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Programmable Printed Circuit Board

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Abstract – The project delves into the design and development of programmable Printed Circuit Boards (PCBs) utilizing the ATmega328P microcontroller, a staple in the realm of microcontroller-based systems, renowned for its versatility and robustness. The core objective is to engineer PCBs that are not only programmable but also equipped with LoRa communication capabilities, thereby enabling long-range wireless connectivity. This integration is pivotal for the Internet of Things (IoT) applications, where devices often operate in remote or inaccessible locations. The ATmega328P serves as the brain of the operation, providing sufficient processing power, while the LoRa module extends the communication reach beyond conventional limits. The project encompasses the entire design cycle from schematic drafting to final testing, with a keen focus on ensuring compatibility between the microcontroller's functionality and the LoRa communication protocol.

Key words: PCB, wireless communication, IOT,ATmega328p, Lo-Ra

I. INTRODUCTION

In the electronics industry, programmable printed circuit boards, or PCBs, are crucial because they make it possible to create devices that are flexible and adaptable. These boards are unique in that they may be programmed to perform a multitude of functions through reconfiguration. A digital circuit board and a logic device, like a microcontroller, are the two primary parts of a programmable printed circuit board. They are combined in accordance with particular computer architectural principles, guaranteeing effective functioning. Electronic Design Automation (EDA) is a software-based method that helps construct intricate and exact circuit layouts, and it facilitates the design and production of programmable printed circuit boards (PCBs). The automated process guarantees a reliable and effective manufacture, which is essential considering the complex structure of contemporary printed circuit boards. From consumer electronics to industrial systems, programmable printed circuit boards are essential in a wide range of applications. Because of their reconfigurability, they play a significant role in the field of reconfigurable computing, which is concerned with software and hardware systems that may be customized for a variety of applications. Programmable printed circuit boards (PCBs) are essential to the development of electronic devices because of the smooth functioning that is made possible by the combination of hardware and software components on these boards. In the electronics industry, programmable printed circuit boards, or PCBs, are crucial because they make it possible to create devices that are flexible and adaptable. These boards are unique in that they may be programmed to perform a multitude of functions through reconfiguration. A digital circuit board and a logic device, like a microcontroller, are the two primary parts of a programmable printed circuit board. They are

combined in accordance with particular computer architectural principles, guaranteeing effective functioning. Electronic Design Automation (EDA) is a software-based method that helps construct intricate and exact circuit layouts, and it facilitates the design and production of programmable printed circuit boards (PCBs). The automated process guarantees a reliable and effective manufacture, which is essential considering the complex structure of contemporary printed circuit boards. From consumer electronics to industrial systems, programmable printed circuit boards are essential in a wide range of applications. Because of their reconfigurability, they play a significant role in the field of reconfigurable computing, which is concerned with software and hardware systems that may be customized for a variety of applications. Because these boards' hardware and software components work together seamlessly, programmable printed circuit boards (PCBs) are essential to the development of electronic products.

