Vdip2

Fault localization in MV grids using measurements on the LV side in distribution transformer stations (DTS)

ELVAC

The localization of earth faults in resonant earthed MV networks – one of the problems waiting for accurate and efficient solution. Currently used solutions are based on fault passage indicator functionality integrated in remotely controlled sectionalizer/reclosers or handheld/portable fault passage indicators evaluating electromagnetic field of the overhead line in front of and behind a fault – both available in ELVAC portfolio. However, multiple switching of the feeder to the earth fault during the localization process might be still necessary.

We are introducing an alternative method called "Vdip2" (Vdip 2nd generation), which utilizes distributed measurement units (DMUs) installed on the secondary sides of MV/LV distribution transformers. Based on the data collected from these units, the system can then calculate the most probable fault location, mark it on a map (GIS), or pass the information to other systems (DMS). In addition to locating earthfaults, which is the main benefit, the system also determines the position and type of short circuits.

System Vdip2 Description

The Vdip2 system was designed for the automatic localization of earth faults in compensated (resonant earthed) systems, which are difficult to localize due to low level of earth fault currents. With regard to its functional principle, the Vdip2 system can also be used for short-circuit faults localization. The concept of the Vdip2 system is simply described using an illustration of compensated distribution network depicted in Fig. 1. The Vdip2 monitoring system itself is composed of feeder protection units (FP) and distributed measurement units (DMU), which are located on the secondary sides of MV/LV transformers. In the event of a fault, the feeder protection is triggered, generating a fault record, which is immediately transmitted to the concentrator (PC or RTU) located at the primary HV/MV substation, and subsequently to the central unit of the Vdip2 system. Fault indication from the feeder protection initiates also downloading of the fault records from the individual DMUs located at transformer stations connected to the faulty feeder.

Any voltage monitor, which enables to store oscillograms of phase voltages in a circular buffer and to send a fault record for the requested time of fault occurrence, can be incorporated into the Vdip2 system, but ELVAC company provides suitable and cost efficient devices (RTU and low voltage monitors) to provide complete solution, so the choice depends on the customer and his starting point (existing equipment in the grid).The fault records from the DMUs and FP are then synchronized and processed in the central unit to obtain the negative sequence changes of voltage $\Delta Um(2)$ and current $\Delta Im(2)$, which are the input to the Vdip2 localization algorithm. Calculated values are then internally evaluated and aggregated to enhance the reliability and accuracy of the presented result.

The localization algorithm of the Vdip2 system is based on the patented method, where the negative sequence current monitor (NSCM) represents a given feeder protection and the negative sequence voltage monitors (NSVM) represent individual DMUs.
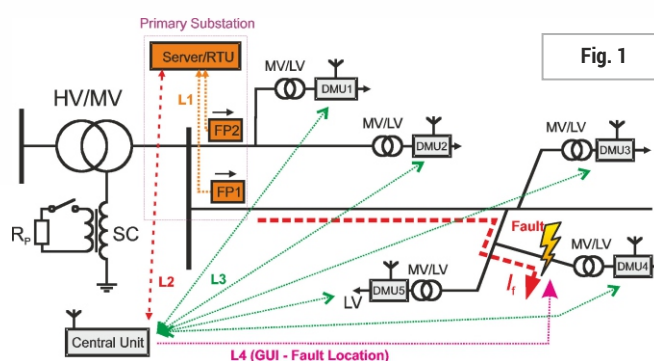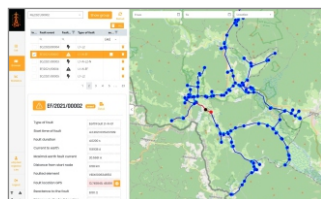

Fig. 1

The results of the localization algorithm are coordinates of the expected fault location, which are displayed to the dispatchers via the user interface (part of the SW solution, but integration into existing SCADA or OMS is also possible). The advantage of the Vdip2 system is possibility of multiple fault localization based on one set of fault records. Based on the deviation of fault locations obtained from one set of fault records, the plausibility of the identified fault location can then be assessed.

System Components and Licensing

It is possible to purchase DMU set based on RTU7M unit produced by ELVAC company, where low voltage monitor (power quality analyzer) and communication module (using LTE modem or other standard) are integrated. If suitable voltage monitoring devices are already installed in the grid, then it is possible to use just RTU7MC3 communication device from ELVAC, which manages connection and data transfer to Vdip2 system server. It is also possible to implement all required functionality into a third party devices.

