INSTRUCTION FOR USE

PU 294 DELTA

TESTER OF ELECTRICAL APPLIANCES

CONTENT:

1 APPLICATION

The instrument **PU294 DELTA** is intended for measurement at revisions of electrical hand-operated tools, appliances and medical equipments according to the standard EN 60601-1. It can be used for the revisions of new products, for repeated revisions as well as for revisions after reparation. Using the instrument PD294 the three-phase appliances can be tested.

The instrument PU294 DELTA enables to measure:

- Insulation resistances up to **399,9 MΩ**, measuring voltages of 50, 100, 250 and 500 V/DC
- Resistance of the protective conductor up to **20 Ω,** the measuring current min. **200 mA/AC** (with the polarity switch-over)
- Resistance of protective conductor up to **0,3 Ω,** the measuring current of **10 A/AC**
- Leakage currents (the current passing through protective conductor, the substituted leakage current)
- Leakage currents of medical equipments
- Touch current
- Mains power voltage
- Current consumption of the tested appliance
- Active input power, apparent input power and power factor **cos**φ of electrical appliances
- Residual voltage on the pins after disconnection of the tested appliance according to the standards EN 61010-1 and EN 60204-1
- Temperature using the sensor Pt100 (PD 294.4)
- Revolutions using the sensor PD 294.3
- Application of the bar code reader PD 294.5

The instrument is equipped with the real time clock (RTC), the back lit graphical display and it enables the data transfer from the internal instrument memory into the PC.

1.1 DESIGN

The instrument is designed into the plastic case. Electronic circuits are located on printed circuit boards, connected by means of connectors. The instrument is controlled by its keyboard. Measured values are displayed on the illuminated LCD display. The instrument is fitted with the mains socket for the connection of the tested appliances. The appliances without the mains plug can be connected by means of leads s from the accessories of the instrument. The connector USB type B is

used for the connection of the instrument to the PC. The optional accessories (the revolution sensor, the bar code reader, the temperature sensor PT 100, the instrument PD294 for the connection of three-phase appliances) are connected into the connectors type MINIDIN on the panel of the instrument PU294 DELTA.
The appliances without the mains plug are connected by means of the leads (from the instrument accessories) into the terminals **PE**, **L/N, I_F** and **R_{PE}** located on the instrument panel.

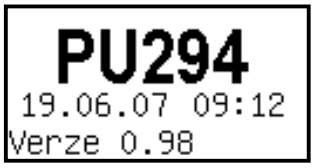
1.2 BASIC INSTRUCTION FOR USE

- The instrument can be used at the ambient temperature from -5°C to +40°C, relative humidity up to 80% at +23°C.
- The instrument must not be exposed to heavy shocks, vibrations and shakes. The instrument withstands common shocks during its application and transport.
- The instrument must not be exposed to aggressive gases and vapours.
- The instrument is designed for common environment according to EN 33 2000-3.
- The heat resistance of the case is max 80 °C.
- The maximum current consumption from the socket of the instrument PU294 DELTA is 10 A/AC permanent.

The instrument PU294 DELTA is fitted with the filter against overvoltage peaks in the supply mains. At the overvoltage higher than 1kV the fuse F 10A/1500 on the instrument panel can be ruptured.

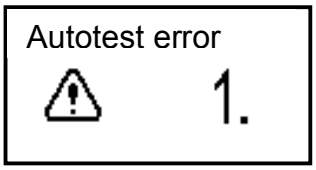
1.3 SETTING INTO OPERATION

The instrument is set into operation by its connection to the mains network by means of the power cord from the instrument accessories. After connection the display is shining and the type of the instrument **PU 294 DELTA** is displayed as well as the firmware version, date and time (Picture 1).



Picture 1

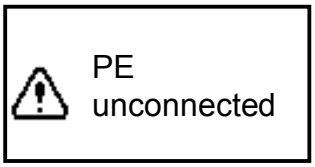
Then the autotest runs and in case of an error the following message is displayed (Picture 2)



Picture 2

1.4 CHECKING OF THE PROTECTIVE CONDUCTOR OF THE NETWORK

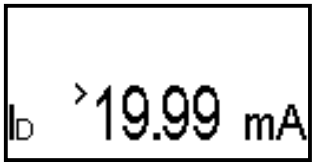
The protective conductor status is checked after the connection to the mains network. If the conductor is interrupted or if there is the voltage >50V between the protective conductor PE and the neutral conductor N then the warning message is displayed (picture 3) and the instrument cannot be used. Also the position of the phase conductor to the neutral contact in the socket is checked and if need to be it is switched over to be on the left in the socket of the instrument PU294 DELTA. The position of the phase in the socket of PU294 DELTA is indicated on the display.



Picture 3

1.5 OVERFLOW OF THE MEASURING RANGE

If the symbol **> (higher then**) is indicated in front of the measured value (picture 4) then the measured value is higher then the used measuring range. If it is possible then switch the instrument to the higher range.

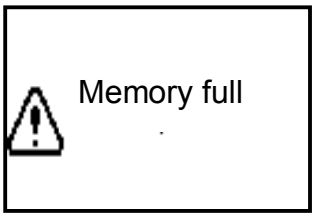


Picture 4

1.6 STORAGE OF THE MEASURED VALUES

The instrument is equipped with the memory which enables to store the results of up to 10 000 measurements. The way how to load the measured values is described at the individual measurements. If the

memory is full then the following message is displayed (Picture 5) and next measured value cannot be stored.



Picture 5

2 THE CONTROL OF THE INSTRUMENT

The instrument PU294 DELTA is controlled by means of the **membrane keyboard.**

The keys serve following functions:

- Key **U,I,P** – selects the measurement of the power supply voltage of the tested appliance, the running current, active and apparent powers inputs and **cosφ**
- Key $\mathbf{I_D}$ – selects the measurement of the leakage current –the alternate method
- Key $\mathbf{I_{PE}}$ – selects the measurement of the current passing through the protective conductor
- Key $\mathbf{I_F}$ – selects the measurement of the touch current
- Key $\mathbf{I_\Delta}$ - selects the measurement of the differential leakage current using the differential transformer
- Key $\mathbf{R_{PE}}$ – selects the measurement of the resistance of the protective conductor
- Key $\mathbf{R_{ISO}}$ – selects the measurement of the insulation resistance and the value of the measuring voltage
- Key **START** - generates the selected measuring mode or loads the measured value into the instrument memory
- Key $\mathbf{U_R}$ – selects the measurement of the residual voltage on the plug contacts after the disconnection of the appliance
- Key $\mathbf{I_M}$ – selects the measurement of leakage currents of medical equipments
- Key EXT- selects the measurement with external sensors connected into the connectors **K1** (PD294) and **K2** (temperature, revolutions etc.)
- Keys ↑and ↓. (arrows) – enable the range switch etc.

The remaining keys do not serve for measuring modes (see below):

- Key **MENU –** for setting of the instrument
- Key **>>** - the function is described below

- Key **No.** – switches the mode for setting of identification numbers of the appliances under the test

2.1 SETTING UP OF THE INSTRUMENT (MENU)

1) Push the key **MENU**, the menu **Memory**, **Setting** are displayed
2) Pushing the keys ↑ or ↓ to select **setting** and confirm it by using the key **START**, the message **Czech, Date and Time** is displayed.

2.2 SETTING UP

2.2.1 Selection of language

Now the instrument PU294 DELTA enables to select the communication language.

