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INKA 3

Contactless Fault Indicator for High Voltage Applications

User Manual

Liberec 13.6.200707

1. Contents

1. Contents....2

2. Preface....3
2.1 General....3
2.2 Setup....4
2.3 Models, Options, Software....4

3. Hardware....5
3.1 Voltage Antenna Input....5
3.2 Power Supply and Module INKA-solar....5
3.3 Outputs....5
3.4 Communication Link....6
3.5 Optical Indication....6
3.6 Inka-expand Module....6

4. Operation....7
4.1 Phase-To-Phase Fault Indication....7
4.2 Ground Fault Indication....8
4.3 Installation Rules....9
4.3.1 Mechanical Installation....9
4.3.2 Electrical Installation....9
4.3.3 Putting In Operation....10

5. Technical Parameters....11

6. Appendices....12
6.1 Inka-expand....12

7. Maintenance, Service....16

2. Preface

2.1 General

INKA 3 Indicator of fault currents from short circuits and ground connections provides indication of excessive currents through power lines on phase-to-phase short circuits and indication of ground fault 5th harmonic current in compensated high voltage power distribution systems.

The power line condition is monitored by measuring and evaluating levels of magnetic and electric fields and of their changes. Fault conditions (phase-to-phase fault current resulting in voltage failure in the power line and the 5th harmonic current on ground fault, respectively) are indicated either with relay break contacts for transmission to control room using remote control section switch radio communication or optically by flashing indicator light or by GPRS data transmission. It is further possible to read the state of the Indicator using a PC via an RS 232 serial link.

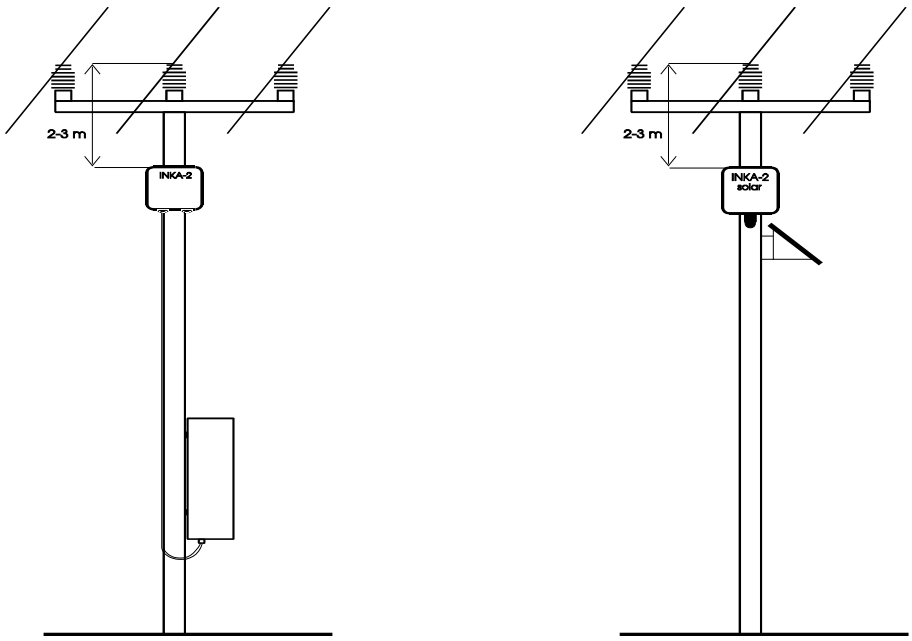
Constants are preset by the manufacturer, they can, however, be modified according to the agreement..

The Indicator draws power either from a remote control section switch electronic circuitry or from built-in accumulators charged from a solar panel.

The instrument comes in a plastic box (IP 65 rating) designed for installation onto a pole. The instrument is to be mounted on an overhead high voltage power line pole about 2 to 3 meters below the power line. It is, however, essential to situate the instrument to be faced to the power lines, so that the instrument's face (its cover) is **perpendicular** to the direction of the power line. The optional solar panel is separate and it is to be positioned facing the south. If the optical indicator is used, it is to be installed in a place allowing as good visibility from an accessible point, such as road, as possible.

The instrument is galvanically isolated from the power line and it can be installed without disrupting power supply while complying with the relevant requirements of local standards.

