Lighthouses Remote Control in the Magellan's Straits

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Abstract

The project it is related with the Telecontrol System of 35 Aids to Navigation (AtoN) Signals in the Magellan's Straits with the purpose to know in every moment the real actual state of any of the signals, preventing any fail that may produce the service interruption that this automatic signal station provides, sending data such as: light ON or OFF, number of available good lamps, battery voltage, etc., taking advantage of the electronics components that can be found in this kind of automatic beacons of these days, which normally has an RS232 interface integrated so the system is able to communicate with a PC which is linked with a Radio Modem that makes the VHF link. Many test are made with this equipment to determinate the system coverage, the equipment performance in a net and the capability to be integrated with other user systems like automatic meteorological stations.

Also it's good to say that to go ahead with this project it is necessary to study the actual procedure that is activated when a light signal fails, which means to move specialist ground crew to very far away points from any populated zone, which is one of the things that it is pretended to be avoided with this system. The savings produced by the operation of the telecontrol will cover the cost of the system itself.

1. Introduction

Time has passed since those days when the first navigators marked with fire their point of departure, with the purpose of recall to it, after being finished their fishing task. The technology obviously has changed in this century, passing quickly from the first lighthouses operated by gas to became to the current electric lighthouses, generally connected to batteries, charged with solar panels. But it's not all in regard with to the maritime signalling, also exist a diversity of other aids to navigation, usually sophisticated equipment like buoys, radiobeacons, racons, radars, GPS, and others electronic equipment of high cost.

2. Problematic

Currently exist more that 900 signals of aids to navigation in Chile, which are maintained by the Chilean Lighthouses Service through its 5 Depots located in: Iquique, Valparaíso, Talcahuano, Puerto Montt and Punta Arenas. A large amount of this signals are automatic, being inspected and maintained every 4 or 6 months. In the meantime they have no real information about the status of the signal, being possible that a fail occur producing the lighthouse's out-of-service. Due to this signals are, obviously, in remote places and very difficult to access, its re-light or repair take long time and it is inefficient. Some times the inverse situation occur, where after a great human and material expenditure, when the personnel in commission arrive to make the irepair to the lighthouse, they found there was a wrong report and the light is working perfectly. From this signals the lighthouses installed are autonomous. This installations normally are of reduced size, have a photoelectric control system, which sense the ambient luminosity and light the signal to the sunset and swich it off at the sunrise, additionally has an automatic lampchanger with a carrousel with several lamps rolling when one of them is burned out. Generally the installations include a lead acid or nickel cadmium battery system that is recharged by means of solar panels.

Summarized the problematic are:

- The fails of any equipment which are part of a light signal, are no immediately informed to the control depots in charge of its maintenance and repair. Therefore, is no possible take corrective actions immediately.
- The "Notice to Mariners" are published late with respect to the moment in that the abnormality occur.
- Doesn't exist other way to check the lighthouses status, more than the expensive and delaying visit to terrain in which means a large amount of human and material means.
- To make any minor modification, such as a characteristic change or light off the lighthouse due a special requirement, is necessary go to the point of installation.

In view of the previous mentioned considerations, it is necessary to evaluate the convenience of having a system that, by remote control, reliable and middling quick, give us information about the real status of each one of this signals, information like:

- ON and OFF lighthouse.
- Number of good lamps on service.
- Normal rotation and flashing.

- Engine status.
- Charge status of the battery, voltage measurement
- System of connection and disconnection as needed.
- Other parameters to measure according to of each particular configuration.

Besides, the data sent to the lighthouse is defined as:

- Configuration commands
- Checkin and activation commands.
- Eventually text message, when maintenance team at the station needs to send imformation.

3. Benefits of the System

- To have a remote picture of the real status of each signal, being able of predict fails using the means to avoid it.

- To give control commands to a remote stations, with the purpose to modify a programmable parameter.

- To keep an automatic record of alarms and fails, having the possibility of generate a report.

