

# RESIDUAL CURRENT DEVICE FOR ELECTRIC VEHICLE

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## 1. Abstract

RCD (Residual Current Device) is an important safety component in electric vehicle charging systems. The RCD is designed to protect the user from electric shocks by automatically disconnecting the power supply in the event of a fault. This paper presents an overview of the use of RCDs in electric vehicle charging systems, including their operation, types, and applications. The paper also discusses the challenges of integrating RCDs into electric vehicle charging systems, such as the need for compatibility with different charging standards and the effects of environmental factors on RCD performance. The importance of proper installation, maintenance, and testing of RCDs in electric vehicle charging systems is also emphasized.

## 2. Introduction:-

Electric vehicles (EVs) are becoming increasingly popular as a clean and sustainable mode of transportation. As more EVs hit the roads, the need for efficient and safe charging infrastructure is growing. Residual Current Devices (RCDs) play a crucial role in ensuring the safety of EV charging systems by detecting and isolating any electrical fault that may cause electric shock or fire hazard. An RCD is an electrical safety device that quickly and automatically disconnects the power supply when it detects a residual current flowing to earth, which indicates a fault in the system. The use of

RCDs in EV charging systems has become mandatory in many countries, and international standards require RCDs to be integrated into charging infrastructure. However, there are several challenges in the use of RCDs in EV charging systems, including compatibility issues with different charging standards, environmental factors affecting RCD performance, and the need for proper installation and maintenance. This paper aims to provide an overview of the use of RCDs in EV charging systems, including their operation, types, applications, challenges, and best practices. The paper also highlights the importance of RCDs in ensuring the safety of EV charging systems and the need for further research to address the challenges in their implementation.

## 3. Literature Survey :-

He et al. (2017) compared the performance of portable and fixed RCDs for EV charging and found that the portable RCD was more sensitive to fault current than the fixed RCD. The authors concluded that portable RCDs are a good choice for EV charging, as they can offer better protection against electrical hazards.

Guerrero et al. (2017) proposed a low-cost RCD design that could be easily integrated into EV charging systems. The authors developed a prototype RCD and tested it under different fault conditions. They found that the RCD was able to detect ground faults accurately and quickly,

making it a viable option for EV charging applications.

Mukhopadhyay et al. (2016) conducted an experimental study of RCD performance in EV charging systems. The authors compared the performance of different types of RCDs and found that RCDs with a faster response time were more effective in detecting ground faults. They also identified some limitations of RCDs, including their sensitivity to different types of faults and the need for regular testing and maintenance.

Pratt et al. (2015) evaluated the performance of RCDs under different fault conditions. The authors tested several RCDs and found that some RCDs performed better than others in detecting ground faults. They concluded that RCDs are an important safety feature for EV charging systems and that careful selection and testing of RCDs is crucial for ensuring their reliability.

Walker et al. (2016) discussed the challenges and solutions for the implementation of RCDs in EV charging systems. The authors highlighted the importance of compatibility with different charging standards, the complexity of the charging infrastructure, and the lack of standardized testing procedures. They proposed several solutions for addressing these challenges, including the use of standardized testing procedures and the development of guidelines for RCD selection and installation.

These papers provide insights into the current state of research on RCDs for electric vehicles, including their design, performance, and challenges in implementation. They could be useful for building a comprehensive literature survey on the topic.

#### 4. Problem Definition :-

The problem addressed in the research paper is the need for reliable and effective protection against electrical hazards during EV charging, which can be caused by ground faults. RCDs are commonly used to detect and interrupt such faults in EV

charging systems, but their implementation faces challenges such as compatibility issues with different charging standards, performance limitations, and lack of standardized testing procedures. Thus, the research paper aims to investigate the performance of RCDs in EV charging systems, identify implementation challenges, and propose solutions to enhance their reliability and effectiveness.

#### 5. Objectives :-

The research on RCDs for electric vehicles are multi-fold. Firstly, the paper aims to evaluate the performance of RCDs in EV charging systems and identify their limitations in terms of sensitivity, response time, and fault detection accuracy. Secondly, the paper aims to identify the challenges in the implementation of RCDs in EV charging systems, such as compatibility issues, technical constraints, and regulatory barriers. Thirdly, the paper aims to propose solutions to enhance the reliability and effectiveness of RCDs in protecting against electrical hazards during EV charging. Finally, the paper aims to provide recommendations for standardization and testing procedures for RCDs in EV charging systems to ensure consistent and reliable operation across different charging standards and environments.