Vdip2 system licensing is based on core license, feeder licenses and DMU device licenses, which are "vendor independent" and managed by Vdip2 system server.

The Vdip2 software provides web based user interface for regular users, administrative tool (MS Windows app) for system configuration and maintenance, and also integration API for interconnection with other SW systems used by the grid operator.

https://www.rtu.cz/en/solutions/vdip2-en/

https://www.rtu.cz/en/solutions/fra-en/

ELVAC RTU7M

One Modular Platform for Wide Range of Solutions in Power Distribution Monitoring and Control - www.rtu.cz

Applications

- Intelligent Electronic Device (IED) / Remote Terminal Unit (RTU) for remote monitoring and control of:
    - primary substations,
    - secondary substations,
    - switching stations,
    - ring main units,
    - load break switches,
    - sectionalizers,
    - reclosers,
    - renewable energy sources (wind, solar, water, combined etc.),
    - objects for electromobility (chargers, small vehicles municipal infrastructure, etc.),
    - intelligent buildings.
- Central or backup communication unit, communication protocol converter, router and data concentrator in power distribution objects.
- Aerial or cable lines − feeder or node monitoring, control, measurement, fault passage indication, protection relay.

Communication Cards

- Optional HW interfaces according to card version:
    - GSM/LTE modem,
    - Ethernet LAN,
    - RS-232/422/485,
    - Optical (via SFP modules).
- Supported communication protocols: IEC 61850, IEC 60870-5-101, IEC 60870-5-103, IEC 60870-5-104, DNP3, HIOCom2, MODBUS TCP/RTU, DLMS, OPC UA, SNMP.
- Multi-channel communication is supported (ex. for communication backup).
- Secure communication according to IEC 62351-3 (TLS).
- OpenVPN and IPSEC tunneling.
- Built-in RTC.
- Integrated web configuration interface and HMI support.
- Programmability via standards IEC 61131-3 or proprietary graphical interface.
- NAT, Firewall functionality, user access control, RADIUS, Syslog, NTP, SSH, SCEP, SQL data storage support.

Power Supply Cards

- Optional input voltage:
    - 10 − 60 V DC,
    - 80 − 275 V DC,
    - 80 − 260 V AC.
- Power supply redundancy is possible on "R" version of 8, 10 and 16-slot backplanes.
- Power supply cards are not used in 2 and 3-slot chassis, where PS 10 − 30 V DC is integrated on backplane.

Optional Battery Backup Cards

- Battery can be charged and monitored directly via RTU system for easy and on time maintenance.
- Integrated in AC cards (for 12 V or 24 V batteries).
- Additional card for DC powering (for 24 or 48 V DC).
- Connectors for lead acid battery, thermal sensor, ON REL - Life contact.

SW Support for RTU7M

RTU7M system setup and parameterization is possible via:
- RTU User Center − free SW for MS Windows.
- Integrated web configuration interface and HMI support.

RTU Chassis with Backplanes

- Optional size:
    - DIN rail mounting (vertical or horizontal) − 2, 3 slots,
    - panel mounting − 2, 3, 5, 8, 10, 16 slots,
    - 19" rack mounting − 16 slots.
- Integrated power supply 10 − 30 V DC in 2 and 3-slot version.
- 8, 10 and 16-slot chassis are available in version for power supply redundancy.

Unpluggable Keyed Connectors for Easy Maintenance

General Information

- Each card in RTU7M has its own processor. Therefore, the system performance is not limited by single CPU power.
- Except the power supply card, all other cards can be used in any slot position in numbers limited only by chassis size.
- Large systems with many I/Os are built from multiple units, one main unit and other slaves, the whole system then looks like one RTU from the perspective of the SCADA system.
- Systems are certified for electronic safety, EMC, EMI and environmental standards usual for power industry systems.
- Available variants of individual cards, datasheets and catalog are at www.rtu.cz, where you can find in Download section the application guides with information about typical use of ELVAC RTU systems.

Digital Input Cards

- Variants:
    - 20 x optically isolated digital inputs on standard cards,
    - 10 x optically isolated digital inputs on combined card with 5 x DO.
- Available for dry or wet contacts (different voltage levels).
- Signal filtering (contact bounce, AC signal).

