



# PROTON-ELECTROTEX RUSSIA

Optimum power handling  
Low on-state and switching losses  
Designed for traction and industrial applications

## Rectifier Stud Diode Type D175-500X-12

|                                 |            |     |     |     |             |      |      |
|---------------------------------|------------|-----|-----|-----|-------------|------|------|
| Mean on-state current           | $I_{FAV}$  |     |     |     | 500 A       |      |      |
| Repetitive peak reverse voltage | $V_{RRM}$  |     |     |     | 600...1200V |      |      |
| $V_{RRM}$ , V                   | 600        | 700 | 800 | 900 | 1000        | 1100 | 1200 |
| Voltage code                    | 6          | 7   | 8   | 9   | 10          | 11   | 12   |
| $T_{j\prime}$ , °C              | -60...+190 |     |     |     |             |      |      |

### MAXIMUM ALLOWABLE RATINGS

| Symbols and parameters |                                           | Units                            | Values               | Test conditions                                                                                  |                                                                                       |
|------------------------|-------------------------------------------|----------------------------------|----------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| ON-STATE               |                                           |                                  |                      |                                                                                                  |                                                                                       |
| I <sub>FAV</sub>       | Maximum allowable average forward current | A                                | 500<br>659           | T <sub>c</sub> =142 °C;<br>T <sub>c</sub> =120 °C;<br>180° half-sine wave; 50 Hz                 |                                                                                       |
| I <sub>FRMS</sub>      | RMS forward current                       | A                                | 785                  | T <sub>c</sub> =142 °C;<br>180° half-sine wave; 50 Hz                                            |                                                                                       |
| I <sub>FSM</sub>       | Surge forward current                     | kA                               | 16.0<br>19.0         | 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>R</sub> =0 V;  |
|                        |                                           |                                  | 17.0<br>20.0         | 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>R</sub> =0 V; |
| I <sup>2</sup> t       | Safety factor                             | A <sup>2</sup> s·10 <sup>3</sup> | 1200<br>1800         | 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>R</sub> =0 V;  |
|                        |                                           |                                  | 1100<br>1600         | 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>R</sub> =0 V; |
| BLOCKING               |                                           |                                  |                      |                                                                                                  |                                                                                       |
| V <sub>RRM</sub>       | Repetitive peak reverse voltages          | V                                | 600...1200           | T <sub>j min</sub> < T <sub>j</sub> < T <sub>j max</sub> ;<br>180° half-sine wave; 50 Hz;        |                                                                                       |
| V <sub>RSM</sub>       | Non-repetitive peak reverse voltages      | V                                | 700...1400           | T <sub>j min</sub> < T <sub>j</sub> < T <sub>j max</sub> ;<br>180° half-sine wave; single pulse; |                                                                                       |
| V <sub>R</sub>         | Reverse continuous voltages               | V                                | 0.6·V <sub>RRM</sub> | T <sub>j</sub> =T <sub>j max</sub> ;                                                             |                                                                                       |
| THERMAL                |                                           |                                  |                      |                                                                                                  |                                                                                       |
| T <sub>stg</sub>       | Storage temperature                       | °C                               | −60...+50            |                                                                                                  |                                                                                       |
| T <sub>j</sub>         | Operating junction temperature            | °C                               | −60...+190           |                                                                                                  |                                                                                       |
| MECHANICAL             |                                           |                                  |                      |                                                                                                  |                                                                                       |
| F                      | Mounting force                            | kN                               | 1.5...2.5            |                                                                                                  |                                                                                       |
| a                      | Acceleration                              | m/s <sup>2</sup>                 | 100                  |                                                                                                  |                                                                                       |

