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ELECTROMECHANICAL HINGE FOR RS-485 CONNECTION AND DOOR POSITION SENSOR IN DATA CENTER RACKS

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Abstract: *Technological developments create to needs data protection, monitoring and remote management have an important point. Plenty of industrial electromechanical locking systems are used in order to provide protection both access monitoring in Data Centre server cabinets and server rooms. One of the important points in remote monitoring is to detective the position of the door. In current applications door position is monitored by wired door sensors or wireless reed-switch and magnets. Although this application methods have both many advantages and disadvantages, it is not useful. Our research is to find an alternative and useful solution for the application areas of Data Centre lock systems with a new application method based on the findings. This alternative and useful solution is offered for the application areas of Data Centre lock systems. In consequence, Thanks to this electromechanical hinge design will prevent not only cutting of the communication cables mounted on the cabinet doors but also will perceive from the safest point without requiring additional cost and labor.*

Key words: *Hinge Design, Electromechanical Locking, Data Center, Server Rooms, Remote Monitoring*

1. INTRODUCTION

In today's world, data centers established to meet the intense data processing and data storage demands are important facilities and the security of the server cabinets in these facilities is extremely critical. Server cabinets are essential data center components that house highly sensitive personal data and high-value devices. In this context, it is an important requirement to monitor user accesses to the cabinets and the door position correctly. Monitoring of door and lock information in cabinets is facilitated by electronic hardware and software in advanced data centers. Electronic interlocks and controllers communicate via the RS-485 communication protocol, typically using wired connections. [3] Wired communication carries the risk of wire breakage and loss. Despite efforts to develop wireless technologies to address this problem, the cost remains prohibitively high.[2] This makes wired communication technology a preferred option in electronic locking systems to date. This study focuses on addressing the problems observed in installation and disconnections in wired communication used in connection of door position sensors and electronic locks in server cabinets. In this study, an electromechanical hinge design and application that will provide a solution to both problems has been investigated. Electromechanical hinge replaces traditional mechanical hinge mechanisms in server cabinets; It has been developed with the aim of avoiding cabling complexities, reducing communication losses and providing data center managers with accurate door location information.

2. BACKGROUND

To manage the electromechanical locking systems used in industrial server cabinets, there are access interfaces such as card reader or keypad on the cabinet. The access interfaces, which are communicated with the RS-485

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communication protocol, are connected to the control unit with communication cables. Access interfaces, on the other hand, are capable of transmitting access signals to electromechanical locks on both the front door and the rear door. The transmitted access signal is sent with the cables connected to the locks with the help of cable channels inside the cabinet.

The PIN details of the RS-485 cable used for the connection between the access interface and the control unit are as follows;

PIN Connections;
PIN 1- GND
PIN 2- + 12V
PIN 3- A (RS-485)
PIN 4- B (RS-485)

Fig. 1. RS-485 Connection Cable for Access Interface

The PIN details of the communication cable used for the connection between the access interface and the electronic locks are as follows;

Fig. 2. RS-485 Connection Cable for Access Interface

PIN Connections;
PIN 1- GND
PIN 2- + 12V
PIN 3- N/A
PIN 4- Door Position Sensor
PIN 5- Control Signal
PIN 6- Handle Position Sensor

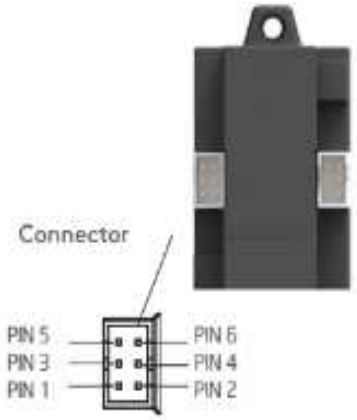


Fig. 3. Connection Point on Electromechanical Handle

In the current connection use, the communication cable can be caught between the mechanical hinge or sheet metal door and the cabinet body. Therefore, the cable may be crushed, damaged and signal data of door or lock sensors may be lost. At the same time, existing cable clutter is another issue that creates risks in wired connections.