The instrument is usually installed in combination with a remotely controlled section switch, via the communication link of which (a radio transceiver) the information on phase-to-phase or ground fault current is transmitted. INKA 3's both output signals (potential-free relay contacts) and power supply input from 10 to 16 V DC are connected to the remote control section switch control circuitry. The instrument does not draw more than 10 mA in its power supply line. In order to be able to read the state of the instrument, an RS 232 communication interface is also to be connected. The instrument's power supply, signal, and communication wires go to the unit in a cable duct where they are connected to a screw terminal board. To facilitate the installation, an optional module, Inka-expand, can be purchased to be installed onto the section switch distribution board's DIN strip. A seven-wire screened cable is to be used to connect an INKA 3 unit.



If installed on a pole without a remote control section switch, the solar panel and optical indicator options or GPRS data transmission are used. In such a case the solar panel and optional optical indicator are connected to an INKA 3 using the cables supplied with the unit.

2.2 Setup

To preset an INKA 3 indicator, the customer needs to supply the following information:

- fault condition parameters at the power node on the high voltage side (or very high voltage side plus transformer's ε_K)
- voltage level
- total capacitive current value, that is current through the compensation inductor on ground fault
- types and parameter settings of protection on power node leads
- usage of automatic devices (such as reclosers) at leads and their settings

2.3 Models, Options, Software

1. **INKA 3.** To be installed in combination with remote control section switch, via the communication link of which (radio transceiver) the phase-to-phase or ground fault current data are transmitted. INKA 3's both output signals (potential-free relay contacts) and power supply input from 10 to 16 V DC are connected to the remote control section switch control circuitry. The instrument does not draw more than 10 mA in its power supply line. An Inka-expand module, which also features an RS 232 serial communication port connector, can be installed at the section switch distribution board. The communication interface can be utilized to monitor the measurement data or for servicing purposes.
2. **INKA 3-Solar.** For installation at a point without a remote control section switch. The Indicator is powered from built-in accumulators that are charged from solar cells. The solar panel is separate and to be attached to the pole independently. Fault indication is by a flashing indicator light.
3. **INKA 3-GPRS.** For installation at a point without a remote control section switch. The Indicator is powered from built-in accumulators that are charged from solar cells. The solar panel is separate and to be attached to the pole independently. Status of the indicator is transmitted via GPRS. Indicator light can be added.

Optional Modules

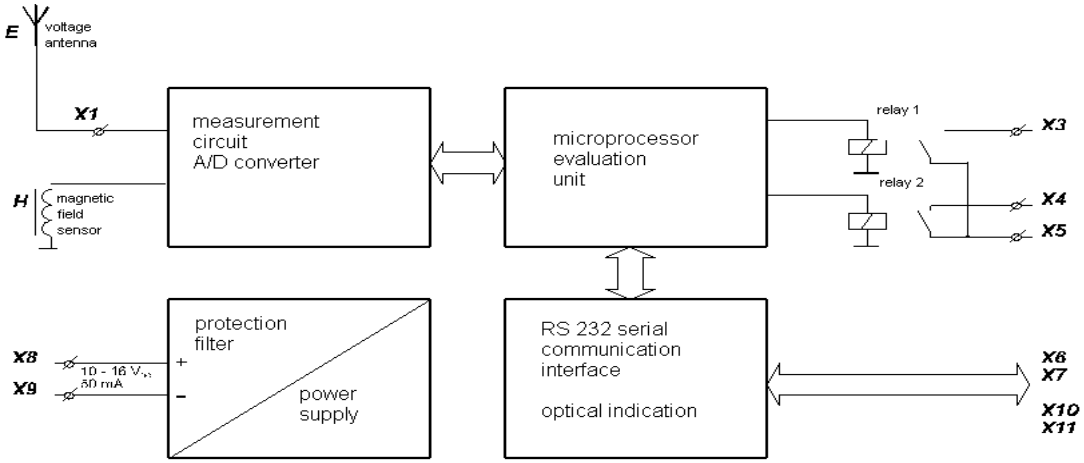
1. **INKA–expand.** A module facilitating connection to the section switch control circuitry. The module is installed on the section switch distribution board's DIN 35 strip. It also has an RS 232 serial communication port connector.
2. **Module INKA-opto.** Module for optical signalisation.
3. **Module INKA-solar.** Power supply solar panel.