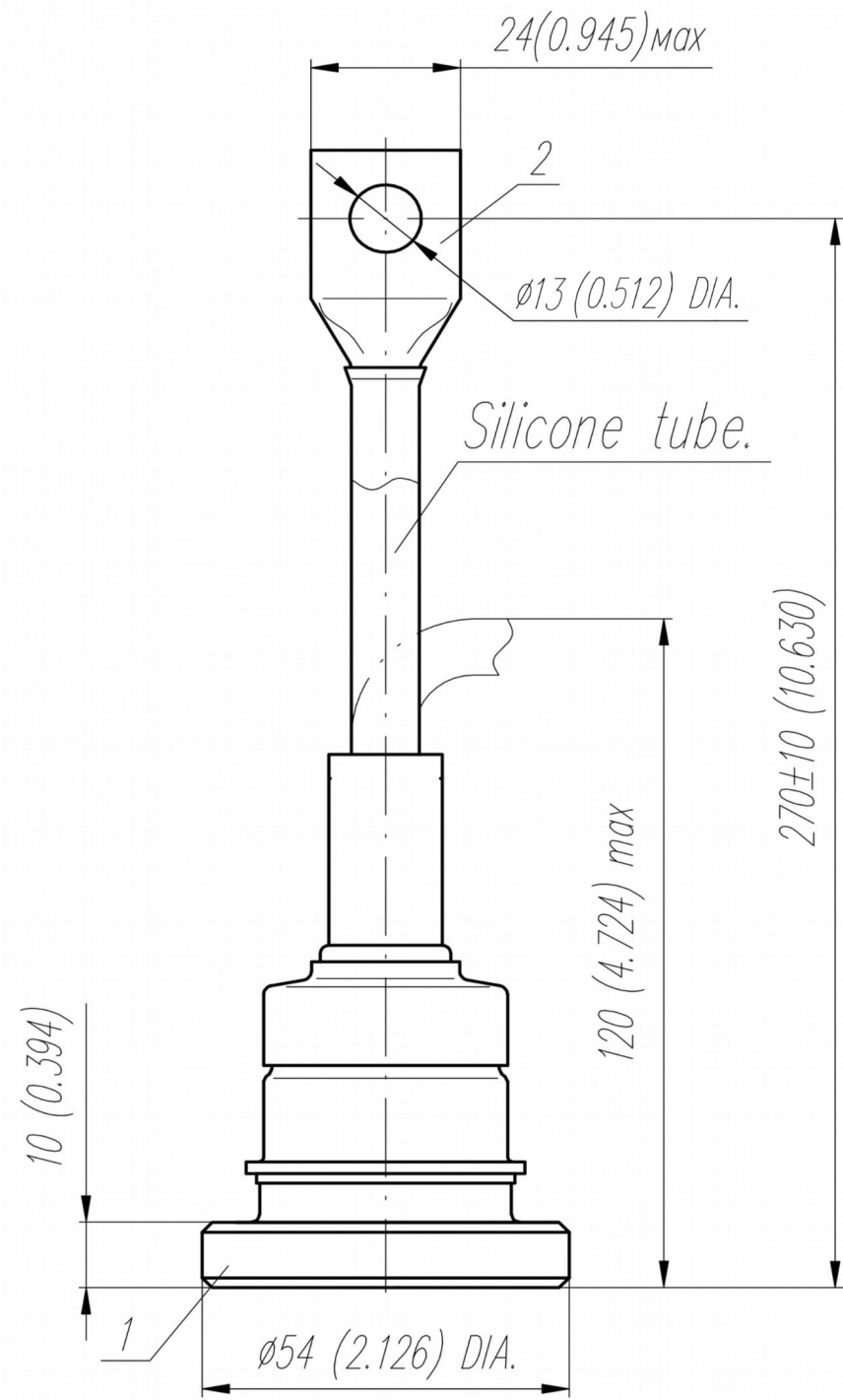
## CHARACTERISTICS

| Symbols and parameters |                                           | Units        | Values          | Conditions                                                                                                                |
|------------------------|-------------------------------------------|--------------|-----------------|---------------------------------------------------------------------------------------------------------------------------|
| ON-STATE               |                                           |              |                 |                                                                                                                           |
| V <sub>FM</sub>        | Peak forward voltage, max                 | V            | 1.40            | T <sub>j</sub> =25 °C; I <sub>FM</sub> =1570 A                                                                            |
| V <sub>F(TO)</sub>     | Forward threshold voltage, max            | V            | 0.809           | T <sub>j</sub> =T <sub>j max</sub> ;                                                                                      |
| r <sub>T</sub>         | Forward slope resistance, max             | mΩ           | 0.376           | 0.5 π I <sub>FAV</sub> < I <sub>T</sub> < 1.5 π I <sub>FAV</sub>                                                          |
| BLOCKING               |                                           |              |                 |                                                                                                                           |
| I <sub>RRM</sub>       | Repetitive peak reverse current, max      | mA           | 40              | T <sub>j</sub> =T <sub>j max</sub> ;<br>V <sub>R</sub> =V <sub>RRM</sub>                                                  |
| SWITCHING              |                                           |              |                 |                                                                                                                           |
| Q <sub>r</sub>         | Recovered charge, max                     | μC           | 830             | T <sub>j</sub> =T <sub>j max</sub> ; I <sub>TM</sub> =500 A ;<br>di <sub>R</sub> /dt=-10 A/μs ;<br>V <sub>R</sub> =100 V; |
| t <sub>rr</sub>        | Reverse recovery time, max                | μs           | 15              |                                                                                                                           |
| I <sub>rr</sub>        | Reverse recovery current, max             | A            | 110             |                                                                                                                           |
| THERMAL                |                                           |              |                 |                                                                                                                           |
| R <sub>thjc</sub>      | Thermal resistance, junction to case, max | °C/W         | 0.075           | Direct current                                                                                                            |
| MECHANICAL             |                                           |              |                 |                                                                                                                           |
| m                      | Weight, max                               | g            | 540             |                                                                                                                           |
| D <sub>s</sub>         | Surface creepage distance                 | mm<br>(inch) | 12.4<br>(4.882) |                                                                                                                           |
| D <sub>a</sub>         | Air strike distance                       | mm<br>(inch) | 12.4<br>(4.882) |                                                                                                                           |

## PART NUMBERING GUIDE

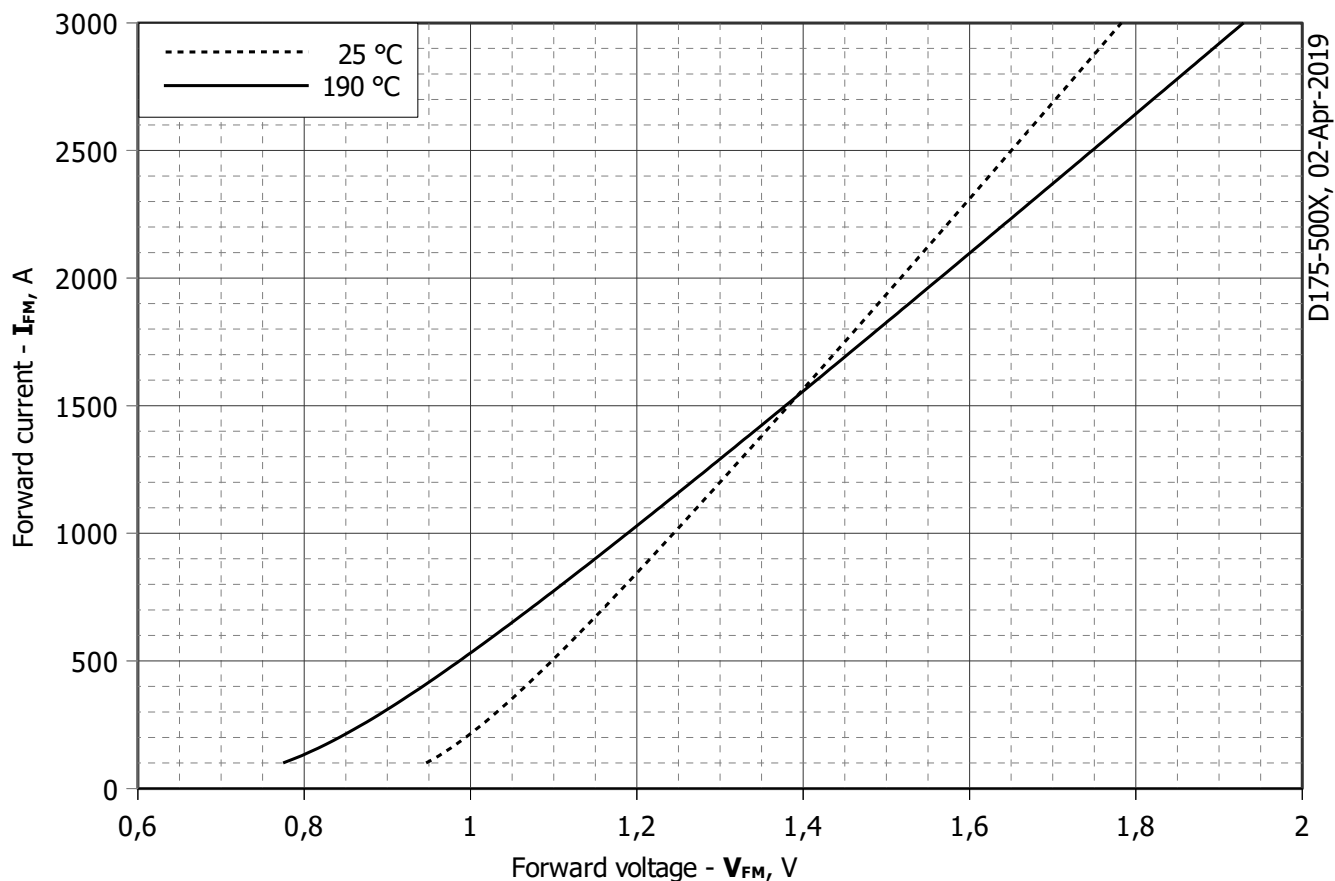
|   |     |     |   |    |   |
|---|-----|-----|---|----|---|
| D | 175 | 500 | X | 12 | N |
| 1 | 2   | 3   | 4 | 5  | 6 |

1. D — Rectifier Diode
2. Design version
3. Average forward current, A
4. Polarity: X – Cathode to Stud; Anode to Stud – no symbol
5. Voltage code
6. Ambient conditions: N – normal; T – tropical



| Polarity |                 | Example of code designation | Reference designation | Colors     |         |
|----------|-----------------|-----------------------------|-----------------------|------------|---------|
|          |                 |                             |                       | Anode      | Cathode |
| Reverse  | Cathode to stud | D175-500X-12                |                       | Black tube | -       |

All dimensions in millimeters (inches)



