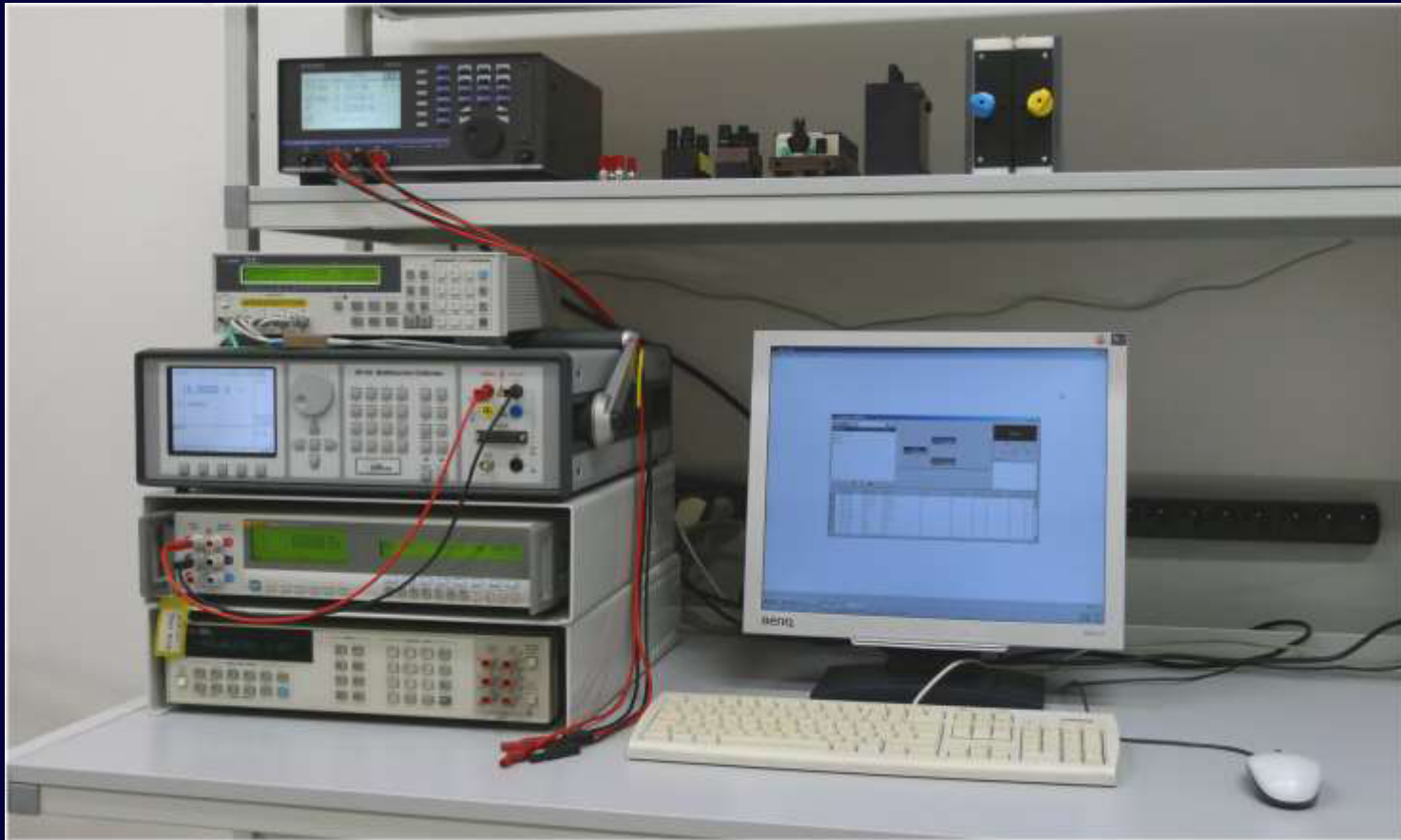


Computer - controlled calibration

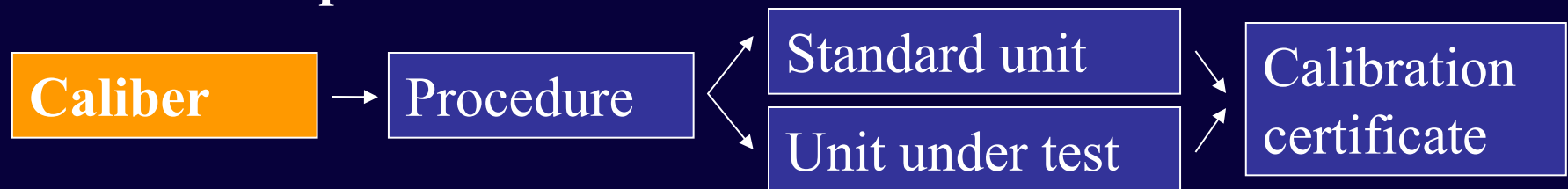


WinQBase and Caliber

WinQbase database software



Caliber computer controlled calibration



Both programs can work independent or together.

Caliber

Automatic calibration of instruments

Procedure "c:\program files (x86)\meatest\caliber\data\m3800.pro**"

Procedure: M3800, Version 1.00

Camera

Readings

Function	Range	Standard	UUT	Deviation	%spec	Allowed	Uncertainty	Symbol
VDC-2W	200 mV	20.0 mV	20.1 mV	100 uV	50	201 uV	61 uV	ok
VDC-2W	200 mV	180.0 mV	180.5 mV	500 uV	50	1003 uV	69 uV	ok
VDC-2W	200 mV	-180.0 mV	-181.0 mV	-1000 uV	-100	1005 uV	69 uV	?
VDC-2W	2 V	0.200 V	0.201 V	1.00 mV	50	2.01 mV	0.58 mV	ok
VDC-2W	2 V	1.800 V	1.813 V	13.00 mV	129	10.07 mV	0.59 mV	*
VDC-2W	2 V	-1.800 V	-1.812 V	-12.00 mV	-119	10.06 mV	0.59 mV	*
VDC-2W	20 V	2.00 V	2.01 V	10.0 mV	50	20.1 mV	5.8 mV	ok
VDC-2W	20 V	10.00 V	10.07 V	70.0 mV	116	60.4 mV	5.8 mV	*
VDC-2W	20 V	18.00 V	18.10 V	100.0 mV	100	100.5 mV	5.8 mV	?
VDC-2W	20 V	-2.00 V	-2.01 V	-10.0 mV	-50	20.1 mV	5.8 mV	ok
VDC-2W	20 V	-18 V						

Caliber – basic features

Supported types of calibration

- **Fully automated**
 - all instruments (standard units SU and unit under test UUT) are connected to PC
- **Semi automated**
 - only some instruments are controlled via PC
- **Manual**
 - all instruments are controlled manually

Caliber – Modules

- **Procedure Window**
 - Creating calibration procedures, calibrating UUT
- **Instrument Card Window**
 - Adding new or modifying devices
- **User Functions Window**
 - Adding new functions for calibration
- **Wizard Rules Window**
 - Creating/Editing rules for automatic procedure generation

Caliber - Procedure window

- Main part of Caliber software, designed for:
 - Calibration of UUT
 - Easy editing and testing calibration procedures
- Procedure contains description of:
 - **Functions**
 - **Ranges**
 - **Points (Values)**
 - **Names of used instruments**

