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Continuous Current Source with Control and Supervision through the Arduine Platform in a CC Electric System in a Telecom Station

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Abstract

The transformation of mobile telephony in Brazil and in the world comes the growth of the telecommunications sector, which is renewing itself at great speed about technological advances. Understanding the functionality of a Direct Current Source, an integral part of a Direct Current Electrical System, is necessary. The present work aims to evaluate the procedures and functionality of an FCC to serve the DC power system, as well as, to learn about the application of Direct Current Source (FCC), it was sought to specify the operational conditions of the FCC, an integral part of the basic infrastructure of a DC power system at a telecommunication station. Bibliographic and *field research, of a quanti-qualitative nature, was carried out, having as place of research a Telecom station located in the city of Manaus. According to the data collected at the locus of the research, the satisfactory result was obtained with the implementation of the Arduino platform for installation, activation and testing of alarms from the FCC.*

Keywords: CC system; Control and Supervision; Telecom.

Resumo

A transformação da telefonia móvel no Brasil e no mundo vem o crescimento do setor de telecomunicações, que se renova em grande velocidade no que se refere ao avanço tecnológico. Conhecer a funcionalidade de uma Fonte de Corrente Contínua, parte integrante de um Sistema Elétrico em Corrente Contínua, se faz necessário. O presente trabalho objetiva avaliar os procedimentos e funcionalidade de uma FCC para atender o sistema de energia em corrente contínua, bem como tomar conhecimento da aplicação de Fonte de Corrente Contínua (FCC), buscou-se especificar as condições operacionais da FCC, equipamento integrante da infraestrutura básica de um sistema de energia CC em uma estação de telecomunicação. Foi executada a pesquisa bibliográfica e de campo, de natureza quanti-qualitativa, tendo como lócus da pesquisa uma estação de Telecom situada na cidade de Manaus. De acordo com os dados levantados no lócus da pesquisa obtivesse o resultado satisfatório com a implementação da plataforma Arduíno para instalação, ativação e testes dos alarmes oriundos da FCC.

Palavras-chave: Sistema CC; Controle e Supervisão; Telecom.

INTRODUCTION

According to the demand and use of the telecommunications network, it is essential and necessary that the DC power system is reliable, always aiming at the good performance and proper functioning of the system, and considering Brazil with its continental dimensions, the sector Telecom becomes strategic and of fundamental importance for the technological development of all regions of the country.

Martins (2004), a Continuous Current System in Telecommunications, or simply DC Power System, aims to meet the demand of telecommunications stations by supplying voltages at -48 VDC (positive grounded) or +24 VDC (negative grounded) through the installation of a Direct Current Source, as well as specific Telecom equipment, and other loads such as: Alarm Control System (in this present work, the Arduino platform is used); Firefighting system; Emergency Lighting, with the objective of providing the supply of all the loads necessary for the operation of the station, also supplying the equipment during the power outage, coming from the non-essential AC power system (commercial electrical network). The FCC, Events from the USCC, such as AC failure; Discharging battery; Rectifier failure; abnormal fluctuations are available on a terminal to be reported to the external environment and sent to a Central Supervision. So, the present work proposed the elaboration and assembly of an interface using the Arduino platform for the DC power system with supervisory control for the collection, monitoring and control of the abnormality events present at the FCC, basic component of the CC system at a power station. Telecom, also allowing the construction of a network for remote control of the equipment, as well as adjustments and programming of parameters that may be necessary.

RECTIFIER SYSTEM COMPOSITION - FCC

The Direct Current Source or Rectifier System, is presented in the form of a shelf is equipped with modular capacity to control up to 04 (four) rectifier units (URs) of 50A / -48V, switched at high frequency, with forced ventilation and Supervision Unit and Microprocessor control, with an internally installed LCD operation interface, complemented by alternating current, direct and battery power distribution sections and with an output current capacity of up to 200 A.

The Rectifier Unit has the constant Voltage and Current quantities, with the purpose of transforming AC energy to transform the AC energy from the electrical network, into DC energy compatible with the consumer and batteries. Under normal AC network conditions, the batteries normally remain in "float" mode through the voltage applied to their terminals, via rectifier, and during the AC power outage, the batteries keep the consumer running. After the return of the AC network, if the batteries have discharged above a certain value, they will go through a recharging process.

Operational alternatives:

a) **Normal situation**: under normal conditions, with AC network present, the batteries will remain in float mode through the Rectifier. The current necessary for the operation of the consumer comes exclusively from the Rectifier, except for cases of sudden variations in the current of the consumer in a time shorter than the dynamic regulation of the rectifier.
b) **AC failure**: In the absence of AC, the rectifier ceases its operation, and the current requested by the consumer will be supplied only by the batteries.
c) **AC Voltage Return**: With the normalization of the AC power supply, the Rectifier starts supplying the consumer's power, as well as recharging the batteries in a floating or charging regime, if the batteries are ventilated.