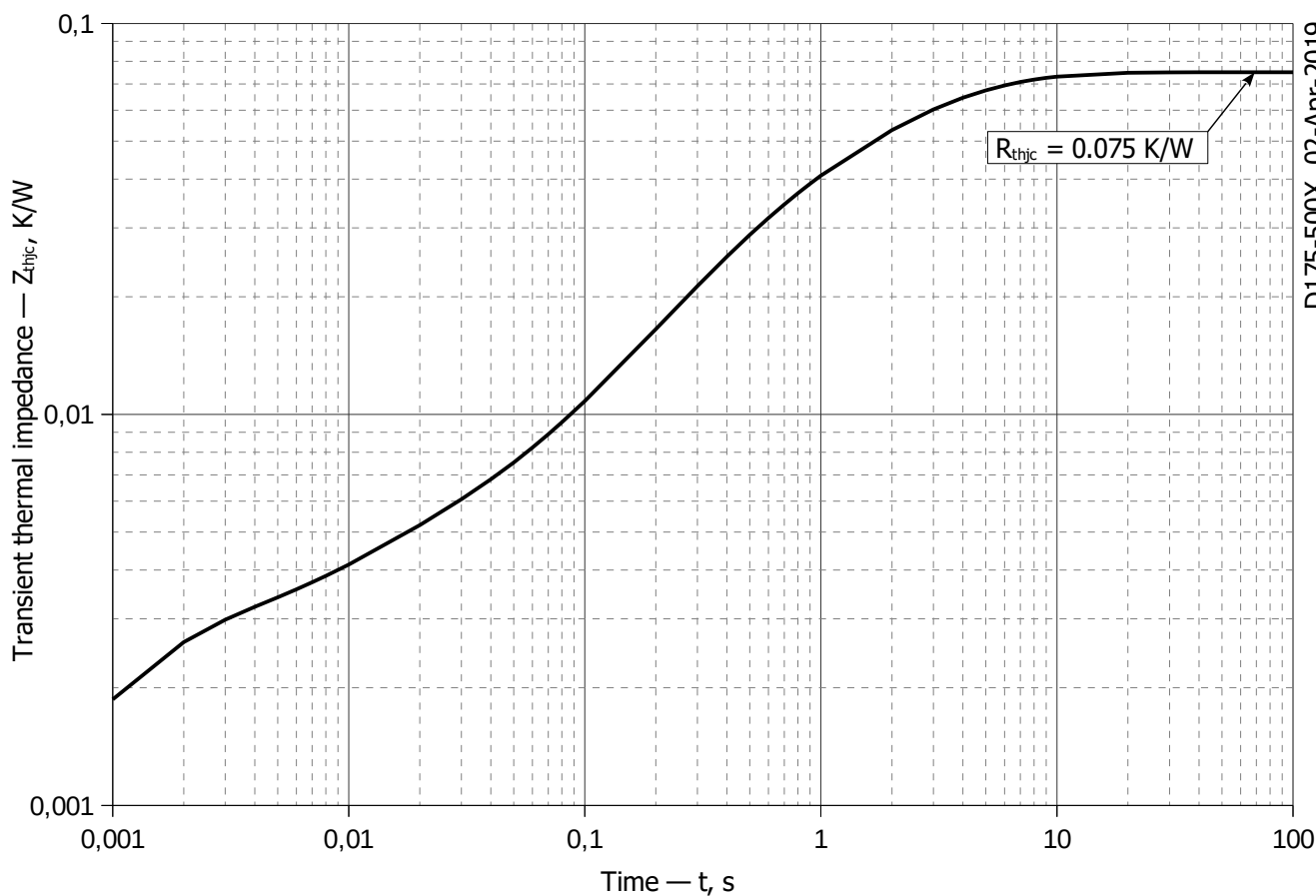
**Fig 1 – Forward characteristics of Limit device**

Analytical function for Forward characteristic:

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

|          | Coefficients for max curves |                    |
|----------|-----------------------------|--------------------|
|          | $T_j = 25^\circ\text{C}$    | $T_j = T_{j \max}$ |
| <b>A</b> | 0.75818000                  | 0.49236000         |
| <b>B</b> | 0.00026115                  | 0.00036297         |
| <b>C</b> | 0.03751000                  | 0.05786700         |
| <b>D</b> | -0.00108460                 | -0.00210100        |

**Forward 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  $t$ .

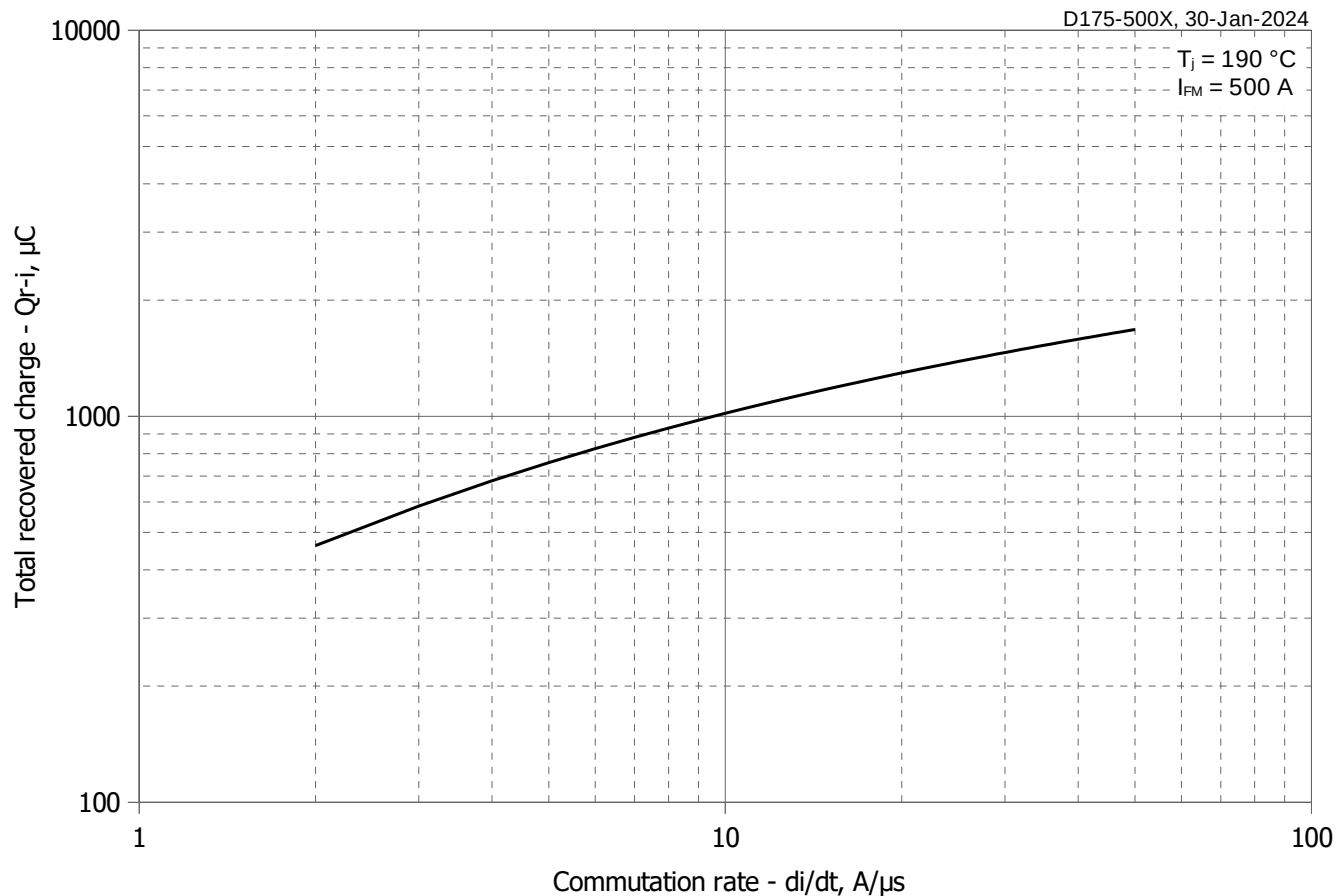
$R_i$  = Amplitude of  $p_{th}$  term.

