Calculation formulas for Platinum RTDs (**R**esistance **T**emperature **D**etectors)

using the Callendar–Van Dusen equation
(-> https://en.wikipedia.org/wiki/Callendar%E2%80%93Van_Dusen_equation)

This calculations are valid for the different Platinum RTDs:
Pt 100 R_0=100Ω
Pt 500 R_0=500Ω
Pt1000 R_0=1000Ω
Pt10000 R_0=10000Ω

To perform the calculation different coefficients are necessary,
which are standardized in various national and international standards:

Callendar-Van Dusen Coefficients Corresponding to Common RTDs

Standard	Temperature Coefficient α_0	*A*	*B*	*C* *
DIN 43760	0,003850	3,9080E-03	-5,8019E-07	-4,2735E-12
IEC 60751:2008 DIN EN 60751:2009-5	**0,003850**	**3,9083E-03**	**-5,7750E-07**	**-4,1830E-12**
American	0,003911	3,9692E-03	-5,8495E-07	-4,2325E-12
ITS-90	0,003926	3,9848E-03	-5,8700E-07	-4,0000E-12

**(For temperatures below 0°C only / C = 0.0 for temperatures above 0°C)*

Reverse Coefficients (numerical calculated):
(for calculating temperature t from resistance R_t for R_t <R_0 (-200°C ... 0°C)

Standard	*D*	*E*	*F*	*G*
DIN 43760	-241,97178	2,2239318	2,5537693E-03	-5,9699237E-06
IEC 60751:2008 DIN EN 60751:2009-5	**-242,08907**	**2,2275964**	**2,5172525E-03**	**-5,8537925E-06**
American	-238,70083	2,2018291	2,4081649E-03	-5,5744200E-06
ITS-90	-238,09156	2,2032821	2,2936607E-03	-5,1835420E-06

1.) Linear approximation

Linear approximation formula for 0°C … 100°C with errors up to +/- 0,4°C
by using the coefficient α_0 (from tables above):

$$\boldsymbol{\alpha_0} = \frac{R_{100} - R_0}{100 * R_0}$$

with R_0 = resistance of the sensor at 0°C and R_{100} = resistance of the sensor at 100°C

$$R_t = R_0 * (1 + (\boldsymbol{\alpha_0} * t))$$

$$t = \frac{R_t - R_0}{\boldsymbol{\alpha_0} * R_0}$$

2.) More exact quadratic and cubic approximation

2.1) Calculating resistance from temperature

2.1.1) Calculating resistance R_t from temperature t for 0°C … +850°C:

$$R_t = R_0 * (1 + \boldsymbol{A} * t + \boldsymbol{B} * t^2)$$

2.2.2) Calculating resistance R_t from temperature t for -200°C … 0°C:

$$R_t = R_0 * (1 + \boldsymbol{A} * t + \boldsymbol{B} * t^2 + \boldsymbol{C} * (t - 100) * t^3)$$

2.2) Calculating temperature from resistance

2.2.1) Calculating temperature t from resistance R_t for 0°C … +850°C:

$$t = \frac{\boldsymbol{A}}{2 * ABS(\boldsymbol{B})} - \sqrt[2]{\frac{\boldsymbol{A}^2}{4 * \boldsymbol{B}^2} - \frac{R_t - R_0}{R_0 * ABS(\boldsymbol{B})}}$$

2.2.2) Calculating temperature t from resistance R_t for -200°C ... 0°C:

$$t = \boldsymbol{D} + \boldsymbol{E} * \left(\frac{R_t * 100}{R_0}\right) + \boldsymbol{F} * \left(\frac{R_t * 100}{R_0}\right)^2 + \boldsymbol{G} * \left(\frac{R_t * 100}{R_0}\right)^3$$

Example for IEC 60751:2008 (=DIN EN 60751:2009-5)
(The signs (+/-) of the coefficients must be respected !)

$$t = -242{,}089 + 2{,}227596 * \left(\frac{R_t * 100}{R_0}\right) + 2{,}51725 * 10^{-3} * \left(\frac{R_t * 100}{R_0}\right)^2 - 5{,}85379 * 10^{-6} * \left(\frac{R_t * 100}{R_0}\right)^3$$