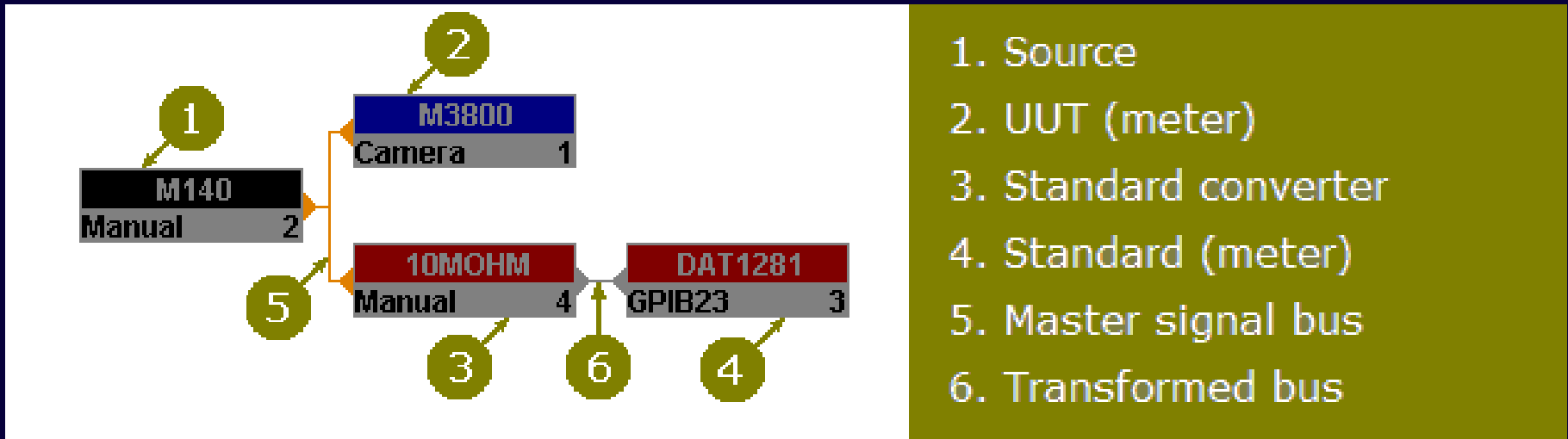
Caliber Procedure – Basic Description

The screenshot displays the Caliber software interface with the following components:

- Procedure window:** Shows 'm3800' with version 1.00, author Meatest, and email meatest@meatest.cz.
- Instrument scheme:** A diagram showing 'M140 COM1' connected to 'M3800 Camera'.
- Status window:** A text area for status information.
- Information line:** A horizontal bar for displaying information.
- User prompt window:** A bar for user prompts.
- Camera window:** A window for camera control with a 'Camera' label and navigation arrows.
- Readings window:** A window for displaying test results.
- Test report table:** A table with columns for Function, Range, Standard, UUT, Deviation, %spec, Allowed, Uncertainty, and Symbol.

Function	Range	Standard	UUT	Deviation	%spec	Allowed	Uncertainty	Symbol
VDC-2W	200 mV	20 mV						
VDC-2W	200 mV	-20 mV						
VDC-2W	200 mV	-180 mV						
VDC-2W	2 V	0.2 V						
VDC-2W	2 V	1.8 V						
VDC-2W	2 V	-1.8 V						
VDC-2W	20 V	2 V						
VDC-2W	20 V	10 V						
VDC-2W	20 V	18 V						

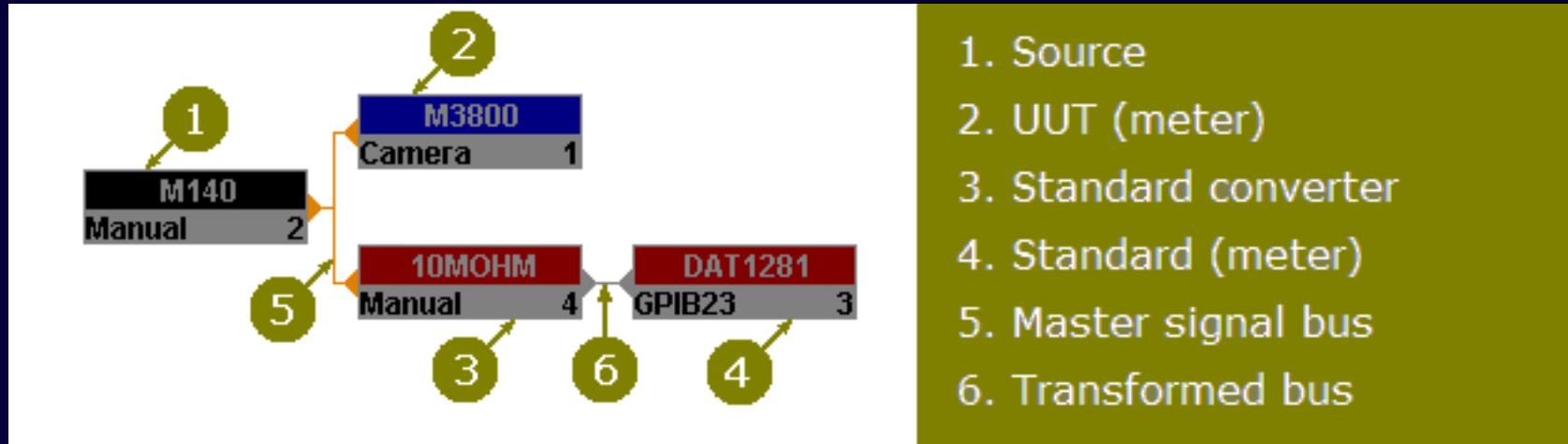
Caliber – Instrument scheme



Key features

- Visible name of used instrument card
- Color identification of instrument position
- Information about interface setting and unique number

Caliber - Calibration scheme Example



Color scheme

•Red

- Standard unit

•Blue

- UUT (unit under test)

•Grey (devices without influence on uncertainty)

- Source, Convertor, Switch

Calibration of meter

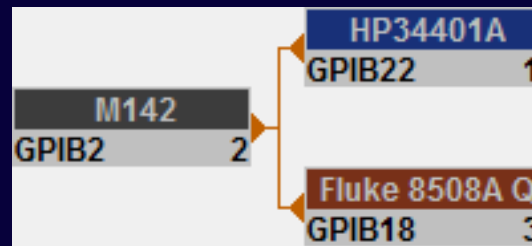
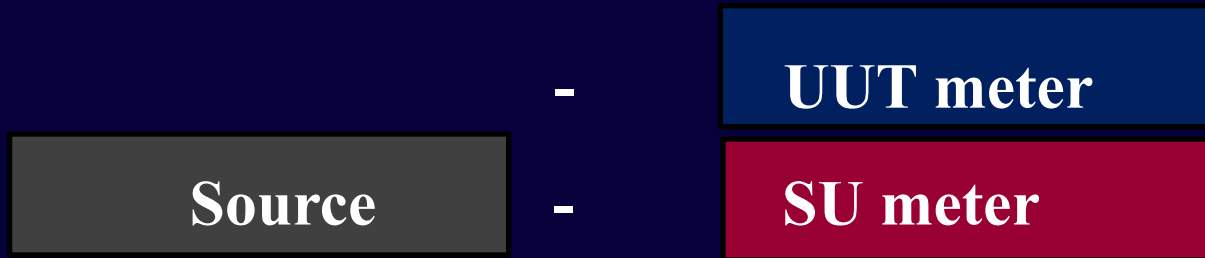
SU + source

