

# Remote Control System for Small Hydro Energy Power Stations

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**Abstract.** This paper presents a Remote Control System for Small Hydro Energy Power Stations. It is destined to provide an integral operability of the telecontrolled installation from a remote central position sited into the electric company's operation offices. It will allow to warrant the strictest security standards that are required nowadays for this type of installations. It has been designed as a storage system of the fundamental information from each power station defined inside the system.

## Keywords

Renewable Energy, Small Hydro Energy, Automation, Remote Control.

## 1. Introduction

Nowadays, the use and application of renewable energy has a great interest to achieve a sustainable development in the future, reducing the use of fossil combustibles, polluting gas emissions to the atmosphere and natural resources consumption. Renewable energy is not drained, it does not reduce our resources and it does not contaminate. For that reason, Europe is supporting with determination the production of energy using all type of renewable resources, getting important advances in the present days. [1]

In this way, and although we are still far from its true potential, the small hydro energy is progressively increasing its contribution to the electric power generation. So, the number of small hydro power stations that contribute, in a clean way, to cover the growing electric power demand is increasing every year and worldwide. [2]-[4]

Due to their special characteristics, these type of installations are sited in quite difficult access locations. So, automation and remote control of these stations results absolutely necessary for the operation and maintenance companies, in order to provide them a

sufficiently reliable and effective tool to obtain the necessary production parameters. Also, the companies will be able to operate and manage them from the central office in a more effective way. [5]

The Remote Control System (RCS) for Small Hydro Energy Power Stations presented in this paper has been developed for its implementation in different small hydro energy power stations from northern Spain. It has been designed with capacity for up to twenty remote stations and its main aim is the local automation of this type of installations and their incorporation into a central control system (dispatching).

For that purpose, it has been used an appropriate combination of integrated hardware of control, process regulation devices and modern systems of operation, supervision, diagnosis and communication [6]-[12]. The developed system has an open and shapeable architecture, so it can be applied to different power station configurations by means of the adjustment and specification of its particular characteristic parameters.

## 2. System structure

The Remote Control System for Small Hydro Energy Power Stations presented in this paper has three clearly distinguished parts:

- Remote Stations.
- Central Control Position.
- Auxiliar Control Positions.

These subsystems are interconnected with an RS-232 series connection and a telephonic modem.

### *A. Remote Stations*

There is a Remote Station (RS) for each small hydro power station included on the telecontrol system. They are sited at the stations' control rooms and, inside them, the Remote Stations have been placed as near as possible

from the Local Control System (LCS) through which the operator-process contact is settled.

The RS picks up, from the local control equipments, information in relation with the status of the station's elements, alarms and magnitudes to send them later to the control positions. In the same way, after being verified and adequately processed, the commands and orders received from the remote operator are sent back.

Due to the specific characteristics of the different incorporated stations, two standards of Remote Station have been used in this pattern of Remote Control System.

Most of the times the Local Control System has turned out to be completely compatible with the equipments which are parts of the RS. So that, the data transmission between them have been made through a local series communication (master-slave).

When the previous has not been possible, basically because of the lack of a channel reserve availability or the incompatibility among their respective protocols, it has been taken a chance to establish a more outstanding information transfer using the corresponding input/output cards. On these cases, the data have been picked up from the LCS or even from the external equipments when it has been thought to be better.

In any case, each RS has a telephonic connection and its corresponding modem to settle contact with the control positions.

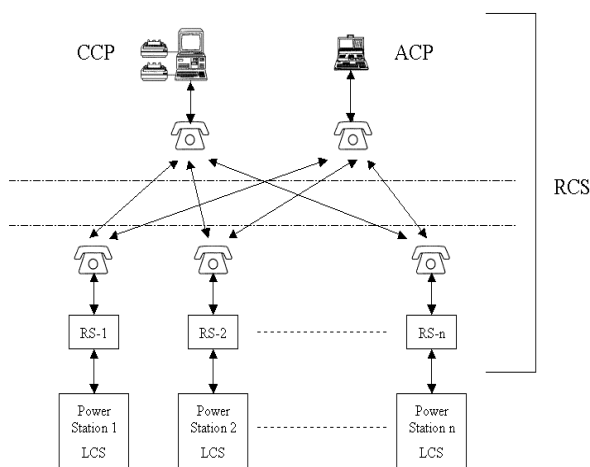


Fig. 1. System structure

### B. Central Control Position

The Central Control Position (CCP) is sited in Barcelona (Spain) and basically consists on:

- A compatible PC Computer.
- Two laser printers.
- Integrated modem card.
- Telephonic connection.