#### 6. RCD Specifications :-

SPECIFICATION MATRIX	
System Topology	Non-Isolated
Nominal Voltage Rating	230V ac
Nominal Current Rating	16 A
PROTECTION/SAFETY MATRIX	
Over Voltage	$\geq 270V_{ac}$
Under Voltage	$\geq 170V_{ac}$
Under Voltage Cut-off	$\leq 20ms$ Max (Detectable and trip the circuit in $t \leq 0.02s$ )
Over Voltage Cut-off	$\leq 20ms$ Max (Detectable and trip the circuit in $t \leq 0.02s$ )
Overcurrent	20 Amp
Short Circuit	Provided for both Input & Output sides
Over Load	Yes, 16Amp max.
Earth Leakage	Detectable and trip the circuit at $< 30mA$ in $t \leq 0.02s$ .
Earth Absence	Yes, Detectable and trip the circuit in $t \leq 0.02s$ .
Line Neutral Interchange	Detectable and trip the circuit

Table 1 Specifications

Electrical Characteristics:-

Operating Voltage: 90V - 265 V

AC Rated current: 6 A Wire size : 0.75 mm sq

Rated frequency : 45 - 65 Hz

Leakage Protection : Type A minimum (RCD)

Accuracy of current : < ± 0.5 A

Operating temperature : -30 to 55 ° C (During charging) @ RH 5to95

Dielectric Characteristics : 1000V 50 Hz AC during 1 minute

Insulation resistance : > 100 Mohm (@ 500 V DC for 1 Minute)

Contact resistance : 0.5 mohm

Max Insulator Inflammability : UL94V0

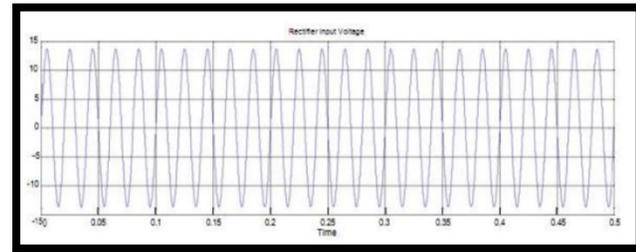


Figure 1.Input Voltage

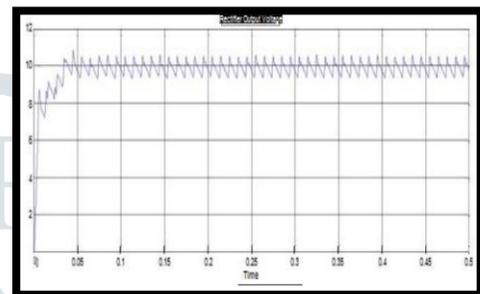


Figure 2.Output Voltage

### 7. Simulations Result :-

Parameters	Rating
Step-down Transformer : Input Voltage	230 V
: Output Voltage	12V
Primary Side Rectifier: Input Voltage	12V
: Output Voltage	12V
Capacitor	1mF
Interleaved Boost Converter: Input Voltage	12V
Inductor	500uH
Capacitor	220uF
Switching Frequency	25000Hz
Duty Ratio	50%
Output Voltage	23V
Single Phase PWM Inverter : Modulation Index	0.7
Carrier Frequency	1050Hz
Inductor	30mH
Capacitor	220uF
Input Voltage	23V
Output voltage	22V
Coupled Inductor: Primary Side voltage	22V
Secondary Side Voltage	12V
Secondary Side Rectifier: Output Voltage	12V
Inductor	33mH
Capacitor	220uF

Simulation Table 2

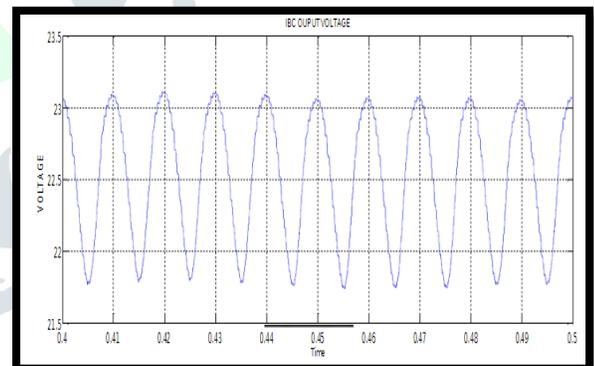
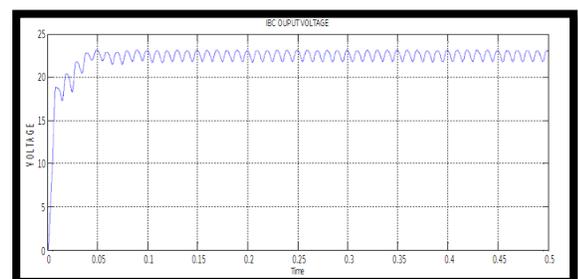


