INTERACTIVE AUTOMATION SYSTEM FOR DATA ACQUISITION FOR DRIVING TECHNOLOGICAL PROCESSES TYPE SAIAD

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Abstract : *Paper presents studies and research for building a interactive automation system with data acquisition in industrial processes based on programmable logic controllers (PLC), in decentralized distributed structure. There are presented and analyzed several system structures dedicated for processes having the possibility to interface a smart display terminal for reading and writing process data. There are also presented models of systems in hierarchical structure with PC supervising, graphic interface of the process and database generation and management.*

Present world's trend is full automatic driving of complex technological processes by means of programmable logic controllers (PLC) based automation systems in decentralised and distributed structures in the framework of processes interconnected to superior hierarchical structures of "pyramidal" type. This kind of structures allows system interconnection for central driving of processes from factories, plants or industrial platforms. For improving performances and quality of the products which result from the process, as well as for obtaining some superior technical and economical performances there arise the need for process modelling and optimisation, adaptive driving of processes using optimised mathematical models. Complex automation installations were produced world-wide for adaptive driving of processes. This installations also take over the decision role from the human factor, the latter having only the job to supervise the installation.

Automatic driving of processes impose having information from the driven process regarding time trends and evolution of parameters, their instant value, system output in case of multiple adjustments for determining the mathematical model which is best suited for the process.

These needs lead to producing, developing and expanding process transducers and sensors.

Industrial manufacturers of process transducers pushed their production to fulfill some technical needs imposed by automation systems and produced output transducers in unified signal current/voltage or created output converters in unified signal that can be easily adapted to various transducers for processing data in automation systems and to make obsolete specialized modules for each type of transducer.

The importance of these transducers is primordial in the framework of adjustment processes, transducer's sensibility having a major part in the result of the adjustment.

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Automation system designed and produced takes into account the possibility of monitoring technological processes in the framework of industrial processes as well as adjusting these processes.

Monitored parameters:

1. class A : pressure - forces - weights - masses - torques - flows;
2. class B : lengths (displacements) - speeds – rotative speeds - angles;
3. class C : currents - voltages;
4. class D : temperatures - humidities - densities - concentrations;
5. class E : special parameters.

Transducers for measuring these parameters have an output on current or voltage either by their design or by adapting a current/voltage signal converter.

The system is based on a programmable logic controller in decentralized distributed structure and is capable to monitor, as single system, up to 224 analogue signals received from process transducers. It can also receive binary information from incremental or proximity sensors the only restriction being the frequency of the input signal to be less than 10 or 50 kHz, depending on the type of PLC used.

PLC's physical interface consists in binary inputs/outputs as well as in analogue outputs and using this interface the program designed and written in PLC's memory can control an entire process.

ABB's decentralized structure – also called CS31 BUS – consists in one master, which can be the central unit or the display terminal for entering and printing data, and up to 31 slave modules.

