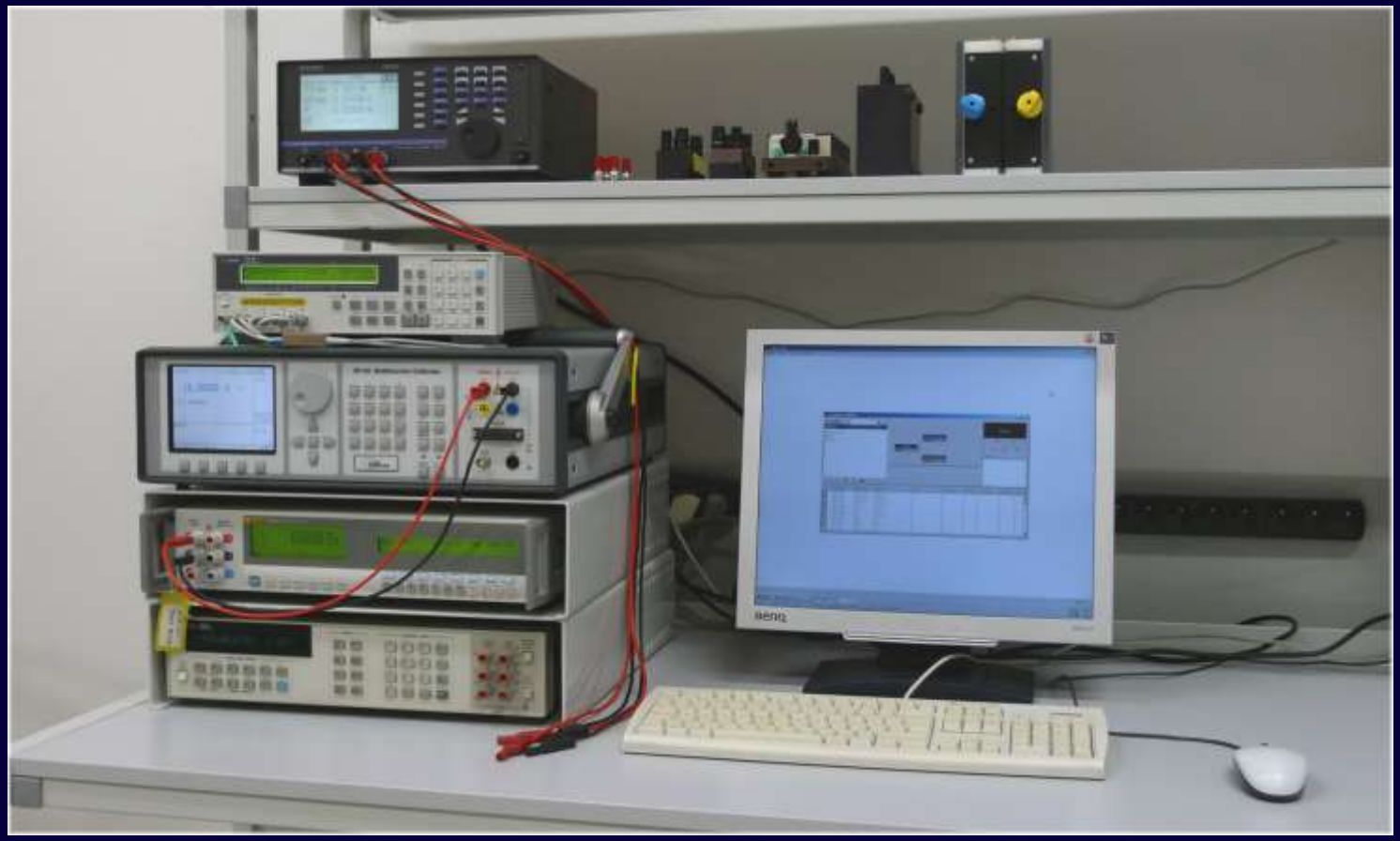
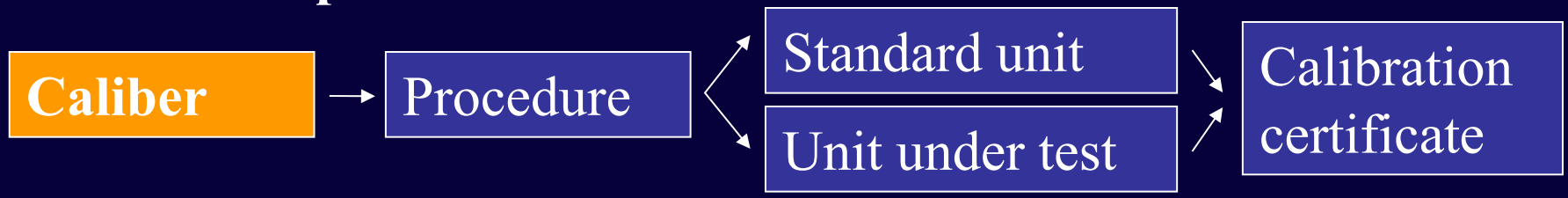
Computer - controlled calibration