Digital Output Cards

- Variants:
    - 10 x relay outputs (load up to 8A),
    - 5 x relay outputs (load up to 8A) on combined card with 10 x DI,
    - 20 x optical relay outputs (load up to 800 mA).
- Dual HW and SW control of output − protection against an accidental switching.

Analog Input and Output Cards

- Variants for:
    - 3-phase voltage and currents measurement,
    - power quality and energy measurement,
    - special fast measurement (up to 40 MS / s),
    - industrial standard I/Os − 20 mA or 10 V,
    - temperature sensors − PT100, PT1000, Ni120, thermocouple K.
- Features of 3-phase measurement cards:
    - measurement and calculation of V (phase, L-L), I, P, Q, S, f, cos φ, THD,
    - calculated V_0 and I_0 (optionally measured directly via 4th input),
    - fault locator,
    - input variants for standard VTs, CTs, low power sensors, Rogowski coils or direct measurement,
    - inputs can be overloaded and still measured, which is useful in protection relay application − see inputs specification in catalog,
    - integration and difference filtering,
    - waveform recording − proprietary or COMTRADE format,
    - fault passage indication and protection relay (ANSI 27/59, 46BC, 47, 50, 50N, 51, 51N, 59, 59N, 67, 67N, 81).
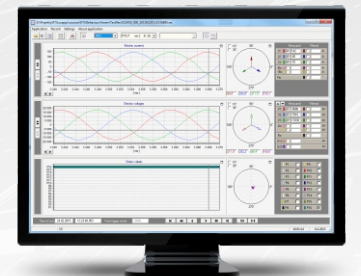
EMU7 – Monitoring, Control and Protection of Medium Voltage Feeders

- 3 x voltage measurement input, variants for low power sensors or voltage detectors (CAPDIS, WEGA),
- 3 x current measurement input (var. 4th input for I_0) for low power sensors (IEC 61869),
- 2 x Ethernet LAN (two networks), 10 × DI, 4 × DO (relay), HMI – display and 5 buttons,
- OpenVPN and IPSEC tunneling, secure communication according to IEC 62351-3 (TLS),
- programmability according to IEC 61131-3 or via proprietary free graphic interface,
- supported communication protocols: IEC 61850, DNP3, IEC 60870-5-101, IEC 60870-5-103, IEC 60870-5-104, MODBUS, HIOCom2, DLMS, OPC UA, SNMP,
- fault indication according to ANSI 27, 46, 47, 50, 50N, 51, 51N, 59, 59N, 67, 67N, 81H, 81L, 81R, COMTRADE recording.

RTU7MC3 – Main Communication Unit for Substations and Other Power Distribution Objects

- Router, data concentrator, communication protocol converter,
- LTE modem, 2 x RS-232/485, 2 x Ethernet LAN (2 independent networks), console,
- OpenVPN and IPSEC tunneling, secure communication according to IEC 62351-3 (TLS),
- programmability according to IEC 61131-3 or via proprietary free graphic interface,
- 1 x DI, RTC and many other features, see the product catalogue …
- supported communication protocols: IEC 61850, DNP3, IEC 60870-5-101, IEC 60870-5-103, IEC 60870-5-104, MODBUS, HIOCom2, DLMS, OPC UA, SNMP.

HMI Panels for RTU7M

- Direct support of graphical HMI in RTU7M Firmware,
- HW variants:
    - panel PC with OS Android with side panel for safe control,
    - graphic panel with buttons and LED indicators,
    - additional control panel for 4 feeders.

EPG7 – 3-phase Voltage and Current Generator for RTU and Protection Relay Tests

- 3 x 10 V and 3 x 60 mA, expandable to 3 x 300 V AC and 20 A via case extension,
- 4 x DI, 4 x DO,
- USB communication with PC,
- P, Q generation,
- fault records playback,
- independent amplitude, frequency, phase setup for individual outputs,
- it can simulate signals from low power V and I sensors for device input tests,
- process calibrator.

ELF7 – Portable Earth Fault Locator in MV Networks

- In-field tool for service teams, significantly shortens the earth fault searching time,
- determines relative position of earth fault,
- compatible with resistance earthed networks and compensated (resonant earthed) networks with active element connecting.

EFA7 – Electric Field Detector

- Signaling of a dangerous approach to a place where medium or high voltage occurs, an additional level of protection to prevent electric shock,
- light, sound and vibration signaling,
- housing with IP67 protection, wrist attachment,
- wireless battery charging,
- Bluetooth communication with Android SW application.