Possibilities for Remote Reading of Electric Power System Parameters

Peter I. Yakimov[1], Stefan J. Ovcharov[2], Nikolay T. Tuliev[3] and Angel T. Stanchev[4]

Abstract – **The paper presents the investigation of some possibilities for remote reading of electric power system parameters. The purpose is to transmit data for the values of the measured parameters from different points of the electric power system to a central point. There are described possibilities using radio communication, industrial network and Ethernet communication.**

The presented results will be used in further investigation of more complex systems for electric power management.

Keywords – **Measuring transducer, Communications, Interface, Industrial networks, Ethernet**

I. INTRODUCTION

The electric power system might be divided to the following parts – manufacturing, distribution and consumption. The stability and correct function of the entire system depends on the right operation and interconnection between all components of the system – power plants, power lines, sub-stations, transformers, circuit breakers, loads and etc. The correct control of the system requests a large amount of information for the parameters in different points. There are in use transducers (fig. 1), which measure the values of the main parameters of the three phase electric power system – voltage, current, frequency, active power, reactive power, power factor, active energy and reactive energy [1].

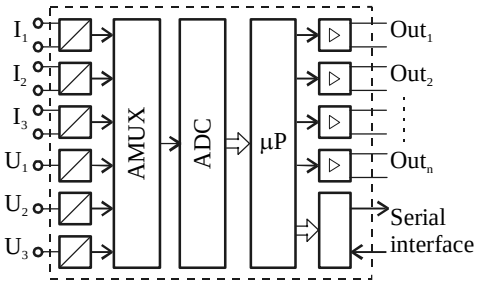

Fig. 1. Block diagram of an universal transducer

Most of the transducers have two types of interface: analog and digital. The output quantities of the analog outputs can be load independent direct current or direct voltage signals. The range of the current outputs may be different - -5mA÷+5mA, 0mA÷20mA or 4mA÷20mA. Usually the range of the voltage outputs is 0÷10V.

The digital interface is usually serial in order to minimize the number of the wires. The standard is mainly RS485, RS232 or LON. There are custom defined interfaces also.

II. DATA TRANSMISSION USING THE DIFFERENT INTERFACES

The transducers may have several analog outputs and they have to be electrically insulated (fig. 1). In some transducers every output is driven by previously determined input variable but in another one there is a possibility for programming which measured variable will control a given output. There must be a response between the ranges of the input variable and the output quantity. The resolution in output signal generating must not be less than in measuring in order for true transmission of the input value. The receiver must have the same resolution. So, the receiver's parameters limit the accuracy. Another disadvantage of the analog interface are the lack of correspondence between the number of the outputs and the number of the measured and calculated by the transducer variables, and the number of connecting wires.

The digital interface uses only two or three wires but presents the possibility to transmit the values of all parameters of the electric power system and contrary to the analog interface the transfer can be bidirectional. This allows a smart transducer to be programmed and checked by external computer. The disadvantage of analog signal synthesis with high resolution does not exist because the transferred data is digital. This transfer has higher noise immunity than the analog. The digital interface is suitable for transmitting the values of the energy. It is very difficult to read the values of the energy using analog output because of the continuous integration of the power, which leads to permanent increasing of the output quantity and fast reaching the upper limit of the output range. The high rate of data transfer enables transmission of large amount of information. The data transmitted by the transducer includes the values of phase voltages (U_1, U_2, U_3), phase currents (I_1, I_2, I_3), active power (P), reactive power (Q), frequency (f), active and reactive energy in four quadrants (ENAPL, ENAMI, ENRPL, ENRMI), phase angles (φU_1, φU_2, φU_3, φI_1, φI_2, φI_3), ratios of the voltage and current measuring transformers (K_U, K_I).

[1]Peter I. Yakimov is with the Faculty of Electronic Engineering and Technologies, Dept. of Electronics, Technical University - Sofia, 1000 Sofia, Bulgaria, E-mail: pij@tu-sofia.bg

[2]Stefan J. Ovcharov is with the Faculty of Electronic Engineering and Technologies, Dept. of Electronics, Technical University - Sofia, 1000 Sofia, Bulgaria, E-mail: sjo@tu-sofia.bg

[3]Nikolay T. Tuliev is with the Faculty of Electronic Engineering and Technologies, Dept. of Electronics, Technical University - Sofia, 1000 Sofia, Bulgaria, E-mail: ntt@tu-sofia.bg

[4]Angel T. Stanchev is with the Faculty of Electronic Engineering and Technologies, Dept. of Electronics, Technical University - Sofia, 1000 Sofia, Bulgaria, E-mail: astanchev@tu-sofia.bg

The quantities and the number of bytes for each of them are presented in Table I.