- To organize in a better way the corrective and preventive maintenance tasks.

- To keep promptly informed to mariners and users about out-of-service lighthouses or failed.

- To make fail statistics of the equipment installed in remote stations.

4. Alternative Solutions

4.1 Radiolink:
Several links have been evaluated, according with the distance, short distance (minor than 50 Km.) and long distance (more than 50 Km.). For the first of this link, the intention is define between telephony, VHF or UHF radiolinks, optic fiber, physical line, etc. For major distance links the options are HF radiolinks, use of satellites and finally, METEOR BURST system, that consist in transmit power about 100 watts in a frequency range of 37 to 76 Mhz, making that the signal rebound in the meteorite layer existing around the earth.

4.1.1 Short distance links:
- Radiofrecuency links, by means of VHF or UHF transceivers.
- Physical line, when the distance is very short, with the exception that depending of the distance should be use a MODEM system.
- Telephone link, when the lighthouse be installed in some naval land unit or near to it.
- By means of microwave links or for a fiber optic cable, when exist some link of this type and exist the possibility to send information of our interest, inside the package of multiplexed signals.

4.1.2 Long distance links:
- Using HF links existent for communications purposes.
- Using data nets for computation, with availability of channels.
- Sending the information by means of the satellite communication system INMARSAT.
- Using the meteorite layer that surround the earth like communications reflector (METEOR BURST).

5. Implementation

The maritime signalling system installed in the south zone of the country and specifically, in the Magellan Straits, require of an efficient control system and supervision, with the purpose of maintaining always the availability of a control link, able of execute determined functions and with the ability of take some data and/or functions parameters and to send it to the control centre located in a remote place.

This remote stations are normally installed in distant points from the urban centres, lacking in electric distribution lines, telephonic lines or within reach of cellular telephony, having therefore create a system of supervision able of “connect” to this stations by means of appropriate and reliable links of radiocommunications.

This system of supervision and control is based in a software provided by the radio modems manufacturer, naamed DMC “Data Monitoring Control”, which was necessary make some levels of programming with the purpose that the received data, from the different sensors (Raw Data), can be interpreted and see by the users in engineering units.

One of the important features of this software is the possibility of display the stations with references of geographic coordinates which make highly convenient, mainly for be stations that vary its position in the time, expected or unexpected, as signalling buoys and others.

After verifying the operation of the prototype system, using an UHF transceiver, model GINA, a pair of MCC545B equipment was obtained from the manufacturer with the purpose of checking the system coverage, making a test from Valparaíso (Playa Ancha) to Cabo Tablas Lighthouse (Los Vilos), with an approximate distance of 60 Nautical Miles. Test was performed with good results, transmitting datum of control, commands and reports to 9600 bps, without difficulties.
Once evaluated the results of this test, the implementation of the system in the Magellan Straits started, installing the Radio Modems in the lighthouses of the area, called automatic beacons (balizas automáticas) because they are unmanned installations. Due to the topographic difficulties of the area, this installations were made

keeping a distance, between stations, no bigger than 20 N.M This first stage included 27 stations distributed in the Magellan Straits between its West acces (Félix Lighthouse) and East access (Dungeness Lighthouse), besides three stations that are used also as Automatic Weather Stations.

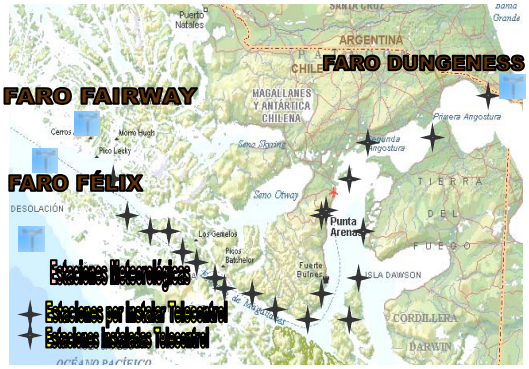


Figure 1. Show the 27 stations currently installed in the Strait of Magellan

6. Equipment included

The following equipment will be used, depending on functions to be controled :

