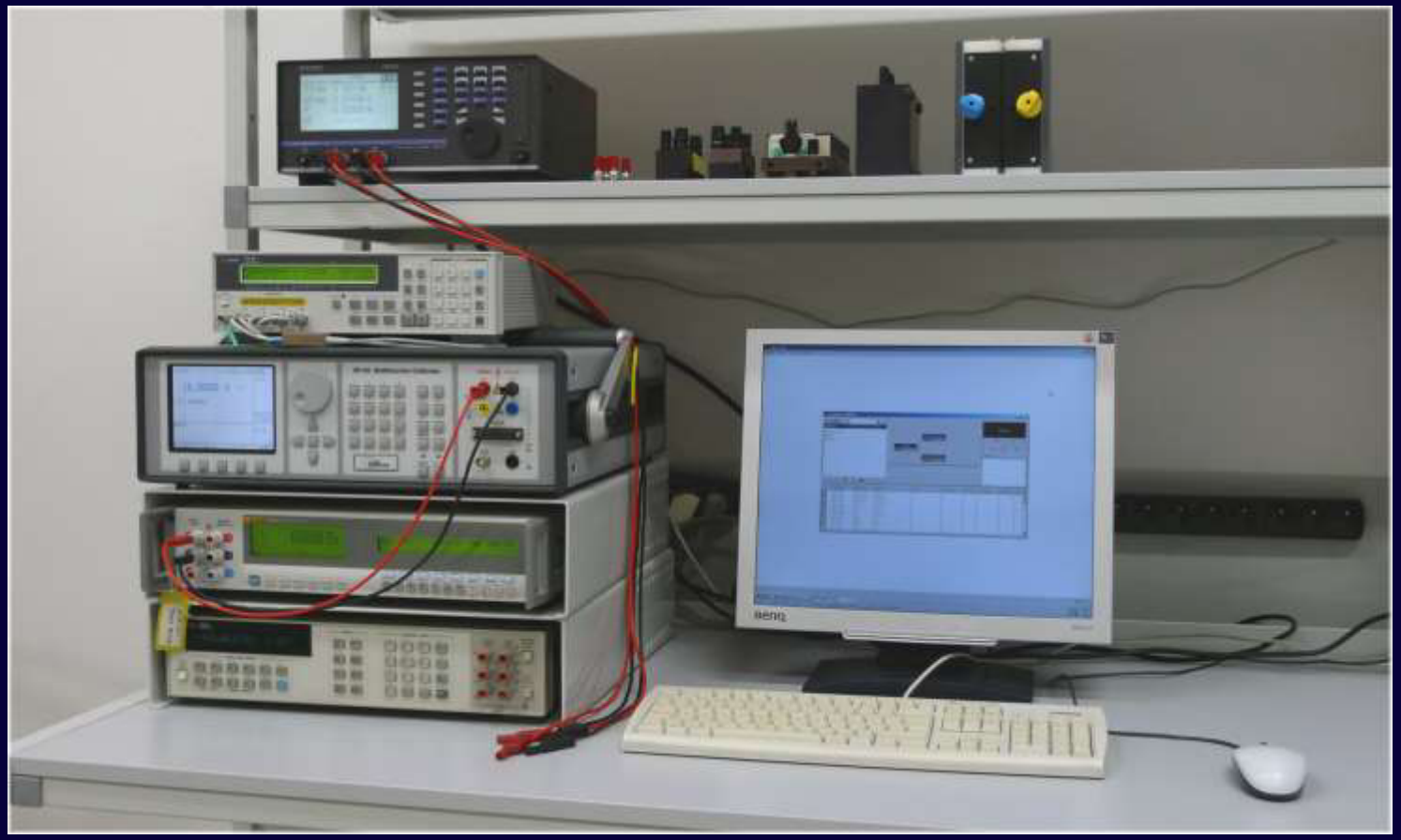
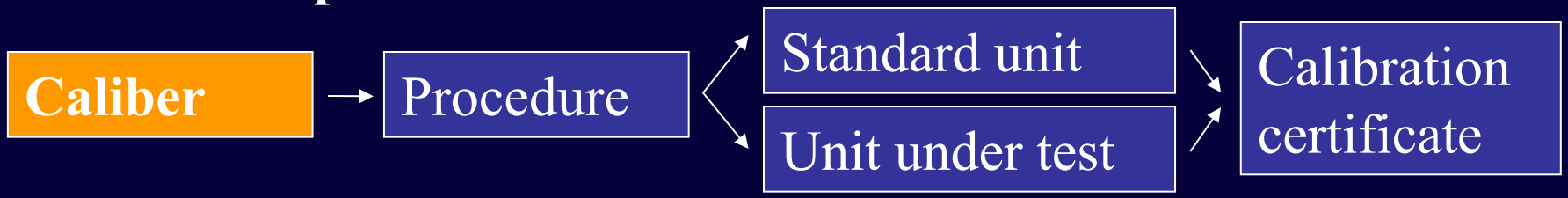
# Computer - controlled calibration



