POWER

Transducers calibration

User's manual

P Power 1.03

Protocols

| Protocol number | Calibration date | | Users Item #1 |
| 3 | 2.10.2003 | | Production 012 |

| Transducer type | Detailed report | Label | Users Item #2 |
| IP512 | detail | label | |

| Serial number | Author | | Users Item #3 |
| 4284423 | Mr. Brown | | |

| Procedure name | Result | | Users Item #4 |
| I512 | Pass | | |

Note

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Calibration after repair.
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Measured values

Conditions	Nominal [A]	Measured [A]	Deviat. [%]	%spe [%]	Allowed [%]	Uncert. [%]
Current	0.5				10	0.07
Current	1				5	0.05
Current	1.5				3.33	0.107
Current	2				2.5	0.09
Current	2.5				2	0.08
Current	3				1.66	0.073

Prot (c:\program files\meatest\power\data\prot.dbf)   Record: 3/3   Rec

CONTENT

1. Basic information

1.1 Introduction

Program POWER is aimed for executing and recording calibration of transducers. Furthermore, the system allows creating of calibration procedures for various transducers. Calibration system consists of PC controller with printer, power calibrator M103/M133 (standard unit - SU) and calibrated transducer (device under test - UUT). Operation environment Windows 98/ME/2000/XP/Vista is required.

Finished calibration of UUT is real result of calibration system. As a document about calibration, test report with all measured and evaluated values is created.

In POWER program are two basic modules. Module **Protocols** serves as an inventory of calibrated transducers and theirs protocols. It allows executing transducer calibration. Calibration procedure can be executed in program POWER only, if appropriate "calibration procedure" exists. Module **Procedures** contains inventory of calibration procedures. Calibration procedure is list of calibration points in that order, how they will be executed during calibration. Calibration procedures for various transducers can be created in POWER program too. For creating, editing and testing of calibration procedures, program module "Procedures" is aimed.

All basic program modules are created in interactive way. Handling of program doesn't require knowledge of programming.

Standard instrument M103 is controlled remotely via GPIB bus. M133 is controlled via GPIB or RS232 bus.

As above mentioned, program POWER consists of two program modules:

a) **Report** – module works with calibration reports of transducers. It enables its creating, editing and executing calibrations.

b) **Procedure** – module works with calibration procedures. It enables its creating, editing and testing.

1.2 System

Following requirements should meet components of calibration system:

- Personal computer Pentium 200 MHz or better, monitor SVGA, RAM 256 MB. If GPIB bus is used to control measuring instruments, appropriate GPIB card must be installed in PC. Recommended type is PCI GPIB card (National Instruments).

- Operating system MS Windows 98/2000/ME/XP/Vista.

- Program POWER

- Power/energy calibrator M103 or M133

- GPIB / RS232 cable

- Test cables

1.3 Measuring circuit connection

1.3.1 Grounding a measuring circuit

When calibrator is connected with one or more other instruments with power line supplying, there is always a danger of **"ground loops"**. These loops are created by connecting of signal terminals (input, output) together with power line cords connected to the power system distribution network. Considerable currents can flow through the ground loops, usually alternating and synchronous with the first or second harmonic of the frequency of power line. Practically their presence results instability of the display reading of the meter. This instability is especially evident when AC ranges are calibrated on frequencies 50, 100, 200, 400 Hz, i.e. multiples of power line frequency. It does virtually not exert at higher values of the measuring signal frequency. Instability can prove as a relatively slow and regular fluctuation of the signal amplitude. Dominant interference frequency is determined by the difference of the exact power line frequency and signal frequency set up on source.

 Take following steps to eliminate the effects of ground loops:

a) Connect all ground terminals in one point.

b) Connect Lo terminals with ground in one point. The best is Lo terminal of the calibrator. Do not calibrate with a non-grounded measuring circuit.

c) Connect all power line cords of all instruments, including personal computer into one power line socket of the distribution frame.

d) If the above-mentioned steps are not efficient enough, use low-frequency toroidal choke on power line cord of the calibrator or of the multimeter. You can make a choke by reeling several turns of power line cord onto a permaloy toroidal core with 7 – 10 cm in diameter.

e) Finally, if the system interference is too high, you can lower its influence on calibration at disharmonious multiples of system frequency, for example 60, 120 Hz (applies only for calibration of alternating voltage and current ranges).

2. Program POWER

2.1 Starting with POWER

Install Power

Before you start the installation check following:

- In case you use hardlock connected via USB, remove it from the computer (connected USB hardlock can cause wrong installation)

- For installation you should use "administrator" account

Insert the software CD into your CD ROM drive. Wait for autorun and select "Software installation" and "Power" or start direct „install\software\PowerSetup.exe".

- Select the language you use and then click OK.

- Installer starts to prepare for the installation.

- Enter your name and name of the company

- Confirm or change the default destination folder

- Restart the computer

After restart leave CD ROM in the computer, connect the hardlock and start installed software from "Start/Program files...". It is possible that operation system will read some next information from CD during the first start.

In case there is no hardlock into the computer during start the program will work in Demo.

For next option (**GPIB card**) you should use installation CD delivered with this interface.

Uninstall Power

To remove the Power software from your system, you should use the "Add/Remove Programs" control panel in Windows ("Start -> Settings -> Control Panel -> Add/Remove Programs" from the Windows Start menu).

2.2 Module „Protocols"

The module is automatically displayed after starting program POWER. It is used for executing of calibration, creating, editing and printing of calibration protocols.

Calibration protocol contains information about object of calibration (type, serial number), calibration conditions (date, procedure, author, user items), printout reports (detailed report, label) and measured values with result.

Following panel is displayed after starting program POWER.

Window consists of two main parts:

1. Tool bar menu – buttons are located in top line.

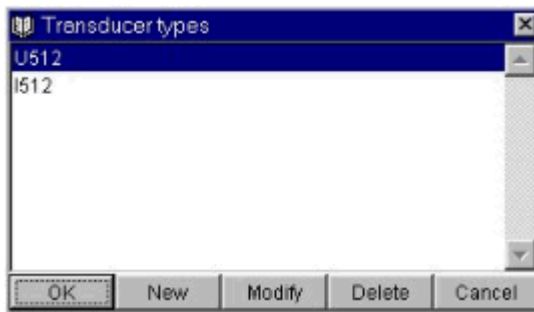2. Working area – active program windows are displayed here.

Required function can be activated by clicking (mouse left button) on the appropriate button in tool bar menu. Control of program uses common used features of system Windows.