In manned Stations and/or manned Lighthouses:
- Racons (radar transponder)
- Automatic weather stations
- Flasher/lampchanger APCL-5
- Data logger
- Other equipment to define
- PC as data terminal

In unmanned (automatic) beacons:
- Flasher/lampchanger APCL-5
- Racons (radar transponder)

In maritime signalling buoys:
- Flasher/lampchanger APCL-5
- Racons (radar transponder)
- GPS

In land units (vehicles) or maritime units (patrol craft)
- PC as data terminal

7. Description of the Equipment

7.1 Lanterns

A flashing lantern, that can carry a multiflasher and a lampchanger, which is able of operate with lamps in CC-8 format of different power to a maximum of 60 watts.

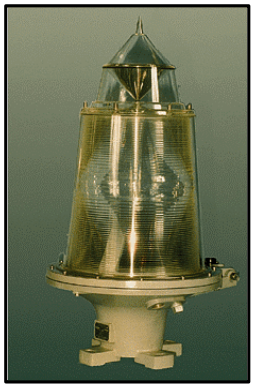


Figure 2 Lampchanger APCL5 and FA-250 Lantern respectively.

7.2 Lampchanger

An automatic lampchanger of 4 positions (spare lamps) APLC-5 that work with a MOTOROLA microcontroller **M68HC705C8A**.

APCL5 Scheme of Elements
MAKER: Automatic Power Inc.
SUPPLIER: United States
APROX. COST: US$ 900
TYPE OF UNIT: Lampchanger, programming flasher and load regulator for solar panels integrated in only one unit.
INPUT: 10 to 30 V.D.C.
LAMPS: C-8 / CC-8 / Halogens
MAXIMUM CURRENT: 5 amperes. There is another model, the APCL – 10, that support up to 10Amps lamps.
VOLTAGE REGULATION FOR LAMPS: Automatic system that keeps 12 V_{rms} in the lamp, independent of the input voltage, by means of the pulse width modulation (PWM). It require as minimum 12.2 Volts DC of input to start regulating 12 V_{rms}. Under 12.2 Volts of input the lamp voltage regulation will be lost, reducing its brightness, but will maintain its flasher characteristic until 5 Volts.
PROGRAMMING OF CHARACTERISTIC: By means of two rotating micro switches of 16 positions, similar to the APF 247-U flasher and using the same table of the 256 characteristics programmed on it.
USE ON ROTATING BEACONS: To use this unit just as lampchanger (fixed light), the microswitch SW1 y SW2 should be set on "0-0" or "F-F". With this setting the lamp will light as a fixed one. (characteristic for rotating beacons) , keeping the Rms regulation of voltage for the lamp.
ALARM OPEN COLLECTOR: When all the lamps of the lampchanger are burnt-out, this will carry out a complete rotation every time that the day/night condition is produced, checking all the lamps in the eventuality that some one can be light. Then the lampchanger will

decrease to the minimum the power and will activate the open collector alarm (all lamps burnt-out).
CHARGE REGULATOR: The charge regulator system is designed to control the lead-acid or nickel-cadmium batterie charge, which is done by solar panels, accepting a maximum range of 20 Amp. For greater currents it must be installed an extern regulator. This regulator acts with a parallel branch that has two threshold at12.9 VDC and 14.4 VDC, making a relay to act to allow the battery charge only when the voltage is in that range. Beside it has a diode of 25 Amp. to avoid the discharge of the battery through of the solar panel during night hours.. (This functions are not used currently in our units).

7.3 Modem

-Two MODEM to transfer the digital control information, between the lighthouse and the transceiver in the remote stations ; and between the computer and its transceiver in the controller station.