# WinQBase and Caliber

**WinQbase database software**

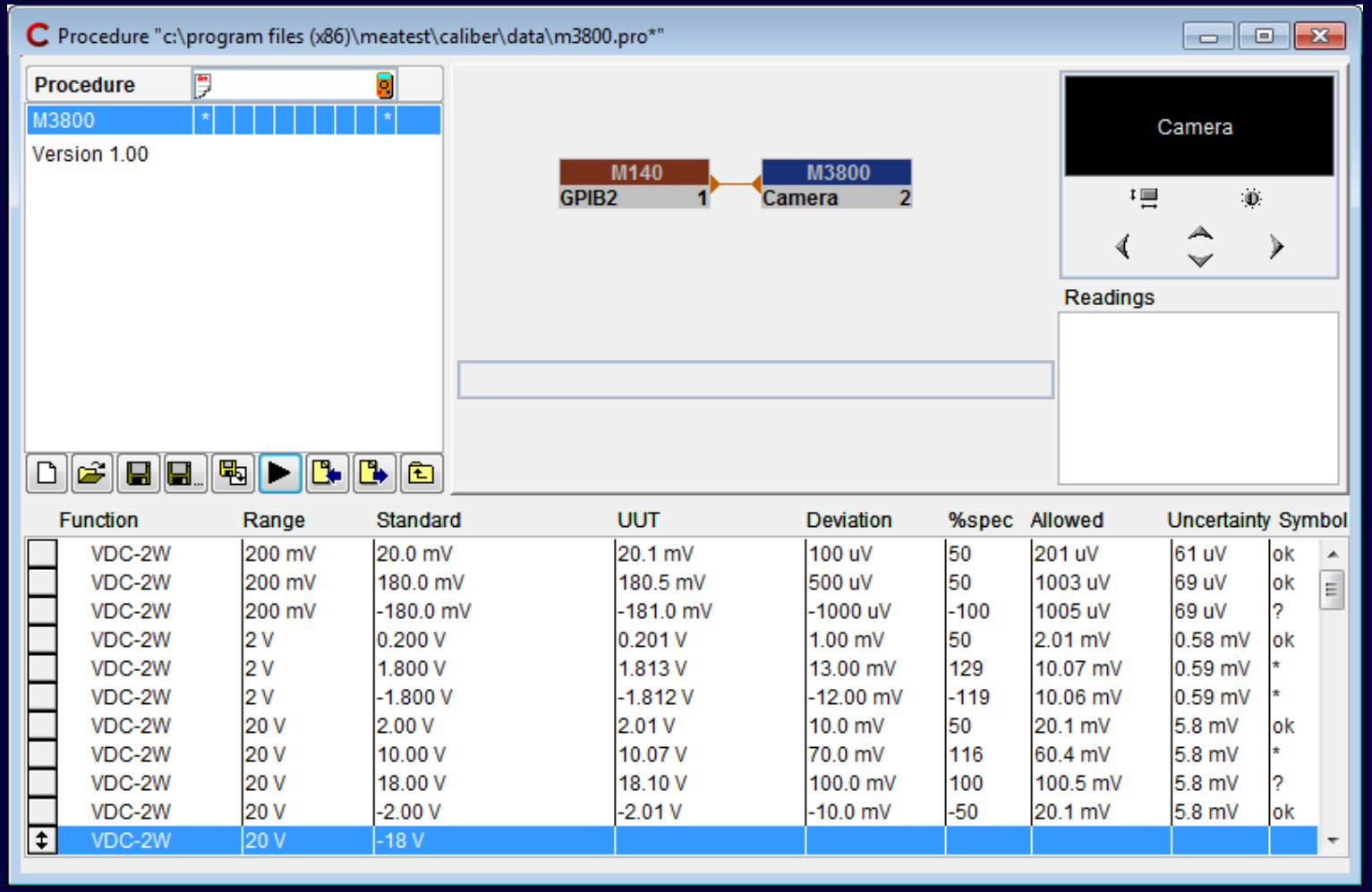

**Caliber computer controlled calibration**




**Both programs can work independent or together.**

# Caliber

## Automatic calibration of instruments




| 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

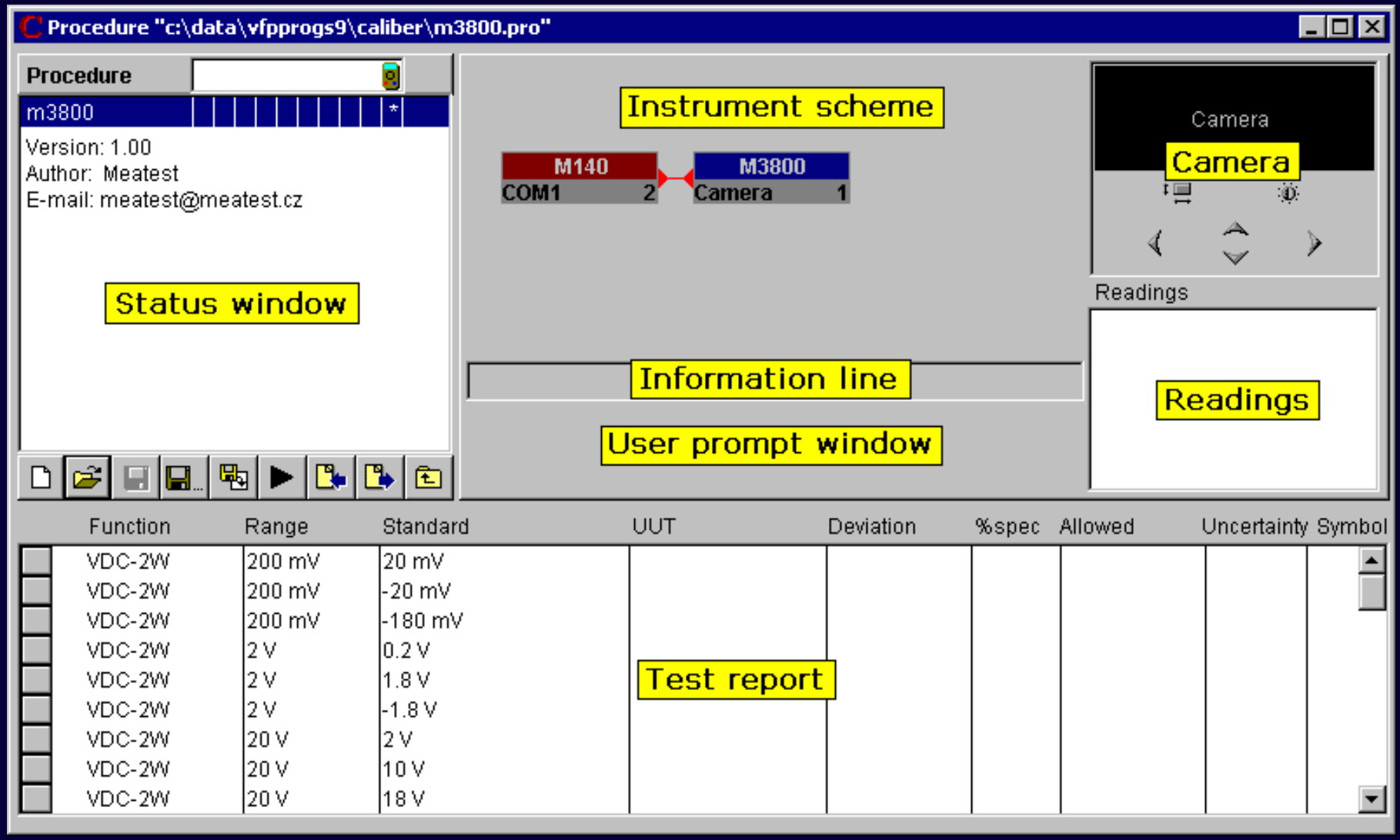
# Caliber – Modules

- 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

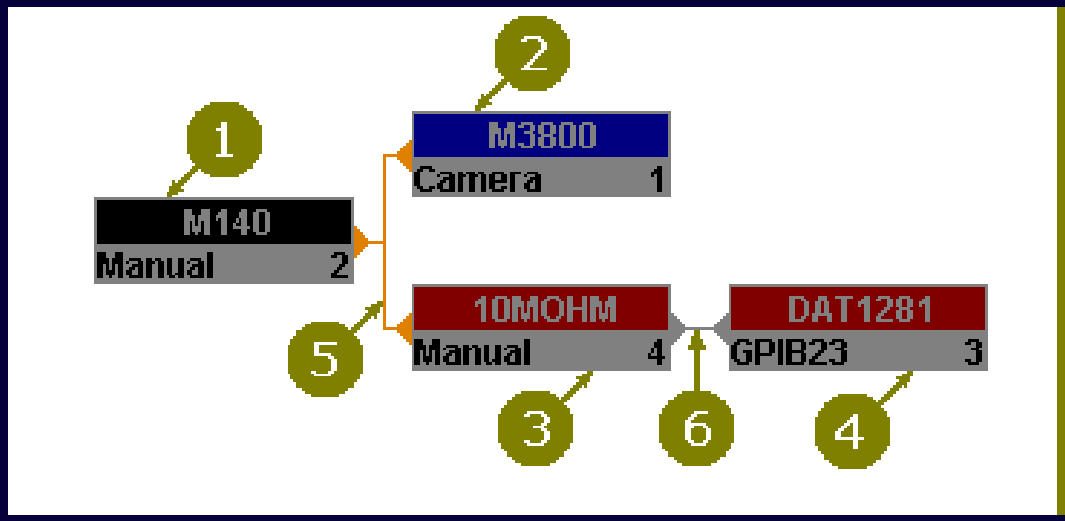
# Caliber - Procedure window

- 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



# Caliber – Instrument scheme

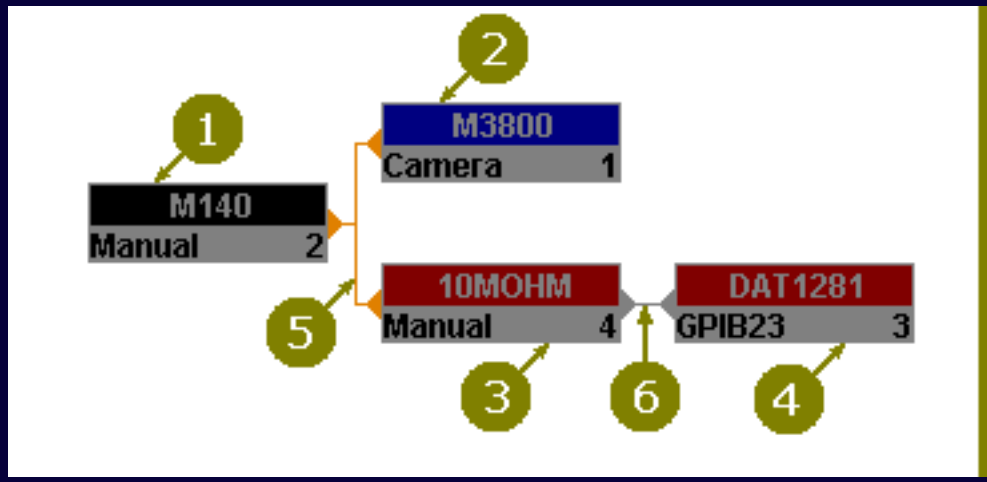



1. Source
2. UUT (meter)
3. Standard converter
4. Standard (meter)
5. Master signal bus
6. Transformed bus

**Key features**

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

# Caliber - Calibration scheme Example




1. Source
2. UUT (meter)
3. Standard converter
4. Standard (meter)
5. Master signal bus
6. Transformed bus

**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**

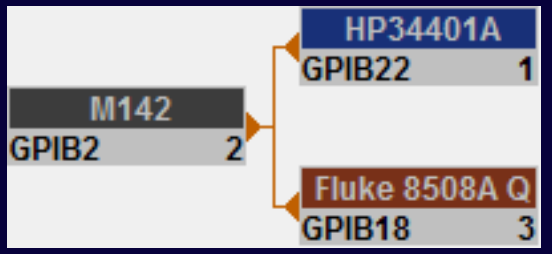
M142 GPIB2 2 — M3800 Camera 1

M622 GPIB2 1 — M3800 Camera 2

# Calibration of meter

**Source** - **UUT meter**

**Source** - **SU 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

**UUT source** - **converter** - **SU meter**

| M140 | | SHUNT10 | | Fluke 8508A Q | |
|---|---|---|---|---|---|
| GPIB2 | 1 | Manual | 3 | GPIB18 | 2 |