TABLE I

TRANSMIT DATA DESCRIPTION

Quantity	Number of bytes
Phase voltage - U_1	2
Phase voltage – U_2	2
Phase voltage – U_3	2
Phase current - I_1	2
Phase current – I_2	2
Phase current – I_3	2
Active power - P	2
Reactive power - Q	2
Frequency - f	2
Positive active energy - ENAPL	4
Negative active energy - ENAMI	4
Positive reactive energy - ENRPL	4
Negative reactive energy - ENRMI	4
Phase angle - φU_1	2
Phase angle - φU_2	2
Phase angle - φU_3	2
Phase angle - φI_1	2
Phase angle - φI_2	2
Phase angle - φI_3	2
Voltage transformer ratio - K_U	2
Current transformer ratio – K_I	2

At a given point of the electric power system – power plant, sub-station, there are usually a big number of transducers. It is useful to be included in a computer network. The digital interface makes it possible.

The network can be developed using the well known configurations – star, ring, bus etc. In order to minimize the connections bus topology is suitable.

III. APPLICATIONS OF REMOTE READING OF ELECTRIC POWER SYSTEM PARAMETERS

In the Development Laboratory for Semiconductor Circuit Engineering (http://www.tu-sofia.bg/r&ds/PS/home.htm) at Technical University of Sofia have been designed universal transducers for use in the electric power system. They have two-wire instrumental serial interface, which enables development of industrial network (fig. 2) [2]. It is configured using bus topology. In order to connect a standard unit – PC or operator's station to the developed network there must be an adapter to translate the logic levels of the industrial interface in accordance with a standard interface, for example RS232.

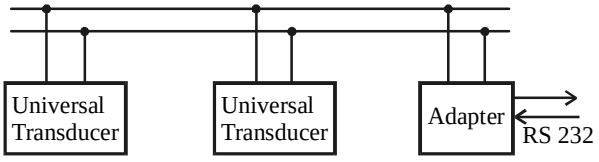

Fig. 2. Universal transducers in an industrial network

The two-wire instrumental serial interface operates reliably when the length is up to 100 m.

When the distance to the central point is longer there is a need to use another approach of communication.

The data might be transferred using telephone line. This requests telephone modems. The telephone modem allows connecting the industrial network to LAN. Disadvantage is the low rate of data transfer limited by the telephone line. Better results will be obtained using ISDN line.

A possible solution is the radio communication [3]. In this case the adapter must have radio modem (fig. 3).

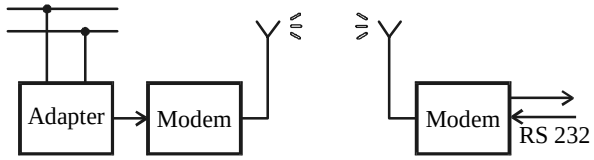

Fig. 3. Radio communication data transfer

This approach is suitable when the network of transducers is developed in area, which is not connected to the telephone network. The solution is useful when the data is collected using mobile hand-held devices. Disadvantage is the need of independent radio frequency. Better results will be obtained using GSM, but the area must be covered by GSM operator.

If the region is covered by local area network possible approach is to connect the industrial network using Ethernet module [4]. The adapter must conform the two-wire instrumental serial interface to Ethernet controller (fig. 4).

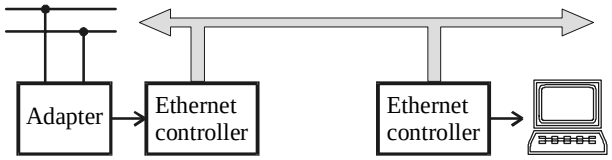

Fig. 4. Data transfer through Ethernet

This approach ensures data transfer rate up to 10Mbits/s.

IV. CONCLUSIONS

The efficient electric power management requires transfer of large amounts of information for the parameters of the system. This forces introduction of new approaches for distance communication. A perspective solution is development of industrial networks connected via Ethernet.

REFERENCES

[1] www.gmc – instruments. com

[2] Ovcharov St., P. Yakimov, Instrumental interface for industrial network development, "Electrotechnics and electronics", Sofia, Bulgaria, in press (in Bulgarian)

[3] Ovcharov St., P. Yakimov, C. Lukarsky, N. Nikolov, K. Gornishky, A. Dimitrov, System for distance reading of electricity meters, Proceedings of 10th Scientific Symposium "Metrology'2000", September 14-17, 2000, Sozopol, Bulgaria, pp. 104-107 (in Bulgarian)

[4] Ovcharov St., N. Tuliev, A. Stanchev, Adapter module for Ethernet Network Communication over TCP/IP, Proceedings of the 13th International Scientific and Applied Science Conference "Electronics ET'2004", September 22-24, 2003, Sozopol, Bulgaria, book 2, pp. 60-65