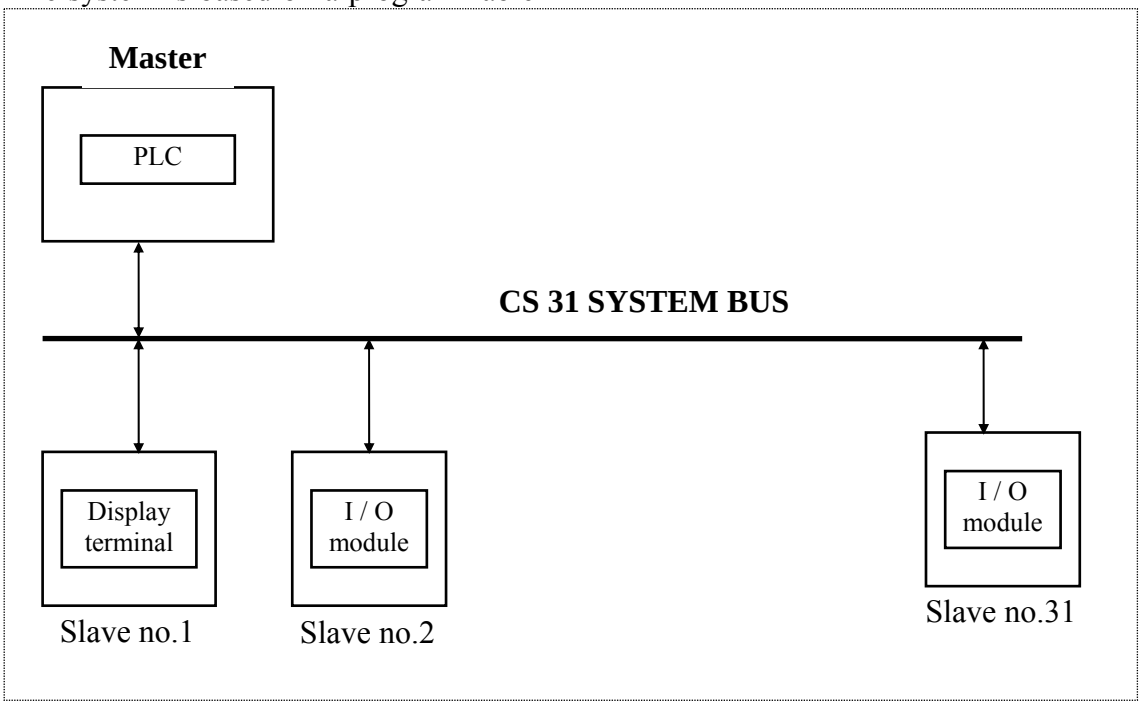

Fig. 1.

SAIAD system was designed especially to work independently or connected to a PC. The computer can be master or slave depending on user's will.

GENERAL STRUCTURE OF A SAIAD SYSTEM

The system has the following decentralized structure:

– Central unit;

- Binary input/output units;
- Analog input/output units;
- Display terminal with communication for reading/writing parameters and process limits;
- Stabilized power supply for transducers;
- Power supply for PLC;
- PC + UPS;
- Printer.

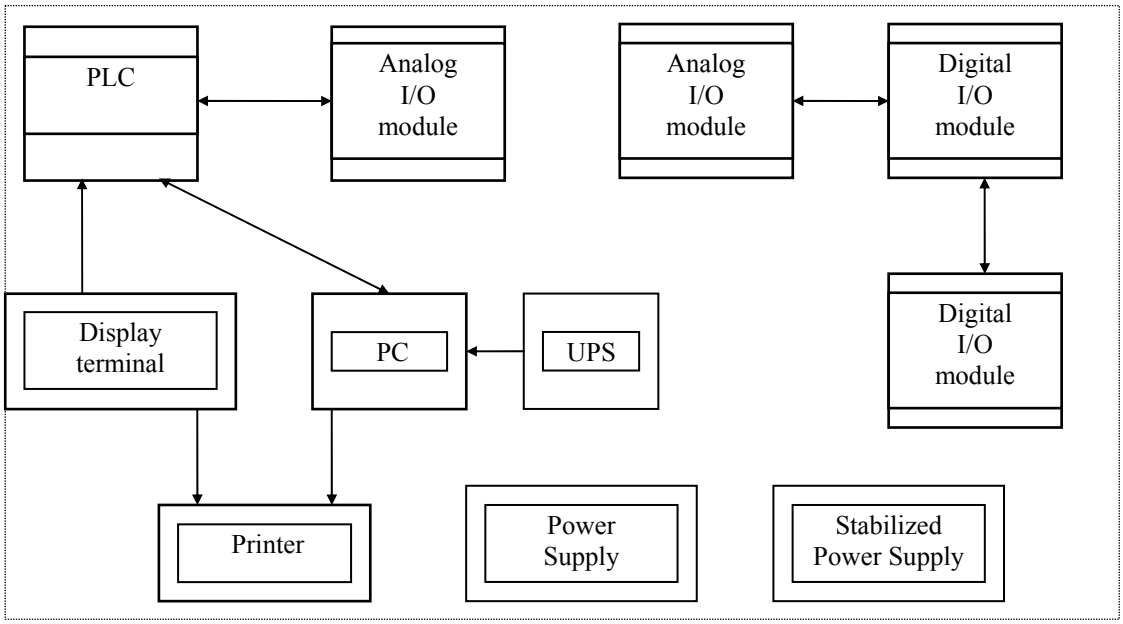

Fig. 2.

The central units, digital input and input/output modules, analog input and input/output modules, power supplies and display terminals used by the system are products of ABB Group.

The types of central units, digital input/output modules, analog input/output modules, power supplies used by the SAIAD system are the following and their characteristics are presented in APPENDIX:

- Central units: 07 KR 91, 07 KT 92, 07 KT 93, 07 KT 94, 07 KT 95, 07 KT 96, 07 KT 97, 07 SA 93;
- Digital input and input/output modules: 07 DI 92, 07 DC 91, 07 DC 92;
- Analog input and input/output modules: 07 AI 91, 07 AC 91;
- Power supplies: 07NG 32, 07NG 34, 07NG 35, 07NG 36.

