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A Review on Protection and Faults Occurs in Electric Vehicle Charging Stations

Ganji Sai Kiran[1], Bairi Jayaram[2]

[1,2]B.Tech Student, Department of Electrical and Electronics Engineering, GMR Institute of Technology,Vizianagaram District, A.P, India

ABSTRACT

As the number of electric vehicles continues to grow and the charging infrastructure expands along with it, the number of questions about charging stations also increases regarding the protection and safety against electric shock from electric vehicle charging stations. This paper analyses the classification of electric vehicle charging stations, layout, and features needed for the electrical protection against direct lightning, earthing systems, equipotential bonding, shielding, routing, and surge protective devices (SPD) installation. And it explains the protection of both grids to a vehicle (G2V) and vehicle to grid (V2G). Needs for a smart dc node's grid-interconnection systems that are used to supply electric vehicle (EV) charging stations and focus on protection relays Potential flaws that often affect the DC side are described. At various EVCS fault sites, faults of different fault impedances have been created, and the related impacts on EVs are analyzed. This term paper provides an overview of existing literature on a proper protection strategy that has been designed and put into place, particularly to make it possible for EVs to charge safe and securely, and the results are summarized.

Keywords: Electric vehicle charging station, Lighting, Earthing, Surge protective devices, Protective relays.

1. Introduction

The transportation industry has opened the way for the usage of electric vehicles due to the expanding pollution issues, greenhouse impacts, and rising prices of petroleum goods (EVs). The complexity and quantity of Electric Vehicle Charging Stations inside the distribution network must rise for EVs to be used widely. Charging infrastructure Features should be taken into account while protecting electric car charging infrastructure from lightning. A comprehensive lightning protection strategy should be used to provide the infrastructure for charging electric vehicles, including direct lightning protection, equipotential bonding, earthing, shielding, correct routing, and the installation of surge protective devices. LEMP and direct lightning protection techniques must be combined to get greater outcomes in protection. Getting a protective system for EVCSs is one of this paper's contributions. The Tavanir organization published instructions for clustering loads based on their power demand, and here they can also be used for the classification of EVCS. Additionally, each EVCS is connected to a particular part of a power system due to its power demand, so a schematic of connection type is also defined in this paper. Both the specified categorization and connection type for G2V and V2G modes are applicable. Finally, the protective system's ability to add EVCS is evaluated, and the functionality of the protective apparatus when EVCS is present is examined. In this paper, a type of electric vehicle safety charging early warning model is designed to enhance the security early warning capability of the electric vehicle charging process. This model realizes the early warning of electric vehicle charging safety for charging processes involving fire, leakage, and other safety accidents. Before setting up a security early warning evaluation index system and discussing the evaluation technique of weight for safety index, it is first necessary to assess the safety aspects related to electric car charging. Additionally, a type of early warning model for electric car charging security is created utilizing genetic wavelet neural network training principles and has multi-scale multi-resolution

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* *Corresponding author.* Tel.: +0-000-000-0000 ; fax: +0-000-000-0000.
E-mail address: author@institute.xxx

2. Literature survey

This paper provides information about damage to electric vehicle charging infrastructure by direct lighting How to install surge protective devices the possible faults that generally occur on the DC side effects faults on respective locations. To ensure electrical safety and prevent hazardous accidents in electric vehicle charging stations. unified a set of requirements for the safe operation of Distribution network operators (DNOs) and railway traction system operators (RTSOs) who will connect bidirectional electric vehicle charging stations (EVCSs) (treated as both load and source) to their power networks. The initial and periodic values of dc charging stations. And safety measures need to be taken against electric shock. The necessity of protection devices for each kind of charging station; residential, public parking lots. The Functionalities in electrical protection requirements for the grid-interconnection systems of a smart dc node used to feed electric vehicle (EV) charging stations, the use of this protection in electric vehicle charging stations identify the locations of the different faults.

3. Methodology

3.1 DAMAGE ANALYSIS

An air-termination system can be constructed using air-termination rods, conductors, mesh, or any combination of these. As long as the bonding length of the metal plates is not less than 100mm and there are no combustible materials below the metal plates, metal plate roofs with a minimum thickness of 0.5mm can be employed as an air-termination system. To get satisfactory protection results, SPDs should be positioned such that they are close to the equipment to be protected, their connecting conductors are as short as feasible, and the effective protection level is lower than the rated impulse withstand voltage of the equipment.

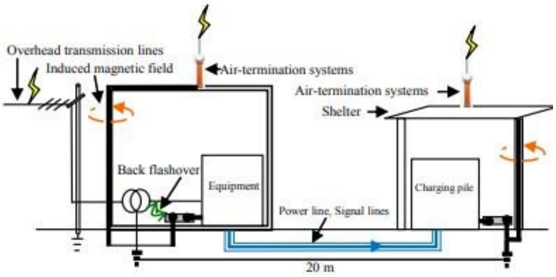

Figure 1. Sources of Lightning damage to the charging infrastructure

3.2 FAULT DETECTION

Battery Charger control system: There are two battery charging control strategies namely ‘constant current’ and ‘constant voltage’ by which the battery of an EV can be charged. Generally, it is advised to charge the battery with a constant current strategy in the initial stages of charging and then switch to a constant voltage strategy to avoid sudden injection of high currents when connected to a DC bus. This paper uses a constant current strategy in the modelled EVCS.