-

UUT meter



Calibration of meter



Calibration of transducer

SU source

-

UUT converter

-

SU meter



Calibration of power source

UUT source

-

SU meter



Calibration of power source using additional convertor



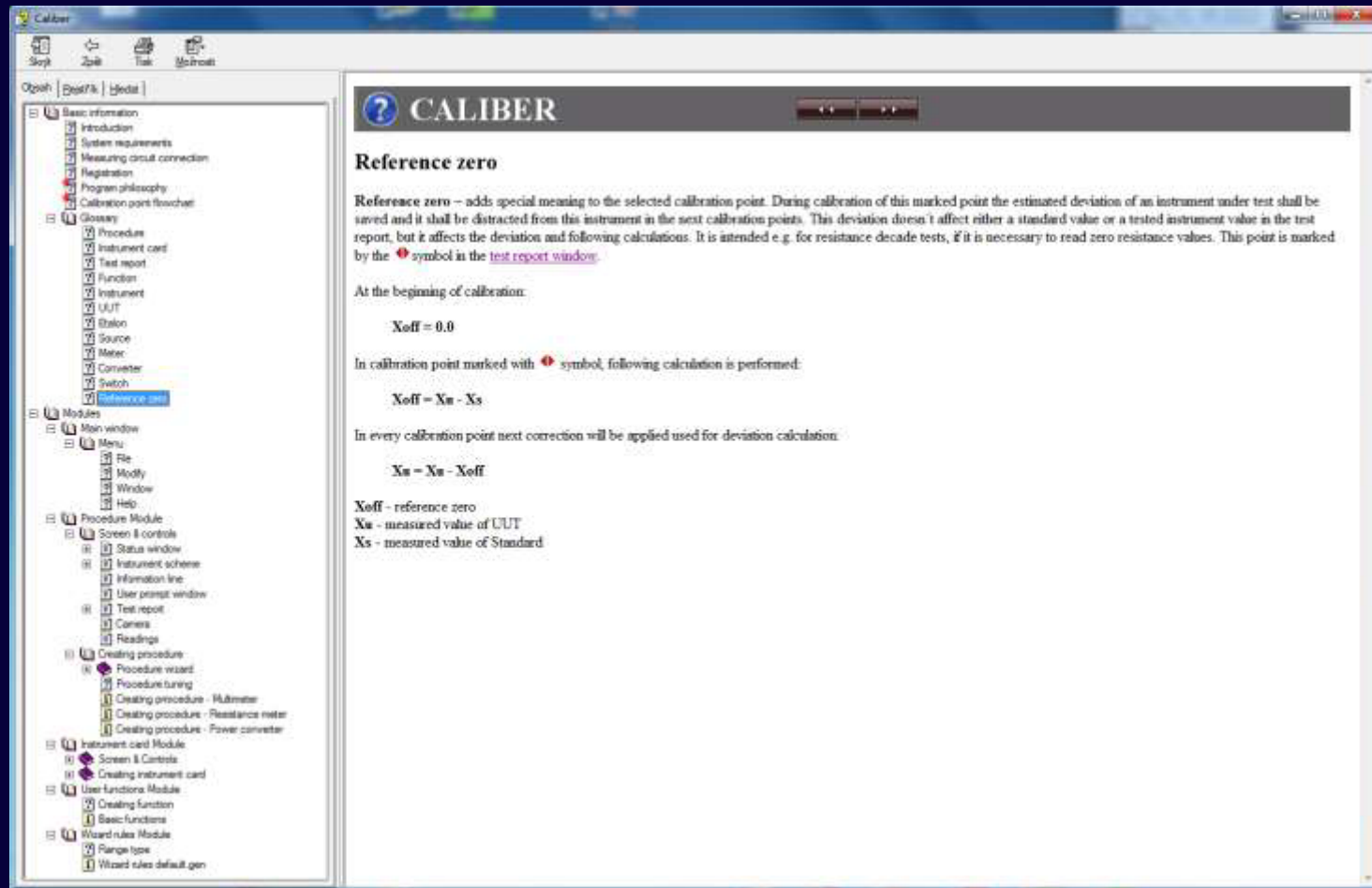
Calibration of power source

under specific Load



Caliber – Help File

Help file is opened on specific topic that depends on actual cursor position after pressing F1 key.



Caliber – Procedure Wizard

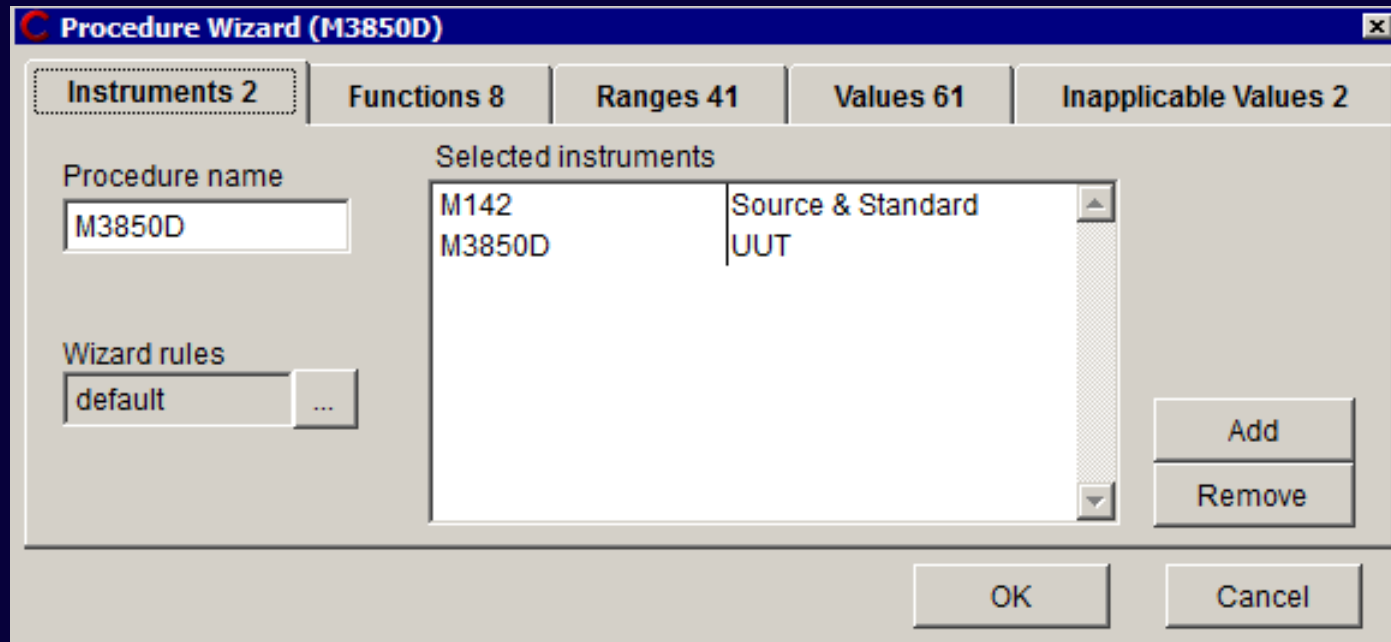
Generation of calibration procedure

Basic Steps:

- 1) Instruments selection, name, wizard rules
- 2) Functions selection
- 3) Ranges selection, type of ranges (density of cal. points)
- 4) Values selection, exact values of calibration points
- 5) Procedure checking, all values should be acceptable for all instruments
- 6) Procedure saving

Caliber – Procedure Wizard

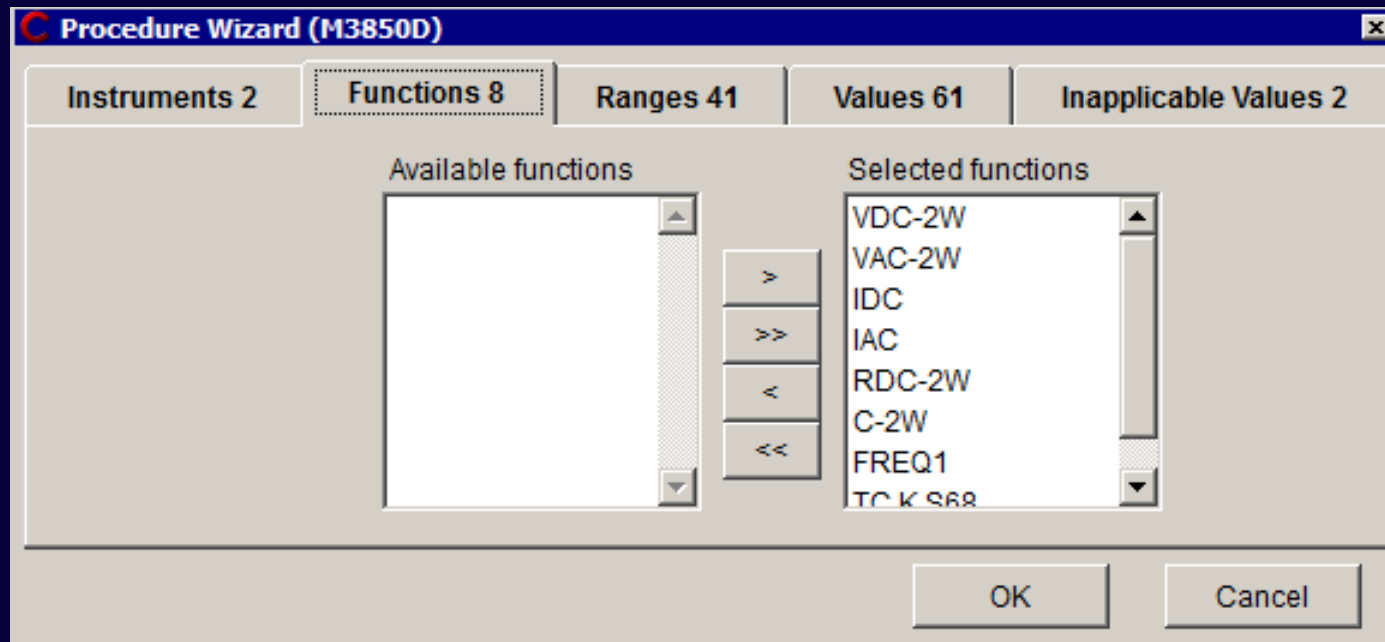
Step 1 - Instruments



- Write Procedure Name
- Choose Wizard Rules (Impact on number of calibration points)
- Add Instruments (UUT and SU)

