Investigation into Voltage Drop Indicator to Overcome the Current Failure of the Switch

Perera DHM [1]
Fernando CAN[2]

ABSTRACT

Telecommunications is one of the most important and rapidly developing technologies, and it has seen so many great inventions over the past fifty years. Perhaps one specific and highly visible example of the recent change in the telecommunication has been the rapid growth in mobility, for both business and residential use, and its potential extension from speech into mobile internet and related data application.

From its humble beginning with the telegraph, Telecommunication with the use of electricity has come a long way. Physical distance is conquered instantly, and any telephone in the world can be reached through vast communication networks that span oceans and continents. We use satellites in space, and sub-marine cables under the sea.

This report is the result of my Industrial Training, carried out at well known reputed organization from 04th August 2008 to 04th February 2009. These training activities were mostly carried out at a switching section.

During my training at switching section I understood the most probably reason for the failure of an exchange as power faults than the errors in transmission area and the outside plant. And I was able to design a simple circuit using PIC18F452 IC to detect and indicate voltage drops immediately and send the messages to responsible person via Ethernet. Ethernet is a protocol that is used to transmit data through a network.

This system was very helpful to this organization in minimizing their loss due to power faults and also to me to improve my experience and knowledge in research.

KEYWORDS: **Battery bank, Exchanges, Power failures, Rectifiers, Telecommunication**

INTRODUCTION

Normally the Exchanges are coming with alarm systems.those are able to indicate power faults. When a fault occurs it will be displayed on the alarm panel which is situated at the Exchange. But there is a need of external indicator to indicate power failures. Because

- If the alarms in Exchanges are working properly they will indicate power failures. Then there should be an employee all the time at the Exchange. It is not cost effective way to occupy employees at night. So there should be a method to monitor the faults which occurs any Exchange in a one place.
- As most of Exchanges were installed before 10 – 15 years, now a day's most of their alarm systems are faulty. So repairing or replacing circuit parts that are responsible for alarm systems are expensive.
- How ever there is no island wide monitoring system for power faults. So it is very necessary to build a system to monitor the power faults island wide from a one place.

Research Objectives

- To find the average loss per a day due to power failures.
- Give a solution to minimize the loss due to power failures, using PIC18F452 IC.
- This system will minimize the loss,
  - By monitoring the battery states via Ethernet system
  - By sending messages to responsible people via Ethernet immediately when a power failure occurs.
- This system also will be able to create an automatic database including the details of battery states.

Scope of the Study / Research

The Scope of the Research is to minimize the loss due to power failure by 'taking necessary maintenances and actions to avoid failing of Exchanges by observing battery states' and 'Limiting the time of failure by informing to the responsible people immediately.

[1]Undergraduate, *Department of Electronics, Faculty of Applied Sciences Wayamba University of Sri Lanka, Kuliyapitiya*

[2]Professor, *Department of Electronics, Faculty of Applied Sciences Wayamba University of Sri Lanka, Kuliyapitiya*

LITERATURE REVIEW

A literature review was done to identify the main problems that are affected on the Exchanges. For this research it is necessary to identify the equipments which are supply power to the Exchange.

Power in an Exchange

The following details were collected by referring manuals of Ericsson AXE 10.

All electronic equipments used in AXE 10 required a stable power supply. AXE 10 switches are designed to operate with -48 Volts DC supply. Following equipments are used to provide -48 Volts power supply.

- Rectifiers that are converting AC main power to – 48 Volts DC.
- Battery bank to provide backup power in the event of main power failure.
- Distribution units contain fuses or circuit breakers on each circuit feeding power to exchange.

The two alternative power systems supplied by Ericsson are,

- The microprocessor controlled power supply (BZA 204)

This system is capable of functioning independently by its own without any intervention from the user. The main components of this power system are,

- Central unit
- High frequency Rectifiers, 28Amp
- Battery units with shelves for battery cell containers.
- Distribution units with automatic circuit breakers.

The Rectifiers are connected in parallel and maintain a constant DC voltage across the batteries while at the same time supplying power to Exchange (full float system).

- The Central Power Plant (BZA112)

The central power plant must be located in a separate room as it requires Led acid batteries as backup power. So it is highly cost than "microprocessor control power supply" And also this uses high noise rectifiers.