WinQBase and Caliber

WinQbase database software

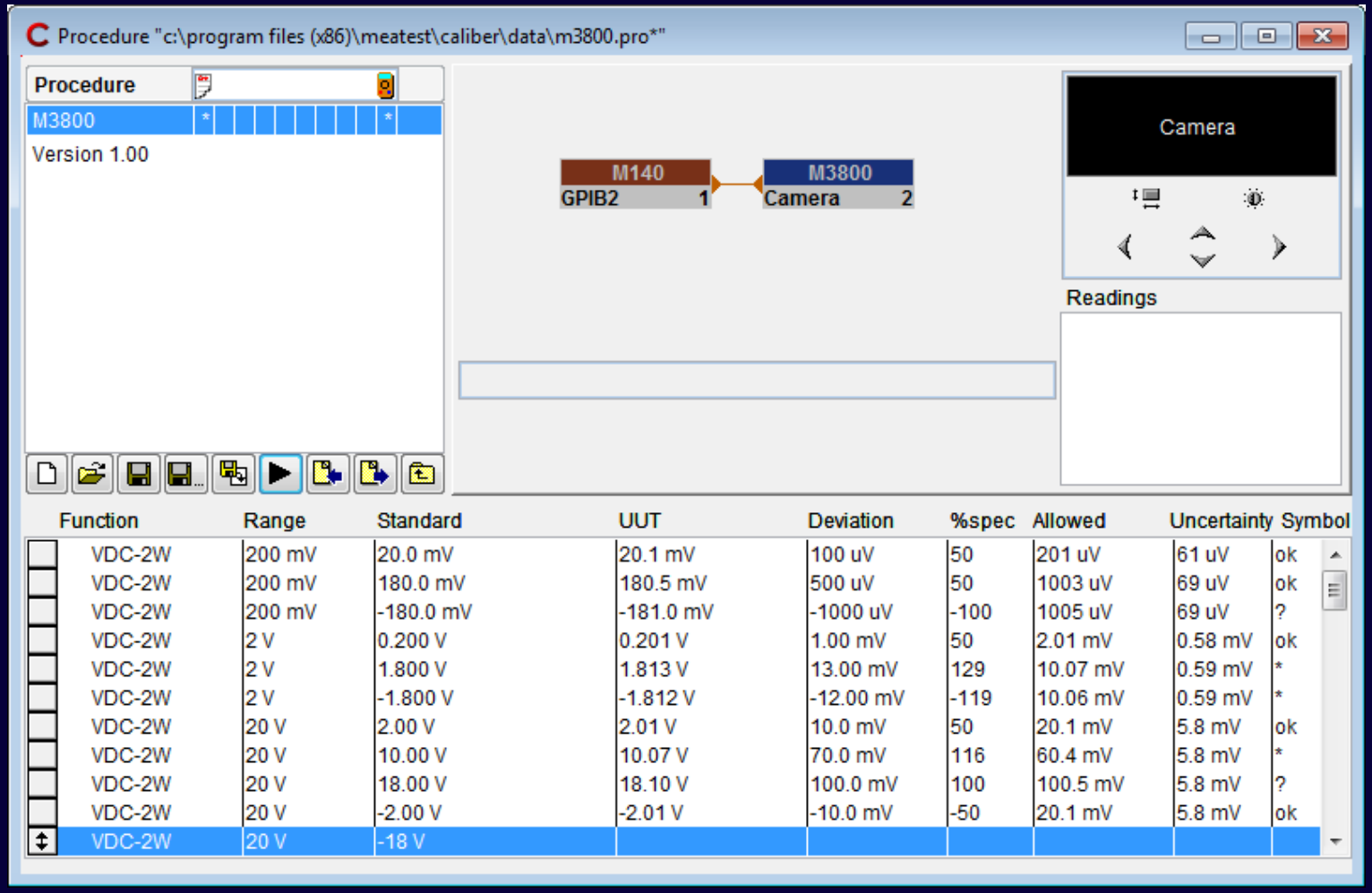
Caliber computer controlled calibration



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

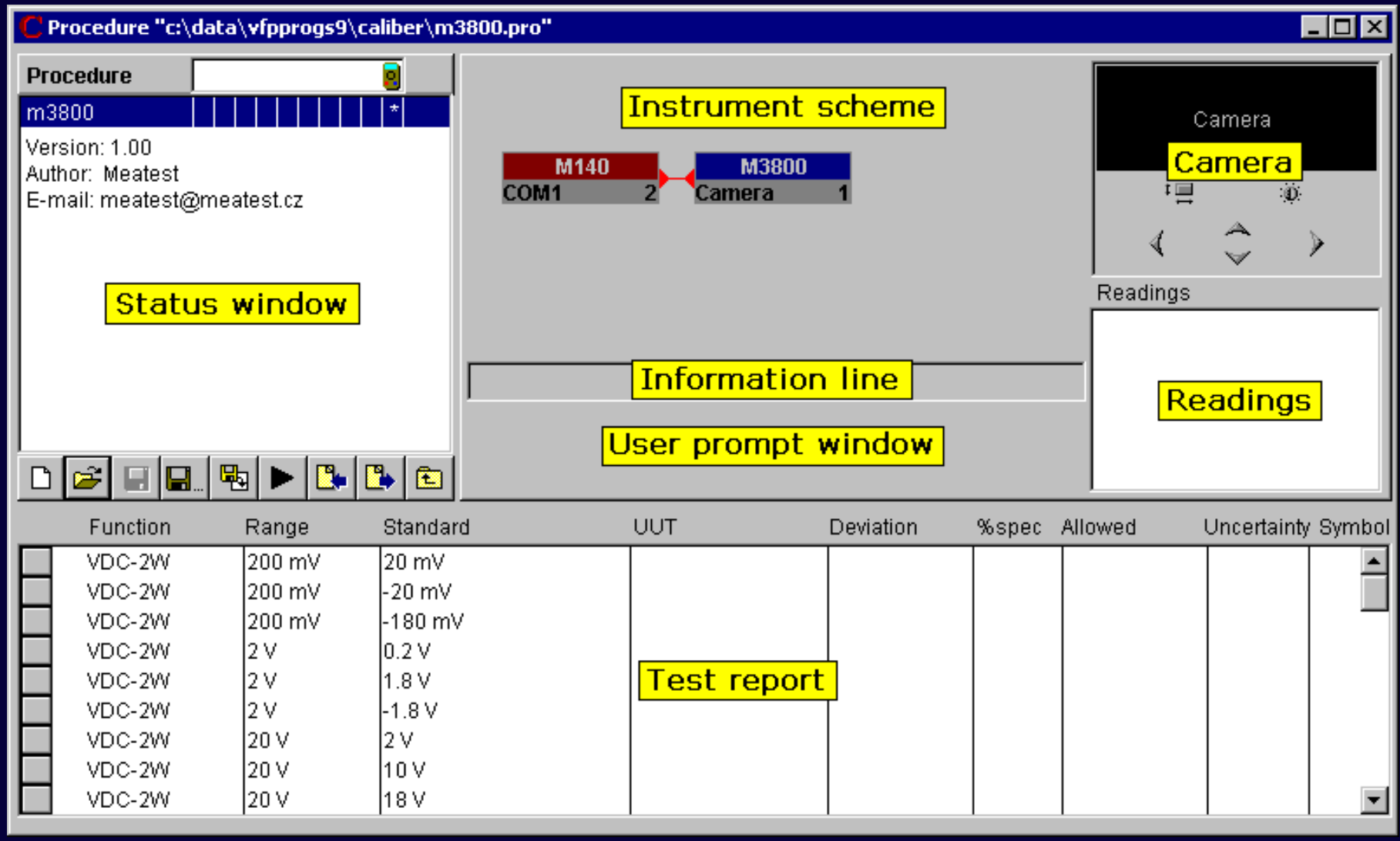
Caliber – Modules

- 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

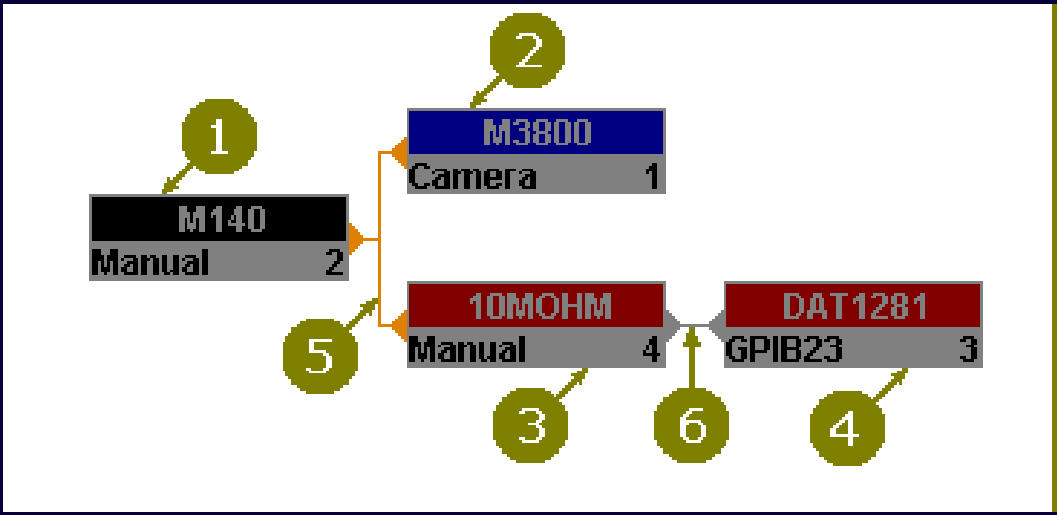
Caliber - Procedure window

- 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

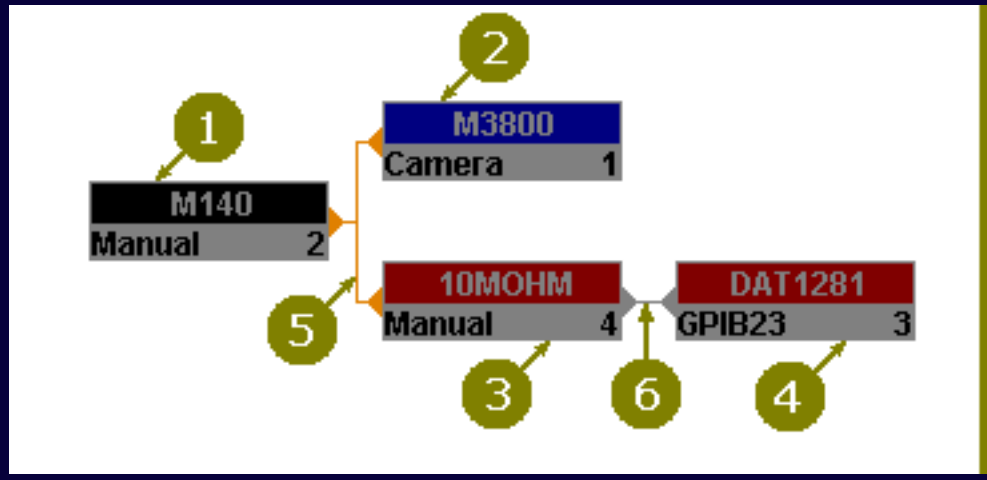


1. Source
2. UUT (meter)
3. Standard converter