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

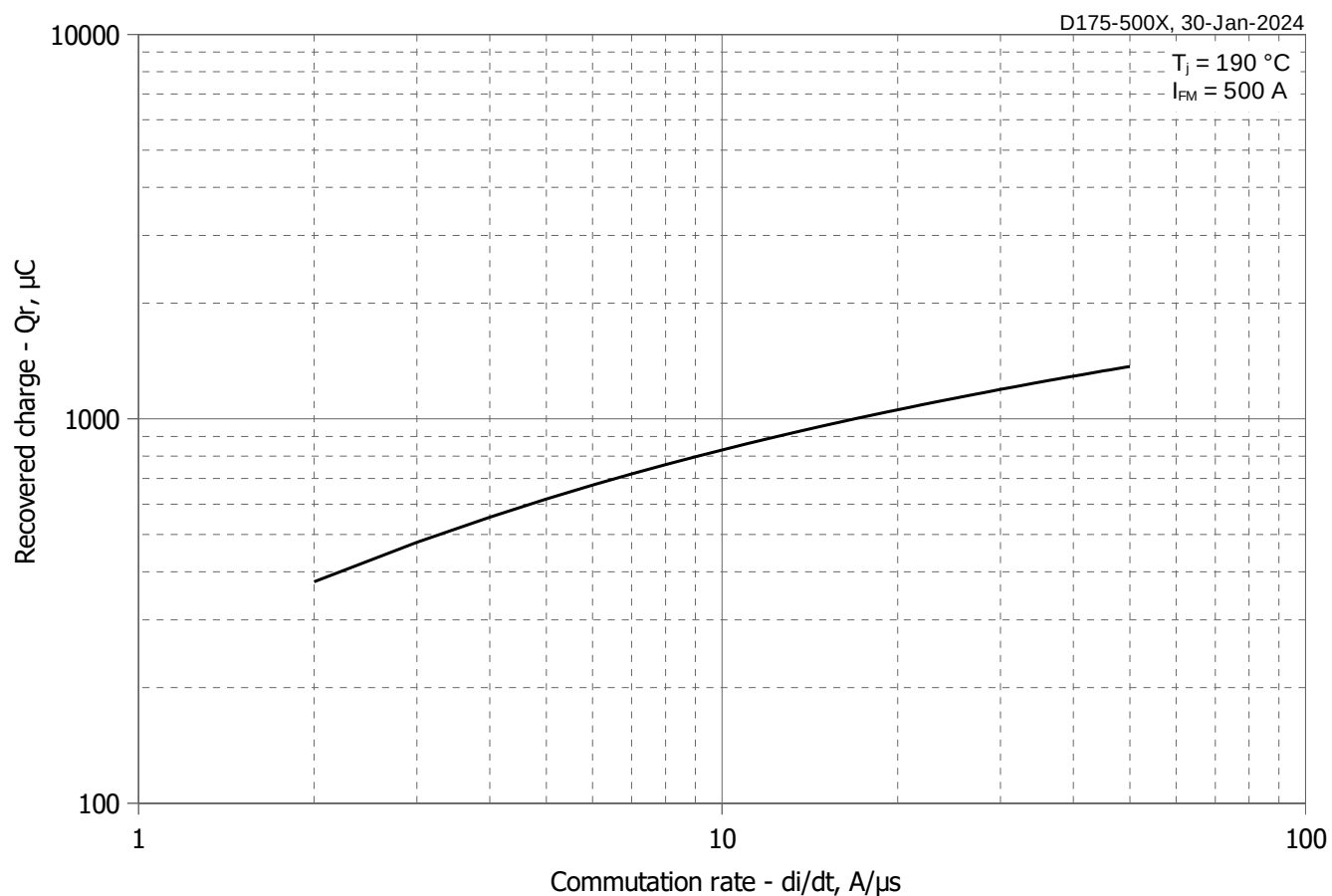
DC

| $i$          | 1        | 2       | 3       | 4        | 5         | 6       |
|--------------|----------|---------|---------|----------|-----------|---------|
| $R_i$ , K/W  | 0.013357 | 0.02733 | 0.01495 | 0.001445 | 0.002488  | 0.01543 |
| $\tau_i$ , s | 4.627    | 2.249   | 0.3406  | 0.01043  | 0.0009112 | 0.9081  |

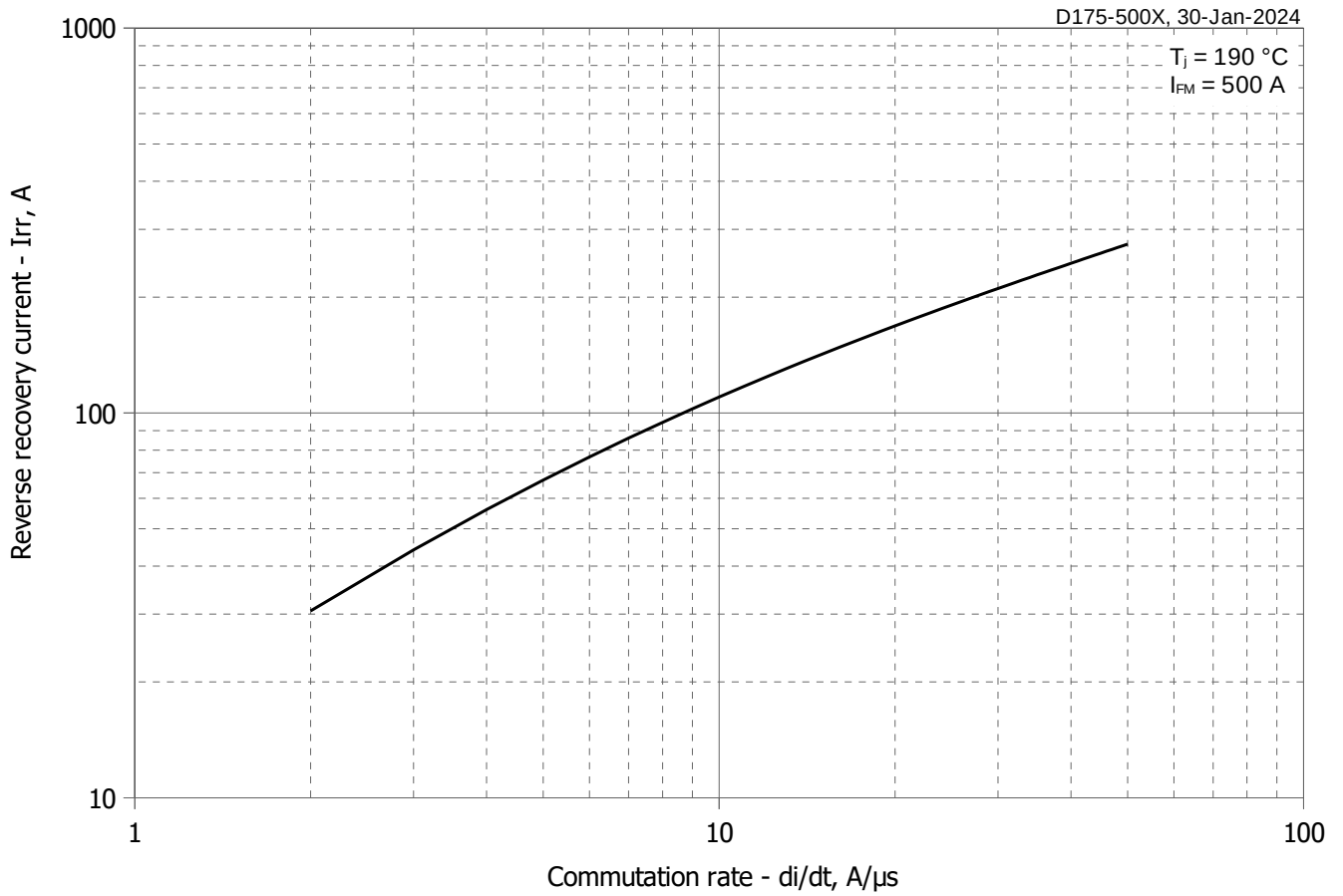
**Transient thermal impedance junction to case  $Z_{thjc}$  model (see Fig. 2)**



