Design and Implementation of Microcontroller-Based Multifunction Relay (TDOC)

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PURPOSE

Advantages of µController-Based Multifunction Relay:

- Adaptive with different system.
- Highly sensitive, secure and selective.
- Multifunction protection.
- High reliability and cost effective, compared with mechanical relays.

Why do we need time delay overcurrent TDOC relays ?

- Overcurrent condition implies overheating of transmission cables with respect to time.
- Starting current of motors exceed the rated current at a certain amount of time, and this is not to be considered an overcurrent..
- Inrush current of transformers acts the same as starting current of motors, thus which TDOC relay is required.

Where can we use TDOC relays in Power System?

- Motor Protection (51).
- Transformer Protection.
- Transmission Line Protection.

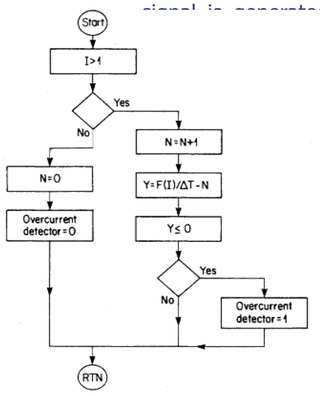
MECHANISMS

General Design of a µ-Controller Based TDOC relay:

- Writing a code to implement TDOC algorithm.
- Current transformers are used to step down the current value inputted to the conditioning circuit.
- Designing a conditioning circuit to eliminate noise, and limiting the voltage input to the microcontroller to be in the range of 0-V up to 5-V.
- Power relays are used to trip the system, after a pre-determined time delay, whenever an over current condition occurs. In priciple,The tripping signal is generated by the microcontroller, and is sent to the

TDOC digital relay algorithm:

- As you can see from the flow chart, the tripping signal will be generated depending on a comparison between multiple currents of pickup value on one hand, and one on the other hand.
- Additionally, function of the line current has been generated to calculate the required time delay.



$$T = \frac{13.5\,D}{\left(I/I_p\right) - 1}$$

T: Time Delay
D: Time Dial Setting TDS
I: Line Current
Ip: Pickup Current

DESIGN SEGMENT

First: Power System

- Connecting three 'NC' relays to the input feeding the motor.
- A 'NO' relay connects the three 'NC' relays to an external 12-VDC source. 5-VDC signal from µ-controller is used to allow an external 12- VDC to energize the power relays. see fig.1.

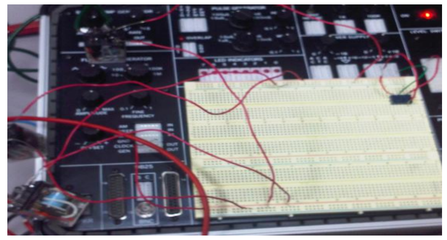


Fig.1: NC power relay & NO electronic relay

- CT's are used to deliver a feedback to the CC (conditioning circuit). Connection of the CT's are determined by the rated current (5A primary nominal value).

Second: Condition Circuit

- Designing of a second order active low pass filter, with a cutoff frequency of 60Hz, see fig.2.
- Designing a limiter and shifter circuits at the range of 0 to 5-V RMS. See fig.3

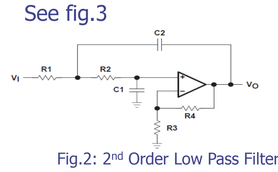


Fig.2: 2nd Order Low Pass Filter

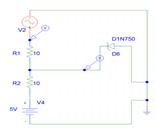


Fig.3: Shifter & Limiter circuit

Third: Programming the µ-Controller

- Test the TDOC algorithm in a MATLAB code. Observe the output signal at fault condition in fig.2 that it takes time to trip.

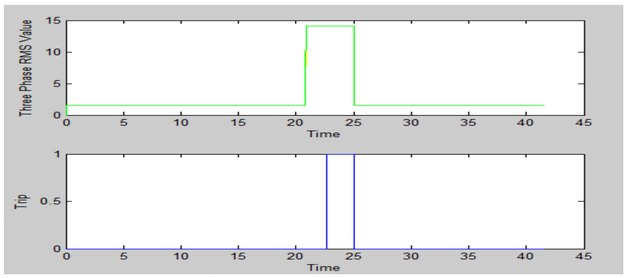
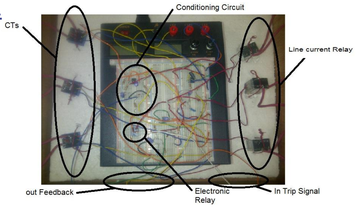


Fig. 2: Trip signal delay at fault condition.

- Designing an A/DC code to read the input voltage from CS.
- Initiate a code to read the data from the ADC and display it on the LCD.
- Designing the TDOC algorithm in 'C' code.
- Integrate the all codes in one.

Fourth: Integration of the Project

- Fabricate a wooden box that contain the whole relaying system



PARTS

ITEM	Info	Qnt	Price(SAR)
LA-25NP	Current Transucer	3	153.16
DPDT relay/ 12VDC	Power Realy	3	22.31
DPDT relay/ 5VDC	Electronic Relay	1	7.31
QL200 PIC MCU Development Board kit	Microcontroller KIT	1	562.47
4.7uF Capacitor	Capacitor	3	37.46
2.4uF Capacitor	Capacitor	3	24.9
1K ohm - Resisitror	Resistor	6	9.375
Opamp	Operational Amplifier	3	3.71
D1N750	Zinner Diode	3	20.81
10 ohm - resistor	Resistor	6	5.62

RESULTS

Fig.3: Tripping Time & Line Current on the LCD

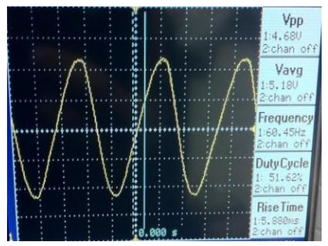


Fig.4: Conditioning Circuit Output in the Oscilloscope

- Fig.3 shows a tripping time at 20% of the rated current (3.38A).
- Fig.4 shows the starting of saturation due to the limiter characteristic.

FUTURE WORK

- Designing different types of relays for different application (i.e. differential relay, ground fault relay, reverse power relay… etc).
- Measuring WATT's, VAR's and VA's using PTs and CTs, and displaying them on the LCD.
- Expand the range of protected to different types motors and generators.

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