1) Push the keys ↑ or ↓ to select the language **Čeština**
2) Push repeatedly the key **START** to select demanded language

2.2.2 Setting of date and time

1) Push the keys ↑ or ↓ to select the message **Date** and **Time** and confirm it by using the key **START**, the figures of date and time are displayed
2) Push the keys ↑ or ↓ to select **date** or **time**, set the correct figures by means of the keyboard and confirm it by using the key **START**

2.2.3 Memory

2.2.3.1 Process of browsing

1) Push the key **MENU** and then use the keys ↑ or ↓ to select **Memory** and confirm it by using the key **START**
2) Push the keys ↑ or ↓ to select **Browse** and push the key **START**
3) Push the keys ↑ or ↓ to browse the content of the separated addresses (the address is displayed in the upper right hand corner of the display)
4) Push the key **No.** to enter on the next upper address containing the identification number of the tested appliance
5) The keys **UIP**, $\mathbf{I_D}$, $\mathbf{I_{PE}}$, $\mathbf{I_F}$, $\mathbf{I_\Delta}$, $\mathbf{I_M}$ $\mathbf{R_{PE}}$, $\mathbf{R_{ISO}}$ and **EXT** return the instrument into the mode of measurement (selection of the measuring modes) and close the process of the browsing

2.2.3.2 Deletion

a) Deletion of a part of the memory

This operation is suitable for deletion of some measured values of a particular appliance or for all measured values including the identification number of the appliance.

1) Push the key **MENU** and then use the keys ↑ or ↓ to select **Memory** and confirm it by using the key **START**
2) Push the keys ↑ or ↓ to select **Browse** and push the key **START**
3) Push the key **DEL** and the question **Delete?** is displayed

- Push the key **START** to delete the memory content from the selected address up to the next identification number of an appliance
- The deletion process can be stopped by pushing the key **ESC** before the pushing of the key **START**. After the deletion the instrument continues to be in the browse mode.

b) Deletion of the all memory

Attention – all measured values stored in the memory will be lost!

Process of the all memory deletion:

1) Push the key **MENU** and then use the keys ↑ or ↓ to select **Memory** and confirm it by using the key **START**
2) Push the keys ↑ or ↓ to select **Delete** and confirm it by pushing of the key **START**. The following question is displayed (Picture 6):

Picture 6

3) Push the key **START** to delete the memory. During the deletion process the message **Deletion** is displayed. After the deletion the message (Picture 1) is displayed and the instrument stays in the mode after the initial switch-on.

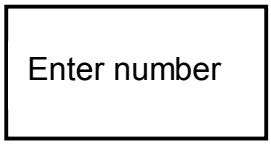
2.2.3.3 Find

At each tested appliance usually several measurements are performed. The instrument PU294 DELTA enables to allocate the **identification number** (up to 14 digits) to each appliance (see *Allocation of the identification number to the tested appliance).* The measured values are bound with this identification number and it is possible to browse through the respective measured values.

Process of the browsing:

1) Push the key **MENU** then use the keys ↑ or ↓ to select **Memory** and confirm it by using the key **START**.

2) Push the keys ↑ or ↓ to select **Browse** and confirm it by pushing the key **START**. The following message is displayed (Picture 7):



Picture 7

3) Give the identification number by means of the keyboard or of the bar code reader and push the key **START**
4) If the memory already contains this identification number then it is displayed. If not then the browsing process stops on the last occupied memory address.
5) Use the keys ↑ or ↓ for browsing of the individual measured values.

2.3 ALLOCATION OF IDENTIFICATION NUMBER TO THE TESTED APPLIANCE

The identification number of the appliance No. makes easy the operations with measured values both in the instrument and in PC. The identification number can be allocated **in two ways**: by means of the keyboard of the instrument PU294 DELTA or with the bar code reader. The identification number can contain up to 14 digits.
In this case the keyboard operates in the numerical mode.

a) Allocation of an identification number by means of the keyboard:
Push the key **No.** The message (picture 7) is displayed.
1) Enter the identification number of the appliance (max. 14 digits)
2) If the enter is wrong then push the key **DEL** and the number is deleted. Repeat the allocation by the keyboard.
3) Push the key **START**. The entered number is stored into the instrument memory. Simultaneously the date and time are stored on the next address.

b) Allocation of an identification number by means of the bar code reader:
1) Connect the bar code reader into the connector **K2** on the panel of the instrument PU294 DELTA.
2) Read the bar code of the tested appliance. The name of the appliance, its location and its identification number are displayed. Simultaneously the date and time are stored on the next address.

3) If the number is read wrong then push the key **DEL** – the number is deleted. Repeat the reading of the bar code.
4) Push the key **START**. The data on the display are stored into the instrument memory and the reading mode is closed.

If the identification number in the bar code has **more than 14 digits** then only the first 14 digits are read. The bar code reader can be connected to the instrument permanently also in the measuring mode.

All following measured values will be attached to this tested appliance – they crate one block up to the address containing the next identification number of another appliance. During the data transfer into the PC these data are processed and stored as one block including the identification number of the appliance.
If it is necessary to measure additional values on the appliance X – and its block of measured values was already closed with the identification number of another appliance - then it is possible to create the second block by re-giving the identification number of the appliance X. At the data transfer into the PC both blocks are jointed into one block attached to the respective appliance.

3 MEASUREMENT WITH THE INSTRUMENT PU294 DELTA

Connect the instrument to the network by means of the power core. The autotest of the instrument is performed and the symbol PU 294, version of the firmware, time and date are displayed. The instrument functions are selected by means of the keyboard.

Recommendation: Connect the doubtful appliances (damaged, troubled) to the instrument PU294 DELTA according to the manual only when there is no voltage on the instrument measuring socket- at the measuring modes R_{ISO}, R_{PE}, I_D. This way you eliminate the rupture of the instrument fuse!!

If the appliance is during the measurement under the operation (measurement of voltage, power etc) then the instrument checks the value of the running current. If this current running from the instrument measuring socket exceeds the value of 16 A then the appliance is automatically disconnected. This is valid only if the appliance was first connected into the socket of PU294 DELTA and then the measuring mode is selected – the supply voltage is connected to the appliance. If the defective appliance (e.g. short circuit of the conductors L and N or L and PE into the power cord) is connected into the live measuring socket (under the voltage) then the instrument ceramic fuse GF10A on the panel of PU294 DELTA can rupture.

During the measurements with mains voltage **the measuring socket** of the instrument PU294 DELTA has the same connection as the network wall socket from which the instrument is supplied, excepting the measurement of the currents I_{PE}, I_F, I_M and I_Δ. In these cases by the repeated pushing of the relevant keys the connection of the conductors L and N can be mutually exchanged in the instrument measuring socket (see below).

3.1 MEASUREMENT OF THE PROTECTIVE CONTUCTOR RESISTANCE R_{PE}

The resistance of the protective conductor can be measured at the appliances of the protective class I. Also the resistance of the interconnection can be measured at this measurement.

Push the key R_{PE} to select the measurement. The measuring range is up to **19,99 Ω**. The minimum measuring current is **10A /AC** at the measured resistance value **<0,3Ω**. At the higher resistance value the measuring current declines but not under **200mA/AC** in the whole measuring range.

Connection of the tested appliance

a) *The appliance of the protective class I is connected by its plug into the instrument socket.* The test lead inserted into the terminal **R_{PE} (blue)** is gradually connected (touched) to the non-live metallic parts of the tested appliance which are accessible to the touch.
b) *At the appliance of the protective class I without the plug* the test lead connected into the terminal **PE (green)** is gradually connected (touched) to the non-live metallic parts of the tested appliance which are accessible to the touch.