The corresponding telecontrol functionality software have been installed and the remote controlled stations configured in the Central Control Position computer.

To have a complete data presentation which provides the remote operator enough information about all the stations under its control, the necessary screens and databases have been developed. In this way, it could be warranted an efficient management and a safe commanding.

### C. Auxiliar Control Positions

The Auxiliar Control Positions (ACP) consist on a notebook or portable personal computer with a data capture similar to the Central Control Position's one, but with a restricted data access.

The main difference between both control positions is that the ACP, according to security parameters, has a restricted information access and treatment. In this way, the commanding capability on the remotes has been reduced to the necessary basic operations.

The main task of the Auxiliar Control Positions is to receive the alarms from the stations and the CCP. At the same time, they allow the operator to access, according to his access level, to the stations' control systems to monitor the actual status of the configured inputs and alarms.

The importance of the ACPs rests on their mobility. The possibility to access the RCS from any place with a telephonic connection, without time or date restrictions, allows the operators to be informed anytime and anywhere about the stations' status, and even to know the status and evolution of the different production parameters.

## 3. Communications' description

The communication between the control positions and the Remote Stations uses the ordinary telephonic grid. It has certain advantages, however, it causes restrictions over the communication protocols to be used.

Communication's format is via RS-232-C series and it is configured according to an asynchronous transmission with a range of velocity between 300 and 9600 Bauds.

The contact settlement could be spontaneous or programmed, and each component of the Remote Control System have a different communication capacity.

The Remote Stations could send data making spontaneous dials when an alarm occurs at the station or they could send data to answer to the external dials.

The CCP could receive data from the remotes as a result of the spontaneous dials, ask the Remotes for data and send data to the ACPs.

In the same way, the ACPs could receive data from the CCP or dial to the Remotes asking for data.

So, there are different types of communication depending on who makes the call or the type of the data transmitted.

#### *A. Status request*

It is a voluntary request about the status of a Remote Station made from any of the control positions.

In this case, the control position will dial to the corresponding RS and after settling contact, it will ask for the data about the actual status of the station's elements. If there is not a successful contact, three more attempts will be done. If all the attempts fail, the contact process will be cut and it will be marked on the screen with the alarm "Remote Contact Failure".

In these cases, the Remote Station will answer sending back just the requested data:

- Actual status of the station's elements.
- Actual value of the magnitudes
- Status of the remote's components

#### *B. Spontaneous dials*

When an Remote Station detects an alarm defined as critical, it makes immediately a dial to the Central Control Position. Once the contact is settled, the RS sends back an station alarm message where the last five incidents are registered with the date and time of each one.

When this message is received, the CCP makes automatically a status request to the remote in failure. So, the actual status of that station is updated and the correspondig operations can be done from the control position in a safety way.

If no contact is settled at the first attempt, the remote will make three more attempts. In the case the failure persists, the number of the highest priority ACP on the remote's configuration will be dialed. If the next three attempts for this contact fail too, it will try with the second ACP on priority and so on.

The contact failure will be registered just in case no contact is successful with any of the control positions. Even so, the previous dials process will be repeat every hour until succesful.

Concerning the dials to the Auxiliar Control Positions, despite their mobility, the Remote Stations' configuration will have recorded a contact phone number for each of them, to make possible the dials described on the previous paragraphs.

#### *D. Programmed dials*

The Central Control Position makes these dials at cheap rate hours, in order to pick up the data stored during the day by the Remote Stations.

At 0:00 A.M. everyday, the CCP starts the programmed dials sequence. This sequence consists on a round of dials in order to contact succesively with each station integrated in the Remote Control System.

The dialing process is very similar to the one described in the previous heading, with three additional contact attempts before trying with the next remote.

Once the contact is settled with each Remote Station, the CCP will ask for the actual and stored data from the remote, including:

- Actual status of the station's elements.
- Actual value of the stations' magnitudes.
- Remote's components status
- Quarter-hourly active and reactive energy accumulations.
- Quarter-hourly registrations of potencies, levels, temperatures and other magnitudes

#### *E. Command sending dials*

These dials are made by authorized staff from the Central Control Position or from any of the auxiliaries in order to act on any of the elements of the remote stations. Having this consideration any operations over the station's status and the remote's one.