Power supplies for central unit, input/output modules and display terminals are chosen function of the number of digital and analog inputs/outputs of the system.

For displaying the values received from the process and writing limits and scaling factors for parameters one can use display terminals with communication that may display texts or graphics. The types of display terminals used are MT60 and MT91; their characteristics are presented in the APPENDIX.

SAIAD system was designed and built starting from a minimum structure that can be expanded to a maximal structure.

A minimal structure has the following features:

1. Number of monitored parameters – analog inputs = 8;

2. Number of adjusted parameters – analog outputs = 4;
3. Number of monitored parameters – fast counting = 2;
4. Number of adjusted parameters – fast counting = 1;
5. Number of inputs/outputs for process automation = 48.

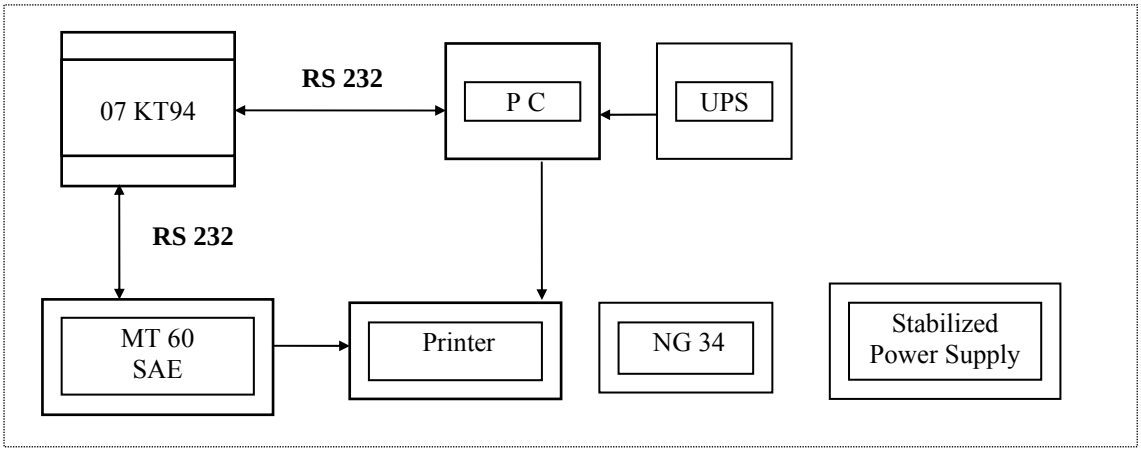

FIG. 3. MINIMAL STRUCTURE OF A SAIAD SYSTEM WITH PLC FROM THE FAMILY ADVANT CONTROLLER - AC31 – ABB.

Process transducers are directly connected to the central unit 07KT94, and parameter supervision is performed on display terminal – MT60. The latter is also used for writing adjustment limits and scaling factors.

SAIAD System has two functions:

1. to monitor process parameters;
2. to monitor and adjust process and process parameters.

The system comes in several variants:

1. SAIAD - M with parameter monitoring on MT 60;
2. SAIAD - M - PC with parameter monitoring on MT 60 and PC;
3. SAIAD - M - RP with parameter monitoring on MT 60 and process adjustment;
4. SAIAD - M - RP - PC with parameter monitoring on MT 60 and process adjustment connected to PC.

Type of process regulators is proportional, proportional - integral, proportional - integral – derivative, special and is performed by means of the software in the PLC or PC.

Scaling values received from transducers is accomplished by the display terminal MT60 or by PC.

PC can do parameter monitoring, generating mathematical model for process driving. Inside the structure the PC may be master but also slave. It also generates and maintains a database for process parameters and charts and diagrams with parameter's variation in time.

Monitored data can be listed by means of a printer connected either to MT60 or the PC. For system upgrading it is necessary to introduce supplementary modules and modify the execution program written in the PLC's memory.

For command and control of movements on several axes there was designed and is to be built a system in two versions:

- SAIAD - M - nRA for adjustment on up to 5 axes with MT60 monitoring and management;

- SAIAD - M - nRA - PC for adjustment on up to 5 axes with PC monitoring and management.

In case of the second version, the PC leads the process as MASTER.

This system is suited for manipulators, specialized robots, mechanical working centers, and is built using special PLCs (type 07SA93) which simultaneously take as input signals from 3 incremental and then can drive any movement on three axes (fig.4).