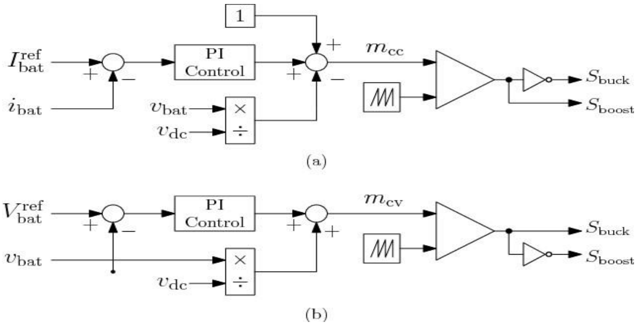

Figure.2 (a) current control system (b) voltage control system

inverter Control System : Inverter Control System the control system used for the inverter is a cascaded control in the DQ frame followed by a PWM generator to send the gating pulses to the switches in the inverter to maintain a constant DC bus voltage. The main function of each PI control block is labelled accordingly.

3.3 TECHNICAL STANDARDS

According to the region or specific boundary circumstances, a low-voltage switchgear assembly that feeds a charging station for electric cars must be erected and operated in compliance with the IEC 61439 series. The NFPA 70 NEC [6], the IEEE C2 (NESC), the IEC 60364 series [5,] or (standards concerning electrical installations). A DC charging station itself must be installed and operated in compliance with the IEC 61439 series, IEC 60364-7-722 (standards for electrical installations), or the IEC 61851 series, depending on the manufacturer's declaration (standards concerning charging procedures). Additionally, the IEC 62893 series will serve as the charging cable standard in the future. All electric vehicle charging connectors must already be established in compliance with the IEC 62196. Despite the many widely accepted standards, there are still no laws that cover the initial and ongoing inspection of DC charging stations.

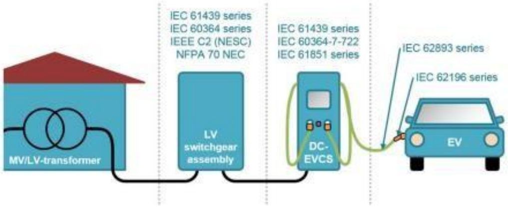

Figure.3 Principle scheme – DC-EVCS as well as selected technical standards

3.4 ELECTRICAL PROTECTION FOR THE 25-KV AC RTS SMART DC NODE GRIDINTERCONNECTION

The smart dc node at the point of common coupling must have a single 25-kV interconnection protection system, according to the Spanish national RTSO (PCC) under/overvoltage detection (27/59 relay) and /over frequency detection (81U/O relay) are required for this protective system. Furthermore, in the case of 25-kV ac RTS failures, overcurrent protection employing a circuit breaker (52), activated by the 50/51 relay, must ensure disconnection of the smart dc node from the 25-kV ac RTS. However, on occasion, the Spanish national RTSO will recommend that the overcurrent protection be handled by the meausingnce protection (21 relays). The maximum short circuit current has to be assessed using. This circuit breaker is additionally tripped by a time-delayed, instantaneous earth overcurrent relay (50/51N) to prevent earth faults on the LV transformer side. The smart dc node must be a part of An additional Undervoltage relay (27X) required for the Spanish national RTSO. The need for an anti-islanding defense is not always necessary [7]. The bidirectional 750-V dc/0.4-kV ac converter should have the protection features stated above embedded into its control software or hardware, according to the Spanish national RTSO (ac side). The 25-kV overhead contact line's smart dc node connection must be made using a visible lockable switch (89) that is accessible at all times by the Spanish-speaking RTSOs employees and protected by a fuse and voltage surge arrestor. The connecting transformer has to provide overcurrent protection on both the LV and HV sides. Visible lockable switches must isolate the reversible dc/ac converter (89). For secure 25-kV ac RTS operation, use the Spanish national RTSO's remote control system. For instance, according to numerous sources, when output power reaches a specific threshold value, a transfer tripping (TT) to the associated circuit breaker (52) is necessary (such as 100 kVA or 1 MVA)[7]. It should also have a bi-directional TT between the 750-V and 25kV connection protection systems to guarantee their simultaneous trip. Synchronized with the smart dc node's reclosing strategy the 750-V dc bus must include a single 750-V internal connections protection system, according to the Spanish national RTSO (Figs. 1 and 2). Under/overvoltage detection must be included in this protective system (27/59 relay). Moreover, the dc circuit breaker (72), is activated by the overcurrent protection In the case of 750-V dc bus problems, the remote control system for safe 25-kV 76 relays operated by the Spanish national RTSO must ensure the disconnection of the bus. The maximum short-circuit current needs to be assessed in light. The bidirectional 750-V DC/0.4-kV ac converter should have certain protection features embedded into the control software or hardware, according to the Spanish national RTSO (dc side).the Spanish national RTSO (dc side).