Caliber – Procedure Wizard

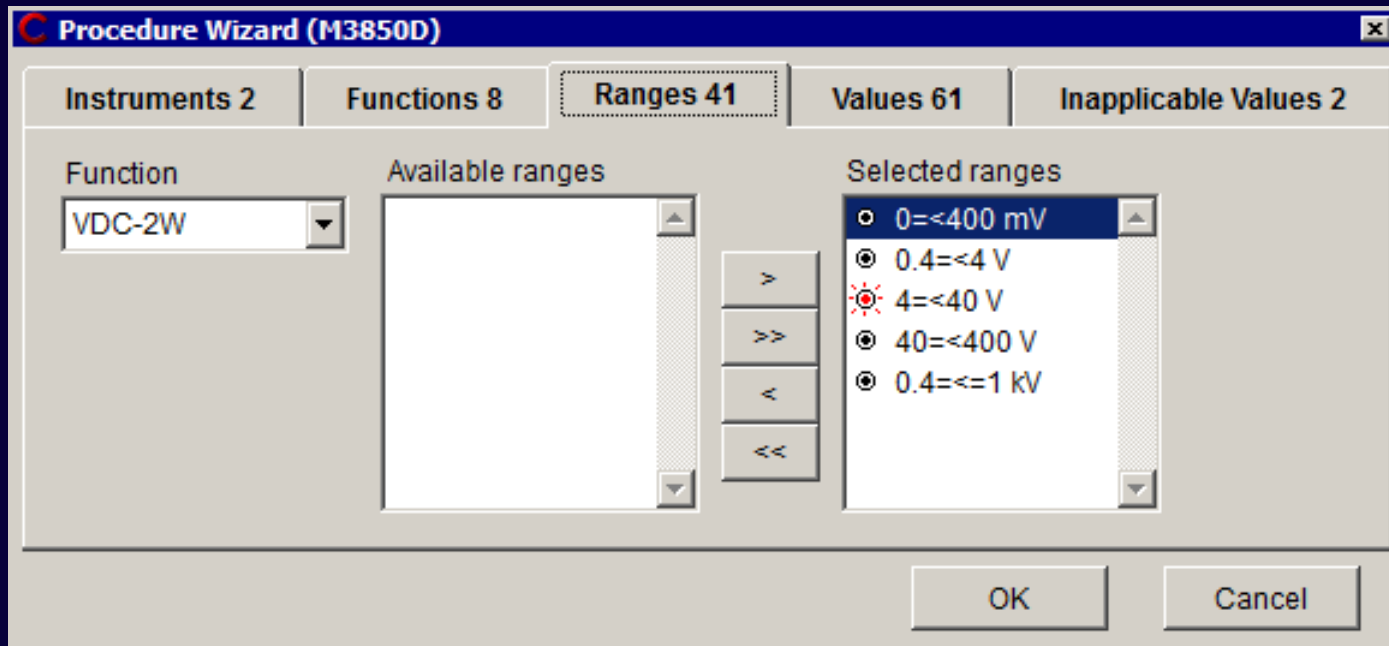
Step 2 - Functions



- Calibrated function (Default setting is select all supported function)
- Numbers after tabulator name gives actual information

