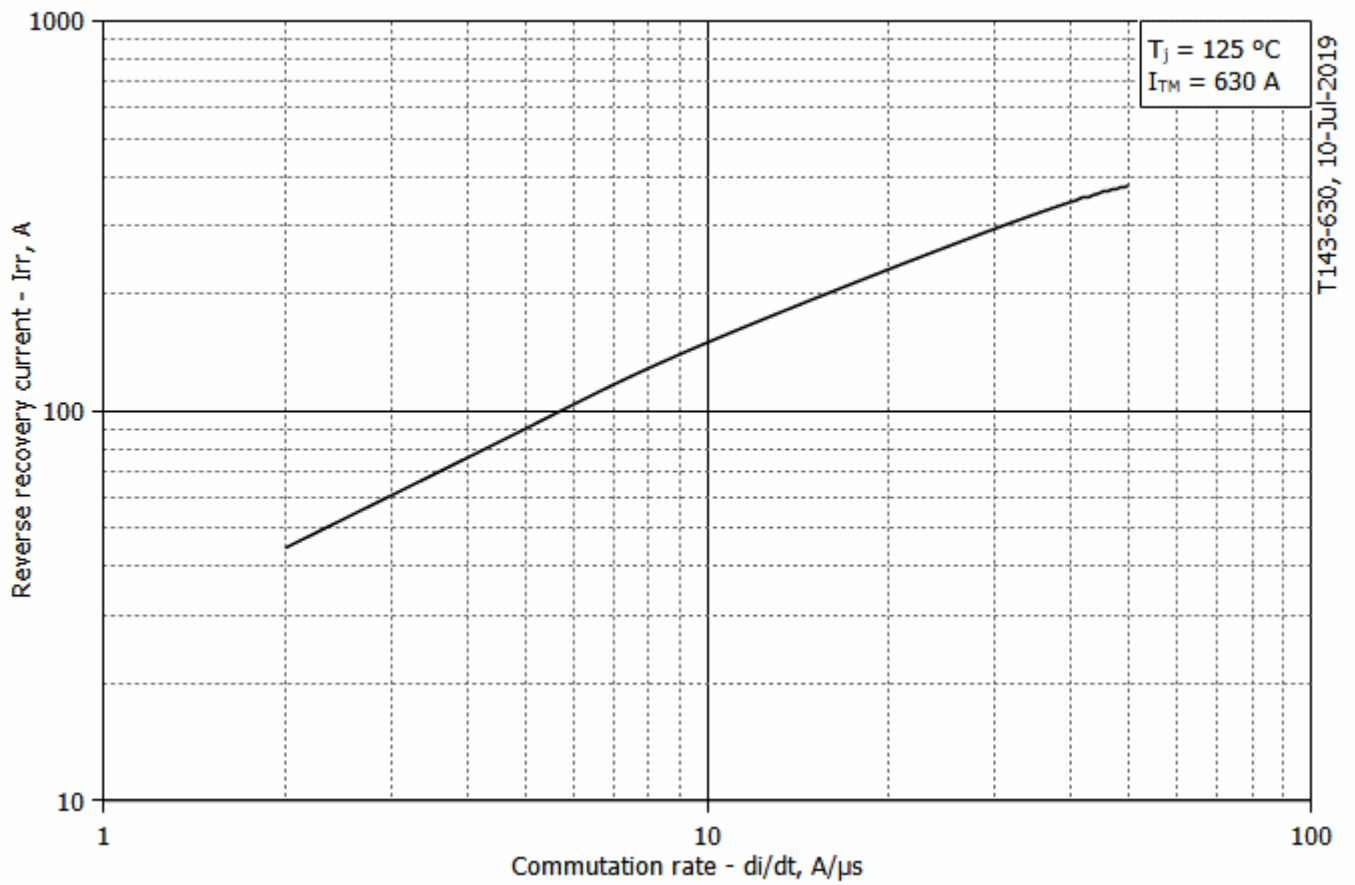
**Transient thermal impedance junction to case  $Z_{thjc}$  model (see Fig. 2)**



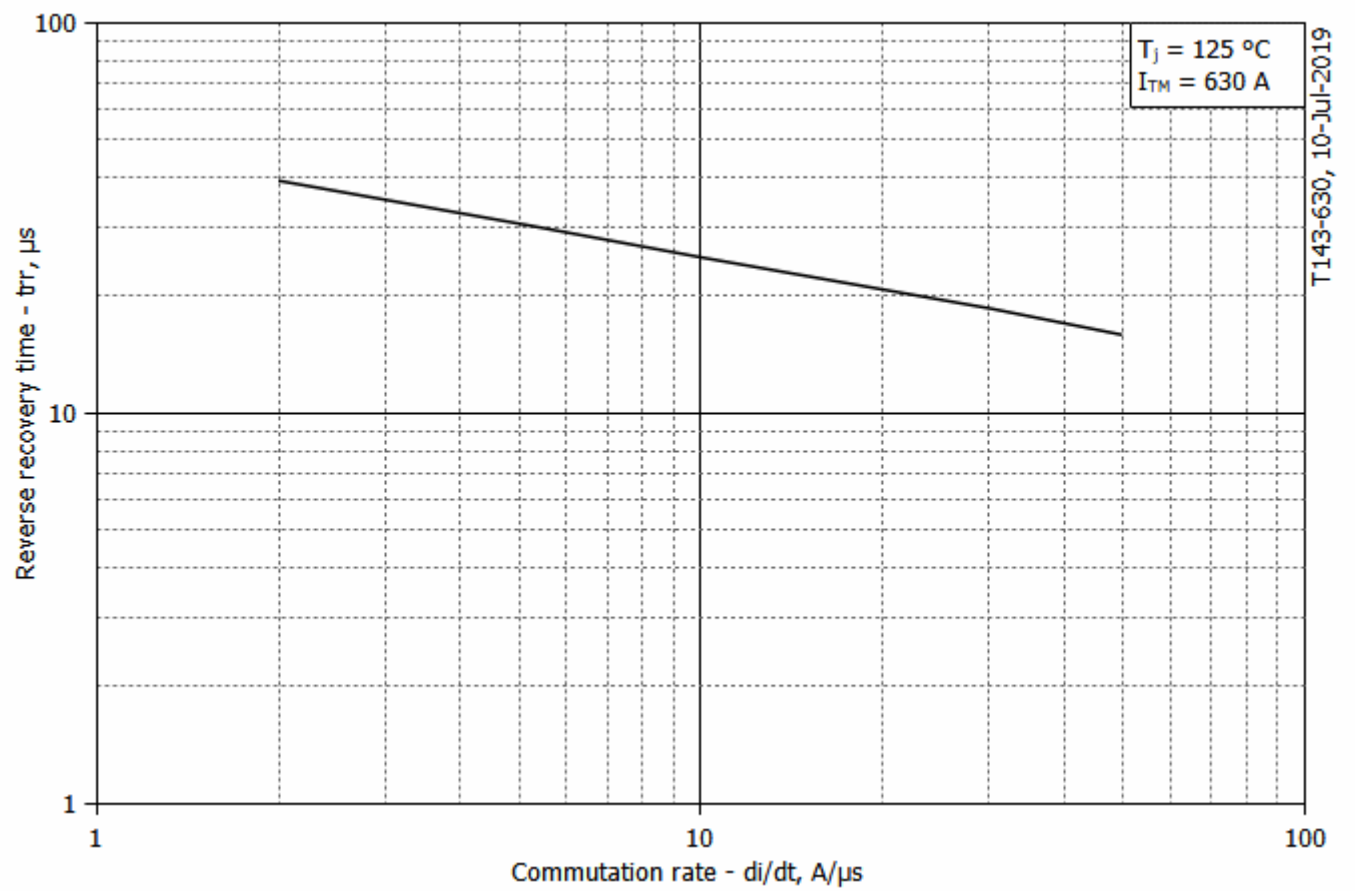
**Fig 3 – Maximum recovered charge  $Q_{rr-i}$  (integral) vs. commutation rate  $di_R/dt$**



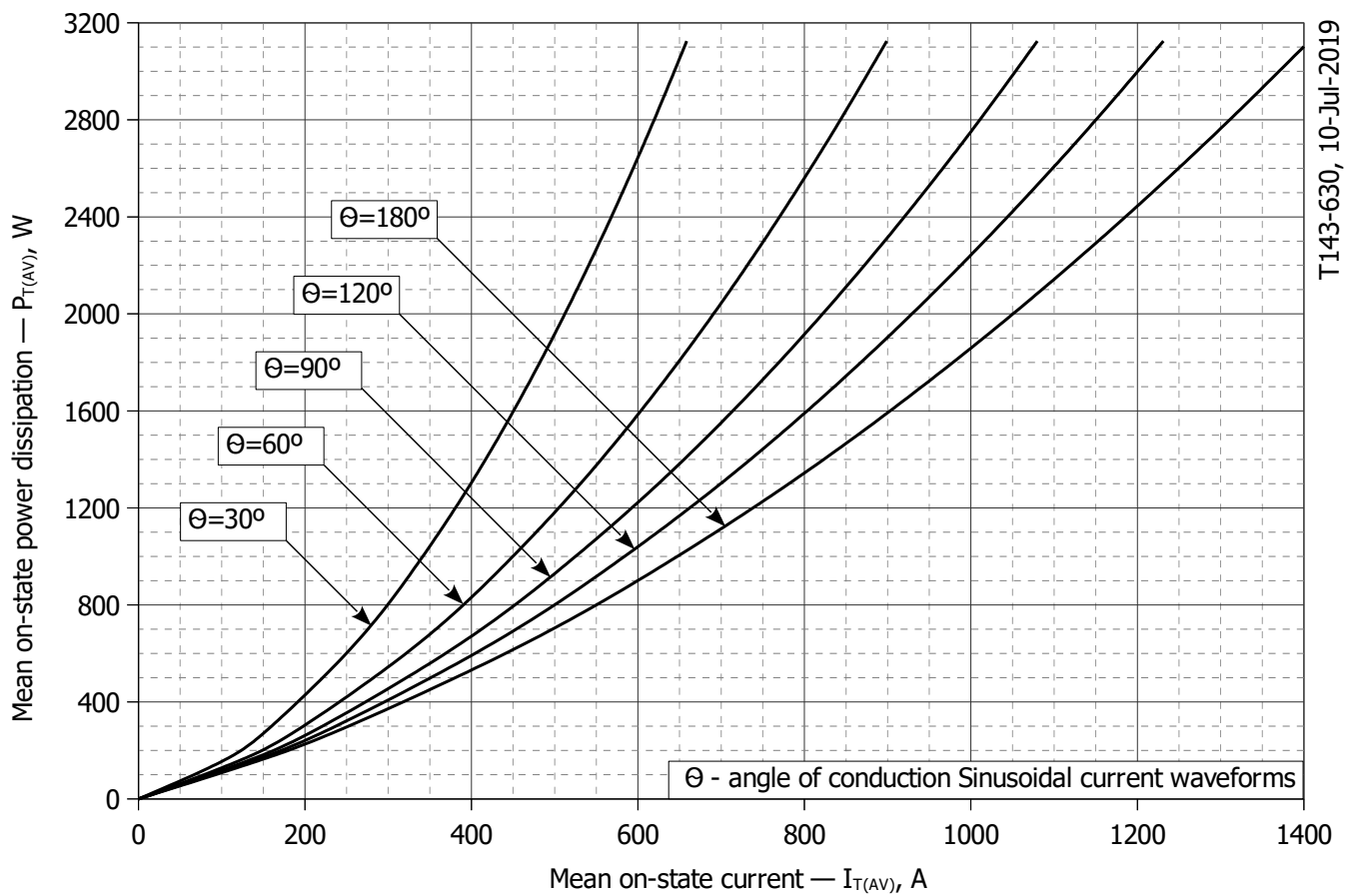
**Fig 4 – Maximum recovered charge  $Q_{rr}$  vs. commutation rate  $di_R/dt$  (25% chord)**



**Fig 5 – Maximum reverse recovery current  $I_{rr}$  vs. commutation rate  $di_R/dt$**

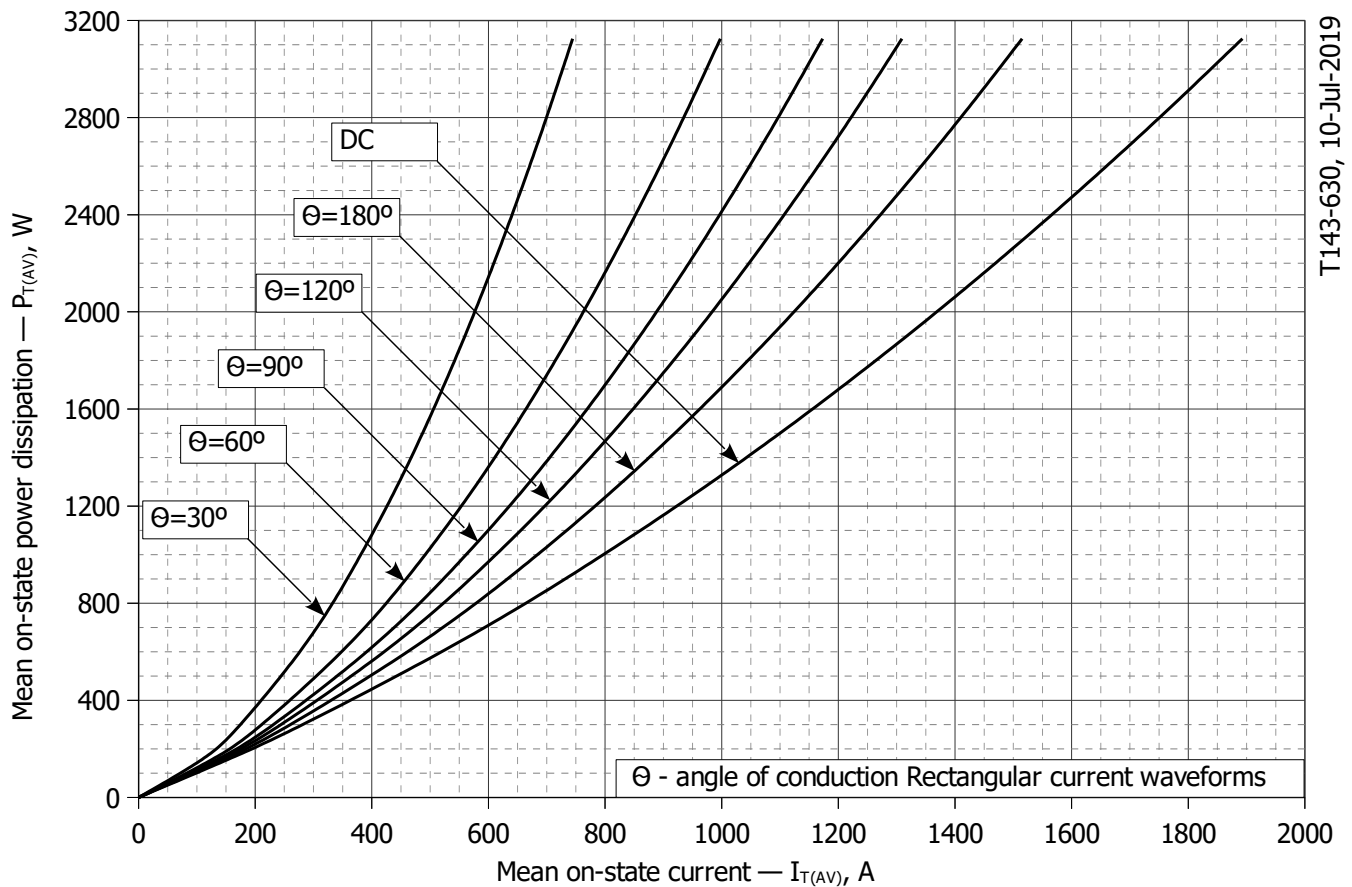


**Fig 6 – Maximum recovery time  $t_{rr}$  vs. commutation rate  $di_R/dt$  (25% chord)**



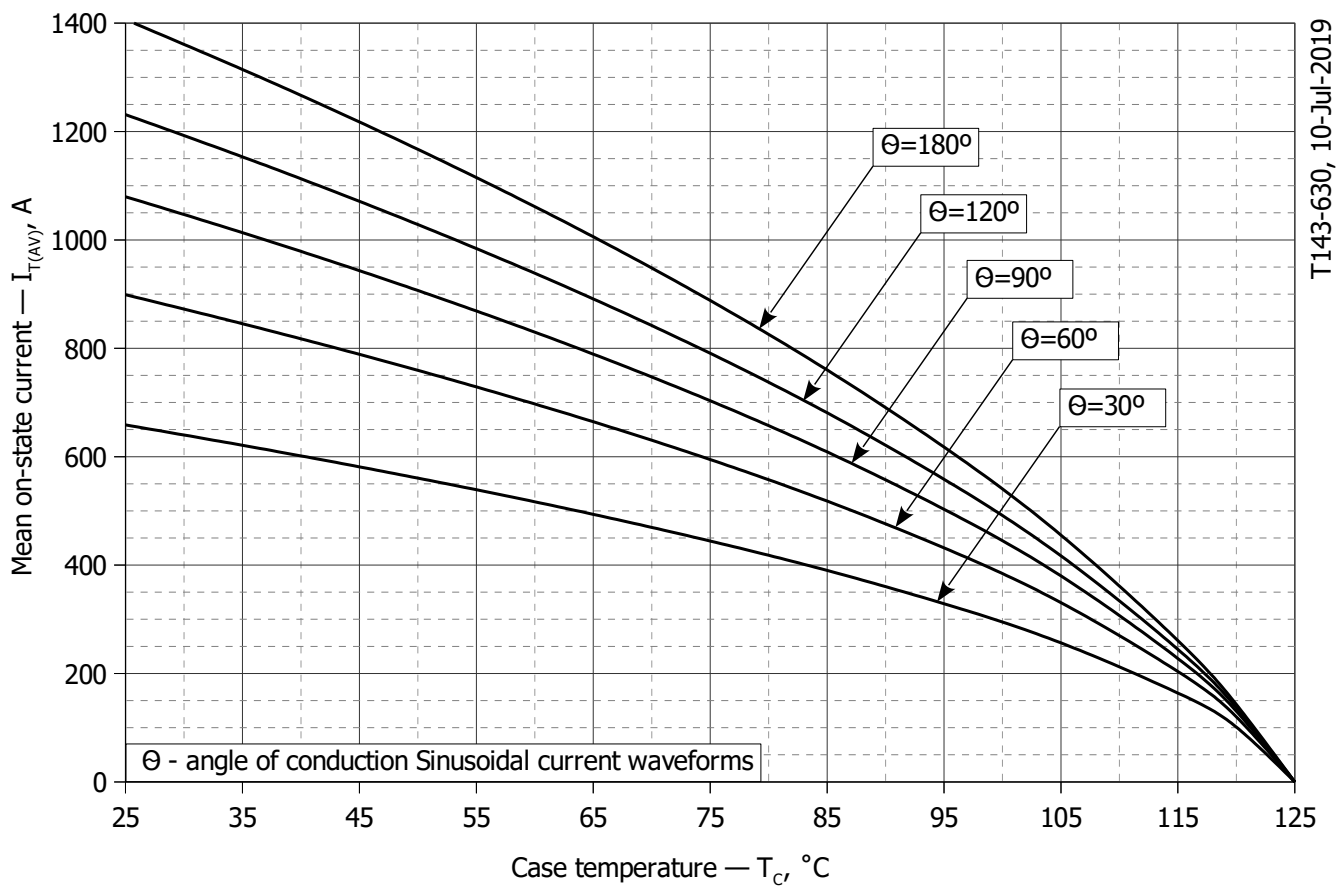