4. Standard (meter)
5. Master signal bus
6. Transformed bus

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

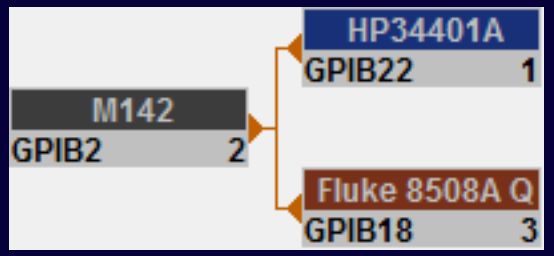
M622 GPIB2 1 — M3800 Camera 2

Calibration of meter

- 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

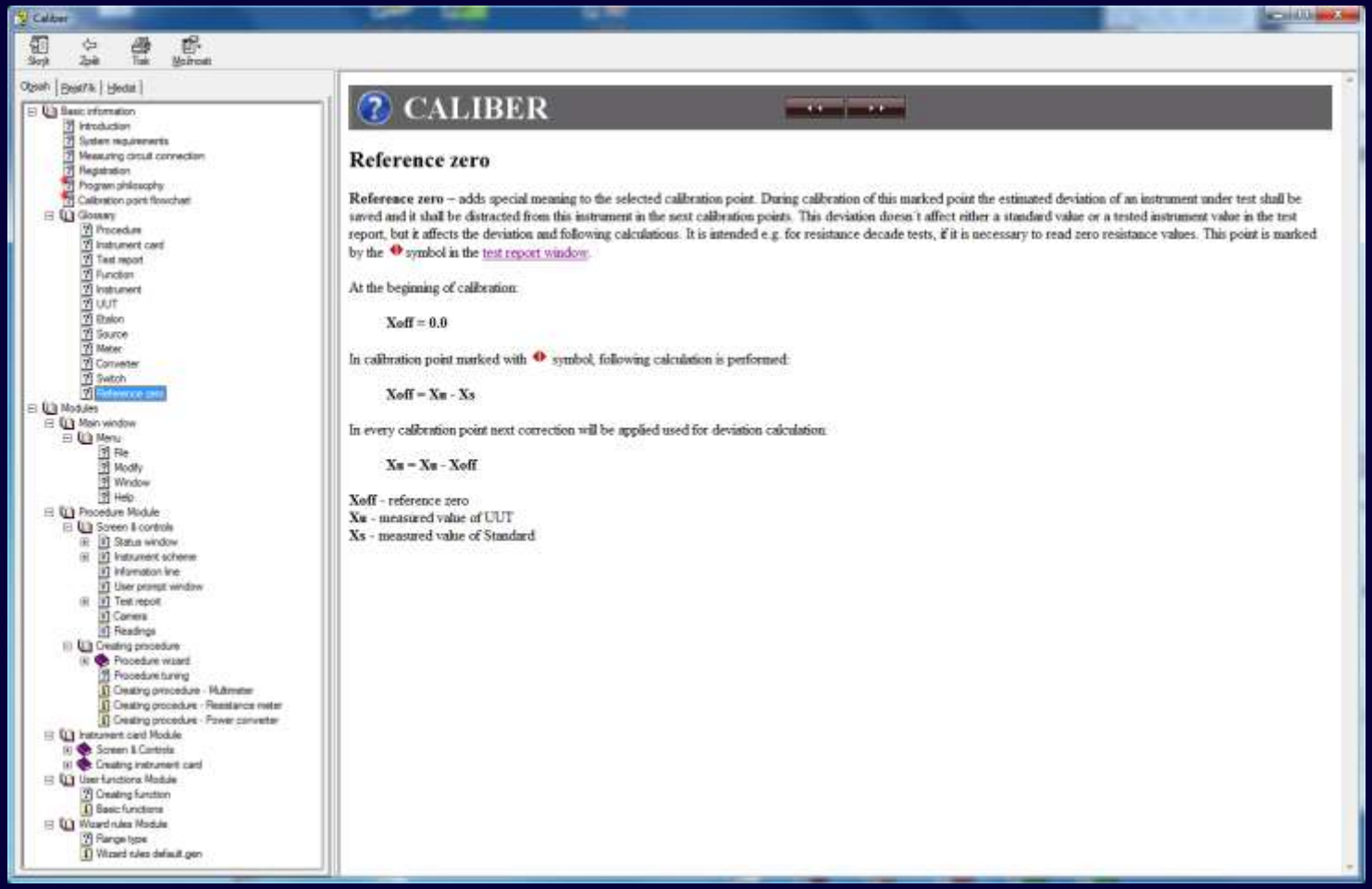
Calibration of power source

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

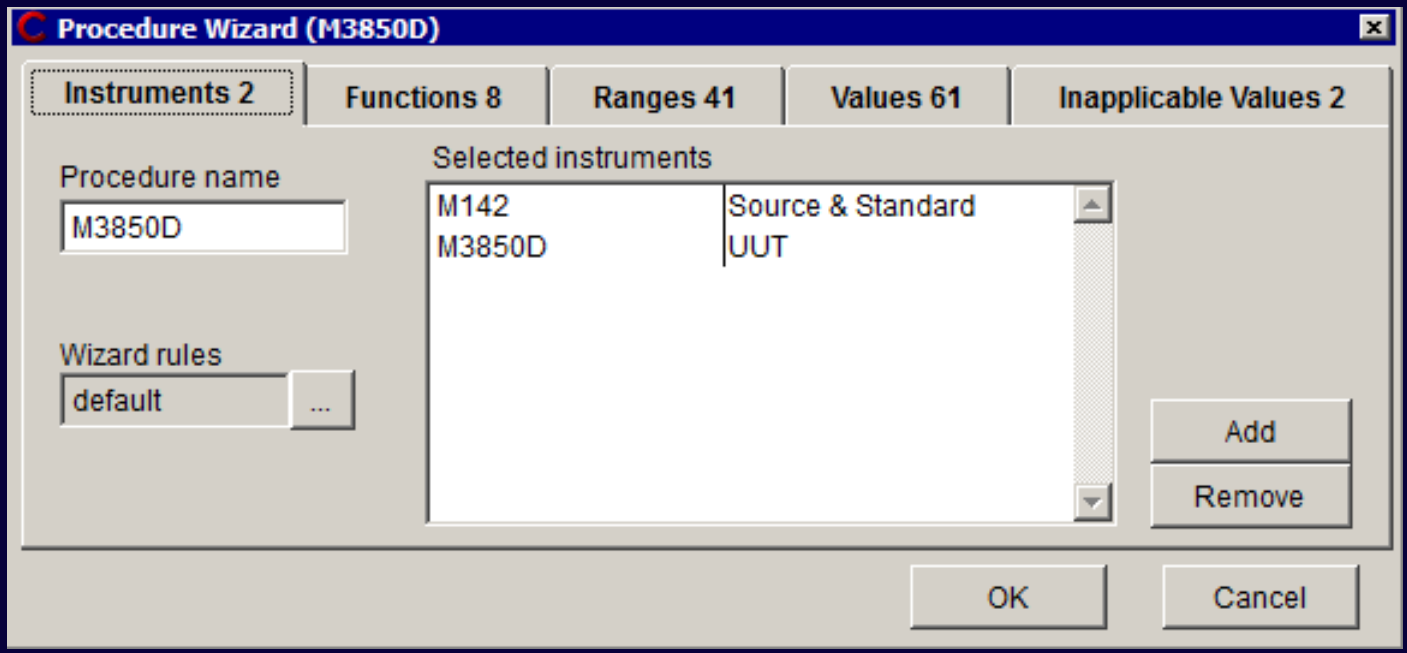
Generation of calibration procedure

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