In this measuring mode any low resistance value can be measured between the pins of the test leads connected into the terminals PE and **R_{PE}**. Because of the alternating measuring current the measured resistances should be of the low inductance.
If the measuring current runs through the measured item over 15 seconds then the measurement is automatically interrupted and dashes are indicated on the instrument display. The measurement can continue by the new pushing of the key **R_{PE}**.

Note – the resistance of the protective conductor R_{PE} cannot be measured at the appliance of the protective class II.

Measuring process of the resistance R_{PE}:

The measured resistance is connected by two-conductor method. Before this measurement it is necessary to eliminate the resistance of the measuring leads by the instrument calibration.

Push the key **R_{PE}**, the symbols **R_{PE}**, **> 19,99 Ω, UΔ** and **> 9,99V** (for voltage drop on the measured resistance) are displayed.

1) Before the measurement on the appliance with the plug connect the test lead in the terminal **R_{PE}** with the PE contact of the socket PU294 or with the test lead connected into the terminal **PE** (at the appliance without the plug). The value of the voltage drop and the value of the resistance are displayed. If the measured resistance is not zero then push the key **R_{PE}** to initiate the automatic calibration. The flowing message is displayed – Picture 8.

Picture 8

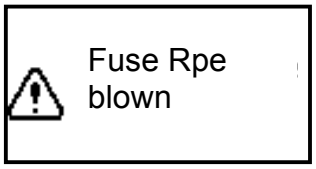
At the short circuit of the test leads or connection of the test leas with the PE contact of the instrument socket (see above) the calibration is automatically initiated and it is finished with the displayed zero resistance value. After the disconnection of the test leads the value **R_{PE} >** 19,99Ω is displayed.

2) Connect the tested appliance. The measuring current is running through the measured resistance and the measured resistance value is displayed. Push the key **START (SAVE)** to store the measured resistance value R_{PE} into the instrument memory. The measuring current is again permanently running through the measured resistance and the momentary value of the resistance is displayed.

Is the measuring current running through the measured item for the period > 10s, then the measurement is automatically interrupted and the following symbols R_{PE} -- -- Ω are displayed. The measurement can be restarted by the pushing of the key **R_{PE}**.

Influence of the external voltage between the terminals **PE** and **R_{PE}**
At the existence of the external voltage up to the value of the phase voltage on the measured item the instrument is not damaged but the measured resistance value is not correct.

If the internal current source is interrupted then the following message is displayed – Picture 9:



Picture 9

3.2 MEASUREMENT OF INSULATON RESISTANCE R_{ISO}

At the appliances where it is not possible to measure the insulation resistance (e.g. PC with electronic network switch) it is necessary to test the insulation status of the tested appliance by other methods – by measurement of the protective conductor current, the touch current and the differential current.

The measurement of the insulation resistance is selected by pushing the key **R_{ISO}**. The values of the measuring voltages (i.e. 50V, 100V, 250V, 500V) are selected by the repeated pushing of the key **R_{ISO}**. The selected measuring voltage is displayed. The measuring ranges are **4 MΩ**, **40 MΩ** and **400 MΩ**. The automatic switch-over of the used range is

indicated by the symbol **AUTO** however the fixed measuring range can be selected manually by the pushing of the keys ↑ or ↓.

Connection of the tested appliance

a) *The appliance of the protective class I* with the plug is connected into the instrument socket on the PU294 DELTA. The appliance power supply switch **must be ON!**

b) *The appliance of the protective class II* with the plug is connected into the instrument socket. The test lead is inserted into the terminal **PE (green)** and is gradually connected (touched) to the non-live metallic parts of the appliance which could be touched. During the measurement the appliance power supply switch **must be ON!**

c) *The appliances with the fixed connection (without the plug)* must be **disconnected** from the network before the measurement to eliminate the damage of the instrument. At the measurement the appliance power supply switch (if any) **must be ON!** The test lead connected into the terminal **L/N (red)** is connected to the short-circuited conductors L and N. At the three-phase appliances all operating conductors are to be short-circuited (L1+L2+L3+N). Connect the test lead inserted into the terminal **PE** to the non-live parts of the appliance (at the appliance of the protective class I these are connected to the protective conductor).

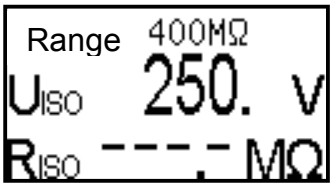
Warning - for the measurement <u>only</u> the test leads with the covered pins from the accessories must be used!!!

Influence of the external voltage

If the external voltage up to the value of the supply voltage is present on the measured item, the instrument will not be damaged; however the measured value will not be correct.

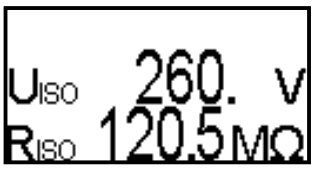
Measuring process of the insulation resistance:

1) Connect the tested appliance
2) Push the key **R_{ISO}**
3) Select the measuring voltage by the repeated pushing of the key **R_{ISO}**.
4) Use the keys to select the measuring range which is indicated in the upper part of the display (Picture 10).



Picture 10

5) Push the key **START(SAVE)** to measure both the insulation resistance and the actual measuring voltage $\mathbf{U_{ISO}}$ (Picture 11)



Picture 11

6) After setting of the data on the display store the value of the insulation resistance and the value of the actual measuring voltage into the instrument memory by pushing of the key **START (SAVE)**. The measurement is not completed – the changing instantaneous resistance value is displayed – not the stored value!
7) **Complete the measurement** of the insulation resistance by pushing of any other key than the key **START (SAVE)** (you select the measurement of other quantity) or by pushing the key $\mathbf{R_{ISO}}$ (this way you select the new voltage value but he measured value is not stored).

Warning: If the measurement is not completed then there is the voltage up to 550V/DC on the socket PU294 DELTA and between the terminals PE and L/N!! The value of the voltage U_{ISO} is indicated on the display.

During the measurement of the insulation resistances the measuring current is limited to approx. **1mA**. That is why the measuring voltage can decrease under the rated value. *E.g. at the rated voltage of 500V and the measured resistance of 200kΩ the measuring voltage will decrease due to the measuring current limitation up to 200V.*

3.3 MEASUTEMENT OF THE ALTERNATE LEAKAGE CURRENT I_D

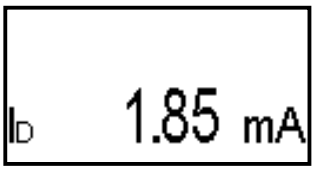
Non-operating appliances are tested by this method. The measuring connection is identical to the insulation resistance measurement but the alternate measuring voltage 230V/AC with limitation of the measuring current is applied.

d) **Warning** – During this measurement the appliance power supply switch **must be ON!** If the appliance is switched by the electronic components (triak, thyristor) then this electronic switch must be short-circuited during the measurement. If it is not possible then this method cannot be applied.

