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Review on Microgrid and its Protection Strategies

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Abstract- Microgrids are indispensable at the distribution level network and is capable of operating in both grid connected and islanded modes. Integration of renewable sources in a microgrid is a viable solution to provide continuity of supply to customers. Due to bidirectional power flow, conventional protection strategies are not applicable to microgrids. Also the change in topology of the network poses a key challenge to protection engineers. This paper reviews the advent of microgrid and also the protection strategies that are incorporated in the system integrated with renewable energy systems (RES).

Keywords Microgrid, distribution system, protection strategies, grid connected, islanded.

1. Introduction

A microgrid is an aggregate of loads, distributed generator (DG) sources and storage devices as shown in Fig.1 [1]. DG sources of few kilowatts or megawatts maybe integrated at load, feeder and substation levels [2]–[3]. If the microgrid is fed by the utility grid, it is said to operate in grid connected mode. If fault occurs in the utility grid, the microgrid isolates itself into islanded mode so as to avoid penetration of fault current into it. In islanded mode distributed generators like micro-turbines, diesel generators, etc feed the load requirements and in turn assures reliable and continuous supply to customers.

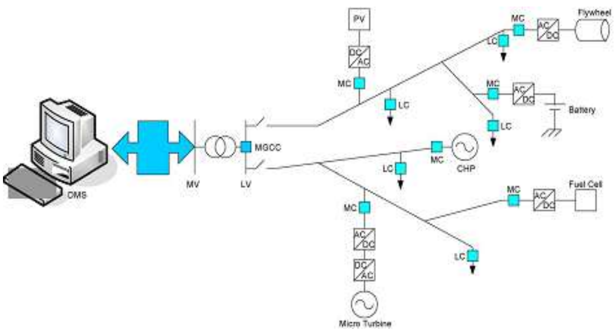

Fig. 1. Microgrid Architecture.

The Microgrids are typical example of system of systems (SOS) [4] due to its following characteristics:

i) Subsystems can operate independently at different geographic locations.

ii) It is possible to add or remove subsystems at any instant of time.

iii) The SOS objective is to cater to load requirements at all times.

The Microgrid SOS is capable of performing its task by utilizing suitable framework as indicated in Fig. 2.

Islanding behaviour of microgrid and various detection techniques that maybe employed on the system [4] are studied. The islanding events are monitored and detected using wavelet transform-based approach [5]. To make the islanded mode of operation more feasible, there is a necessity to review Electricity Safety, Quality and Continuity Regulations (ESQCR) [6]. The necessity of key non-technical factors in the deployment of microgrids is discussed [7]. Microgrids wth multiconverter devices are a solution in providing highly reliable, efficient and quality power supply [8].

A model predictive control technique by which the RES caters to the load demands of the microgrid and reduces the dependability on micro gas turbines is suggested in [9]. The explanation of how the DG sources operate in parallel to the utility grid to provide uninterrupted supply to consumers is analyzed in [10]. Various real-time microgrid test systems and its control strategies are presented in [11-12]. Supervisory control and data acquisition (SCADA) systems are utilized in performing various laboratory experiments [13].

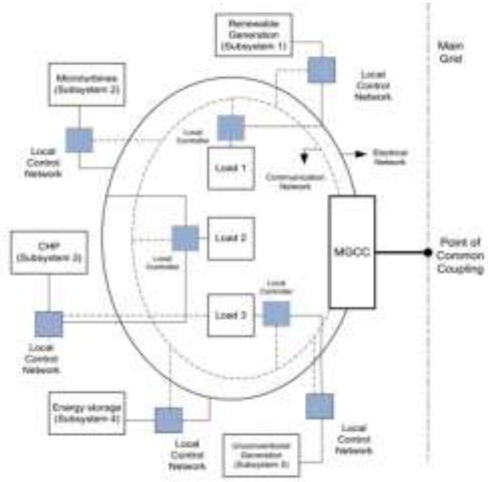

Fig. 2. Microgrid Framework.