Short description of tool is displayed next to the mouse pointer in some cases.
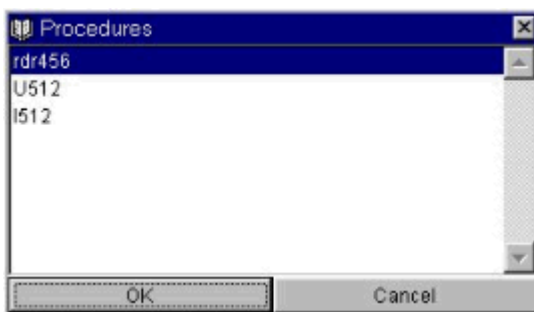
Protocols window contains following items:

1. **Protocol number** is assigned to individual protocol by computer. It can be changed. User can enter any combination of 20 characters. Protocol number will be generated automatically, when you create a new protocol. Value of new "Protocol number" equals "Last protocol number" + 1.

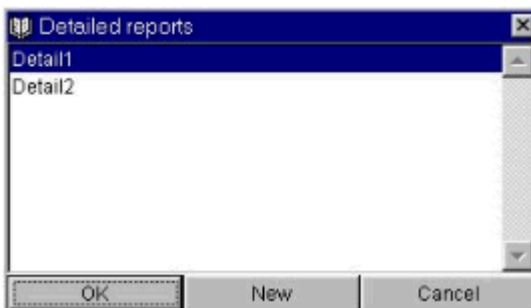2. **Transducer types** contains name of model of the UUT (instrument), for example U512, I512 etc. It can be changed. You can enter any combination of 20 characters at most. By clicking right mouse button inside this window (edit mode is required), list of default items is displayed. You can select item from list, edit item, create new item or delete item.

3. **Serial number** contains serial number of the instrument. It can be changed. You can enter any combination of 20 characters at most.

4. **Procedure name** contains name of calibration procedure. Calibration procedure must be prepared before performing new calibration. By clicking right mouse button inside this window (edit mode is required) list of created procedures is displayed. You can only select a new procedure. For creating and editing of calibration procedures you must use module "Procedures".

5. **Calibration date** is set by the computer according to the current date of calibration. It can be changed. You can enter any other date.

6. **Detailed report** is a type of report (it is only report form not real output), which is used for printing a calibration protocol in its full form. By clicking right mouse button on this window (edit mode is required) list of default items is displayed. You can select item from list or create new item. Newly created report has default form of calibration protocol. You can change it using tool "Print".

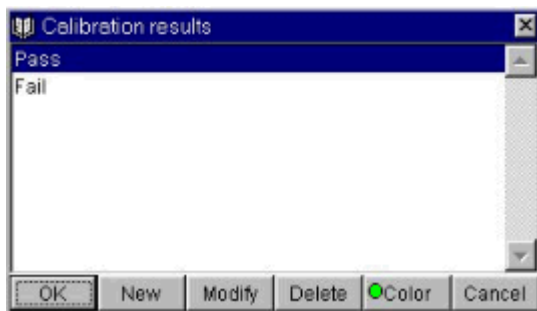7. **Label** is a type of report, which is used for printing a label (brief form of calibration protocol). By clicking right mouse button on this window (edit mode is required) list of default items is displayed. You can select item from list or create new item. Newly created report has default form of label protocol. You can change it using tool "Print".

8. **Author** contains the name of operator which provides the calibration. It can be changed.

You can enter any combination of 30 characters at most. By clicking right mouse button on this window (edit mode is required) list of default items is displayed. You can select item from list, edit item, create new item or delete item.

9. **Result** contains the result of a calibration. After creating a new calibration, program

evaluates and determines the result automatically (Pass or Fail). Expression of the result can be changed. You can enter any combination of 30 characters at most. By clicking right mouse button on this window (edit mode is required) list of default items is

displayed. You can select item from list, edit item, create new item, delete item and set default colour of item.

10. **Users Item #1 .. #4** are items purely for special user requirements. They can be changed. You can enter any combination of 30 characters at maximum. By clicking right mouse button inside this window (edit mode is required) list of default items is displayed. You can select item from list, edit items or create new item. You can also change the name of this window by double clicking this item. Following screen will appear :

You can enter any combination of max. 30 characters as new name of this item.

11. **Note** is designed for additional information relating to the given calibration protocol. It can be changed. You can enter any text.

12. **Measured values** contains measured and evaluated data. This item can be changed. You can enter any text too.

There are several functional buttons (tool bar) in the upper side "Protocol" window. The tools are the following:
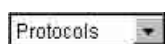
`Protocols ▾`   Switching between modules "Protocols" and "Procedures".

☐   Creates a new protocol.

✎   Switches over the displayed protocol into edit mode. Only in edit mode can be done changes.

🖫   Confirmation of changes or a new entry and storing new protocol in a database. It is visible in edit mode only.

↶   Cancels made changes. No record to the database is made. It is visible in edit mode only.

✕   Excludes the displayed protocol from the database. User is asked for confirmation.

◄◄   Go to the first protocol.

◄   Go to the previous protocol.

►   Go to the next protocol.

►►   Go to the last protocol.

🔍   Displays menu with search conditions (easy search). You can write text which you want to find out in protocol. Protocol with searched text will be displayed. By pressing key ENTER or button Find you can start new searching.

🔍   Displays menu with search conditions for protocols filtering (advanced search). Only protocols selected by this filter will be displayed in the browse window (or will be printed using browse report) until you cancel the filter or open the filter window again. In the filter dialog window you can enter up to four conditions by which protocols will be filtrated (selected).
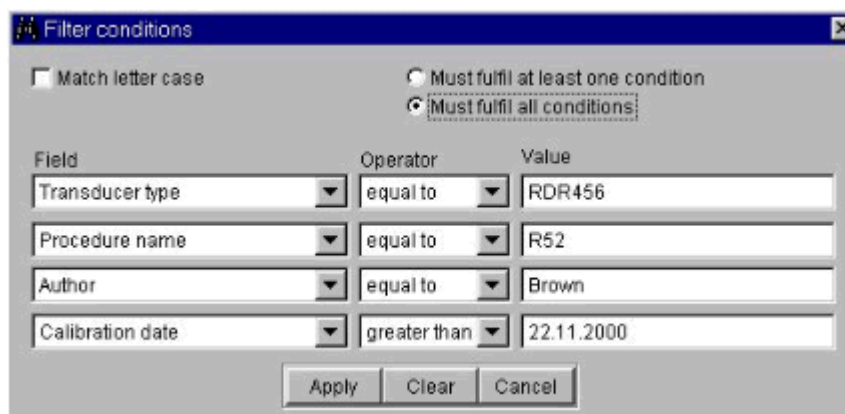
Must fulfil all conditions– selected records must meet all set-up conditions.

Must fulfil at least one condition– selected records must meet at minimum one set-up condition.

Match letter case – if it is not checked, searching will not be case sensitive.

Field – is an item, which is to be the subject of searching. The menu displays fields, valid for the current window.

Operator – is a comparative function (less than, between, equal etc.). There is also Contains function, which can search a part of the whole text (for example M3 – searches all items containing M3 – M3800, M3850, etc.).