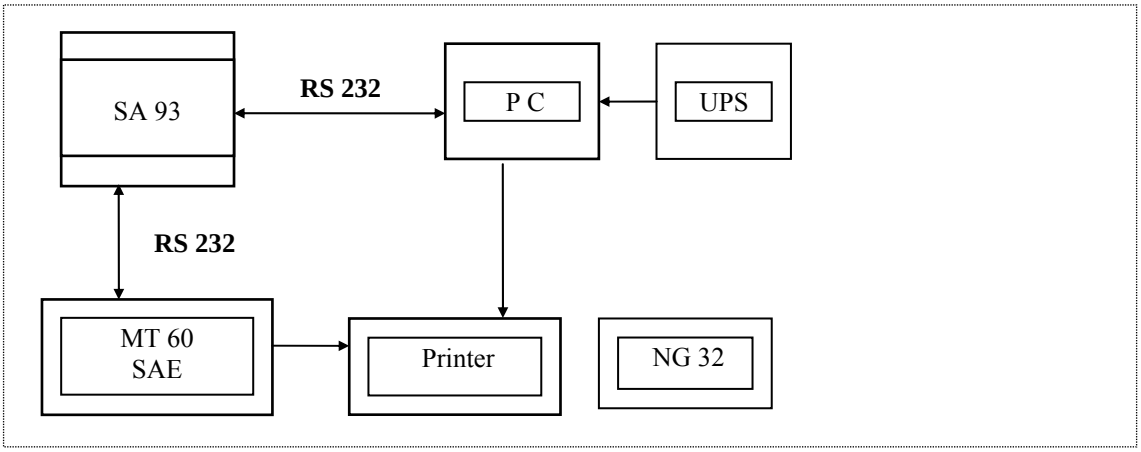

FIG.4. SAIAD - M - nRA - PC for control and adjustment on 3 axes.

In case of using two PLCs for control on 5 axes the transmission is made on a MODBUS bus and there are necessary two communication modules 07KP93 and two display terminals MT60.

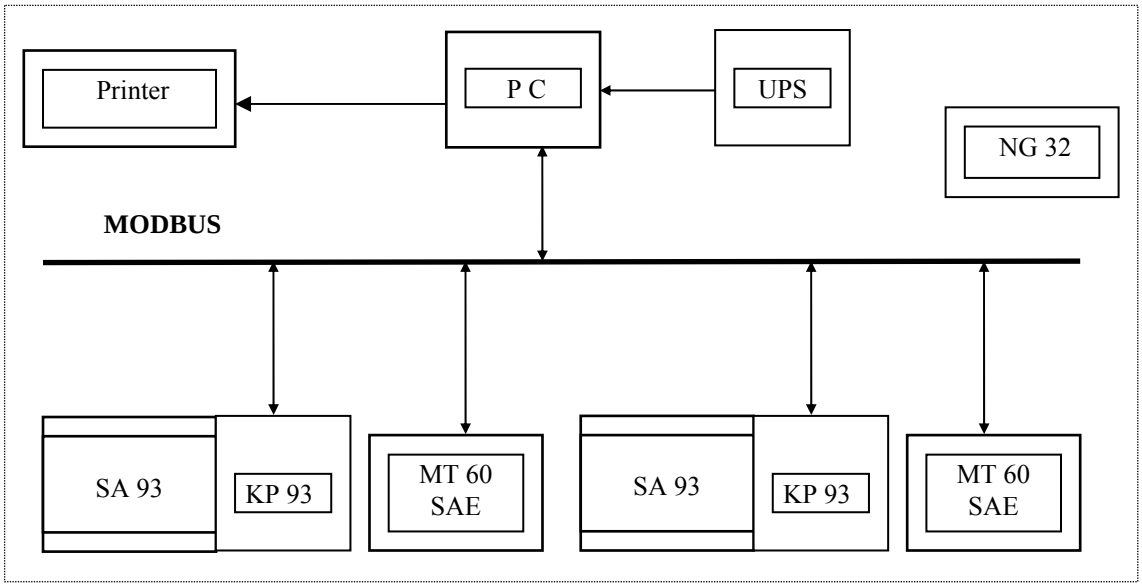

FIG.5. SAIAD - M - nRA - PC for control and adjustment on 5 axes.