Caliber – Procedure Wizard

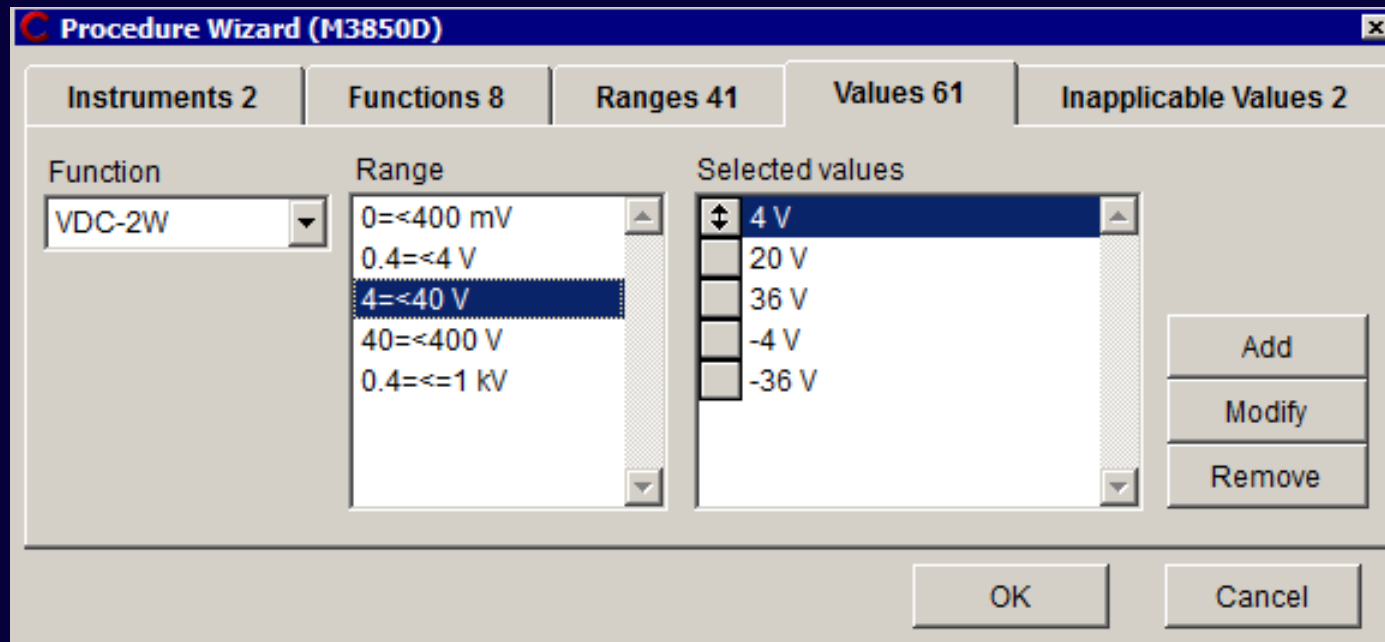
Step 3 - Ranges



- Selection of ranges used during calibration

Caliber – Procedure Wizard

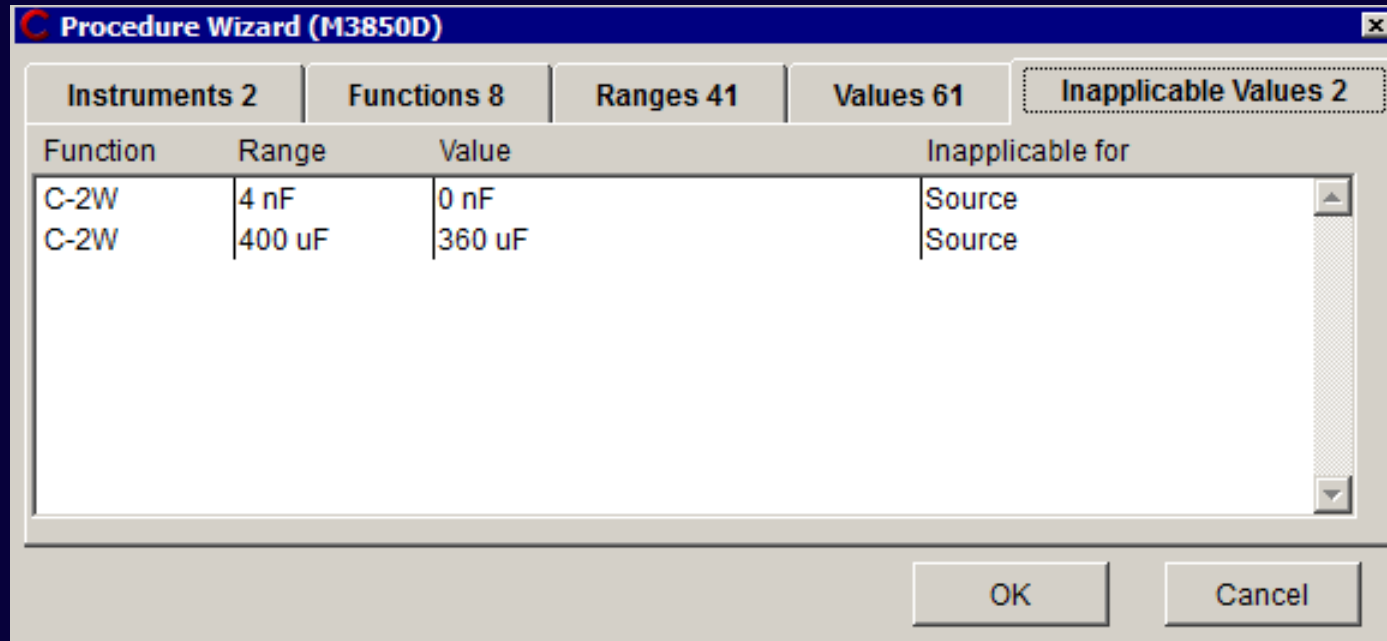
Step 4 - Values



- Adding, modifying or removing points
- Changing points position

Caliber – Procedure Wizard

Step 5 – Checking / Confirmation



- Note
 - Multifunction calibrator M-142
 - capacitance range: 0,7 nF to 100 uF

Caliber – Procedure Wizard

Step 6 - Saving new calibration procedure

Procedure "c:\program files (x86)\meatest\calibercz\data\m3850d.pro*"

Procedure: M3850D

Version: 1.00
Author:
E-mail:

M142 GPIB2 1 → M3850D Manual 2

Camera

Readings

Function	Range	Standard	UUT	Deviation	%spec	Allowed	Uncertainty	Symbol
VDC-2W	400 mV	40 mV						
VDC-2W	400 mV	360 mV						
VDC-2W	400 mV	-360 mV						
VDC-2W	4 V	0.4 V						
VDC-2W	4 V	3.6 V						
VDC-2W	4 V	-3.6 V						
VDC-2W	40 V	4 V						
VDC-2W	40 V	20 V						
VDC-2W	40 V	36 V						

Practical Example

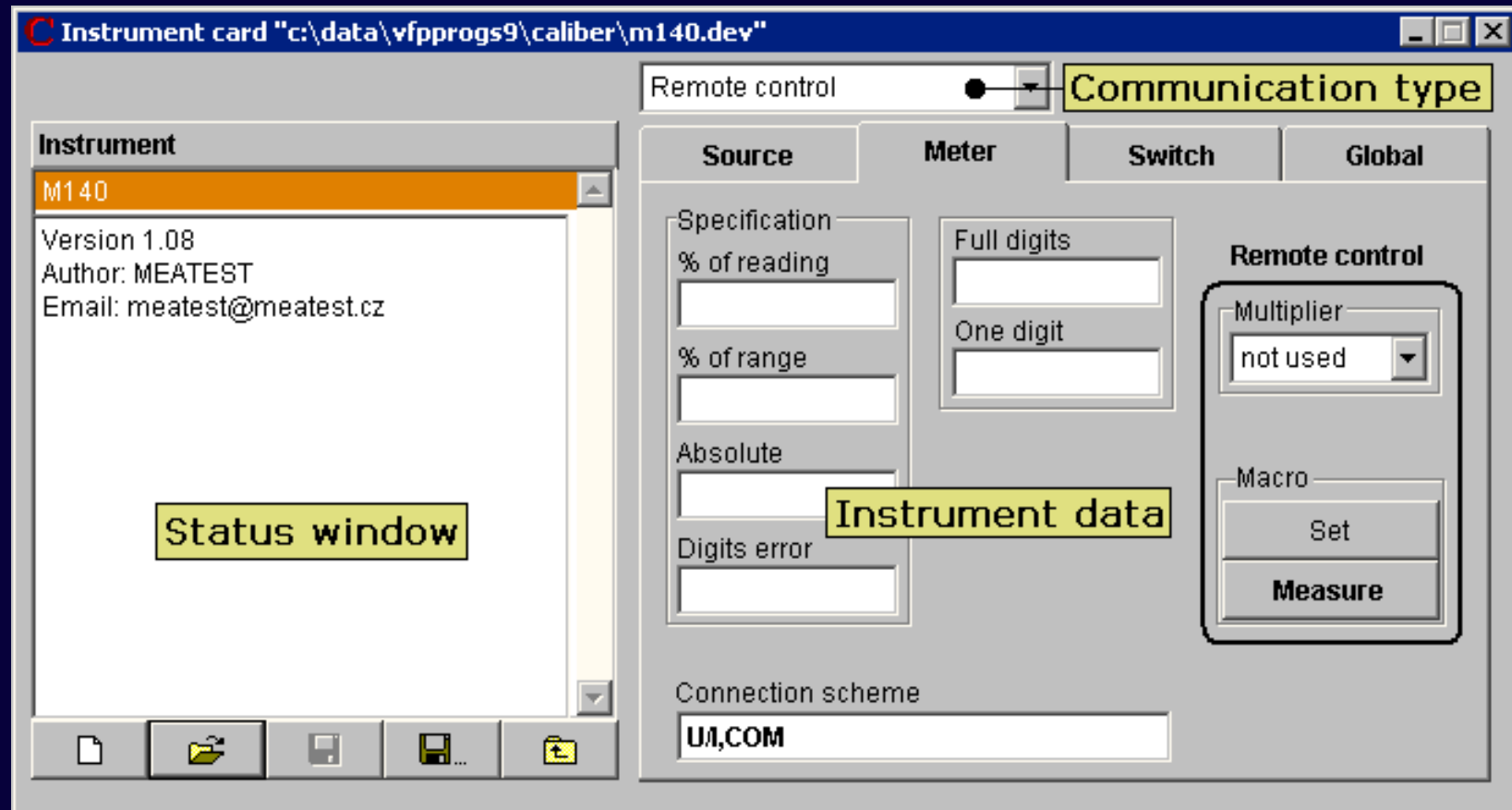
Creating new calibration procedure with
PROCEDURE WIZARD