RECTIFIER OPERATING DESCRIPTION

According to the Delta SR 300A/ -48V Technical Manual, the Rectifier Unit is governed by two stages of high frequency power conversion, and the power factor (FP) correction is performed using the topology called BOOST with switching frequency at 90 KHz, actuality responsible for the correction of the power factor and harmonics existing in the input current. The DC-DC converter uses the complete bridge type topology with frequency and switching at 90 KHz, being responsible for galvanic isolation and rectification of the DC output. The interface and control of the UR control circuits and protections during operation are carried out through the supervision of the rectifier system. If the input voltage exceeds the specified limits, the RH will be turned off, and will only restart when the input voltage returns to the specified range, in case of low voltage, a decrease in the output power is activated to limit the input current to values within the acceptable range. For voltages at the mains input, 276 to 300 V AC, the power factor correction stage is self-protected, and the waveform of the input current is not sinusoidal.

CONTROL AND SUPERVISION UNIT

The Omibra Indoor Energy Systems Manual (2015), the Control and Supervision Unit (USCC) was designed for the control, command and supervision of the Direct Current Source, consisting of Rectifier Units, Batteries and Distribution Units used in the telecommunications station.

Logic and analog signals necessary for the correct operation of the rectifier systems and other equipment are received and treated by the USCC, transmitting all the necessary commands for the correct operation of the equipment, controlled according to pre-defined adjustments or programmed by the technician at the USCC itself. The structure of the USCC is made up of different subsystems, each specialized for a specific application.

There is an interface, called IOS, and includes an interconnection with LCD and keyboards that allows the interaction of the operator with the system to consult the operating states and to make changes to the functional parameters, if necessary. The parameters that can be programmed through the Control and Supervision Unit (USCC) are as follows: Fluctuation voltage; charge voltage; load current limiting value, load cycle value; charge cycle completion value; maximum charge time after which an alarm is issued; Maximum charging time after which an alarm is issued; Value from which a maximum voltage alarm is issued; Value from which a low voltage alarm is issued.

The main features of MUCS are as follows:

- Monitoring and control of voltage and current of DC loads.
- Battery current monitoring (for each installed Battery Bank).
- Battery temperature monitoring.
- Thermal compensation of fluctuation stresses.
- Programmable limitation of battery charging current.

- Automatic (programmable) battery discharge test (Not applicable).
- Disconnection of the load through the LVDS System.
- Alarm log record.

Remote monitoring of the system can occur through 5 (five) relay contacts, all voltage-free, corresponding to the Rectifier Failure, Discharging Battery, AC Failure, Open DC Circuit Breaker and Abnormal Fluctuation alarms. Alternatively, an RS-232 port can be used to view all system and rectifier information on a local PC with resident software or by connecting to a modem on a remote PC. With this facility, it is possible not only to monitor, but also to control all parameters of the rectifier and the system. In addition, the system can dial up to three phone numbers to connect to the remote PC in the event of a system failure and will continue to dial until the failure is reported.

BATTERY BANK

The 48 V battery banks are of the sealed type (AGM) consisting of 04 (four) 12 V 105 AH batteries considering that it is possible to program the control and supervision unit (USCC) in accordance with any type of battery used.

MATERIAL AND METHODS

The present study consists of a bibliographic and field research, having a qualitative characteristic, with the procedure of describing the functioning of a DC power system. For this purpose, the ARDUINO platform was used to carry out the control and collection of information, where the control of the rectifiers and monitoring of the charge of the batteries and the electrical network in question was carried out. This information will be obtained and sent through a network to be designed and placed on a PC with SCADA-type supervisory software.

Qualitative research becomes a useful approach in this work, as it aims to present a tool that helps in solving a problem, because, according to Gerhardt (2009) qualitative research: “It is not concerned with numerical representativeness, but with deepening the understanding of a given problem, an organization and others. Researchers who adopt the qualitative approach are opposed to the assumption that defends a single research model for all sciences, since the sciences have their specificity, which presupposes their own methodology, since the researcher cannot make judgments or allow that their prejudices and beliefs contaminate research (GOLDENBERG, 1997, p. 34)".

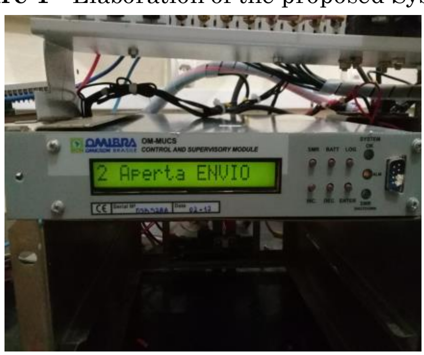
For Fonseca (2002), field research is characterized by investigations in which, in addition to bibliographic and / or documentary research, data collection is carried out with people, using different types of research (ex-post-facto research), action research, participatory research and others). Thus, the set of methods listed in this work add conditions to assist in understanding and detailing the functionality of a CC system.