Value – is a value, which the field must equal to, according to the selected function. For some fields, the value can be entered from a list of items using the right mouse button.

Apply – executes a selection by conditions. If no record meets set-up criteria, appropriate message ("No record fulfilling conditions was found.") is displayed on the screen. It is necessary to change the conditions or not to execute the selection at all.

Clear – selects all records (clears the last selected filter).

Cancel – does not change the last selected filter and closes entering conditions.

Displays active protocols in the browse form (each protocol is on one line). You can set up the width of individual columns arbitrarily.

Allows printing of calibration protocol or list of protocols selected by filter condition. It concurrently allows adjustment of the report format. The "Import" and "Export" items are aimed for exporting or retrieving already created test reports. For a more detailed description of report adjustments, see chapter "2.2.2 Printings protocol".

Enables recovery or backup of data managed by the POWER program.
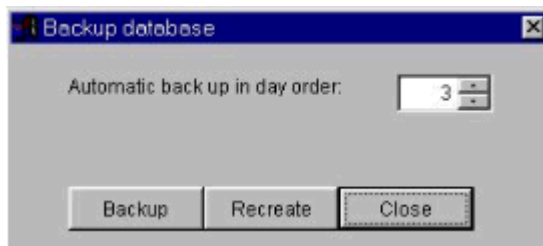
Backup – this function is run automatically always by ending Power, after the number of days determined in the backup form pass. During **automatic backup**, two subdirectories ARCHIV1 and ARCHIV2 are stored alternatively and placed in the DATA database directory. Backup file in these subdirectories is named "Power.pck". It is recommended to set a number of days for automatic backup higher than zero, so that if you often start your computer when data are damaged, backups in the ARCHIV1 and ARCHIV2 directories are not overwritten by these incorrect data as well.

Apart from automatic backup, you can also backup your data by pressing the "Backup database" button. This option allows you to backup directly on a selected media (magnetic tape, diskettes, external disk, CD ROM and other). When you use backup

on diskettes, it is necessary to mark the sequence of individual diskettes. Here backup files are also named "Power.pck".

Recreate – initiate database recreation from a selected media or directory (from the file "Power.pck").

2.2.1   Creating a new protocol

You can only perform new calibration for such instrument, for which its calibration procedure has been created. Detailed description of calibration procedures you can find in chapter 2.3.

Push the button „New". Program displays following form:
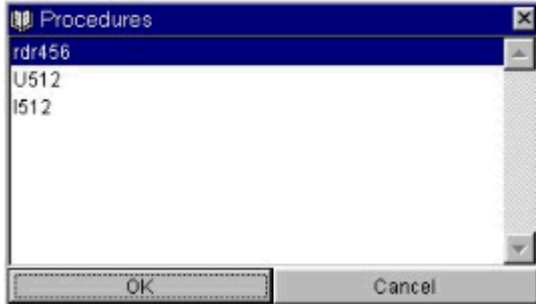
You must select a calibration procedure (which will be used for transducer calibration) by double click on appropriate row with mouse. Program displays selected procedure in program module "Procedures" (see chapter 2.3). You can start the calibration with the button
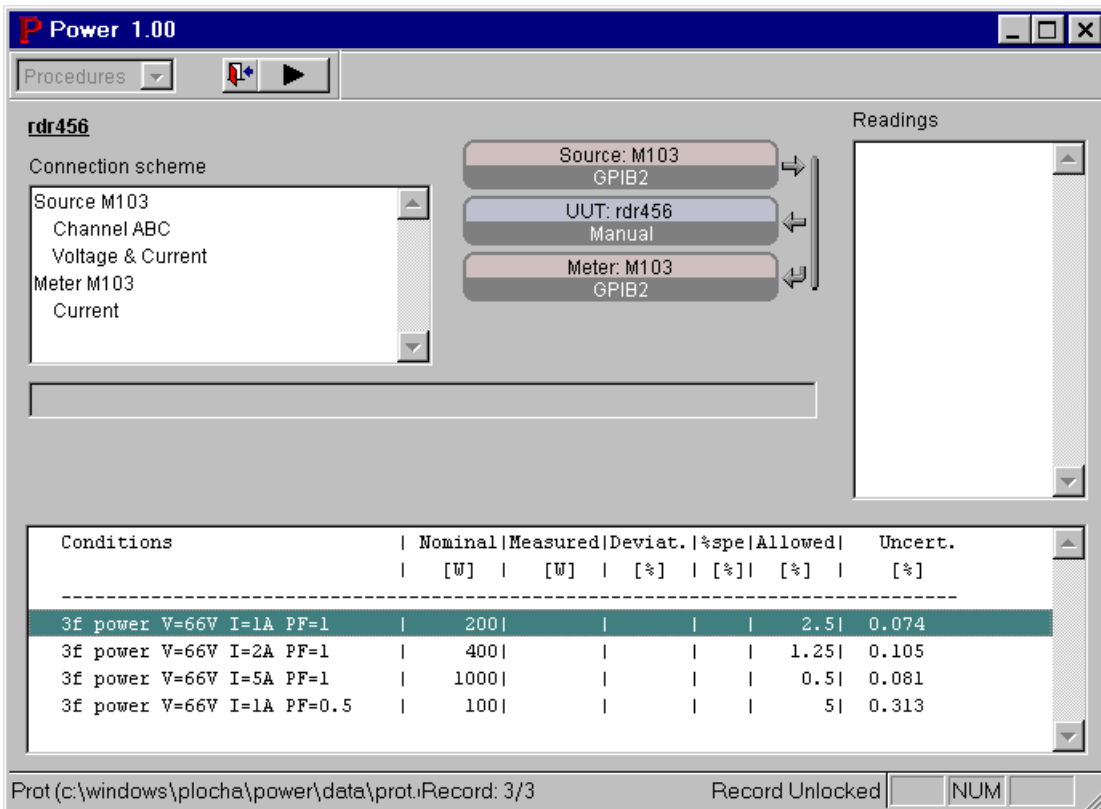
"Start calibration" or "Stop" it at any time by pressing the key ESC. After finishing calibration you can return to the module "Protocols" by pressing button "Close calibration".

Now you can correct items in working area of protocol window. Protocol is written to the database by pressing button "Save" in the tool bar. If you don't want to make a new record in the database, press button "Revert changes".

2.2.2 Printing protocols

Program POWER allows you to print a selected calibration protocol in three forms:

- **Detailed report** prints calibration protocol in full form, with measured values (calibration certificate). Always only one calibration protocol is printed.

- **Label** prints calibration protocol in brief form, without measured values (label). Always only one label is printed.

- **Browse report** prints list of all calibration protocols selected by filter conditions. Implicitly all calibration protocols are selected. You can use it for printing of list of protocols with some specific features, for example protocols created between two dates, list of protocols of one transducer type, etc.

