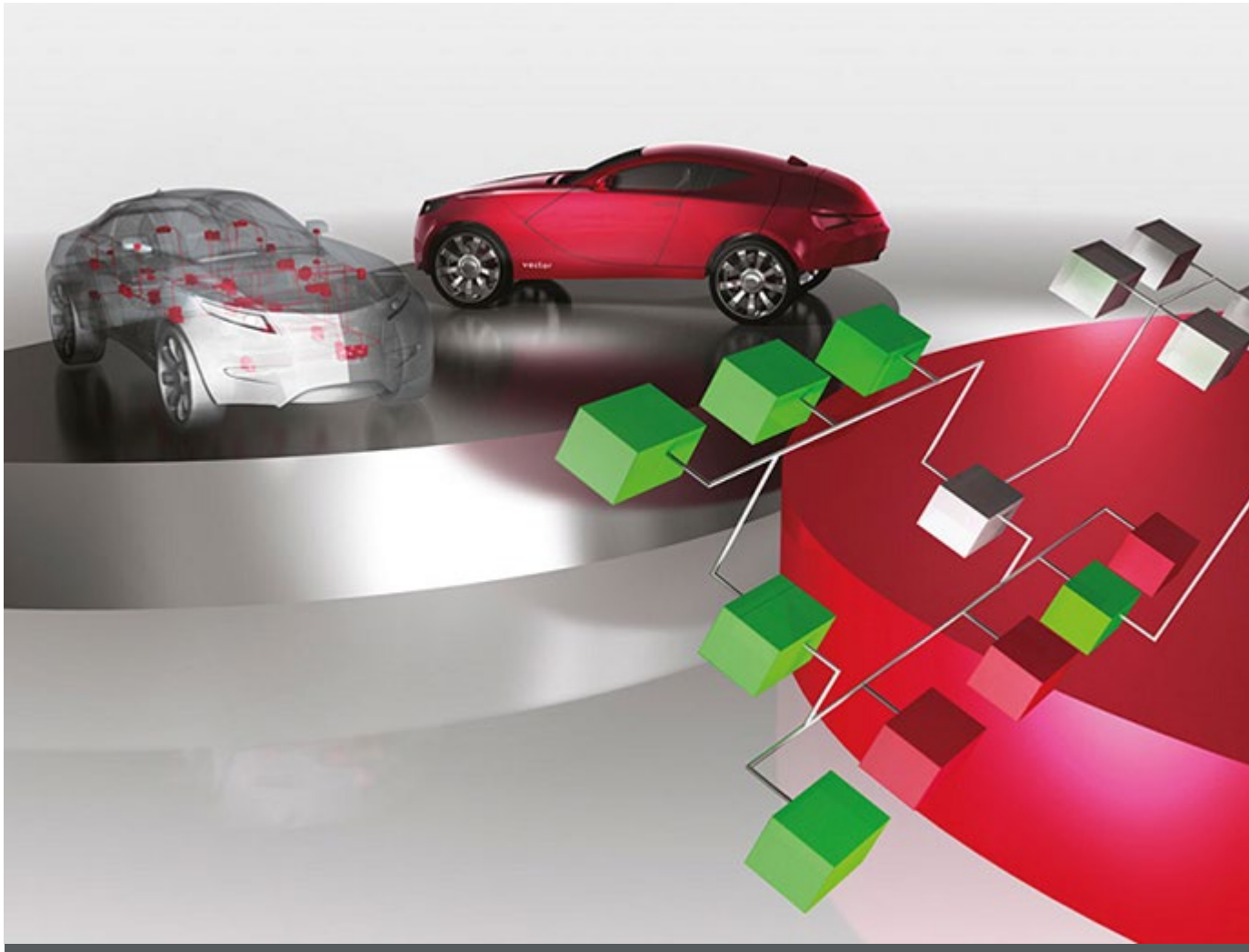
VECTOR



User Manual
VT System Calibration Manager
Calibrate Measurements and Output Channels

Version 1.0.2
English

Imprint

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Table of Contents

1 Introduction

This chapter contains the following information:

1.1 About this User Manual

To find information quickly

This user manual provides you with the following navigational aids:

- At the beginning of each chapter you will find a summary of the contents
- The header shows which chapter and paragraph you are located in
- The footer shows which version the user manual refers to
- The index, located at the end of the manual on page, helps you to find information quickly

Conventions

The following two charts show the spelling and symbol conventions used in this manual.

