

The Remote Control of Power Supplies – Experience of Exploitation*

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Abstract: The remote control of power supplies has been developed according to Telecom Serbia's technical requirements. It has been exploited for five years. From this system specially developed for the needs of a telecom company, it has evolved into a universal system.

After five years of usage of SDNU, analysis and systematization of the detected problems were carried out. The data were collected from about 200 external devices. The analysed objects were of the first priority, located in larger cities, but also objects in inaccessible locations far from the city. The identified problems were grouped into four categories. According to classification of the problem, recommendations about SDNU users' work organisation were made in order to exploit the results effectively.

This paper presents the characteristic forms of signals for every category of the detected problems.

Keywords: Remote control, Power supply, Exploitation.

1 Introduction

SDNU system enables remote monitoring and control of the devices that are placed in remote objects. System is specially developed for the needs of Telecom Serbia. It is usually used in objects which are of great importance for the user, or objects that are placed in remote areas. Heart of this system is the device for data acquisition DNU24 which is mounted in the peripheral objects. With its probes that are connected to characteristic measuring points, by the request of the user, it measures the currents velocity, voltage or temperature. Measured quantities are sent to the computer in the monitoring center. Graphical display on the computer gives clear and unambiguous information about the status of the device which is being monitored. Collected data is memorised and the user can get the report of the work for monitored device at any time. In this way, we can very simply do the analysis of the work of monitored device, or work of the system of devices in monitored object. It was

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*Award for the best paper presented in Section *Electronics*, at Conference ETRAN 2011, June 6 – 9, Banja Vrućica – Teslić, Bosnia and Herzegovina.

observed that there are objects where single devices work very good, but that with their connection in the system creates a problem that is not easily recognized. With correct usage of SDNU and with analysis of the results by the side of professional staff, mistakes can be quickly noticed and removed before they create a breakdown in the work and greater consequences to the devices

In the five year exploitation period, product-development team of the remote monitoring and control system SDNU has faced different problems connected to the work of devices which are being monitored, installation in monitored objects and disorders created by the weather conditions.

2 Reports of Remote Control

Reports on the work unit, obtained from SDNU, contain important data, which indicate the operation of the unit, problems that occur (incidents), a skilled analysts from these reports can reveal the cause of the incident. Remote monitoring devices not only allow the supervise company to determine what is right on the device and that adjustments or repairs are needed. These reports also allow to device manufacturers to determine defects in the devices which were monitored and improve their production process.

Report of the remote control can be used for different purposes. The most common application is to gain insight into device operation and incidents that occur. However, these reports can be used for different analysis, such as analysis of the incidents which locations are most likely to occur, the analysis of the most common causes of accidents, etc.

All reports received from SDNU must be analyzed and this analysis document. In the addition is given the suggestion of the main phases that each documented report of remote monitoring must go through. Bacis phases [4] can include the following.

1. Identification of the report - Report has been identified at the moment when it arrives in the computer system and when the person that follows the remote monitoring notices that there is an incident that occurred on the device. Incident can also be reported by SMS. Each report about the incident (as well as the foregoing daily reports about the work of the device) has its own unique mark, which consist from the date and time when incident occurred, as well as the mark of the device and location where it is placed.
2. Storage and usage of the report - Reports that arrive must be taken into consideration as soon as they are identified, in order to undertake the necessary measures, so that we do not have failiure in the work of the device. However, these reports have to be stored on the computer, so that we are able to do additional analysis of the report. Also, we need to

define who will be responsible for following the reports, gathering them, storing them and later analyzing them. Employee which is responsible for the that (usually they are employees of the monitoring center) have to be appropriately trained.

Ability to recognise priority in obtained reports is very important. Not every report of the remote monitoring will indicate on the incident which causes the system to stop working. Sometimes, incidents are less significant. That is why we need to define which reports indicate on urgent actions (repairs, significant adjustments, replacement of parts..), because, for example, they indicate that device has stopped working and that system will not be able to function. Urgency of action in relation to results of the report needs to be based on detailed analysis of the risk. Risk analysis should take into consideration all of the damages that can occur with malfunction of the device, with possibility of the damages appearing again.

