Microcontroller Based Line Differential Protection for OFC

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ABSTRACT

Differential Protection of a line is required to protect the line from the effects of internal faults. This project work focuses on the design of one such system comprising of microcontroller based line differential protection using fiber optics communication. To achieve this, a working model is designed that employs PIC 16F877A microcontroller and fiber optic communication. Microcontroller programming is done for the LED display, seven segment display, analog to digital conversion, and RS232 conversion. The communication between the transmitter and receiver is established using fiber optic cable. For an internal fault, the received value is compared with a reference signal using microcontroller. Any received value below the threshold is an indication of internal fiber damage. Thereafter, an alarm is raised using LED. Major activities carried out during the project work – fabrication of connections; microcontroller programming for RS232 serial data transfer, 7 segment display, conversion to fiber media etc.

Key Words: Optical Fiber, RS232, PIC16F877, 7-Segment Display

INTRODUCTION

The line differential protection is used to protect strictly selective areas at high speed. The simple measuring principle of current comparison requires a communication link between the partner devices. While in former times, analog measured values used to be transmitted (current balance principle), modern devices use the advantages of digital communication. The wide availability of fiber communication along with the power grid transmission system at central and state level along transmission lines, leads to the evolution of various applications and usages in bigger ways.

One such function that is in the developmental stage is line differential protection using fiber communication. The differential protection is a failsafe mechanism for control function. It involves electronics circuitry fabrication, interfacing with field devices, data acquisition in digital form, transmission over fibre communication and programming for input, output and logics to meet required functions in microcontroller.

In the proposed system, the voltage differential relay is only interested in fault voltage levels on the protected line. The local relay receives a voltage value which is converted to an equivalent eight bit from the remote end (negative for the ground subsystem). At the local end, a reference signal is also converted to an equivalent eight bit value using an analog to digital converter of the PIC 16F877A Microcontroller by programming. For an internal fault, they are both compared using a comparator. The reference signal is used as a threshold, below which there is indication of internal fiber damage. The scheme can be implemented using differential voltage measured with different methods

- Magnitude comparison
- Phase comparison
- Phasor comparison (magnitude and angle)
- Charge comparison
- Combinations of the above.

Common to all line differential relays operation is the reliable electronics circuit design and communications

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channel. A remote quantity containing the voltage information needs to be transferred to the local end for comparison with the local voltage. The quantities to be compared have to be time-coincident and the magnitude and angle information of the remote voltage must be preserved.

OVERVIEW

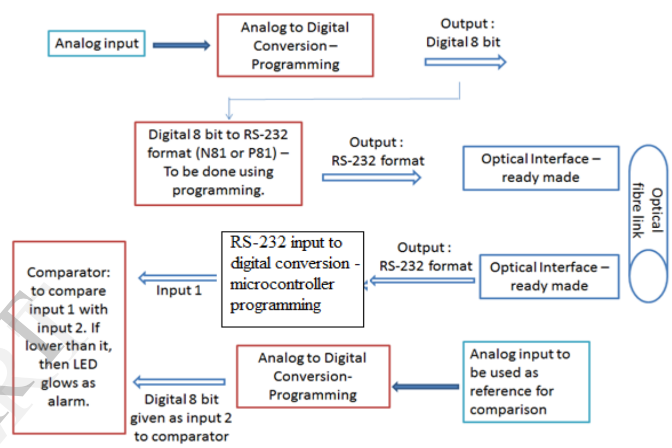
A line differential protection using fiber optics communication is developed using PIC 16F877A Microcontroller. A digital current differential relay needs to compensate for the delay introduced by the communications channel for transmitting the digitized current information from one line terminal to the other.

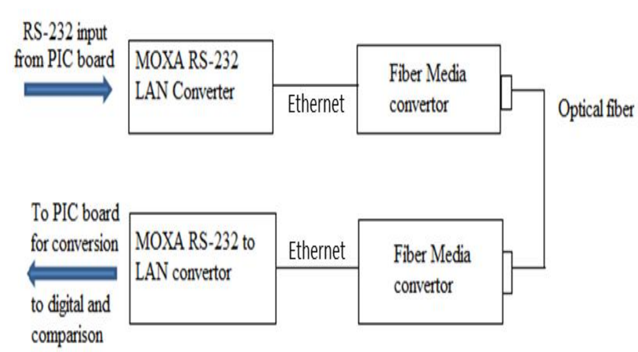
In addition, the characteristics of the communications channel need to be taken into account both by the relay's communications interface design and the measuring principle used. The communications interface has to block a corrupted data message from being delivered to the relay and ensure that the two relays remain synchronized to each other. Accurate channel time delay measurement has to be performed so that proper alignment of the measuring quantities can be made. The relay's measuring principle needs to properly handle errors introduced by any asymmetric channel delay (different transmit and receive paths) on switched communications networks in addition to deal with power system issues causing false differential currents.

Differential protection compares two or more voltages to locate a fault; which actually makes voltage protection. In comparison with other types of protection, differential voltage protection possesses an absolute selectivity in the sense that it operates smartly only in those cases where the fault is within the protected zone, and does not operate at all if the fault is out of its zone. All differential relays are high speed.

The programming of Microcontroller is done for analog to digital conversion, display, RS232 conversion and the reverse mechanism at the receiver. Compilation is done using Customer computer services (CCS) C Compiler and MPLAB ICD3 in-circuit debugger is used. PIC Development board is used for the design of the system.

