SCADA system of diesel generators of Broadcasting Center of Montenegro

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Abstract
In 2016 Broadcasting Center of Montenegro (BCM) started the project with intention to provide SCADA system for backup power supply (diesel generators) in their emission objects. The second phase of this project began in 2017 with the announcement of a tender and selection of diesel generator's supplier for locations where backup power supply did not existed. This project included delivery and installation of the new diesel generators, replacement of PLCs on existing diesel generators, configuration of the new PLCs, testing, commissioning of the diesel generators and implementation of a new SCADA. Furthermore, the control and monitoring of diesel generators through mobile application was enabled. With the realization of this project, reliability of power supply was increased and power quality parameters were improved, which was necessary for correct operation of the telecommunication devices of Broadcasting Center of Montenegro.

Keywords: backup power supply, diesel generator, SCADA, PLC, power quality.

1. Introduction

In Montenegro, the company with the largest number of telecommunication sites and one of the commercial providers of television packages is the Broadcasting Center of Montenegro. After the digital signal DVB – T2 was released on June 15, 2015 [1], there was a need to improve all parts of the system. One of the most important was backup power system. In order to ensure the satisfactory of power quality required for the normal operation of telecommunications equipment, Broadcasting Center mostly enables with the installation of diesel generators. Therefore, the first SCADA system was implemented, which would be used to manage a complete backup power supply, consisting of a total of 58 diesel generators. The diesel generators was distributed by sites located in all municipalities and cover with a signal 97% of the territory of Montenegro.

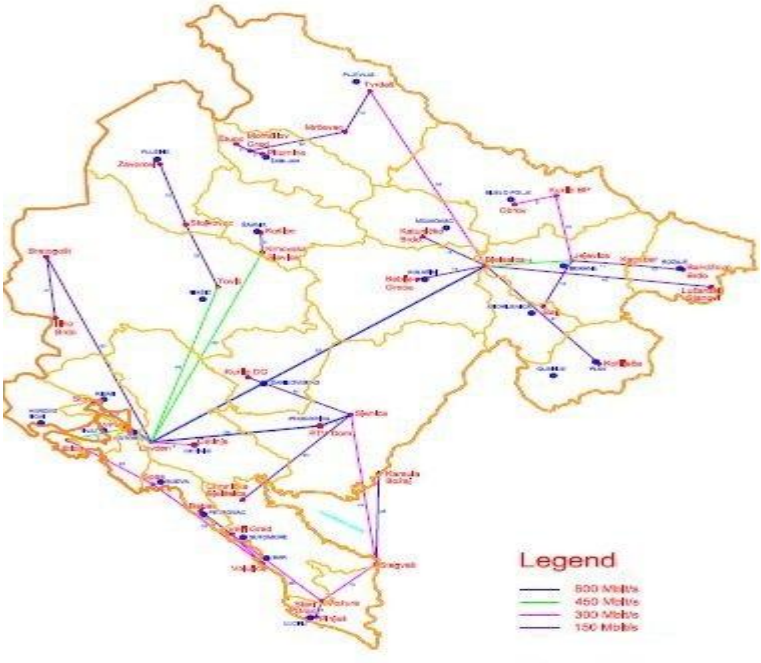


Figure 1: Topology of IP network – Brodacasting Center

2. Materials and methods

2.1. Configuration of PLC

The control logic of modern diesel generators is based on the application of PLC (programmable logic controller) controllers and operator panels. The PLC sets and overview values and parameters of the diesel generators. PLC is settable through PC (computer).Acquisition of data is through the input analog and digital modules, and control signals are sent via the output modules [4].Considering that the Broadcasting Center owns diesel generators from different manufacturers, with diferent control systems, in order to connect to the planned SCADA system, it was necessary to replace the old ones and to configure the new PLCs. In accordance with the conditions present at the telecommunication sites, engineering experience and standards, the configuration of the PLC was adjusted, which is important for operation and maintenance of diesel generators.