3. Approach to the reports – Approach to the reports should be granted only to employees in the monitoring center, which are appropriately trained for conducting this activity.
4. Rejection of the reports – Not all of the reports from monitoring center should be stored forever. It is enough to keep the reports from previous three years. However, we need to make report analysis for each year and to store them as documents for acquisition the new knowledges in the company. From each analysis we are able to see the deficiencies in the work of the device and to determine places for improvement.

3 Categorization of the Problem of Power Electronics

Devices for continuous power feed between primary sources of energy and users-consumer devices. Besides the fact that we need to provide the continuous work of consumer device, devices for continuous power are awarded the protective function so we can say that they represent heart of every system. There are different factors that affect the work of equipment which is powered from the electrical network, and the quality of the electrical energy is one of them. Influence of the voltage changes in the electrical network is directly transferred to consumer devices, and there is mutual influence of the devices that are connected to the same power line. Correct work of the devices of Power electronics is one of the conditions for undisturbed work of the equipment which is powered from electrical network.

Analysis conducted over the period of years have confirmed that many of the failures in telecommunication systems are caused by the shutdown of the devices that are used for power supply.

The analysis of reports which are drawn from the existing system SDNU mounted in Serbia and Republika Srpska at about 200 peripheral structures, was found that the problems of the power devices can be classified into four groups:

1. External Factors

The problems caused by external influences such as incorrect incoming voltage from the power company, atmospheric discharges, intervention by unauthorized persons, etc. are often the cause for malfunctioning. Rectifier plant must be adapted to conditions by, wherever possible, to protect consumer devices from external factors. Protective role of rectifier systems can be classified in the first and second group of problems.

2. The Quality Of The Delivered Equipment

The delivered power electronic equipment is often not in accordance with the specifications under which it is declared as stated in 1. For example, rectifier systems must meet the required standards. One of the important features of these regulations is to charge the battery at IVV (voltage-current-voltage) characteristics. Only in this way it is possible to achieve the life of the battery capacity prescribed by the manufacturer. However, the practice is often the case.

3. Installation Errors

Errors occurred while connecting installations are common in buildings mounted decades ago, but are also present in the new facilities. It is very difficult to detect errors of this type. Error can be manifested in different ways and therefore difficult to locate. SDNU facilitates detection of such errors, but you need a good working knowledge of monitored devices and SDNU.

4. The Human Factor

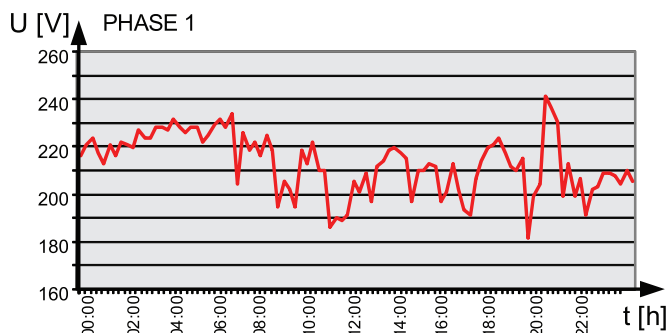
Non-intentional errors that occur caused by human factors are uncommon and cannot make the catastrophic consequences, but they are enough to lead to incorrect operation. Employees responsible for the equipment monitoring, resolve problems in different ways to avoid downtime and catastrophic outcomes. Often, unintentionally, other problems are caused.

4 Identified Issues After Five Years of Exploitation

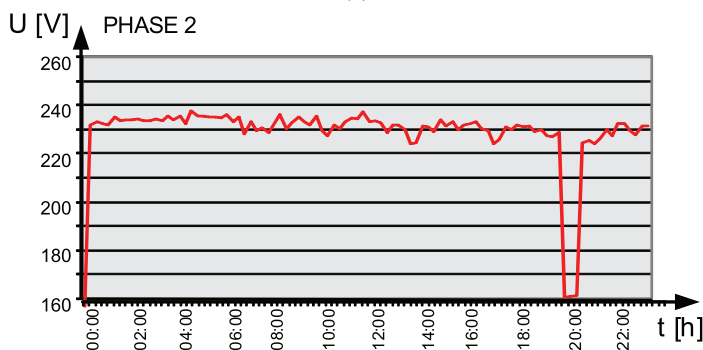
During five years of exploitation many irregularities have been observed. They were recorded and analyzed in detail by experts of power electronics. Some of them are mentioned here to illustrate the possibilities SDNU.