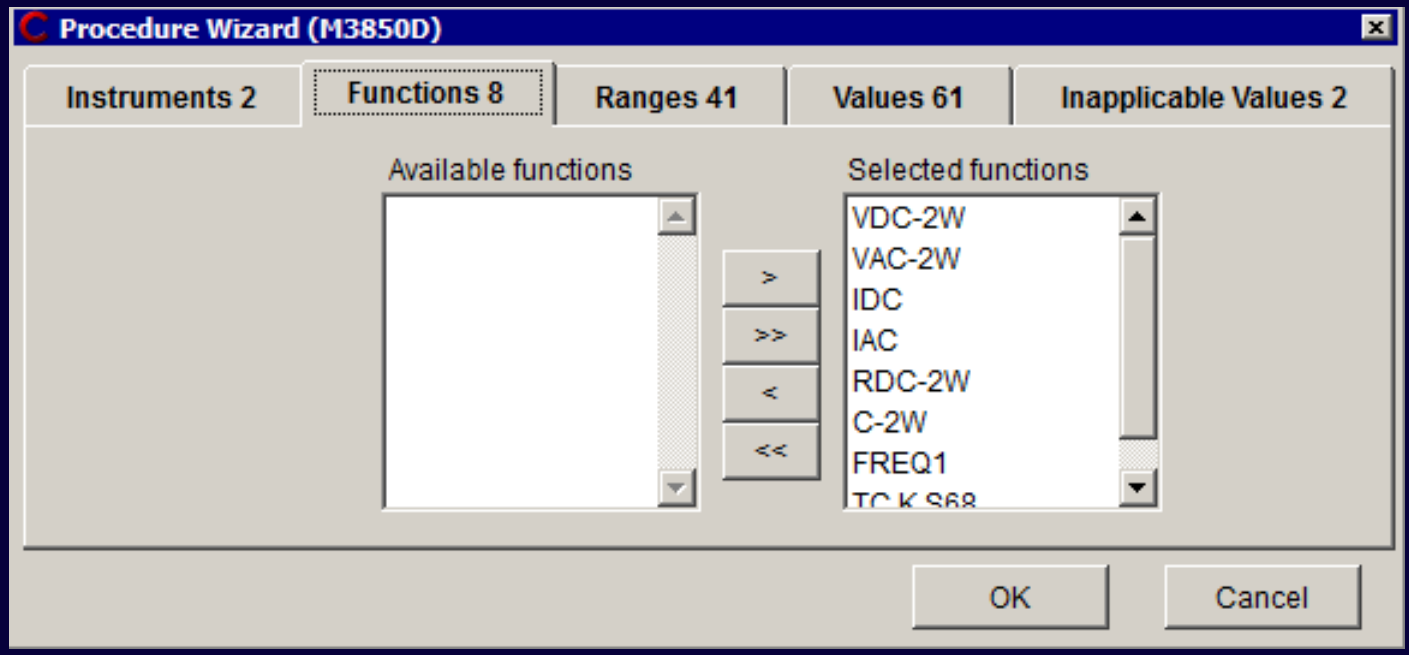
Step 1 - Instruments



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

Caliber – Procedure Wizard

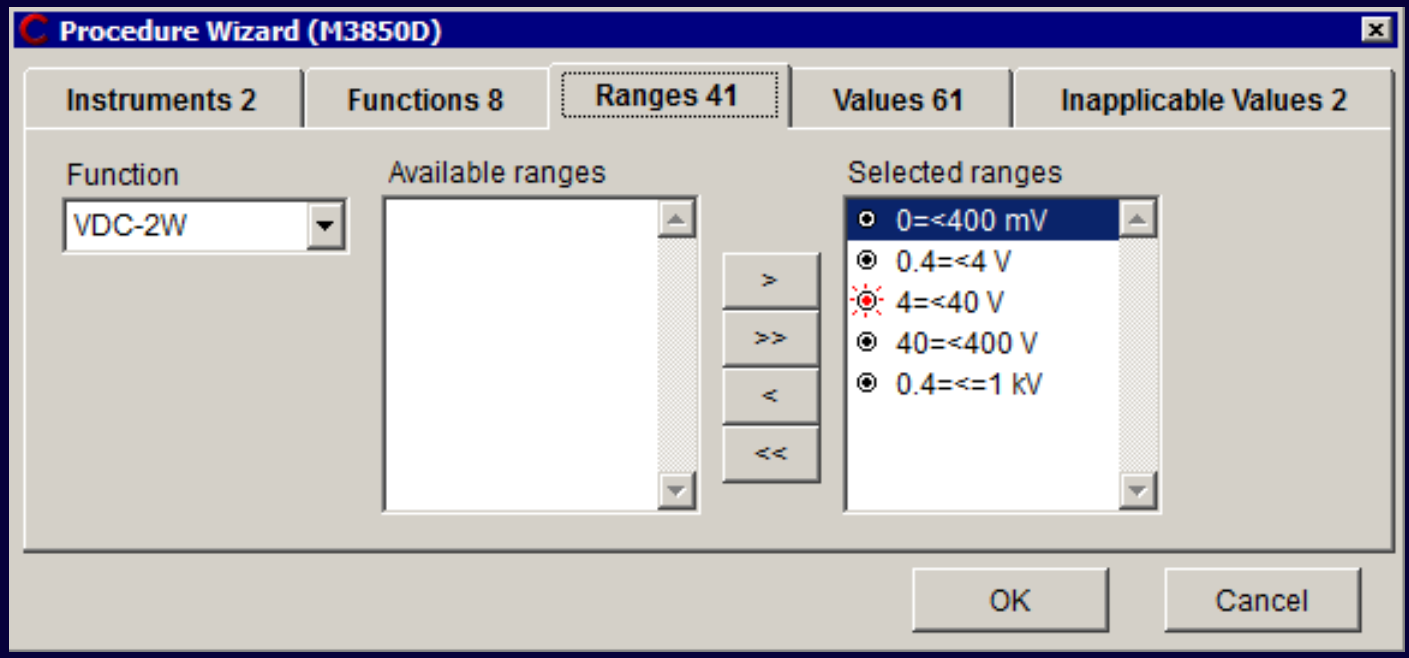
Step 2 - Functions



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

Caliber – Procedure Wizard

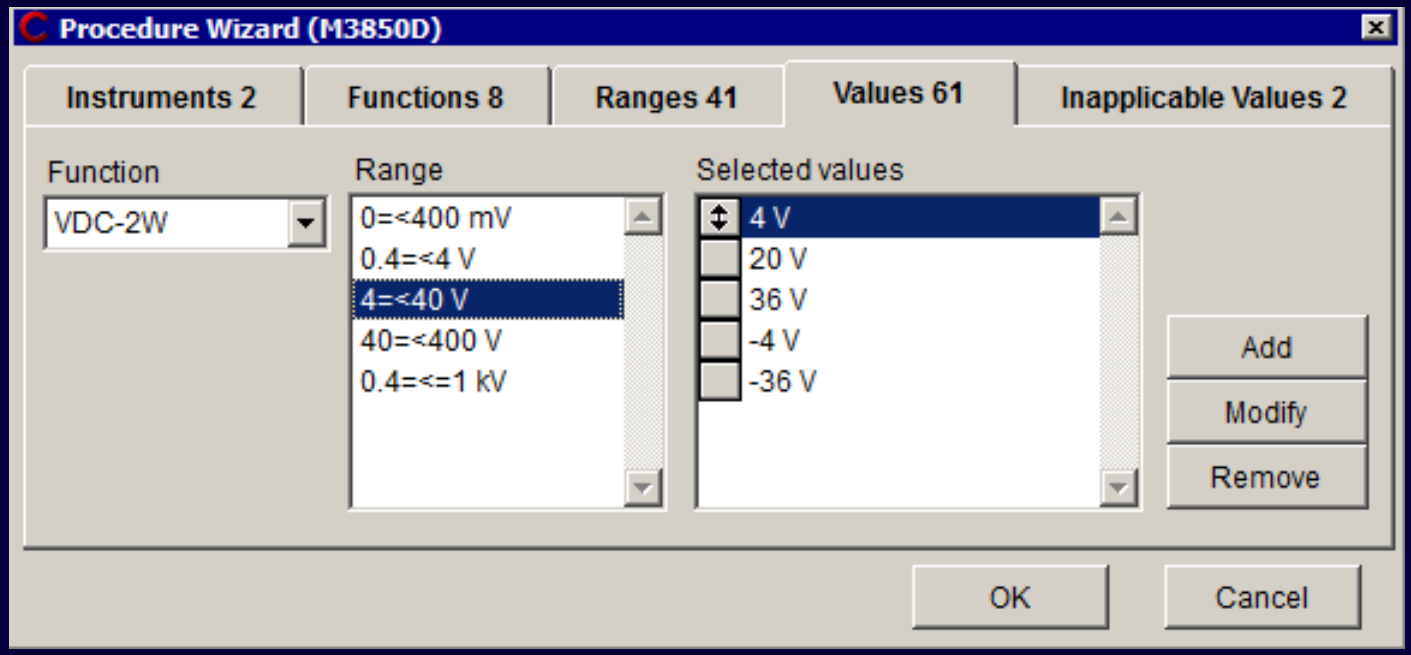
Step 3 - Ranges



– Selection of ranges used during calibration

Caliber – Procedure Wizard

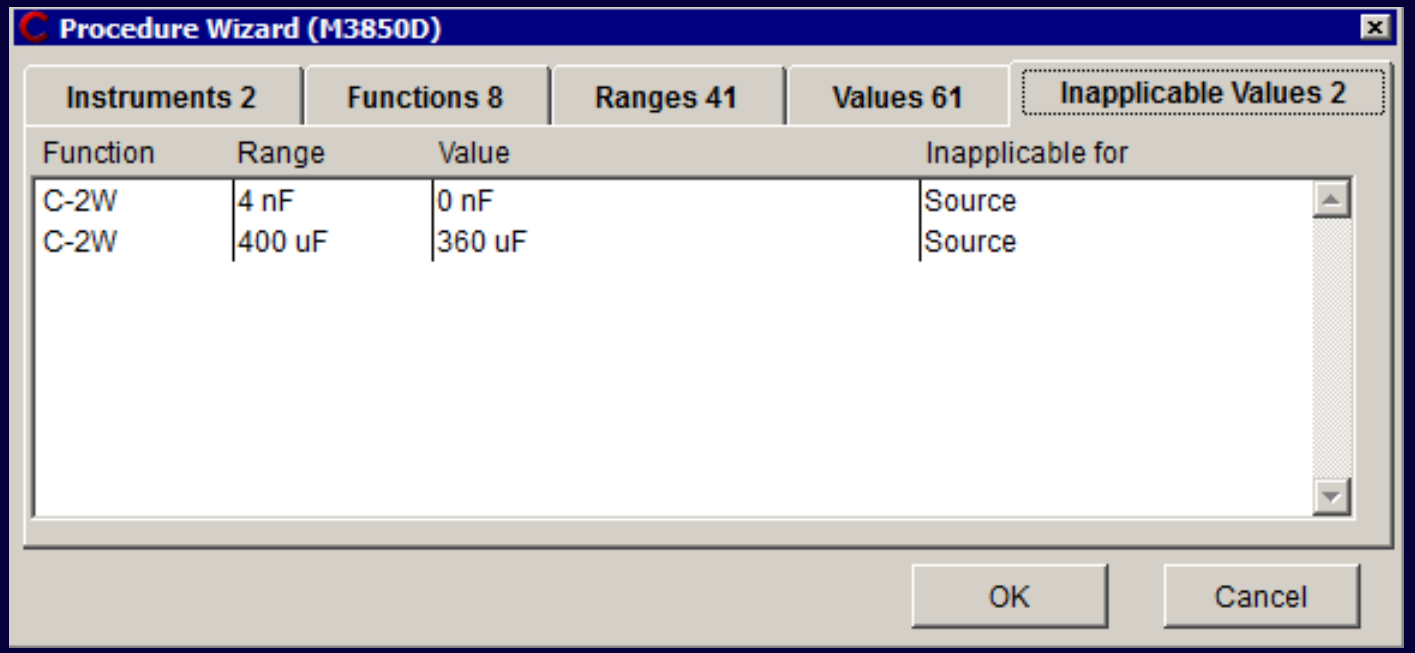
Step 4 - Values



- Adding, modifying or removing points