Each power unit is supervised by its own built-in-microprocessors, which is in continuous communication with the central unit via a two way loop bus

Rectifiers

The AC voltage is converted to DC voltage by Rectifiers and for the purpose of indicating voltage drop we should consider the voltage value given by these rectifiers.

- Rectifiers supply – 48 Volts DC at 28 Amps, and is controlled by built in microprocessor.

- The front panel of the rectifier displays output voltage and current.
- The rectifiers operate noiselessly as the conversion frequency is high.
- If a rectifier fails alarm from rectifiers are transmitted to the central unit.
- The number of rectifiers required by the Exchange depends on the expected peak traffic load (maximum supply current 28Amps).

Ex: An exchange with APZ212 and equipped for about 40,000 subscribers will be approximately 400 Amps.

Battery unit

- During a main power failure or a rectifier failure the battery unit will take over the power supply to the Exchange.
- The battery unit occupies three shelves at the bottom of the cabinet. The two lower shelves can each holds three sealed batteries, while the top one contains a microprocessor, circuit breakers and a maximum of two sealed batteries.

Default power alarms in AXE 10

All power system must be supervised by the alarm system in AXE 10. The alarm connections from power equipments are connected to an external alarm device that is located in the IOG (Input Output Group) cabinet. This device is then connected in software, so power lamp will light on AXE alarm panel, if a fault occurs.

PIC18F452 microcontroller

The PIC18F452 is a microcontroller that uses powerful 10 MIPS (100 nanosecond instruction execution) is easy-to-program (only 77 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC architecture into an 40 pin package and is upwards compatible.

METHODOLOGY

Research Design

The main parts of organization are outside plant, Transmission and Exchange. Outside plant consists subscriber's side. Normally the failure of outside plant is effect on few customers or group of customers. The fault of outside plant never affected all the customers connected to the outside plant. Transmission is receiving and transmitting paths and technology between two or more Exchanges. Normally an Exchange is connected to more other exchanges. Therefore there are more transmits paths from an Exchange. So if one transmit path is out of services the Exchange can use other transmit path to send and receive data (can send and receive data indirectly via another exchanges). The fault of one transmission path is not affected every customers connected to that MSU. Normally it is impossible to fall the every transmission paths.

But when we consider the Master Switching Unit (MSU), it is the Heart of the system .Every other part is controlled by the MSU. The failures of the MSU affect every customer those are connected to MSU. The major reason for the faults of the MSU is the power faults. So it is very necessary to identify power failures immediately and takes an action before the Exchange fails. And also it is very necessary to minimize the outage time, if the switch fails.

The major problem is at most time it is not recognized power problems, until the Exchange fall down. So this research is to identify the loss and damage that makes due to power faults, and to introduce a new system to detect power faults and voltage drops immediately through intranet.

The data will be collected from Log books and from computer databases. The mean loss per a day will be calculated, after analyzing the collected data.

DATA COLLECTION AND ANALYSIS

Data Collection Strategy

In research, Secondary data is collecting data from common sources of secondary data such as censuses, large surveys, and organizational records. Advantage to the secondary data collection method is, it provides a larger database.

- The number of customers affected from the failure of the Exchange.

So it is possible to select "Secondary Data Collection Method" as the Data Collection Strategy than "Primary Data Collection Method".

A table was designed to collect the data as shown in table 1.

Data Analysis Strategy

- Finding average call cost for Peak, Economy and Discount hours. (Time periods of organization)
- Finding average loss on outage hours at all fault with normal customer capacity.
- Finding average loss on outage hours at Power fault with normal customer capacity.
- Compare and calculate the percentage value for average loss on all faults with average loss on power faults.
- Find mean lost per a day due to power faults.

MSU area	Switch Type	Fault (SW/TX/ Power)	Reported Date	Reported Time	Cleared Date	Cleared Time	Outage Hours	Number of Customers affected

Table 1. Designed table to collect data

Note: MSU = Master Switching Unit,
TX = Transmission and
SW = Switch

They maintain Log books in their every department and sections. They keep records on every important thing.

They keep records about,

- Any failure of their Telephone network including switching, transmission and out side plant.
- Any new installation in the Telephone network.