An example of the impact of external factors

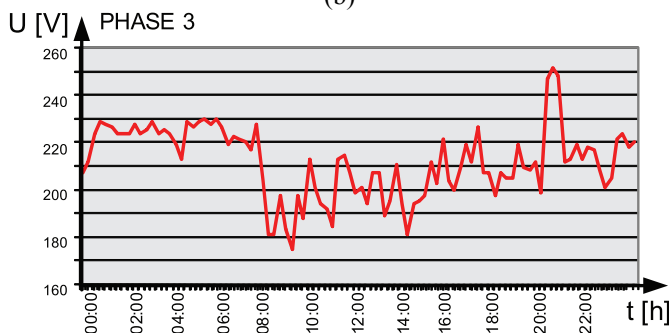
Figs. 1 and 2 show the captured signal forms of the input line voltage, which clearly shows the power supply problems. Fig. 1 shows the waveforms of all three phases of the input voltage signal. It was observed that the disappearance of one phase (Fig. 1b) causes an increase of voltage values of other two phases (Figs. 1a and 1c). Increase in input voltage causes disruption in the work of consumer products and even their failures.



(a)



(b)



(c)

Fig. 1 – Forms voltage mains voltage: (a) first phase; (b) second phase; (c) third phase.

Waveform shown in Fig. 2 shows the measurement of a input phase voltage during the day. Measurements were recorded in fifteen minutes intervals. It is clear that during the 24 hours interval, supply voltage was disrupted for four times. The first disappearance lasted for 7h, the second and third fifteen minutes and the last 45 min. Common variations in supply voltage can affect backup-battery life by reducing its capacity.

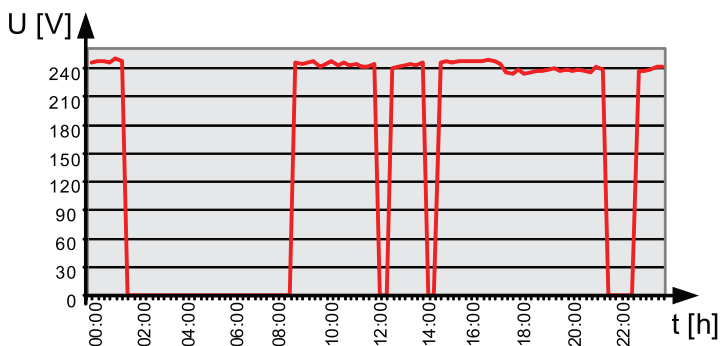


Fig. 2 – (a) Forms voltage one phase mains voltage.

An example of the impact of quality of delivered equipment

Figs. 3, 4 and 5 show the voltage and current waveforms at the output of rectifier plants and demonstrates the way they work. Comparing Fig. 3 and Fig. 4 easily can be noticed that plant rectifiers charge batteries in different manners. Fig. 3 shows rectifier which charges the battery without the regime of constant current and without charging voltage V_{boost} . The battery is charging with 10 A and with voltage V_{float} .

Fig. 4 shows the charging waveforms of batteries that are charged in compliance with standards. Battery is charged with constant current to a preset voltage charging (V_{boost}). The battery voltage rises exponentially to voltage V_{boost} . After reaching that voltage, charger goes into constant voltage mode, where the charge current decreases and the voltage is held constant. When battery current reaches a predefined value, the voltage applied to the battery gets the value of V_{float} .

Fig. 5 shows the voltage and current waveforms of rectifying plant that does not charging the battery properly. The battery has defined boost and float voltage, but there is no constant current charging. It can be seen in Fig. 5a that there it is not applied an exponential charging curve. Peak current (Fig. 5b) that fully charges the battery to V_{boost} damages the battery.

Battery charging, shown in Figs. 3 and 5, very quickly lead to battery damage. Rectifier plants that charge the battery in the manner shown in Figs. 3 and 5 after several times damage the battery (battery lose its capacity).