In order to warrant the security on the manoeuvre, when the operator asks for permission to carry out a command over an RS, the control position dials that remote, to make a status request before sending the command.

Once the station's status is updated, the system will verify whether the operator is allowed to execute the command from this control position. If that's possible, it will send the command application to the Remote Station to be processed and dealed, just in case all the security standards stablished on the local control systems are fulfilled.

From the beginning to the end of the commanding process, the Remote Control System follows it with a timing control that will conclude with a signal of "Command Executed" or "Failure in Command Execution" depending on the case.

#### 4. Data treatment at the RS

All the data configured on the Remote Stations' database are controlled at the Local Control equipments of each station.

From the Remote Control System's point of view, the data gathered into four different units depending on the ulterior treatment they're going to be given:

- Status and Magnitudes
- Alarms
- Registrations
- Accumulations

On the first unit there are included the actual values of the magnitudes and the status of the station's elements, including the remote's ones.

As alarms, there are classified all those signals defined as that (those coming from the station's elements and those derived of the RCS operation).

In the same way, the RS develops a registration where the most important alarms and events are sequentially and chronologically stored. Each registration shows the date, hour, minute, second and second hundredth when the incidents happened, the signal description and its status to make easier its ulterior analysis.

Referring to the accumulations, some important magnitudes are submitted in the remotes into well arranged data storage treatments on the moment they happen. These data are magnitudes as power, levels, temperatures and basically, energy accumulations.

They are stored every fifteen minutes and the Remote Stations send them to the CCP inside the every day programmed dials.

In order to avoid the data loss due to communication failures, these data will be stored up to fifteen days.

In case of some critical magnitudes, measuring values will be stored minute by minute until ninety minutes data are stored. So on, the remote operator will be able to study their evolution on the last hour and a half.

#### 5. Data presentation on the CCP

For each Remote Station, there are five type of screens on the CCP, corresponding to the different signals treated on the RCS:

- Status and magnitudes main screen.
  - Electric scheme. (Fig. 2)
  - Hydraulic scheme. (Fig. 3)
- Command screen.
- Alarm and events' screen.
- Stored data tables screen.
- Evolution curves screen.

The software of the control positions is capable to make graphic representations of the hourly, daily, monthly and annual evolution of the magnitudes stored on the Remote Stations. In the same way, it allows obtaining production reports where the most useful data are stored, into different formats, to make the analysis of the station's production.