RESULTS AND DISCUSSION

A Continuous Chains System in Telecommunications is a DC Power System that aims to meet the demand of telecommunications stations by supplying voltages at -48 VDC (positive grounded) or +24 VDC (negative grounded) specific Telecom equipment, as well as other loads, as mentioned above, the Alarm Control System (ARDUINO platform, in this study) stands out; Firefighting system; Emergency lights. All these fundamentals have the role of providing the supply of all the loads necessary for the operation of the station, also supplying the equipment supply during the power outage, coming from the non-essential AC power system (commercial electrical network).

The Description of Indoor Modular Power System at 48 VDC 200 A (Direct Current Source). The indoor power station is a 48 VDC / 50A Rectifier System with active load sharing controlled via the controllable current limiting and control unit; Micro-processed Control and Supervision Unit with LCD operation interface; complemented by output of dry contact alarms integrated to the Arduino platform to report alarms from the system, such as: rectifier defect; discharging battery; AC failure; open DC circuit breaker and abnormal fluctuation, as well as all system control, such as current sharing (equalization) of the currents supplied through the rectifiers, monitoring and control of voltage and DC output current and batteries, programming of all operating parameters of the System, complemented by Alternating Current Distribution Sections (with general isolating circuit breaker and thermomagnetic circuit breakers, one for each rectifier); DC distribution (equipped with NH00 delay fuses) and -48VDC battery bank, which can be sealed or ventilated (expandable in up to two battery banks). Figure 1 shows the interface of the system proposed in the work, demonstrating a real operating situation, interconnected, and acting. DC distribution (equipped with NH00 delay fuses) and -48VDC battery bank, which can be sealed or ventilated (expandable in up to two battery banks). Figure 1 shows the interface of the system proposed in the work, demonstrating a real operating situation, interconnected, and acting. DC distribution (equipped with NH00 delay fuses) and -48VDC battery bank, which can be sealed or ventilated (expandable in up to two battery banks). Figure 1 shows the interface of the system proposed in the work, demonstrating a real operating situation, interconnected, and acting.

Figure 1 - Elaboration of the proposed System.



Source - Own Authorship, 2018

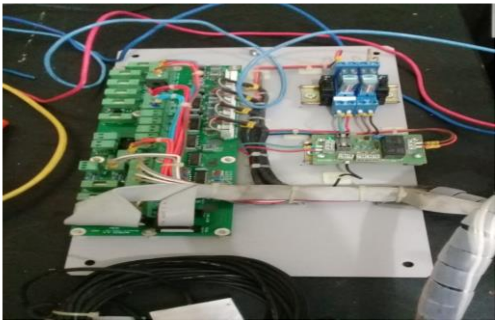
Figure 2 shows the proposed system in operation in a perspective opposite to that shown in figure 1, in this scenario it is possible to perceive the intercommunication of the system and its functionality. In this system it integrates all the conditions to monitor the functioning of the feeding and control systems of the station.

Figure 2 - Proposed System in Operation

Source - Own Authorship, 2018

Figure 3 highlights the layout of the elaboration and assembly of the system with the Arduino platform for integrating the device into the platform.

Figure 3 - Elaboration and assembly of the Arduino platform for Integration with the System.



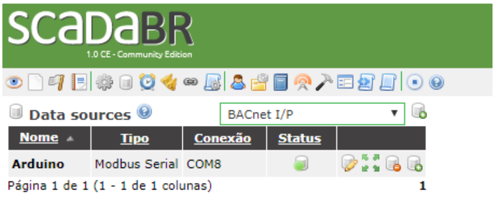
Source - Own Authorship, 2018

The properly installed system provides data that are then analyzed by specific software and that allows data tabulation and its proper interpretation, in this case the SCADA system is used.

SCADA SYSTEM

SCADA system connected to Arduino via serial communication, RTU serial Modbus protocol. SCADA is not a specific technology, but an application type. SCADA stands for supervisory control and data acquisition. Any application that obtains operational data about a system in order to control and improve that system is a SCADA application. This application can be a petrochemical distillation process, a water filtration system, a pipe compressor or anything else (AVEVA, 2018). Figure 4 shows the interface of the SCADA system connected to the Arduino.

Figure 4- Visual interface of the SCADA system



Source- Madeira, 2018.

Copa data (2018), SCADA systems allow the monitoring of predefined values, the entry of defined values, as well as other control interventions. The values collected at the lowest level are presented in the clearest and most understandable way possible, enabling user interventions. And one level up, engineers obtain panoramas, plans, documents and protect controlled processes. The structure of the SCADA system consists of physical data points and is calculated. They provide values and a time stamp, enabling real-time or historical data monitoring, control and reporting. The system captures the data generated by the system and the data points defined to be associated with the alarms are shown in figure 5.