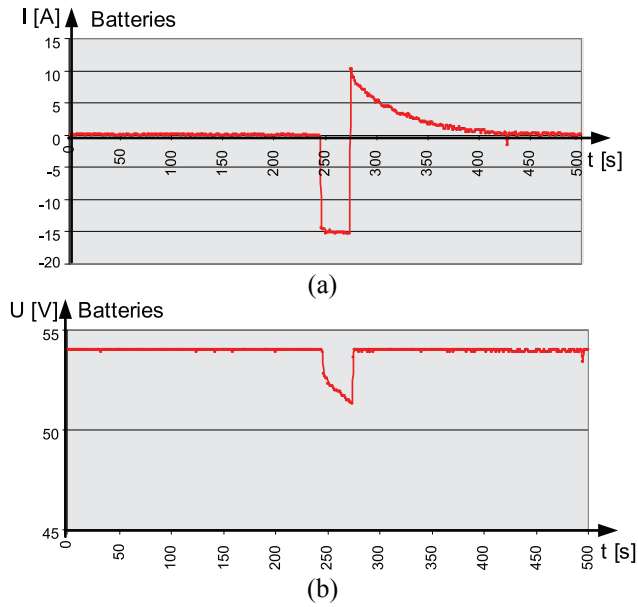


Fig. 3 – Forms of signals at the output of power supplies: (a) voltage; (b) current.

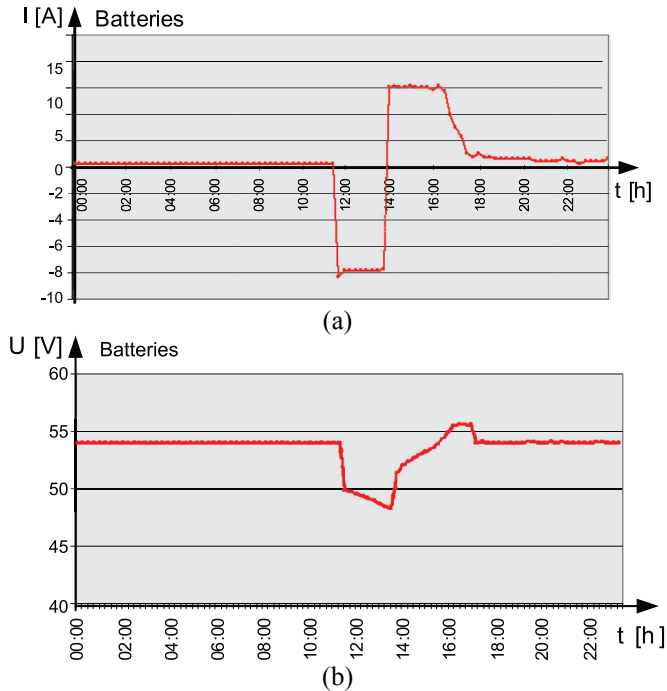


Fig. 4 – Forms of signals at the output of power supplies: (a) voltage; (b) current.

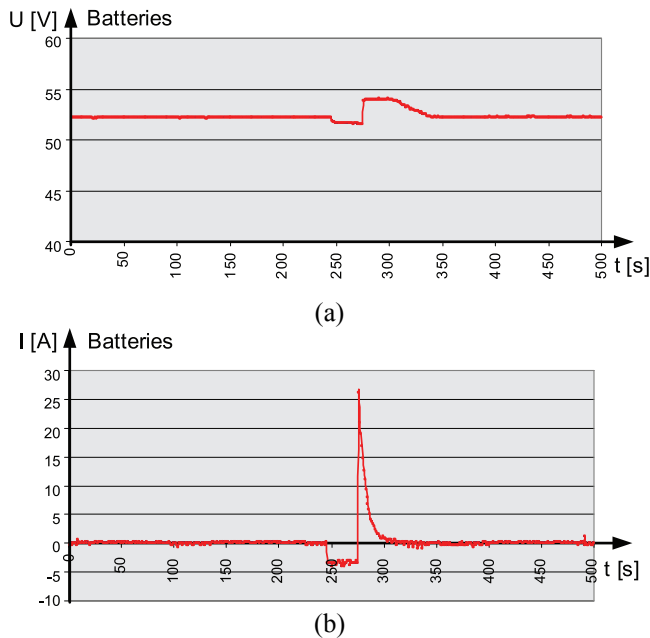


Fig. 5 – Forms of signals at the output of power supplies: (a) voltage; (b) current.