Caliber - Instrument Card Window

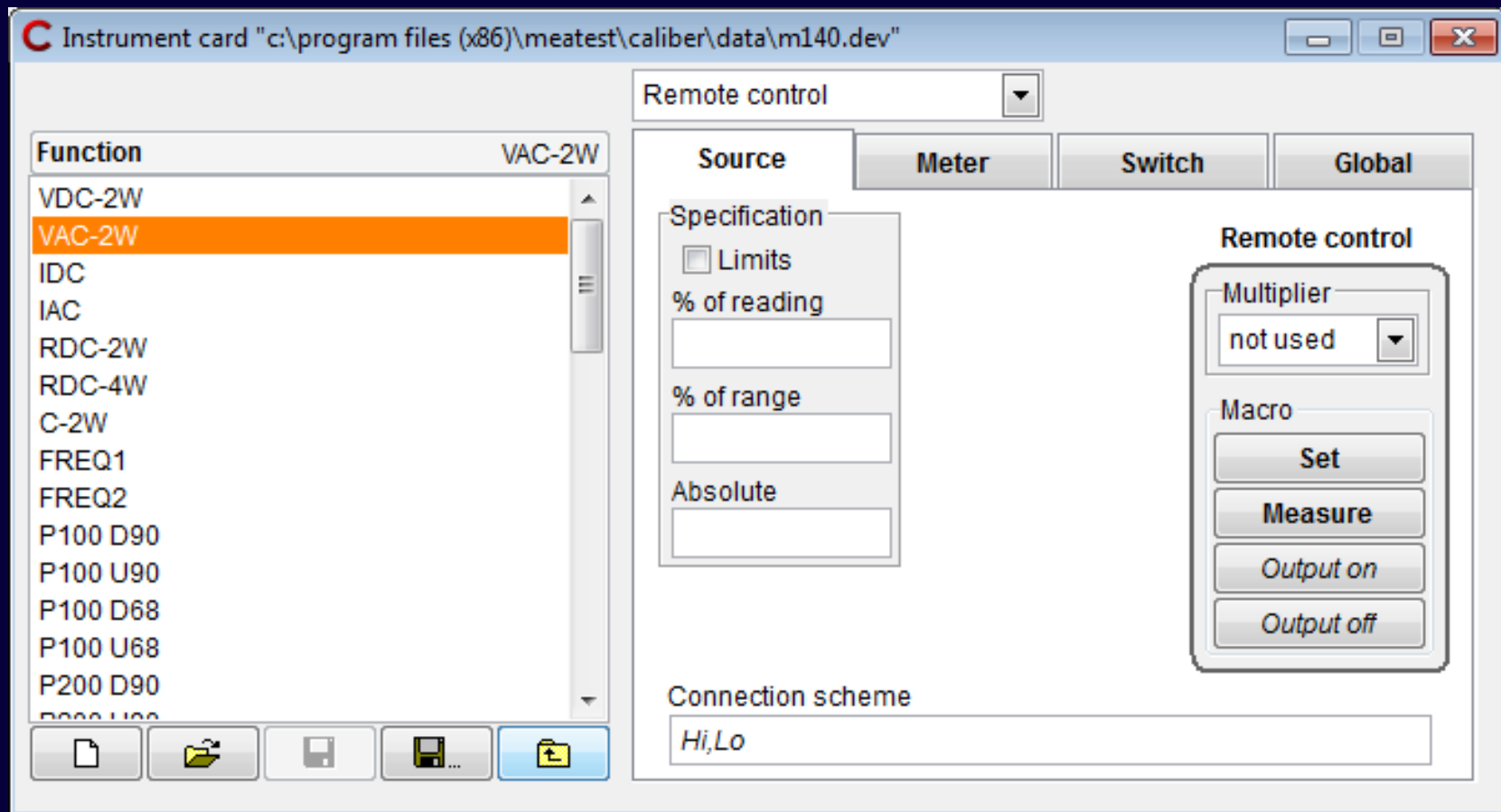
Tool for adding new instruments into the Caliber software.

- Contains separate definition for: Source, Meter, Switch
- Card contains description of the instrument:
 - **Functions**
 - **Ranges**
 - **Accuracy, limits**
 - Description of output terminals
 - Remote control commands
 - User Notes

Caliber - Instrument Card - Description



Caliber - Instrument Card - Description



Caliber - Instrument Card - Specification

The screenshot shows a software window titled "Instrument card 'c:\program files (x86)\meatest\caliber\data\m140.dev'". The interface is divided into several sections:

- Range Selection:** A list of voltage ranges is shown on the left, with "1<=20 mV" selected. Other ranges include "20<=200 mV", "0.2<=2 V", "2<=20 V", "20<=240 V", and "0.24<=1 kV".
- Remote control:** A dropdown menu is set to "Remote control".
- Source:** Three tabs are visible: "Meter" (selected), "Switch", and "Global".
- Specification:** A section with a "Limits" checkbox (unchecked) and three input fields:
 - "% of reading": 0.2
 - "% of range": 0.05
 - "Absolute": 0.00002
- Remote control (sub-section):** Contains a "Multiplier" dropdown set to "not used" and a "Macro" section with four buttons: "Set", "Measure", "Output on", and "Output off".
- Connection scheme:** A text field containing "Hi,Lo".

At the bottom of the window, there is a toolbar with icons for file operations (New, Open, Save, Save As, Print).

Practical Example

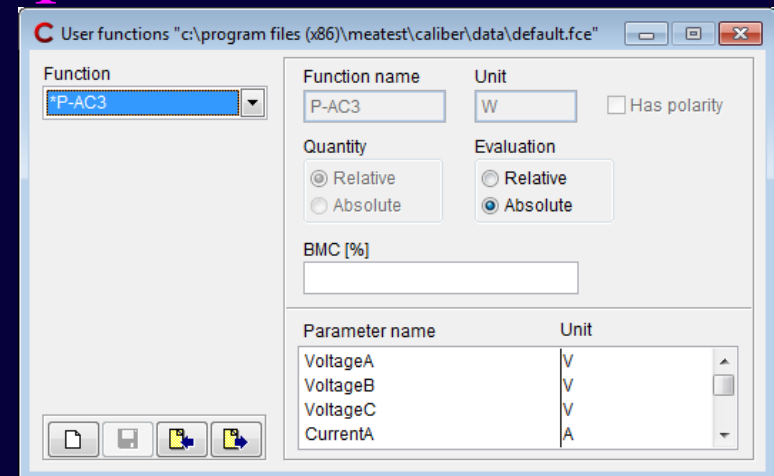
Creating/Changing instrument card with
INSTRUMENT CARDS

Caliber - User Functions Window

Tool for adding **new functions** into the Caliber software. For calibration should be used only functions defined in this window.

Defined function contains description of:

- **Name**
- **Unit**
- **Quantity (type of function)**
- **Evaluation style**
- **BMC (Best Measurement Capability)**
or CMC (Calibration and Measurement Capability)
- **Additional parameters (optional)**



Caliber - Evaluation

Calibration uncertainty

Method of calculation meets requirements of **EA-4/02**

Basic calculation formula:

$$U = k_u \times u_c$$

k_u extension coefficient

u_c [%] combined standard uncertainty

$$u_c = \sqrt{(u_a^2 + u_b^2 + u_{ud}^2 + u_{ua}^2 + u_{sd}^2 + u_{sa}^2 + u_{sb}^2 + u_{td}^2 + u_{ta}^2 + u_{tb}^2 + u_{cb}^2)}$$

Caliber - evaluation

Calibration uncertainty

$$\mathbf{u}_c = \sqrt{(\mathbf{u}_a^2 + \mathbf{u}_b^2 + \mathbf{u}_{ud}^2 + \mathbf{u}_{ua}^2 + \mathbf{u}_{sd}^2 + \mathbf{u}_{sa}^2 + \mathbf{u}_{sb}^2 + \mathbf{u}_{td}^2 + \mathbf{u}_{ta}^2 + \mathbf{u}_{tb}^2 + \mathbf{u}_{cb}^2)}$$

- \mathbf{u}_a general uncertainty of type A
- \mathbf{u}_b general uncertainty of type B
- \mathbf{u}_{ud} uncertainty due to the limited resolution of UUT
- \mathbf{u}_{ua} uncertainty type A - repeated measurements UUT
- \mathbf{u}_{sd} uncertainty due to the limited resolution of SU
- \mathbf{u}_{sa} uncertainty type A - repeated readings SU
- \mathbf{u}_{sb} uncertainty due to the uncertainty of SU
- \mathbf{u}_{td} uncertainty due to the limited resolution of auxiliary SU (transmitter)
- \mathbf{u}_{ta} uncertainty type A - repeated readings auxiliary SU (transmitter)
- \mathbf{u}_{tb} uncertainty due to the uncertainty of auxiliary SU (transmitter)
- \mathbf{u}_{cb} uncertainty due to the accuracy of converter (if used)

Caliber - Example 1

Multimeter M3800 calibration

Funkce	Rozsah	Etalon	UUT	Odchylnka	%spec	Povoleno	Nejistota	Symbol
VDC-2W	2 V	0.2 V						
VDC-2W	2 V	1.8 V						
VDC-2W	2 V	-1.8 V						

Caliber - Example 1

Calibration uncertainty

$$\mathbf{u}_c = \sqrt{(\mathbf{u}_a^2 + \mathbf{u}_b^2 + \mathbf{u}_{ud}^2 + \mathbf{u}_{ua}^2 + \mathbf{u}_{sd}^2 + \mathbf{u}_{sa}^2 + \mathbf{u}_{sb}^2 + \mathbf{u}_{td}^2 + \mathbf{u}_{ta}^2 + \mathbf{u}_{tb}^2 + \mathbf{u}_{cb}^2)}$$

$$\mathbf{u}_c = \sqrt{(\mathbf{u}_{ud}^2 + \mathbf{u}_{ua}^2 + \mathbf{u}_{sb}^2)}$$