Figure 2: Wiring and instalation of diesel generator

The diesel engine, and therefore the diesel generator, operates in optimal mode when the load is at 75 ÷ 80% of nominal. This load has the lowest fuel consumption. When the load falls below 50% of rated power, there is a rapid drop in efficiency. In event of a network power supply failure, diesel generator takes 10 seconds to start and an additional 20 seconds to take over the load of the object. The diesel generator control was configured to follow network parameters fluctuations for 120 seconds. If during this time it turns out that the voltage is within the normal limits defined by the standards, the diesel generator stops working. The minimum amount of fuel that must be present in the tank is 30%, which allows a continious operation of 72 hours. Diesel generator has the option of 3 consecutive starts, because there are situations when due to the cold and similar negative conditions the engine cannot start from the first time.

The following signals were wired to the PLC inputs:

- fuel levels in the tank (lower safety level, lower operating level, upper operating level, upper critical level),
- refrigerant level in the arbor,
- fuel flow,
- diesel engine speed,
- diesel engine temperature,
- diesel engine oil pressure,
- coolant temperature,
- generator voltage, current, power, frequency,
- network voltage, current, frequency,
- 12 VDC battery voltage,
- switch contact statuses,
- communication with ATS (Automatic Transfer Switch) unit for network-generator switching.

The following signals were wired to the PLC outputs:
- control of diesel engine heating,
- indication of diesel engine operation,
- indication of generator operation,
- indication of alarm status.

The safe and reliable operation of the diesel generator required the following functions to be realized:
protection by fuses,
- overcurrent and short circuit protection,
- automatic shutdown of the generator, via switches with electronically adjustable protection fromcurrent overload and short circuit,
- protection against dangerous touch voltage.

Automatic shutdown of generators and diesel engines is necessarily in the following cases:
- low oil pressure,
- increased engine speed (120% of rated speed),
- diesel engine coolant temperature above the permitted limit,
- generator whorl temperature above the permitted limit,
- generator current value above the permitted limit,
- short circuit.

In certain situations the generator switch is not switched off but the diesel engine is stopped:
- low fuel level in the tank,
- generator voltage for a certain amount out of the permitted limits,
- generator frequency out of the permitted limits [5].