Connection of the tested appliance for the measurement of I_D
a) The appliance of the protective class I and II with the plug is connected by insertion of its plug into the socket of PU294 DELTA. The test lead inserted into the terminal **PE (green)** is connected to the non-live parts of the tested appliance which are accessible to the touch *(appliances of the protective class II)* eventually to the non-live parts of the tested appliance accessible to the touch and not connected to the protective conductor - *appliance of the protective class I* (e.g. metal screws in the parts which are made from insulation materials etc.).
If all non-live parts of the appliance of the protective class I are connected to the protective conductor then the connection to the instrument socket is sufficient for the measurement of I_D.

b) At the appliance without the plug the test lead inserted into the terminal **PE** is connected to the non-live parts of the tested appliance accessible to the touch and the test lead inserted into the terminal **L/N (red)** is connected to the short-circuited operating conductors L and N of the tested appliance. At a three-phase appliance all the operating conductors are to be short-circuited. (The connection is the same as at the measurement of the insulation resistance).

Measuring process of the alternate leakage current I_D:
1) Connect the tested appliance and switch-on its supply switch.
2) Push the key **I_D**. The value of the alternate leakage current calculated for the rated voltage 230 V/AC will be displayed.
3) Push the key **START**. The displayed measured value of the alternate leakage current I_D (Picture 12) is stored into the instrument memory.



Picture12

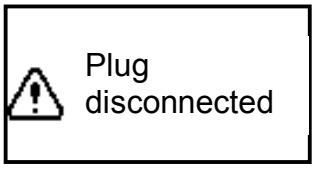
3.4 EXCHANGE OF CONDUCTORS L/N AT MEASUREMENT OF I_F, I_{PE}, I_Δ , I_{M3} , I_{M4}

The PU294 DELTA instrument enables to exchange the wiring of the conductors L and N in the instrument socket during the measurement of the leakage currents and the touch current. It enables to perform two measurements with reverse wiring of these conductors. The measured results can vary (due to the different capacities of the capacitors in the anti-jamming filter etc.). The higher measured value is decisive. Push

the keys ↑ or ↓ to change the wiring in the instrument socket. If there is the mains voltage on the socket the phase conductor position is displayed.
Warning – during the change of the conductors L and N the power supply of the appliance connected to the instrument PU294 DELTA socket is for short time switched-off and switched-on again.
Note: If the tested appliance is not connected into the instrument socket then the conductors L and N cannot be changed by the described method.

3.5 CHECKING OF THE APPLIANCE CURRENT CONSUMTION

The current consumption of the tested appliance connected into the instrument **PU294 DELTA** socket is permanently checked. If the running current is higher than (12+3) A/AC then the power supply voltage is switched-off and the following message is displayed (Picture 13):



Picture 13

For testing of the three-phase appliances and the appliances with the higher current consumption it is recommended to use the accessory instrument **PD294**.

3.6 MEASUREMENT OF THE TOUCH CURRENT I_F

This measurement is performed at the appliances of the protective class II and on the non-live parts of the appliances of the protective class I which are **not connected** to the protective conductor (e.g. metallic tags or plates on the plastic parts of the appliance etc.). **The effective value of the current including the DC component (TRMS) is measured.** The advantage is the possibility to test the appliance without the switch-off and the subsequent connection into the instrument PU294 DELTA socket. If the tested appliance is connected into another wall socket then its protective conductor must be on the same potential as the protective conductor of the instrument *PU294 DELTA.*

Connection for the measurement of the touch current I_F

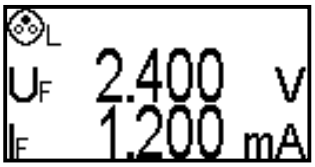
a) *The appliance of the protective class I and II* with the plug is connected into the measuring socket of the instrument PU294 DELTA

b) The instrument PU294 DELTA is connected into the same double- or multi-socket from which the tested appliance is supplied.

The test lead is inserted into the terminal **I_F (yellow)** on the panel of the instrument PU294 DELTA. The pin of the test lead is connected to the non-live parts of the tested appliance accessible to the touch which are **not connected** to the protective conductor.

Measuring process of the touch current I_F:

1) Connect the tested appliance into the instrument socket and switch-on its switch.
2) Push the key **I_F**. The measured value of the touch current **I_F** and the value of the touch voltage **U_F** (i.e. the voltage drop of the equivalent impedance of the human body at the passing of the measured touch current I_F) are displayed.
3) Find out that part of appliance with the highest value of the touch current by connecting the pin of the test lead to the non-live metal parts which are not connected to the protective conductor.
4) Push the key **START (SAVE).** The measured value of the touch current **I_F** just indicated on the display is stored into the instrument memory (Picture 14).
5) For the next measurement with changed conductors L and N push the key ↑ or ↓.
6) Push the key **START (SAVE)** to store the measured value of the touch current **I_F** into the instrument memory.



Picture 14

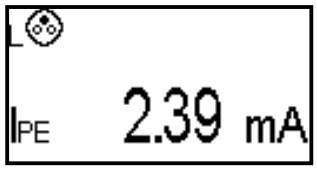
3.7 MEASUREMENT OF THE PROTECTIVE CONDUCTOR CURRENT I_{PE}

The appliance of the protective class I is tested by this method under their operation. **Only the appliance with the plug can be power supplied from the instrument socket PU294 DELTA. The effective value including the DC component (TRMS) is measured.** This method is not suitable for the appliance **not standing insulated** from the

ground. The total leakage differential current can be higher then the current passing through the protective conductor.

Measuring process of the protective conductor current I_{PE}:

1) Connect the plug of the tested appliance to the socket of the PU294 DELTA; switch-on the switch of the appliance.
2) Push the key **I_{PE}**. The value of the current passing though the protective conductor is displayed.
3) Push the key **START (SAVE)**. The value of the protective conductor current **I_{PE}** just indicated on the display (Picture 15) is stored into the instrument memory.
4) For the next measurement with the changed wiring of the conductors L and N, push the key ↑ or ↓. Push the key START (SAVE) to store the measured value of **I_{PE}**.



Picture 15

3.8 MEASUREMENT OF THE DIFFERENTIAL LEAKAGE CURRENT I_Δ

The appliances of the protective class I and II are tested **under their operation** by this method. **Only the appliance with the plug can be power supplied for the instrument socket PU294 DELTA.**
Warning – the appliances with the power switch must be **switched-on** during the measurement!

Connection of the tested appliance during the measurement of the differential current I_Δ

*The appliance of the protective class I and II wi*th plug is connected into the socket of PU294 DELTA.

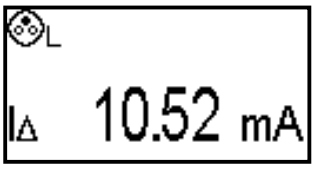
The appliance without the plug cannot be measured by this method.

Measuring process of the differential current I_Δ:

1) Connect the tested appliance into the measuring socket PU294 DELTA and switch-on the switch of the appliance.
2) Push the key **I_Δ**. The value of the differential current I_Δ is displayed (Picture 16). The symbol of the phase position in the instrument socket PU294 is shown in the left hand upper corner of the display.

During the measurement at the appliances of the protective class II contact with the pin of the test lead the metal parts accessible to the touch. The test lead is inserted into the terminal ***I_F*** *of the instrument PU294 DELTA.*

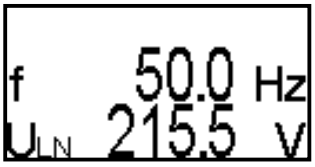
3) Push the key **START (SAVE)**. The measured value just displayed is stored into the instrument memory.
4) For the next measurement with the changed conductors L and N push the key ↑ or ↓. Store the next measured value of the differential current I_Δ by pushing of the key **START (SAVE)**.