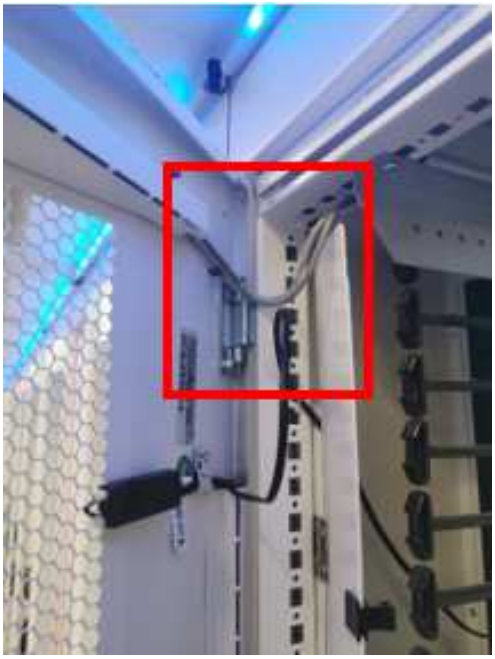


Fig. 4. High Break Risk Cable Assembly

Fig. 5. Current Mechanical Hinge

3. DESIGN AND DEVELOPMENT

The electromechanical hinge design developed in this study will reduce the risks of loss in RS-485 communication and will provide safe transfer of door position information to the control unit. Providing the correct door position information is important for monitoring the temperature values in the server cabinets and thus ensuring energy efficiency.[5]

Communication cable used for the electronic lock on the cabinet when the doors of the server cabinets are opened and closed for operator work; it can get stuck between the door and the body and access to electronic locks can be cut off. For this reason, while designing the hinge, the communication cable was passed through the hinge body in a controlled manner and the door position detection sensors were positioned inside the hinge.

3.1 Electronic Design and Development

Electronic PCB board and connection cable are designed to provide communication transmission and door position detection to be used inside the hinge parts. On the electromechanical hinge to be used instead of the mechanical hinge;

There will be electronic PCB board for connector and cable connections, flex PCB for communication transfer, Reed-Switch that provides door position information and magnetic magnet. The purpose of using Flex PCB is to ensure that communication and energy transmission are not damaged in the open-close movement of the hinge. Flexi PCBs are frequently preferred in such movable mechanisms.[4]

The reed switch used in our design - the electronic component that provides switching with the magnetic field effect - is positioned on one side of the hinge and the magnet on the other side of the hinge body.[1] As a result of the reed switch entering the magnetic field created by the magnet, we obtain the position information of the door.

When the door is closed or opened, the magnetic magnet comes close to the reed switch, and the contact of the switch is opened or closed by the effect of the magnetic field. This change enables the position of the door to be detected.

The energy and trigger signal provided from the control unit to the electromechanical lock will be connected to the electromechanical hinge mounted on the same door with the lever position information communication cable provided from the lock to the control unit in the opposite direction. The developed electromechanical hinge will be able to transmit all data from the electromechanical lock to the control unit, along with the door position information obtained with the help of the Reed Switch on it.

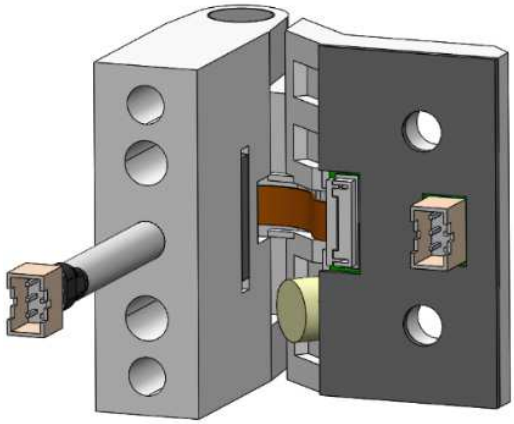


Fig. 6. Electromechanical Hinge Design

3.2 Mechanical Design and Development

Attention has been paid to ensure that the developed electromechanical hinge product has sufficient strength to ensure communication transmission and to ensure that the server cabinet cover can fulfill its mechanical function in a long life. [6] In this context; The material selection of the hinge has been determined as PA6 GFR30, taking into account industrial applications and strength requirements.

The 30% GFR additive included in the PA6 material increases the strength of the product. Using additives more than 30% value is not preferred as it will increase the fragility of the product. [8]

Another reason for choosing the material as plastic is to provide insulation of the PCB board used for communication and signal transmission

and not to prevent the interaction between the reed switch-magnet.

Server cabinets can be preferred in different sizes. Mechanical hinges and electromechanical hinges can be used together in order to support the weight of the door and maintain functionality in high-sized cabinets. For cable and communication transfer, it is sufficient to use 1 electromechanical hinge for each cover.

The rib structure used in the design and the determined wall thicknesses are also important points in providing the expected strength of the hinge. Therefore, the wall thicknesses and rib structures in the design have been determined in accordance with the Plastic Product Design Standards.