II. LITERATURE SURVEY

An innovative 1.2 kV SiC MOSFET half-bridge package integrated into a PCB for 22 kW electric car on-board chargers (OBCs). Through careful consideration of elements such as layer count, trace width, and integration, the package attains ideal electrical and thermal performance. Minimal parasitic resistance is revealed by static characterisation, and switching efficiency is increased using simulated inductances. Low junction-to-case thermal resistance is maintained via the design's non-isolated case selection. With regard to EV charging systems, this creative approach promises compactness, efficiency, and dependability[1]. We report a novel low-inductive half-bridge and gate driver package that takes advantage of two GaN-on-Si ICs embedded on a printed circuit board (PCB). We minimize on-chip parasitics by combining driver and monolithic half-bridge functions. However, attaching external capacitors presents a difficulty. Our approach combines monolithic circuit integration with PCB embedding. Thick copper layers are used in the fabrication of GaN-on-Si power circuits, which include integrated gate drivers, freewheeling diodes, and sensors. At 350 V and 450 W, the PCB-embedded dc-dc converter reaches an efficiency of up to 98.7%. In power electronics applications, this novel method promises compactness, efficiency, and dependable performance[2]. Limited fault samples impair the performance of PCB defect identification. We provide a few-shot model that combines multi-scale fusion with feature augmentation. Key areas are highlighted and noise is suppressed by the feature module (based on improved CBAM). For minor flaws, multi-scale fusion increases precision. Experiments verify the superiority compared to the most advanced techniques. Our model's practical value stems from its ability to balance precision and efficiency[3]. Hardware Trojans are a serious danger to printed circuit board (PCB) trust. The system integrity may be jeopardized by these malevolent changes, leading to crucial infrastructure damage or the loss of private data. We suggest PRISTINE, a PCB-level emulation system made especially to find hardware Trojan insertions, as a solution to this problem. PRISTINE helps create PCB-level Trojan benchmarks and facilitates the research of Trojan impacts by simulating board-specific properties. This study strengthens cybersecurity in electronic systems and improves supply chain confidence[4]. A low-cost, low-power wireless sensor network for groundwater monitoring (LWNGM) was created in Zanzibar, Tanzania. It extends communication via LoRa and integrates sensors, all built around the ATmega328P microprocessor. The technology ensures responsible resource management by providing real-time groundwater data[5]. Power distribution networks in sub-Saharan Africa deal with supply disruptions and temporary stability issues. Researchers look for cutting-edge ways to identify errors in medium- and low-voltage networks. The Internet of Things has promise. We suggest a cost-effective LoRaWAN-based Internet of things platform for distribution network monitoring. Our system in Nakuru County, Kenya, sets up defect alarms in less than 100 milliseconds, allowing for quick repairs. This flexible platform turns historical grids into intelligent entities while addressing financial constraints in poorer nations[6]. The decision between IEEE 802.15.4 and LoRa technologies is still crucial in the field of Internet of Things-enabled smart buildings and cities. Our comparative analysis highlights advantages and disadvantages based on actual indoor deployments in European school buildings. When LoRa is deployed on top of Arduino-based hardware, it turns out to be a surprisingly reliable and affordable option.

At a lower cost than IEEE 802.15.4, LoRa delivers comparable or superior link quality with multi-floor installations and minimal bandwidth needs[7]. LoRa technology offers reliable connections for industrial monitoring and control systems, however signal suppression and interference can cause data loss. We provide a real-time LoRa protocol that groups nodes according to signal attenuation and employs slot scheduling to reduce collisions. Time limitations are satisfied by efficient allocation made possible by logical slot indexing. Our protocol, which uses multiple listen-before-talk (mLBT), performs better in terms of reliability and throughput while dealing with signal problems than existing approaches[8]. The Internet of Things (IoT) holds great potential for revolutionizing vehicle communication. LoRa technology provides low-cost hardware, resilience, and simplicity at frequencies below 1 GHz. Because of its superior signal penetration and dispersion, it may be used in urban settings. Our field trials show that LoRa has a good reach, making it a competitive option for brief message transfers. We assess stationary vehicle communication, V2I, and V2V, taking into account the Doppler impact and scattering effects in addition to signal intensity, reception ratio, and signal-to-noise ratio[9]. A new measurement technique utilizing S-parameters and a shielded flexible probe is suggested to reduce parasitic impedance in PCBs. The curve-fitting process produces accurate results, with a characteristic impedance accuracy of up to 1.37% and a propagation time accuracy of 0.81%[10]. Communication technologies are essential to the transformation of daily life brought about by the Internet of Things (IoT). IoT relies heavily on LoRa, which is renowned for its long-range and low-power capabilities. We discuss real-time LoRa network deployments based on UAVs, with a focus on long-distance transmission dependability. If researchers follow our recommendations and publishing trends, they can investigate UAVs for Internet of Things-based LoRa communication[11]. We introduce a real-time, low-power gas leak detection system that utilizes LoRa wireless communication. The system consists of a LoRa gateway located in the community and a LoRa client installed in the kitchen, which was constructed using an Arduino Uno and the RFM69HW LoRa module. The system triggers the GPS sensor, buzzer, and LCD in the event of a gas leak. The Ubidots IoT platform stores data and sends alerts to consumers and law enforcement. Furthermore, the system uses thermoelectric power generation (TEG) modules to harness waste heat from the gas stove to provide a reliable power source[12]. A current sensor model for GaN-based devices is proposed in this paper. The sensor achieves high sensitivity and appropriate bandwidth by utilizing the Rogowski coil principle of printed circuit boards in a GaN half-bridge construction that is installed on a surface mount device. For several types of power semiconductors, it discusses the trade-off between measurement sensitivity and sensor arrangement[13].