Three challenges in microgrid are fluctuation in voltage and frequency, protection and islanding of microgrids [14].Severe issues in protecting islanded microgrid occur predominantly due to fluctuation of fault current magnitude and bidirectional power flow [15]. The issues caused due to high DG penetrations like power, power factor and voltage fluctuations, bidirectional power flow, rise in frequency regulation and harmonics, unintentional islanding, variation in fault current magnitude in grid connected and islanded mode and grounding issues are analyzed in [16]. Power fluctuations in microgrid is witnessed when intermittent renewable sources like wind and photovoltaic (PV) are connected as DG sources. It is necessary to stabilize the power fluctuations to avoid equipment damage [17]. An elaborate stability study of microgrid is essential before commissioning [18]. The fluctuation in short circuit currents, inappropriate protection schemes, ineffective line reclosing and unexpected islanding in microgrids are illustrated in [19]. It indicates the necessity of changes in distribution protection philosophies to avoid such situations.

This paper is organised in a manner that Section 2 highlights the protection issues in Microgrid, Section 3 reviews the protection strategies employed in autonomous microgrids. Section 4 elaborates on the communication assisted adaptive protection schemes incorporated in microgrids. Section 5 discusses about the embedded system based relays that are conveniently used in microgrid protection. The feasibility of employing optimization of relay parameters to achieve prompt fault clearance is showcased in Section 6.

2. Protection Issues

Microgrids are predominant with overcurrent faults. The conditions that may occur in grid connected microgrid are normal operation, faults in feeder, fault in utility grid, fault in bus and resynchronization issues. Reconfiguration of microgrid causes the conventional relays to fail in clearing faults. Amplitude and direction variation of short circuit current poses severe protection issues. Few key protection issues are discussed in the following subsections.

2.1. Inverter-Interfaced Distributed Generator (IIDG) in Microgrid

In grid connected mode, about 20-50 times higher fault current is witnessed. The Distributed Energy Resources (DER) provide 1.1 to 1.2 times the rated DER current (I_{der}) to a fault. IIDG has less fault current capacity of about 50% of its rated current. But the IIDG maybe designed to contribute higher fault currents. About five times full load current of the system is injected at the fault, when the microgrid is in islanded mode. The significant reduction of fault current in IIDG based islanded microgrid is due to microsources with power electronic (PE) converter systems that contribute up to 200% of load current to a fault.

2.2. Variation in Fault Current Level

The magnitude of potential faults in a network is expressed in terms of the fault level (FL) as indicated in (1) and (2), whose unit is in MVA.

$$FL = \sqrt{3} * V_{nominal} * I_f \tag{1}$$

$$MVA_b = \sqrt{3} * V_b * I_b \tag{2}$$

By dividing (2) by (1) the per unit (pu) quantities are given in (3) as,

$$FL^{pu} = I^{pu} = \left\{ \frac{1}{Z_{th}^{pu}} \right\} \tag{3}$$

The fault level is an indication of 'how close' a particular point is from the sources of a system.

In Fig. 3, when the DG is disconnected from the network, the impedance measured at the relay location closer to fault is computed using (4). When the DG is connected to the network, the impedance measured at the relay location and the total fault current contributed to faulted point is indicated using (5) and (6) respectively. This in turn causes the fault current seen by upstream protective device to decrease. If $Z_{rl} < Z_{sl}$, the relay operates for a given fault.

$$Z_{rl} = \frac{U_{rl}}{I_{FG}} \quad (4)$$

$$Z_{rl} = Z_{upstream\_r} + \left\{ \frac{I_{FDG}}{I_{FG}} \right\} Z_{downstream\_r} \quad (5)$$

$$I_{FT} = I_{FG} + I_{FDG} \quad (6)$$

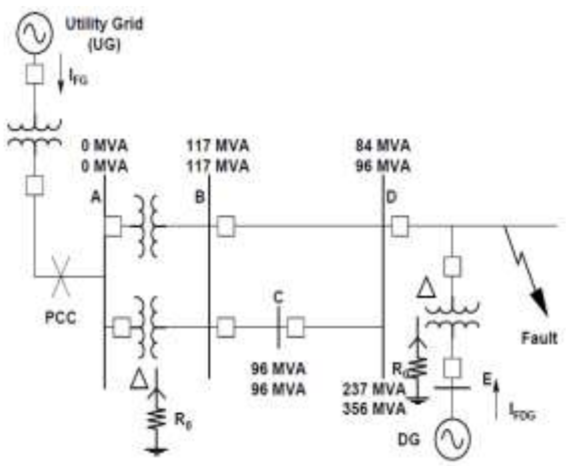

Fig. 3. DG interfaced Microgrid.