MODEM description:
The MCC-545A RF MODEM provide versatile communications from mobiles and fixed points. The 545A can be used to send and receive messages, position reports, data records or other specific applications. Design to operate on a diminished land wave and in an intermittent meteor burst channel, the unit allows a low consume of standby power, (<1 watt) that make it ideal to remote places and mobiles operations.
The 545 A is totally compatible with the MCC's range of the Master Station, including the MCC-520B. The unit work in a half-duplex mode and has a solid state switch Tx/Rx that allow to a common antenna be share by both, transmitter and receiver. This can be operated in a simple frequency or in two separate frequencies.

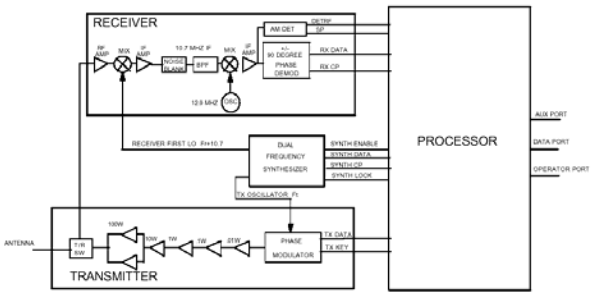
Sending and receiving messages
This equipment, with a portable operation terminal or a PC running a software of terminal emulation, which can interchange messages with any other remote stations in the net, has full capacity of messages reception. The messages can be text or binary datum, and can be tracked to multiple destinations, simple or to a datum centre.

Additional Capacities
The radio modem 545A, can be connected to a great variety of equipment if they have a RS 232 interface, like automatic meteorological equipment, satellite positioning equipment and others; for instance in the positioning case, it can send reports of a buoy that cut its anchorage and is drifting.
This equipment give the information about the location from a standard GPS used in land and mobile units, in air or sea. The 545A send the position of the location to a Master Stations, which re-send the information to the "information centre" to be processed.

Transmiting Stage
The transmitter has 100 watts of power and basically has the following stage:
- A solid state amplifier class C in of 100 watts.
- A modulator BPSK of constant amplitude
- An solid state antenna switch T/R
- Antenna Filters .

Control System
The control system is based in the Motorola MC 68332 microprocessor, which has the following functions:
- EPROM memory Programmable Reading Only of 256 K bytes.
- RAM Storing Datum of 512 K bytes.
- 3 External ports RS-2323 I/O.
- Communications port with transmitter
- Communications port with receiver
- Converters A/D of 10bit.
- Real time clock.
- Power fail detection circuit .

Receiver Stage
The receiver has inside the following stages:
- An amplifier of radio frequency.
- A BPSK demodulator of 90°.
- A filter of undesirable signals.
- A 486 DX computer, with a processing velocity of 50 Mhz., 4 Mb of ram, hard disc of 500 Mbyte, monitor U-VGA of 14 inch, 39 colour monitor no interlinked, 6.2 DOS, Windows, serial communications port type DB-9 and an appropriate communication software to control and managing the telecontrol system.



MCC-545A BLOCK DIAGRAM
Figure 3

8 System Working

8.1 Enviroment or Operative System

The Software of Monitoring and Data Control (DMC) have been design to operate in a Microsoft Windows or Microsoft Windows NT enviroment, with the purpose of working with data bases that can be exported to other applications to make statistic calculations or others.

General Description
It work simultaneously with a screen divided in two parts, one of them show a map and the general status of the monitoring stations and other section where it appear the commands, instructions or reports as they travel

through the communication net, as you can see in the figure 4.

The configuration of this RS232 port is make under the following parameters:
Transmission Velocity: 9600 bauds
Parity: Non (N)
Bits of datum: 8
Bit of stop: 1