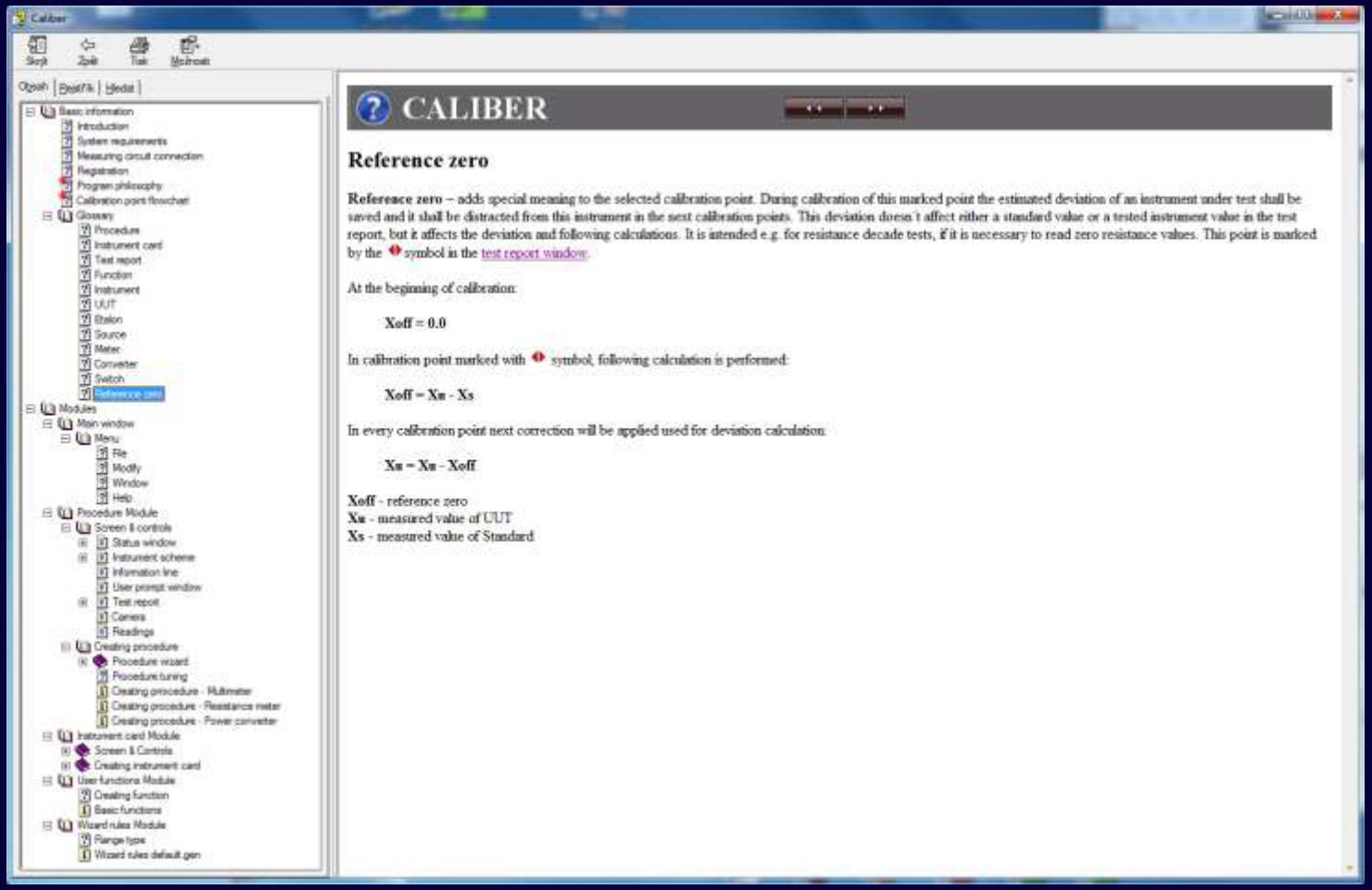
# Calibration of power source

**under specific Load**

| AGILENT E3633 | C_LOAD | CHROMA 63106A | HP34401A |
|---|---|---|---|
| GPIB5 1 | Manual 2 | COM1 4 | GPIB22 3 |

# Caliber – Help File

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



# Caliber – Procedure Wizard

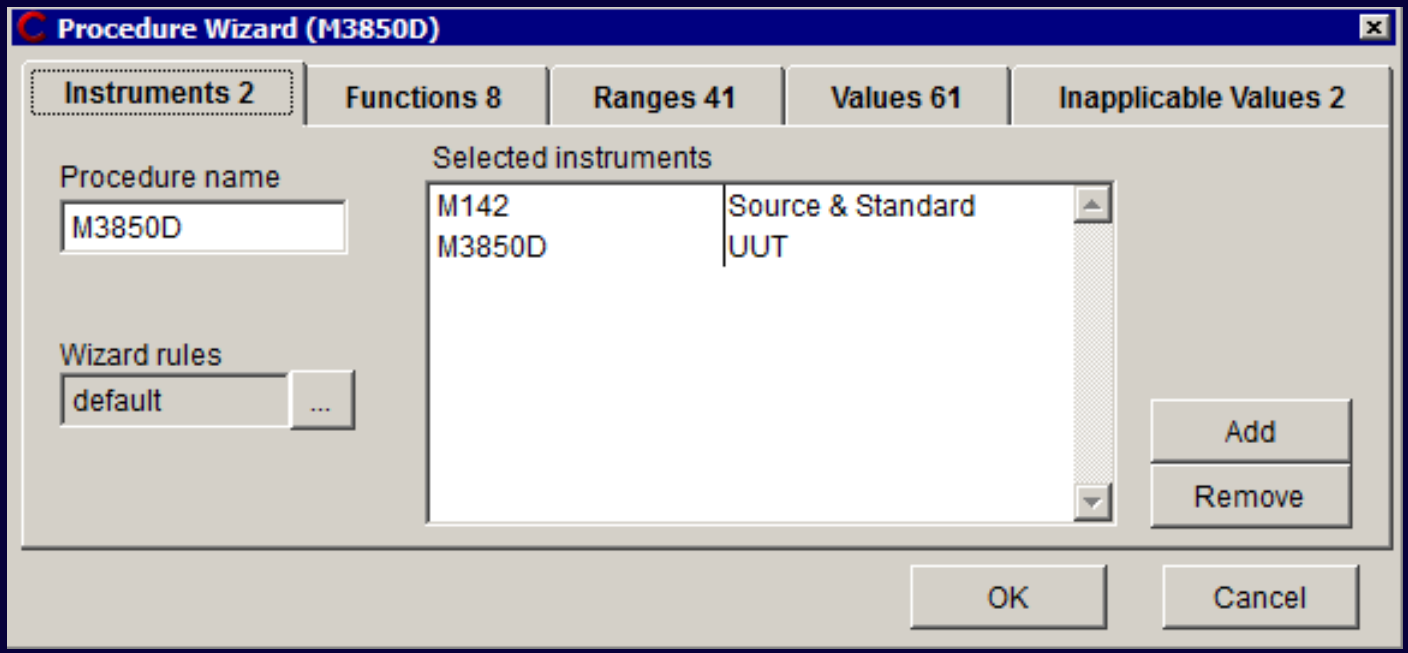
## Generation of calibration procedure

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

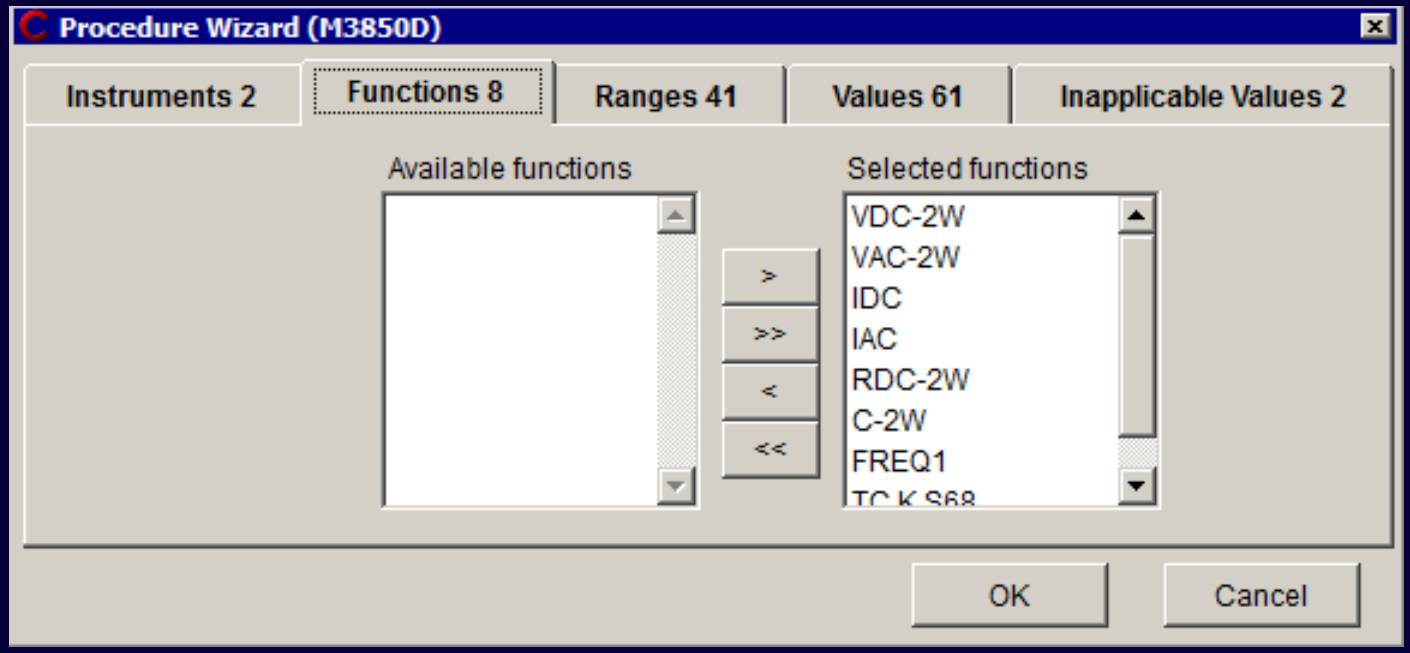