Software

1. **INKA3–W.** A program to run under Windows 98 and higher. It can be used to monitor the measurement data or for servicing purposes. The program also allows archiving of each INKA 3 Indicator's settings.

3. Hardware

INKA 3 has a magnetic field sensor to sense current through the power line, an antenna to sense the electric field to indicate the power line's voltage, two potential-free contacts to indicate the high voltage power line's faults, an RS 232 serial communication interface to connect to a PC, a power supply with electromagnetic interference protection, measuring circuitry with an A/D converter, and a programmable microprocessor evaluation circuit. Additionally INKA 3-solar has accumulator with charging automatics and solar panel. There is solid-state switch for optical signalization instead of relay. INKA 3-GPRS has also communication module GPRS.



INKA 3 Block Diagram

The power supply, signal, and communication wires go to the instrument in a cable duct, through a bushing into the unit's case where they are connected to a terminal board. The wires' recommended cross section areas are from 0.5 to 1.0 square millimeter each, in a cable with plastic insulation.

3.1 Voltage Antenna Input

The voltage antenna is supplied assembled. It goes through a bushing in the case top and it is connected to terminal X1. At INKA 3-solar and INKA 3-GPRS types the voltage antenna is integrated on PCB.

3.2 Power Supply and Module INKA-solar

INKA 3 is powered with a direct current voltage between 10 and 16 V connected to terminals X8, $+V_{CC}$, or plus, and X9, GND, or minus. The current drawn is up to 10 mA. **There is no protection of the power supply line inside the instrument, so it has to be protected on the host distribution board with a slow fuse T 100 mA / 35**. Module Inka-expand is already equipped with the fuse. INKA 3-solar and INKA 3-GPRS types are powered with solar panel. The optional solar panel connects to terminal X8, $+V_{CC,}$ with its plus lead and to X9, GND, with its minus lead. The accumulator is not supplied connected. The accumulator is inside the instrument, it is necessary to connect it.

3.3 Outputs

There are two relays to output information about faults and state of instrument. Their potential-free contacts go to terminals X3 to X5.

Relay 1 indicates fault current with subsequent voltage failure in the power line. Under faultless conditions the X3 and X5 terminals are short circuited by relay closed contacts while on a phase-to-phase fault they are insulated because of open relay contacts.

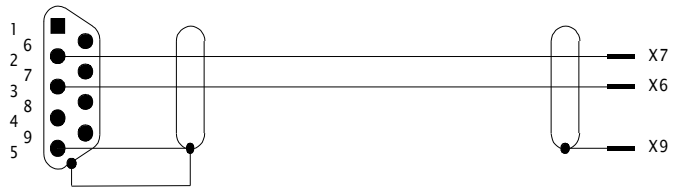
Relay 2 indicates 5th harmonic current on ground fault. Under faultless conditions the X4 and X5 terminals are short circuited by relay closed contacts while on a ground fault they are insulated because of open relay contacts.

If both relays have open contacts (that is terminal pairs X3-X5 and X4-X5, respectively, are not short-circuited), loss of power supply or INKA 3 error is being indicated.

If both relays have closed contacts (that is terminal pairs X3-X5 and X4-X5, respectively, are short-circuited), faultless power line condition is being indicated.

3.4 Communication Link

The INKA 3 has an RS 232 communication interface to connect to a PC. The serial line is to be connected to terminals X6, RxD, and X7, TxD. The signal ground pole is the same as power supply minus pole at terminal X9, GND.



Communication Cable to Connect INKA 3 to a PC.

A standard communication protocol is used in the communication and it takes place via a computer's standard communication port (COM1 or COM2). Data transmission takes place at baud rate 9,600, with 8 data bits, no parity, 1 stop bit. The suitable PC software, INKA3-W, to run under Windows 98 or higher operating system and for reading measured values and other data and for testing the unit has to be ordered, together with a communication cable, separately.

3.5 Optical Indication

An additional optical indicator of fault conditions is to be connected its plus pole to terminal X5, and its minus pole to terminal X4. The signalization of phase-to-phase fault current gets double flashing at 2.5-second intervals, the signalization of ground current gets single flashing at 2.5-second intervals. Running signalization gets single flashing at 6-minutes intervals. If no flashing indicated, the accumulator is discharged or the instrument is in failure.