Before printing a "Detailed report", the program selects the type of report (form of calibration protocol), which is set in the "Detailed report" item. When printing a "Label", the program selects the type of report (form of calibration protocol), which is set in the "Label" item.

By pressing the button "Print" in the tool bar program displays following form:
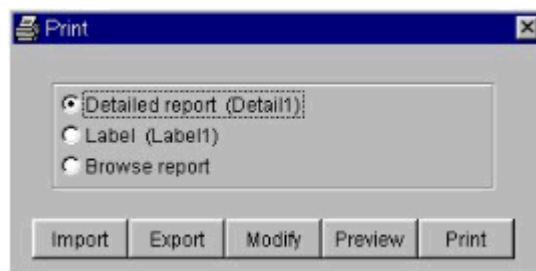

You have to select form of calibration protocol. In the picture above, Detailed report with name "Detail1" is selected. Following operations with selected form of calibration protocol can be done :

- **Import** allows you to restore report, previously saved with function Export.

- **Export** allows you to store a report. Naturally, a new created report is saved in the central database. Furthermore, you can create its backup as a file. This system allows you to create several reports (types of calibration protocols) for a single form (for example a detailed report).

- **Modify** allows you to modify calibration protocol reports according to your needs. You can modify origin reports and newly created as well. More detailed description of modifying the reports you can find in next chapter.

- **Preview** according to the selected report form, it displays a calibration protocol preview. You can use newly displayed tool bar to switch to any side of the report, select a display scale, close the preview or print the report.

- **Print** prints the current calibration protocol on the connected printer.

2.2.3 Modifying of calibration reports (protocols)

All printouts contain implicitly defined reports. You can modify these reports according to your needs. Newly created reports are stored in the database. Each protocol can have its own detailed report and label report. But only one browse report is valid for whole database.

To execute modifications, select form of protocol (detailed, label or browse) and push the "Modify" button in the printer menu. For example, for a detailed form of calibration protocol following screen will display:
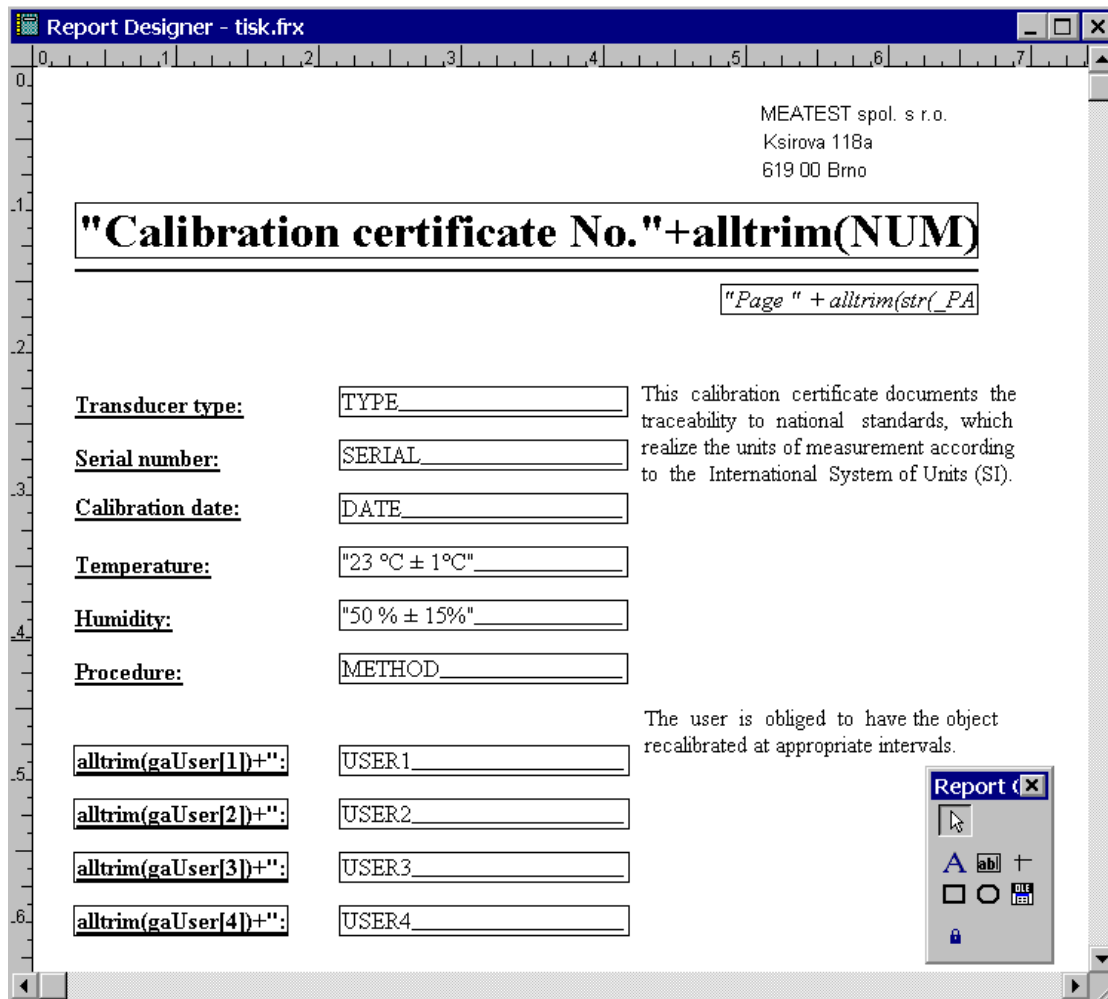
So-called „Report designer" allows you to make these modifications to actually opened output report form:

The „**File**" menu :

Close – closes the report modification. The program asks whether you wish to save the file. If your answer is negative, the new procedure is not saved and the original procedure is preserved.

Save – saves new report modification into the database.

Page Setup – allows you to set the printer which will be used for prointing of this report. You can set page parameters too (size, printable area, orientation etc.).

The „**Edit**" menu is standard item for the Windows OS. It is used for copying and moving of text blocks etc..

The „**Format**" menu. This menu allows you to arrange items in the procedure and change the text font.
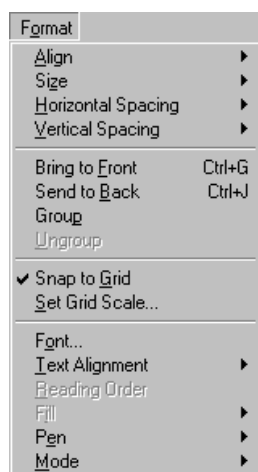
Align – align objects in procedure.

Size – modifying size of selected items.

Horizontal spacing – horizontal spacing between selected objects.

Vertical spacing – vertical spacing between selected objects.

Bring to Front – selected object is transferred to front.