2.3. Determination of Fault Current Coefficient

When the microgrid is disconnected from utility grid and acts in islanded mode, DERs may be treated as subset of units that act as contributors to short circuit current in a defined direction as indicated in (7) and (8).

$$I_{k\min} = \sum_{1}^{n} K * I_{rder} \quad (7)$$

$$K = \frac{I_{kder}}{I_{rder}} \quad (8)$$

2.4. Underreach

A microgrid test system is shown in Fig. 4, and its Thevenins equivalent is shown in Fig. 5. If a DG unit is interfaced in the network, then a component of fault current, i_{fault}, is contributed by the DG unit, i_{DG}. Thus in this case there is less grid current contribution, which causes the current sensed by the relay at CB2 to be minimized and hence fault is not detected. When the DG is disconnected from the microgrid, a fault at a given location is fed completely by the grid. Thus a large current magnitude is sensed by the relay and trips CB2.

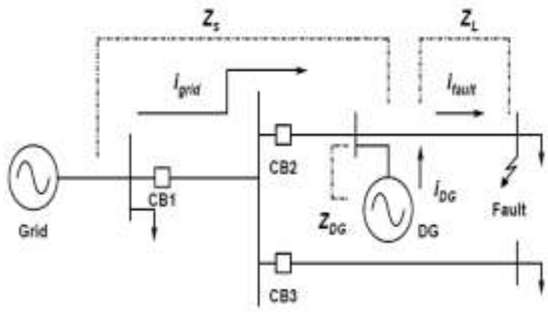

Fig. 4. Microgrid Protection Issue- Underreach.

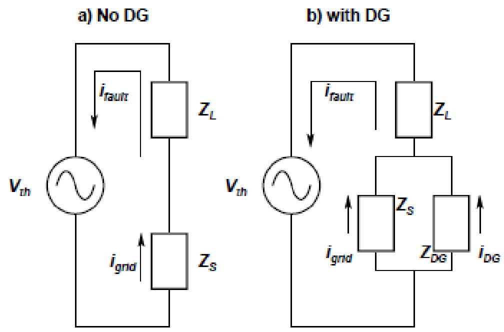

Fig. 5. Thevenins equivalent of Fig. 4.

2.5. Sympathetic tripping

This protection issue causes disconnection of a healthy feeder due to DG units that cause reverse power flow as indicated in Fig. 6.

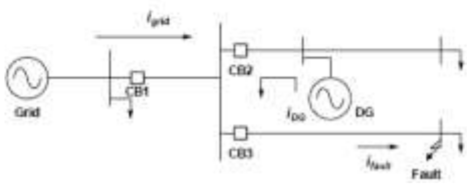

Fig. 6. Microgrid Protection Issue- Sympathetic tripping.

2.6. Issues in DG interfaced microgrid

DG interfacing in microgrid causes major protection issues like underreach, sympathetic tripping, unsuccessful clearing of faults, and unintentional islanding. These concerns may be addressed by limiting the location, number and capacity of DG units.

Other techniques to overcome issues in microgrid protection are:

i) including high fault current capacity inverters

ii) incorporating energy storage devices in the network, with large current supplying capabilityincase of faults.

iii) performing elaborate analysis of fault behavior in islanded microgrid with DG units.

iv) employing differential protection scheme

iv) ground connection with balanced combination of DG units

vi) implementing detection techniques based on voltage

vii) using adaptive protection schemes

viii) deriving differential and symmetrical components based protection scheme.

Hence a complete analysis of microgrid dynamics is essential before, during and after islanding.