3.6 Inka-expand Module

To facilitate connection of the INKA 3 instrument, an Inka-expand module is available for installation onto the section switch distribution board's DIN35 strip.

The module comprises a screw terminal board, to connect an INKA 3 Indicator and the section switch circuitry to, a fuse T 100 mA / 35, and a 9-pin D-Sub connector to link to a portable PC via the RS 232 serial line. For module wiring see appendix.

A 7-wire screened cable (see above) is recommended to connect an INKA 3 instrument, and the terminals are to be connected as follows:

X2 - Y2 – screening	X6 - Y6 – RxD
X3 - Y3 – relay 1	X7 - Y7 – TxD
X4 - Y4 – relay.2	X8 - Y8 – +12 V DC
X5 - Y5 – relays, common	X9 - Y9 – GND

The following terminals are used for connection to the section switch:

Z3 – relay 1 contact – phase-to-phase fault signal	Z8 – 12 V DC power supply plus pole
Z4 – relay 2 contact – ground fault signal	Z9 – power supply minus pole, ground
Z5 – relays contacts' common	⏚ – grounding

4. Operation

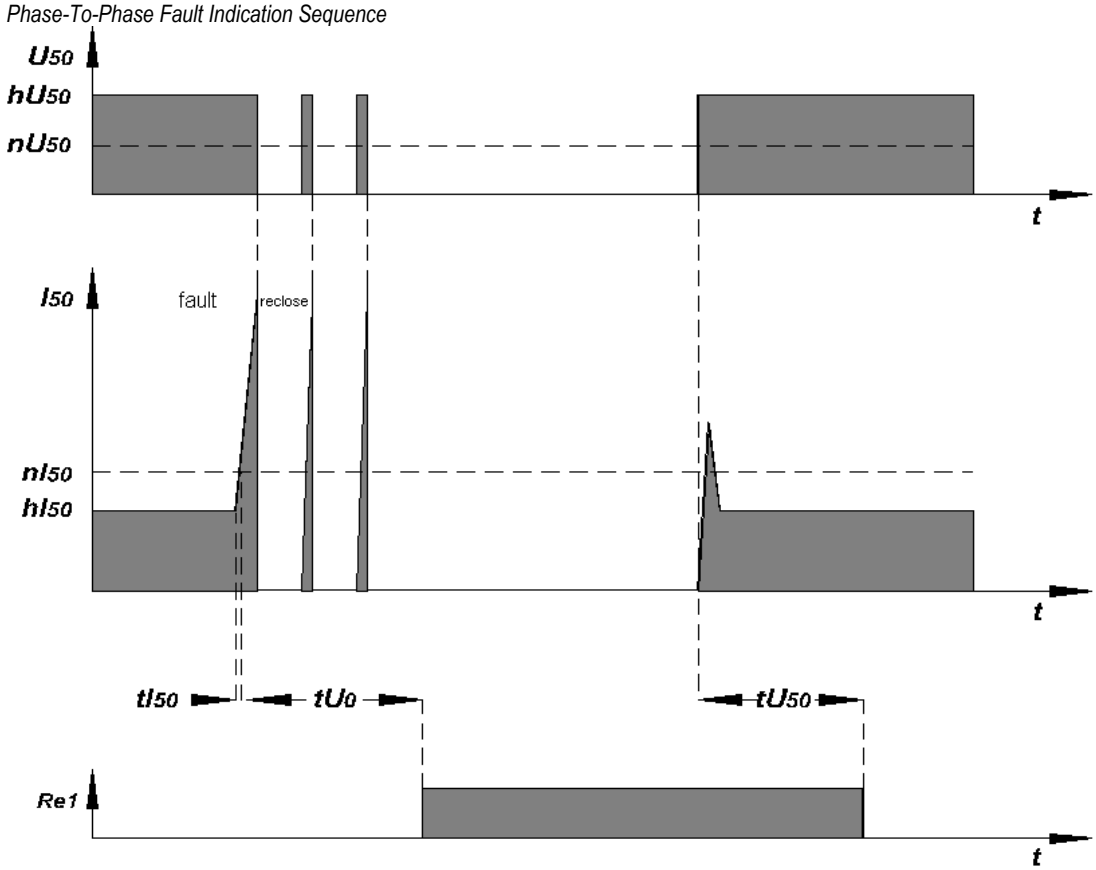
INKA 3 Fault Indicator is a microprocessor-based measuring instrument. Its parameters are preset by the manufacturer and it can be changed by agreement. Operating line values are to be set up automatically.