Style	Utilization
bold	Fields, interface elements, window and dialog names in the software. Accentuation of warnings and notes. **[OK]** Buttons are denoted by square brackets **File** | **Save** Notation for menu paths (menu commands)
CANoe	Legally protected proper names and side notes.
`Source code`	File name and source code.
Hyperlink	Hyperlinks and references.
<Ctrl>+<S>	Notation for shortcuts.

Symbol	Utilization
	You can obtain supplemental information here.
	This symbol calls your attention to warnings.
	You can find additional information here.
	Here is an example that has been prepared for you.
	Step-by-step instructions provide assistance at these points.
	Instructions on editing files are found at these points.
	This symbol warns you not to edit the specified file.

1.1.1 Certification

Certified Quality Management System
Vector Informatik GmbH has ISO 9001:2008 certification. The ISO standard is a globally recognized quality standard.

CE Compliance
All VT System products comply with CE regulations.

1.1.2 Warranty

Limitation of warranty
We reserve the right to change the contents of the documentation and the software without notice. Vector Informatik GmbH assumes no liability for correct contents or damages which are resulted from the usage of the user manual. We are always grateful for references to mistakes or for suggestions for improvement, so as to be able to offer you even better-performing products in the future.

1.1.3 Support

Need support?
You can get through to our hotline by calling

+49 (711) 80670-200

or you can send a problem report to CANoe Support.

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2 Calibration Concept

This chapter contains the following information:

2.1 General

Calibration for accuracy

To increase the accuracy of VT System modules some devices have the ability to calibrate their measurements and output channels.

VT System Calibration Manager

The VT System Calibration Manager is intended to read and write the calibration parameter of VT Modules. Another purpose of the tool is to start the automated self-calibration process.

Two ways for calibration

The calibration is software based and allows a linear correction of the supported measurement or output channels. For a correction normally two parameter scale and offset are available. Each measurement or output range on one channel can be calibrated separately. The calibration parameters can be determined in two different ways. One way is the internal self-calibration process and the other way is the external calibration with additional measurement equipment.

2.2 Internal Self-Calibration

Calibration without additional equipment

The internal self-calibration is an easy method to acquire the calibration parameter without any additional measurement equipment. Each supported module has a special build in circuit for this purpose. The internal self-calibration has its limits and isn't as precise as an external calibration would be.

Note: For the internal self-calibration it's important that no external wiring is connected to the VT System module. Otherwise the calibration process won't work correctly or it even comes to a damage of the module.

2.3 External Calibration

Calibration more precise with additional equipment

For the external calibration additional measurement equipment is needed to determine the correction parameters. This calibration method needs more effort but leads in the best possible accuracy according to the used external measurement instruments.

2.4 Parameter Calculation

Manually calculation for external calibration

For the external calibration the correction parameter must be calculated manually. For this purpose a series of measurement values must be acquired first. Based on these values the parameter scale and offset of the regression line can be calculated.

Calculation of the regression line

Formula	Description
$f_R(x) = m_R \cdot x + t_R$	m_R is the gradient and t_R is the offset value of the regression line. These two parameters will be needed for the calculation of the new calibration factors for the module.

Calculation of $\mathbf{m_R}$

Formula	Description
$m_R = \frac{\sum_{i=1}^{n}(x_i-\bar{x})\cdot(y_i-\bar{y})}{\sum_{i=1}^{n}(x_i-\bar{x})^2}$	x_i: Target value $\bar{x}$: Average of target values y_i: Measured value $\bar{y}$: Average of measured values

Calculation of $\boldsymbol{t_R}$

Formula	Description
$t_R = \bar{y} - m_R \cdot \bar{x}$	$\bar{y}$: Average of measured values $\bar{x}$: Average of target values

Calculation of $\bar{x}$ and $\bar{y}$

Formula $\bar{x}$	Formula $\bar{y}$
$\bar{x} = \frac{\sum_{i=1}^{n} x}{n}$	$\bar{y} = \frac{\sum_{i=1}^{n} y}{n}$

With the value of m_R and t_R the needed correction scale value m_C and the correction offset value t_C can be calculated.

