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Controlling electrical equipment in the master-slave system using Modbus RS485 communication of PLC Mitsubishi

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ABSTRACT: Modbud communication has been and is being applied in many fields. In this paper, we focus on introducing a solution to control civil electrical equipment based on the master-slave principle through Modbus RS485 communication. By applying the Mitsubishi FX PLC in combination with the FX1N-485-BD communication module, it is possible to verify the method on a real model, processing data in both analog and digital formats. Experimental results have verified the correctness of the proposed solution.

KEYWORDS: Modbus protocol, Master-Slave syytem, Smart equipment, communication module, Automation system.

I. INTRODUCTION

The research and control of electrical equipment in many fields such as: industry, agriculture, building management technology, hotel... through communication standards is always the inevitable trend of the times. In which, Modbus communication is considered as a widely used communication method. Modbus is an industrial communication protocol standard that was released and developed by MODICON in 1979, and officially belonged to Schneider Electrics in 1996. Modbus has quickly become the communication standard in industries. Automated by stability, ease, convenience and currently maintained by the organization "modbus.org".Currently, Modbus is known and widely used in industry including 3 standards: Modbus RTU, Modbus TCP and Modbus ASCII.Some studies in the world about Modbus communication are as follows:[1]This paper proposes a link architecture between devices operating on the Modbus protocol and IoT platform developed based on the oneM2M standard, the processes required to establish interoperable communication, and the optimization methods for this architecture. The solution appears to be developed and illustrated in a solar management use case. This paper highlights the performance of Modbus communication, considering scenarios in which distributed devices are integrated and accessed registers are or are not at consecutive addresses. The Modbus protocol allows reading one or more holding-type data registers [2].Research [3] by exploiting this feature of the Master-Slave architecture, we have built a covert channel wherein the receiver maps each character of the covert message into an instruction and sends it to the slave and the slave strips off the data in that instruction and sends it to the intended receiver, where the receiver maps the instruction back to the character and prints out the message.In this paper [4], that will summarize preparation efforts to accommodate the Modbus-TCP support in the TPS control system. (The TPS (Taiwan Photon Source) project will have some Modbus-TCP enabled devices which are distributed in utility facilities and accelerator system).

Several control solutions for residential electrical equipment can be applied by different solutions, such as: Research [5] focuses on proposing solutions to control equipment through the combination of RF and wifi waves. In [6], the major content of this article focuses on building control signal communication methods, as well as designing a monitoring interface on Visual studio, AT driver server, Itag builder software... to manage and control electrical devices over Ethernet/Internet with applying PLC (Programmable Logic Controller) as the central controller.

Thus, it can be said that the application of different communication solutions to control electrical equipment is always an open problem for research. Therefore, in the content of this article, we focus on introducing the solution to control electrical equipment via Modbus RS485 communication using Mitsubishi FX PLC.

The structure of control and monitoring of agricultural station applying IoT technology is

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proposed as Fig.1. Including the coordination between LoRa and Internet communication waves.

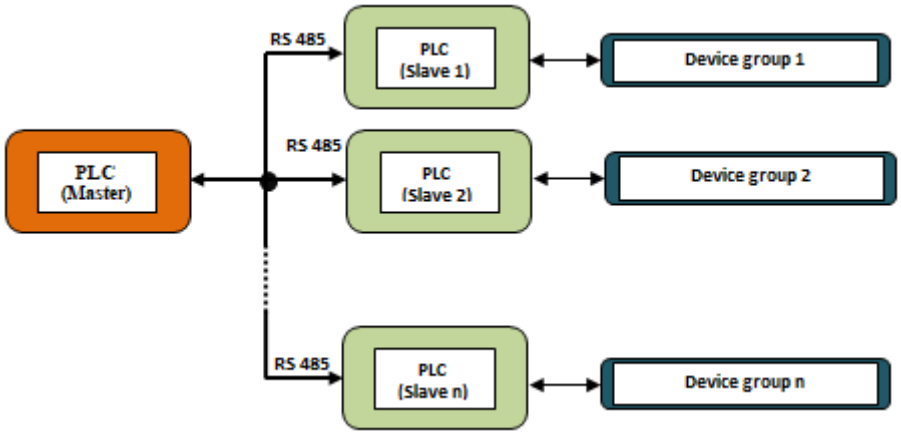

Figure1. Control structure of civil electrical equipment via Modbus communication