Picture 16

3.9 MEASUREMENT OF MAINS VOLTAGE U_{LN}

Push repeatedly the key **U,I,P** to select the mode of the voltage measurement. The symbol **U_{LN}**, the value of the voltage on the instrument socket of PU294 DELTA and the **V** unit are displayed. Also the mains voltage, symbol f and the **Hz** unit (Picture 17) are indicated on the display. The voltage and frequency values are stored by pushing the key **START (SAVE)**.

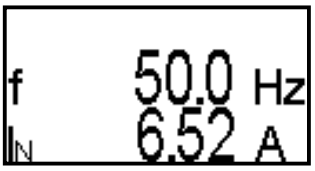


Picture 17

3.10 MEASUREMENT OF THE APPLIANCE CURRENT CONSUMPTION I_N

1) Connect the plug of the tested appliance into the socket on PU294 DELTA.
2) Push repeatedly the key **U,I,P** to select the measurement of the current running into the tested appliance. The symbol **I_N**, the measured current value and the **A** unit (Picture 18) are displayed. Also the current frequency, the symbol **f** and the **Hz** unit are

indicated. The current value and the frequency value are stored by pushing the key **START(SAVE)**.

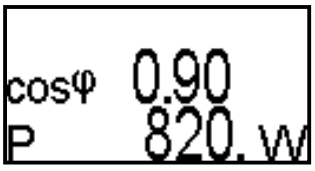


Picture 18

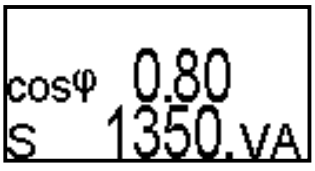
3.11 MEASUREMENT OF POWER AND OF POWER FACTOR

1) Connect the plug of the tested appliance into the socket on the instrument PU294 DELTA.
2) Push repeatedly the key **U,I,P** to select the measurement of the active input power. The symbol **P**, the measured active input power, the **W** unit and the power factor **cos** φ are displayed (Picture 19). The measured input power and the power factor are stored into the instrument memory by pushing of the key **START (SAVE)**.
3) Push repeatedly the key **U,I,P** to select the measurement of the apparent input power. The symbol **S**, the measured apparent input power, the **VA** unit and the power factor **cos** φ are displayed (Picture 20). The measured apparent input power and the power factor are stored into memory by pushing the key **START (SAVE)**.

*The measurement of the active input power, the apparent input power, the current and the voltage can be selected by the repeated pushing of the key **U,I,P.***



Picture 19

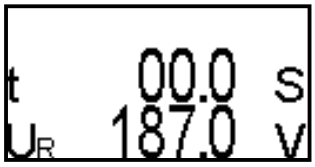


Picture 20

3.12 MEASUREMENT OF THE RESIDUAL VOLTAGE U_R

1) Connect the plug of the tested appliance into the socket of the instrument PU294 DELTA and switch-on the tested appliance.
2) Push the key **U_R** to select the measurement of the residual voltage.
3) Push the keys ↑ or ↓ to select the time when the measurement of the residual voltage U_R on the plug of the tested appliance will be measured. The selected time means the interval from the moment of the appliance switch-off.

4) Push the key **START**. The measurement is started, the displayed time counts down. When the period lapses the beep signal sounds and the residual voltage U_R (Picture 21) is displayed. The measured value is stored into the internal instrument memory.



Picture 21

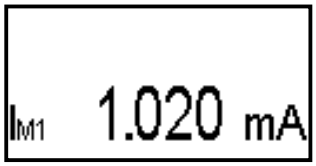
3.13 MEASUREMENT OF LEAKAGE CURRENTS AT THE MEDICAL EQUIPMENTS

Push repeatedly the key **I_M** to select this measurement.
Use the accessory **PD294.7** for the connection of touch items (contacts) of the tested equipment.

3.13.1 Measurement of the leakage current I_{M1}

The tested equipment is out of operation. The AC voltage from the instrument auxiliary power supply is connected to the contacts L and N (terminal L/N) of the measuring socket of PU294. The measuring circuit **MD** according to the standard EN 60601-1 is connected to the terminal **I_F (yellow)**
Warning – the mains switch of the tested equipment must **be switched-on!** If the tested equipment is switched by electronic components (triak, thyristor) then this electronic switch must be short-circuited during this measurement. If it is not possible then this method cannot be applied.
Measuring process of the leakage current I_{M1}

1) Connect the tested equipment into the socket PU294 and switch-on its mains switch.
2) Connect the interconnected touch items (contacts) into the terminal **I_F (yellow).**
3) Push repeatedly the key **I_M** to select the measurement **I_{M1}**. The measured value of the leakage current at the mains voltage 230 V is displayed.
4) Push the key **START**. The displayed measured current **I_{M1}** is stored into the instrument internal memory (Picture 22).



Picture 22

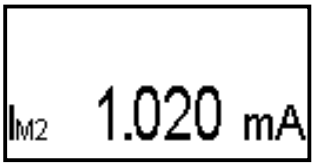
3.13.2 Measurement of the leakage current I_{M2}

The tested equipment is out of operation. The AC voltage from the instrument auxiliary power supply is connected to the protective contact (terminal PE) of the measuring socket of PU294. The measuring circuit **MD** according to the standard EN 60601-1 is connected to the terminal **I_F (yellow)**

Warning – the mains switch of the tested equipment must **be switched-on!** If the tested equipment is switched by electronic components (triak, thyristor) then this electronic switch must be short-circuited during this measurement. If it is not possible then this method cannot be applied.

Measuring process of the leakage current I_{M2}

1) Connect the tested equipment into the socket PU294 and switch-on its mains switch.
2) Connect the interconnected touch items (contacts) into the terminal **I_F (yellow).**
3) Push repeatedly the key **I_M** to select the measurement **I_{M2}**. The measured value of the leakage current calculated at the mains voltage 230 V is displayed.
4) Push the key **START**. The displayed measured current **I_{M2}** is stored into the instrument internal memory (Picture 23).



Picture 23

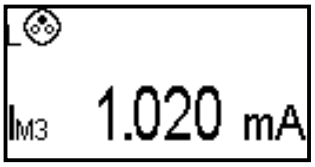
3.13.3 Direct measurement of the leakage current I_{M3}

At this measurement the tested equipment is **in operation** and it is connected into the socket of the instrument. The leakage current between the accessible parts and the touch items is measured. This method is suitable for the equipment with the mains electronic switch. The measuring circuit **MD** is connected between the accessible parts and the touch items and the leakage current is measured when the equipment is in operation.

Measuring process of the leakage current I_{M3} :

1) Connect the tested equipment into the instrument socket PU294 and switch-on its mains switch.
2) Connect the interconnected touch items (contacts) into the terminal **I_F(yellow)**

3) Push repeatedly the key **I_M** to select the measurement **I_{M3}**. Switch-on the tested equipment. The measured value of the leakage current calculated at the mains voltage 230 V is displayed.
4) Push the key ↑or ↓ to measure with exchanged conductors L, N.
5) Push the key **START**. The displayed measured current **I_{M3}** is stored into the instrument internal memory (Picture 24).



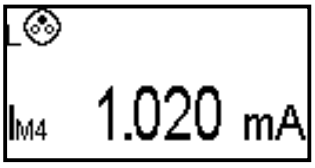
Picture 24

3.13.4 Direct measurement of the leakage current I_{M4}

This method combines two methods described in the chapters 3.10.2 and 3.10.3. It is suitable for equipments with the electronic mains switch. The tested equipment is connected to the measuring socket PU294 DELTA and it is switched-on. The auxiliary power supply in series with the measuring circuit **MD** is connected between the accessible parts and touch parts. The total current generated by the tested equipment and the auxiliary power supply is measured.