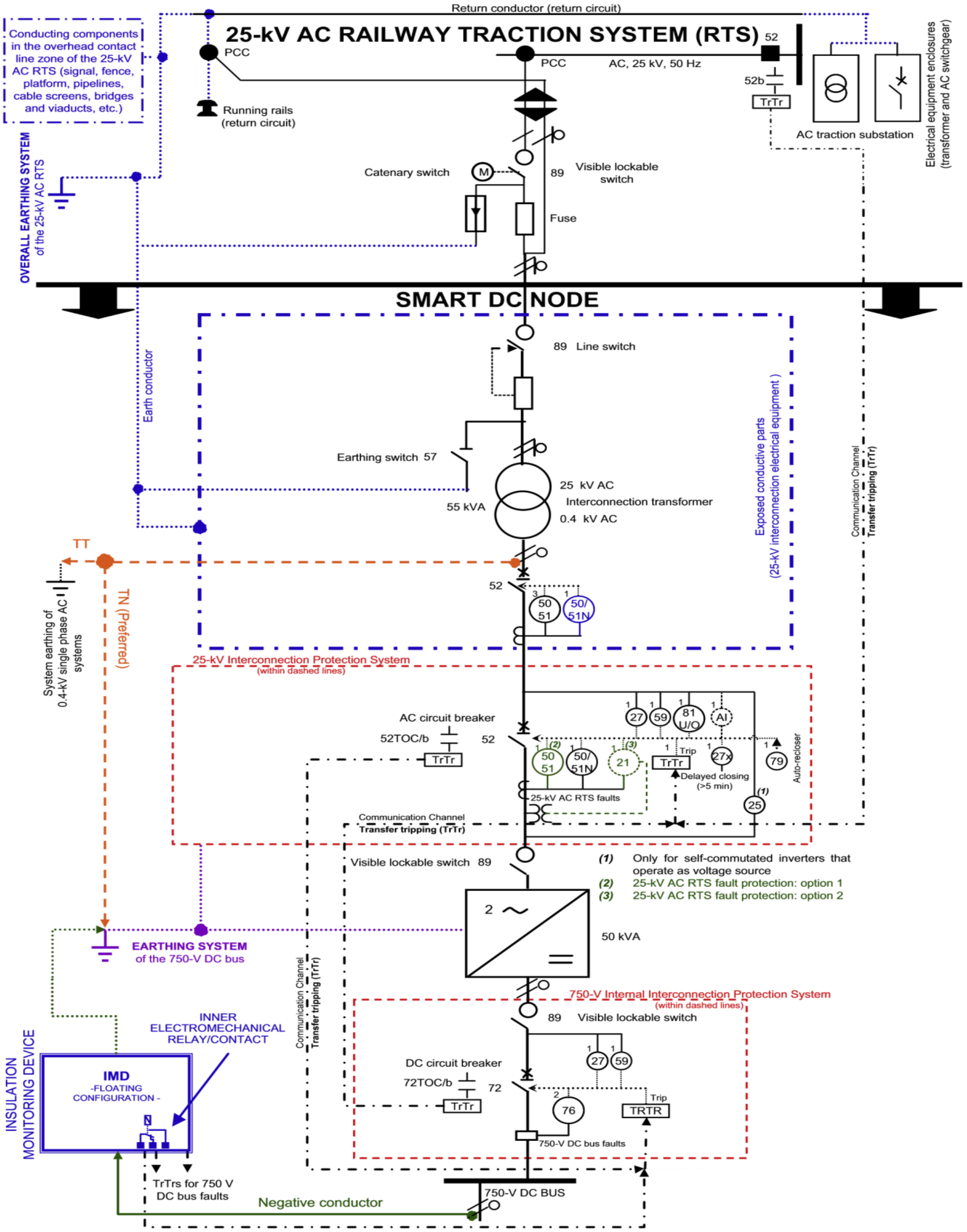

Figure.4: 25-kv AC railway traction system (RTS)

4. Conclusion

This study has proposed a single regulatory framework for grid-interconnection systems of a DC node used as a reference for feeding bidirectional EVCSs, which is relevant to the requirements for electrical safety and earthing arrangements [5]. Additionally, electric car charging stations include lightning-sensitive monitoring and communication systems, rectifiers, charging heaps, and power supply equipment [15]. The peculiarities of electric car charging systems should be taken into account while designing lightning protection. To create a full lightning protection system and get superior protection outcomes, general Protection against direct lightning and LEMP should be used [1]. The implications of introducing general faults that happen often to the modelled EVC S are explored to create a protection mechanism that would mitigate all potential faults happening both on the AC side as well as the DC side. Modelling of protection strategy is also discussedas a whole. The responses to the protection scheme for various faults are introduced [17].The application of the design concept can significantly improve the safety and reliability of electric vehicle charging stations [3].

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