CAT SWARM OPTIMIZED NON-SUPERCONDUCTING FAULT CURRENT LIMITER FOR SUPPRESSING FAULTS

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ABSTRACT

This project proposes an optimization-controlled transformer-based solid-state fault current limiter (TBSSFCL) for radial distribution network applications. The proposed TBSSFCL is capable of controlling the magnitude of fault current. In order to control the fault current, primary winding of an isolating transformer is connected in series with the line and the secondary side is connected to a reactor, paralleled with a bypass switch which is made of anti-parallel insulated gate bipolar transistors. By controlling the magnitude of ac reactor current, the fault current is reduced and voltage of the point of common coupling is kept at an acceptable level. In order to control a switch pulse cat swarm optimized pulse generation used. CSO is generated by observing the behaviors of cats, and composed of two sub-models, i.e., tracing mode and seeking mode, which model upon the behaviors of cats. Experimental results using six test functions demonstrate that CSO has much better performance than Particle Swarm Optimization (PSO). Also, by this TBSSFCL, switching overvoltage is reduced significantly. The proposed TBSSFCL can improve the power quality factors and also, due to its simple structure, the cost is relatively low. Laboratory results are also presented to verify the simulation and theoretical studies. It is shown that this TBSSFCL can limit the fault current with negligible delay, smooth the fault current waveform, and improve the power quality.

Keywords –*PIC Microcontroller,Cat Swarm Optimizer*

1. INTRODUCTION

Fault-Current Limiters (FCL) using high temperature superconductors offer a solution to controlling fault-current levels on utility distribution and transmission networks. These fault-current limiters, unlike reactors or high-impedance transformers, will limit fault currents without adding impedance to the circuit during normal operation. Development of superconducting fault-current limiters is being pursued by several utilities and electrical manufactures around the world, and commercial equipment is expected to be available by the turn of the century. Electric power system designers often face fault-current problems when expanding existing buses. Larger transformers result in higher fault-duty levels, forcing the replacement of existing bus work and switchgear not rated for the new fault duty. Alternatively, the existing bus can be broken and served by two or more smaller transformers. Another alternative is use of a single, large, high-impedance transformer, resulting in degraded voltage regulation for all the customers on the bus. The classic tradeoff between fault control, bus capacity, and system stiffness has persisted for decades.

2. CURRENT -LIMITING PRINCIPLE

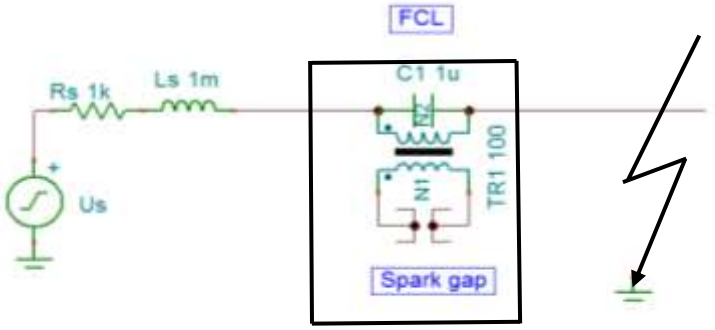

Fig-1 Fault system network including the FCL

The current-limiting principle of the FCL is illustrated in the solid line frame of Figure 1. A capacitor is connected in parallel with a reactor. The secondary winding of the reactor is connected to a spark gap for controlling the inductive reactance. Under normal operating conditions, the voltage drop across the capacitor is low enough to be neglected with respect to the nominal system voltage. The breakdown of the spark gap cannot take place due to quite a low voltage across the secondary winding. The inductive reactance of the reactor with its secondary winding opened is the magnetizing reactance and is much higher than the capacitive reactance of the capacitor. Therefore, the existence of the FCL has almost no effect on the system operation.

2. OBJECTIVES

- To ensure the safe and stable operation of DC micro grid, reliable DC fault protection strategy is indispensable.
- To overcome DC short circuit fault **Cat Swarm Optimization (CSO)** is used for sudden identification and prediction.