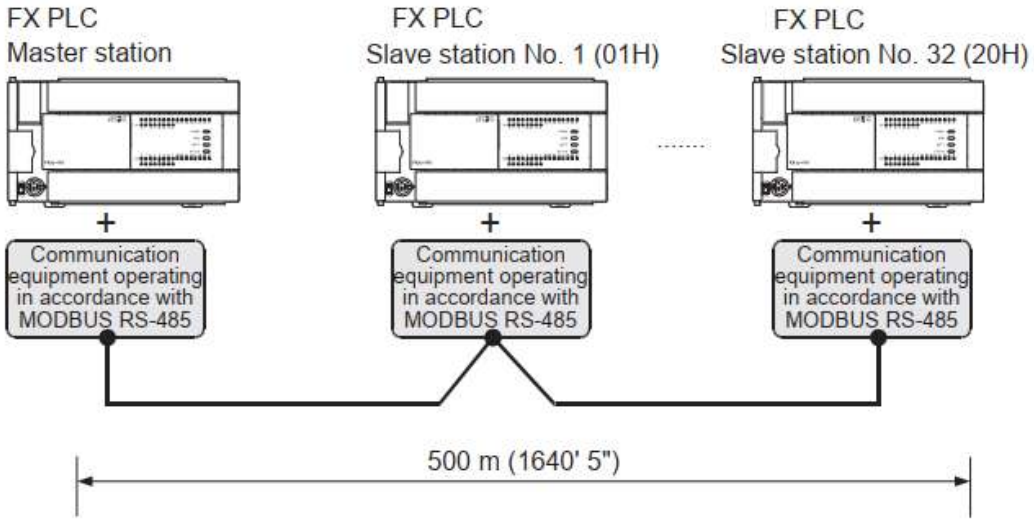

Figure 2. Modbus communication maximum distance between Mitsubishi FX PLC stations

II. PROPOSED CONTROL STRUCTURE OF ELECTRICAL DEVICES THROUGH MODBUS COMMUNICATION

The control structure of civil electrical equipment via Modbus RS485 communication with PLC application is shown in Figure 1. In which, PLC Master has the function of managing all electrical equipment in a building, hotel... indirectly through PLC slaves. Each PLC Slave is used with two functions, one is to collect information from the sensors sent back, the other is to receive control commands from the PLC Master to control electrical equipment in each group.

The essence here is to exploit Modbus RS485 communication between PLC stations. For MODBUS RS-485 communication between Mitsubishi FX PLCs, up to 32 PLC Slave Stations can be connected to one PLC Master Station. However, make sure that the total extension is not more than500 m. In the framework of the content of the topic, focusing on researching the Modbus RS485 communication solution between Mitsubishi FX3G PLC stations through the FX3G-485-BD module, one FX3G-485-BD module allows one Master station to connect up to a maximum of 7 Slave stations with a maximum total distance of 50m.

Modbus RS485 communication specifications between stations Mitsubishi FX PLC using RS485-BD module in Table 1.To implement Modbus RS485 communication between PLC FX stations through RS485-BD module, we need to configure some bits and registers as shown Table 2.

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Table 1. Configure Modbus RS485 communication parameters between FX .PLC stations

Item		Specifications	Remarks
Number of connectable units		8 maximum	
Transmission standard		RS-485 standard	
Maximum total extension distance		500 m (1640' 5") or less when 485ADP is used 50 m (164' 0") or less when 485BD is used	Distance varies depending on communication equipment type.
Protocol type		Inverter computer link	Link startup mode
Control procedure		Asynchronous system	
Communication method		Half-duplex, bidirectional communication	
Baud rate		4800, 9600, 19200 or 38400*1 bps	Any one can be selected.
Character format		ASCII	
	Start bit	—	
	Data bit	7-bit	
	Parity bit	Even	
	Stop bit	1-bit	

Table 2. Setting ranges for Modbus RS485 communication address between stations Mitsubishi FX PLC using RS485-BD module

Device	Name	Description	Set value
M8038	Parameter setting	This device is a flag for setting communication parameters, and is used to check for absence/presence of N:N Network program also. Do not set this device to ON in the sequence program.	
M8179	Channel setting	Set the channel of the communication port to be used (in the FX3G, FX3GC, FX3U and FX3UC). When "OUT M8179" program does not exist: ch 1 When "OUT M8179" program exists: ch 2	
D8176	Station number settings	Set the station number used in the N:N Network. Master station: 0, slave station: 1 to 7 [Initial value: 0]	0 to 7
D8177	Slave station quantity setting	Set the total number of slave stations. This setting is not required in PLCs working as slave stations. [Initial value: 7]	1 to 7
D8178	Refresh range setting	Select the desired pattern of device points used for communication. This setting is not required in PLCs working as slave stations. [Initial value: 0] Only pattern 0 is applicable when a FX0N or FX1S Series is included.	0 to 2
D8179	Number of retries	When a response is not given even after communication is repeated the specified number of times, it is regarded as an error. Errors in other stations can be checked. This setting is not required in PLCs working as slave stations. [Initial value: 3]	0 to 10
D8180	Monitoring time	Set the time (50 to 2550 ms) for communication error in 10 ms units. This setting is not required in PLCs working as slave stations. [Initial value: 5]	5 to 255