Measuring process of the leakage current I_{M4}:

1) Switch-on the tested equipment and connect it into the measuring socket of PU294 DELTA
2) Connect the interconnected touch items (contacts) into the terminal **I_F(yellow)**
3) Push repeatedly the key **I_M** to select the measurement **I_{M4}**. Switch–on the measuring instrument. The measured value of the leakage current is displayed.
4) Push the key ↑ or ↓ to measure with exchanged conductors L, N.
5) Push the key **START**. The displayed measured current **I_{M4}** is stored into the instrument internal memory (Picture 25).



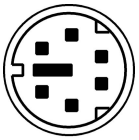
Picture 25

4 MEASUREMENT WITH ACCESSORIES

Push the key **EXT** to initiate the measurement from the accessories connected into the connector **K1**. If the **K1** is not used the accessories connected into the **K2** is activated. If neither connector is occupied then after the pushing of the key **EXT** the instrument PU294 measures temperature. Push repeatedly the key **EXT** to switch the function of the accessory connected in the connector **K1**.

If the accessory is fitted with microprocessor then the communication with the instrument PU294 is initiated automatically. The application of the accessories is in detail described it relevant manuals. Connection of accessories to the PU294 DELTA is given in the following table 1.

Table 1.

Accessory	Type	Picture	Connector ⚠	Connection
Test modulo	**PD294.1**			**Socket of PU294 DELTA terminals R_{PE}, I_F, R_{ISO}, PE (see manual PD294.1**
Accessory for medical equipment tests	**PD294.7**			**Terminal I_F (see manual PD294.7)**
Revolution counter	**PD294.3**			**At the connection adjust the mark K2 on the jack against to the mark K2 on the panel of PU294**
Temperature sensor	**PD294.4**			
Bar code Reader	**PD294.5**			
Clamp on ammeter	**PD294.2**			**At the connection adjust the mark K1 On the jack against to the mark K1 on the panel of PU294**
Instrument for three phase appliances	**PD294**			

4.1 MEASUREMENT OF TEMPERATURE

The sensor PD294.4 – platinum thermometer Pt100 – is used for measurement of temperature. It is an optional accessory of the instrument PU294 DELTA.

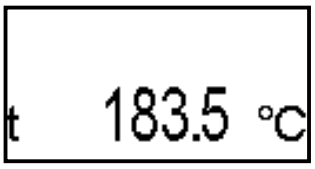
The connection of the tested appliance

The appliance can be connected into the socket of the instrument PU294 DELTA or can be supplied from the other network socket. The temperature sensor is inserted into the seven-pin MINIDIN connector **K2** on the instrument panel.

The connector K1 must be free at the measurement of temperature!!
Warning – Do not touch the parts under voltage with the sensor!!

Measuring process of the temperature measurement:

1) Insert the sensor PD294.4 into the connector **K2**. ⚠
2) Push the key **EXT.**
3) Touch the measured surface with the pin of the sensor. After stabilisation of the reading the measured temperature is displayed (Picture 26).



Picture 26

4) Push the key **START** to store the measured value into the instrument memory.

Note: At this measurement the mains voltage is in the socket of PU294 DELTA.

4.2 MEASUREMENT OF REVOLUTIONS

The sensor PD294.3 is optional accessory used for measurement of revolutions.

Connection of the tested appliance

The appliance can be connected into the socket of the instrument PU294 DELTA or can be supplied from the other network. The revolution counter (sensor) is inserted into the connector **K2** on the instrument panel.

Measuring process of the revolution measurement:

1) Connect the counter - sensor PD294.3 - into the connector **K2**. ⚠
2) Put the sensor close to the rotating part of the tested appliance. The rotated part must be fitted with a reflection mark.
3) After the green LED is lighting then push the button on the sensor PD 294.3

4) The revolutions per minute are displayed (Picture 27).

Picture 27

5) Push the key **START** to store the displayed measured value into the instrument memory.

Note: For detailed information about the revolution counter PU294.3 see the relevant manual PU294.3.

4.3 MEASUREMENT OF THREE-PHASE APPLIANCES.

For the testing of three-phase appliances the instrument **PD294** is intended. It is connected to the connector K1 on the panel of the instrument **PU294 DELTA.**

This accessory PD294 in connection with the instrument PU294 enables to measure phase voltages, currents, active and apparent input powers, the power factor cos φ and the total input power. Also leakage currents I_{PE} and I_{Δ} can be measured. The other measurements such us the insulation resistances, the alternate leakage currents and the resistance of the protective conductor are perform by the instrument PU294 DELTA. The measurements are controlled by the keyboard of the instrument PU294 DELTA. The connections and functions of both units are described in the relevant manual for PD294. ⚠

4.4 BAR CODE READER PD294.5

The bar code reader reads the identification number of the tested appliance. The identification number has max 14 digits. The reader is connected to the connector **K2** on the panel of PU294. ⚠

Characteristics of the bar code reader:

Any type of a bar code reader (CCD BARCODE SCANER) with the standard keyboard interface (WEDGE) can be connected to the instrument PU294 DELTA. The cable of the reader must be fitted with the connector MINIDIN 5M.

Process of the bar code reading:

1) Connect the bar code reader into the connector **K2** of the instrument PU294 DELTA
2) Read the bar code (see the relevant manual for PD294.5).

The identification number of the tested appliance is displayed. Push the key **START** to store the identification number into the instrument memory. The measured values will be stored on the next addresses of the memory.

5 Communication of the instrument 294 with PC

The instrument PU294 DELTA is fitted with the USB connector type B for communication with PC. Us the cable USB A/B MM from the accessories for the connection into the free USB port of the PC. The communication is controlled with the software (PROGRAM ReviSoftDB) which is delivered together with the instrument.

Process of the communication:

1) Connect the non-live instrument PU294 DELTA via the connector **USB/B** with the free USB port or the PC.
2) Connect the instrument PU294 DELTA to the mains network.
3) Start the communication software REVISOFT on your computer and follow the instructions in the relevant manual and on the PC screen.

6 MAINTENANCE OF THE INSTRUMENT

The instrument PU294 DELTA does not need any special maintenance. Only the pins of the tested leads should be kept clean to minimize the contact resistance at the measuring process. Also it is necessary to verify the perfection of the insulation of the instrument, of the cords and of the testing leads. Never use the mechanical damaged instrument or accessories which do not meet the condition of the capitol 10 of the manual.

6.1 DECLARATION OF THE INSTRUMENT DISPOSAL

After the instrument lifetime expires it is necessary to respect the environmental regulations. The instrument price includes the disposal cost of the electrical equipment according to the Act No.7/2005.

6.2 DECLARATION OF THE PACKING MATERIAL DISPOSAL

The manufacturer Metra Blansko has closed the agreement regarding the reprocess of the packing material with the company EKO-KOM under the clients code EK-F00024744

7 Transport

The instrument can be transported in the original packing with all common transportation means. During transport the shocks and vibrations should be minimized. Permitted transport temperature ranges from -25°C to +55°C.

The instrument meets the standard EN 60721- 2, class 2K2.

8 STORAGE

In the store the instrument should not be exposed to the direct sun rays. The storage temperature ranges from -10°C to +45°C, relative humidity under 95 % at the temperature 30°C. Damaging gases, vapours, dust and moulds should be eliminated from the store space.
The instrument meets the demands of the standard EN 60721-3-1, classes: K2/1Z1/1B1/1C1/1S1/1M.