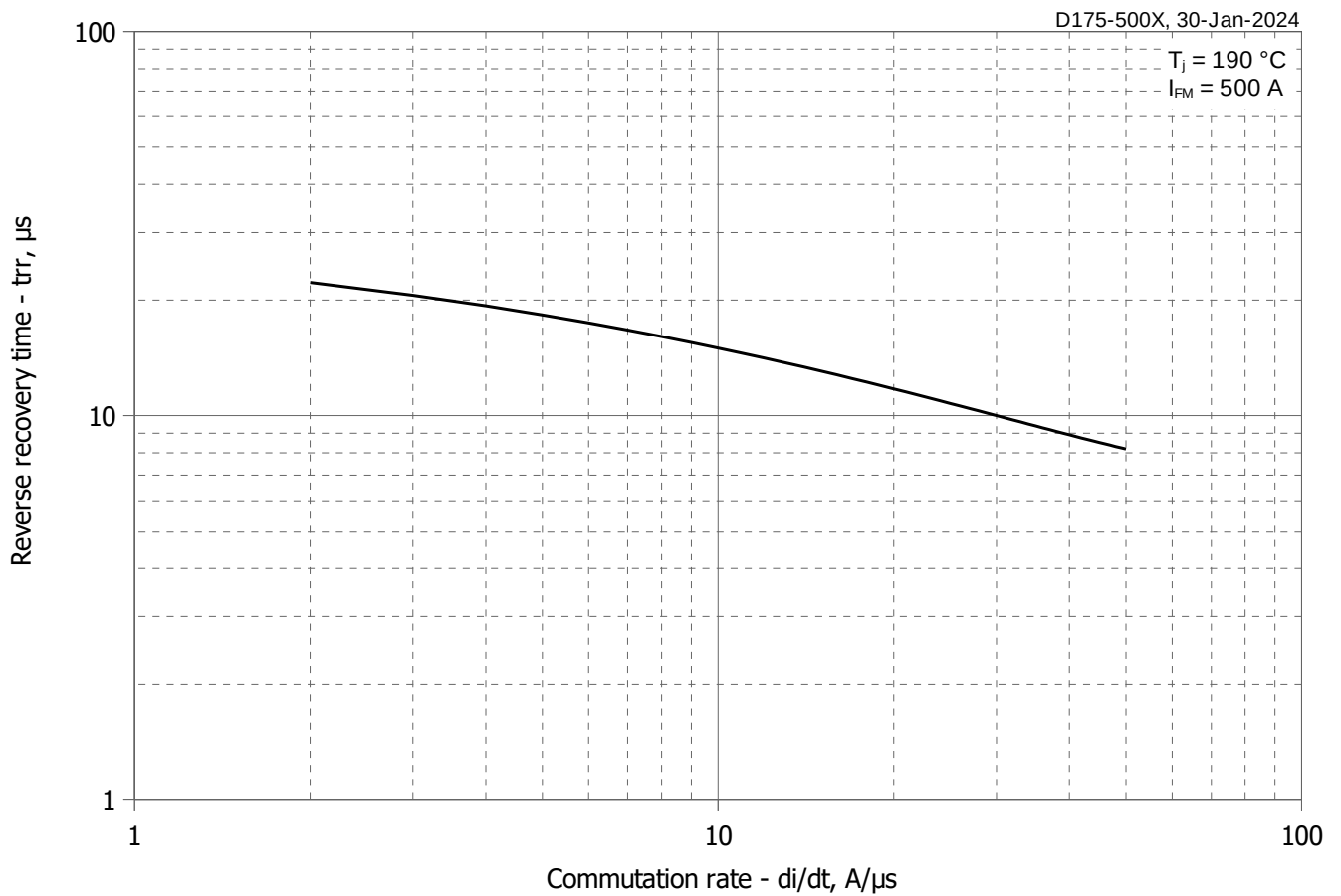
**Fig 3 – Maximum recovered charge  $Q_{r-i}$  (integral) vs. commutation rate  $di_R/dt$**