3. Protection Strategies in Autonomous Microgrids

An autonomous microgrid is available in University of Wisconsin, United States as shown in Fig. 7. Fault current magnitudes vary significantly in grid connected and islanded modes of operation. Power flow in microgrid network is not uni-directional due to multiple sources in microgrid. These two are key challenges to protection engineers as conventional protection schemes no longer hold good for microgrids. [20,21] suggests a novel LV-microgrid-protection system and the details of protection devices that are used is analyzed. Control and protection of microgrid is realized using back-to-back converters [22]. A new fault detection method [23, 24] is employed in microgrids based on abc-dq transformation. A microprocessor based relay [25] is realized and utilized in microgrid, which is independent of communication and magnitude of fault current. But the system is complex and time-consuming. A differential relay is placed at every cable section for protecting the microgrid [26].

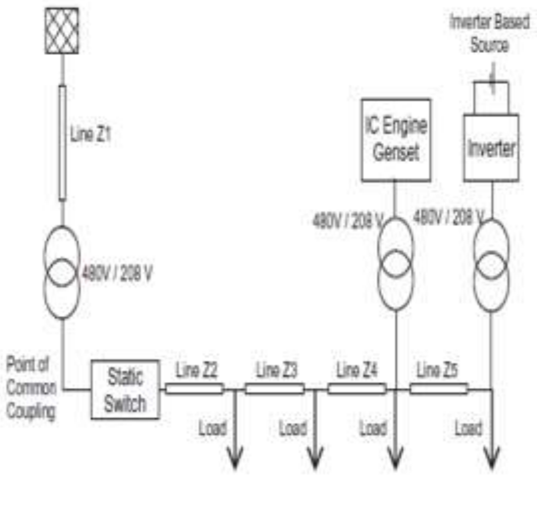

Fig. 7. Autonomous Microgrid in USA.

During voltage sags, it is important to protect the microgrid from large fault current by employing suitable current-limiting algorithm [27]. A technique to identify fault direction is proposed for a series compensated line based on positive-sequence current and voltage at a fault location [28] .An intelligent distribution fault anticipation (DFA) [29] is used for predicting failures in a microgrid system. [30] suggests a scheme in which at the event of fault occurrence at a node, the current phase jump is measured. This measured value is compared with prefault conditions and changes in rate. This technique identifies the direction of fault and trips the appropriate breakers to clear the fault. This scheme is tested on a microgrid modeled in PSCAD/EMTDC program. Various islanding protection schemes [31] are incorporated universally. Relay agents [32] are placed at various zones of the microgrid and are responsible in capturing the bus currents at their specific location. Using the entropy of wavelet coefficients the proposed technique is capable of fault identification. This technique is validated on medium voltage (MV) microgrid and a 66 kV microgrid in the Alexandria test microgrid system.

Two modes of assessment [33] for critical clearing times in a microgrid are: (a) two end of line is tripped simultaneously; (b) at one line end tripping is instantaneous and is further used for identifying the critical clearing times for the other end. Case (b) proves more effective when validated on a test system. A user friendly software tool based on feed forward multilayer perceptron neural networks [34] assist in the decision making in early phase of design which analyzes the impact of fast transients and its electromagnetic interference on the protection of distribution substations which is critical for protection engineers [35]. Suitable protection is provided for a radial distribution network. The impact of distributed generator connection at certain buses of the system is analyzed. This proves that conventional protection schemes are not sufficient for DG interfaced microgrid [36]. Fig. 8 indicates the effect of fault current contribution from the DGs in the microgrid.

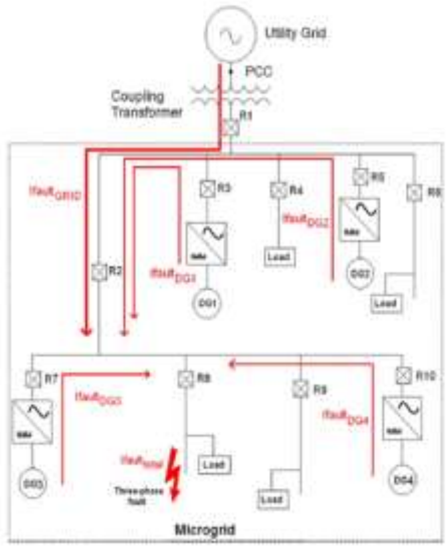

Fig. 8. Fault current contribution by DG's in microgrid

Table 1. Available Microgrid Protection Schemes

Protection Technique	**Line/bus protection**	**Dependency on microgrid configuration**	**Protection against subsequent faults**	**Cost**
Adaptive protection	Both	Yes	No	Reasonable
Dıfferential protection	Only Bus	No	Yes	Expensive
Voltage-based protection	Both	Yes	No	Reasonable
Deployment of external devices	Both	Yes	No	Very expensive
Overcurrent and symmetrical components	Both	Yes	No	Reasonable