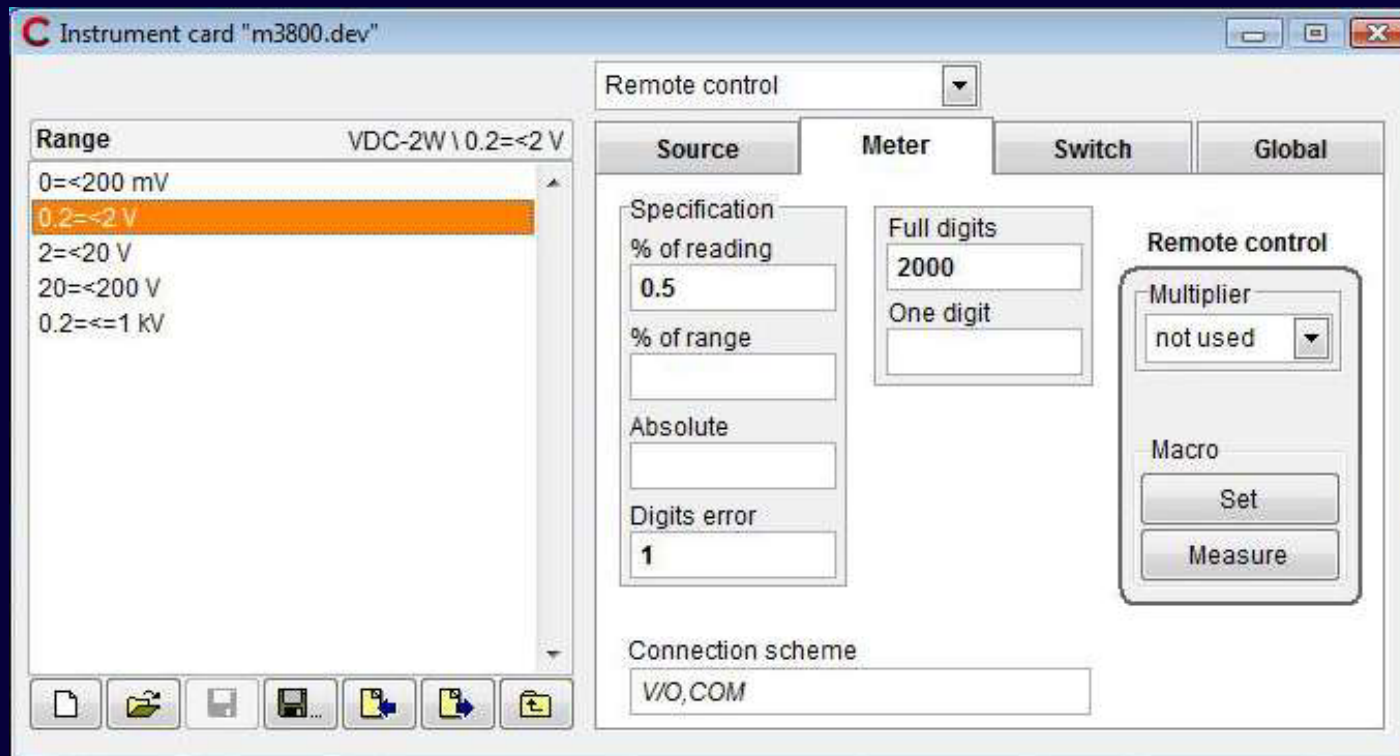
- \mathbf{u}_{ud} uncertainty due to the limited resolution of UUT
 - calculated from parameters written in instrument card
- \mathbf{u}_{ua} uncertainty type A - repeated measurements UUT
 - calculated from repeated measurements
- \mathbf{u}_{sb} uncertainty due to the uncertainty of SU
 - calculated from parameters written in instrument card

Caliber – Example 1

U_{ud} uncertainty due to the limited resolution of UUT

$$u_{ud} [\text{mV}] = 0.29 * \text{Dig}_u = 0.29 * 2000 \text{mV} / 2000 \text{dig} = 0.29 \text{mV}$$

$$u_{ud} [\%] = 0.29 \text{mV} * 100\% / 200 \text{mV} = 0.145\%$$



Caliber – Example 1

U_{ua} repeated measurement of UUT

$$u_{ua} \text{ [mV]} = \sqrt{((\Sigma(a_j - Xu)^2)/(j*(j-1)))} = 0\text{mV}$$

$$u_{ua} \text{ [%]} = 0\text{mV} * 100\% / 200\text{mV} = 0\%$$

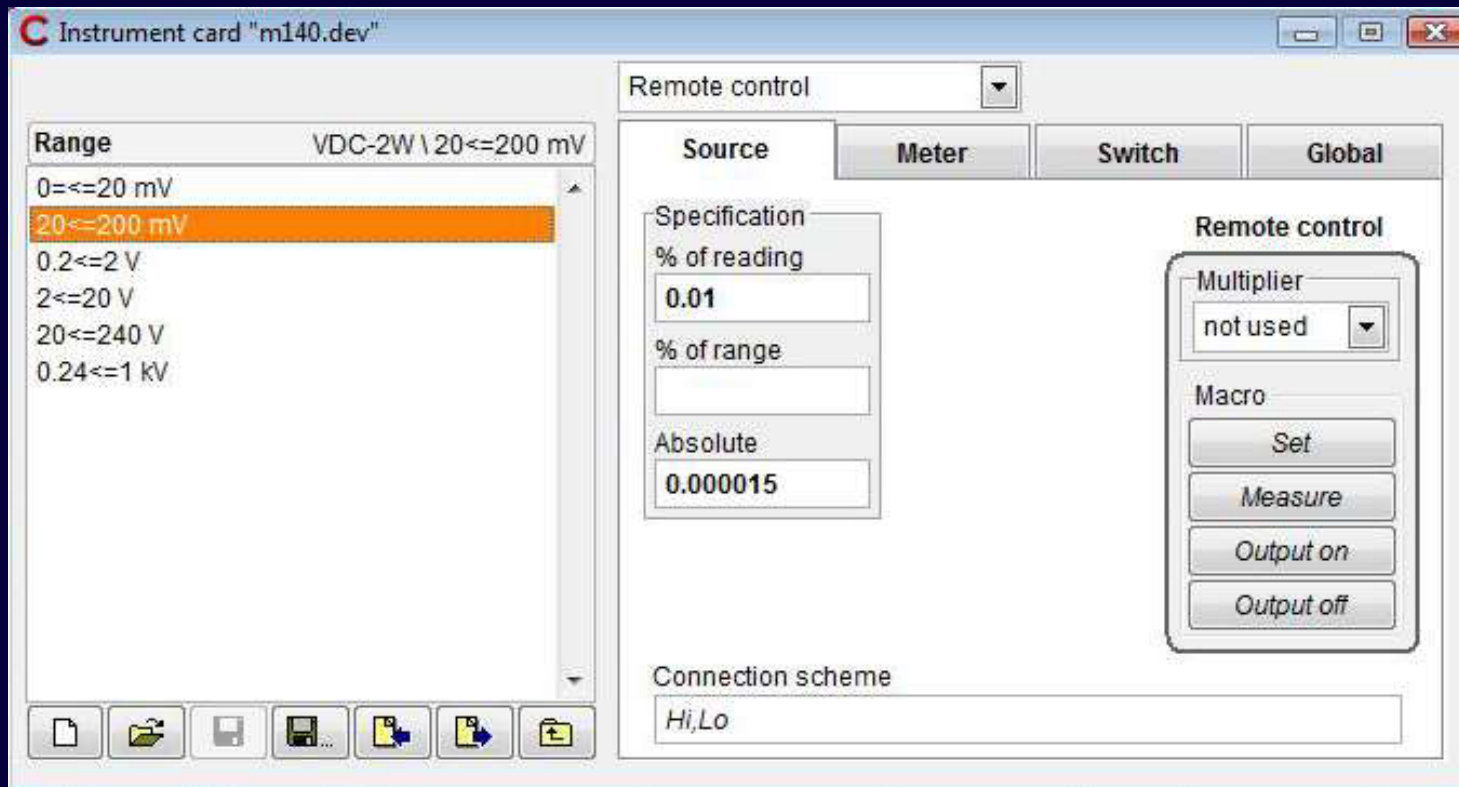
The screenshot displays a software interface for a Meatest device. At the top, there is a 'Camera' window. Below it, a diagram shows two manual meters: 'M140 Manual 2' (orange) and 'M3800 Manual 1' (blue), connected by a double-headed arrow. A status bar at the bottom left shows a yellow warning icon and the text 'Setting outputs off Standard M140... Switch off outputs manually'. On the right, a 'Readings' list shows ten entries, each with a number and the value '0.2':