The information on power line faulty conditions and state of the instrument is indicated by positions of two output relays' contacts or optically or via GPRS. Other information can be received using a serial communication link to a computer.

4.1 Phase-To-Phase Fault Indication

The following diagram illustrates the method of evaluating and indicating a phase-to-phase fault.

Phase-To-Phase Fault Indication Sequence



Legend:

U50 *power line fundamental harmonic voltage (electric field)*
hU50 *standardized voltage measurement value to range between 80 to 120% of the nominal*
nU50 *voltage threshold level, preset to 20%*
I50 *power line fundamental harmonic current (magnetic field)*
hI50 *standardized current measurement value to range between 70 and 140% if sufficient current passes through the power line*
nI50 *current threshold level, preset to 100%*
tI50 *maximum time of increase to fault current, preset to 80 ms*
tU0 *minimum time with no voltage, momentary voltage occurrences on reclosing are filtered out, preset to 10 s*
tU50 *time to terminating fault indication, also time of insensitivity on power line connection to voltage, preset to 20 s*
Re1 *relay 1contact opening function*

When indicating a phase-to-phase fault, relay 1 gets open. With the optical indication option, the indicator light gets double flashing at 2.5-second intervals. A phase-to-phase fault is evaluated on **concurrent** occurrence of the following conditions in the power line:

- Absolute current increase measured is greater than the minimum absolute current increase. The default value is 50 A, which corresponds to phase-to-phase short circuit current increase.
- Relative current increase measured is greater than the minimum relative current increase. The default value is 100%.
- Current increase time is shorter than 80 ms.
- Current increase is followed by voltage fault in the power line for a time longer than the time of no-voltage condition preset to 10 seconds. Momentary reclosures are filtered out thus not affecting measurement.
- This filters out false fault signals on power grid recovery or successful reclosure.

Indication of phase-to-phase fault (relay one closed) is terminated when voltage in the power line recovers for a time longer than the insensitivity time on grid recovery, preset to 20 seconds.

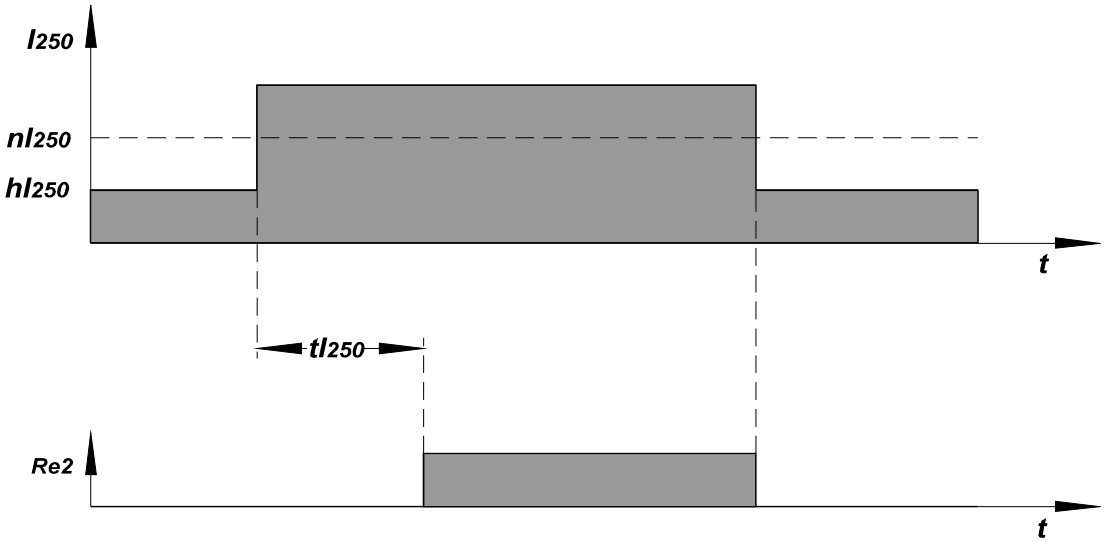
On INKA 3's power supply failure, relay 1 gets open too (concurrently with relay 2, which indicates INKA 3 error condition).