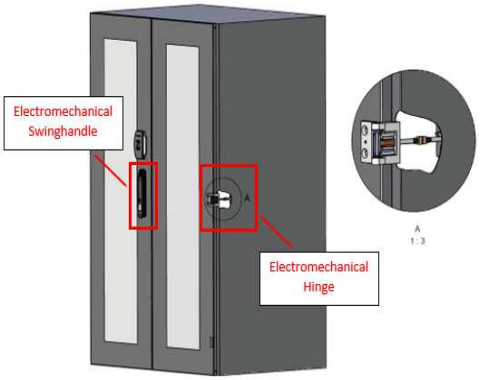


Fig. 7. Applications and Connection

4. TEST AND FORCE ANALYSIS

The hinge designed in SolidWorks 3D modeling program was simulated using the force values in the real working area. During the simulation, static analysis was applied to the hinge using real force values.[7]

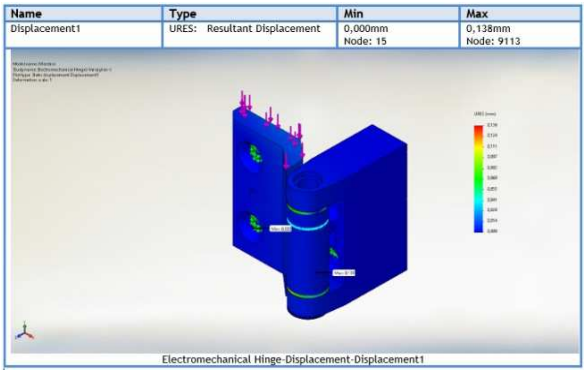
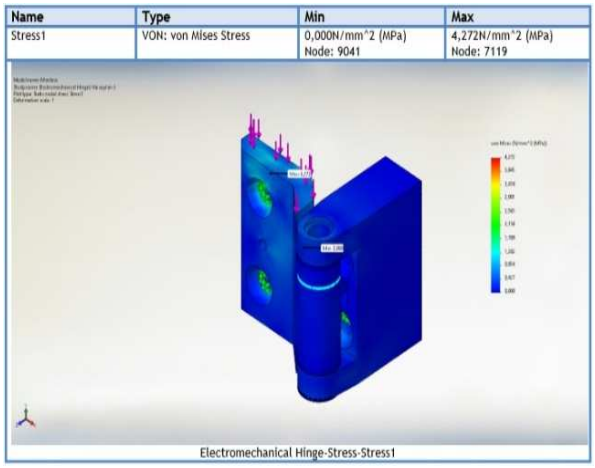


Fig. 8. Displacement

When the static analysis results applied were examined, it was concluded that the hinge had sufficient strength. Plastic deformation does not occur in the product under real load.

Fig. 9. Resultant for Von Mises Stress



5. RESULT

It has been concluded that the product developed within the scope of Data Centre applications can prevent cable clutter and communication losses.

The designed hinge will be able to not only visually inform the users of the door position information, but also to regulate the cable passages between the door and the cabinet.

Electronic lock and wired communication provide solutions to access control needs in many different applications.

It allows users to remotely monitor and manage the positions of cabinet doors and locks.

The product designed in the study can be used in many different applications to control the door position of the cabinets and to reduce the risk of cuts in cable jumps. In this way.

The problems that can be encountered in the remote monitoring and management systems of the locks used in the industry will be eliminated.

When the results obtained are evaluated, the developed product offers data center operators a viable solution to provide more effective door control and monitoring.

6. ACKNOWLEDGMENTS

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Balama electromecanică pentru conexiune RS-485 și senzor de poziție a ușii în rafturile centrului de date

Abstract: Evoluțiile tehnologice creează nevoi de protecție a datelor, monitorizarea și managementul de la distanță au un punct important. Sunt utilizate o mulțime de sisteme de închidere electromecanice industriale pentru a oferi protecție atât monitorizarea accesului în dulapurile serverelor din Centrul de date, cât și în camerele serverelor. Unul dintre punctele importante în monitorizarea de la distanță

este detectarea poziției ușii. În aplicațiile curente, poziția ușii este monitorizată de senzori de ușă cu fir sau întrerupător și magneți fără fir. Deși aceste metode de aplicare au atât multe avantaje, cât și dezavantaje, nu este utilă. Cercetarea noastră este de a găsi o soluție alternativă și utilă pentru domeniile de aplicare ale sistemelor de blocare a centrelor de date cu o nouă metodă de aplicare bazată pe constatări. Această soluție alternativă și utilă este oferită pentru domeniile de aplicare ale sistemelor de blocare a centrelor de date. În consecință, Datorită acestei balamale electromecanice, designul va preveni nu numai tăierea cablurilor de comunicație montate pe ușile dulapului, ci și va percepe din cel mai sigur punct fără a necesita costuri suplimentare și forță de muncă.

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