An example of influence of installation errors

An example of influence of installation errors is given in Fig. 6. Waveforms on the left represent supply voltage, and waveforms on the right output voltage of the generator.

Fig. 6 clearly shows that the backup unit properly overtakes the role of power supply when grid failure occurs. However, the output voltage of backup unit exceeds value of 300V, which can affect the consumer devices. Analysis revealed that the neutral conductor is not properly connected.

An example of influence of the human factor

An example of the impact of human factors: workers responsible for maintenance of power electronics devices always striving to increase the use of batteries. Very often they make the situation worse.

Fig. 7 shows the battery voltages. It can be easily seen that one battery is charging another battery. This means that one battery is malfunctioning. We thus conclude that the workers wanted to strengthen the system by adding an extra set of batteries. This caused that the set of high capacity batteries charge the weak set of batteries. In this manner, a counter effect occurred and instead of increasing overall capacity by adding a set of battery, battery capacity is reduced because the defective battery consumed energy.

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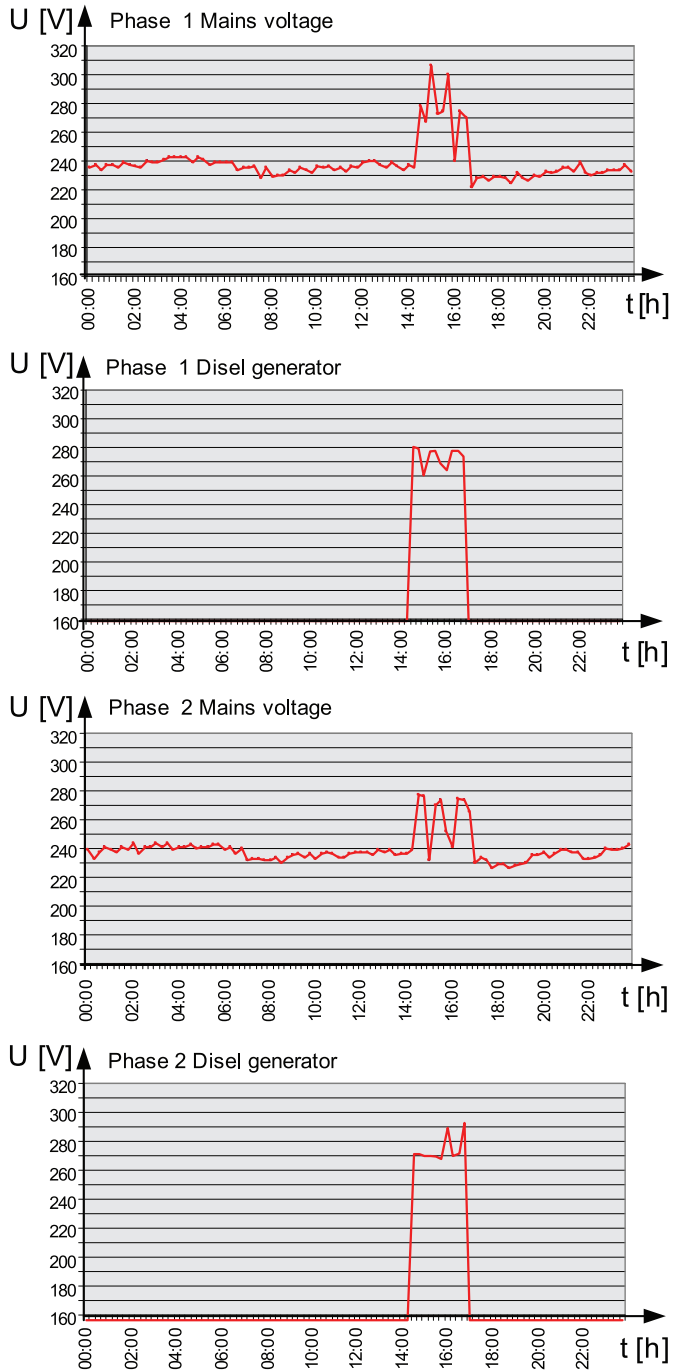


Fig. 6 – Forms of signals main voltage end diesel generators.