As my research is "Voltage Drop Indicator to Overcome the Failure of the Switch", I have to collect the data to find out following details,

- The dates and times when the failure of the Exchange occurs
- The reason for the failure of Exchange on above dates and times
- The premise that the failure occurs (Either it is MSU or RSU, and the place)

Details of Data Analysis

	Per minute charge(Rs.)		
Call category	Peak	Economy	Discount
A - A Local	2.80	1.40	0.50
A - A National	4.00	2.00	0.50
A-Other Fixed-Local	3.20	1.60	0.50
A-Other Fix-Natio.	4.60	2.30	0.50
A – Mobile	4.60	2.30	0.50
Internet dial-up	1.40	0.70	0.25

Table 2: Tariffs

Tariffs are shown in figure 2 and average call cost for Peak, Economy and Discount hours was found.

Average call cost peak = Rs. 3.43
Average call cost Economy = Rs. 1.72
Average call cost discount = Rs.0.46
Average call cost at any time = Rs. 1.87

Finding average loss on outage at all fault with normal customer capacity

The normal customer capacity is 10% of all customers. The calculation of average loss on outage hours due to all faults are as follows,

- Loss due to outage = (Outage minutes * Affected customers * Average call cost) *10/100
- Average loss per a day due to any fault = Loss / Number of days

Finding average loss on outage hours at Power fault with normal customer capacity

The normal customer capacity is 10% of all customers. The calculation of average loss on outage hours due to power faults are as follows,

- Loss due to outage = (Outage minutes * Affected Customers * Average call cost) *10/100
- Average loss per a day due to power faults = Loss / Number of days

Percentage value for average loss on all faults with average loss on power faults.

= average loss on power faults/average loss on all faults*100%

RESULTS AND DISCUSSION

Results

- The average loss (mean value) due to all faults is Rs. 15329.51 per a day.
- The average loss(mean value) due to power faults is Rs. 8423.65 per a day.
- The loss due to the power faults is 55% of all faults. So power faults are playing a major roll on losses.

Limitations of this Research / Study

- There are various types of Exchanges under various manufactures.

  Those types are,
  - Alcatel (1000E10 OCB 283, E10B OCB 181)
  - AT&T (5ESS)
  - Fujitsu (FETEX)
  - NEC (NEAX 61E, Zigma)
  - Nokia (DX)
  - Ericsson (AXE)
  - Motorola (EMX 2500)

  Purpose system was tested with an Ericsson switch. The system was not tested for the other Exchanges.
- The purpose system was designed using microcontroller PIC18F452. Some of microcontrollers are sensitive for electric sparks and magnetic fields. The system will be very reliable if it designed with a Programmable Logic Device (PLD).
- The Exchanges are going to be replacing with NGNs (Next Generation Networks), which are based on Packet Switching with Internet Protocol (IP). This system is not being able to connect with these NGNs.
- The communication between the PIC18F452 and the monitoring computer is done via Ethernet Protocol. It needs network connection. If the network connection failed, the communication between these two equipments also failed.

Problems Encountered and Alternative Actions have been taken

- To program the PIC, it needs high voltages. Normally these voltages are supplied through Serial port (COM port) of the computer. But in some computers, especially in Laptops, it is difficult to supply high voltages through its Serial port. External power sources have to be used to give these high voltages, at these cases
- When a power fault occurs, the system that was designed using PIC should not be out of work. So the power can provide by a rechargeable 9V battery, since PIC18F452 does not need high current to operate.
- The baud rates of computer and the PIC 18F452 must be same, to receive and transmit bits correctly. This can be adjust by saving necessary settings in Hyper Terminal and by setting the relevant baud rates.
- It is necessary to select Code Protection when the PIC18F452 is programmed. By doing this no one will be able to copy the code by reading it through a JDM programmer.

Further / Future Research opportunities

For the best working conditions of an Exchange following margins should be satisfied as shown in Table 3.

	Recommended Range	Permitted Range
Voltage	44V to 48V	39V to 52V
Temperature	-15^{0}C to 25^{0}C	-5^{0}C to 35^{0}C
Humidity	40RH% to 65RH%	20RH% to 80RH%

Table 3: Working conditions of an exchange

Voltage levels can be observed by the designed system and able to take necessary actions if the voltage value goes below recommended range. As future developments,

- This system can be developed to sense the temperature of the Exchange, and give an alarm signal, if the temperature value goes beyond recommended 25^0C. The temperature value should be kept between recommended ranges for the better life time of the Exchange equipments. The temperature control by Air Conditioners in an Exchange.
- And also this system can be developed to sense the humidity of the exchange, and give an alarm signal, if the humidity value exceeds the limits of recommended range. The Humidity value should be within recommended range for the better performance of the Exchange.
- Designed system can be modified to detect voltage values of the NGNs (Next generation networks.).
- It is very necessary to keep temperature values, humidity values, in recommended range at the "Transmission Section". This system can be developed to monitor these values in transmission section.