Figure 4..IBC Input Voltage



### 8. Flow Chart :-

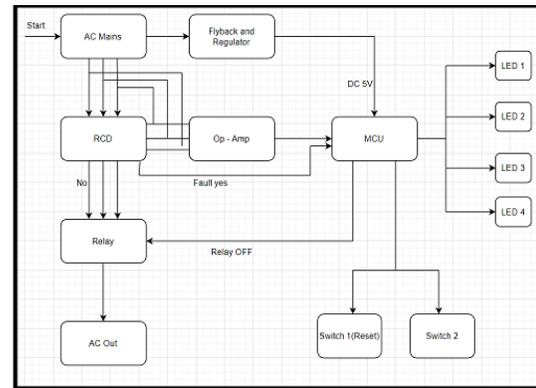


Figure 6.Flow Chart

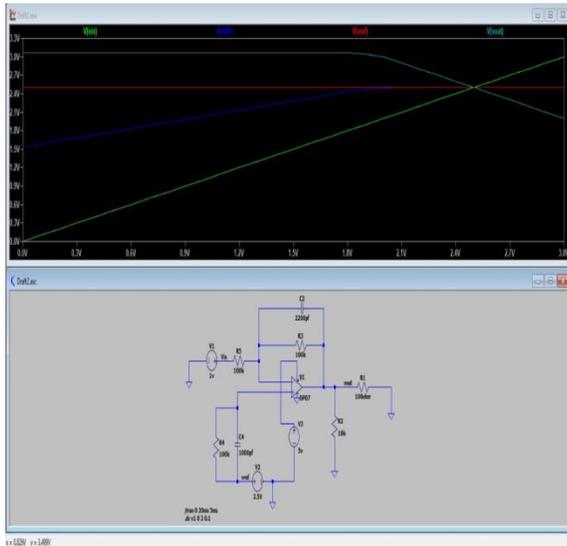


Figure 3.Reference Voltage

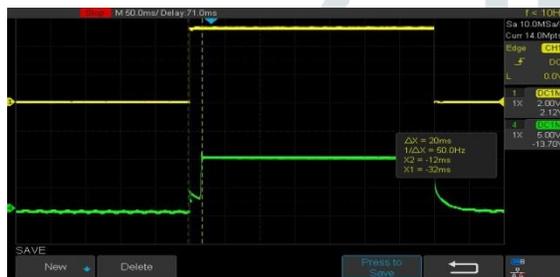


Figure 5.IBC Output Voltage

Figure5.1

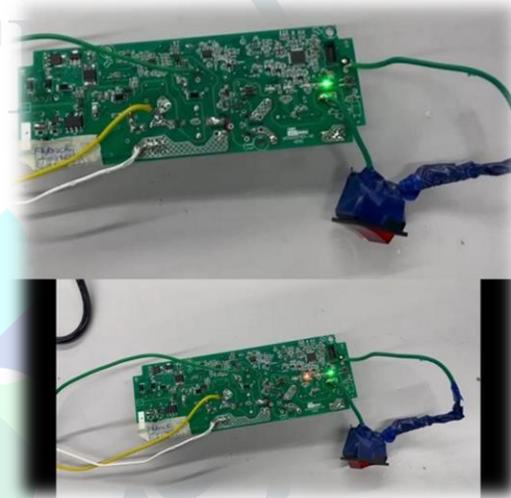


Figure 7.Result of the Device

### 9. Testing of The Device:-

There are three connections Line , Neutral and Earth having yellow, white and green color respectively. Switch is connected between earth and neutral to detect leakage current (in our case 25miliAmp leakage current ). The RCD supply is turned on . For main supply the indication is green When charging starts the indication is in yellow Now connect the leakage by pressing switch. As soon as RCD detects leakage current disconnects the supply

### 10. Conclusion:-

RCDs are an essential component of EV charging systems that protect against electrical hazards and ensure safe charging. While RCDs have proven to be effective in preventing electric shock and fire incidents, there are still limitations and challenges that need to be addressed. The research paper has provided insights into the performance of RCDs in EV charging systems, identified their limitations and challenges, proposed solutions to enhance their reliability and effectiveness, and recommended standardization and testing procedures to ensure consistent and

reliable operation. This research and development in RCD technology can help improve the safety, efficiency, and reliability of EV charging systems.

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