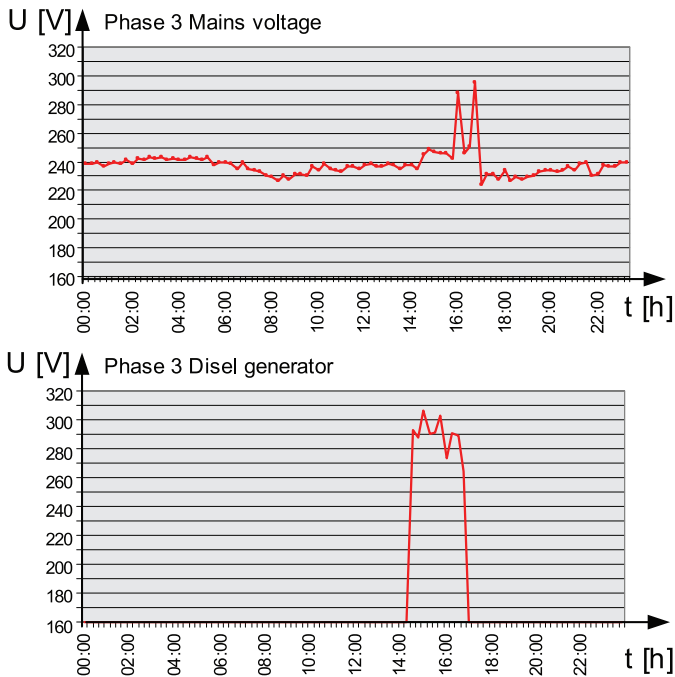


Fig. 6 (continuation) – Forms of signals main voltage end diesel generators.

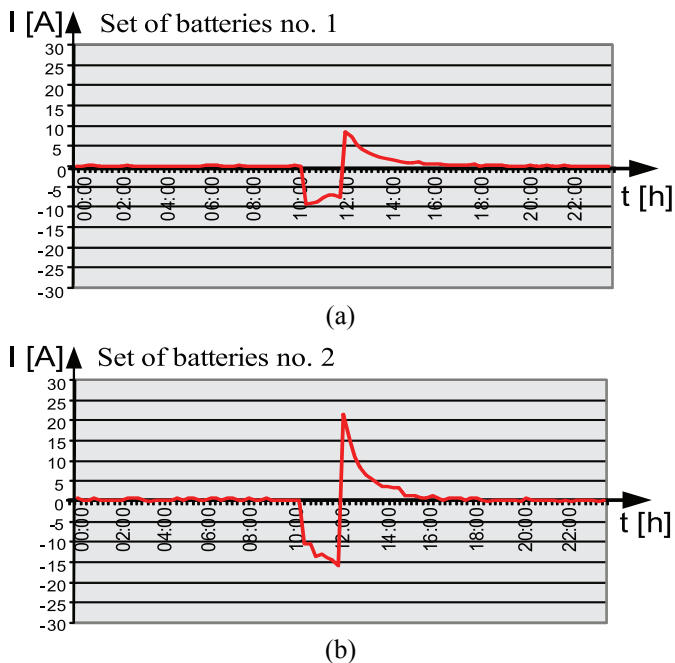


Fig. 7 – Forms of signals: (a) first battery bank; (b) second battery bank.

5 Conclusion

Proper use of reports generated by the system for remote monitoring and management SDNU, as discussed in chapter two, can help prevent the operation of monitored systems. No matter which devices are being monitored, errors in setting up and installation of equipment can occur. On the other hand, weather conditions cannot be predicted and therefore, there is possibility of equipment failure. To take full advantage of SDNU, the user should make a proper organization of employees. In other words, failure information should be sent to the operator who can react accordingly. SDNU device provides detailed information for each measured size and the occurrence of an alarm is transmitted immediately when it happens. The experts who analyze the results sent by SDNU can very easy recognize the problem and eliminate it before damage occurs. SDNU offers the user the freedom in the choice of measured values, alarm thresholds and where the measured information will be sent. Therefore, the best results are achieved if SDNU device is properly used.

6 Acknowledgement

This paper is partially supported by the project TR32016 which is carried out with the financial support of the Ministry of Science and Education of the Republic of Serbia, to which the authors are very grateful.

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