Calculation of m_C and t_C

Formula m_C	Formula t_C
$m_C = \frac{m_{C_{Old}}}{m_R}$	$t_C = \frac{m_C \cdot (t_{C_{Old}} - t_R)}{m_{C_{Old}}}$

$m_{C_{Old}}$ and $t_{C_{Old}}$ are the actual values for scale and offset which were active during the measurement of the new values.

2.4.1 Example

Following example demonstrates the needed steps for calculating the correction parameter of m_C and t_C for an external calibration.

Step 1

Read current values from the module

First of all read the current value of m_C and t_C from the module of the needed channel and range with the VT System Calibration Manager. For this example the values are as follows:

$m_{C_{Old}}$ = 1.021

$t_{C_{Old}}$ = -0.108

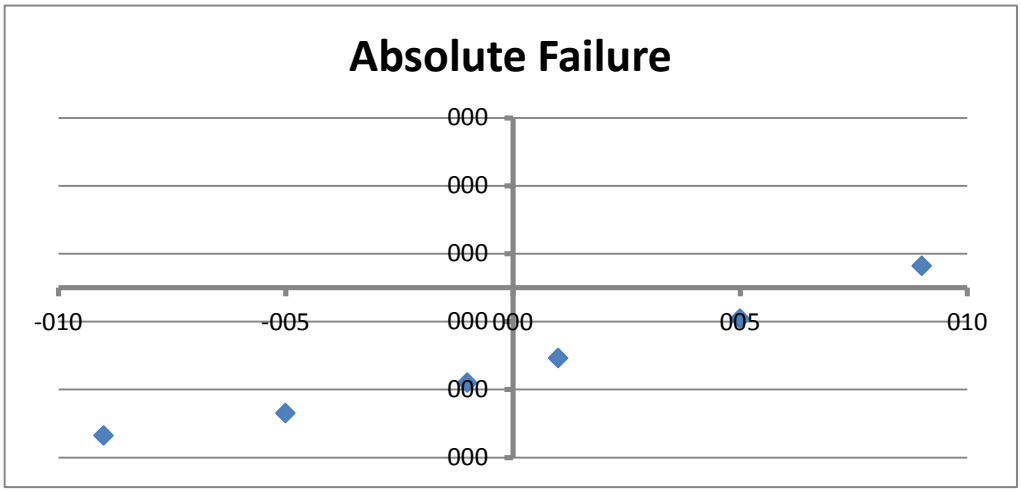
Step 2

Now measure the voltage on some points in the measurement rang of the channel. In this example following values were measured:

Measurement voltages before calibration

Number (i)	Target Voltage (x_i)	Module Measured Voltage (y_i)
1	-9 V	-9.218 V
2	-5 V	-5.185 V
3	-1 V	-1.140 V
4	1 V	0.896 V
5	5 V	4.954 V
6	9 V	9.032 V

Absolute failure of the measured voltages before calibration



Step 3

Calculate regression line gradient m_R and offset t_R of the measured values

$$\bar{x} = \frac{\sum_{i=1}^{n} x}{n} = \frac{(-9) + (-5) + (-1) + 1 + 5 + 9}{6} = 0$$

$$\bar{y} = \frac{\sum_{i=1}^{n} y}{n} = \frac{(-9.218) + (-5.185) + (-1.140) + 0.896 + 4.954 + 9.032}{6} = -0.110$$

$$m_R = \frac{\sum_{i=1}^{n}(x_i - \bar{x}) \cdot (y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

$$m_R = \frac{\big((-9) - 0\big) \cdot \big(-9.218 - (-0.110)\big) + \cdots + (9 - 0) \cdot \big(9.032 - (-0.110)\big)}{((-9) - 0)^2 + \cdots + (9 - 0)^2} = 1.014$$

$$t_R = \bar{y} - m_R \cdot \bar{x} = -0.110 - 1.014 \cdot 0 = -0.110$$

Based on the values of m_R and t_R the new correction values m_C and t_C can be calculated

$$m_C = \frac{m_{C_{Old}}}{m_R} = \frac{1.021}{1.014} = 1.007$$

$$t_C = \frac{m_C \cdot \big(t_{C_{Old}} - t_R\big)}{m_{C_{Old}}} = \frac{1.007 \cdot ((-0.108) - (-0.110))}{1.021} = 0.002$$