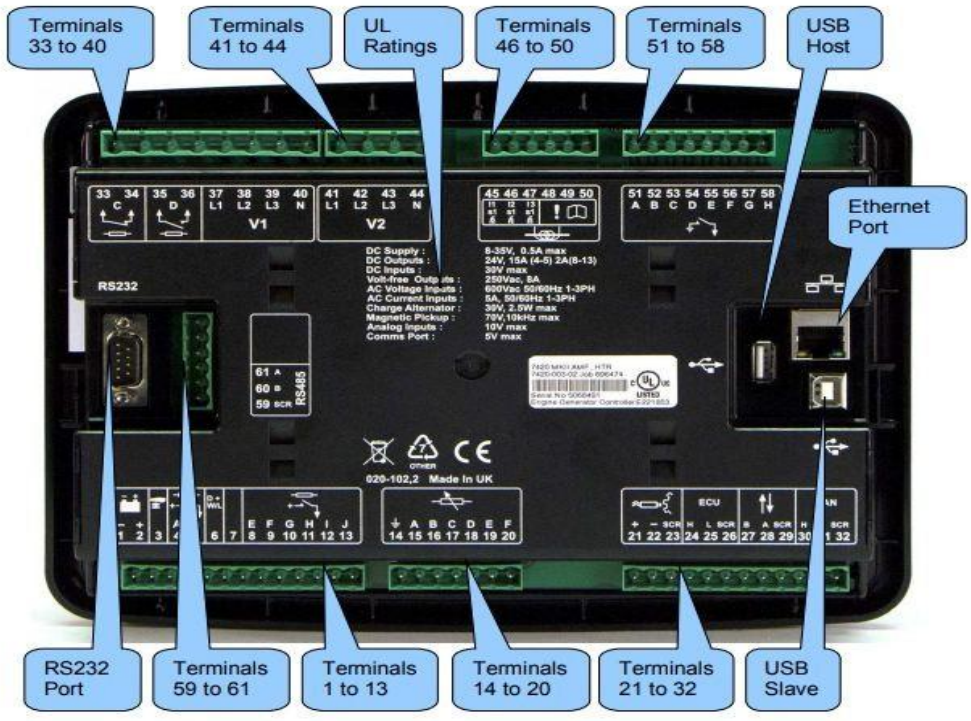


Figure 3: PLC's backround – positions for wiring input and output signals

Display shows the characteristic values and parameters of diesel generator in the form of tables, alarms, help messages, warnings and singaling. Confirmation of the alarms and review of the events database are performed, reports are generated with the results of real logged data and recommendations to the operator. Based on the data analysis, a realistic picture of the condition of the equipment is obtained. The function keys on PLC are used to select the views on display (status, alarms, values, etc.) [3]. Events can be listed at any time, such as: switch manipulation, power network failure, etc., or alarm lists can be displayed: protection switching, power supply delay (longer than 30 s), engine speed overrun, critical fuel level, etc. When an alarm shows, an alarm lamp flashes at a frequency of 0.5 Hz, every 10 seconds. The displays has a message which describes the event that caused the alarm. Confirmation of the alarm on the panel the sound signal is turned off and the light signal remains until the cause of the alarm is eliminated. If more than one alarm event occurs on the display, the most recent alarm is showed first, and each alarm must be confirmed individually.

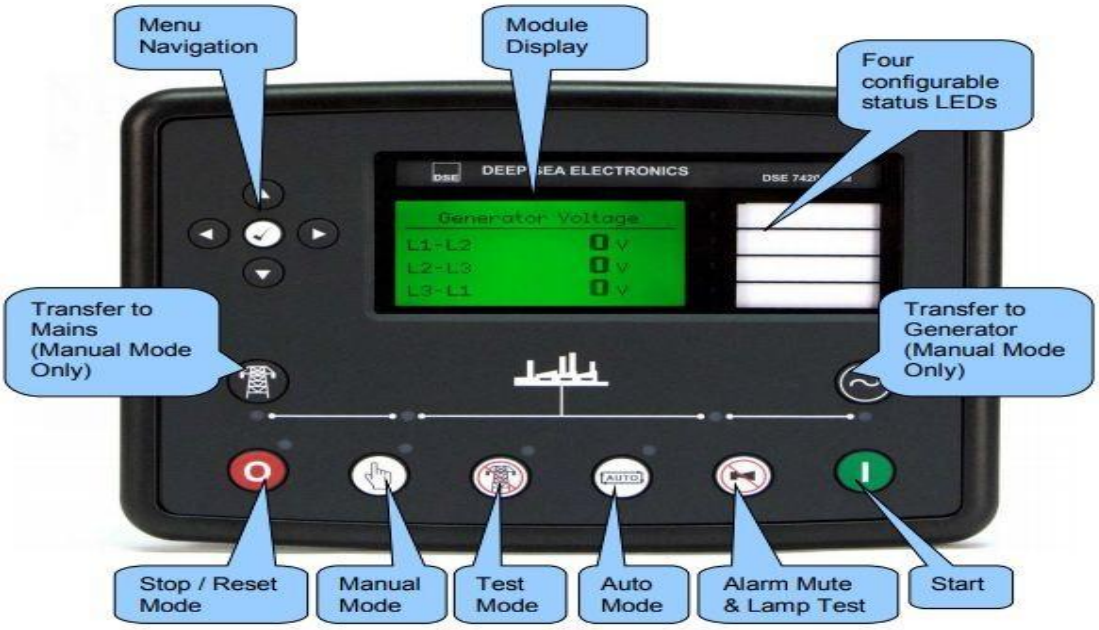


Figure 4: Front view of PLC – display and manipulation keys

2.2 SCADA implementation

After installation the same type of PLC (Deep Sea DSE 7420), in every type of diesel generators of Broadcasting Center of Montenegro. With the software, through IP address, it is possible to access each diesel generator individually, check the specified parameters, its status and exercise control over it. The appearance of the controller on the software is identical to the real one, so the view is to the user as if he were in front of the diesel generator.

