USING MODULAR PLCS IN POWER NETWORKS MANAGEMENT

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Abstract. We make one exemple of using the modular PLCs connected at one 20 kV feeder bay. This programme makes the protection of the feeder at short-circuit. The distance between the defect and feeder bay determinate if the protection is fast or delay time.
Keywords: *PLCs, feeder bay, power networks management.*

Introductions

The distribution system shown below illustrates many of the features of a distribution system making it unique. The voltage level of a distribution system can be anywhere from about 6 kV to as high as 20 kV with the most common voltages in the 20 kV class. Areas served by a given voltage are proportional to the voltage itself indicating that, for the same load density, a 20 kV system can serve considerably longer lines. Lines can be as short as a mile or two and as long as 20 or 30 km. Typically, however, lines are generally 10 miles or less. Short circuit levels at the substation are dependent on voltage level and substation size. The average short circuit level at a distribution substation has been shown, by survey, to be about 10.000 amperes. Feeder load current levels can be as high as 600 amperes but rarely exceed about 400 amperes with many never exceeding a couple of hundred amperes. Underground laterals are generally designed for 200 amperes of loading but rarely approach even half that value. A typical lateral load current is probably 50 amperes or less even during cold load pickup conditions.

There are two types of faults, low impedance and high impedance. A high impedance fault is considered to be a fault that has a high Z due to the contact of the conductor to the earth, i.e., Zf is high. By this definition, a bolted fault at the end of a feeder is still classified as a low impedance fault.

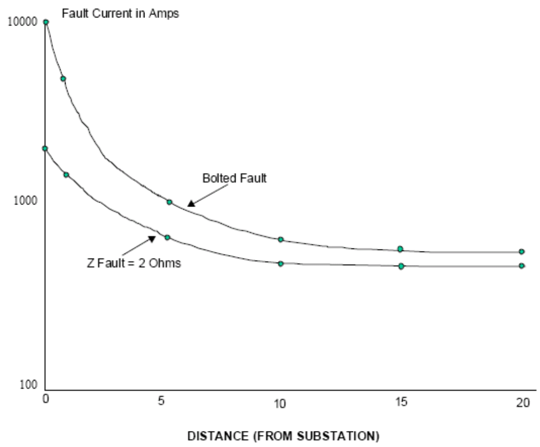

Fig.1 – Low impendance faults

Low impedance faults or bolted faults can be either very high in current magnitude (10,000 amperes or above) or fairly low, e.g., 300 amperes at the end of a long feeder. Faults able to be detected by normal protective devices are all low impedance faults. These faults are such that the calculated value of fault current assuming a "bolted fault. and the actual are very similar. Most detectable faults, per study data, do indeed show that fault impedance is close to 0 ohms. This implies that the phase conductor either contacts the neutral wire or that the arc to the neutral conductor has a very low impedance. Figure 1, shown below, indicates that 2 ohms of fault impedance influences the level of fault current depending on location of the fault. As can be seen, 2 ohms of fault impedance considerably decreases the level of fault current for close in faults but has little effect for faults some distance away. What can be concluded is that fault impedance does not significantly affect faulted circuit indicator performance since low level faults are not greatly altered. High impedance faults are faults that are low in value, i.e., generally less than 100 amperes due to the impedance between the phase conductor and the surface on which the conductor falls.

PLC – XC101

The XC100 and XC200 modular PLC, by Moeller, between them cover a wide range of applications, from simple simple applications with a small number of digital inputs and outputs to complex application with direct Enthernet and WEB connection. The range is well equipped with virtually all you may need, from memory card to integrated fieldbus. It forms a good basis for meeting constantly increasing requirements.