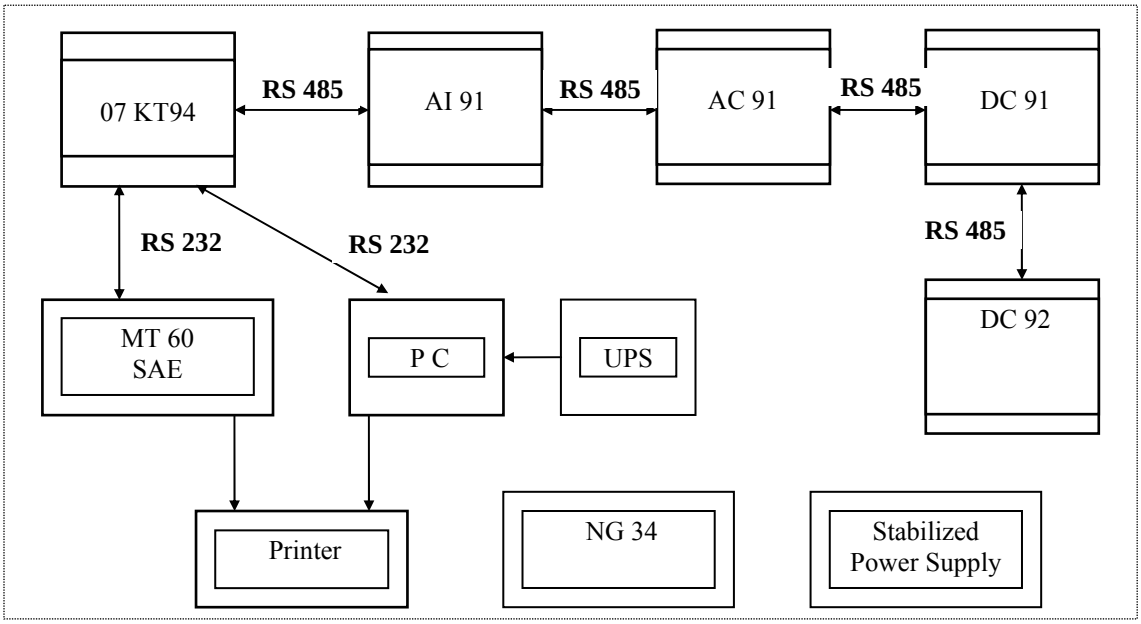

FIG. 6. SAIAD system with PLC and digital and analog i/o modules from the family ANVANT CONTROLLER - AC31 - ABB

There are situations when a process to be driven has several areas where parameters are monitored. In this particular type of situation there are needed several display terminals for writing/reading data, terminals which are connected via a MODBUS network to the MASTER which is in present case the PLC.