III.METHODOLOGY

In the proposed methodology, as we are designing a ppcb, first we need to read the data sheet of required components to design the ppcb . After that use eagle software to desing the circuit diagram. After Creating basic circuit diagram then add sensors needed and lora and wifi communication Circuits to it. Because we are designing this board to make it compatible with wireless Data transmission. At present days, IOT dealing all over the world. Fig:1 shows the block diagram for basic ppcb , Fig:2 shows the block diagram for Lora Transmitter and Fig:3 is for Lora Receiver.In transmitter side we are using ldr sensor to transfer the data for proving that our board is working,and the data is receiving in the reciver side.

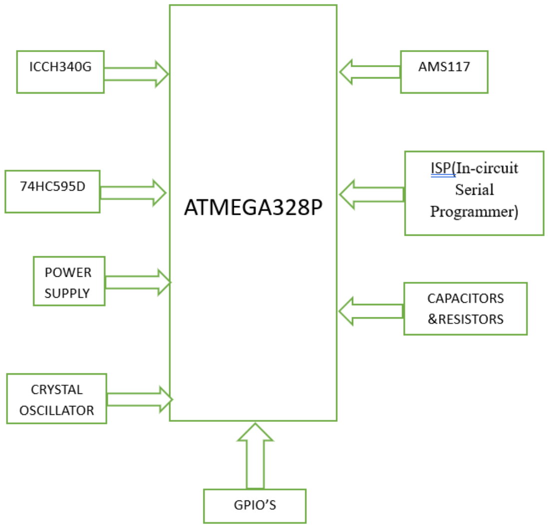

Fig:1 Block Diagram of Ppcb using Atmega328p (Customized ppcb)

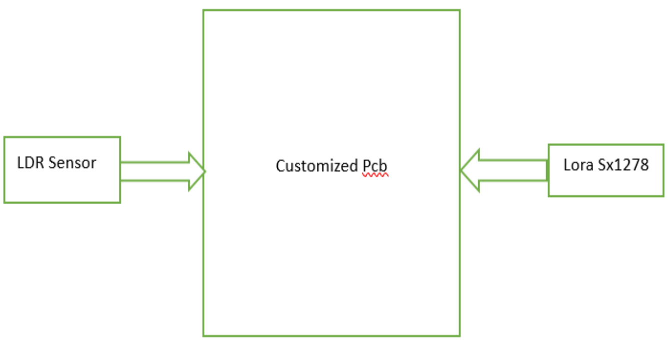

Fig:2 Block Diagram of Lora Transmitter with Ldr sensor

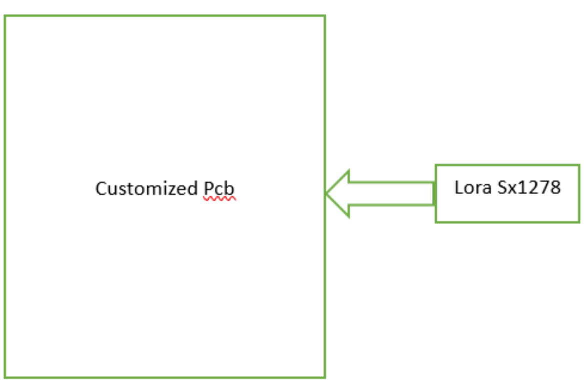

Fig:3 Block Diagram of Lora Receiver

IV. COMPONENTS REQUIRED

1.Atmega328p controller.

Microcontrollers are compact, versatile devices that play a crucial role in electronic projects. They offer computational power, connectivity, and a wide range of features that enable users to interface with sensors, actuators, and other peripherals. With a variety of input and output pins, microcontroller boards can be configured to serve multiple purposes, allowing users to customize their projects and interface with a range of hardware devices. Additionally, microcontrollers come equipped with communication interfaces like USB, serial, or wireless protocols such as Wi-Fi, lora and Bluetooth, which enable them to connect with other devices. They also support popular programming languages like C/C++ or Python, making them accessible to developers of all skill levels. Their built-in memory for storing data, program code, configuration settings, and expandable memory options, such as SD cards or external flash memory, make them ideal for storing large amounts of data. Overall, microcontroller boards offer a powerful and flexible platform for designing and prototyping electronic projects.