Step 4

Write new Values to the Module

Now write the new values of m_C and t_C calculated in step 3 to the module via the VT System Calibration Manager. The two parameters have following new values:

m_C = 1.007

t_C = 0.002

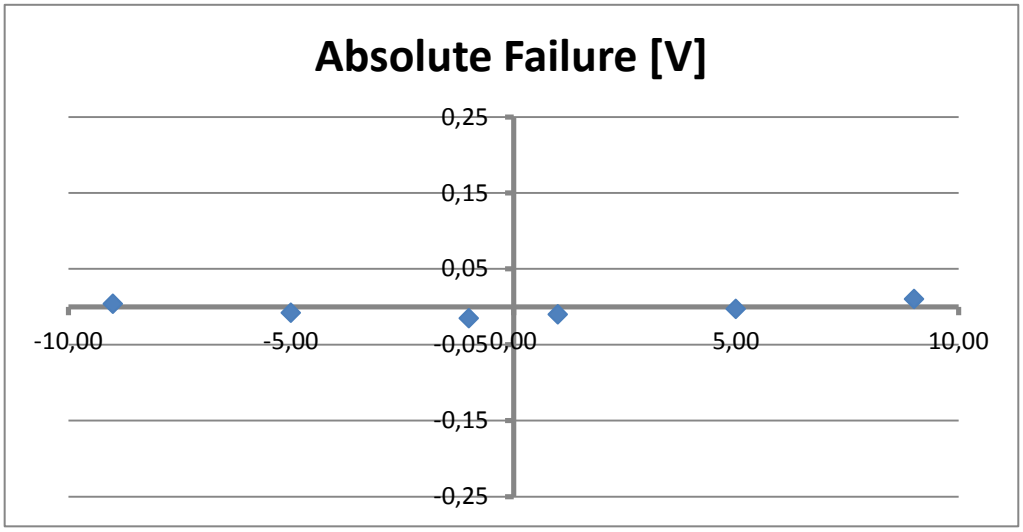
Step 5

After the new values were written to the module make a further measurement and check if the calibration has worked correctly. In this case following values were measured:

Measurement voltages after calibration

Number (i)	Target Voltage (x_i)	Module Measured Voltage (y_i)
1	-9 V	-8.996 V
2	-5 V	-5.008 V
3	-1 V	-1.015 V
4	1 V	0.990 V
5	5 V	4.997 V
6	9 V	9.010 V

Absolute failure of the measured voltages after calibration



2.4.2 Templates

Correction parameters for external calibration

The **Templates** folder (…\VTSystem\CalibrationManager\Templates) contains some predefined Excel sheets to easily determine the correction parameters for an external calibration.