## Step 1 - Instruments




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

# Caliber – Procedure Wizard

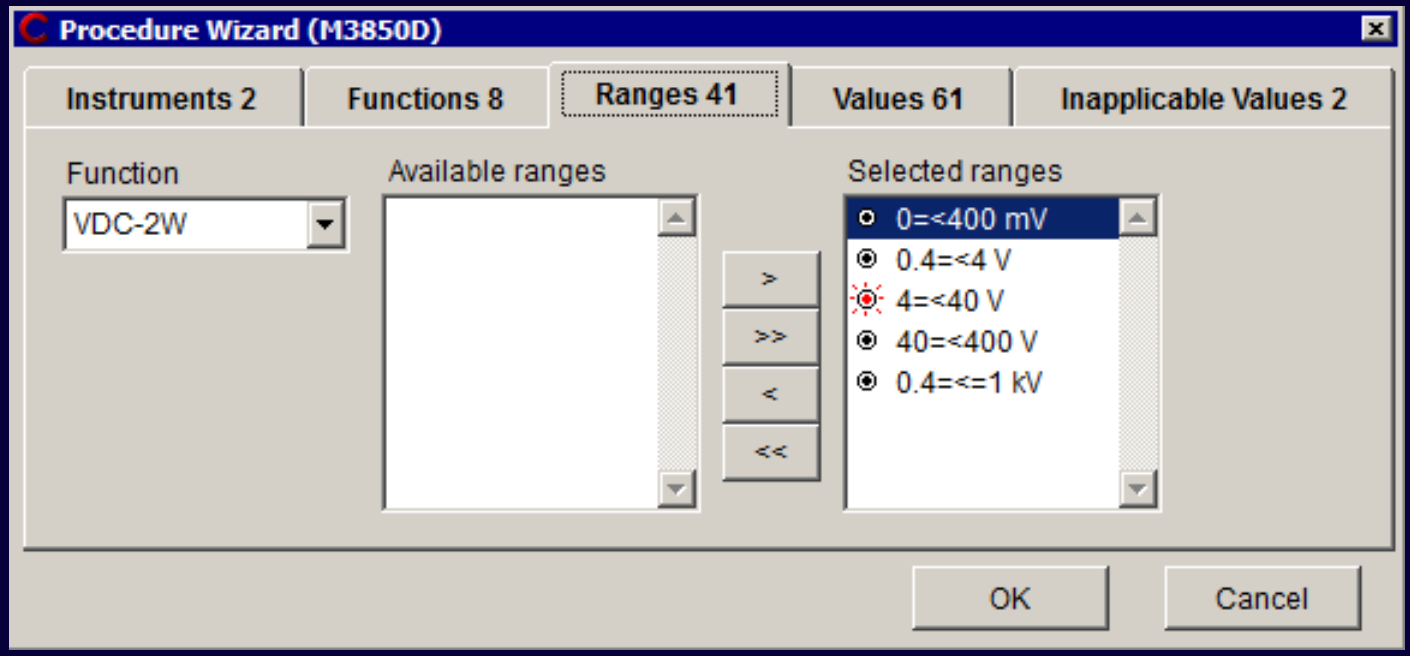
## Step 2 - Functions




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

# Caliber – Procedure Wizard

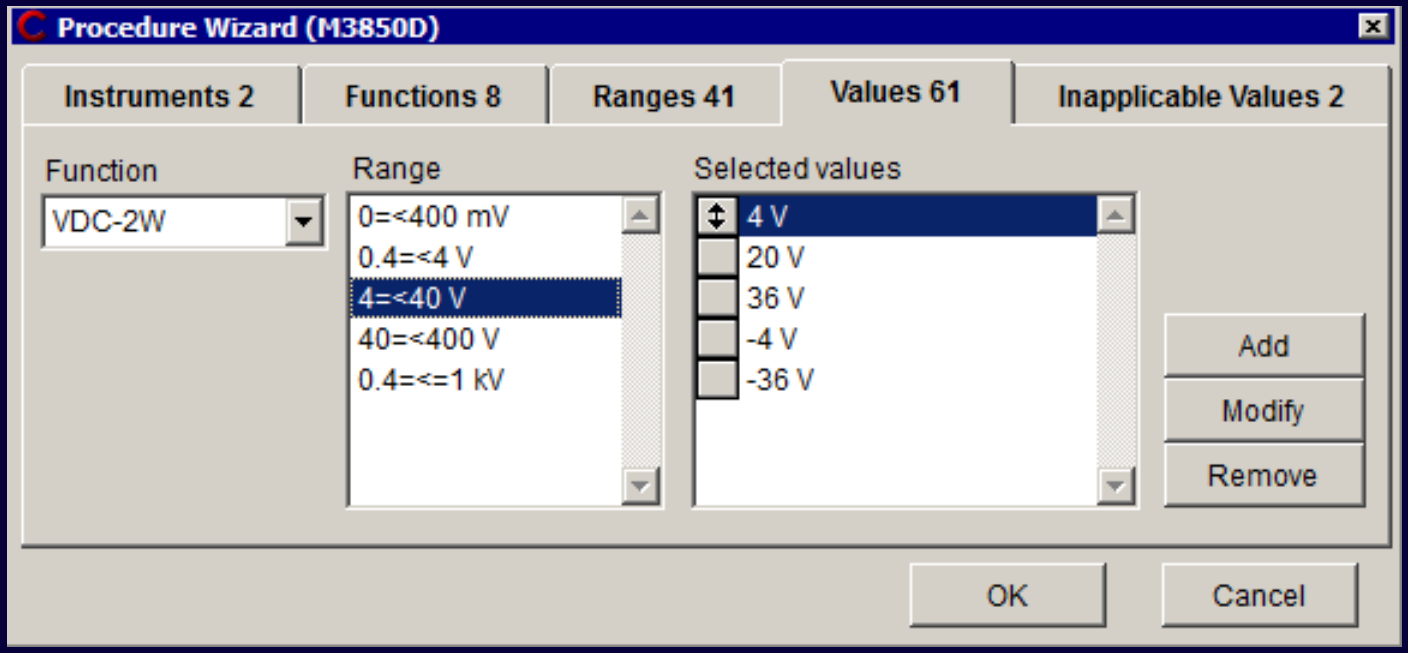
## Step 3 - Ranges




– Selection of ranges used during calibration

# Caliber – Procedure Wizard

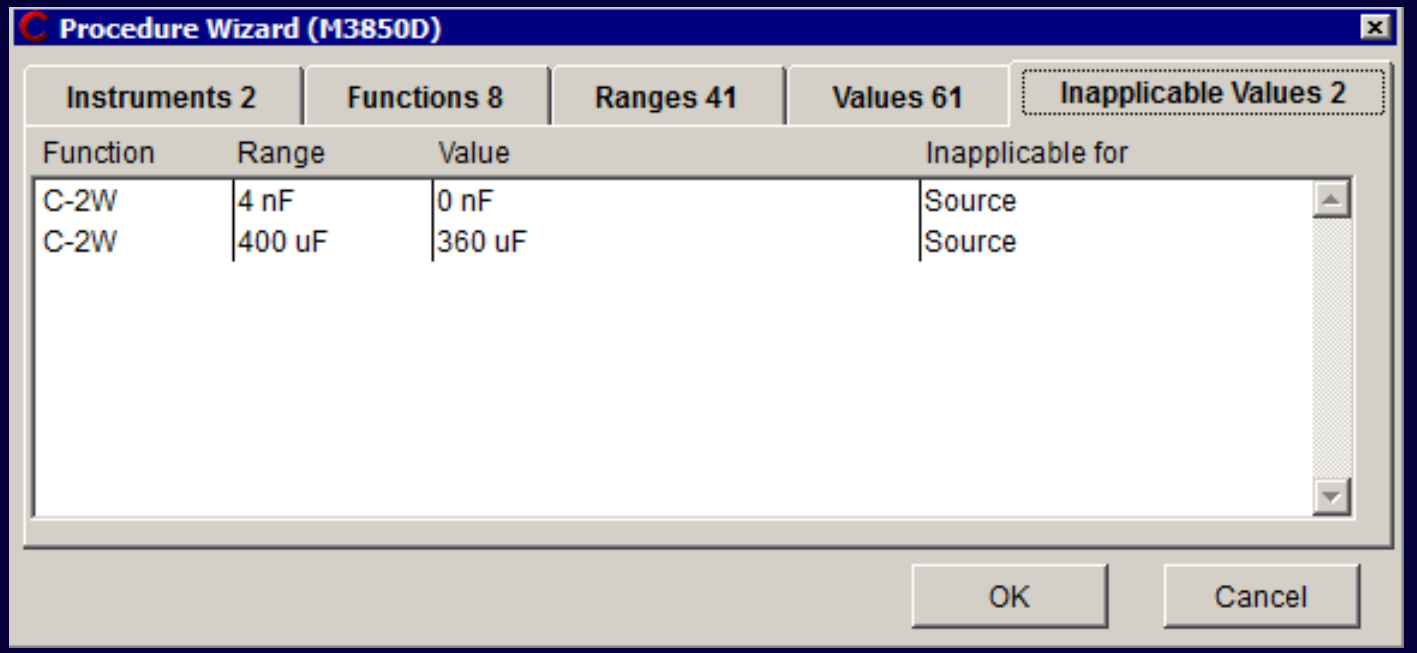
## Step 4 - Values




- Adding, modifying or removing points
- Changing points position