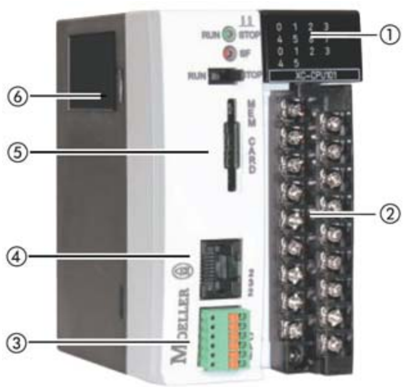

Figure 2 – Layout of CPU XC100

Figure 2 present the layout of CPU XC100 where:

1. LED indicators for terminals, as well as RUN/STOP and SF (system fault)
2. Terminations
3. CANopen Combicon interface
4. Programming interface RS 232
5. Slot for memory card
6. Battery compartment

Features

- High-performance compact controller (0.5 ms/ 1000 instructions)
- Jointly-used XSoft software for programming, visualization, configuration and test/commissioning; comprehensive data management provides data consistency and cost-optimized engineering
- Integrated CANopen interface
- Integrated RS232 interface with adjustable baud rate (4.8 to 115 kbaud)
- Integrated central I/O
  - 8 digital inputs (of which: 4 interrupt inputs)
  - 6 digital outputs
  - electrically isolated
  - Cable connection via clamp terminal block
- LEDs for RUN/STOP and collective error
- Local operating mode switch RUN-STOP
- Central expandable I/O: up to 15 XI/OC modules (free selection)
- Slot for memory card
- On the memory card:
  - saving option for the operating system
  - of the default program (on starting, this overwrites the non-volatile program stored in the SRAM main memory),
  - of the sources (source code, libraries, bitmaps, GSD-files etc.),
- Internal Flash memory for operating system (system booting) and operating system data (not usable for program backups)
- SRAM main memory (static RAM): 128 kB each for program and data (including remanent data)
- Battery-buffering of the real-time clock and the SRAM main memory
- Watch-dog
- Mounting on top-hat rails (DIN-rails) and connection of up to 15 central XI/OC series I/O modules via module carriers (backplanes)

Experimental results

In this paper we present two examples of using modular PLCs in power network management.

This exemple make the automatic reclosing of the 20 kV circuit-breaker for “fast” operation and “time-delay” operation. The modular PLC used is XC101 with 128kB, from Moeller. The PLC is mounted in PC case with relays (for digital outputs), optocouplers (for digital inputs) and power supply, illustrated in Fig.3.

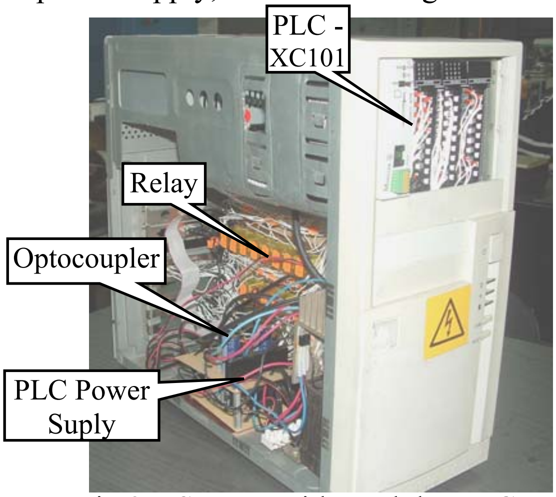

Fig.3 – System with modular PLC

The system with modular PLC is connected with the feeder fault simulation and automatic reclosing signalling equipment, presented in figure 4.

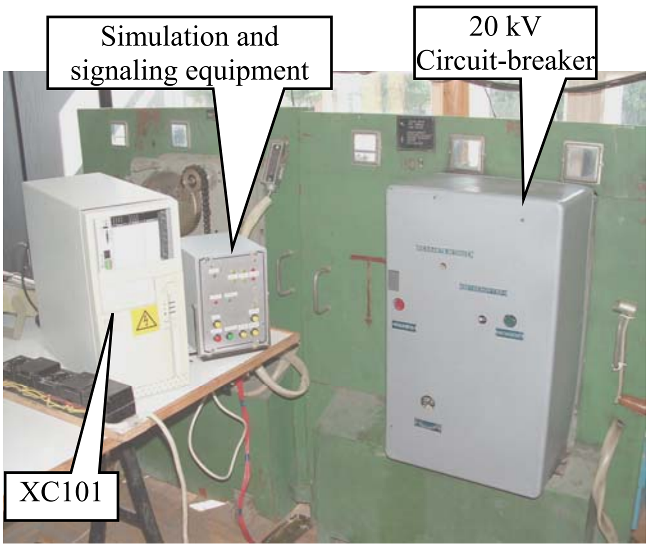

Figure 4 – Experimental arrangement with circuit-breaker

For programming PLC is used XSoft software. With this software is possible visualization some signals (max 8 variable). In figure 6 is presented timing diagram for ”time-delay” and “fast” operations. The visualized variables in figure 6 are:

Var1 – signal to opens circuit-breaker coil;
Var2 – signal to closing circuit-breaker coil;
Var3 – contacts of circuit-breaker;
Var4 – fault signal for “Fast” Opperations;
Var5 - fault signal for “Time Delay” Opperations.