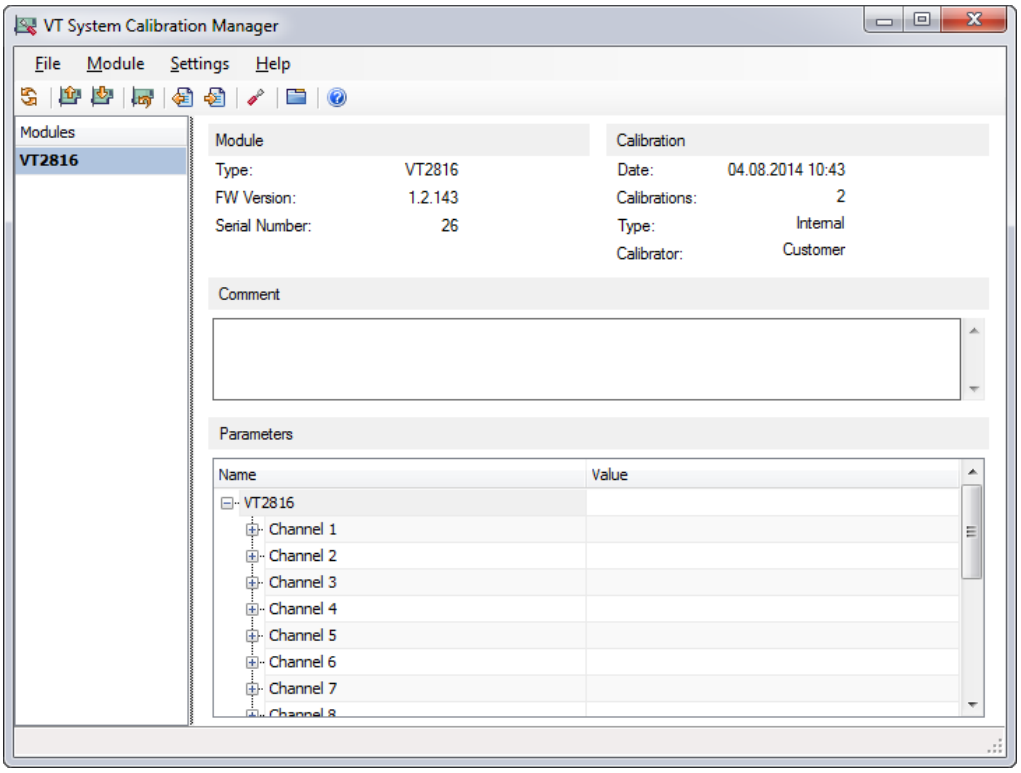
3 VT System Calibration Manager

This chapter contains the following information:

3.1 Main Window

The main window consists of two areas

The **Modules** list on the left side contains the found VT System modules in the network.
The right side of the window contains the information of the current selected module.



The **Module** area contains some general information:

Type — Type of the VT module.

FW Version — Firmware version of the VT module.

Serial Number — Serial number of the VT module.

The **Calibration** area holds following calibration specific information:

Date — Date of the last calibration.

Calibrations — Calibration counter. Will be incremented each time when the parameters will be written or reset on the module.

Type — Calibration type. Internal if the self-calibration process was used for the determination of the parameter values otherwise external.

Calibrator — Information about the calibrator who has calibrated the module.
Possible entries **Vector** or **Customer**.

Comment — In the **Comment** input box a calibration remark with a limited number of characters can be entered. This comment will be stored on the module.

Parameters — The **Parameters** area contains the actually parameters of the module. The different parameters are grouped by channel in the tree list. The values of the parameter can be edited direct in the tree list.

3.2 File Menu

Import		Open the menu path **File|Import Parameters…** or click the button in the toolbar to import saved parameters for the current selected module. Only parameters for the same type of module can imported.
Export		Open the menu path **File|Export Parameters…** or click the button in the toolbar to export the parameter values of the current selected module.

3.3 Module Menu

Scan		Open the menu path **Module|Scan** or click the button in the toolbar to scan the network for modules.
Read Parameters		Open the menu path **Module|Read Parameters** or click the button in the toolbar to read the parameter of the current selected module. Normally the parameter will be read automatically from module on scan.
Write Parameters		Open the menu path **Module|Write Parameters** or click the button in the toolbar to write the parameter of the current selected module.
Reset All Parameters		Open the menu path **Module|Reset All Parameters** or click the button in the toolbar to reset all parameter on the current selected module to its default values.
Start Self Calibration		Open the menu path **Module|Start Self Calibration** or click the button in the toolbar to start the internal self-calibration process. For further information see section Internal Self-Calibration on page 8).

3.4 Settings Menu

Network		Open the menu path **Settings|Network…** or click the button in the toolbar to choose the network adapter for the module scan.

3.5 Help Menu

Templates	Open the menu path **Help|Templates** to open the templates folder. This folder contains some predefined Excel sheets for the determination of the correction parameters for an external calibration.

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