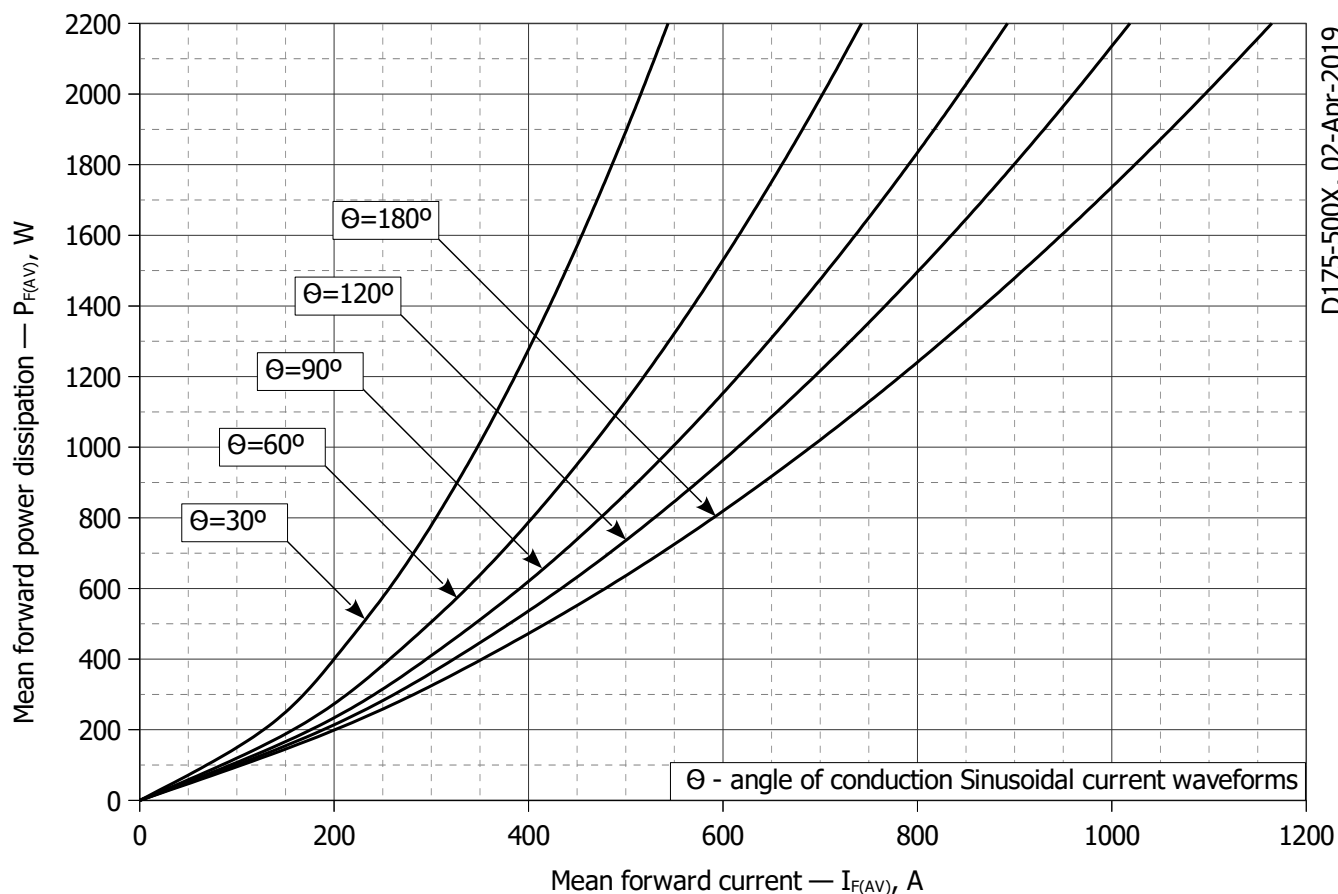
**Fig 4 – Maximum recovered charge  $Q_r$  vs. commutation rate  $di_R/dt$  (25% chord)**