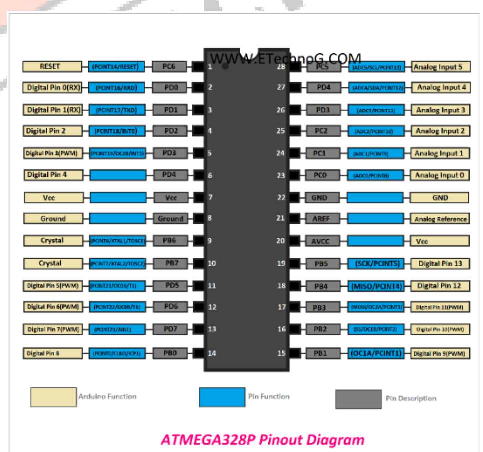

Fig :4 Atmega328p Controller

2.Crystal Oscillator

An electronic circuit that uses the inverse piezoelectric effect is called a crystal oscillator. An alternating voltage across a piezoelectric crystal's surfaces causes it to vibrate at its inherent frequency. After that, these vibrations are transformed into electrical oscillations, which produce an output frequency that is accurate and steady.

Because of its mechanical strength, affordability, and natural availability, quartz is the most widely used crystal material. Nonetheless, other materials that also display the piezoelectric action include tourmaline and Rochelle salt.

Usually, two metallic plates are used to support a quartz crystal in the crystal oscillator circuit. The crystal functions electrically like a series RLC circuit, consisting of the following parts:

A resistor with a low value. An inductor with a high value.

A capacitor that has a low value.

Parallel Capacitance: Owing to the electrodes on the crystal.

In this design we are using 2 crystal oscillators of 12mhz and 16mhz.

Fig :5 Crystal Oscillator

3.IC CH340G

A USB bus converter chip called the CH340G was created by Nanjing Qinheng Microelectronics Co., Ltd. Its main job is to convert USB impulses into serial signals so that computers and other devices that need serial communication can communicate with each other. Because of its affordability and ease of use, this small but powerful chip has become widely used in electronic projects and products.

The CH340G operates by combining a serial interface engine, crystal oscillator, and USB transceiver. It is capable of full-speed USB 2.0 transfer at up to 12 Mbps. The device supports both 5V and 3.3V logic levels and

can handle a variety of operating systems. It also offers interoperability with both the FIR and SIR modes of IrDA. Applications of the CH340G span various domains, including serial communication, Arduino projects, and embedded systems. Whether you're bridging USB and serial interfaces or upgrading existing UART devices, the CH340G plays a crucial role.

Fig:6 IC CH340G

4.AMS117 Voltage Regulator.

A popular 3-pin LDO regulator for controlling voltage in a variety of electrical applications is the AMS1117. Its main job is to convert USB impulses into serial signals so that computers and other devices that need serial communication can communicate with each other. Because of its affordability and ease of use, this small but powerful chip has become widely used in electronic projects and products.

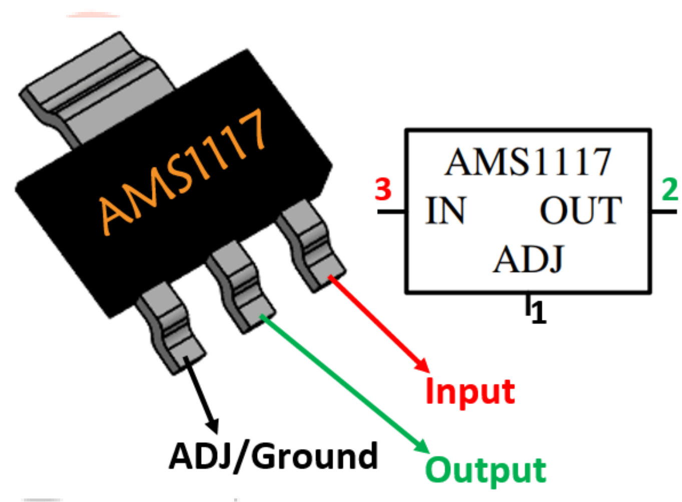

Fig:7 AMS117 Voltage Regulator

5.Capacitors and Resistors

An electrical resistor is a part that restricts the amount of current flowing through a circuit by obstructing the flow of electrons. They are frequently employed as a component of a filter network or to control voltage levels. Additionally, resistors can be employed to guard against short circuits and overvoltage.