The software designed for modular PLC make automat reclosing with "time-delay” and “fast” operations.

In the first case Var5 have pulse width 15s. The PLC wait 2s and then command the opening for circuit-breaker contacts. The first reclosing for circuit-breaker contacts is make after 3s, and the second reclosing is make after 9s. If the fault persists, the contact is closed 0,5s. The different function of PLC between „time-delay” and „fast” operations consists in different time for waiting at fault appearing (2s in the first case and 0,1s in the second).

Conclusions

Using modular PLCs in power network management offers more advantages such as: flexibility, higher reliability, lower dimension, high-performance compact controller (0.5 ms/ 1000 instructions) and easy upgrading.

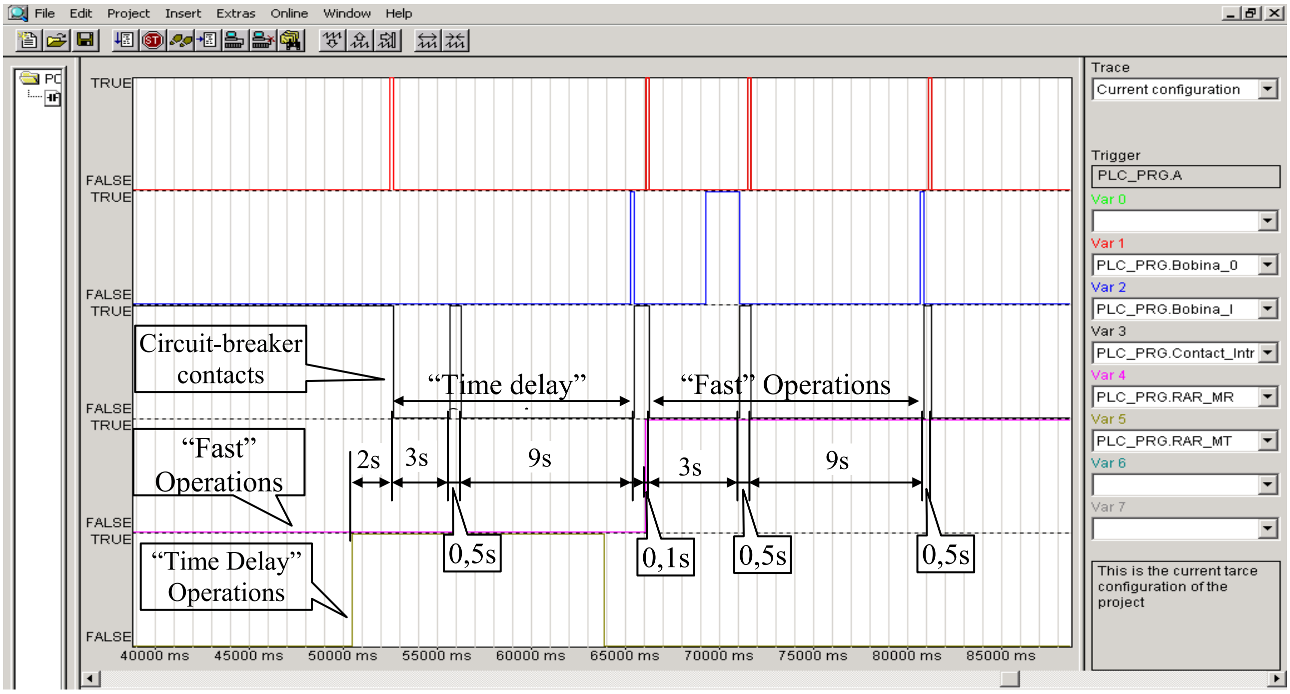

Fig.5 – Timing diagram

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