Figure 5- Data points collected

Data points

Nome	Tipo de dado	Status	Escravo	Faixa	Offset (baseado em 0)
Bateria_Descarga	Binário		1	Registrador holding	1/0
Disjuntor_DCAberto	Binário		1	Registrador holding	3/0
Falha_AC	Binário		1	Registrador holding	2/0
Falha_Retificador	Binário		1	Registrador holding	0/0
Flutuacao_Anormal	Binário		1	Registrador holding	4/0

Source: Madeira, 2018.

Alarm management is associated with the process, including logging, hierarchization, distribution by operator and others. The alarms can be monitored in the watch list, as shown in figure 6.

Figure 6. Monitoring alarms in the watch list.

Source: Madeira, 2018.

The connected system is capable of supervising the operation of a direct current system in a telecom network.

According to Maluf (2008), among the facilities facilities of the infrastructure of a Telecommunications site, the DC Power System (direct current) has the purpose of supplying power at voltages of -48 or 24 volts to electronic equipment. The main objective is to supply all the loads necessary for the operation and maintenance of the station. It must guarantee the levels of tension and oscillation compatible with the equipment of the system and in an eventual lack of energy to sustain the demand. In addition to supplying specific telecommunications equipment, the following loads are normally supplied by the DC power system: Emergency lighting system; Fire fighting system; Emergency ventilation system for electronic telecommunication equipment; Alarm Control System.

Figure 4 shows the DC power system serving a telecom station, thus, the system is monitored and possible failures and inconsistencies in the system's operation become possible for detection and possible analysis, thus, the monitoring system using the integrated system a a telecom station, generates coordinated conditions to improve the understanding and functionality of the system within a demand for control and monitoring.

Figure 7-DC Power System Serving a Telecom Station.

Source - Own Authorship, 2018.

ARDUINO PROGRAMMING

According plware (2018) Arduino is a free hardware platform, designed with an Atmel AVR microcontroller. It is an open-source board based on a simple input / output circuit, micro controlled and developed on a library that simplifies the writing of C / C ++ programming, it can be programmed with the Arduino programming language, which is based on the Wiring language and its development environment is based on Processing. Figure 8 shows the Arduino programming system.

Figure 8- Arduino programming commands.

```
#include <SimpleModbusSlave.h>
#define alm1 8
#define alm2 9
#define alm3 10
#define alm4 11
#define alm5 12
enum
{
ALM_1,
ALM_2,
ALM_3,
ALM_4,
ALM_5,
HOLDING_REGS_SIZE
};
unsigned int holdingRegs [HOLDING_REGS_SIZE];
void setup ()
{
modbus_configure (& Serial, 9600, SERIAL_8N1, 1, 2, HOLDING_REGS_SIZE, holdingRegs);
modbus_update_comms (9600, SERIAL_8N1, 1);
pinMode (alm1, INPUT);
pinMode (alm2, INPUT);
pinMode (alm3, INPUT);
pinMode (alm4, INPUT);
pinMode (alm5, INPUT);
}
void loop ()
{
modbus_update ();
digitalWrite (alm1, HIGH);
digitalWrite (alm2, HIGH);
digitalWrite (alm3, HIGH);
digitalWrite (alm4, HIGH);
digitalWrite (alm5, HIGH);
holdingRegs [ALM_1] = digitalRead (alm1);
holdingRegs [ALM_2] = digitalRead (alm2);
holdingRegs [ALM_3] = digitalRead (alm3);
holdingRegs [ALM_4] = digitalRead (alm4);
holdingRegs [ALM_5] = digitalRead (alm5);
}
```

Source: Own authorship, 2018.

The combination of the tools that integrate the monitoring system of the action tools to analyze the sources of direct current to verify the maintenance of a telecommunications system in a station. It has become a satisfactory system and suitable for activities that require combined support for functionality.

CONCLUSION

This study presents the integration between the areas of power electronics combined with the control of systems and computer networks. In the study of Direct Current Source (FCC), an integral part of a DC power system to serve a Telecom station, it was successful in controlling and monitoring the FCC of the Telecommunication station in question, promoting the non-loss of information from data, reporting abnormality events from the equipment through the Arduino platform to a supervisory central that controls all the information generated, thus optimizing the functions and visualizing the proposed system, as well as guaranteeing the integrity and normal functioning of this system as a whole .

The work became important in an integrative way to scientific and practical knowledge regarding the direction for the training of electrical engineering professionals, as well as presenting the forms of execution and implementation of the activities relevant to the presented project. The study initiative suggests that studies be expanded to that system that requires energy sources that requires functional monitoring to generate more efficiency and bring benefits to the segment.

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