Note 1: The absolute current increase measured is an approximate value. It also depends on the distance between the instrument and the power line, the instrument's position and properties of surrounding objects (metal pole structure, section switch control circuitry power supply voltage converter transformer, and the like).
Note 2: On voltage recovery in the power line, the instrument does not respond to any changes in current, on power grid recovery, for the insensitivity time.
Note 3: All INKA 3 instruments located between the point of power supply and the spot of a phase-to-phase fault indicate a failure.

4.2 Ground Fault Indication

The following diagram illustrates the method of evaluating and indicating a ground fault.

Ground Fault Indication Sequence



Legend:

I250 *5th harmonic current through the power line (magnetic field)*
hI250 *standardized 5th harmonic current value measured*
nI250 *5th harmonic current threshold level*
tI250 *minimum time of 5th harmonic current (ground fault)*
Re2 *relay 2 contact opening function*

To indicate a ground fault, relay 2 gets open. With the optical indication option, the indicator light gets single flashing at 2.5-second intervals. Detection of ground fault is based on measuring the 5th harmonic (250 kHz) capacitive current level through the power line as it increases to several fold levels, closing the circuit through the power line's stray capacitance to the ground and from the ground through ground connection back to the power line. This current's vector angle changes at the same time. A ground fault is evaluated at **concurrent** occurrence of the following conditions:

- The standardized 5th harmonic current value measured is greater than the ground fault indication 5th harmonic current threshold level.
- This current's vector angle changes. While the 5th harmonic current vector is vertical under faultless conditions in the power line, it is horizontal under the ground fault conditions.
- The time of the 5th harmonic current through the power line is longer than the ground fault indication delay time preset to 5 seconds.

A ground fault indication is cancelled on drop of the 5th harmonic current through the power line below the threshold level or after its current's vector angle change.

On INKA 3's power supply failure, relay 2 gets open too (concurrently with relay 1, which indicates INKA 3 error condition).

Note 1: All INKA 3 instruments located between the point of power supply and the spot of a ground fault indicate a failure.

4.3 Installation Rules

4.3.1 Mechanical Installation

1. It is **required** to observe minimum distances of the instrument from other power lines and electrical equipment, which radiate electromagnetic fields, in accordance with the following table:

line voltage	to 10 kV	22 kV	35 kV	110 kV	220 kV	400 kV
distance	25 m	35 m	50 m	100 m	200 m	300 m

2. The instrument is to be attached to a pole using stainless steel bands (Bandimex) 2 to 3 meters below the power line to be monitored.
3. INKA 3 **must be always** installed facing (with its cover) the power line monitored perpendicularly.
4. It is recommended to choose an installation location as far as possible from other metal installations on the pole, **especially** from a section switch circuitry power supply voltage converter.
5. It is recommended to choose an installation location as far as possible from other electrical installations on the pole, **especially** from a section switch circuitry power supply cable from the voltage converter.
6. It is recommended to install an INKA 3-Solar on a pole without a section switch.

Note: The instrument can be installed without disrupting power supply while complying with the requirements of local standards

4.3.2 Electrical Installation

7. The section switch circuitry power supply voltage converter's secondary output **must not** be grounded within the converter. The section switch power supply must go to the distribution board using a two-wire cable. If it is required to ground the secondary winding at one of its poles, this must only be carried out at the section switch **distribution board**.
8. Power supply, signal, and communication wires go to the instrument in a metal cable duct and through a bushing into the unit where they are connected to a terminal board. The wires' recommended cross section areas are from 0.5 to 1.0 square millimeter each. If the cable duct is not metal, it is necessary to use screened cables and **ground** the cable screening by connecting to terminal X2 in INKA 3 and at the section switch distribution board.

9. The power supply **must be** protected with a glass tube fuse T 100 mA / 35. If connecting to a section switch distribution board, use of an Inka-expand module is recommended. It has a fuse specified above and it further has a D-Sub connector to connect a serial communication line to as well as a cable fastener for easier cable installation.
10. With INKA 3-Solar and INKA 3-GPRS, only a solar panel and an optional separate indicator light are connected to the unit (watch correct polarity).