# Caliber – Procedure Wizard

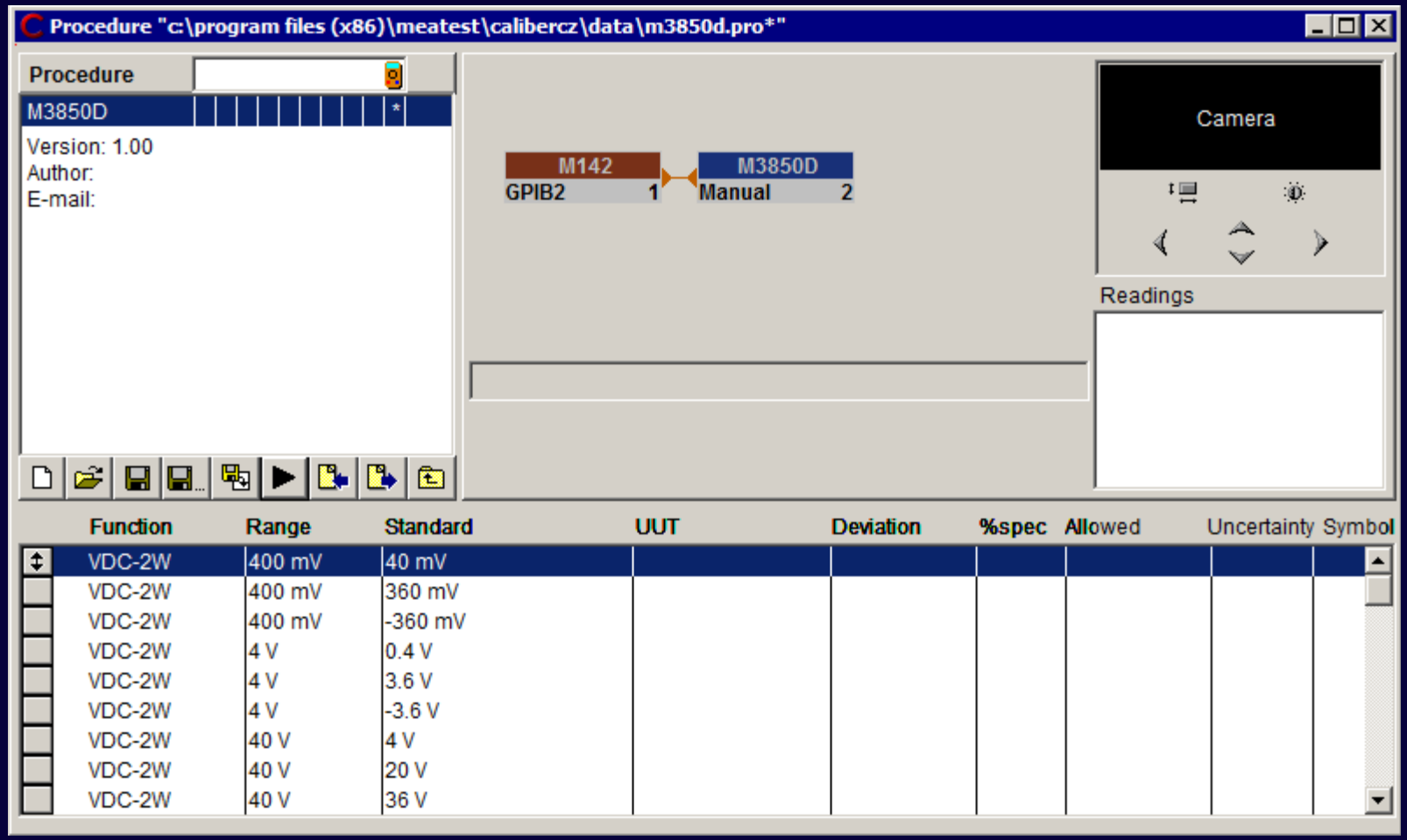
## Step 5 – Checking / Confirmation




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

# Caliber – Procedure Wizard

## Step 6 - Saving new calibration procedure



# Practical Example

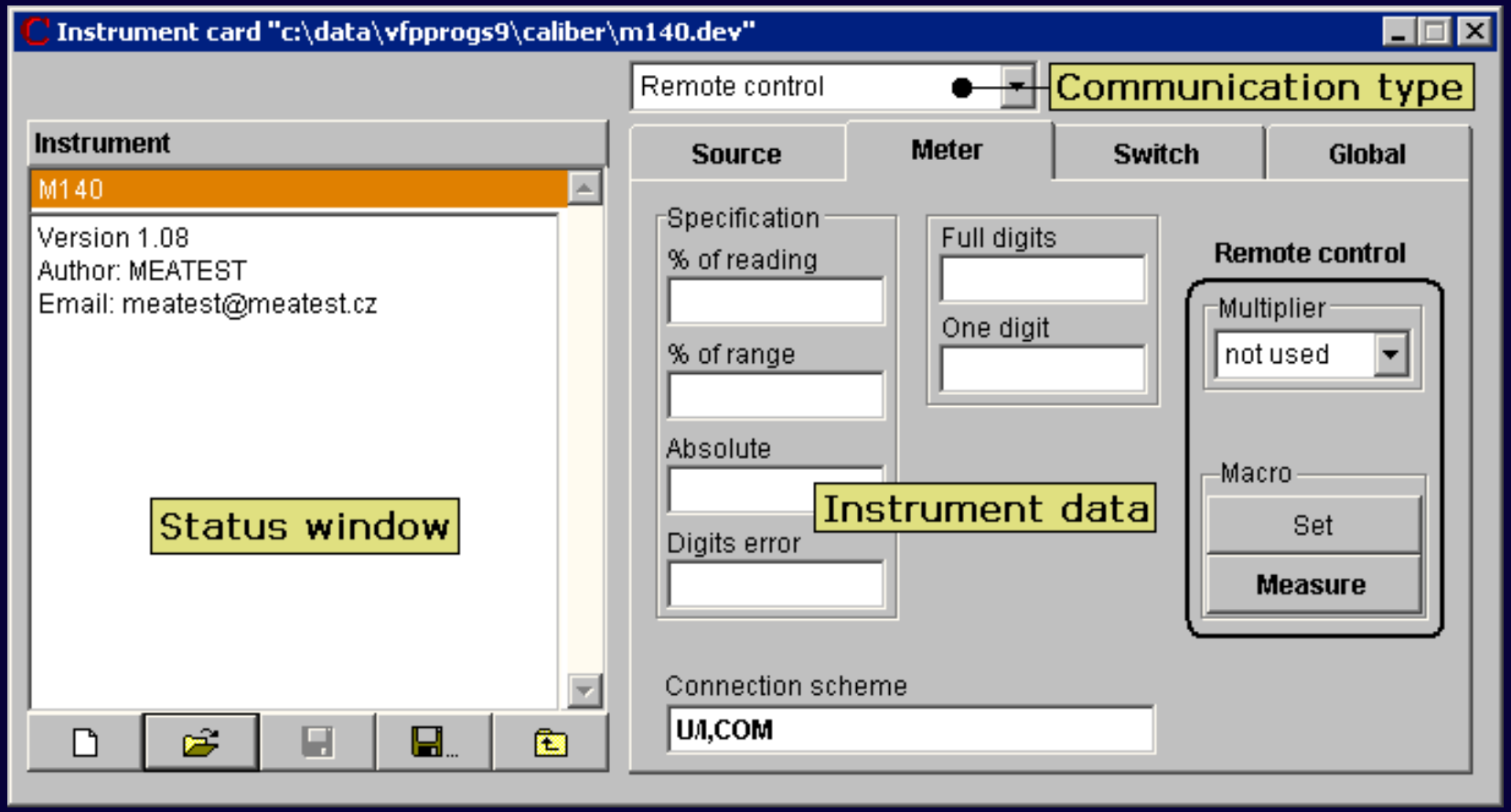
Creating new calibration procedure with PROCEDURE WIZARD

# Caliber - Instrument Card Window

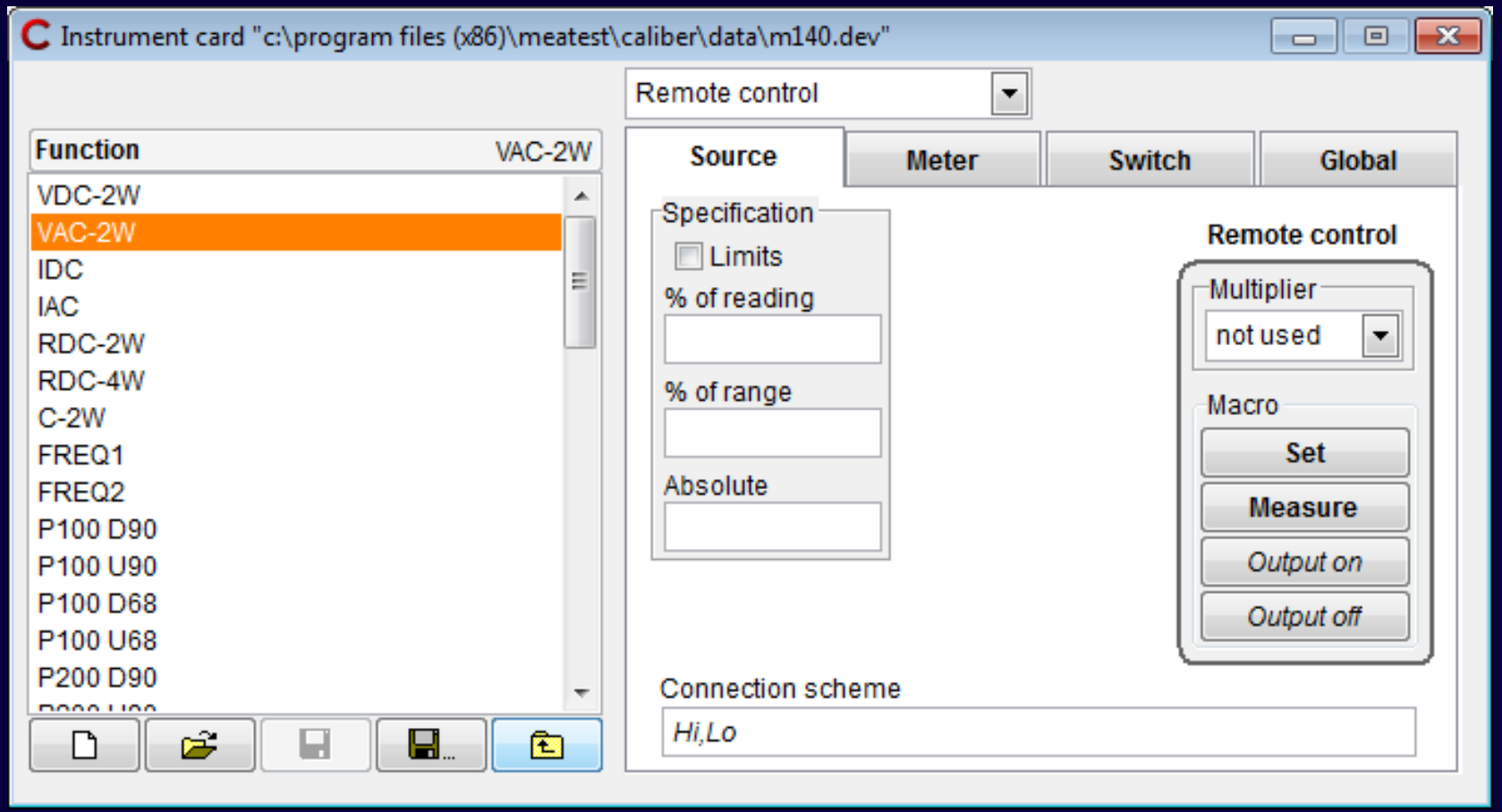
Tool for adding new instruments into the Caliber software.