Figure 5: Look of software for PLC

With the web application it is possible to monitor all implemented diesel generators. The application's name is DSE WebNet and is very well optimized [2]. Requires, in addition to the existing PLC, the installation of a Gateway, which must have a SIM card. The SIM card also allows sending SMS for configured alarms as well as start / stop of diesel generators.

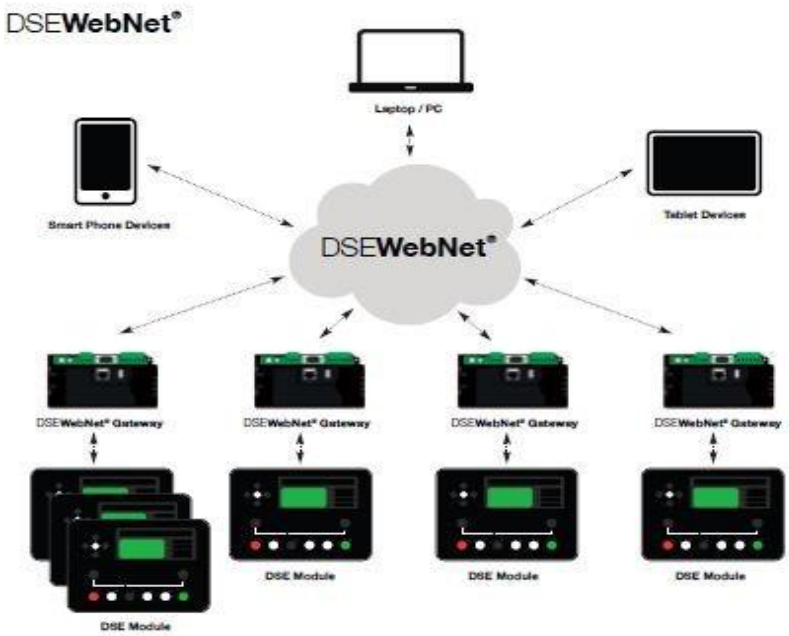


Figure 6: DSE WebNet monitoring

This application allows you to monitor and control the status of the diesel generator, where the color of the symbol will change after changing the status. That means if the diesel generator rest, it shows blue, if runs green, or if it is alarm shows red.