4.3.3 Putting In Operation

Immediately after installation check the wiring:

11. Connect power supply +12 V . (Usually by closing the section switch circuitry main circuit breaker).
12. Connect a PC (with the original cable supplied) and run **INKA3-W** software.
13. Select **Contact Test**.
14. On selecting the contact test, the relays' outputs and optical indication contacts are tested. The test takes 8 seconds while for each 2 seconds the following sequence takes place:
    both relays open, **Error** indication
    relay 1 closes and relay 2 opens, **Ground Fault** indication
    relay 1 opens and relay 2 closes, **Phase-To-Phase Fault** indication
    both relays close, **Operation** indication
15. If the test fails, instrument's power supply, cabling, communication cable and COM port number setting have to be checked. It is necessary to use the original cable supplied with the software. A standard RS 232 cable will not work.
16. On the instrument's stabilization (in about 1 minute) select **Data from INKA to PC**. Data from the instrument are transmitted and displayed in a chart form on the PC for further use. Select **Edit** and set the identification number (can be set e.g. similar to the section switch number).
17. Select **Set INKA.** Changed data are to be transmitted to the instrument and control data reading is to be done automatically.
18. Data can be saved into PC file for further use. The file names use **identification number** and it is convenient to add a comment that the file contains data from a condition when the instrument was being put in operation.
19. On high voltage introduction to the power line and stabilization of conditions in the power grid, save data from INKA on the PC again; with closed section switch if possible. It is again suitable to add a comment to the file's name.
20. Thus created xxx.dat files can be archived. Steps 16 through 19 are not mandatory.
21. At INKA 3-solar optical signalization is check visually only.
22. At INKA 3-GPRS data transmission has to be checked (the best with the help of www….site). **Attention**, there has to be sufficient signal of relevant mobile provider (according to the SIM card) in the local area. SIM card has to be released for GPRS and PIN **cannot** be activated. **SIM card is not supplied.**

5. Technical Parameters

Line measured

number of conductors	3
voltage	6 ÷ 100 kV
current	no limit

Binary outputs — failure indication

number	2, galvanically isolated
load	60 V / 200 mA

Serial link

interface	RS 232
rate of transmission	9,600 Baud
maximum distance	12 m

Optical indication - option

Indication	phase-to-phase fault current	double fleshing at 2.5 s
	ground connection	single fleshing at 2.5 s

Power supply

direct current voltage	(supplied from section switch)	10 to 16 V / 10 mA
accumulator	(no external supply)	6 V / 7.5 Ah
solar cell		7.7 V / 340 mA

Physical parameters

enclosure		IP 65
dimensions (W x H x D)	- INKA 3 without/with antenna - INKA 3-solar - INKA 3-GPRS - optical indication - solar panel	125 x 125/195 x 85 mm 175 x 175 x 85 mm 175 x 175 x 85 mm 125 x 75 x 85 mm 127 x 242 x 140 mm
mass	- INKA 3 - INKA 3-solar - INKA 3-GPRS - optical indication - solar panel	0,5 kg 2 kg 2 kg 0,5 kg 1 kg
material		polycarbonate
operating environment		D1 class as in IEC 654-1
temperature	- operating - storage	-25° to +70° C -40° to +85° C
relative humidity		0 to 100 %
service life	- accumulator - others	min. 5 years, typ. 10 years min. 20 years