Send to Back – selected object is transferred to back.

Group – groups selected objects into one object.

Ungroup – object combined using "Group" is split again.

Snap to Grid – place objects in the grid.

Set Grid Scale – invokes a panel for grid size setup.

Font – invokes a panel for font setup.

Text Alignment – layout of text (alignment, formatting etc.).

Fill – sets a fill colour of a box.

Pen – sets width of lines and their style for lines and boxes.

Mode – sets transparency or non-transparency for selected objects.

The „**Report**" menu is recommended for users, who are experienced in Visual FoxPro.

There are tool bars available in the menu . Again, the first two bars (Data grouping and Data environment) are left here only for completeness. Their use is recommended after contingency perusal of user's manuals for Visual FoxPro 7.0.

When you open "Report designer", the standard „**Report pushbuttons**" bar is displayed.

With this tool you

can add figures, texts or other variables available in the given report. You can either draw figures using available tools, or import them in the BMP format.

Description of basic tools included in the "Report pushbuttons" bar is shown bellow.

Select objects – selects one or more objects in the output report.

Description – places any text in a selected place of the output report.

Field – places any database item in the output report. The program offers you a list of items available for the given report automatically.

Line – places a line in the output report.

Box – places a box in the output report.

Box with round corners – places a box with round corners in the output report.

Figure/linked OLE element – places a figure in the BMP format or an OLE object in the output report.

Button lock – locks a selected function on the tool bar. This is useful, if you place more identical elements in the output report.

You can format individual fields or texts, define conditions for printing etc. Program offers a list of format commands automatically.

Next tool bar is the "**Color palette**".

If you have a colour printer, with using of this palette you can set a colour for individual texts (figures) and for the background as well. Description of basic tools included in the "Colour palette" bar is bellow:

Foreground colour – a two-state button. Its lower (pressed) position means active function.

Background colour – a two-state button. Its lower (pressed) position means active function.

Palette of 16 colours – by activating one of the colours the colour of the pre-selected object changes directly.

Other colours – displays a standard palette of other colours.

The last tool bar is the "**Layout**". It allows to align individual items, order them etc.

Before you use the first eight functions, you have to select a group of objects (they can be texts, table fields or figures) to be aligned.

Align left
Align right
Align upper margins
Align bottom margins
Align center vertically
Align center horizontally
Set same width

Set same height
Set same size
Center horizontally
Center vertically
Bring to front
Send to back

Because modification of reports is very extensive and because it allows everything, what Visual FoxPro 7.0 enables, users interested in a more detailed are recommended to study a user's manual of above mentioned environment. In any case, if you make a failure in creation of output report, you can return to the implicit report format, supplied with the program (the "Import" function – see below).

2.3 Module „Procedures"

The module is used for creating, editing and testing of new calibration procedures and for calibration of transducers as well. Measured and evaluated values are written into the window Measured values in module "Protocols".

Calibration procedure is record, which contains list of points, where UUT is to be calibrated. Other features are specification (allowed tolerance of measured transducer, accuracy of M103/M133) and nominal transducer value.

Module „Procedures" controls all communication between PC and calibrator. It makes all measurement evaluation, uncertainty evaluation and generates part of calibration certificate (measured values). Also break points can be set, where program interrupts calibration process. Order of calibrated points can be changed during calibration too. If change of calibration point order is requested, place mouse pointer on the field for moving, located on the left side in every line, in window Protocol. Click left mouse button, hold it and move the pointer up or down as requested. Right order of calibration points can make calibration easier, reduce number of necessary re-connections and shorten calibration time.

Program module "Procedures" can be controlled with mouse or via keyboard. By pushing the button ESC currently running calibration procedure is interrupted.

Following panel is displayed after starting module "Procedures".

In left upper side "Connection scheme" window is located. It describes outputs of calibrator used in calibration procedure. Always when change of connection have to be arrange during calibration, simple description of new connection is displayed in this window and program is interrupted. Warning to do this change is displayed too, in the middle of the screen. In the middle part active instruments (i.e. those that will be used during calibration - source, transducer, meter) are displayed.
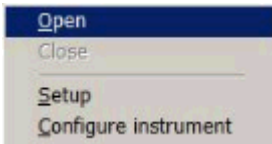
Under name of the instrument, method of control is signed. By pushing the right mouse button over the instrument next sub-menu is recalled. Using this sub-menu you can change type of instrument and parameters of computer control.

Open After clicking, program opens the instrument for communication. The function is aimed for procedure testing purpose. During calibration opening communication of instruments is performed automatically.

Close After clicking, program disconnects and close the instrument. The function is aimed for procedure testing purpose. During calibration opening and closing of instruments is performed automatically.

Setup Setup defines parameters of interfaces. You can check status or you can modify parameters. If you modify parameters, new setting is valid for currently loaded calibration procedure.

Depending on way of control, one of following menus will appear:

- Instrument is controlled via **GPIB** bus. PC has to be equipped with GPIB card. GPIB address of the instrument must be set here in range 1 to 30. Address „0" is reserved for PC.
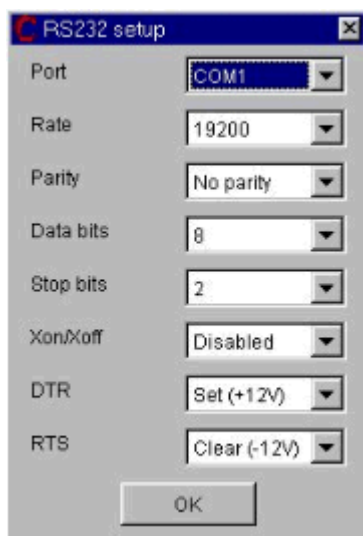
- The instrument is controlled via **RS-232** line. In this case a free RS port must be available in PC. Number of port, communication speed, parity, number of stop bits, number of data bits, Xon/Xoff and meaning of signals DTR and RTS can be set here.

M103 is controlled via GPIB, transducer is controlled manually. M133 can be controlled also via RS232.

Configure instrument It recalls menu, which involves changing the instrument and its method of control. You can select type of the instrument you want to use for calibration and the type of remote control.
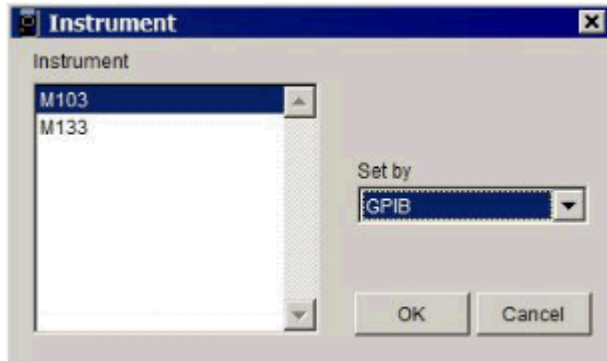
In right side window labelled "Readings", real readings or set up values are rolling during calibration. In bottom table list of calibration points is displayed. On the beginning of calibration, columns with calibration results are empty. During calibration, measured and evaluated data are filled in appropriate columns according to the process of calibration.