- 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

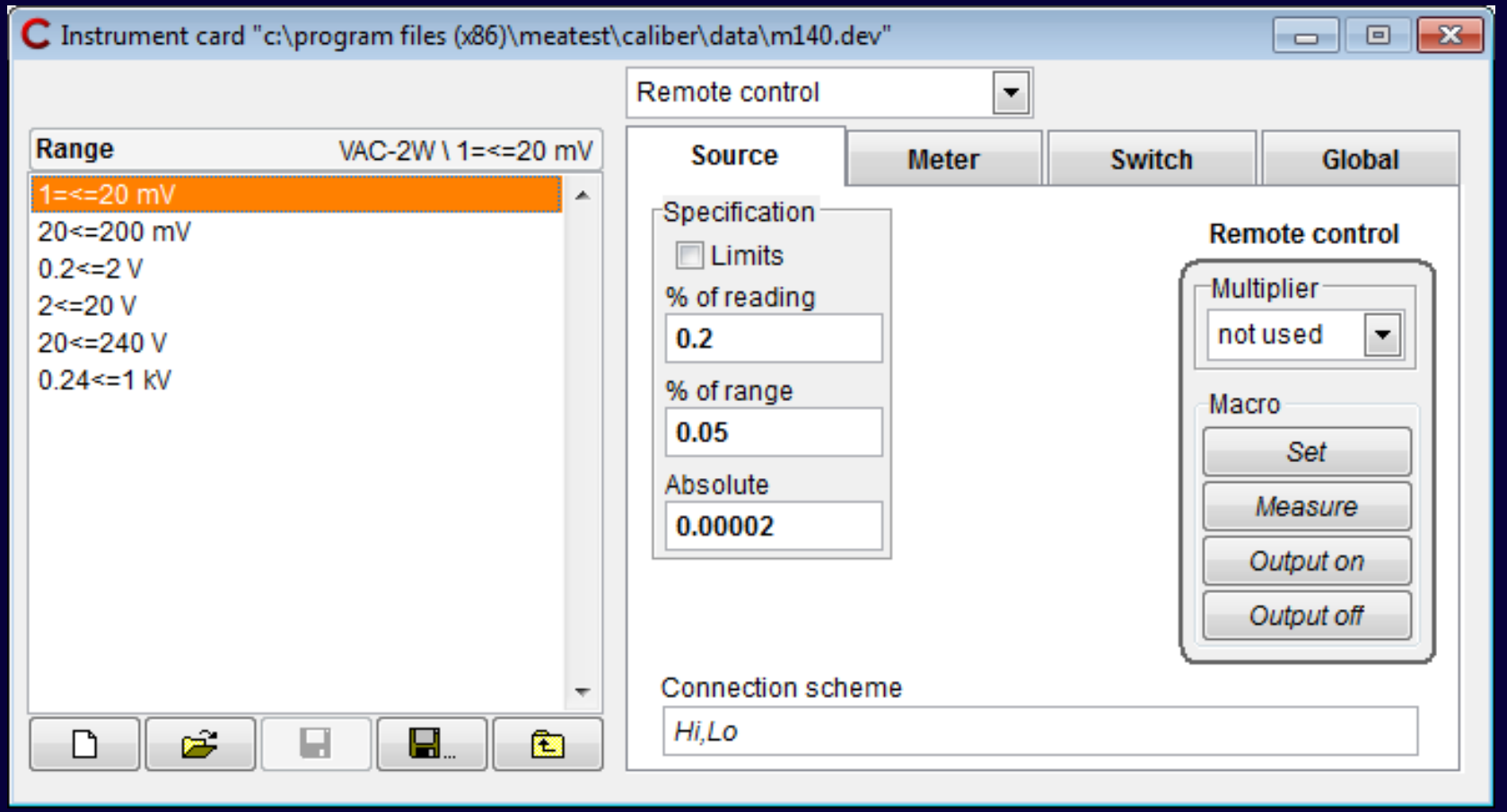
# Caliber - Instrument Card - Description