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

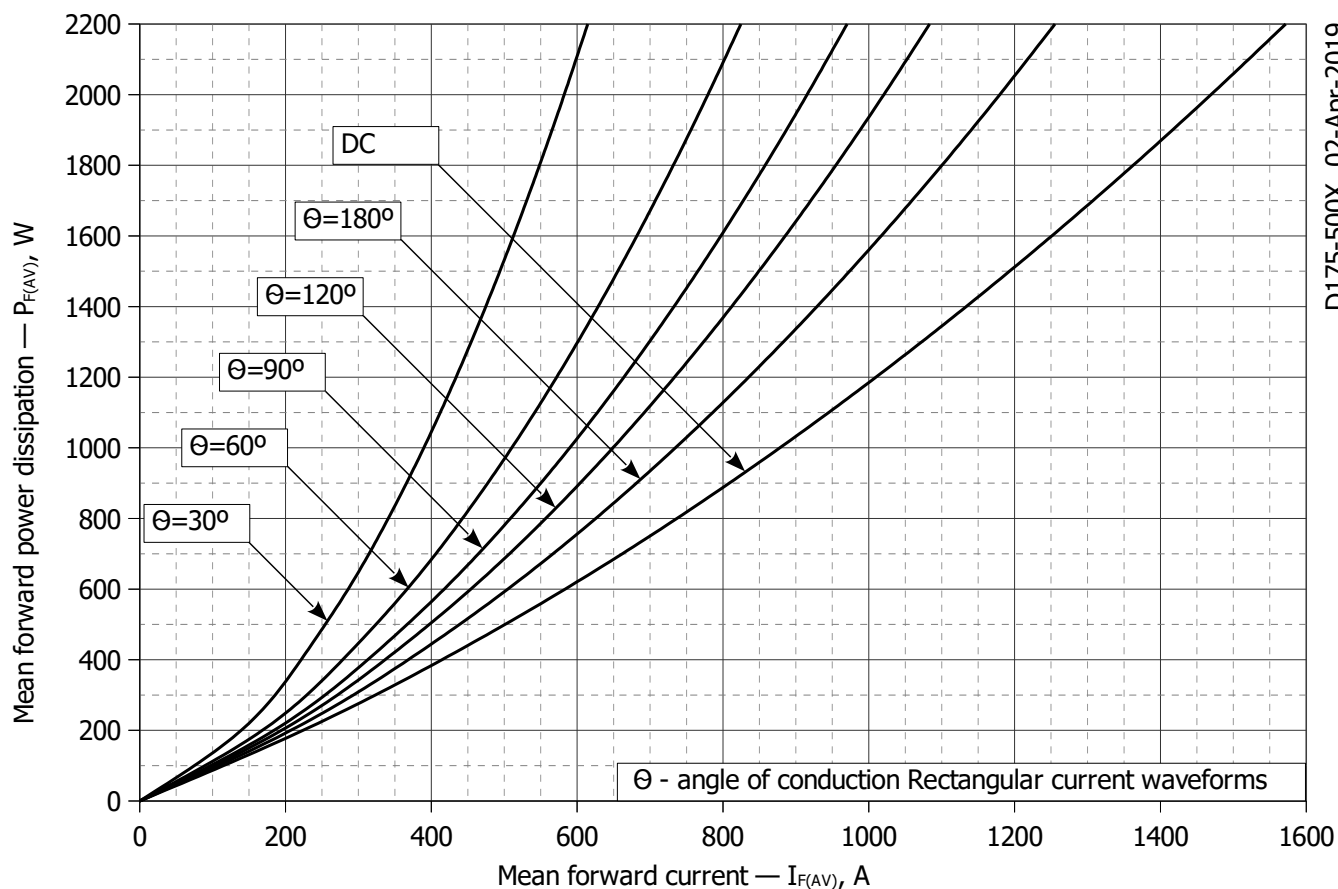


**Fig 6 – Maximum recovery time  $t_{rr}$  vs. commutation rate  $di_R/dt$  (25% chord)**



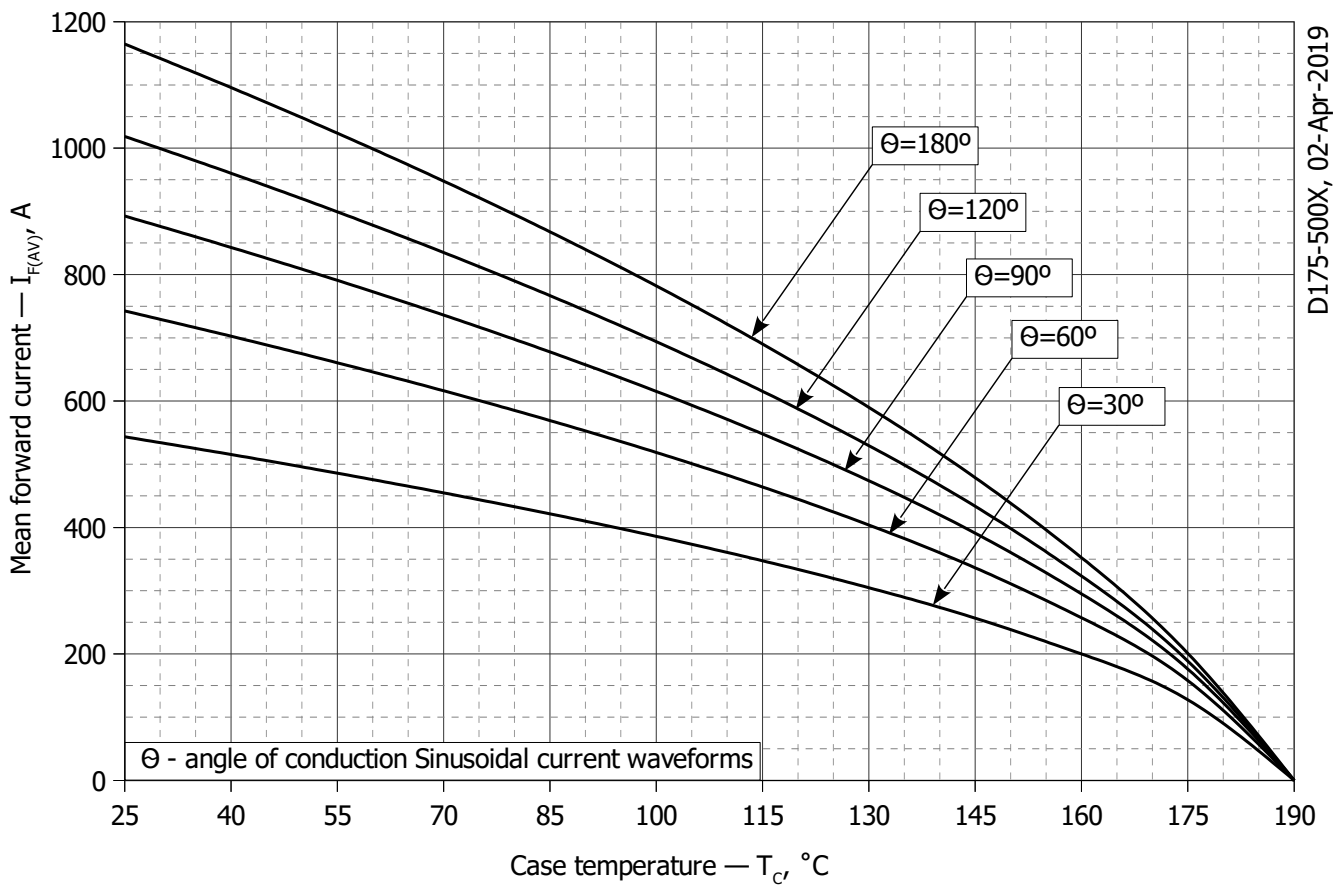
D175-500X, 02-Apr-2019

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



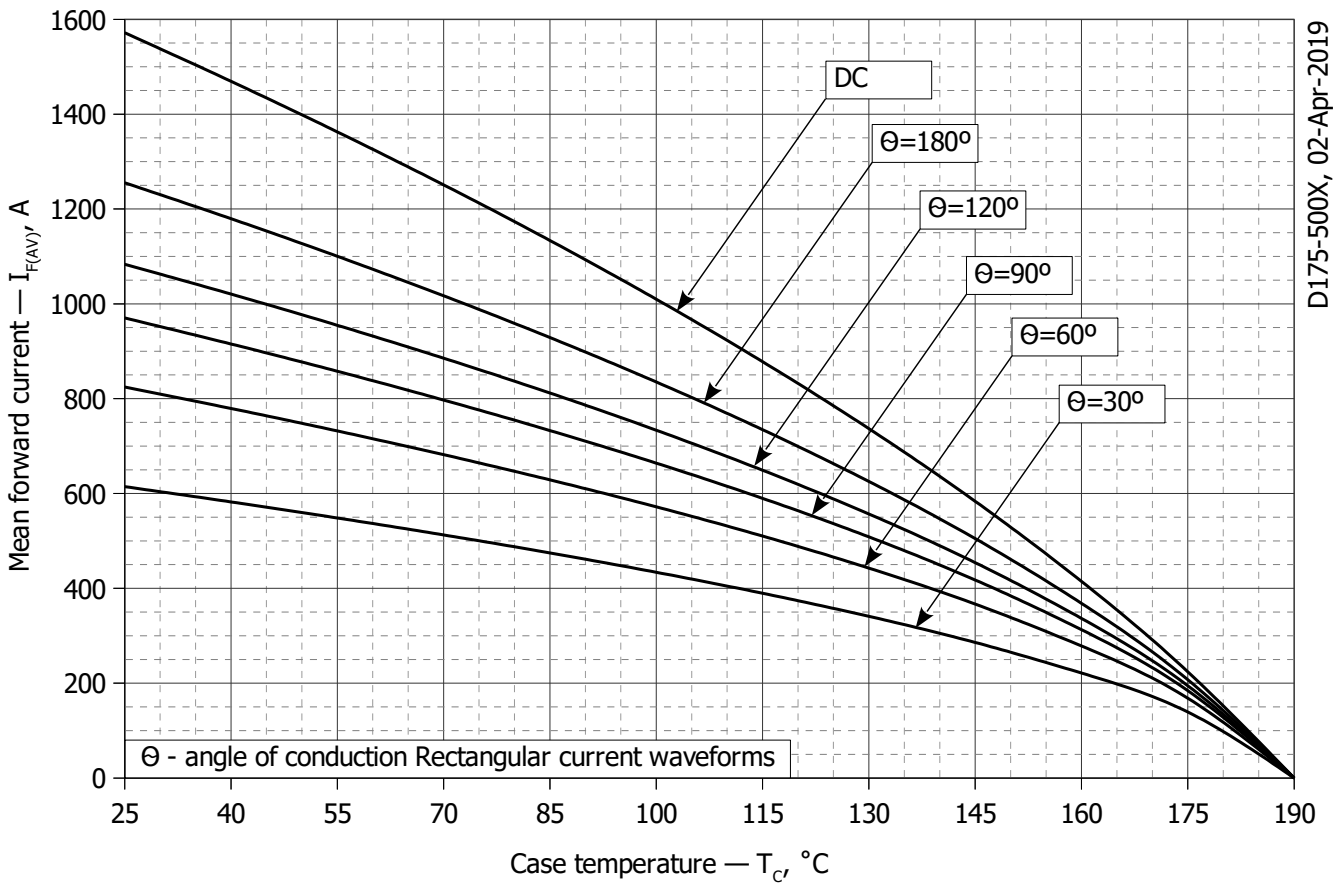
D175-500X, 02-Apr-2019

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



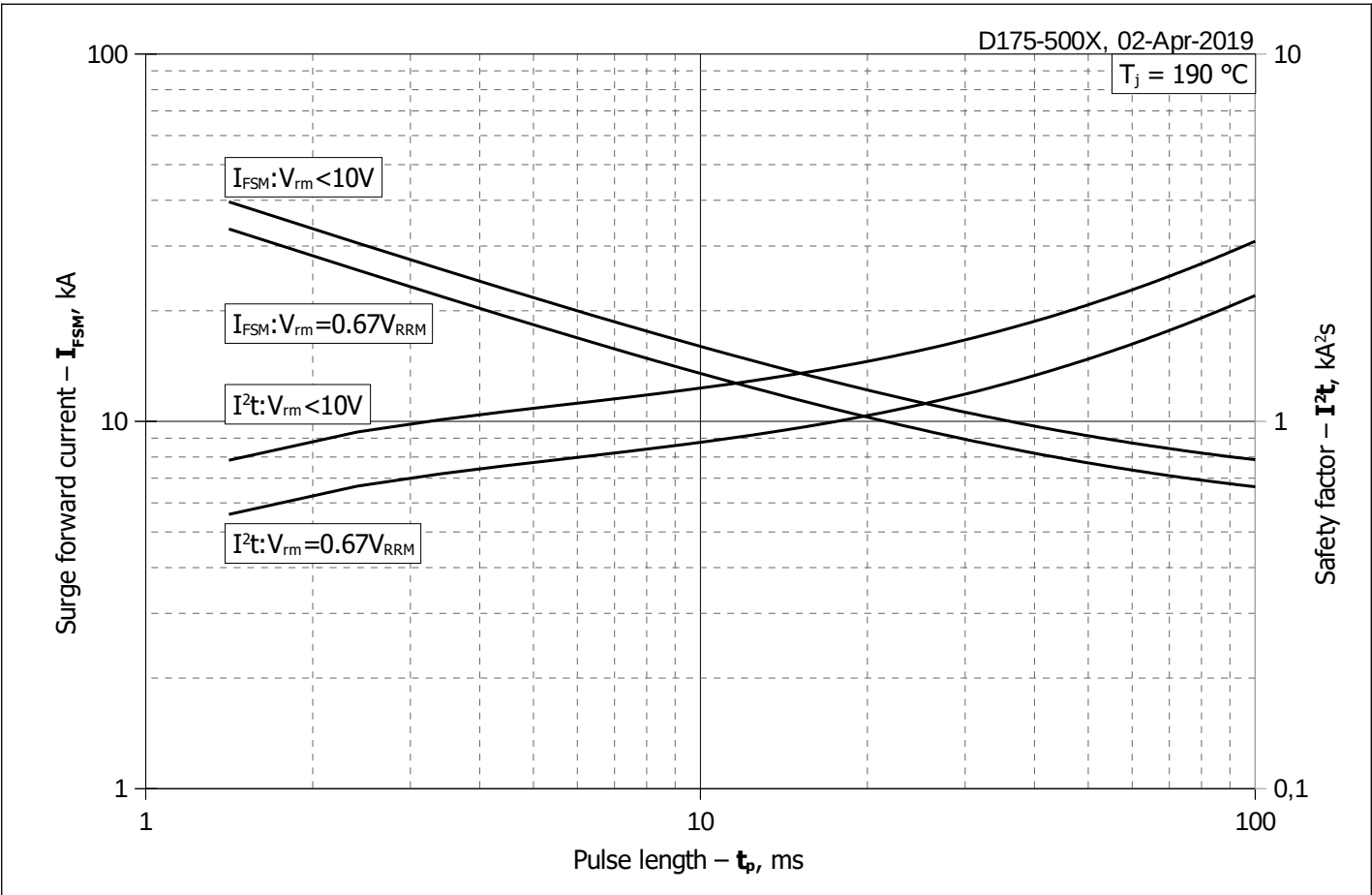
D175-500X, 02-Apr-2019