Interpretation of findings

The final outcome of my research was to make an island wide monitoring system, using PIC18F452 IC by connecting to the database through network using Ethernet protocol.

The access to the database and monitoring system was granted to authorize persons through intranet using their username and passwords. After log on he/she can view the battery voltage level of any exchange and if any fault found he/she can take actions to fix them. And also it was made to give an alarm and a critical message on computer's screen to the officers who are log on, when the voltage level is go down under specified level in any Exchange.

The PIC18F452 was connected to the "Serial to Ethernet converter". This converter was responsible to send the data to a specified IP (internet protocol) address. The converter was programmed with two IP addresses such as client address and Host address. When the host address was added, the converter connects with that computer at Head office and continues to send the data. Hyper Terminal can be used to view data on the computer at Head office after setting the parameters. The Host address should be added correctly to connect with the converter. To set the Host address, it can do by adjusting the properties of the connection which can find under file menu. .

The communication path will be connected after setting the Host address. After connecting both converter and computer, we can see every data on the screen of Hyper Terminal those are sent by the PIC18F452 via "Serial to Ethernet" converter.

Discussion and recommendations

- When designing the "Voltage drop indicator to overcome the power failure of the Exchange", it is very cheap to design using PIC18F452 microcontroller. It can be developed within thousand rupees.
- The "Voltage drop indicator" should be checked for a period of time and should do a research again to find how the purpose system affected on power faults.
- For the better stability, it can be developed using a PLD (programmable logic device).
- There is a facility of accessing Ethernet parameters directly in the PIC18F452. But it was rather difficult to program, therefore "Serial Communication" was used with the "Serial to Ethernet Converter".
- Received data to the computer was read via the Hyper Terminal which comes as a communication tool in Windows. A java program can be written with more facilities to do this job in a very user friendly environment.
- Using this system the loss due to the power faults is minimized. The percentage value for the loss due to power faults over all faults can be recalculate using new data after installing this system.

CONCLUSION

"Voltage drop indicator" was designed to overcome the power faults in Exchanges under the guidance of the University. My first supervisor Prof. CAN Fernando and the course coordinator Dr. KDDN Dissanayake were very helpful me in designing this System. And also Mr. Smith Wikramasingha at Peradeniya University was helped me in designing the circuit.

PIC 18F452 microcontroller IC was used to design the circuit. But there are some limitations such as, this system was tested only for Ericsson switches and not tested for the other various exchanges. And also PIC 18F452 IC was not a very stable IC. It is sensitive for electric sparks and magnetic fields. To overcome these limitations, this circuit could be checked with other various type of exchanges such as Alcatel (1000E10 OCB 283, E10B OCB 181), AT&T (5ESS), Fujitsu (FETEX), NEC (NEAX 61E, Zigma), Nokia (DX), Ericsson (AXE) and Motorola (EMX 2500). And also this system can be designed with a programmable logic device (PLD) instead of PIC 18F452 IC, to make a better stable and reliable circuit.

As future developments this circuit can be developed to detect temperature and humidity value of the exchange. And also this circuit can be developed to monitor voltage, temperature and humidity values in transmission section.

Finally it could be concluded the circuit, which has designed to detect voltage drops was very helpful in applying my theoretical knowledge to a real world practical problem.

REFERENCES

BOOK:

- Dogan Ibrahim, (2008), Advanced PIC Microcontroller Projects in C· From USB to RTOS with the PIC 18F Series, Newnes, London, p. 251 – 295
- Christoffersen M. & Henten A., (1993), Telecommunication, IOS Press, Netherlands.
- Robert B. Northrop, (2005), Introduction to instrumentation and measurements, 02nd Edition, CRC Press, London.

INTERNET AND ONLINE CITATIONS:

- Worms C.O., (2009), PIC microcontroller, Viewed 12th December 2008. <http://en.wikipedia.org/wiki/PIC_microcontroller #Device_Programmers.>
- Biscuittin, (2008), Viewed 21st February 2009. <http://en.wikipedia.org/wiki/Voltage_divider>