- Changing points position

Caliber – Procedure Wizard

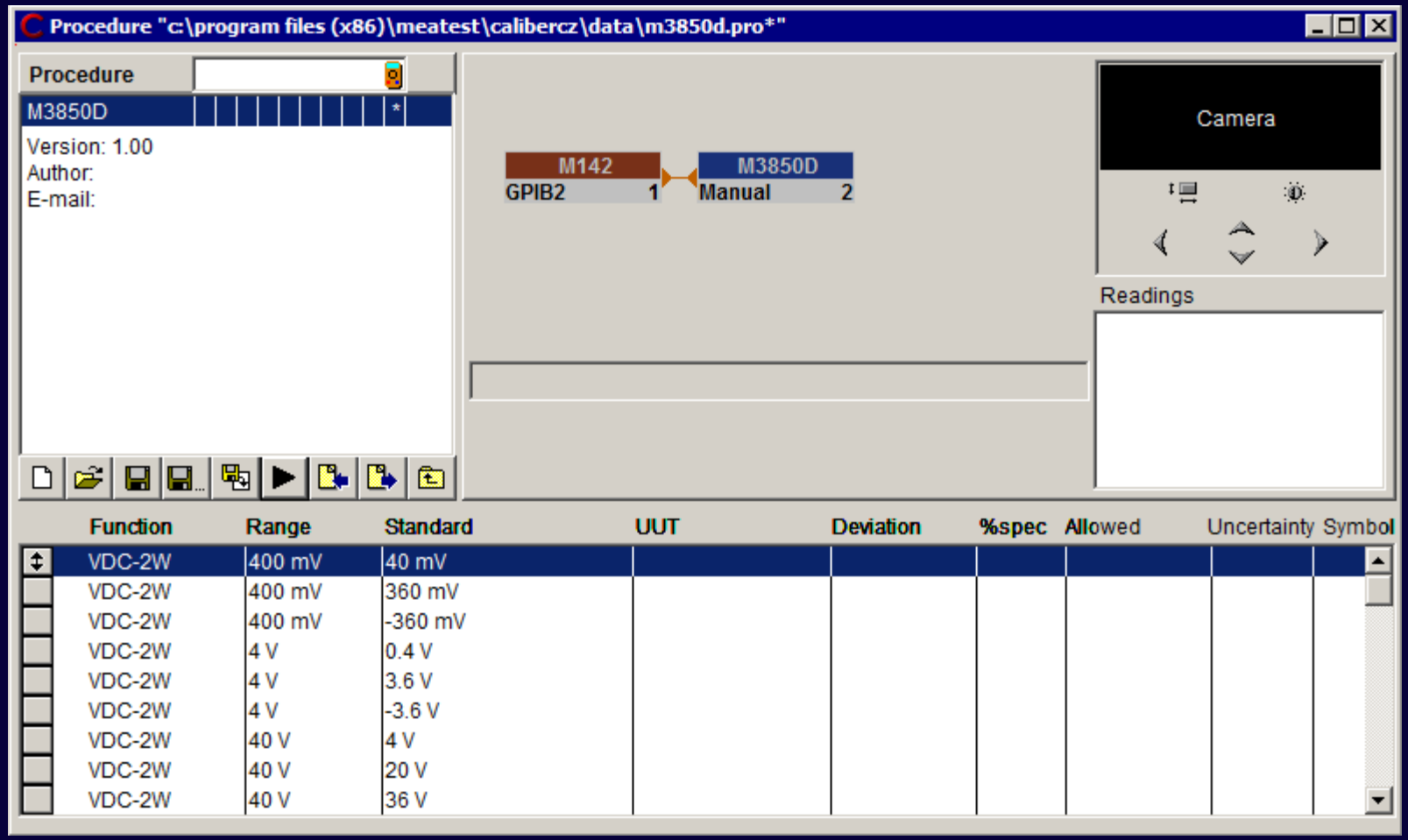
Step 5 – Checking / Confirmation



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

Caliber – Procedure Wizard

Step 6 - Saving new calibration procedure



Practical Example

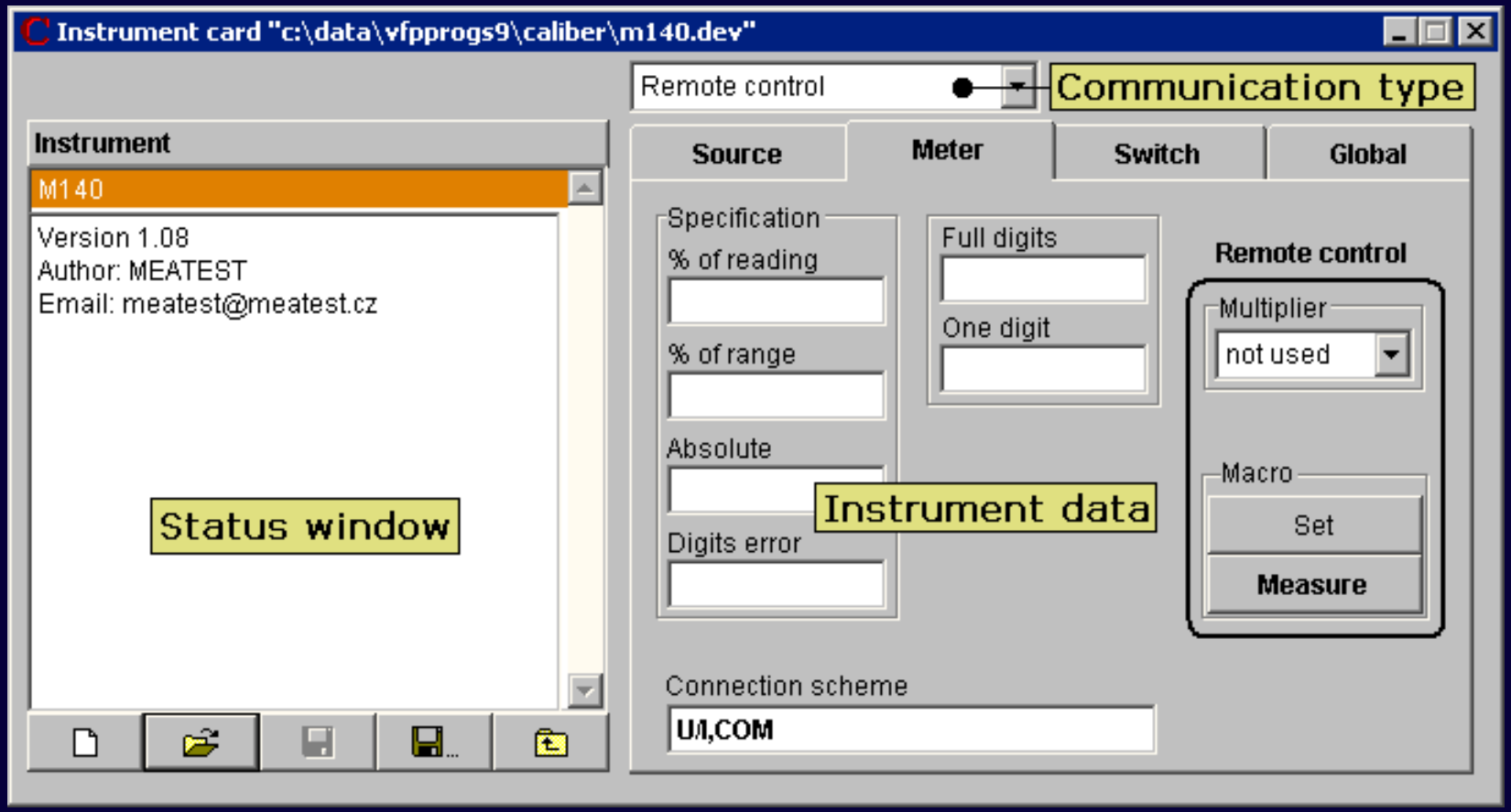
Creating new calibration procedure with PROCEDURE WIZARD

Caliber - Instrument Card Window

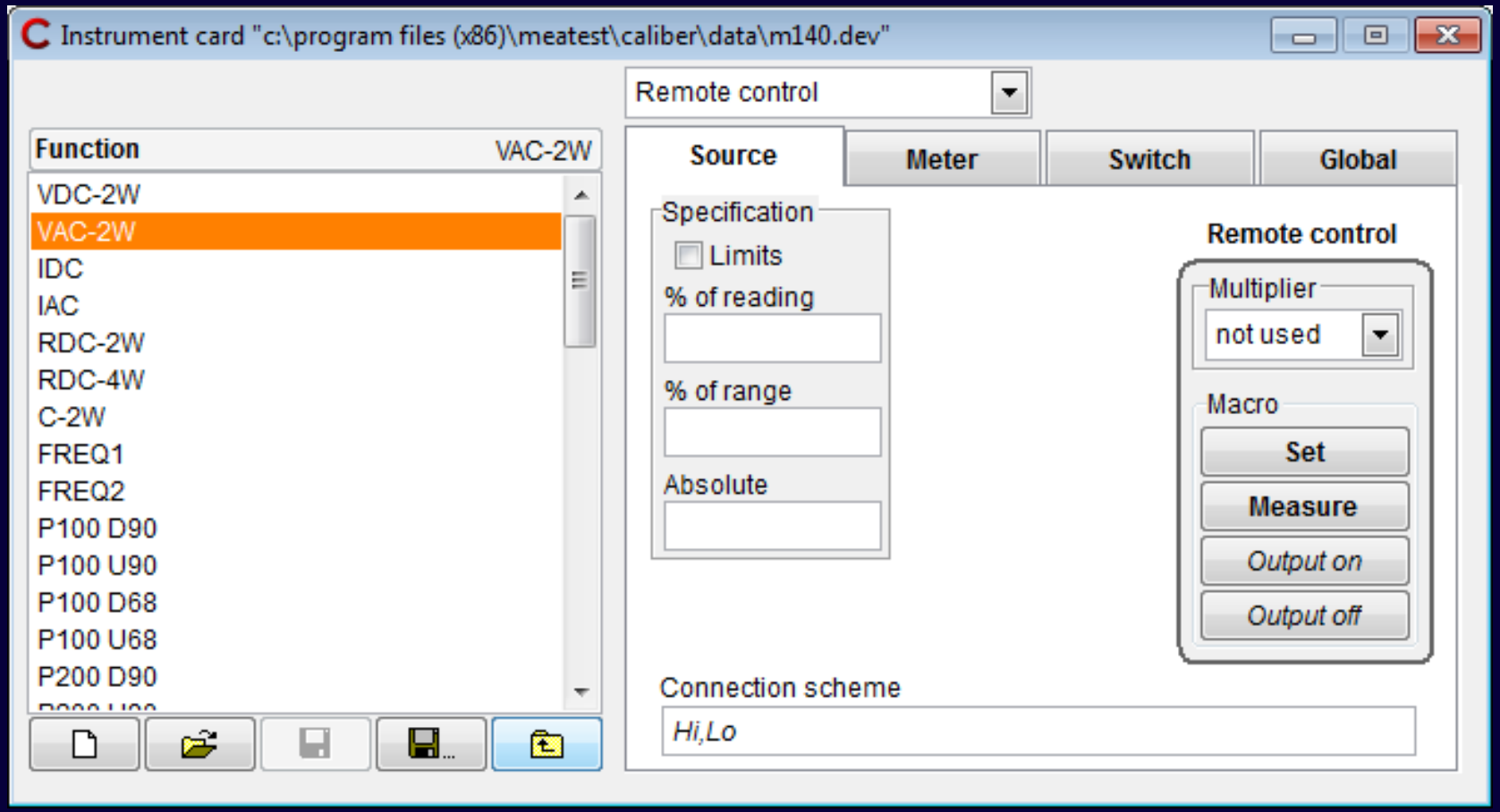
Tool for adding new instruments into the Caliber software.