3. CAT SWARM OPTIMIZATION TECHNIQUE

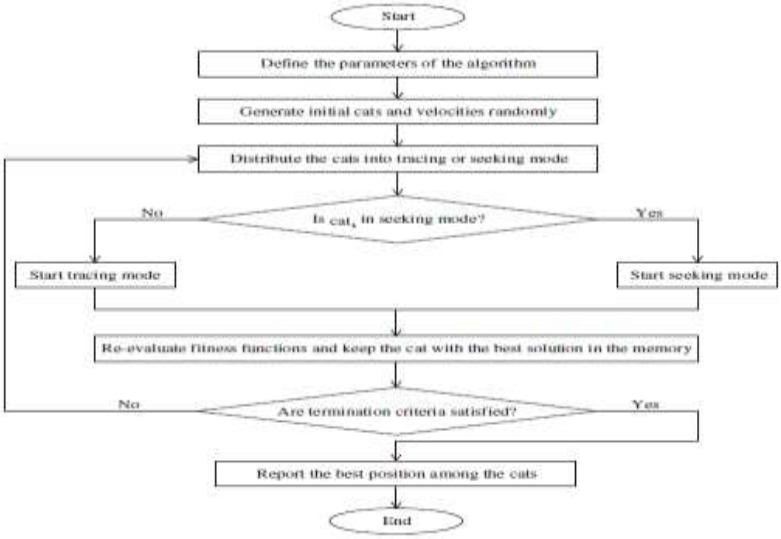

Fig-2 Flowchart of Cat Swarm Optimization Technique

4. WORKING PRINCIPLE

The one end of the primary winding of current transformer is given to the source and the other end is connected to the load. The secondary end is connected to the current measurement. The current measurement is used to measure the flow of current. Then it is connected to the Cat Swarm Optimizer (CSO). It is used to analyze the previous occurred fault. At that instance the duty cycle is varied so that the fault can be easily detected. The CSO is then connected to the gate drive. The gate drive is used to insist whether the secondary winding is open circuited. Then it is connected to solid state device like MOSFET to limit the fault current. During normal state the line current separately flows through the primary and secondary winding of the flux coupling reactor. When a fault event occurs at the downstream of the BSFC-NSFCL, the current detection and control circuit detects the fault current and then turns off the bridge switch. The secondary side of the flux-coupling reactor is open-circuited, and the fault current will totally flow through the primary side of the flux-coupling reactor. Since the primary inductance of the flux-coupling reactor can restrain the fault current to the expected fault current value. After the fault is cleared, the BSFC-NSFCL will fast recover to the normal state and be ready for the next short-circuit fault occurrence.