A capacitor, on the other hand, is an electrical part that has the ability to hold electric charge. It is made up of two conducting plates that are divided by a dielectric, or insulating medium, such plastic or air. Each plate accumulates electric charge when voltage is applied across it. The electric potential of the plates differs as a result. This charge can then be used to power a circuit.

6.LDR Sensor

An optoelectronic sensor used to detect light in the surroundings is called an LDR, often referred to as a photoresistor. The amount of light shining on it determines how resistant it is. The LDR's resistance lowers in response to light, increasing the amount of current that may pass through it. On the other hand, resistance rises in the dark, limiting the flow of current. LDRs are frequently found in automated streetlights, light meters, and light sensors. They are used in many different fields, including as consumer goods that need to detect light intensity and burglar alarms. These adaptable parts are essential to electronic designs.

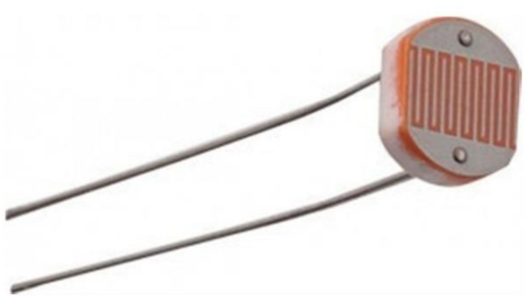

Fig:8 Ldr Sensor

7. Lora Module(sx1278 Ra-02)

A modulation method called LoRa (Long Range) is intended for low-power, wide-area network (LPWAN) applications. Long-range wireless communication is made possible by it, with a range of up to 10 kilometers in rural areas and penetration into interior and urban spaces. With millions of low-power devices supporting networks, LoRa is perfect for the Internet of Things (IoT). Its Chirp Spread Spectrum (CSS) technology enables adaptable network deployment and is resistant to interference. The LoRa Alliance123 oversees the LoRaWAN protocol, which establishes the network's system architecture. LoRa is revolutionizing IoT connectivity with its long battery life, wide coverage, and affordable price.

Fig:9 Lora Module

V. RESULTS AND DISCUSSIONS

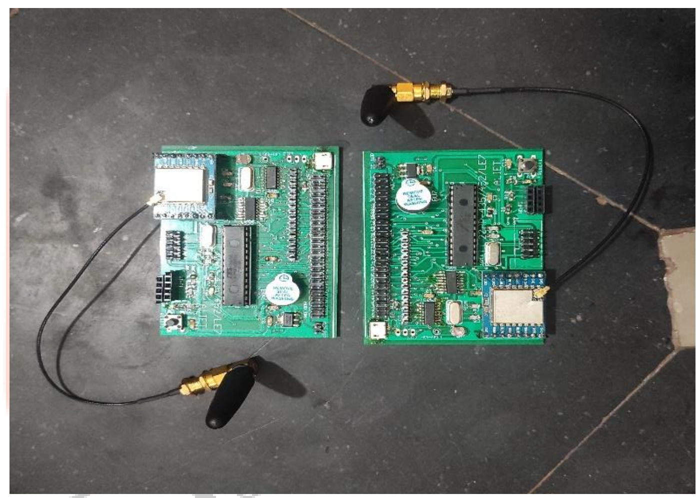

Fig: 10**:** Customized ppcb with lora communication

This programmable pcb is designed to establish wireless communication using lora module. Even though it is designed for wireless communication we can use it for connecting different sensors and used for different applications.One pcb is used as transmitter and other as receiver. It supports c and c++ languages to program atmega328p. We can Program this board using Arduino ide . This Board is fabricated using FR-4 substrate and can withstand upto 150deg.