- 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

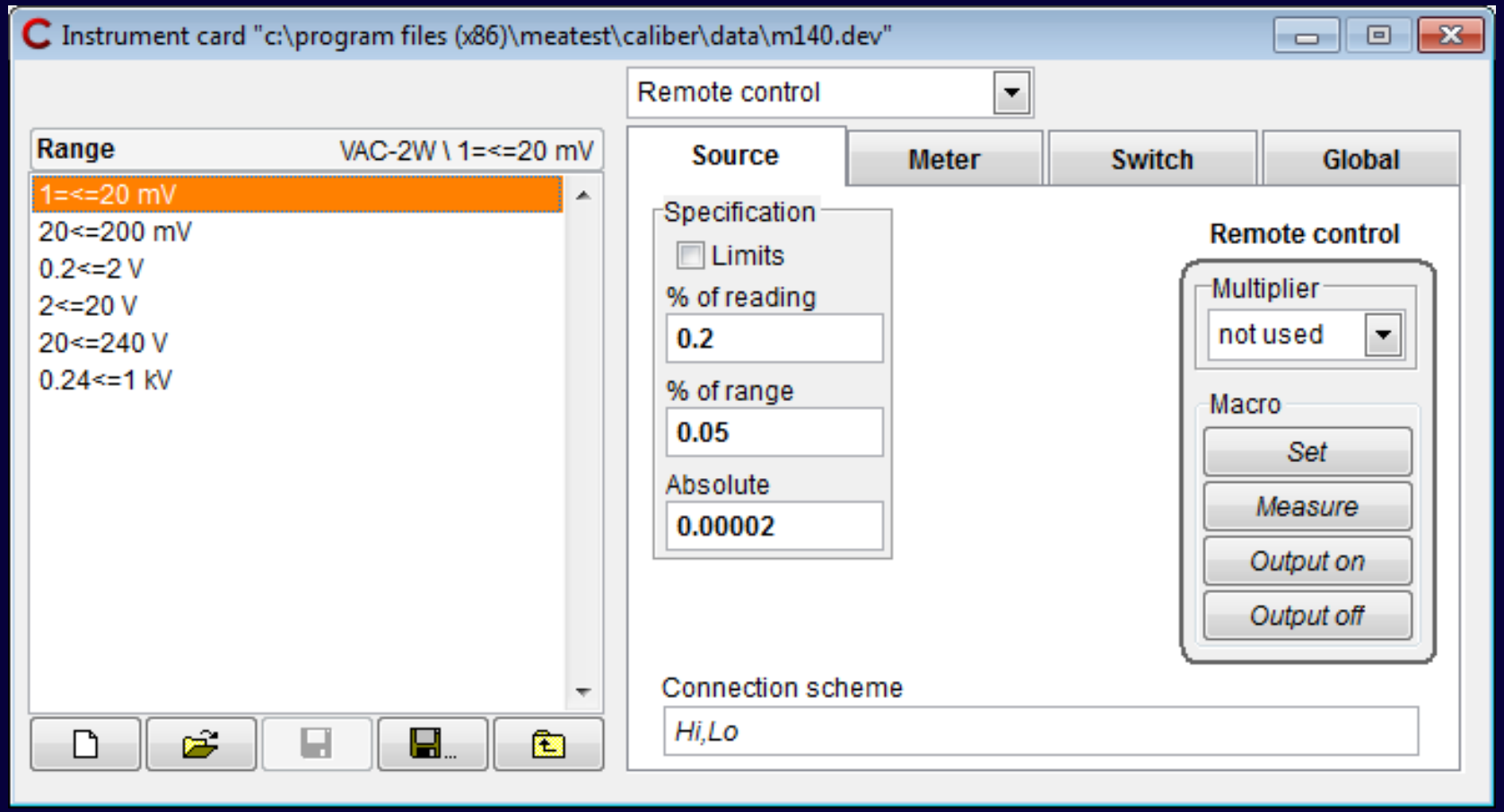
Caliber - Instrument Card - Description



Caliber - Instrument Card - Description



Caliber - Instrument Card - Specification



Practical Example

Creating/Changing instrument card with
INSTRUMENT CARDS

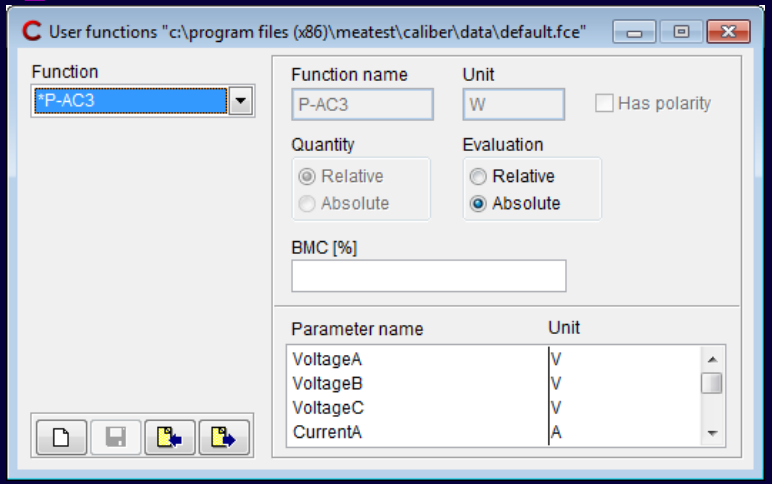
Caliber - User Functions Window

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

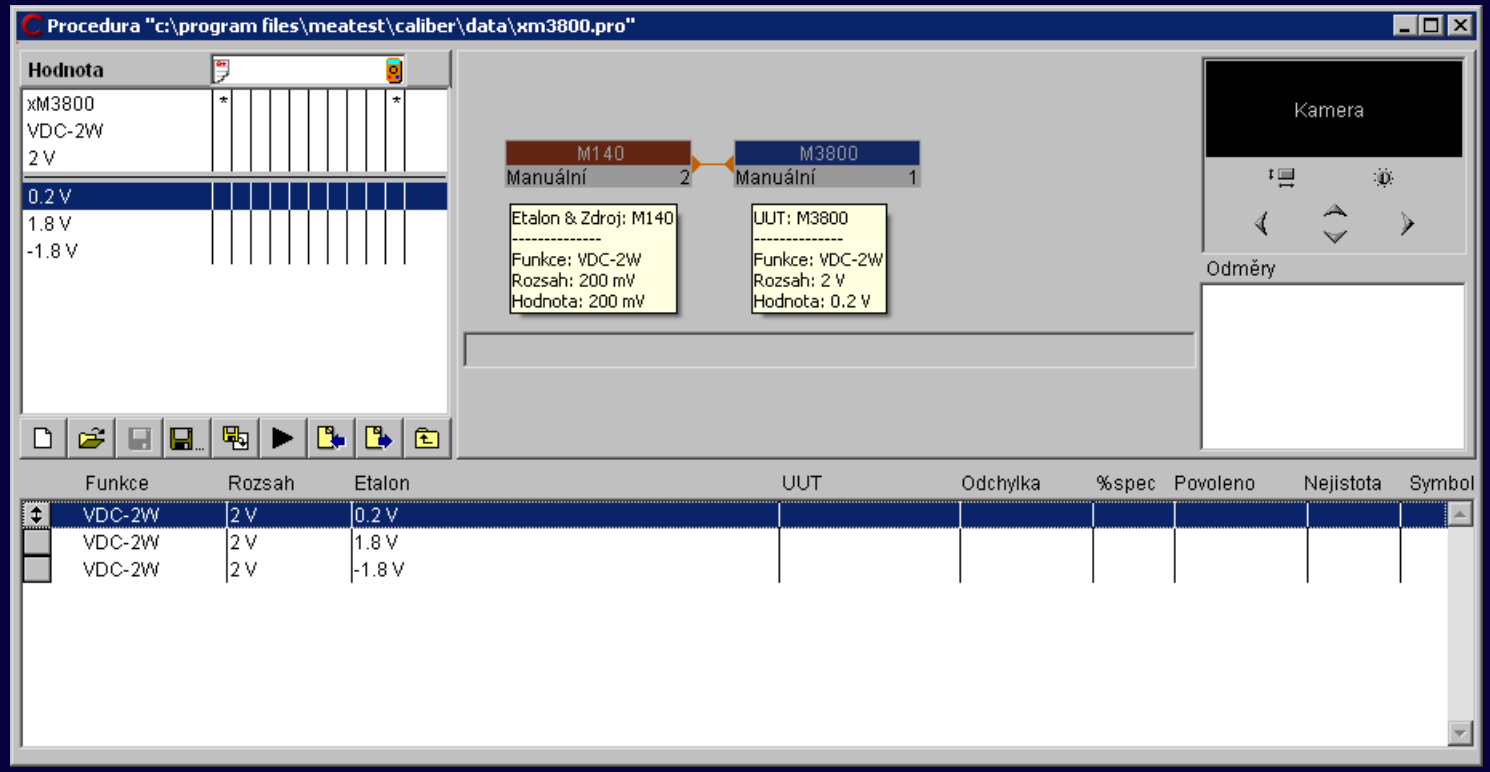
Calibration uncertainty

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

- 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

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

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

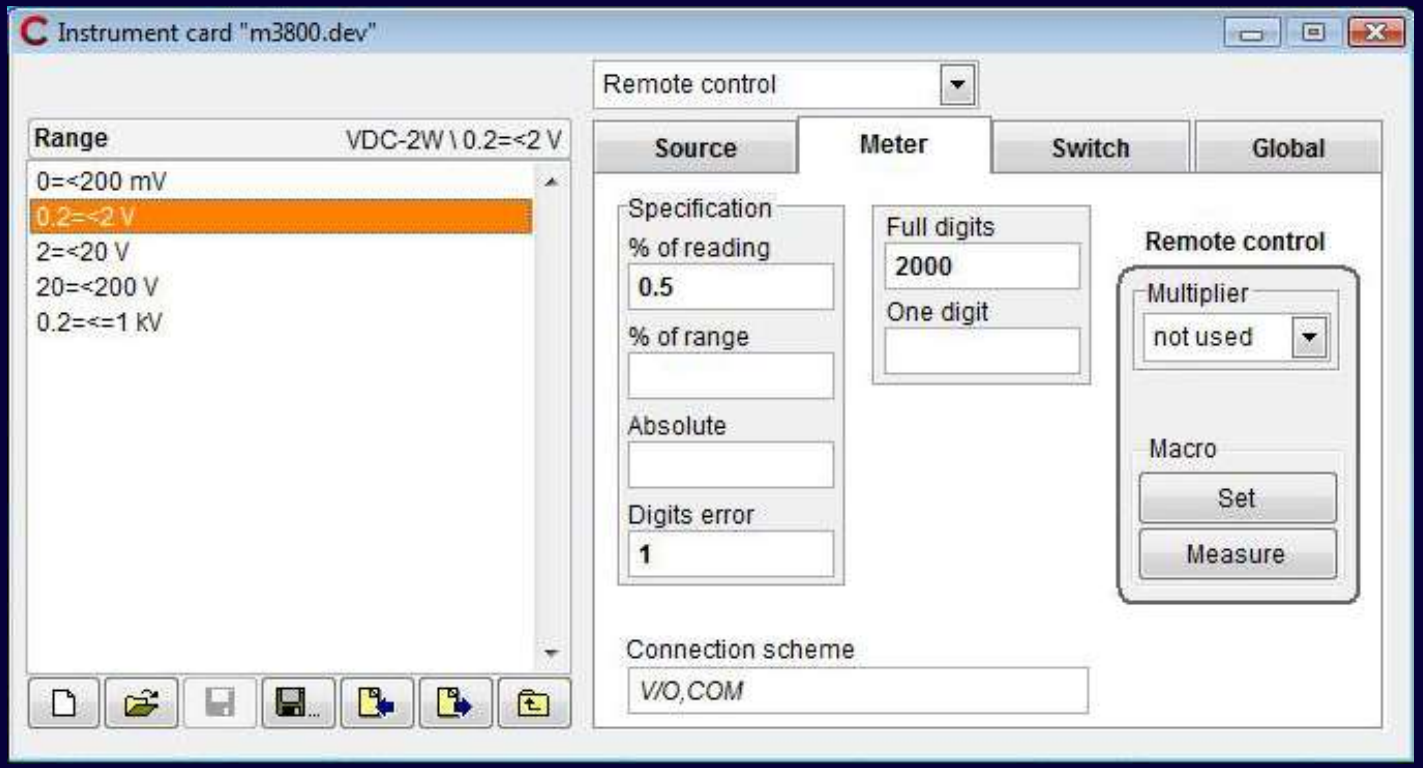
- u_{ud} uncertainty due to the limited resolution of UUT
  - calculated from parameters written in instrument card
- u_{ua} uncertainty type A - repeated measurements UUT
  - calculated from repeated measurements
- u_{sb} uncertainty due to the uncertainty of SU
  - calculated from parameters written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