There are common buttons (tool bar) in the upper side of "Protocol" window:

`Procedures ▼`   Switches between modules "Protocols" and "Procedures".

🗋   Creates a new calibration procedure.

📂   Opens an existing calibration procedure.

💾   Saves calibration procedure to the database.

▦   Saves calibration procedure with a new name to the database (makes a copy of calibration procedure).

📥   Imports calibration procedure which was saved previously with button "Export". The procedure is in format ".prw". This format is suitable for transferring procedures among users. It is not necessary to use this function, when calibration procedure creation and calibration executing is done on the same computer.

📤   Exports a file containing the selected calibration procedure in a text format.

▶   Starts executing of calibration procedure. Calibration procedure can be started from any calibration point or it can continue from any of these points.

Ω   Adds header line into the calibration procedure. You can use standard header line, displayed on the picture or you can change it. It is not possible to change width of the

columns. You can insert header line to the calibration protocol by pressing key ENTER or revert changes by pressing ESC.

‒‒   Adds separator line into the calibration procedure. It is mostly used to separate different parts of protocol (for example head – calibration points).

◆   Adds calibration point into the calibration procedure. Following form with setting of calibration point is displayed:

In the upper part there are settings of source (calibrator M103/M133).

Conditions – contains measurements conditions. You can enter any combination of max. 30 characters. Text is inserted into the column "Conditions" in the calibration protocol. It contains usually name of measured quantity, settings of voltage channels, phase settings or frequency settings, etc.

Channel A,B,C – you can select which channels will be used for calibration in this point. Only in selected channels will be switched output terminals ON.

Voltage [V], Current [A] – you can select which outputs will be used for calibration in this point. Only in selected outputs will be switched output terminals ON.

Value fields - there are 10 fields for setting of output values on the calibrator. You can set voltage in volts, current in amps, phase in degrees and frequency in Hz. You mustn't use values that are out of calibrator range.

In the lower part there are settings of meter (M103/M133 meter). The button ≈ selects between the "standard" and "extended" mode of measuring value definition. The reason for that is the compatibility with older procedures.

Standard mode

Nominal value – numeric value of calibrating point. You can write only numerical value. Units of measured quantity must be written in the header line.

Nominal transducer value – expected value on UUT (transducer) output. This value is evaluate for ideal transducer with nominal value of calibration point applied to its input. You can select type of transducer output. Choose V (+/- 0 .. 12 V) or mA (+/- 0.. 25 mA).

Tolerance [%] – maximal deviation allowed for UUT in this calibration point. This deviation is related to the measured value. During calibration, program will check, if measured deviation is lower than this tolerance.

Uncertainty [%] – this part of evaluated uncertainty presents accuracy of source value. For output electric power, this accuracy is displayed on the calibrator's screen. In other functions (voltage, current, phase, frequency) it have to be evaluated by user according to the calibrator specifications. In every calibration point, program calculates calibration uncertainty and evaluates standard distributed uncertainty too. More detailed information about uncertainty evaluation you can find in chapter 2.4.
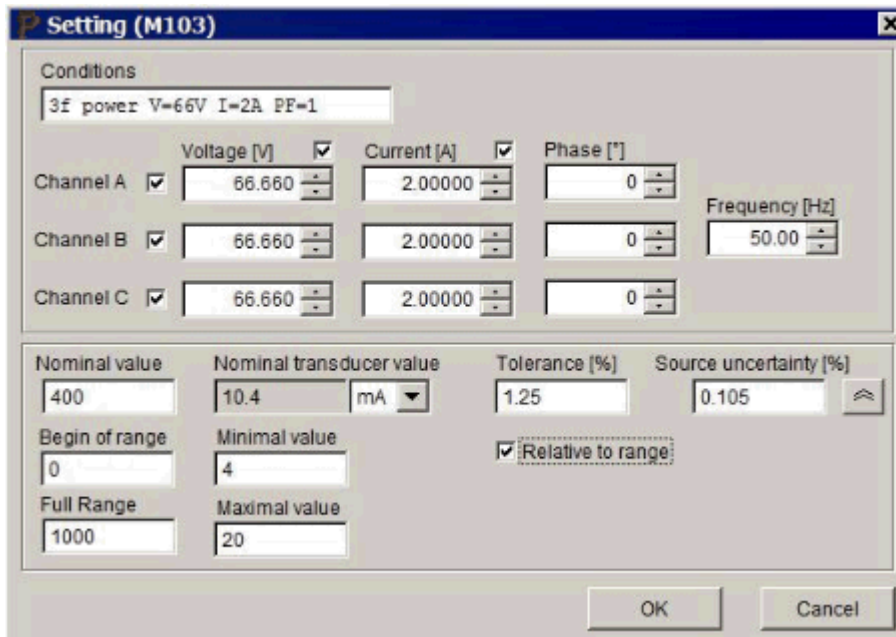
Extended mode

Nominal value – numeric value of calibration point. You can write only numerical value. Units of measured quantity must be written in the header line.

Begin of range – numeric value, begin of measured transducer range. You can write only numerical value. Units of measured quantity must be written in the header line.

Full Range – numeric value, end of measured transducer range. You can write only numerical value. Units of measured quantity must be written in the header line.

Nominal transducer value – expected value on UUT (transducer) output. This value is evaluate for ideal transducer with nominal value of calibration point applied to its input. You can select type of transducer output. Choose V (+/- 0 .. 12 V) or mA (+/- 0.. 25 mA).

Minimal value – numeric value, begin of output signal of measured transducer range. You can write only numerical value. Minimal value is expected value of transducers output in case that on the input of transducer is "Begin of range" value applied. This value is 4mA in case of current output 4...20 mA.

Maximal value – numeric value, end of output signal of measured transducer range. You can write only numerical value. Maximal value is expected value of

transducers output in case that on the input of transducer is "Full Range" value applied.

Relative to range – in case that this item is active, numeric values in the calibration certificate (Deviat., Allowed, Uncert.) are calculated relative to the transducer's range. In case that "Relative to range" is not active, values are calculated relative to the nominal value of calibration point.

Tolerance [%] – maximal deviation allowed for UUT in this calibration point. This deviation is related to the measured value or to the range – according to the "Relative to range" setting. During calibration, program will check, if measured deviation is lower than this tolerance.

Uncertainty [%] – this part of evaluated uncertainty presents accuracy of source value. For output electric power, this accuracy is displayed on the calibrator's screen. In other functions (voltage, current, phase, frequency) it have to be evaluated by user according to the calibrator specifications. In every calibration point, program calculates calibration uncertainty and evaluates standard distributed uncertainty too. More detailed information about uncertainty evaluation you can find in chapter 2.4. This value is related to the measured value or to the range – according to the "Relative to range" setting.