Table 2. Available Microgrid Protection Schemes in islanded mode

Protection Scheme based on	**Methods**	**Type of fault**
Harmonic content	Total harmonic distortion and frequency measurement of converter voltages, communication link between relays	LLG
Voltage	Abc-dq0 transformation of DGs output voltages, communication link between relays	LLL, LL, LG
Symmetrical fault and residual current	Overcurrent relays, static switch at PCC, zoning principle	LG,LL
Adaptive protection scheme	IEDs, high speed communication link	-

A novel technique [37], which is a combination of artificial neural networks (ANNs) and wavelet transform (WT) is used for detecting the high impedance faults (HIFs) in microgrid feeders. The ANN learning algorithm and structure used in this method is the Levenberg–Marquardt back-propagation algorithm and multilayer perceptron network respectively.

The implementation of priori patterns and a pattern discovery algorithm [38] is employed for recording electrical events in different substations. It intends to define sequential patterns, or episodes, formed by ordered collections of events pertaining to faults in the power system. Episodes are few subsets of significant events that indicate the impact of permanent and transient faults in mcirogrid.

Peak let-through current based method [39] of device interaction analysis is suitable for selectivity of protective devices. A novel time–current limit curve [40] is applied for realizing stability in radial systems. Stability limit curve is proposed for lines which are fed from both ends. Power frequency voltages and current traveling waves based microgrid protection is possible [41]. The former is

used to identify a fault and the latter is used to identify the faulted zone. In [42] the microgrid is bifurcated into many zones. The asymmetric faults maybe identified using negative sequence component as the characteristic quantity. The protection scheme is validated with EMTDC tool.A multi-agent system (MAS) [43] controls a PV based microgrid. The MAS islands the microgrid in the event of fault occurrence in main grid, which in turn secures the critical loads. After the fault clearance the microgrid is resynchronized with the main grid. Matlab Simulink is used for elaborate microgrid simulation [44]. Four major faults types are initiated at each bus in both grid-connected and islanded modes. The fault currents are analyzed and suitable protection scheme using digital relays are applied to the distribution network to facilitate microgrid functionality. An electrical substation incorporates protection philosophy based on digital bit exchange between devices and programmable logic based microprocessor technology [45]. DIgSILENT Power Factory 13.1 [46] is utilized to perform the load-flow analysis and to analyze the overcurrent protection (OCP) devices placed on the test feeder. This information is useful in providing relay coordination for various faults. Directional overcurrent and earth fault protection [47] is successfully implementation in a Malaysian microgrid. [48] discusses the significance of directional and non-directional overcurrent relays (DOCR) for power system protection.

When the power flow is bidirectional, the directional overcurrent relays with current and voltage sensors, depend on reference voltage phasor for indicating the fault direction. The implementation of novel inverse-type relay is analyzed to protect a microgrid [49]. The relay characteristic is dependent on measured admittance of the protected line. The relay effectively detects faults under varying fault current levels. The performance of the relay is evaluated using PSCAD simulation and lab experiments. An instantaneous current protection scheme is proposed for a microgrid. The relay settings are altered based on operating mode of microgrid and DG output power without the use of communication medium. A gist of available microgrid protection schemes is indicated in Table 1 [50]. The list of exclusive protection schemes from microgrids in islanded mode is given in Table 2 [51].