9 REPARATIONS AND SERVICE

Manufacturer:
METRA BLANSKO, a.s.
závod Elektrotechnika
Pražská 7/1602
678 49 Blansko
telefon: 516 591 254
fax: 516 591 504
e-mail: klein@metra.cz

Calibration service:
METRA BLANSKO, a.s.
Oddělení Metrologie-KMS
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678 49 Blansko
telefon: 516 591 041
fax: 516 591 426
e-mail: kubesova@metra.cz

Reparations and services:
METRA BLANSKO, a.s.
závod Elektrotechnika
Opravy a servis
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678 49 Blansko
telefon: 516 591 233
fax: 516 591 504
e-mail: masijová@metra.cz

Warranty reparations:
METRA BLANSKO, a.s.
závod Elektrotechnika
oddělení Reklamace
Pražská 7/1602
678 49 Blansko
telefon: 516 591 029
fax: 516 591 504
e-mail: hlozek@metra.cz

Recommended interval of calibration at manufacturer: each 2 years!

10 SCOPE OF DELIVERY

a) Instrument PU 294 DELTA
b) Power cord
c) Test lead with the covered pin 2 units
d) Crocodile-clip 2 units

e) Communication cable (USB A/B)
f) CD with the communication software REVISOFT
g) Spare ceramic fuse GF10A 1unit
h) Instruction for use PU294 DELTA
i) Carton package
j) Certificate of warranty

Optional accessories on the extra order:

Accessory PD294 for the three-phase appliances
Test module PD 294.1 for R_{ISO}, R_{PE}, U_R, I_M, I_D, I_F, I_Δ
Clamp on ammeter PD294.2
Sensor of revolutions PD 294.3
Temperature sensor PD294.4
Bar code reader PD294.5
Accessory for testing of medical equipments PD294.7

Spare parts:
a) Pin of the test lead
b) Crocodile clamp
c) Test lead with covered pin
d) Power cord

11 TECHNICAL DATA

Reference conditions:
Supply voltage 230 V ± 1%
Frequency 50 Hz ± 0,5 Hz
Temperature (23 ± 2) °C
Relative humidity (45 to 55) %
Position of instrument: arbitrary

Operating conditions:
Supply voltage 187 to 253V
Frequency 49 to 51 Hz
Temperature -5°C to 40°C
Rel. humid. max. 80% at 23°C
Position of instrument: arbitrary
Magnetic induction 0,5 mT

Time for the reading setting on the display:
max. 20 s at the measurement of the insulation resistance (for the pure resistive load)
max. 5 s – for other measurements

Current consumption – max. 12 A (it depends on the load in the instrument socket)

Electromagnetic compatibility - the instrument complies with the requirements of the standard EN 61326-1 (version 1), table C1.

Safety requirements - the instrument complies with the requirements of the standard EN 61010-1: Devices with the protection class classification I for the voltage 300V against ground, CATIII, pollution degree 2.

Weight:	**PU294 DELTA**	**approx. 4 kg**
Dimensions:	**270 x 240 x 130 mm**	

Table 2 – Measuring ranges and measuring accuracy

Measured quantity	Measuring range	Measuring voltage	Current [1] {I_k}, I_n I_m	Measuring accuracy	
				Reference conditions	Operating conditions
Mains voltage U_{LN}	(180 ÷ 253)V	-	-	±(1%MV+5D)	±(1%MV+10D)
Insulation resistance R_{ISO}	(0,1 ÷ 3,999)MΩ (1,0 ÷ 39,99)MΩ (10 ÷ 399,9)MΩ	50 to 70 V 100 to130V 250 to300V 500 to 600V	{≤4 mA} (1+0,5) mA	±(3%MV+10D) [5]	±(5%MV+10D) [5]
Resistance of protective conductor R_{PE}	(0,01 ÷ 19,99) Ω	max. 20V/AC	*0,3 to 18A/AC*	±(3%MV+10D)	±(5%MV+10D)
Touch current I_F	(0 ÷ 3,999) mA	-	-	±(1%MR)	±(1%MR)
Current I_{PE}	(0 ÷ 19,99) mA	-	-	±(2%MR)	±(2%MR)
Current I_D	(0 ÷ 19,99) mA	max. 250V/AC	-	±(2%MV+5D)	±(2%MV+10D)
Differential current I_Δ	(0 ÷ 19,99) mA	-	-	±(2%MR)	±(2%MR)
Current of appliance I_N	(0 ÷ 16) A	-	-	±(2%MV+5D)	±(2%MV+10D)
Active power P	(0 ÷3700) W	-	-	±(3%MV+10D)	±(5%MV+10D)
Apparent power S	(0 ÷3700) VA	-	-	±(3%MV+10D)	±(5%MV+10D)
Power factor cosφ	(0,50 ÷1,00)	-	-	±5D	±10D
Revolutions n	(200÷9999) min^{-1} [3]	-		±(1%MV)	±(2%MV)
Temperature t	(-20 ÷ +350)°C [4]	-	-	±3°C	±5°C
Residual voltage U_R	(20 ÷ 300)V	-	-	±(2%MR)	
Leakage current I_{M1}	(0 ÷ 3,999) mA	max.250V/AC	-	±(2%MV+5D)	±(5%MV+5D)
Leakage current I_{M2}	(0 ÷ 3,999) mA	max.250V/AC	-		
Leakage current I_{M3}	(0 ÷ 3,999) mA	-	-		
Leakage current I_{M4}	(0 ÷ 1,999) mA	max.250V/AC	-		

Notes:

MV measured value

MR measuring range

D digit (digit of the lowest order)

$\mathbf{I_n}$ *rated current* - max. current at the rated voltage when the insulation resistance is measured

$\boldsymbol{I_m}$ *measuring current* - passing through the resistor when the resistance of the protective conductor is measured

$\mathbf{I_k}$ *short circuit current* - passing between the short circuited pins in the mode of the isolation resistance measurement

$\mathbf{I_F}$ *touch current* - current passing through the personal body to the earth from the electrical appliances with the protective class II and from the metal parts accessible to the touch of the appliances with the protective class I which are not connected to the protective conductor (e.g. decorative parts) (touch voltage $\Delta U = I_F \times 2\ k\Omega$)

$\mathbf{I_N}$ *consumption current* - passing through the tested appliance

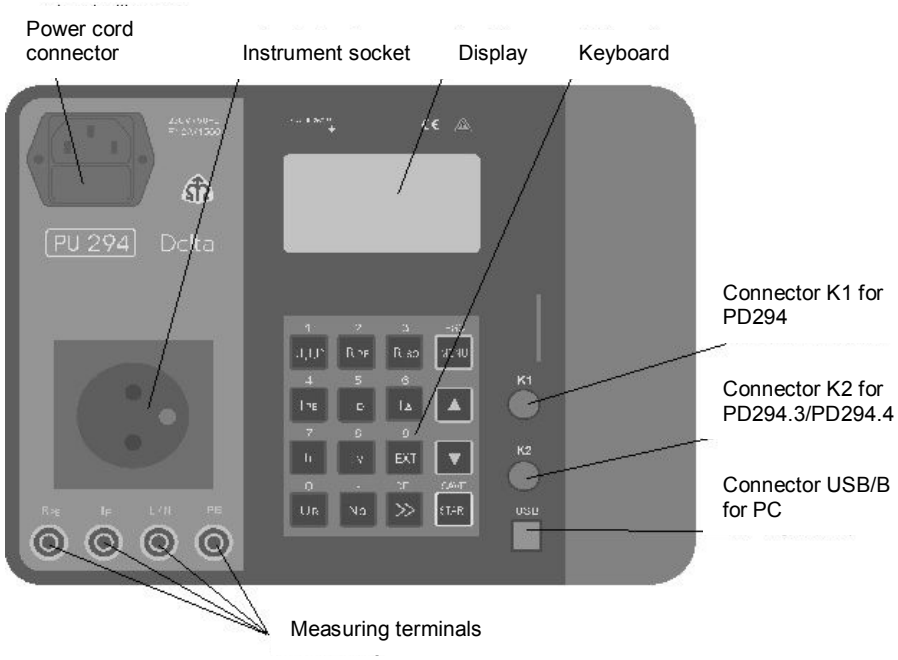
1) {I_K} short circuit current - at the measurement of insulation resistance