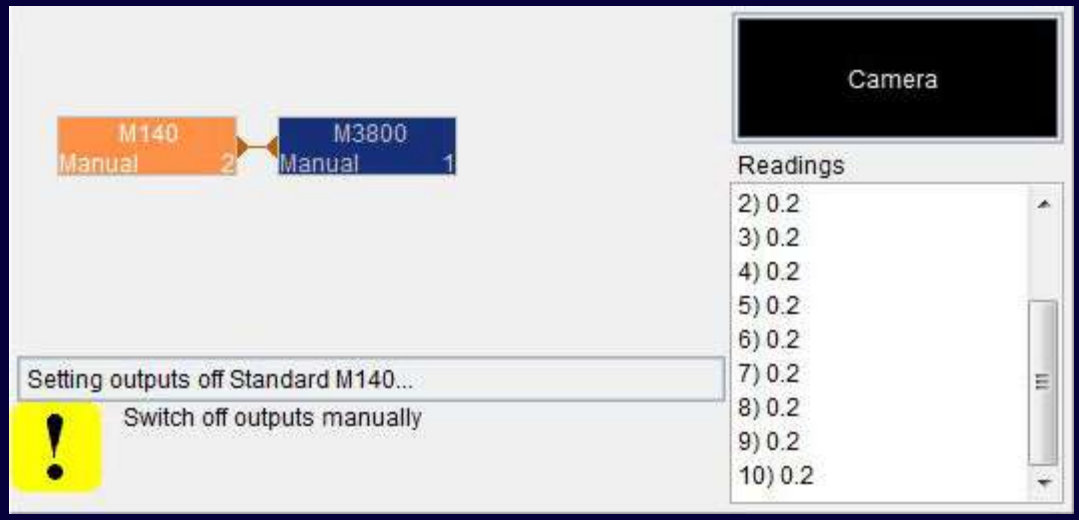


Caliber – Example 1

U_{ua} repeated measurement of UUT

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

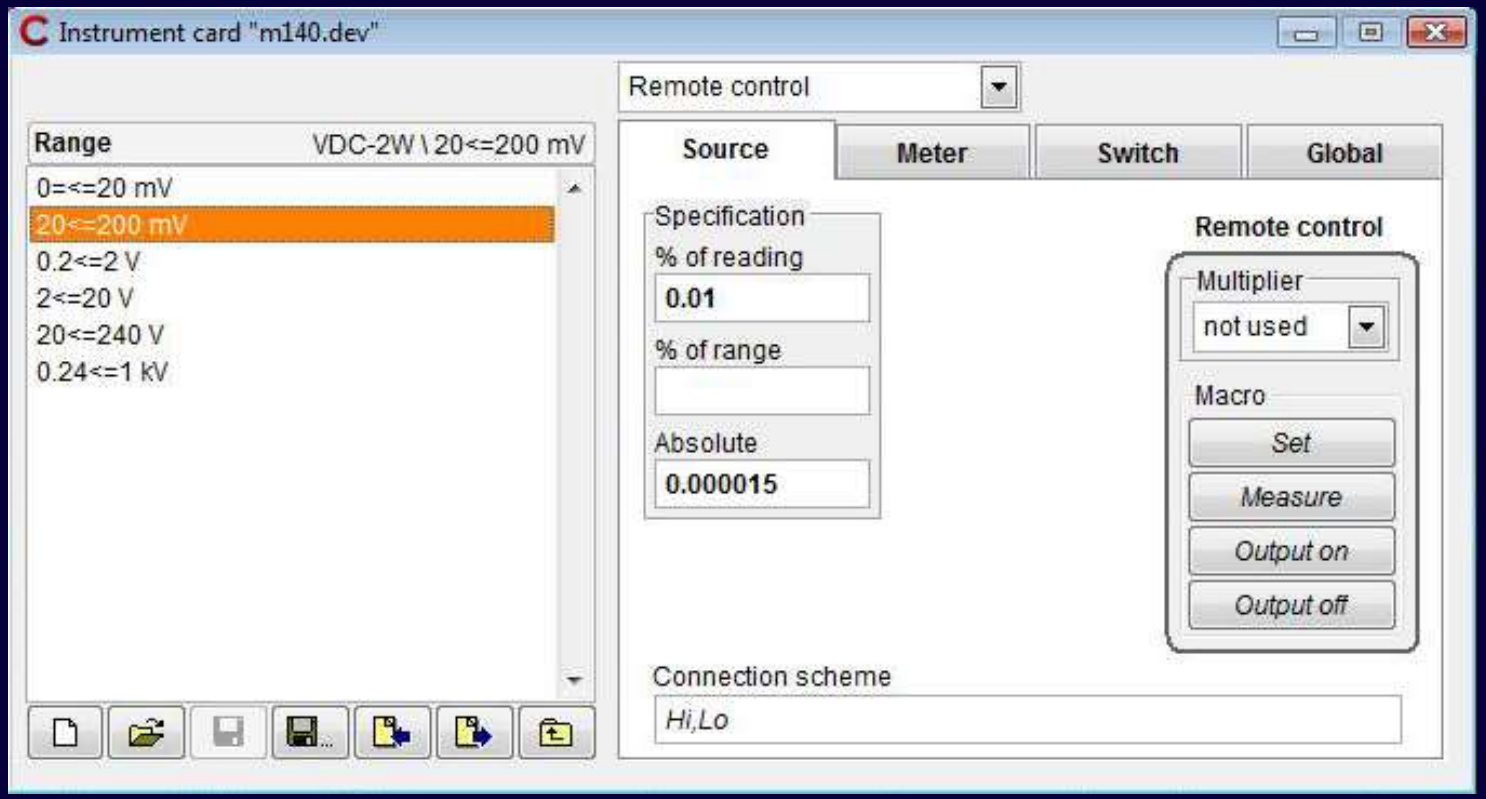
$$u_{ua}\ [\%] = 0mV*100\%/200mV = 0\%$$



Caliber – Example 1

U_{sb} uncertainty due to the uncertainty of SU

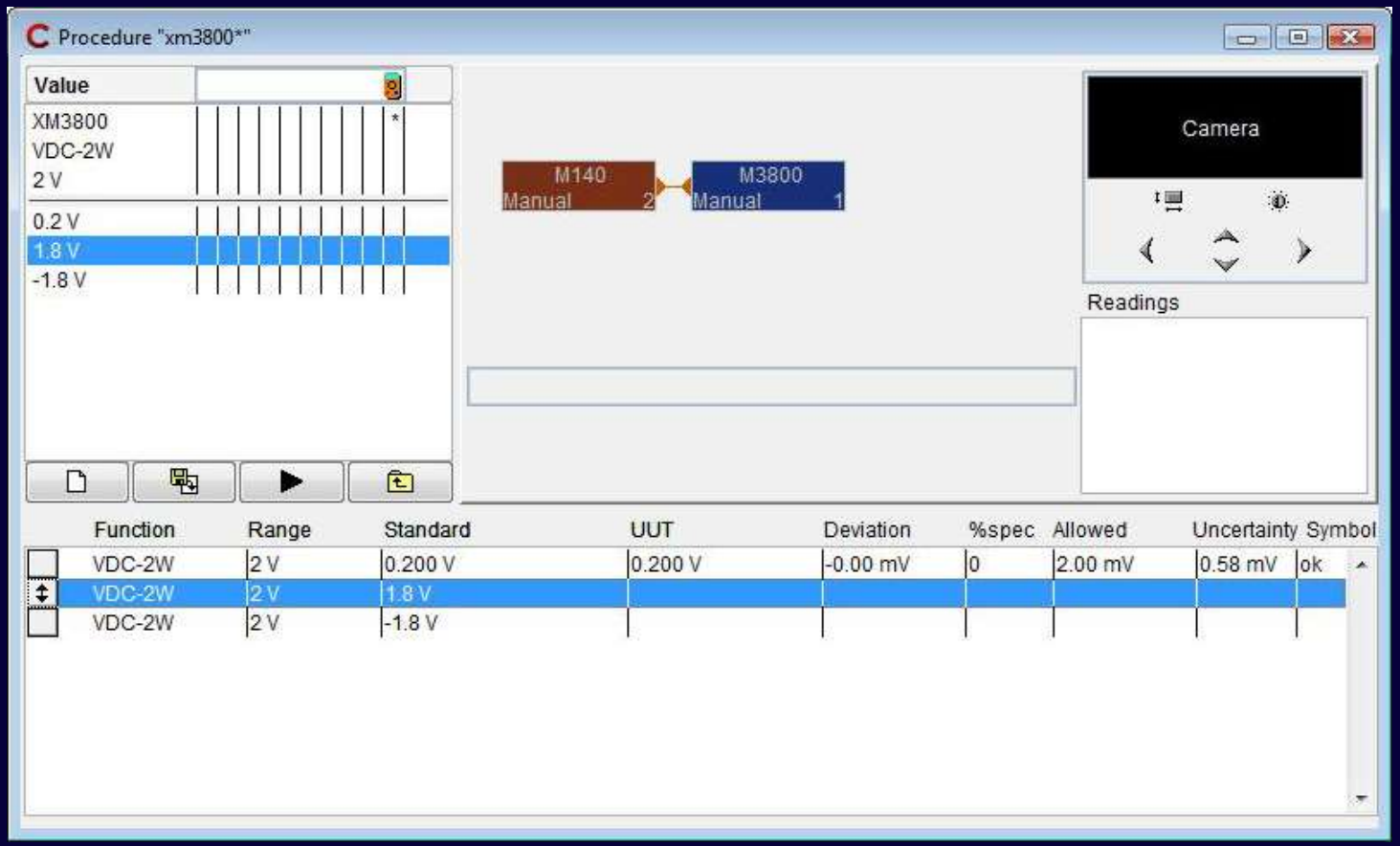
$$u_{sb}\ [mV] = Dmax\_s / \sqrt{3}$$
$$= (200mV*0.01\%/100\%+0.015mV) / \sqrt{3} = 0.02021\ mV$$