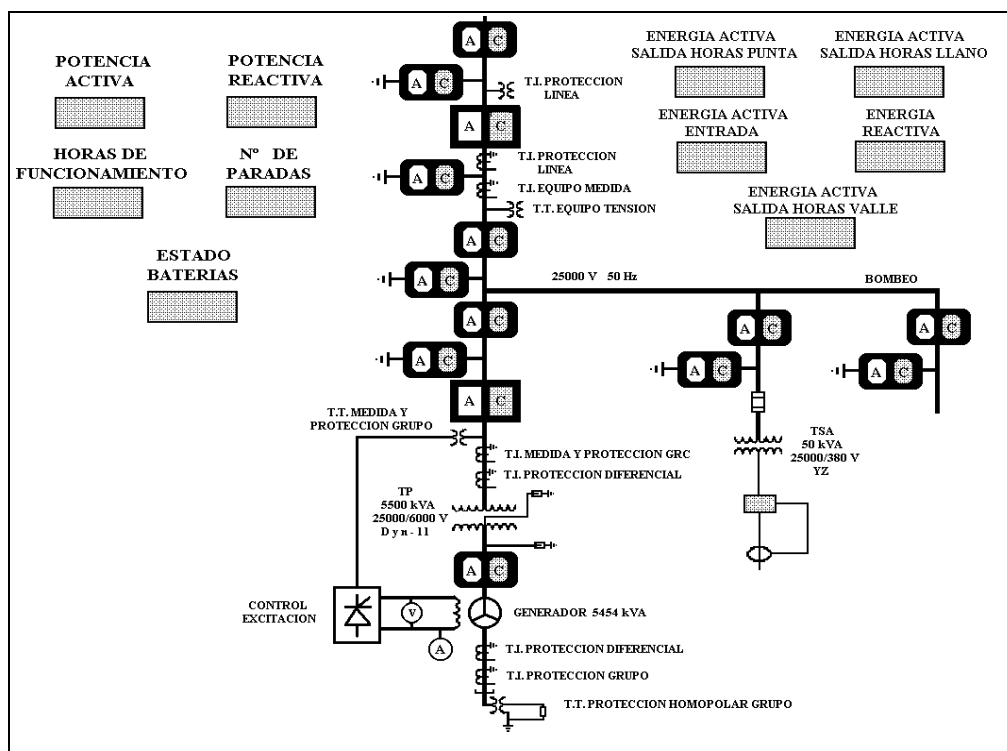


Fig. 2. Electric scheme

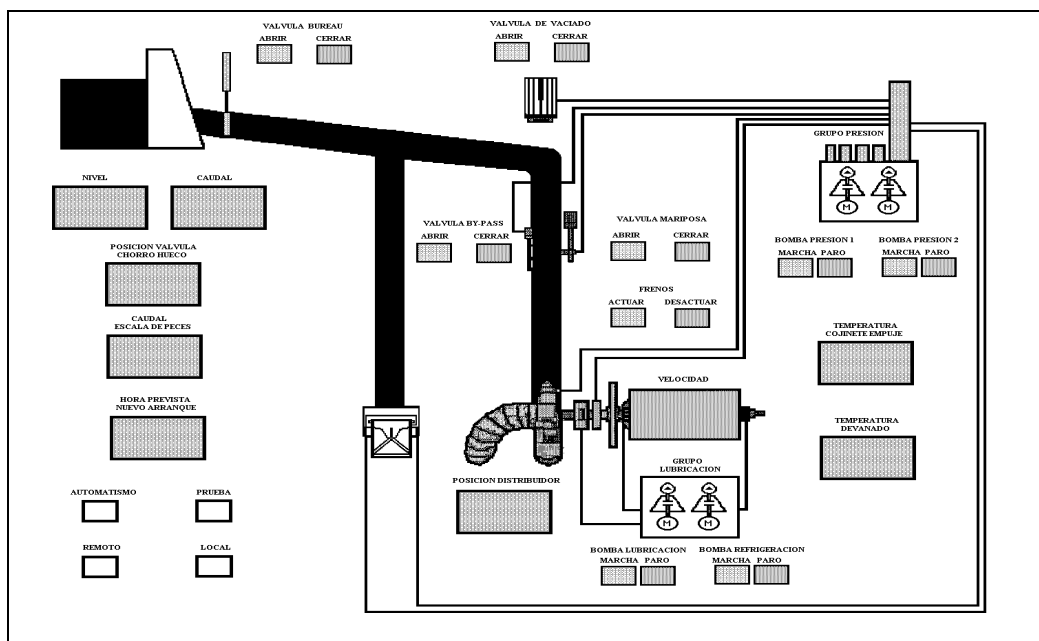


Fig. 3. Hydraulic scheme

In this way the remote operator could surf through the available screens and pick up, in a graphic and direct way, all the information that needs to carry out the tasks efficiently.

All the graphics and reports could be manually printed, selecting the appropriate option. In the same way, after each programmed dial an automatic print is made about the daily report where the accumulated data of the last twenty four hours are included.

Finally, downloading of production reports and registration queues to diskettes is allowed in order to make possible its ulterior informatic treatment at external management systems.

## 6. Conclusion

The Remote Control System for Small Hydro Energy Power Stations presented in this paper is destined to provide an integral operability of the telecontrolled installation from a remote Central Control Position sited into the electric company's operation offices. It warrants the strictest security standards that are required nowadays for this type of installations. It has been designed as a storage system of the fundamental information from each power station defined inside the system, that can be summarized as follows:

- Actual status of the operation and protection equipments.
- Actual value of the Station's magnitudes.
- Historic evolution of production parameters.
- Historic registration of Station's alarms and events.
- Others.

All this information is screened by means of synoptics, displays and interactive windows. So, the operator has a visual image of the installation's actual status. At the same time, the developed system allows all these data to be stored and processed by the remote operation's central position for its later analysis. By means of easy reader parts and graphics it is possible to obtain chronological vision of each Station's values of energy production.

In the same way, this Remote Control System provides a full operation to the Power Stations by means of the corresponding commands or set-points dispatching.

With the purpose of preserving the installations security, there are several accessibility levels, identified by their corresponding codes and access keywords.

## Abbreviations

RCS	Remote Control System.
LCS	Local Control System
RS	Remote Station.
CCP	Central Control Position.
ACP	Auxiliar Control Position.

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