T143-630, 10-Jul-2019

**Fig. 7 - Mean on-state power dissipation  $P_{TAV}$  vs. mean on-state current  $I_{TAV}$  for sinusoidal current waveforms at different conduction angles ( $f=50\text{Hz}$ , DSC)**

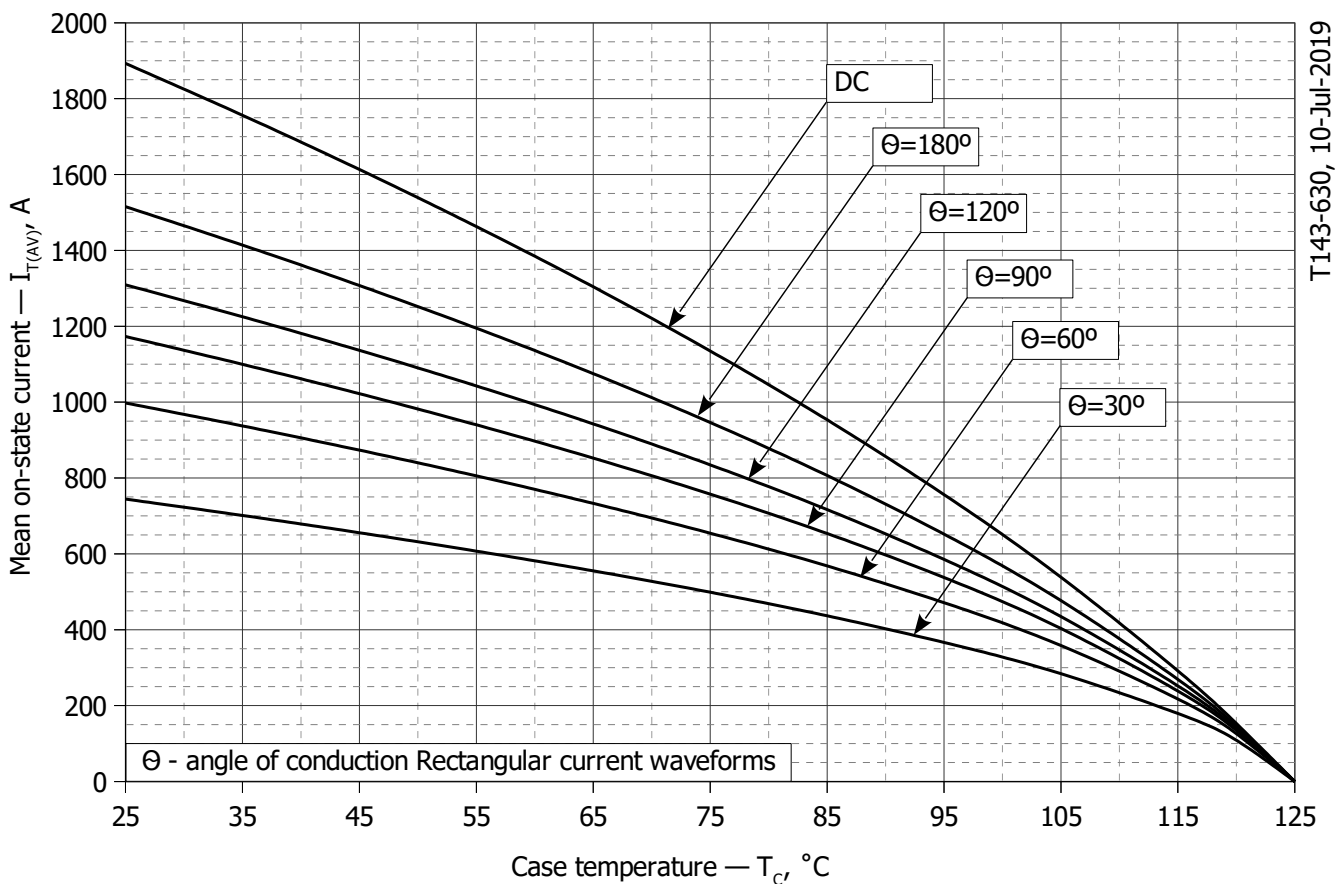


T143-630, 10-Jul-2019

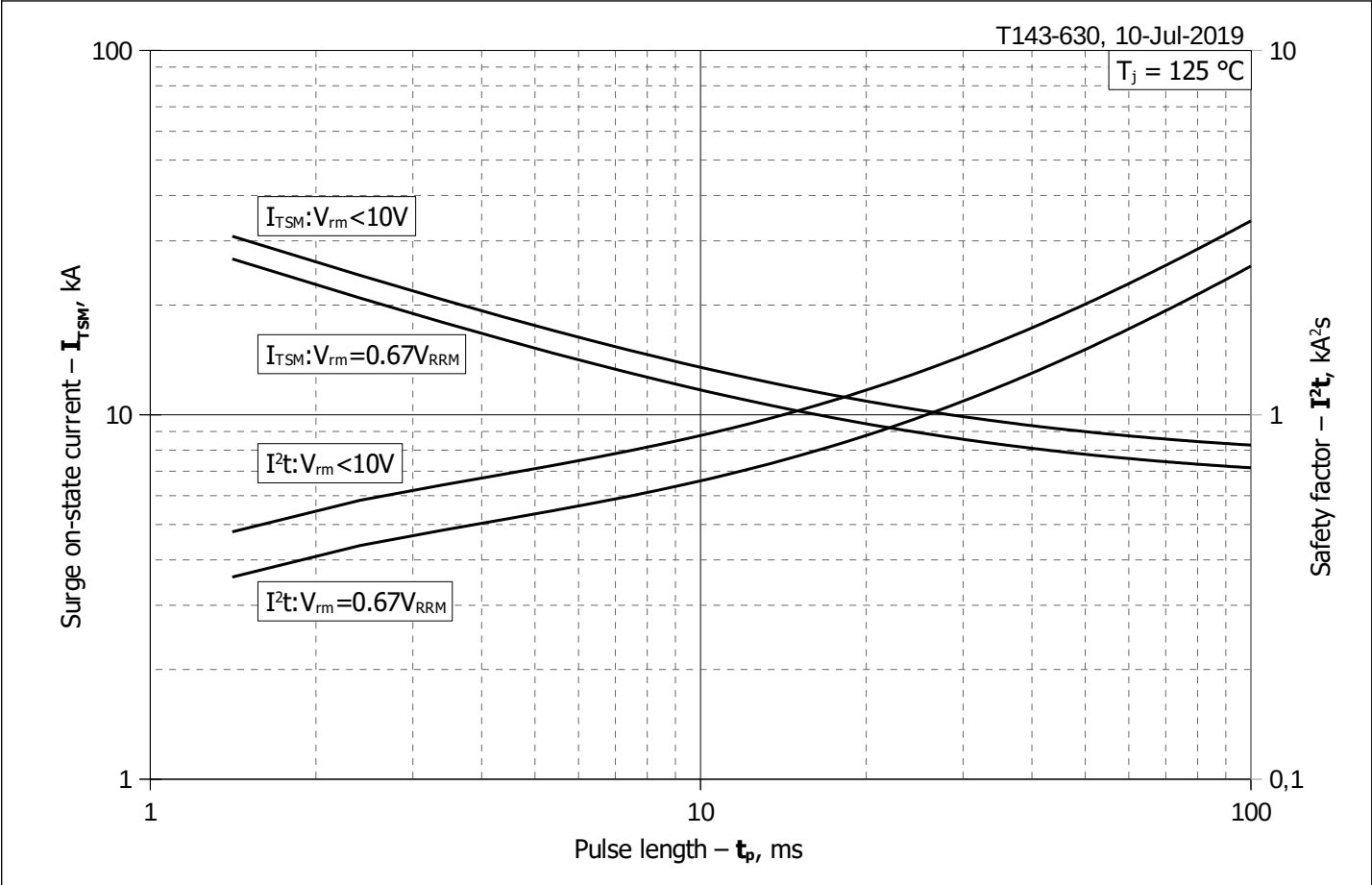
**Fig. 8 - Mean on-state power dissipation  $P_{TAV}$  vs. mean on-state current  $I_{TAV}$  for rectangular current waveforms at different conduction angles and for DC ( $f=50\text{Hz}$ , DSC)**



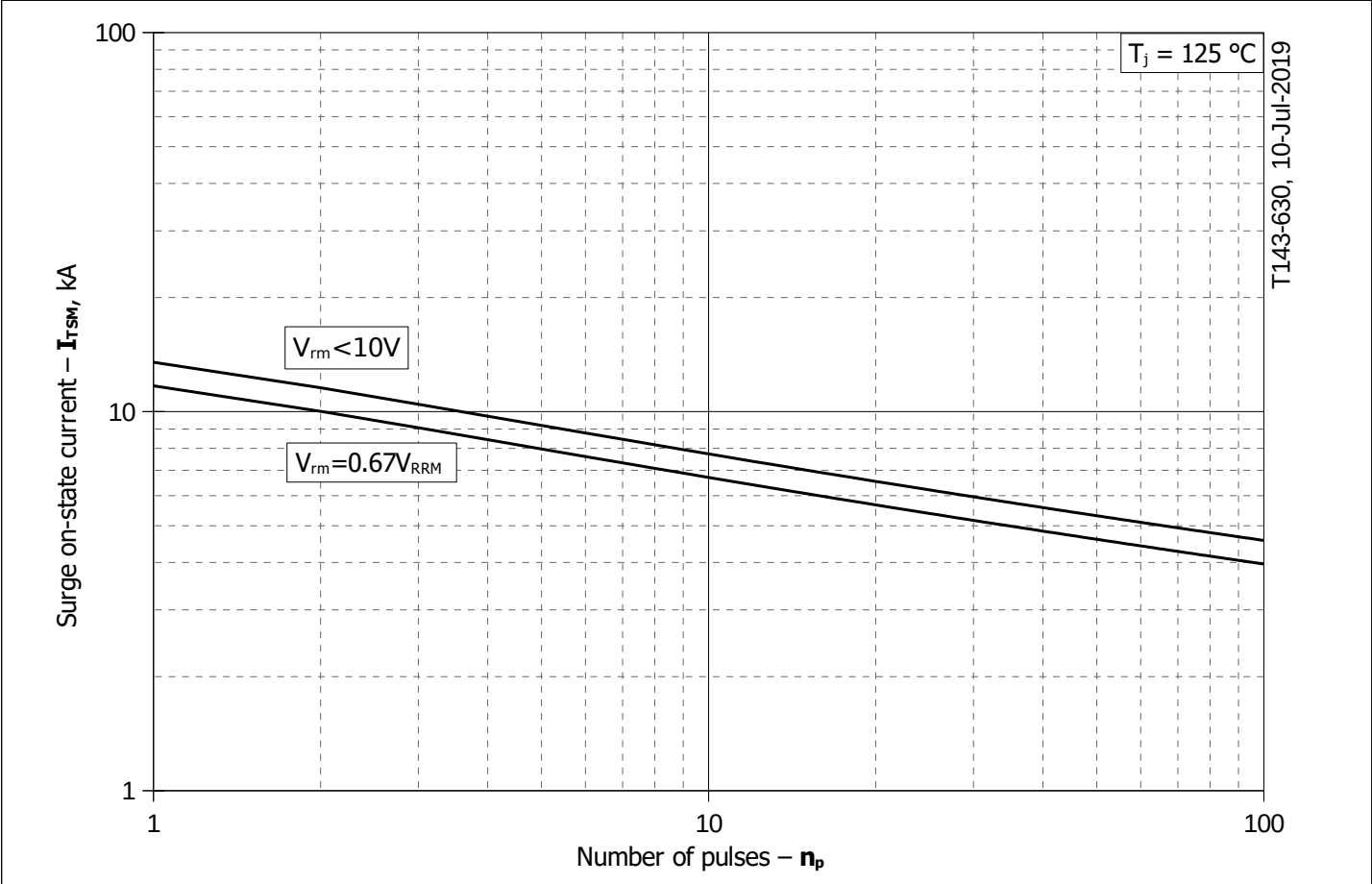
**Fig. 9 – Mean on-state current  $I_{TAV}$  vs. case temperature  $T_C$  for sinusoidal current waveforms at different conduction angles ( $f=50\text{Hz}$ , DSC)**



**Fig. 10 - Mean on-state current  $I_{TAV}$  vs. case temperature  $T_C$  for rectangular current waveforms at different conduction angles and for DC ( $f=50\text{Hz}$ , DSC)**



**Fig. 11 – Maximum surge on-state current  $I_{TSM}$  and safety factor  $I^2t$  vs. pulse length  $t_p$**



**Fig. 12 - Maximum surge on-state current  $I_{TSM}$  vs. number of pulses  $n_p$**