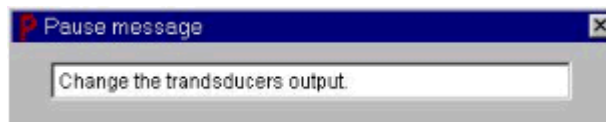|	
A	Adds text into the calibration procedure.
✂	Cuts selected line from the calibration procedure.
🖺	Copies selected line into the clipboard.
📋	Inserts line from clipboard on place of cursor.
📝	Switch the selected calibration line in edit mode. Only in edit mode can be done changes.

Inserts break point into the calibration procedure. Break point is valid only for selected calibration point. You must fill some text in the form "Pause message". This message will be displayed at this calibration point.

P Pause message ✕

Change the trandsducers output.

 Inserts extension coefficient of calibration uncertainty. See chapter 2.4.5. Standard value is pre-set to 2.0..

 Global settings for calibration procedures. You can definite program behaviour, if "Deviation error" or "Communication error" occurs. If appropriate fields are ticked, calibration is interrupted in case of this errors and manual correction is requested. In opposite case, calibration procedure goes on to the next calibration point. Implicit setting is to stop calibration in case of detected any error. "Deviation error" occurs when measured deviation is five times greater than allowed tolerance of transducer. "Communication error" occurs when any instrument does not communicate with PC. Field "Wait interval before reading" contains time delay between setting outputs ON and the first reading. You can set this delay if the transducer reaction time is too long for standard measuring.

2.3.1 Creating a new calibration procedure

Calibration of UUT can be performed only, if appropriate calibration procedure has been created. For each type of UUT-transducer, calibration procedure have to be created.

To create new procedure, push the button „New". Program displays following form:
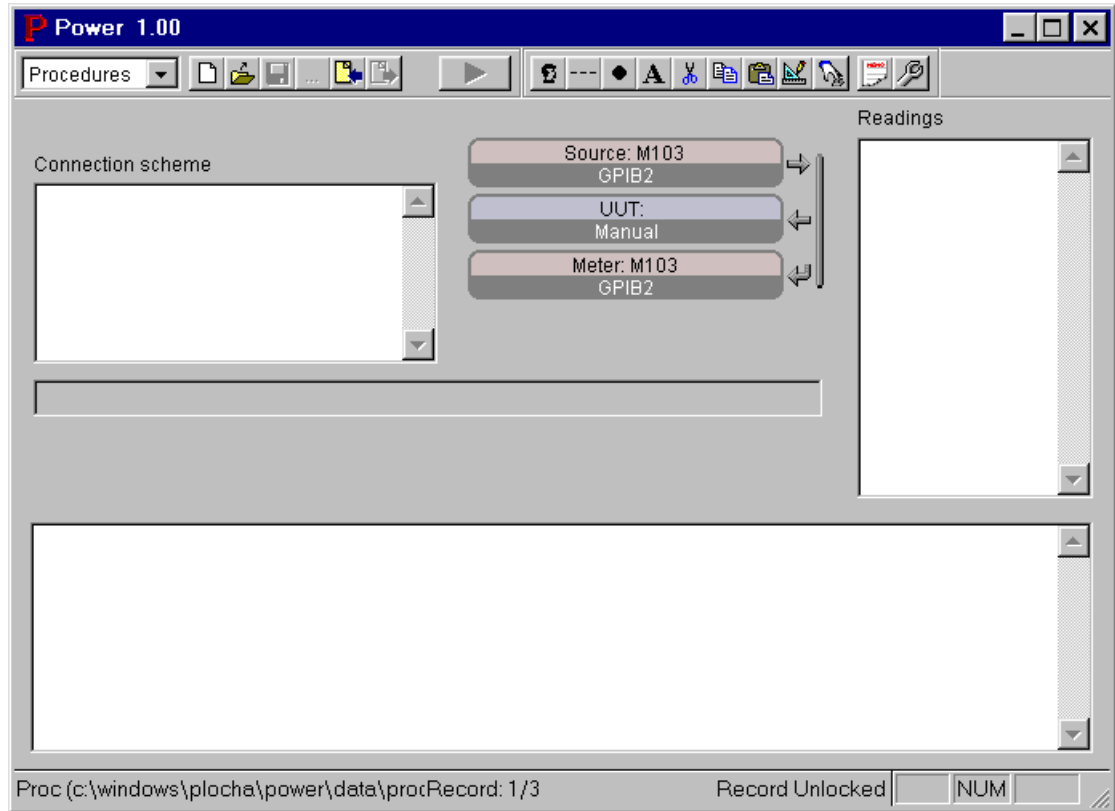
Calibration procedure can be created using buttons from tool bar in the top line.

The first, you have to create header line using button "Add header". You can insert it
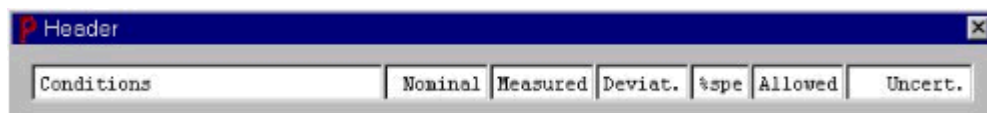
into protocol by pressing key ENTER. If you want to use units of quantities in the second header line, use button "Add header" again and correct items as follows:

Add separate header lines using button "Add separator", if necessary.

In the second step, you should put all calibration points. Use the button "Add measurement point".

You have to write newly created procedure to the database. Use button "Save" end choose desired name of the procedure.

2.4   Evaluation of deviation and calibration uncertainty

2.4.1   Structure of the calibration in one point

The procedure of calibration in each calibration point consists of following steps:

a)   Setting of function of M103/M133 meter.

b)   Setting of functions and ranges of M103/M133 source.

c)   Switching output terminals of M103/M133 on.

d)   Reading of setting values from M103/M133. (Normally it is nominal set up value).

e)   Reading of value from M103/M133 meter. Program performs 11 readings. The first reading is not used for further calculation.

f)   Program calculates average value, root mean square, calibration uncertainty, etc. Program compares evaluated value with criteria for course error. If course error seems to arise during calibration, procedure according to the items a) to e) is repeated. Course error identification see chapter 2.4.4.

g)   Switching off the output terminals of M103/M133.

If during calibration deviation error is identified (measured deviation to nominal value is five times greater than allowed tolerance of transducer), program is either interrupted or continue in calibration process. Program will be interrupted, if the item "Stop on" – "Deviation error" is ticked, see chapter 2.3. Repeating of calibration in this point is offered. If item "Stop on" – "Deviation error" is not ticked, program will ignore course error and continue to the next calibration point.