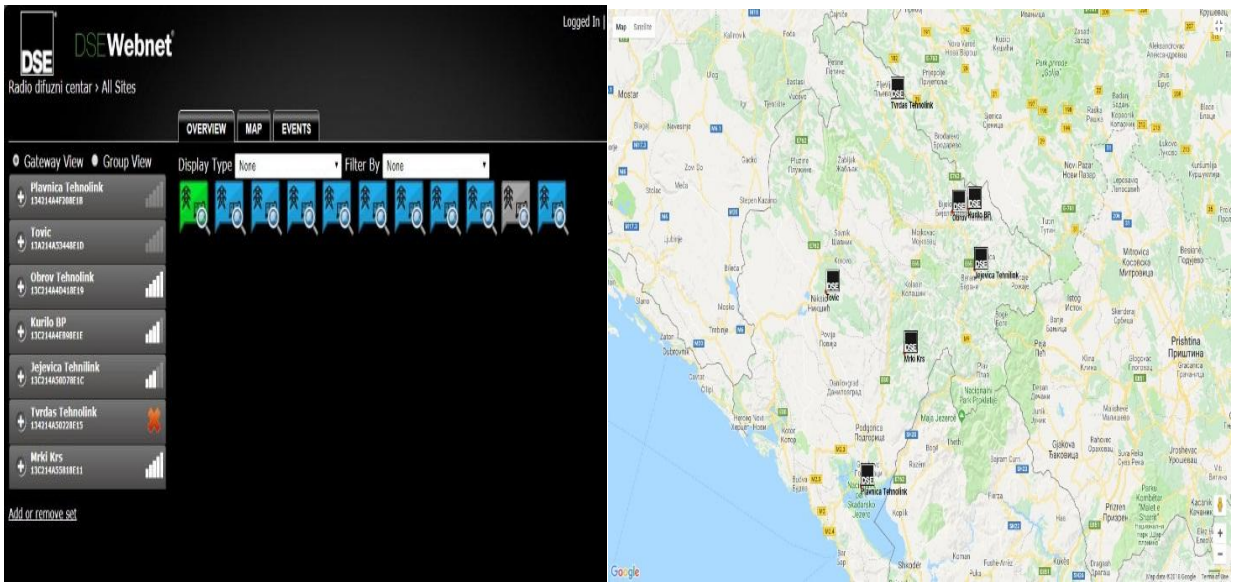


Figure 7: SCADA system view – during the implementation process

Deep Sea also has a mobile application, which the user has possibility to access, check status and manage the generator at any time.

Figure 8: Mobile application view

4. Results and Discussion

After commissioning SCADA system, Broadcasting Center had immediately improvements. On some sites the problems with power supply were noticed, which contributed to the rapid reaction and repair of the observed failure. For example, the problem with drop voltage to 160 V was observed every 20 minutes. After a detailed analysis, and afterwards the mending of undeground power supply cable, the fault was removed and the equipment was able to operate. In some sites, an increase in voltage was observed to above the permitted value (up to 250 V).

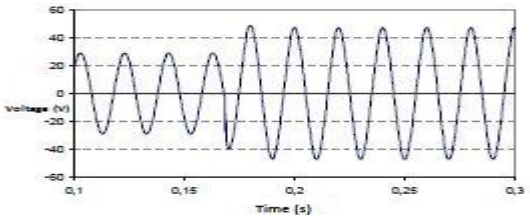
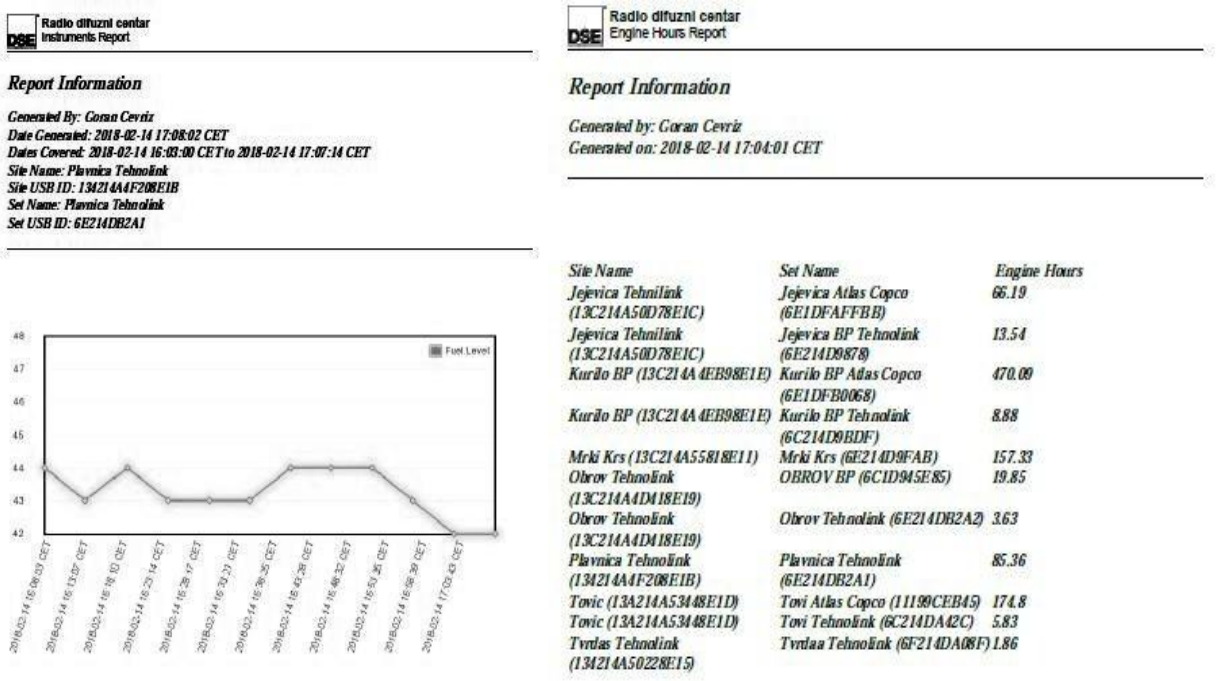