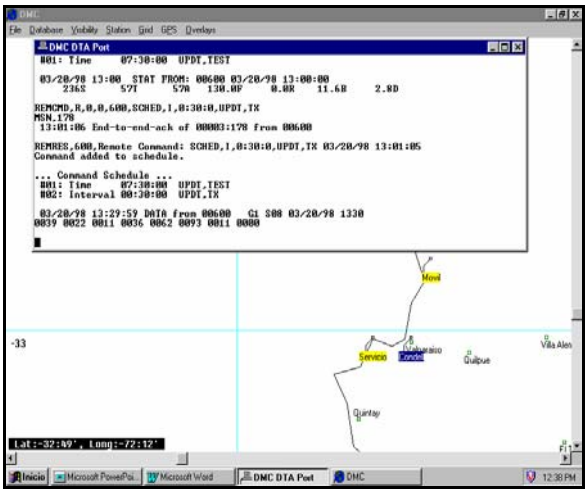


Figure 4: DMC screen

Functions Description
In the main screen you have access to multiple functions, the mains being:
- Communication with the remote.
- Select the lighthouse in the main screen.
- Define and put a new lighthouse in its district or location.
- Examine the operation and status of any lighthouse.
- See the history of any lighthouse.
- Print reports about lighthouse's condition.
- See historic records.
- Delete any lighthouse or edit its information.
- Save the configuration.

An example of the work screen is given as figure 5, where you can see how a station's configurations is edited, "Condell Lighthouse", remarking with a circle to the right of the configuration square, in order to redefine its number, name, position or type of station.

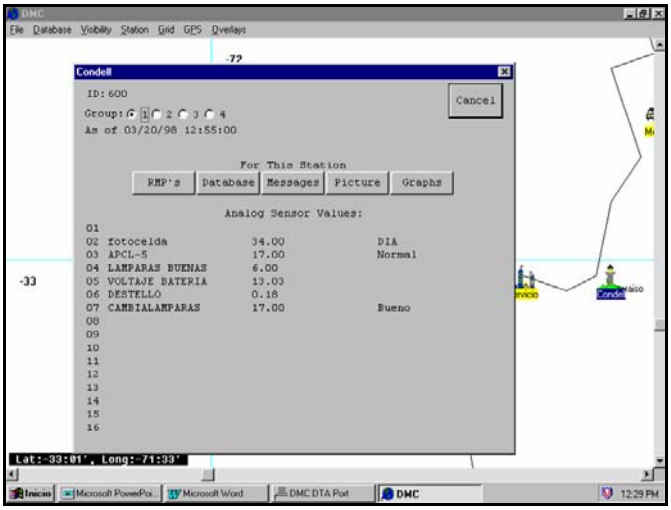


Figure 5: Configuration screen of a new station

8.2 A new station report

The method to ask the report to a new station is extremely simple, a "click" on the station's icon is enough and will appear the historic report of such station, showing initially the data obtained in the last report emitted for the station as is seen in the figure 6.

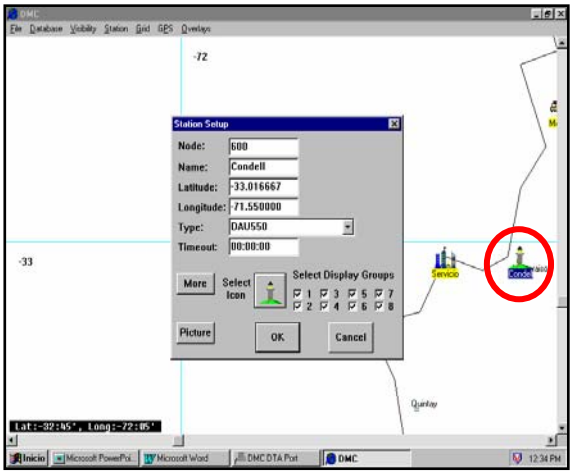


Figure 6: Report of a telecontrol station

If a command is send to ask an immediate report from a station, the station answer with a screen similar to the one showed in the figure 7 (raw data), where the data is still codified, using sequences of decimals, to decode it.

The software make an association of the numerical datum received with mathematical conversion tables stored previously, denominated lookup tables, to show again a screen as the one showed in the figure 8, but updated with the moment information.