4. Communication Assisted Adaptive Protection in Microgrids

Fig. 9 indicates how adaptive protection is done for microgrids offline and online. Sample microgrids and their communication medium are indicated in Table 3 [12]. Possible coordination strategies for microgrids based on adaptive techniques are studied in literature. In [52], the microgrid is divided into zones and each zone is isolated from other zones using digital breakers. The OPEN or CLOSE signals are issued adaptively from a computer at remote location. The main relays in the network are responsible for analyzing data and establishing communication with the trip circuits of the mcirogrid. The main relays sense the fault type in a zone and clears the faulted section by tripping appropriate breakers. The working of an adaptive protection scheme based on backtracking algorithm to provide primary and backup protection in a microgrid for various fault scenarios are analyzed in [53]. This technique aids in restoring supply to consumers and decreasing the downtime during power failures.

A communication-aided protection scheme with high selectivity using DOCR's based on intertripping and blocking transfer functions is proposed in [54]. An adaptive microgrid protection system utilizing digital relays and communication protocols is presented in [55]. In this system, a centralized architecture is responsible for altering relay settings based on microgrid operating conditions. A central protection system monitors the operating mode of microgrid [56]. In the event of fault occurrence, the relay settings are adaptively altered to clear the fault instantly. A protection strategy based on differential protection devices [57, 58] is facilitated on each line of the microgrid. But this scheme is expensive and technically complex.

Technique capable of detecting and isolating high impedance faults with appreciable reliability of the microgrid system is attained by forming a loop structure [59]. A microgrid protection system is modeled using IEC61850 and IEC61850-7-420 communication standards [60].

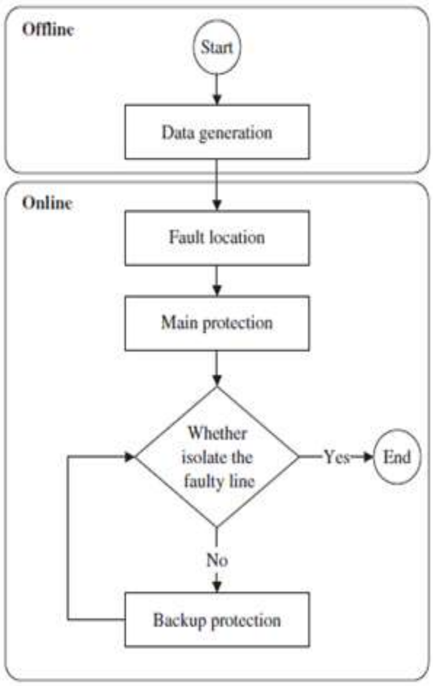

Fig. 9. Adaptive protection schemes in microgrids.

Table 3. Sample Existing Microgrids

Location	Power Supply	DG source	Energy Storage	Microgrid Controller	Communication
Bronsberg, The Netherlands	AC	PV	Battery	Central	GSM based
Am Steinweg, Germany	AC	CHP, PV	Battery	Agent Based	TCP/IP
CESI RICERCA DER, Italy	DC	PV, wind, diesel, CHP	Battery	Central	LAN Ethernet, wireless and power line
Bornholm, Denmark	AC	Diesel, wind	None	Autonomous	Optical fibre network
Kythnos, Greece	AC	PV, diesel	Battery	Central	Power line
CAT, Wales, UK	AC	Hydro, wind, PV	Battery	Central	Not discussed

This novel communication based protection monitors the dynamic microgrid and alters the relay settings based on it. To coordinate differential current protection in microgrids [61, 62], an IEC 61850 an IEC 61850-7-420 based microgrid central protection unit (MCPU) is suggested. An adaptive current protection scheme for providing suitable primary and backup protection is proposed in a microgrid. This scheme is independent of type of DG and fault [63].

The microgrid is divided into zones and Multilayer Perceptron (MLP) based neural network facilitates fault identification [64]. This protection scheme is implemented and validated on Shiraz, Iran test bed. [65] presents a monitoring technique that is capable of identifying fast transients as well as small variations of non-dispatchable photovoltaic devices and penetration level of RES. A microgrid protection system, which is a combination of traditional differential protection and adaptive protection scheme, is studied [66].

This increases the accuracy of the protection strategy used and it involves low communication cost. The transition between the protection schemes is done smoothly using switching algorithms. A central adaptive protection system analyzes the data obtained from the field Intelligent Electronic Devices.