BLOCK DIAGRAM





- Analog input is given to the PIC-16F877A Microcontroller.
- Programming is done in C to convert analog value to digital.
- 8-bit Digital value thus obtained is input1 and is displayed on Seven Segment display by programming.
- The 8-bit digital value is converted to RS232 format for transmitting over Fiber Optic Cable through programming.

- Optical interface consists of MOXA LAN Converter and Fiber Media Convertor.
- Signal obtained in RS232 format is converted back to 8-bit digital value and this value is displayed on Seven Segment display.
- 8-bit Digital value thus obtained is input2 which is sent to a comparator and is compared with input1.
- If the value of input1 is found to be below threshold, an alarm is raised using LED.

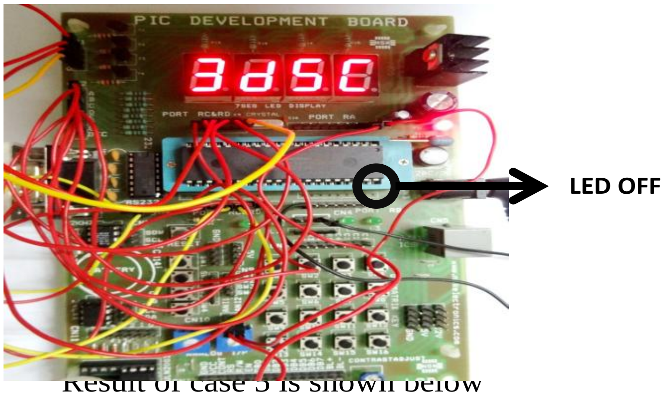
This system will detect data loss between sending and receiving points. Data loss computation is done at digital levels which are equivalent to respective analog values (line current). There would be control signal output for actuating fast acting control functions and also digital display of signals like sending end, receiving end, comparison value, data loss etc. The scheme can be filed trial implemented for a reliable current differential power line protection.The CCS C compiler is specifically designed to meet the unique needs of the PIC microcontroller. The compiler can efficiently implement normal C constructs, input/output operations, and bit twiddling operations. All normal C data types are supported along with special built in functions to perform common functions in the MPU with ease. The MPLAB ICD 3 is an in-circuit debugger that is controlled by a PC running MPLAB IDE (v8.15 or greater) software on a Windows platform. The MPLAB ICD 3 in-circuit debugger is a complex debugger system used for hardware and software development of Microchip PIC microcontrollers (MCUs) and PIC Digital Signal Controllers (DSCs) that are based on In-Circuit Serial Programming (ICSP) and Enhanced In-Circuit Serial Programming two-wire serial interfaces. The debugger system will execute code like an actual device because it uses a device with built-in emulation circuitry, instead of a special debugger chip, for emulation. All available features of a given device are accessible interactively, and can be set and modified by the MPLAB IDE interface. Use of fiber communication has further enhanced the functioning of protocol conversion from RS232 to Ethernet and further to fiber and vice versa.

RESULTS

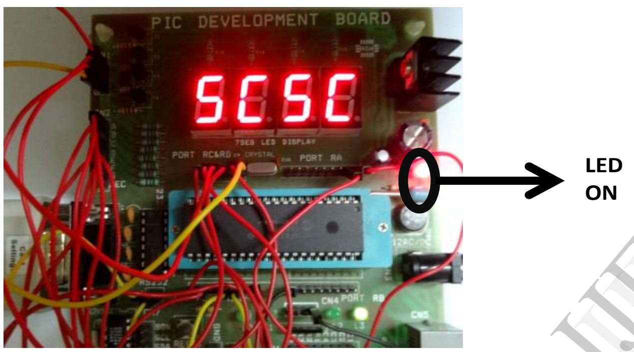
This project focuses on the design of microcontroller based line differential protection using fiber optics communication. The working model was successfully implemented and used concepts of electronics design, ADC, data communication and conversion on RS232 format, fiber communication, and programming of microcontroller. The communication is established using fibre optic cable and the optical interface includes MOXA LAN Converter and NPort Fiber Media Convertor. This system is checked for different values of voltage and the values at both transmitter and receiver were recorded and displayed. If the difference in the values at the receiver and the reference was below a threshold, an alarm was raised using LED. PIC Development board is used for the design of the system. ADC module, Analog comparator, CRC, General purpose I/O, Interrupts, Timer module and capture and compare module were used. The following observations were made.

Case	V_{REMOTE} (Hex)	V_{REF} (Hex)	Threshold (Hex)	LED Status
1	3D	5C	20	OFF
2	3D	5C	15	ON
3	44	5C	20	OFF
4	44	5C	15	ON
5	5C	5C	20	ON
6	7A	5C	20	ON
7	C7	D9	15	OFF

Result of case1 as below



Result of case 3 is shown below



CONCLUSION AND FUTURE SCOPE

This project gives the design for a system which provides line differential protection for fibre communication. Data loss computation is done at digital levels which are equivalent to respective analog values (line current). There is a control signal output for actuating fast acting control functions and also digital display of signals like sending end, receiving end, comparison value, data loss etc. The scheme can be field trial implemented for a reliable differential power line protection. Some of the improvement features are as under as compared to the test case: Length of fiber optic cable can be increased from the project test case from 10 metre to several km for real time application.Input may be given from external source instead of 5V internal source.Buzzer may be used instead of LED for alarm and many more things can be done.

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