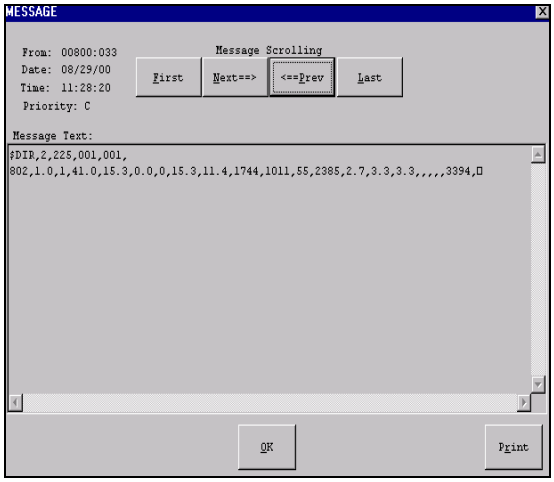


Figure 7: Raw data, before translate.

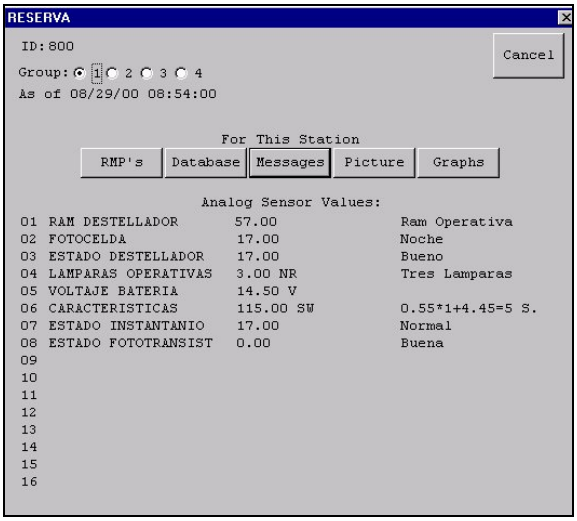


Figure 8: Update datum.

9. Conclusions

Comments related to tests carried out

Although the radio modem are efficient, they are not easy to programming, even having a Spanish version of the Manual, it doesn't describe which is exactly, the procedure for assembly and configure a net, including different equipment to the integrated by the company, such as the meteorological equipment.

On the other hand the test carried out proved that the equipment can provide a communication link to other systems and/or devices that have a communication serial port. In addition to this, test were carried out with equipment such as GPS, radar transponder and other, being possible to demonstrate the high degree of compatibility and versatility of the proposed system, which give the possibility of makeing some reprogramming and remote checking, avoiding in this way to have to visit very often a remote station..

9.1 Final Conclusions

After tests carried out, we can state that as it was mentioned in the introduction of this paper, it was possible to verify the good performance of the radio modem proposed, even considering that it was integrated to an acquisition datum system for which it was no designed, like the meteorological system, where the demand levels were higher that the reports generated for a normal lighthouse, regarding to the amount and periodicity of them.

Finally we must highlight the experience obtained with the configuration and operation of this net and its multiples uses in other areas, such as the industrial control, agronomy, oceanography and other sciences where this model is perfectly applicable. In some of this areas have been possible prove the existence of a dissociation among an datum acquisition system and its sending in real time to the control centre, since in the most of tacks in which is required read or sense some parameters from distance points, the work is made by means of datum in situ and not all the systems offer a sending in real time. Work with information in real time, without doubt, improve enormously the system benefits due its capability of carry out immediate corrective actions, using the some communication link with the purpose of activate for instance valves, ventilator or any other device that allow diminish the hysteresis's range and make a much more detailed control over any or some variables.

Maybe this project can be carry out with other type of equipment, but is important to have in mind that the operation conditions will be in extreme zones, extremely hard weather conditions and distant from urban centres, for this reason is the equipment selected, at the first sight, could be appear as over dimensioned in power and covering, but is possible make sure that in spite of everything, its operation will be not free of problems, difficulties in the putting into service and some initial fails, for which the experience obtained and the collected information is extremely valuable.