Communication in this environment is established using IEC 61850 standards [67]. This adaptive protection system is developed, tested and implemented at Hailuoto island, Finland. A multi layer IEC 61850 based control strategy for microgrid operation and control is discussed [68].A communication aided hierarchical protection strategy for directional OC relays in Illinois Institute of Technology, Chicago microgrid for both modes of operation is presented in [69]. This protection system is applicable for varying fault current magnitudes, irrespective of mode of operation of microgrid.

A differential protection scheme with short distance communication capability is proposed for a microgrid network in [70].

5. Embedded Systems Based Relays in Microgrids

A microprocessor-based relay is applied to low-voltage microgrids [71]. No communication is required for this proposed system. This protection system is independent of magnitude of fault current and the microgrid mode of operation. The characteristics of protection reliability is highlighted in [72]. It is used as a tool for protection reliability seeking data collection, reliability modeling and quantitative analysis, and improvement measures formation. A field programmable gate array (FPGA) is used to realize a wavelet-based digital DOCR for power transformer protection [73]. The prototype relay is realized using SPARTAN3E FPGA kit and coded using VHDL. The relay logic performs disturbance detection and fault discrimination in a given system. The necessity of techniques that prevent relay from operating because of transient and harmonics in current in the power system is discussed [74]. A technique based on symmetrical components is employed to discriminate fault current from the transient and harmonic currents. A cumulative-sum-based fault detection algorithm is used for relays in a network [75]. This algorithm based relay operation involves high detection speed and performs effectively with uncertainties like noise, frequency deviation and load changes. A system is developed in which details of faulted phase and nature of fault is displayed on a microcomputer [76]. A state-diagram-based algorithm for relays, which provides reliable response in parallel circuits is discussed in [77]. Different techniques to overcome the issues caused by alternating control voltage used in multifunction microprocessor-based relay is elaborated [78]. A digital signal processor (DSP) TMS320F2812 based overcurrent relay is discussed in [79]. The overcurrent relay functionality is realized in MATLAB/Simulink and then implemented using DSP.

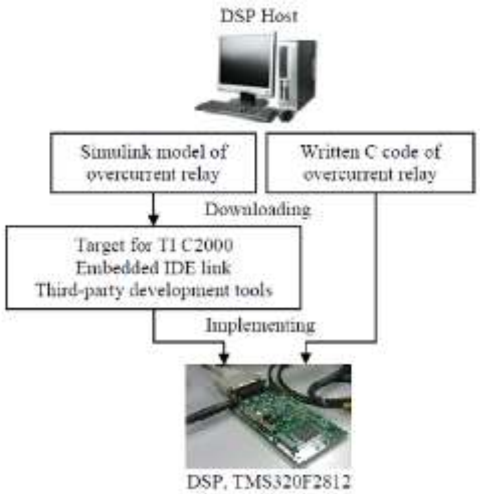

Fig. 10. Overcurrent relay implementation using DSP.

A technique wherein extensive current transformer (CT) or voltage transformer (VT) measurements are captured in digital substations is utilized to ensure that protective relay operates only for actual faults and not for fake measurements [80]. A two swift resetting algorithm is employed for breaker failure protection [81]. These algorithms possess reset time that is witnessed to be less than half of that of power system cycle. [82] compares the overall performance of a conventional digital relay with oversampling techniques for various operating and fault conditions. Anti-aliasing method is not used in this relay module. It is necessary to deduce a reliable protection model for microgrid [83]. It highlights that the reliability may be improved if failures due to relay hardware and software, ancillary equipment, ineffective routine inspections, low reliance of self-checking, inefficient backup operation and personnel error are avoided. Issues faced in a distribution network during three-phase faults due to voltage that drops to zero and capacitor coupling voltage transformer that contributes to transients is presented in [84]. The above issues are addressed using a solution based on concept of power-flow direction. A DSP TMS320F2812 based overcurrent relay realization is indicated in Fig. 10 [85].