Fig:11 Transmitter Output

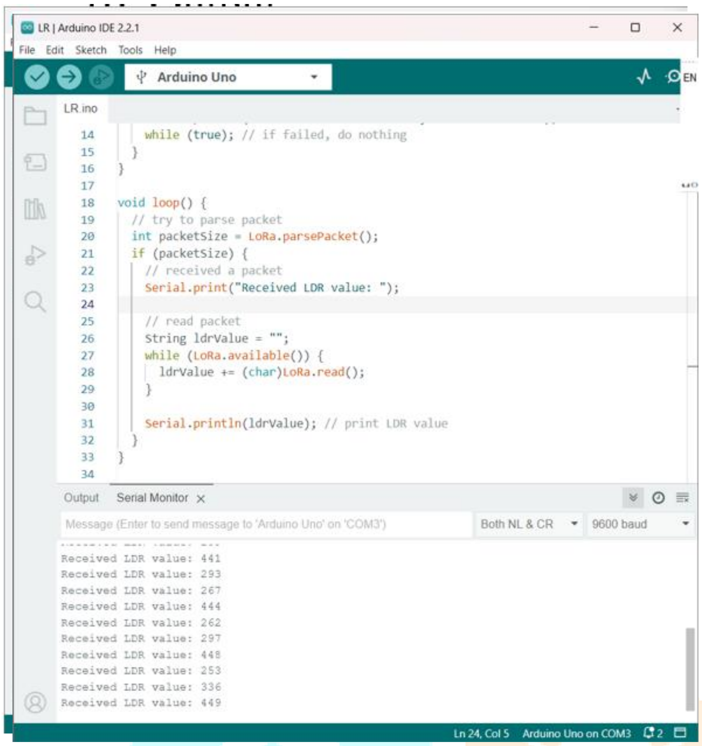

Fig:12 Receiver output

In transmitter side ldr sensor takes the values and transmit to the receiver side using lora module. And the data is received by the receiver lora module.

VI.FUTURE SCOPE

the future scope of a project that uses the ATmega328P microprocessor to design programmable PCBs and integrates them with LoRa communication.

This project has a wide range of exciting potential directions:

Energy Harvesting: Self-sustaining systems for remote monitoring applications in agriculture, wildlife tracking, and environmental sensing can be created by including energy harvesting technology (such as solar panels or piezoelectric devices).

Mesh Networking: By combining LoRa's mesh networking features, a robust network of linked devices is made possible. This increases the coverage area and guarantees clear communication even in difficult settings. AI and Machine Learning Integration: Edge computing is made possible by directly integrating AI algorithms on PCBs, taking advantage of the ATmega328P's processing capabilities. Local data analysis saves energy and lessens the need for continuous transmission.

Enhanced Security: To protect against cyber threats in the expanding IoT world, sophisticated encryption, secure boot procedures, and intrusion detection technologies are implemented.

Wearable Applications and Miniaturization: Adoption of wearable technologies is made possible by further shrinking PCBs. Compact form factors that enable LoRa-enabled connectivity are advantageous for medical wearables, fitness trackers, and smart apparel.

Education Kits: By creating teaching kits based on these PCBs, instructors can impart programming, embedded systems, and wireless communication knowledge to their pupils. Possibility of Commercialization: Usable LoRa-capable modules can serve researchers, businesses looking for dependable wireless communication solutions, and enthusiasts.

Personalization and Adaptability: Enhancing the PCBs' adaptability and versatility enables customers to effortlessly incorporate or eliminate components according to particular project specifications.

Environmental Adaptability: By improving PCBs for severe temperatures, dust resistance, and waterproofing, they can be used in polar, desert, and maritime research.

VII.CONCLUSION

Especially in the context of the Internet of Things, this paper represents a noteworthy accomplishment in the field of electronics design. A significant advancement in the development of adaptable, long-range communication devices is demonstrated by the combination of the ATmega328P microprocessor with LoRa communication technology on a programmable PCB substrate. These PCBs have the potential to completely transform the way data is transferred over long distances, shattering connection obstacles and creating new opportunities for innovation across a range of industries, including environmental monitoring, logistics, and agriculture. The success of the project depends on careful design, stringent testing, and a thorough comprehension of the standards of the LoRa protocol as well as the capabilities of the microcontroller. The resulting PCBs serve as both a model for upcoming developments in the constantly changing field of Internet of Things solutions and a monument to the possibilities of fusing conventional microcontroller applications with contemporary communication technologies. A new era of connectivity is being heralded by the knowledge and experience gained, which open the door to further research and development of smart, connected devices capable of operating independently across great distances.

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