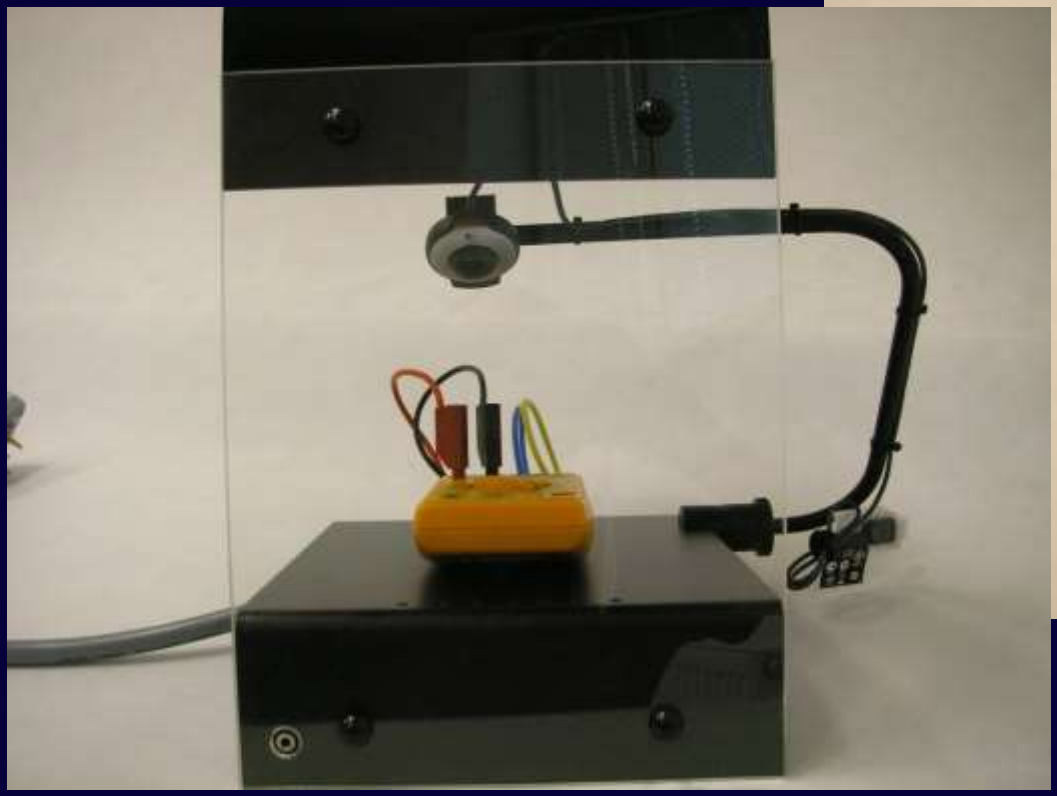
Caliber – Example 1

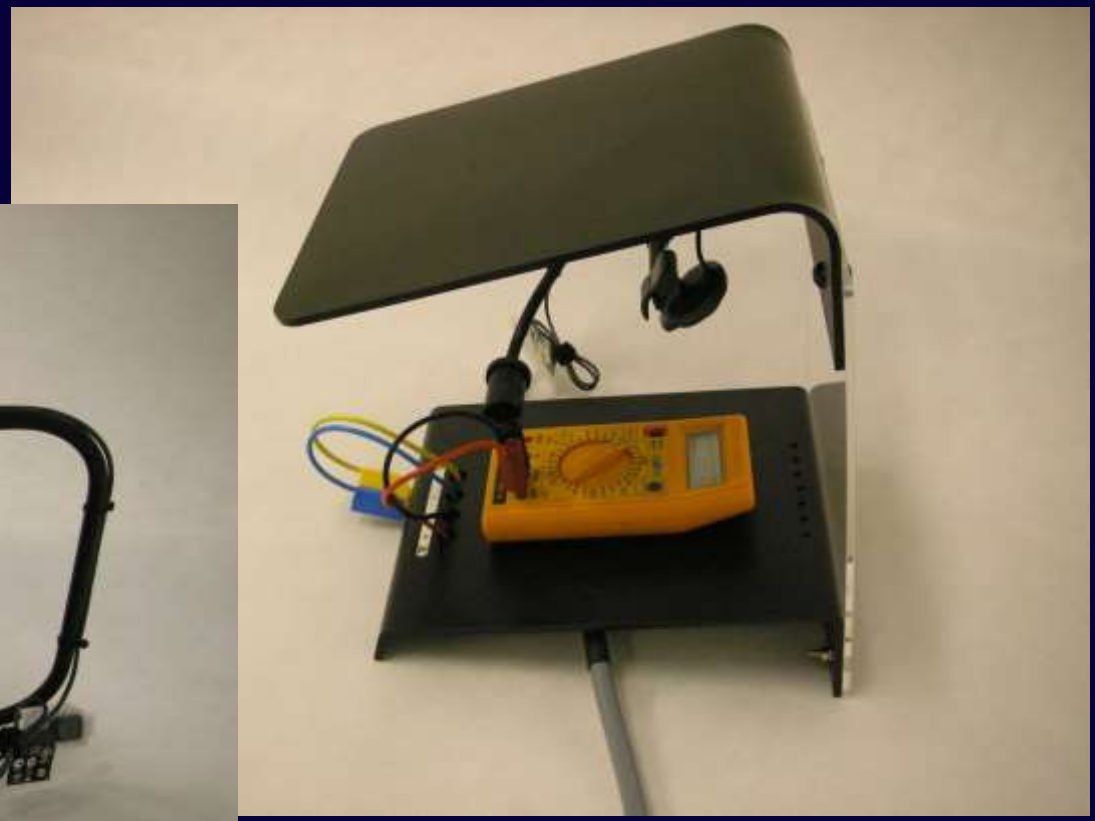
$u_c = \sqrt{(u_{ud}^2 + u_{ua}^2 + u_{sb}^2)} = \sqrt{(0.29^2 + 0^2 + 0.02021^2)} = 0.2907$ mV

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



CamOcr - Camera Module





CamOcr - Camera Module

Purpose

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

Advantages

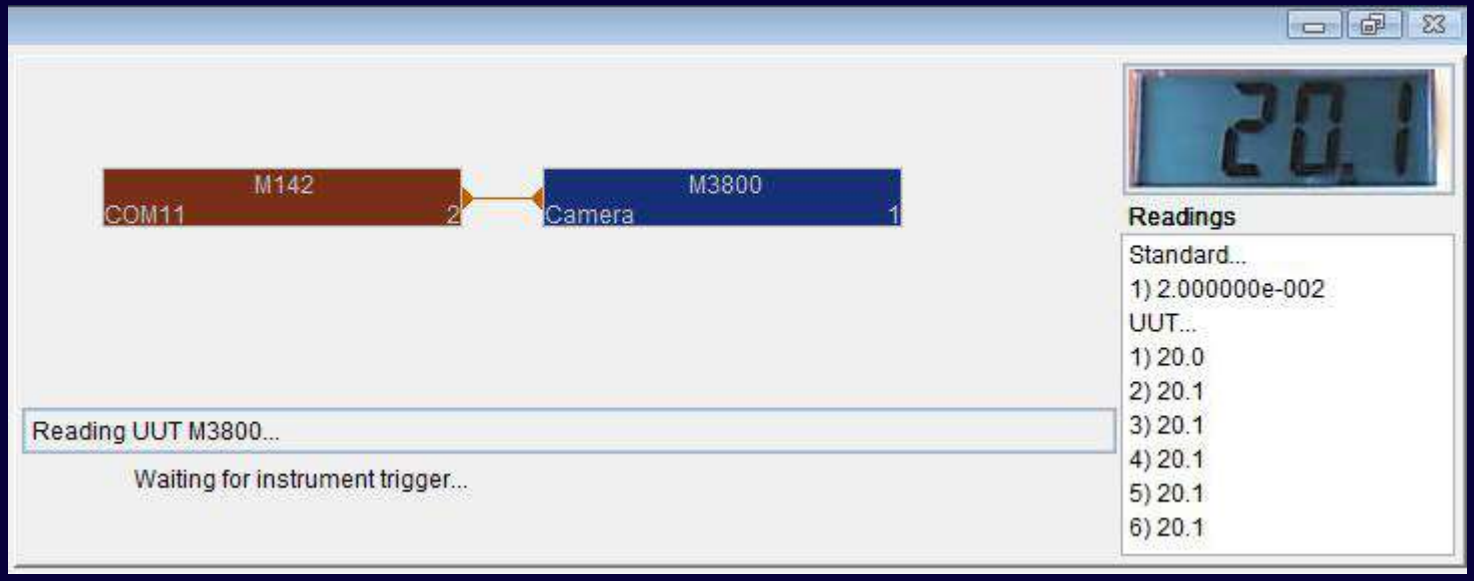
There is no need to enter values manually – less human work.

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