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디지털 필터 설계를 이용한 자동 진공 콘덴서 스위치의 기술 동향

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A Technical Trend on Automatic Vacuum Capacitor Switch with Modified Digital Filter Design

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Abstract - In this paper, the authors introduce a high-speed microprocessor based on automatic vacuum capacitor switch with a modified digital filter design using distributed arithmetic. The automation trends particularly the automatic vacuum capacitor switch has helped ameliorate the power factor essentials and automatically triggered to close when the line current exceeds rated value. Microprocessor relays use digital filters to extract only the fundamental and attenuate harmonics. To provide optimum speed characteristics a distributed arithmetic based filter design in the microprocessor controller which not only enhances filtering speed but additionally enables lower power consumption at the cost of area has been introduced. The result is a unified description that describes a digital filter structure down to bit level.

1. Introduction

We are quite aware that many discussions at various forums had taken place for the necessity of power factor improvements to increase the efficiency of the distribution systems by reducing the line loses after installing necessary line capacitors. In this paper we are going to exchange our views under the heading of automation trends particularly about the automatic vacuum capacitor switch developed recently to cater to the needs of our rural distribution system of our continent and neighbours. Till date SF6 interruption medium was used by other manufacturers with the conventional solenoid operated mechanism with sophisticated catch latch mechanism and various SF6 gas sealing arrangements. After analyzing the pros and cons of this technology and the advantages of vacuum and SF6 technology, the vacuum technology was opted for to avoid all negative aspects of the alternative.

2. Experimental

The vacuum interrupter is supported at its fixed terminal and is mounted to the base assembly by a special grade fiberglass epoxy mixed supports. These supports ensures unnecessary contact bouncing problems thereby the contact erosion is brought under control as well the possibility of non sustained disruptive discharges or re-ignition or re-strikes are totally eliminated as the result reveals on capacitor switching tests at the neutral high power lab. The vacuum interrupted can perform unto a fault level of kA and required contact pressure can be set so that the switch can meet the required making capacity. A Magnetic actuator is used at the operating mechanism of the vacuum switch. This ensures almost limitless life even-though IEC/ IS specifies only 2000 mech.operations. The magnetic actuator consists of one set of permanent magnets, two solenoid coils and a plunger positioned at one end. The provision of the magnetic actuator in place of conventional solenoid operated mechanism has reduced considerably the total number of components, thereby enhancing the overall reliability of the mechanism to a very high endurance level. This switch had undergone successfully for an endurance life of 15000 maintenance free operations.

3. Results and Discussion

The relay uses INTEL 8085 microprocessor. Voltage signal V from the VT is fed to the Microprocessor through an auxiliary VT and a zero crossing detector (ZCD) for measuring system frequency . The zero crossing detector uses an operational amplifier giving a TTL compatible square wave output. The output voltage from the auxiliary VT is rectified, filtered, and digitized using an analog to digital converter (ADC) to measure voltage magnitude. The digital output of the ADC is fed to the microprocessor through an input port of programmable parallel interface chip 8255. Load currents I1, I2 ,I3 are converted into voltages through transactors. Outputs of the transactors are rectified , filtered , and fed to the microprocessor after digitization in the ADC . The four channels of the ADC are selected by its two address lines through an output port . The start conversion pulse for the ADC is given from another line of the same port. Contacts of the power directional relay are connected to one input part line for checking tie line conditions . For each frequency switches with BCD outputs are provided . The microprocessor reads the end of conversion signal to examine whether the conversion is over or not . As soon as the conversion is over the microcomputer reads the current signal in digital form and compares it with the pick up value.

In the case of overcurrent the microcomputer sends tripping signals to the circuit breaker if fault current exceeds stated value . The microcomputer determines the magnitude of fault current and then selects the corresponding time of operation. The output signals for trip and closing of breakers, two indication signals and two alarm signals are provided by the microprocessor. The microprocessor based relay uses analog filter for frequency ranging between 40 and 70 Hz. Generally the measured value is fed into the a harmonic filter to eliminate harmonics. Smoothing filters are also used sometimes to eliminate ripple but in high speed relay such filters cannot be used because at low frequencies analog filters are slow. Hence the key to the behavior of microprocessor relays is in calculating the response of the digital filter and comparing the deviation of the response to the ideal sine - wave signal. Microprocessor relays execute mathematical procedures and produce analytic characteristics that can be described accurately by equations. We, therefore, have the opportunity to calculate relay response to any specified waveform. The key to the behavior of microprocessor relays is the output of the digital filter . This is obtained by sampling sine - wave currents and / or voltages at discrete time intervals. A fixed number of instantaneous samples per cycle are converted to digital quantities by an A/D converter and stored for processing . Digital filtering is the simple process of multiplying the successive samples by predetermined coefficients and then combining them to obtain digital quantities representing the phasor components of the input. For example, a first sample taken at an arbitrary time on a current sine wave is the instantaneous dc value representing I cos(wt + o), where o is an arbitrary phase angle. A second sample taken 90 degrees later is I sin(wt + o). Consequently, just taking two samples 90 degrees apart extracts the real and imaginary components of a phasor. The term "filtering" is used because the magnitude of the components change when the sampling interval remains fixed and the input frequency is varied. The filter output then varies in magnitude and phase as a function of the input frequency. Consequently, more than two samples per cycle are used, and filter coefficients are selected to obtain a favorable frequency response . The coefficients are applied and the samples are summed to produce the output.

4. Conclusion

Vacuum Circuit Breaker uses the Vacuum interrupter for circuit interruption. The Vacuum Circuit Breaker is controlled by an exterior microprocessor based control unit. The reduced number of components in the magnetic actuator mechanism increases reliability and life of the product. Vacuum Circuit Breaker uses adjustment of the load current at which the capacitor switch closes and trips Microprocessor relays employ a digital filter to extract the fundamental and to reject higher harmonics. The distributed arithmetic was seen to be an efficient method for evaluation of certain partial products with this new formulation and it allows a trade of arithmetic for memory. The distributed arithmetic has been concerned with hardware implementation and can be used in large high speed memory.

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