2.4.2.   Evaluation of deviations

Structure of deviation calculation is fixed in program and it cannot be changed. Evaluated deviation represents relative deviation related to the measured value.

2.4.3   Maximal allowed deviation of transducer

It is set by user for each calibration point in the field "Tolerance". It relates to measured value.

2.4.4   Transducer deviation

Transducer deviation is calculated from the formula:

$$d = \left(\frac{X}{E} - 1 \right) * 100 \quad [\%]$$

$X = \dfrac{\Sigma\, a_i}{10}$ - average of 10 measured values of M103/M133 meter in standard units (V, A). It is evaluated by program.

E - nominal value of calibration point. It is defined in calibration procedure.

Course error identification is done according to the relation:

$$|a_i - X| > 2.5 * \sqrt{\frac{\Sigma\,(a_i - X)^2}{10}}$$

If above described relation is fulfilled for any single reading ai (i.e. course error occurs), calibration procedure is repeated in this calibration point. If the set of values doesn't meet criteria for course error excluding for third time, the last readings are used, but remark „~" not stable on the end of appropriate row in the measured values report is written.

2.4.5.   Calibration uncertainty

Calibration uncertainty calculation is determined according to the standard EA-4/02. Structure of calibration uncertainty evaluation cannot be changed but values of some partial uncertainties can be modified by user according to the real uncertainties in measuring circuit.

POWER calculates appropriate root mean square value (u_a) and average value of 10 repeated readings.

When calculated UUT-transducer deviation is lower or equal to allowed tolerance, appropriate line is signed with symbol „Ok". When deviation is higher, symbol „Ok" is used.

Standard distributed uncertainty is calculated for every calibration point. Both standard distributed uncertainty and all its components are expressed in %.

$$U = k_u * u_c \quad [\%]$$

where

k_u - extension coefficient. It is determined in calibration procedure, (normally $k_u = 2$).

$u_c\,[\%]$ - combined standard uncertainty, evaluated from the formula

$$u_c = \sqrt{u_{sb}^2 + u_{mb}^2 + u_{ma}^2} \quad [\%]$$

u_{sb} [%]   - uncertainty due to the M103/M133 source accuracy. It is set by user for each calibration point in the calibration procedure.

$$u_{sb} = \frac{d_{max}}{\sqrt{3}} \ [\%]$$

d_{max} [%] - M103/M133 source accuracy, defined in calibration procedure, related to the calibration point value.

u_{ma} [%]   - uncertainty of type A evaluated from 10 readings ai of M103/M133 meter

$$u_{ma} = \frac{\sqrt{\dfrac{\Sigma (a_i - X)^2}{10 * 9}}}{|X|} * 100 \ [\%]$$

$X = \dfrac{\Sigma a_i}{10}$ - average of 10 measured values of M103/M133 meter in standard units (V, A). It is evaluated by program.

u_{mb} [%]   - uncertainty due to the accuracy of M103/M133 meter

$$u_{mb} = \frac{d_{pmax}}{\sqrt{3}} \ [\%]$$

d_{pmax} [%] - M103/M133 meter accuracy, related to the measured value. It is evaluated by program.

2.5 Calibration protocol

Result of calibration procedure is calibration protocol. It contains main information and calculated values for each calibration point. Structure of calibration protocol (its columns) is fixed and cannot be changed. In each line calibration uncertainty and summary result are appended. Normally, major part of calibration uncertainty creates uncertainty of teh calibrator. Exact procedure of uncertainty evaluation was described in chapter 2.4.5. On the end of each row in test report following characters can appear:

* - means, that UUT deviation is higher than allowed tolerance.

~ - means that measured value is not stable (see chapter 2.4.4)

ok - transducer is in calibration point OK

Example of test report:

```
Conditions                      | Nominal|Measured|Deviat.|%spe|Allowed|  Uncert.
                                |   [W]  |   [W]  |  [%]  | [%]|  [%]  |   [%]
-------------------------------------------------------------------------------
3f power V=66V I=1A PF=1         |    200| 199.63| -0.186|  -7|  2.500|  0.087 ok
3f power V=66V I=2A PF=1         |    400| 400.0 |  0.01 |   0|  1.25 |  0.12 ok
3f power V=66V I=5A PF=1         |   1000| 1001.3|  0.133|  27|  0.500|  0.095 ok
3f power V=66V I=1A PF=0.5       |    100|  99.60| -0.41 |  -8|  5.00 |  0.38 ok
```

Meanings of titles are as follows:

Conditions   calibrated function (power, current, …) and any other conditions (phase, frequency etc.). This text item is defined by user in calibration procedure.

Nominal   nominal value (calibration point), which is set on the calibrator output and applied to calibrated transducer. This numeric item is defined by user in calibration procedure.

Measured   M103/M133 meter reading (average value of 10 readings). Measured values are recalculated according to the nominal value. Unit is the same as in column "Nominal". Number of printed places is limited and it is determined with value of calibration uncertainty. For example if uncertainty is presented with resolution 0.01%, also standard value is printed with the same resolution.

Deviat.   transducer deviation (see chapter 2.4.4). Number of printed places is determined by calibration uncertainty.

% spe   gathered percent of specification (Deviation / Allowed * 100 %). Value is displayed with 1 % resolution. Maximum value is 999 %.

Allowed   maximal allowed transducer tolerance. Number of printed places is determined by calibration uncertainty.

Uncert.   extended standard deviation for extended coefficient ku = xxx (see chapter 2.4.5). Number of printed places is two.

3. Terminology

In the chapter special metrological terminology in the operation manual used is explained.

Calibration protocol – is result of transducer calibration. Protocol is created by POWER program after calibration automatically. Calibration protocol consists of several pages. The first page contains information about calibration laboratory, UUT, conditions of calibration, etc. A part of the first page picture can be too (for example logo of calibration laboratory). As next pages measured values are appended.

Calibration procedure – file where exact calibration procedure for calibration of known UUT with calibrator M103/M133. In the file type of transducer and calibration points are set out. Calibration procedures are located in POWER database for creating and editing of calibration procedures, program module "Procedures" is aimed. Without existing and correct Calibration procedure, calibration cannot be performed.

GPIB – (General-Purpose Interface Bus) is standardised parallel interface bus for remote control of measuring devices. It enables to remote control up to 16 instruments connected to the GPIB bus. Instruments must be defined on different addresses. Program POWER requires GPIB card installed in PC.

Power – SW program system aimed for calibration of transducers. It consists of two program modules. The result of POWER is calibration protocol. Parts of calibration protocol are transducer deviations and calibration uncertainty.

Standard – (SU – Standard Unit) standard instrument which is source of "true" (standard) value of an electric quantity. SU is calibrator M103 or M133.

UUT (Unit Under Test) – calibrated transducer.