2) Consumption current I_N must be min. 0,5A

3) Valid for the revolution counter PD294.3

4) Valid for the temperature sensor Pt 100, PD294.4

5) At the measuring voltage 50V and 100V the accuracy is guaranteed to the resistance value 40MΩ only

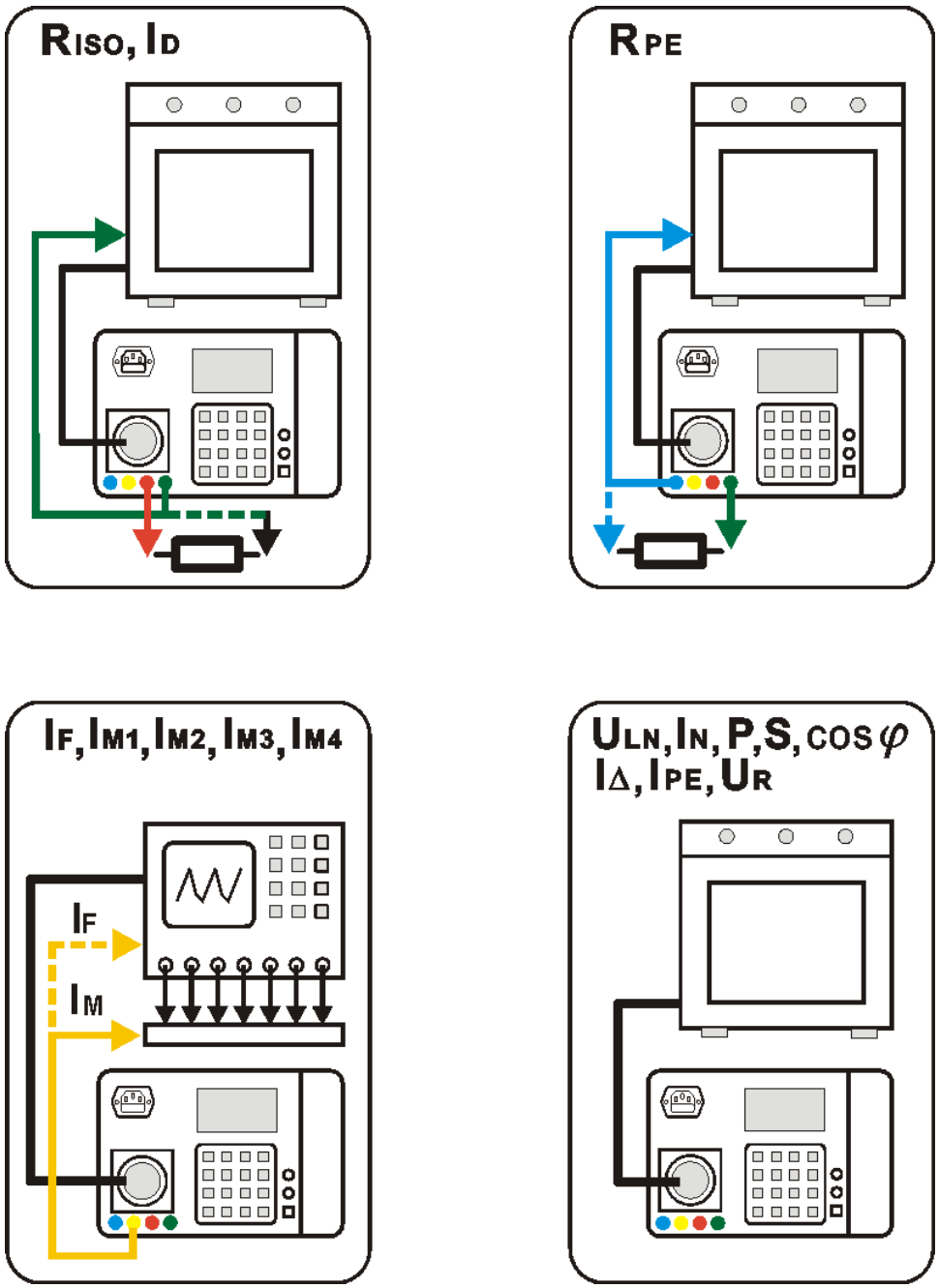


Picture 28: Panel of the instrument PU294 DELTA

12 REVEVISION OF THE INSTRUMENT PU294

In the sense of the standard EN 33 16 10 the instrument PU294 is considered to be an electric appliance and as such must be tested-revised regularly. The recommended process of testing is as follows:

1) Check the resistance of the connection between the protective contact of the power cord inserted into the switched-of instrument PU294 and its body (one of the screws in the legs of the instrument PU294). The measured value should be max 0,15Ω.
2) Check the resistance of the connection between the protective contact of the measuring socket of the switched-on instrument PU294 in the mode of measuring voltage and its body (one of the screws in the legs of the instrument PU294). The measured value should be max 5Ω.
3) Measurement of insulation resistances:
   - insulation resistance between the contacts L (N) and PE of the mains power instrument socket of PU294 cannot be measured because of the indicating circuits of the phase position in the socket of PU294.
   - to measure the insulation resistance between the contacts L(N) and PE (the protective contact of the mains instrument socket). The measured value should be min. 100MΩ.
   - Switch-on the tested instrument, select the mode of the voltage U_{LN} measurement and measure the insulation resistance between the contact L(N) and its body (one of the screws in the legs of the instrument PU294). The measured value should be min. 100MΩ.
4) Measurement of the leakage current I_{PE} (I_{Δ}) (instrument PU294 is switched-on).
   - connect the tested instrument PU294 into the measuring socket of another testing instrument. On this testing instrument select the mode measuring the leakage current I_{PE} or I_{Δ}. The measured value should be max 1,5 mA.
   - switch over the tested instrument PU294 in the mode measuring the current of the protective conductor I_{PE} and on the testing instrument select the mode measuring the leakage current I_{PE} or I_{Δ}. The measured value should be max 0,3 mA.



Picture29. Connection of the tested appliances to the instrument PU294

Notes:

ČESTNÉ UZNÁNÍ

Odborné hodnotitelské komise 16. mezinárodního veletrhu elektrotechniky a elektroniky

AMPER 2008

Název oceněného exponátu: **Přístroj pro revize - PU 294 DELTA**

Přihlašovatel exponátu: **METRA BLANSKO, a.s.**

Prof. Ing. Jiří Tůma, DrSc.
předseda komise / committee president

Praha, 2. 4. 2008

Ing. Jiří Šviga
generální ředitel / managing director

The instrument PU294 was honored by this diploma on the fair AMPER 2008 in Prague.