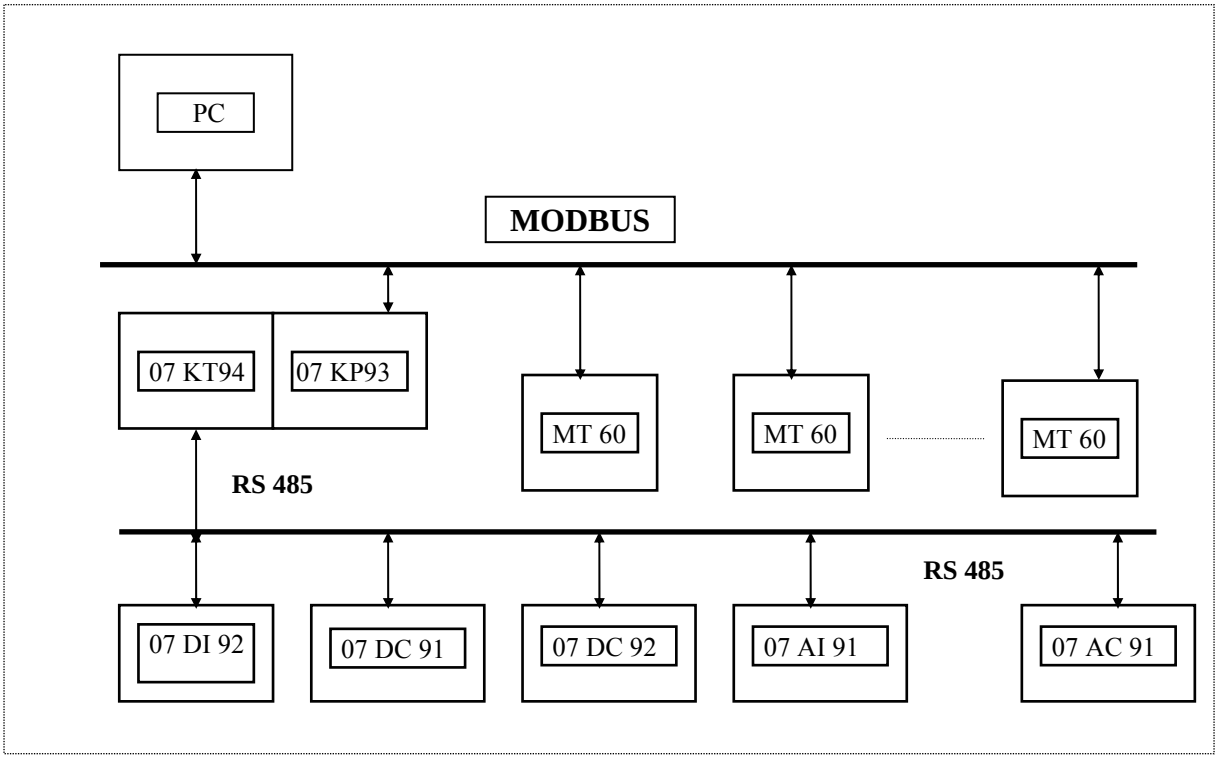

FIG.7. SAIAD system with multiple terminals connected by means of MODBUS network.

For a larger number of parameters to be monitored one can connect via ARCNET network up to 256 SAIAD systems so that the maximum number of monitored parameters can reach 57.344.

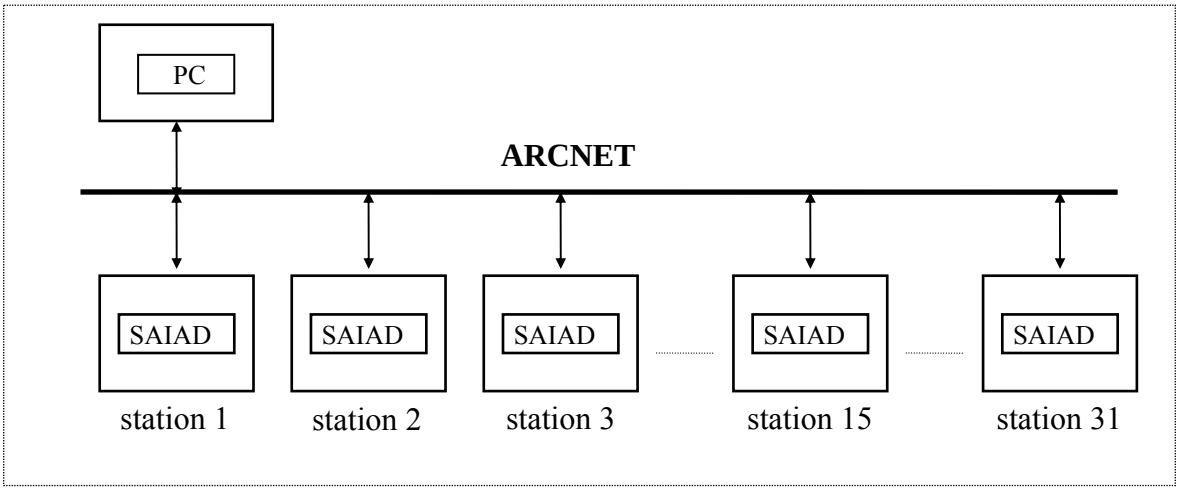

FIG.8. SAIAD systems connected via ARCNET network.

SOLUTION ANALYSIS

The designed system wants to be a solution for driving and adjusting industrial processes using mathematical models optimized and adapted to processes.

Advantage of using such a system built in decentralized distributed structure is the fact that the system can be expanded in the future provided the users have the financial resources to do that.

For such a system the costs are quite low in comparison with classical acquisition systems with an equivalent number of parameters monitored, because regulators' actions are performed by software, it uses a cable quantity 60% smaller and has lower energy consumption level.

The system provides an increased reliability, reduces costs related to service and maintenance, reduces technological losses due to accidental shutdowns, or technological losses due to incorrect adjustments, once the human factor is eliminated from process driving and decision making.

For operators this system represents a factor generating instruction and improvement by using top technology and processing techniques.

The system provides to the user the possibility of improving transducer's performances through characteristic linearisation, generating weight functions correlated to transducer's characteristics. It can also be connected to a LABVIEW system that some of the users have.

Since it has communication modules and protocols for RS 232, RS485, MODBUS - RTU, ARCNET, MASTER - FIELD - BUS, AF 100 - BUS, Pendant and PROFIBUS the system can also be integrated in complex automation installations based on other types of programmable logic controllers.

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