Reading	Value
2)	0.2
3)	0.2
4)	0.2
5)	0.2
6)	0.2
7)	0.2
8)	0.2
9)	0.2
10)	0.2

Caliber – Example 1

U_{sb} uncertainty due to the uncertainty of SU

$$u_{sb} [\text{mV}] = D_{\text{max}_s} / \sqrt{3}$$
$$= (200\text{mV} * 0.01\% / 100\% + 0.015\text{mV}) / \sqrt{3} = 0.02021 \text{ mV}$$



Caliber – Example 1

$$u_c = \sqrt{(u_{ud}^2 + u_{ua}^2 + u_{sb}^2)} = \sqrt{(0.29^2 + 0^2 + 0.02021^2)} = 0.2907 \text{ mV}$$

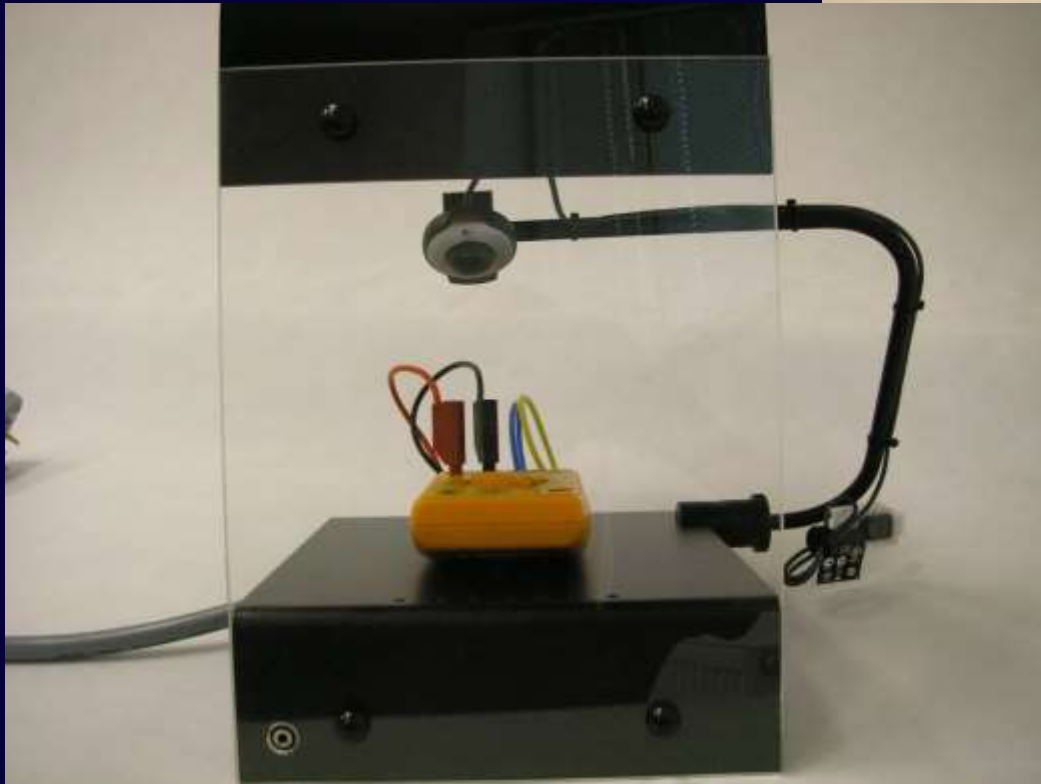
$$U = k_u * u_c = 2 * 0.2907 = 0.58 \text{ mV (rounded)}$$

The screenshot shows the Meatest software interface for a procedure named "xm3800". The interface includes a "Value" table, a central workspace with a diagram of two manual meters (M140 and M3800), a "Camera" control panel, and a "Readings" section. At the bottom, there is a table with columns for Function, Range, Standard, UUT, Deviation, %spec, Allowed, Uncertainty, and Symbol.

Value
XM3800
VDC-2W
2 V
0.2 V
1.8 V
-1.8 V

Function	Range	Standard	UUT	Deviation	%spec	Allowed	Uncertainty	Symbol
VDC-2W	2 V	0.200 V	0.200 V	-0.00 mV	0	2.00 mV	0.58 mV	ok
VDC-2W	2 V	1.8 V						
VDC-2W	2 V	-1.8 V						

CamOcr - Camera Module



CamOcr - Camera Module

Purpose

Scanning of non-system multimeter's display. Recognizing of displayed number.

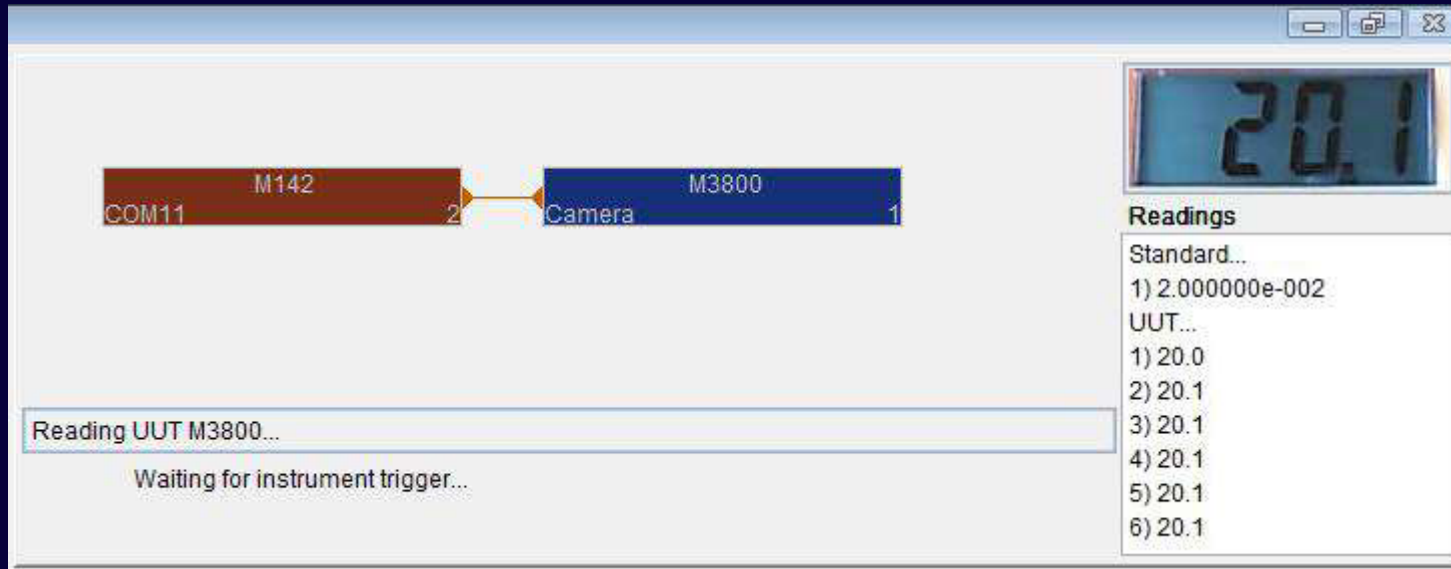
Advantages

There is **no need to enter values manually** – less human work.
Simple repeated **measuring with fixed sampling rate** and calculation of calibration uncertainties.

System requirements

OS Windows 2000 or higher, USB port

CamOcr - Camera Module - Example



Measuring of 20 mV on Multimeter M3800

Thank you for your attention

Company web sites: www.meatest.com