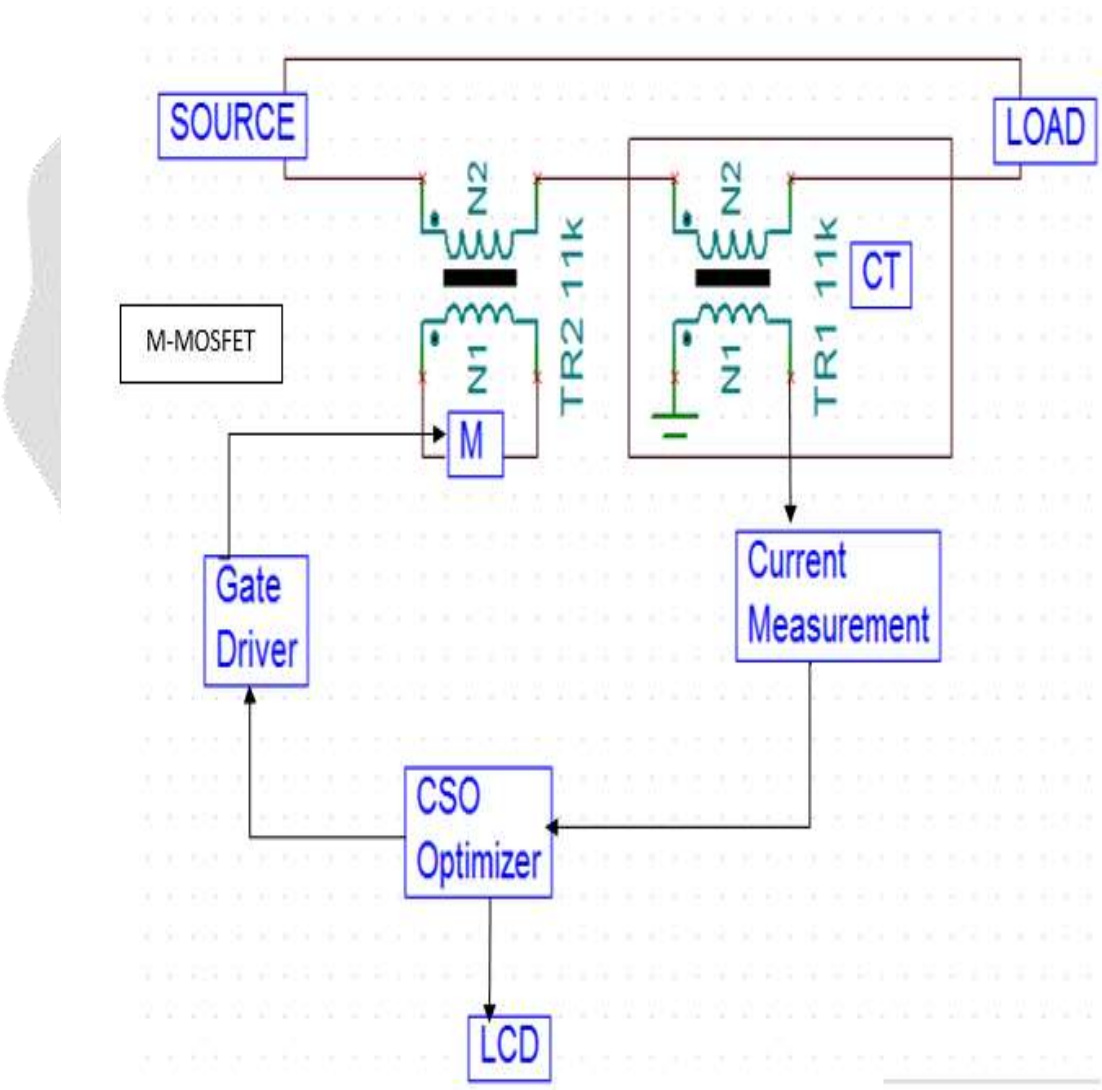

Fig 3- Block diagram of cat swarm optimization technique

5. HARDWARE CIRCUIT DIAGRAM

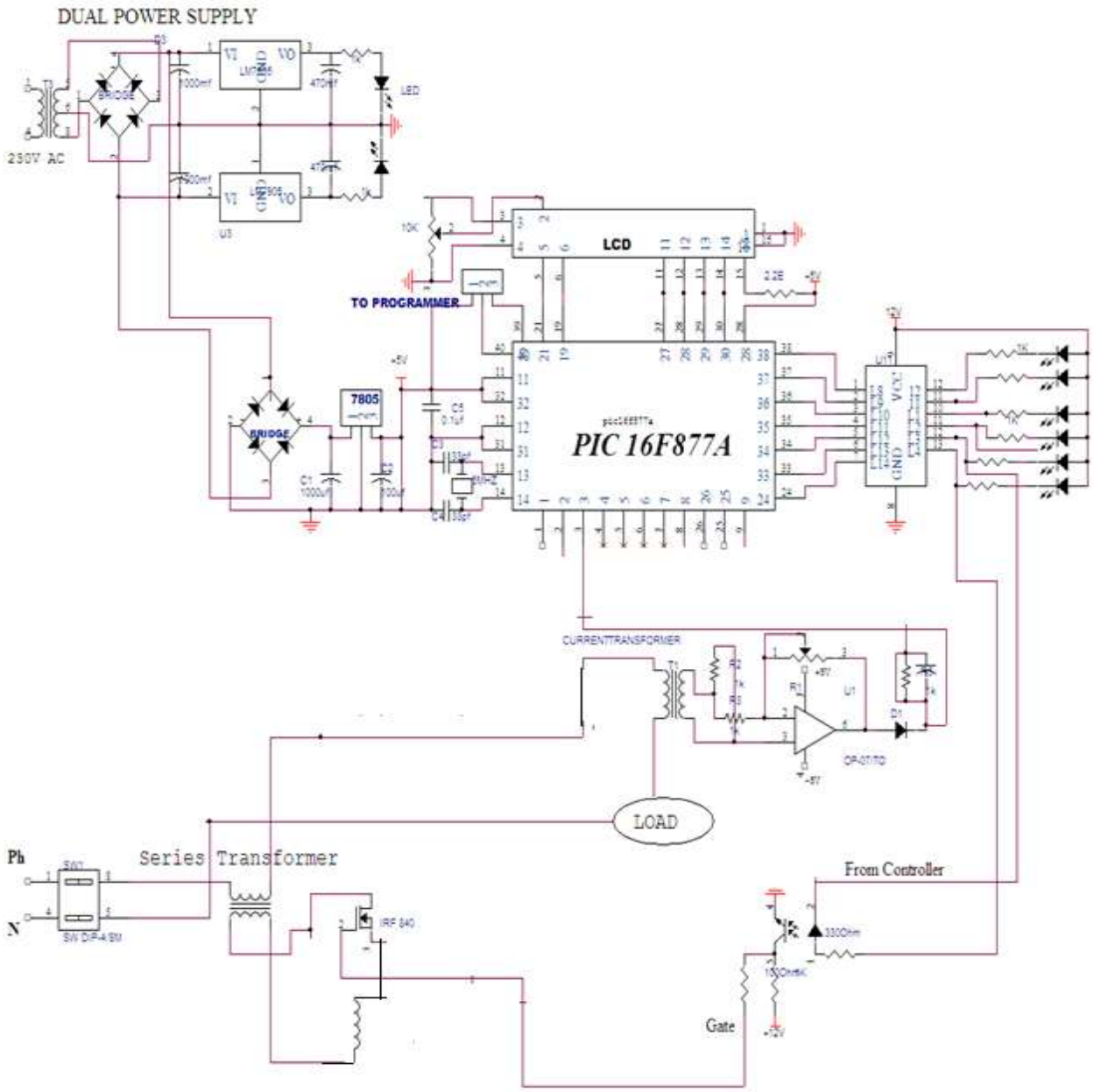

Fig-4 Hardware circuit diagram

The hardware circuit diagram consists of PIC microcontroller, single power supply, transformer, LCD and Bridge rectifier. The one end of the source is connected to the primary side of the series transformer. The other end of the source is connected to the load. The primary winding of the series transformer is connected to the current transformer. The current transformer is used to measure the flow of current. The secondary winding of the series transformer is connected to the MOSFET. The secondary winding of the current transformer is connected to the PIC Microcontroller. A 230V AC supply is given to the Bridge rectifier and Regulator. Then it is given as an input to PIC microcontroller. The output of the PIC Microcontroller is shown using LCD display.

5. HARDWARE SNAPSHOT OF CAT SWARM OPTIMIZED NON-SUPERCONDUCTING FAULT CURRENT LIMITER

Fig-5 Hardware Snapshot of Cat Swarm Optimized Non-Superconducting Fault Current Limiter

A 230V power supply is given as an input to the step-down transformer where the voltage step down to 12KV.Then by using rectifier AC supply is converted into DC supply. Then it is connected to regulator where it supplies 5V to the PIC Microcontroller. It consists of capacitor and Colpitts oscillator. The capacitor is used to supply pure DC without any ripples.in this PIC Microcontroller, Cat Swarm Optimized coding is written to limit the fault current.it has ON/OFF switch to start the working when supply is given. Then it has current and potential transformer. The current