**Fig. 9 – Mean forward current  $I_{FAV}$  vs. case temperature  $T_C$  for sinusoidal current waveforms at different conduction angles ( $f=50\text{Hz}$ )**

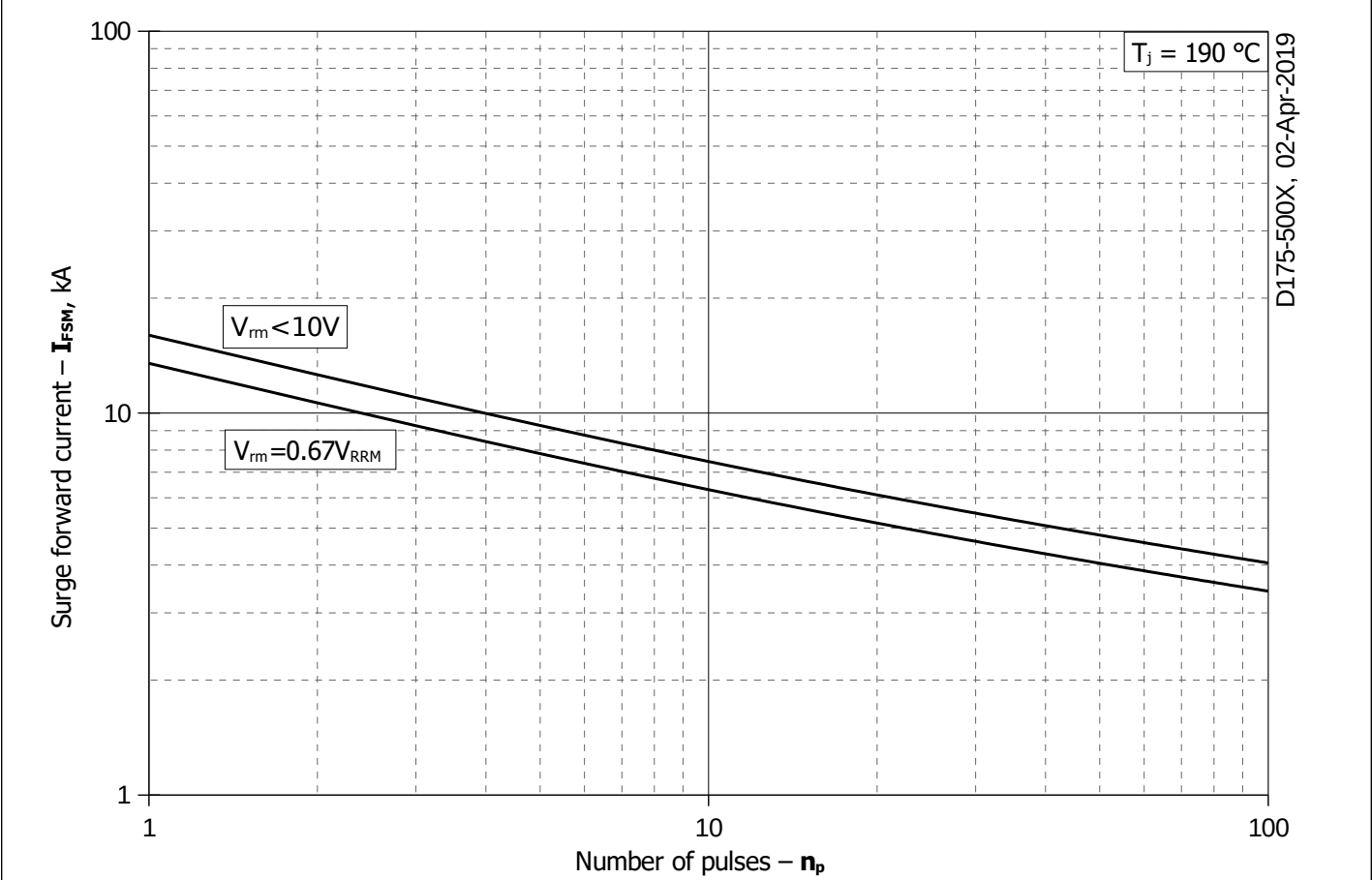


D175-500X, 02-Apr-2019

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



**Fig. 11 – Maximum surge forward current  $I_{FSM}$  and safety factor  $I^2t$  vs. pulse length  $t_p$**



**Fig. 12 - Maximum surge forward current  $I_{FSM}$  vs. number of pulses  $n_p$**