# Caliber - Instrument Card - Description



# Caliber - Instrument Card - Specification



# Practical Example

Creating/Changing instrument card with
INSTRUMENT CARDS

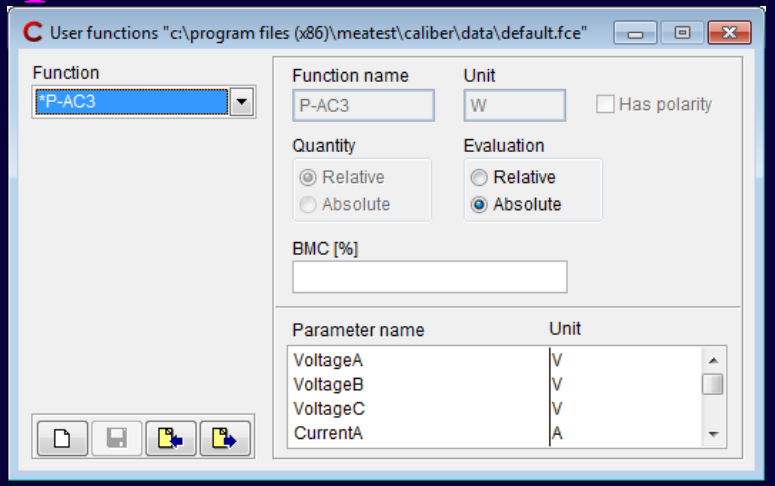
# Caliber - User Functions Window

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

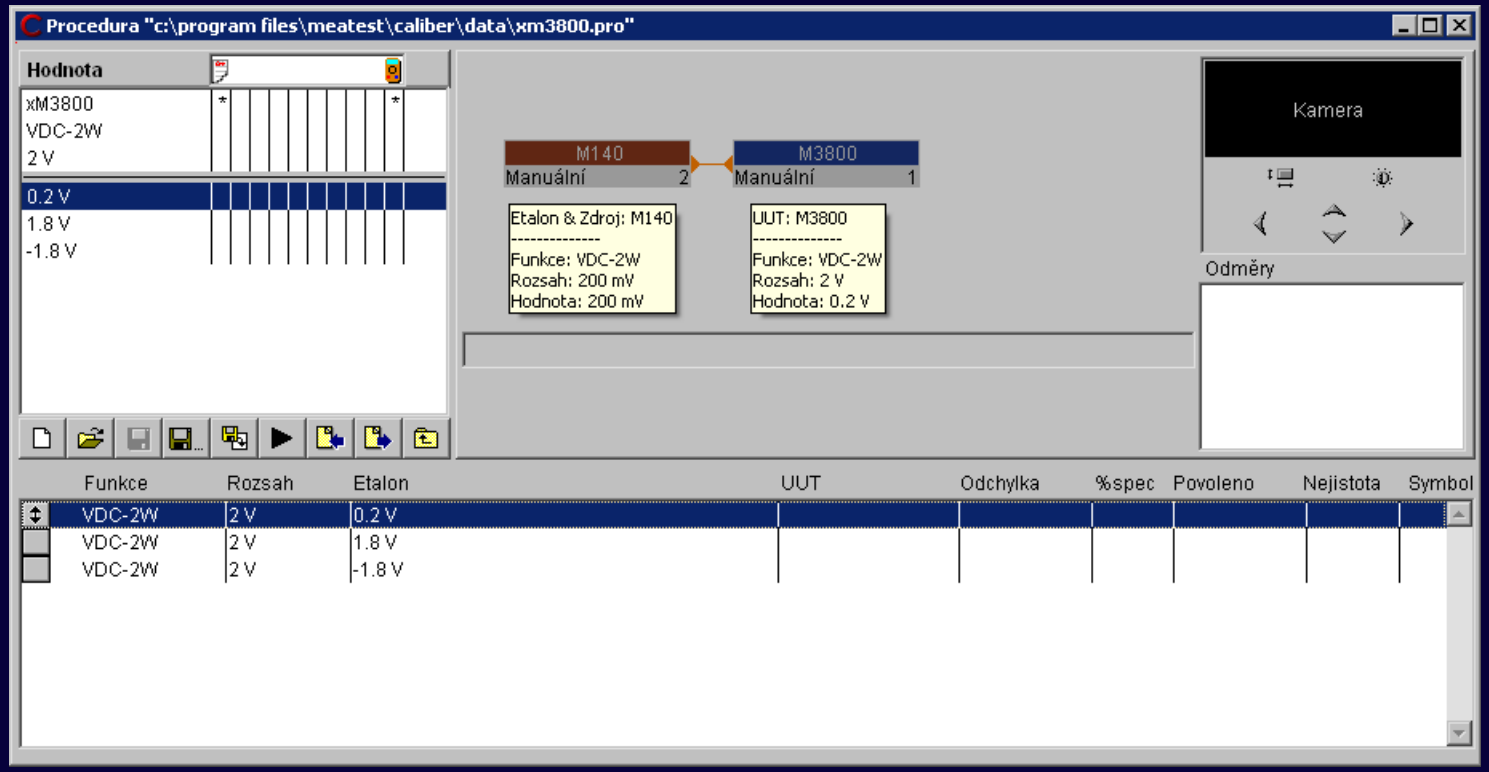
## Calibration uncertainty

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

- $u_a$ general uncertainty of type A
- $u_b$ general uncertainty of type B
- $u_{ud}$ uncertainty due to the limited resolution of UUT
- $u_{ua}$ uncertainty type A - repeated measurements UUT
- $u_{sd}$ uncertainty due to the limited resolution of SU
- $u_{sa}$ uncertainty type A - repeated readings SU
- $u_{sb}$ uncertainty due to the uncertainty of SU
- $u_{td}$ uncertainty due to the limited resolution of auxiliary SU (transmitter)
- $u_{ta}$ uncertainty type A - repeated readings auxiliary SU (transmitter)
- $u_{tb}$ uncertainty due to the uncertainty of auxiliary SU (transmitter)
- $u_{cb}$ uncertainty due to the accuracy of converter (if used)

# Caliber - Example 1

## Multimeter M3800 calibration



# Caliber - Example 1

**Calibration uncertainty**

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

$$u_c = \sqrt{(u_{ud}^2 + u_{ua}^2 + u_{sb}^2)}$$

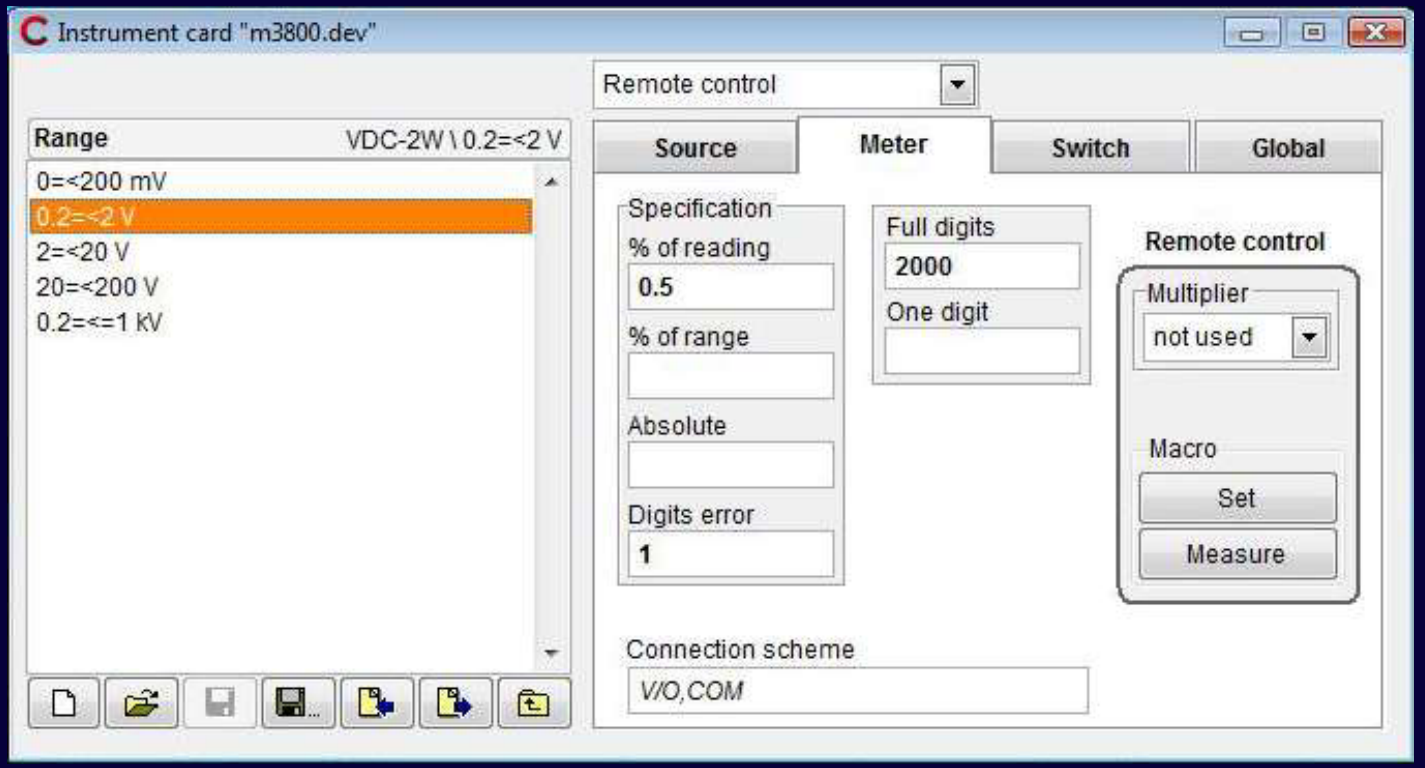
- $u_{ud}$ uncertainty due to the limited resolution of UUT
  - calculated from parameters written in instrument card
- $u_{ua}$ uncertainty type A - repeated measurements UUT
  - calculated from repeated measurements
- $u_{sb}$ uncertainty due to the uncertainty of SU
  - calculated from parameters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