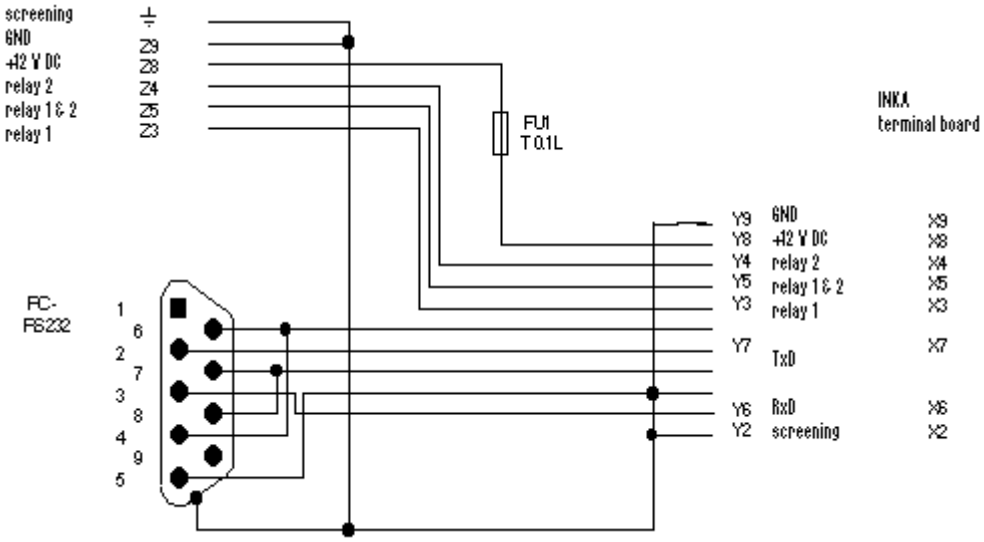
6. Appendices

6.1 Inka-expand

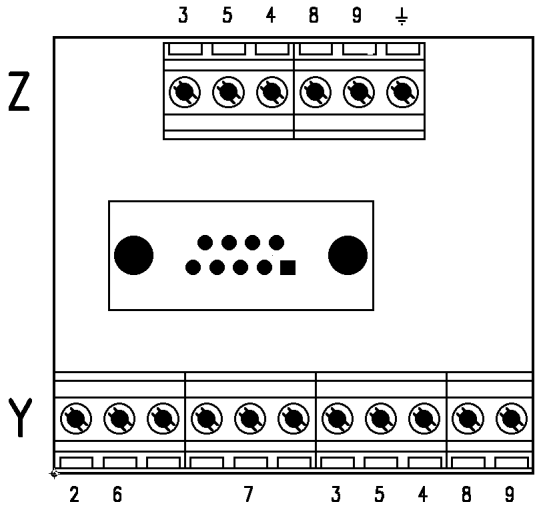
This module is designed for installation in a section switch distribution board cubicle on a DIN strip. Its outer width is 56 millimeters and height 50 millimeters.

The module comprises a terminal board to connect a 7-wire screened cable from an INKA 3 to, a terminal board for connection to a section switch control circuitry, a glass tube fuse T100 mA / 35 to protect INKA 3 power supply voltage, and a 9-pin D-Sub connector for a communication cable to a PC or PSION Workabout handheld computer.

Inka-expand Wiring Diagram:



Terminal Board Pinouts:



7. Maintenance, Service

The INKA 3 instruments do not require any maintenance in their operation. For reliable operation it is only necessary to meet operating conditions specified and not expose the instrument to violent handling and activity of water or chemicals which could cause mechanical damage.

The instrument has mains fuse to disconnect it on incorrect power supply voltage connection or on a breakdown. The fuse is not accessible for a user, the instrument needs to be sent to the dealer that will arrange its replacement.

If the product has a breakdown, you need to complain to the supplier at their address:

Supplier: Manufacturer : KMB systems, s.r.o.
Dr. M. Horákové 559
460 06 LIBEREC 7
Czech Republic
telephone: +420 485 130 314
fax: +420 482 736 896
e–mail : kmb@kmb.cz
website : www.kmb.cz

The product must be in proper package to prevent damage in transit. Description of the problem or its symptoms must be delivered together with the product.

If a warranty repair is claimed, the warranty certificate must be sent in. In case of an out–of–warranty repair you must enclose an order for the repair.

Warranty Certificate

Warranty period of 24 months from the date of purchase is provided for the instrument. Problems in the warranty period, provably because of faulty workmanship, design or inconvenient material, will be repaired free of charge by the manufacturer or an authorized servicing organization.

The warranty ceases even within the warranty period if the user makes unauthorized modifications or changes to the instrument, connects it to out-of-range quantities, if the instrument got damaged in out-of-specs falls or by improper handling or if it has been operated in contradiction with the technical specifications presented.

type of product: **INKA 3**……..... serial number .....

date of dispatch: ..... final quality inspection: .....

manufacturer's seal:

date of purchase: ..... supplier's seal: