Available online at: http://www.ijmtst.com/vol6issue03.html

International Journal for Modern Trends in Science and Technology

ISSN: 2455-3778 :: Volume: 06, Issue No: 03, March 2020

PI Based Coupled Inductor Circuit Breaker

T Amar Kiran[1] | K C S Navya Sri[2] | E Rohit Sai[2] | N Sesi Kiran[2]

[1]Associate Professor, Department of Electrical and Electronics Engineering, Godavari Institute of Engineering and Technology (A), Rajahmundry, Andhra Pradesh, India.
[2]UG Students, Department of Electrical and Electronics Engineering, Godavari Institute of Engineering and Technology (A), Rajahmundry, Andhra Pradesh, India.

To Cite this Article
T Amar Kiran, K C S Navya Sri, E Rohit Sai and N Sesi Kiran, "PI Based Coupled Inductor Circuit Breaker", *International Journal for Modern Trends in Science and Technology*, Vol. 06, Issue 03, March 2020, pp.:168-172.

Article Info
Received on 06-February-2020, Revised on 26-February-2020, Accepted on 10-March-2020, Published on 14-March-2020.

ABSTRACT

According to the paper we are developing the new type of DC circuit breaker. In order to reduce the power conversion step for future micro grid with the renewable energy source which is best for the DC power system. Therefore, according to the system components like source, load and the power conversion which can identify easy and ready to use. There the main limitation is to interrupting a current which does not have a zero crossing will sustain an arc. Here we are utilizing the short conduction path between the breaker and load along with mutual coupling to automatically and rapidly switch OFF in response to a fault. we are used BESS (battery energy storage system) for Output side to store the energy with PI controller.

I. INTRODUCTION

According to the DC electric power which have various beneficial in the modern applications, such as electric ships, data centres, micro grids with renewable energy, and future applications such as the dc home. As researchers consider design of dc power systems, fault protection, and the circuit breaker are of significant interest. Along these lines mechanical breakers for ac systems can be used [1], but with limited range. Hybrid mechanical/solid-state breakers have been introduced [2]– [5] with the benefit of low losses. Another protection method that has been suggested is to utilize converters and associated control [6]– [9]. Alternatively, solid-state dc circuit breakers have been considered [10]. These breakers offer rapid response to faults, but tend to have higher power losses. There are various advantages of circuit breaker such as very rapid operation and automatic disconnection of faulty loads.

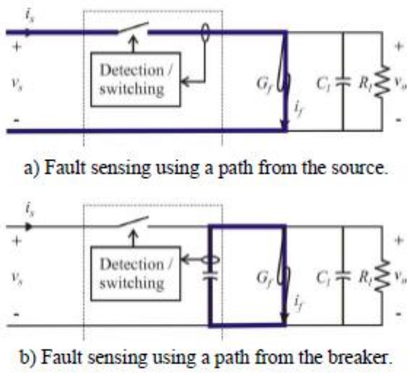


Fig.1.Fault sensing techniques.

LVDC electrical energy using renewable environmentally friendly power is frequently seen in many applications as helpfully modern. Considering the design of DC power systems, it is important to focus on fault protection and maintain the power system's DCCB. Only solid-state circuit breakers should be considered for installation and applied to these types of systems because these are the only type's breakers that respond quick enough to faults to prevent damages even though they tend to have a greater rate of power loss than other breaker types. SSCBs are pure semiconductor devices that monitor all the behaviours of the IGBT which are tremendously important to switching transitions. Solid state LVDCCBs make use of a completely manageable power semiconductor device from the primary branch to interrupt electrical current and doesn't require a mechanical switch. They interrupt DC current very effectively. The idea being introduced in this system is a new type of DC solid state circuit breaker with transformer coupling that uses coupled inductors to detect and isolate faults. These types of circuit breakers gain advantages over other types of circuit breakers because they don't have as many parts and has an adjustable current threshold that can be set to operate when the level of current rises past the set threshold causing the circuit breaker to trip. Normally, the circuit breaker is in the system between the source and the load. SSCBs are used in high voltage systems because they have a swift switching speed and interrupt high voltage DC current very efficiently. During fault interruption, the rapidly dropping current will expose the SSCB to serious strain due to overvoltage. If this is left uncorrected, this overvoltage can easily cause the SSCB to become unresponsive and might possibly damage the sensitive devices inside the SSCB [7], [8]. To address this issue, it is necessary to install a snubber circuit to protect the system by suppressing overvoltage. Having an installed snubber circuit becomes essential to the safe turn off of the system. There are some requirements that should be able to be met by the snubber circuit. It should be highly reliable for medium capacity, low voltage applications. Overvoltage should cause a minimal level of stress to the SSCB at turn off. The presence of a snubber circuit that has been designed and specialized for precise application in SSCBs is of extreme importance. Generally, methods of snubber design anticipate that snubbers be must be suited for converter switches and thus, they cannot be applied directly to the SSCB snubber. There are many reasons for this. Reduction of snubber loss as well as rapid suppression features does not get lots of attention in SSCB snubber design because of inconsecutiveness as well as infrequency of SSCB switching. Suppression of overvoltage as well as ability to withstand fault current are the features which receive the most attention in SSCB snubber design due to the magnitude of fault current that is met and, as a consequence, SSCBs become exposed to high overvoltage [7-10]. This paper is organized as follows: section two covers related work, section three present the background of the LVDC system and protection using SSCB for LVDC grid applications. In section four, analytical analysis of proposed dc protection circuit is presented. In section five, examination of IGBTs for implementation in LVDC SSCB is covered. Section six presents modelling the LVDC system under study and section seven conclusion.

II. EXISTING SYSTEM

The Defence Science and Technology Organisation (DSTO) have undertaken a review of direct current (dc) circuit breakers for submarines as a deliverable under the System Integration (SI) Corporate Enabling Research Program (CERP). This review is conducted to support evaluation of dc circuit breaker options for future submarines. A circuit breaker is a device capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions. Circuit breakers are installed in submarines to protect crew and plant equipment against large currents caused by electrical faults. With advancements in battery technologies, and the increased use of power electronic converters, the magnitude of fault currents in a future submarine is likely to be substantially larger than that of existing submarines.

DIS-ADVANTAGES:

- Boosted thermal losses.
- Create huge DC existing harmonics.

III. SUGGESTED SYSTEM

In Proposed eliminate power conversion steps, future micro grids with renewable energy sources are being visualized as dc power systems. System components such as sources (solar panels, fuels cells, etc.) loads, and power conversion have been identified and are readily available. However, when it comes to dc circuit breakers, many designs are still in the experimental phase. The main limitation is that interrupting a current which does not have a zero crossing will sustain an arc. This paper introduces a new type of dc circuit breaker. It uses a short conduction path between the breaker as well as mutual coupling to automatically and rapidly switch off in response to a fault. The proposed breaker also can have a crowbar switch on the output so that it can be used as a dc switch. Mathematical analysis, detailed simulation, and laboratory measurements of the new dc switch are included.

Advantages of suggested system:

- Enhance the Air Conditioning power top quality,
- Much better tracking capacity and also DC harmonics decrease.

Now, the above-mentioned technique is admirable but, in addition, the short path can be used as a means of switching the breaker off in response to a fault. Consider the proposed dc circuit breaker shown in Figure 2. During normal steady-state operation, current flows from the source to the load through the SCR and coupled inductors. A fault on the load side will cause an impulse current in the short path containing the capacitor and secondary winding of the coupled inductors. With a turn's ratio, this current is reflected to the primary and essentially pushes the SCR current to zero; at which time the SCR switches off. It should be noted that the turn's ratio can also be set so that the breaker does not identify a large change in load as a fault.

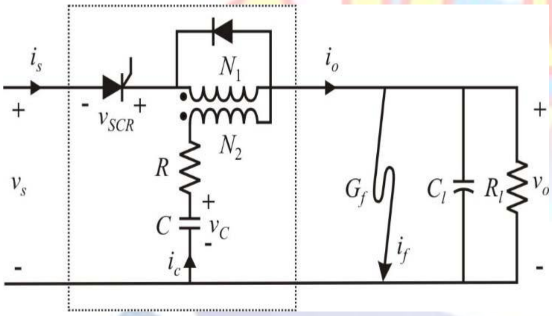


FIG 2

An alternate approach to the proposed breaker is the variation shown in Figure 3. In this circuit, the main path current flows through the primary and secondary windings. As with the circuit of Figure 2, the fault current flows through the secondary winding and causes the SCR current to go to zero. This results in the value of capacitance in listed Table I. Finally, the resistance is set to a low value as not to interfere with the breaker performance, but still provide damping of the oscillations which occur when the breaker is switched off. The last row of Table I shows the SCR ratings. A laboratory test system operating with a 100 V 6 A dc load would be within the ratings of the SCR.

TABLE 1. Parameters of the system.

$N_1 = 70$	$r_1 = 0.373\Omega$	$L_{l1} = 51\mu H$	$L_{m1} = 960\mu H$
$N_2 = 24$	$r_2 = 0.128\Omega$	$L_{l2} = 6\mu H$	$L_{m2} = 116\mu H$
$R =$ 0.02Ω.02ΩΩ	$C =$ 100μF00μFF		
$V_{RRM} = 400V$	$I_{TRMS} = 40A$	$t_q = 35\mu s$	

OPERATION

The equivalent circuit of the proposed breaker with the SCR conducting. In this circuit, the transformer resistance and leakage inductance are neglected.

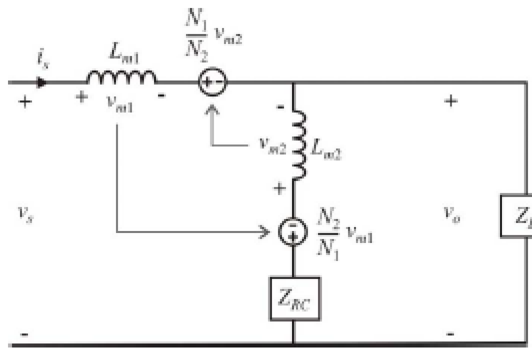


Fig.3. Equivalent circuit of the proposed dc breaker.

$$\frac{v_o}{v_s} = \frac{s(L_{m2} - L_{12}) + Z_{RC}}{s\left(\frac{L_{m1} Z_{RC}}{Z_L} + L_{m1} + L_{m2} - 2L_{12}\right) + Z_{RC}}$$

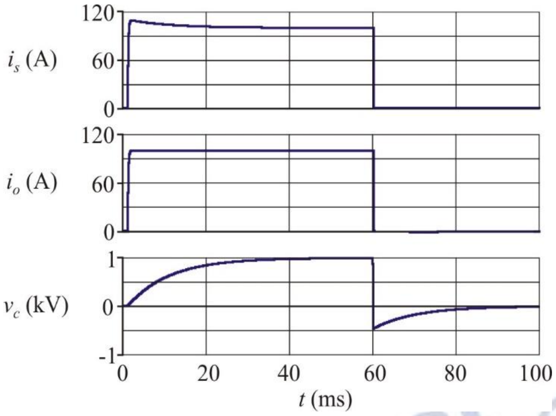
And the impedance as seen from the source is

$$\frac{v_s}{i_s} = \frac{s\left(\frac{L_{m1} Z_{RC}}{Z_L} + L_{m1} - 2L_{12}\right) + Z_{RC}}{s\left(\frac{L_{m2}}{Z_L} + \frac{L_{m2}}{Z_{RC}} - \frac{L_{12}^2}{L_{m2} Z_{RC}}\right) + \frac{Z_{RC}}{Z_L} + 1}$$

Where

$$L_{12} = \sqrt{L_{m1} L_{m2}}$$

Dissipate stored energy in circuit inductance. In these breakers the arc is forced into the arc chute, where it is stretched and cooled to help dissipate the heat generated by it. After most of the energy is dissipated as heat, the electrical arc extinguishes leaving an open circuit [15, 17]. This technology is widely used in low voltage, high power traction and marine applications [18, 19]. This technology is also used in most low voltage, low power moulded-case circuit breakers [14, 20] commonly found in residential and commercial premises. This technology is commonly used in submarines, and is discussed in greater detail in section 2.2.



Based on the parameters of Table I, a detailed simulation was carried out. In this study, the source voltage is 100V and the load is purely resistive. Figure 7 shows the source and load currents when the load is stepped from 50 to 16.7 Ω. The variables are the same as those labeled in Figure 2. As can be seen, the load current steps from 2 A to 6 A.

IV. SIMULATION RESULTS

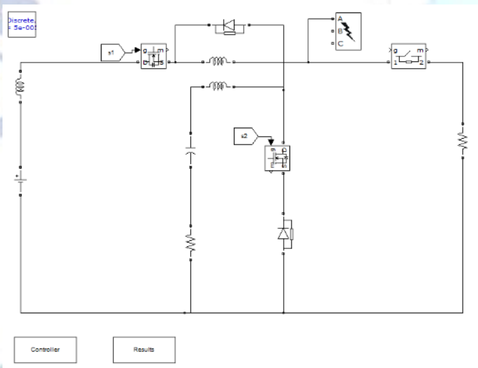


Fig.4.**Simulink model**

Consider MOSFET near the coupled inductors as M1.

MOSFET parallel to capacitor as M2.

In this circuit diagram, DC supply is applied as input and output is depend upon load. DC-AC converter is used to convert DC to AC.

At normal condition, M1 is on state and power passes through step down transformer and reach to load. At this condition capacitor is in charging mode and M2 is in off state.

Whenever the fault occurs, Due to thevenin's equation the fault current flows through capacitor the M1 goes to off state and the M2 gets on state to continue the power supply at the load. Switching operations of the MOSFET is based on the operation of PWM controller.

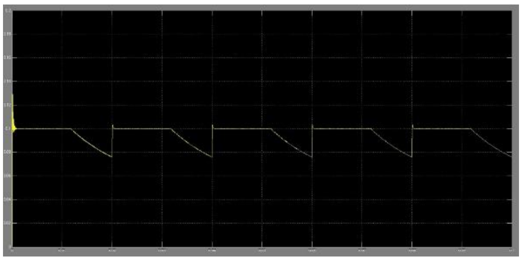


Fig.6.voltage waveform of the load

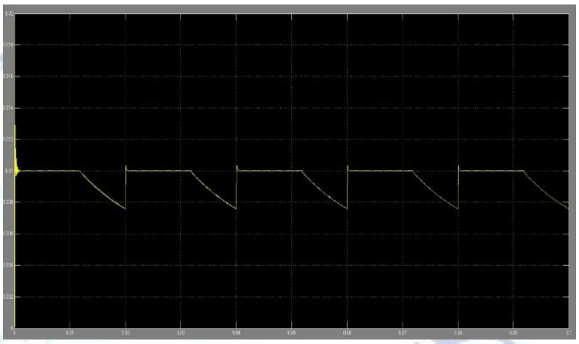


Fig.7.current waveform of the load

At normal condition, the output of resistor is linear. whenever abnormal condition occurs due to circuit breaker the voltage and current values of the load decreases.

V. PROPOSED CIRCUIT DIAGRAM

In this proposed diagram we are using Battery energy storage system this is one of the applications of dc loads. And also, here controller we are developed with help of PI controller to control the circuit breaker.

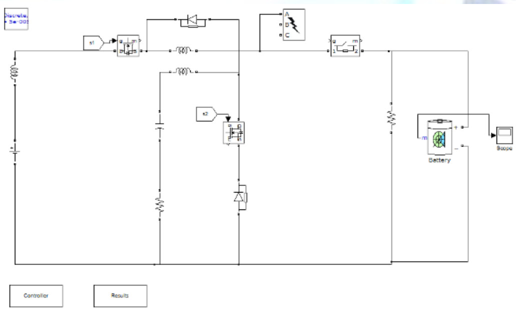


Fig. 8.Simulink models with battery

In place of PWM technique we replaced with PI controller and with battery at the load side for the purpose of storing power.

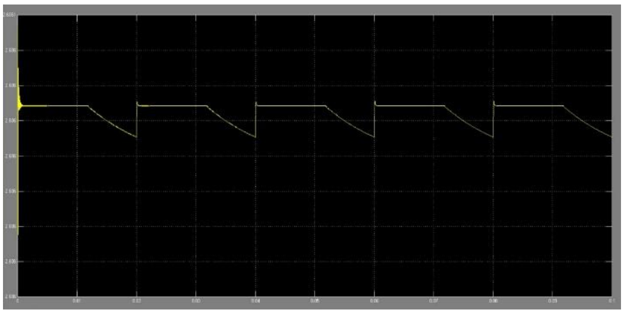


Fig.9. voltage waveform of load

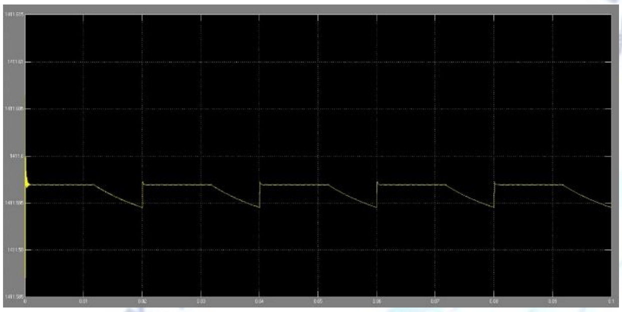


Fig .10. output current across the load

Voltage and current across the load are increased due to change in controllers (PWM to PI).

VI. CONCLUSION

As dc sources and dc micro grids become more prevalent, a solution is sought for dc switches and circuit breakers. Traditional methods relied on over-sized ac breakers, hybrid breakers, and solid-state breakers. The dc switch proposed in this project is a variation on the solid-state breaker, but has the added feature that it can automatically switch off in response to faults. Furthermore, there the turn's ratio in the circuit's transformer allows the designer to determine the amount of transient current that will be identified as a fault; as opposed to a step change in load. Analysis, design, demonstrate the proposed breaker's response to a step change in load and to a fault. The breaker compares favorably to recent designs in that it has a common ground between source and load, is invariant to step changes in load, and does not produce ringing resonance in the source current.

References

[1] M. YekiniSuberu, M. Wazir Mustafa, and also N. Bashir, "Energy storage space systems for renewable resource power market combination as well as reduction of intermittency," Renew. Maintain. Power Rev., vol. 35, pp. 499-- 514, Jul. 2014.

[2] S. Vazquez, S. M. Lukic, E. Galvan, L. G. Franquelo, as well as J. M. Carrasco, "Energy Storage Systems for Transport and also Grid Applications," IEEE Trans. Ind. Electron., vol. 57, no. 12, pp. 3881-- 3895,Dec. 2010.

[3] M. G. Molina and also P. E. Mercado,"Power Flow Stabilization and also Control of Microgrid with Wind Generation by Superconducting Magnetic Energy Storage," IEEE Trans. Power Electron., vol. 26, no. 3, pp. 910-- 922, Mar. 2011.

[4] M.-E. Choi, S.-W. Kim, as well as S.-W. Search engine optimization, "Energy Management Optimization in a Battery/Supercapacitor Hybrid Energy Storage System," IEEE Trans. Smart Grid, vol. 3, no. 1, pp. 463-- 472, Mar. 2012.

[5] G. Qiu, C. R. Dennison, K. W. Knehr, E. C. Kumbur, as well as Y. Sun, "Porescale evaluation of results of electrode morphology and also electrolyte circulation problems on efficiency of vanadium redox circulation batteries," J. Power Sources, vol. 219, pp. 223-- 234, Dec. 2012.

[6] X. Tan, Q. Li, and also H. Wang, "Advances as well as fads of power storage space modern technology in Microgrid," Int. J. Electr. Power Energy Syst., vol. 44, no. 1, pp. 179-- 191, Jan. 2013.

[7] N. R. Tummuru, M. K. Mishra, as well as S. Srinivas, "Dynamic Energy Management of Renewable Grid Integrated Hybrid Energy Storage System," IEEE Trans. Ind. Electron., vol. 62, no. 12, pp. 7728-- 7737, Dec. 2015.

[8] T. A. Smith, J. P. Mars, as well as G. A. Turner, "Using supercapacitors to boost battery efficiency," in 2002 IEEE 33rd Annual IEEE Power Electronics Specialists Conference. Process, 2002, vol. 1, pp. 124-- 128.

[9] R. A. Dougal, S. Liu, as well as R. E. White, "Power as well as life expansion of battery-ultracapacitor crossbreeds," IEEE Trans. Elements Packag. Technol., vol. 25, no. 1, pp. 120-- 131, Mar. 2002