A bang–bang controller based on fuzzy logic is used as control technique to provide suitable overcurrent protection. The performance of this DSP based system is tested based on steady state and transient analysis, efficient coordination and execution time of the processor. A novel hardware architecture for a digital protective relay is presented in [86]. The measurements and relay coordination is calculated using generalized COordinate Rotation DIgital Computer (CORDIC) algorithm. The CORDIC based protective relay was implemented in a 0.35 lm CMOS technology and is proved to have higher processing capability and good coordination accuracy. The realization of numerical overcurrent relay based on digital signal processors (DSP) is available in literature. The protection is significantly improved since the relay performs complex processing faster and accurately. The performance of the relay is derived based on operating time,memory usage, execution time and transient analysis. protection is significantly improved since the relay performs complex processing faster and accurately. The performance of the relay is derived based on operating time,memory usage, execution time and transient analysis.

6. Optimization of Relay Parameters in Microgrids

Frequent reconfiguration of microgrid throws challenge to protection engineers in providing suitable protection schemes. To handle this challenge [87] Kruskal aided Floyd Warshall algorithm is used for identifying current topology of microgrid at iny instant of time. If a fault occurs, then the shortest path from a fault to the nearest operating source is identified to clear the fault in a microgrid with minimum load disconnection. Optimized values are obtained for Time multiplier setting (TMS) and time of operation of overcurrent relays, which will facilitate in clearing the fault faster [88]. The implementation of integrated-Rough-Set-and-Genetic-Algorithm to hypothesize anticipated relay behavior based on association rule from event report of digital protective relay is investigated in [89]. The overcurrent relays' application and coordination in a radial power system with feed from single or multiple sources is analyzed in [90]. The operating characteristics, pickup current and TMS of relays are treated as optimization parameters for optimal coordination of DOCR's [91]. Linear formulation is used to optimize each parameter. The proposed scheme is validated on an 8-bus system and the IEEE 30-bus system. The stability and integrity of power system network is achieved using suitable coordination between protection relays [92]. Time delay settings of backup distance protection are done remotely using fault trees with time dependencies (FTTD). Coordination of distance and overcurrent relays is treated as an optimization problem and solved using genetic algorithm (GA) [93]. Opposition based chaotic differential evolution is used to obtain optimized values of overcurrent relays in distribution test systems [94]. To facilitate better speed and sensitivity [95], on-line coordination of the DOCR's is achieved in microgrid. The optimization of relay parameters is achieved using genetic algorithm, ant colony and differential evolution algorithms. Teaching Learning Based Optimization (TLBO) and informative differential algorithms [96-97] are applied for optimization of DOCR in a distribution network. The primary and backup relay combinations are set using LINKNET structure, which inturn avoids mis-coordination of relays. Binary programming model for online coordination of DOCR problems are utilized in interconnected distribution networks [98] . The optimized settings are done using SCADA. The NSGA-II is used to find the optimal coordination of overcurrent relays [99]. The proposed system attains the reduction in both discrimination time and operating time of all relays. Multiple Embedded Crossover particle swarm optimization techniques is employed for optimal coordination of distance and DOCRs [100]. As indicated above, various optimization algorithms maybe employed in microgrid to optimize the real settings for clearing the fault effectively in microgrid. A novel hybrid method based on advantages of Genetic algorithm (GA) and Non Linear Programming (NLP) is identified the optimized settings of overcurrent relays [101]. The proposed method overcomes the drawback witnessed in Genetic Algorithm and Non Linear Programming methods.

7. Conclusion

The literature review on microgrid protection performed in this paper is indicative of the fact that selecting the most suitable microgrid protection scheme has many factors which are to be handled collectively. The technological evolution of microgrid protection challenges and schemes are discussed from 2004 in this review work. It is realized that investigation of unconventional protection schemes is necessary, which considers the bi-directional power flow issues, impact of DER and variation in fault current magnitude in both grid connected and islanded modes of operation of microgrid. The application of adaptive protection scheme based on communication protocols is an important feature in clearing faults in microgrid. In addition, the scopes of incorporating embedded system based relays in microgrid is addressed. Various techniques to optimize the time of operation of relays is discussed. By improvising and selecting suitable microgrid protection schemes, more microgrids will come into existence in existing power grid ensuring the continuity of supply to local consumers.

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