transformer is used to measure the flow of current. A MOSFET switch along with heat sink is given to prevent the MOSFET during overheating.it is connected to secondary winding of the series transformer. A PIC Microcontroller is used to control the MOSFET switch by ON/OFF. The potential transformer is used to generate the square pulse which is used to ON/OFF the MOSFET switch. It is also used for generating PWM signal by using square wave generator. Then it is connected to amplifier to measure the current and voltage flowing through the controller. The Series Fault Current limiter (SFCL) switch is ON when the fault current is to be limited.

6. HARDWARE REQUIREMENTS

- Current Transformer
- Potential Transformer
- LCD
- PIC Microcontroller
- MOSFET
- SFCL Switch
- Load (200W and 100W Bulb)
- Buffer
- Rectifier

7. SOFTWARE REQUIREMENTS

- MATLAB

8. CONCLUSION

This project has presented the theoretical analysis, simulation and experiment for the fault-current limiting capability of the proposed modified BSFC-NSFCL. During the normal state, the primary and secondary fluxes counteract each other, and hence the voltage across the proposed NSFCL is small enough to be negligible. Also, the secondary coil plays a key role in the current sharing function. In addition, there is almost no distortion to the voltage of PCC and line current after the insertion of the BSFC-NSFCL. As a result, the BSFC-NSFCL has almost no impact on the circuit. When a fault occurs, the primary and secondary coils are no longer magnetically coupled, and only the primary coil inserts into the circuit to effectively restrain the fault current to the expected value.

9. REFERENCES

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