Figure 9: Overvoltage

Because of very hard conditions in winter, bad access roads, untimely reaction of power distribution company, diesel generator runed continuosly for several days. SCADA helped to check the situation and improve faster reaction. So, on some site in 2015 diesel generator runed 552 h, and in 2017 runed 326 h (41 % less). On other site in 2015 diesel generator runed 1207 h and in 2017 runed 895 h (26 %). Also, some sites had the situation without power supply less time than before SCADA implementation.

The application provides the ability to send the given information to the email users, which is very useful for generating daily, weekly or monthly reports for someone who wants to follow the situation and improve functioning of the whole system.



Radio difuzni centar
Instruments Report

Report Information

Generated By: Goran Cevriz
Date Generated: 2018-02-14 17:08:02 CET
Dates Covered: 2018-02-14 16:03:00 CET to 2018-02-14 17:07:14 CET
Site Name: Plavnica Tehnolink
Site USB ID: 134214A4F208E1B
Set Name: Plavnica Tehnolink
Set USB ID: 6E214DB2A1

Radio difuzni centar
Engine Hours Report

Report Information

Generated by: Goran Cevriz
Generated on: 2018-02-14 17:04:01 CET

Site Name	Set Name	Engine Hours
Jejevica Tehnilink (13C214A50D78E1C)	Jejevica Atlas Copco (6E1DFAFFBB)	66.19
Jejevica Tehnilink (13C214A50D78E1C)	Jejevica BP Tehnolink (6E214D9878)	13.54
Kurilo BP (13C214A4EB98E1E)	Kurilo BP Atlas Copco (6E1DFB0068)	470.09
Kurilo BP (13C214A4EB98E1E)	Kurilo BP Tehnolink (6C214D9BDF)	8.88
Mrki Krs (13C214A55818E11)	Mrki Krs (6E214D9FAB)	157.33
Obrov Tehnolink (13C214A4DA18E19)	OBROV BP (6C1D945E85)	19.85
Obrov Tehnolink (13C214A4DA18E19)	Obrov Tehnolink (6E214DB2A2)	3.63
Plavnica Tehnolink (134214A4F208E1B)	Plavnica Tehnolink (6E214DB2A1)	85.36
Tovic (13A214A53448E1D)	Tovi Atlas Copco (11199CEB45)	174.8
Tovic (13A214A53448E1D)	Tovi Tehnolink (6C214DA42C)	5.83
Tvrdas Tehnolink (134214A50228E15)	Tvrdaa Tehnolink (6F214DA08F)	1.86

Figure 10: e – mail reports

5. Conclusion

An example of the strategies used to contribute to the stability of the power supply is the installation of a backup power system. In order for the mentioned system to have maximum efficiency in operation, it is neccessary to have SCADA. All analysis and examples told us how is important to have backup power supply, which is the most important part for increasing the reliability and power quality. Every company, with telecommunication or power supply system, has Maintenance and Control Center. As one of these, Broadcasting Center of Montenegro has mentioned Center, where was installed SCADA system for diesel generators.

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