III. MODBUS RS485 COMMUNICATION MODEL DESIGN BETWEEN FX MITSUBISHI PLC STATIONS

To illustrate the Modus RS485 communication technique between Mitsubishi PLC stations of FX series, in the article, a model of a PLC Master station and a PLC Slave station are built using FX3G series through communication module FX3G-485-BD. The model to ensure the communication of both bit and write signals is as follows:

+ Two-way communication between Master station and Slave station to turn on and off electrical equipment in the hotel building (in the illustrated use model are the lights on the Master side (M1, M2, M3); on the Slave side (S1, S2, S3), bit data transmission).

+ Set frequency from the monitoring interface on the computer, through the Master send a signal to the Slave to control the hotel corridor ventilation fan system (in the model used illustrated by 3-phase motor, communication register data).

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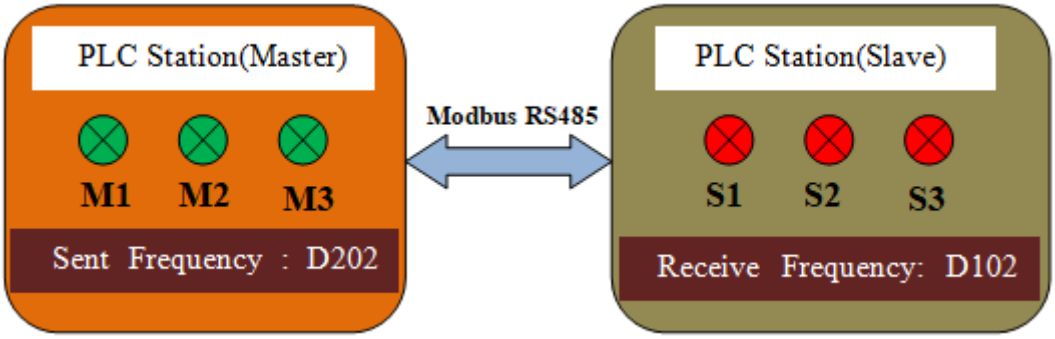

Figure 3. Image of Modbus RS485 communication data between two PLC FX stations in the model

The proposed problem can be explained as follows: Assuming each floor of the building/hotel is fitted with a controller that is a PLC Slave, the PLC Slaves connected to the sensors and devices of that floor ensure for the control and monitoring of the equipment of that floor (usually connected at the switchboard of each floor). As for the PLC Slaves of the floors, they connect to the PLC Master (located in the central control room) through Modbus RS485 communication, so through the PLC Master the operator can control and monitor the electrical equipment, layer through data communication back and forth between PLC Slave to PLC Master. The interface for controlling and monitoring electrical devices in the model is designed on GT Designer 3 monitoring software in Figure 4.

Figure4. Master-Slave monitoring interface via Modbus communication

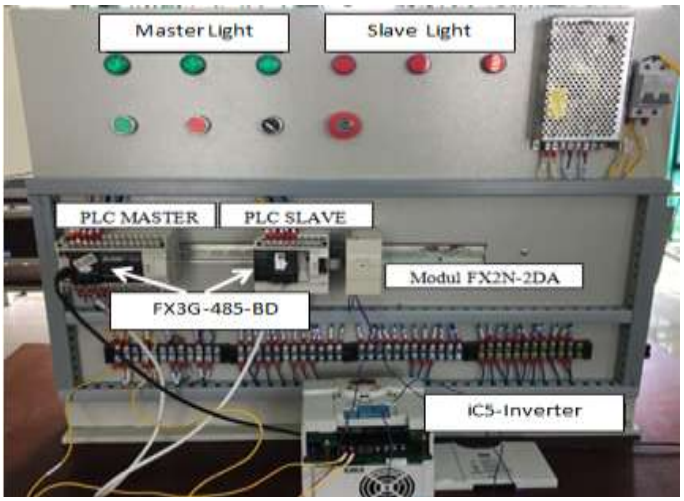

Figure5. Experimental model to verify the proposed solution

IV. CONCLUSION

Through the process of conducting tests on real equipment, we have checked the stability and accuracy of the solution for monitoring and controlling electrical devices proposed in this paper. By applying Modbus communication between Mitsubishi FX PLC stations with FX3G-485-BD communication module, this result can be applied to small and medium-sized buildings and hotels.

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