# Caliber – Example 1

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

**$u_{ud}$ [mV] = 0.29*Dig_u = 0.29*2000mV/2000dig = 0.29mV**

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

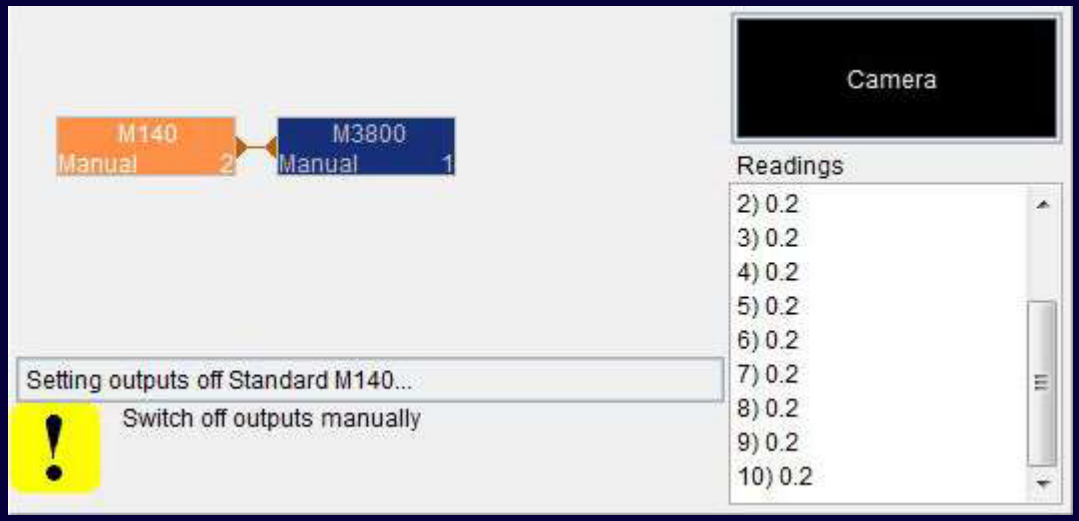


# Caliber – Example 1

**$U_{ua}$ repeated measurement of UUT**

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

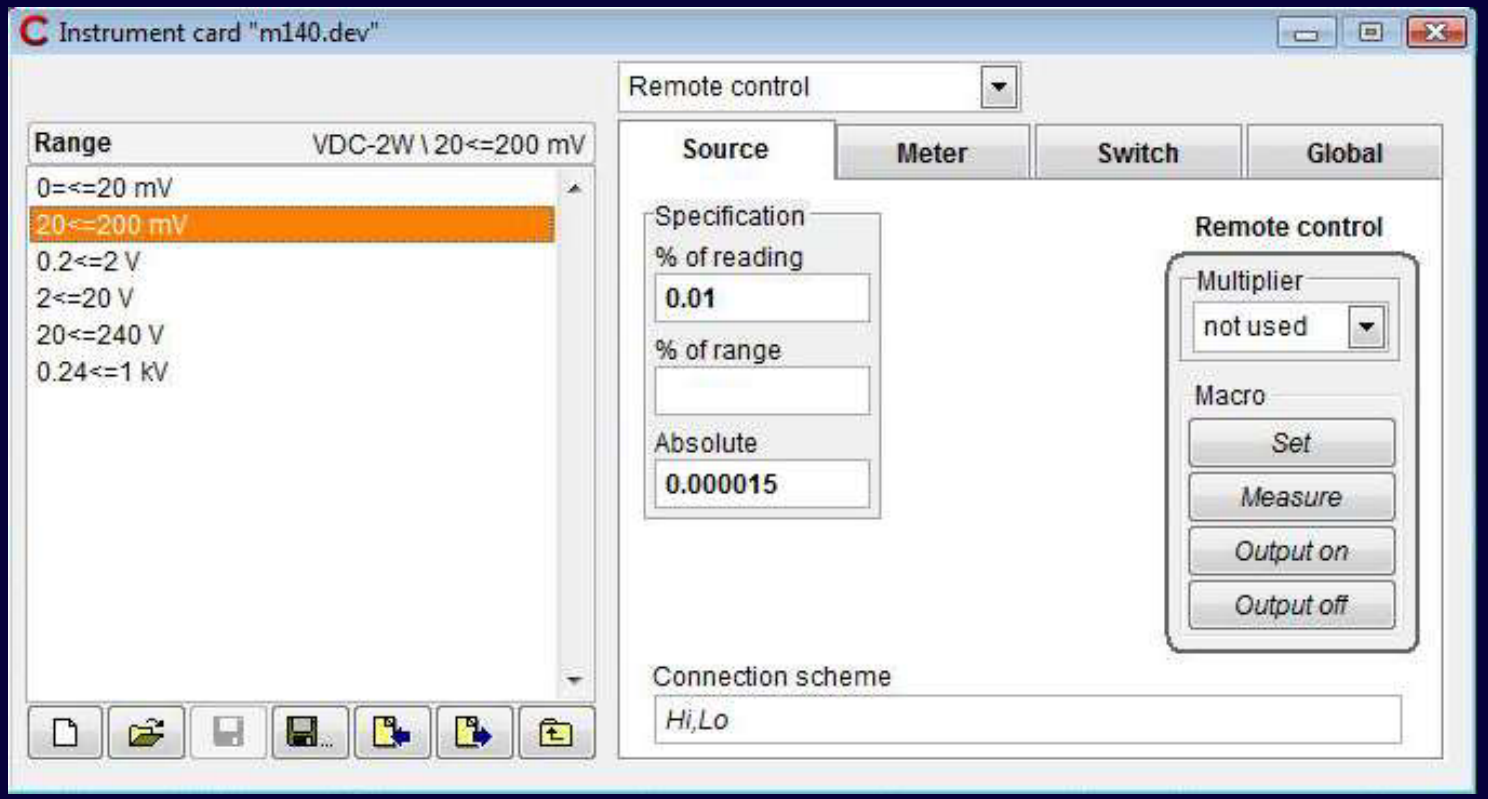
$$u_{ua}\ [\%] = 0mV*100\%/200mV = 0\%$$



# Caliber – Example 1

## $U_{sb}$ uncertainty due to the uncertainty of SU

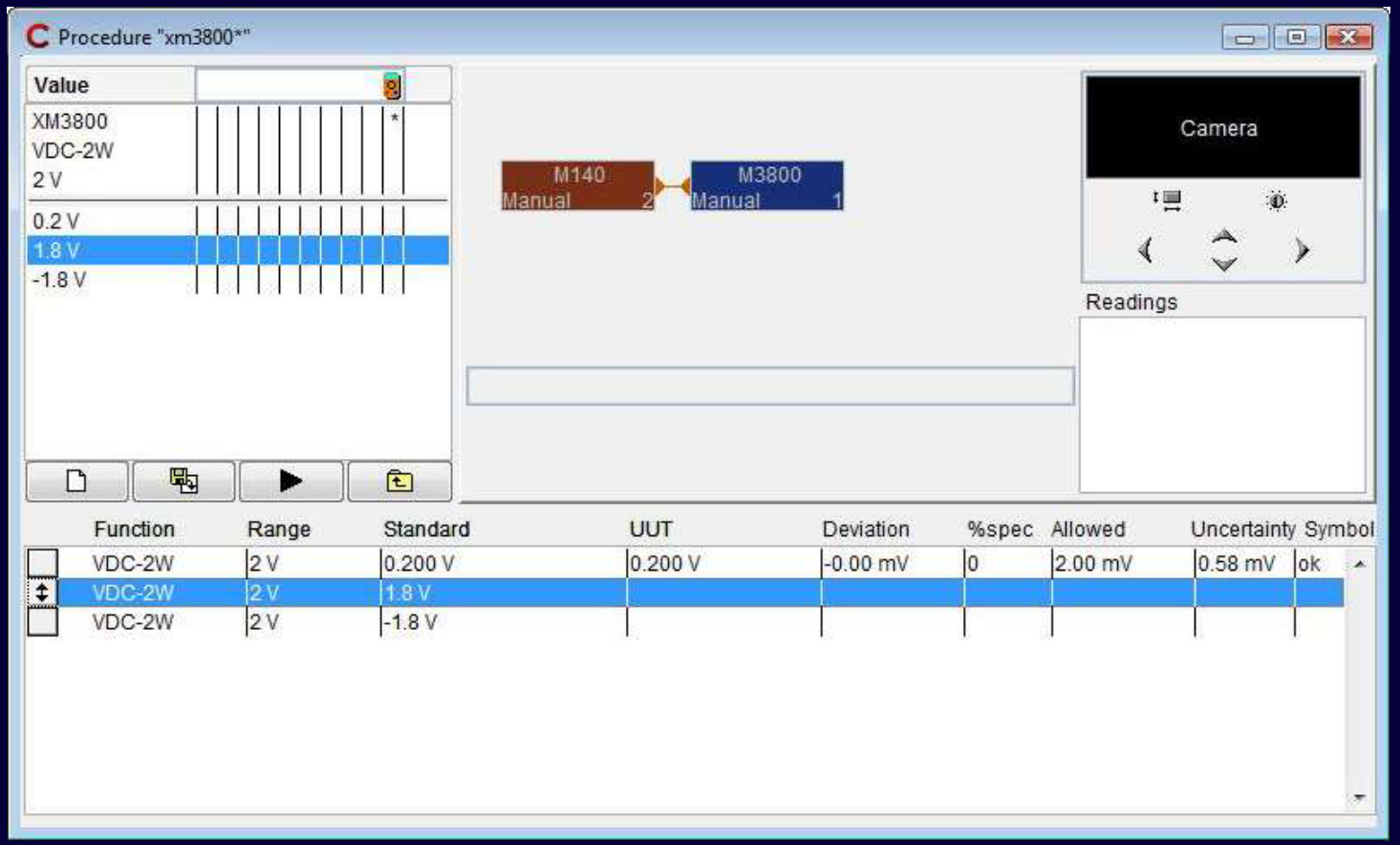
$$u_{sb}\ [mV] = Dmax\_s / \sqrt{3}$$
$$= (200mV*0.01\%/100\%+0.015mV) / \sqrt{3} = 0.02021\ mV$$



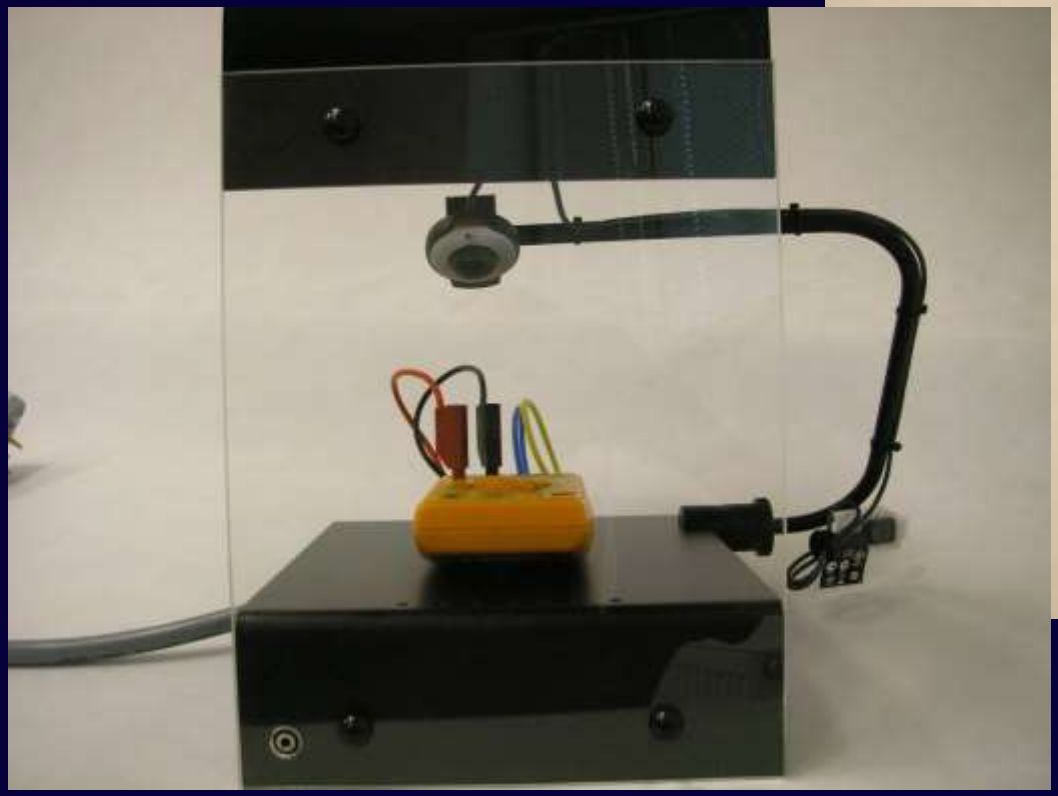
# Caliber – Example 1

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

$U = k_u * u_c = 2 * 0.2907 = 0.58$ mV (rounded)



# 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