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# Enhanced air conditioning control for the smart home

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## ABSTRACT

Automation is a wide range of technologies that minimise human involvement in various home systems to improve the quality of life. Home automation systems are becoming more common and easier to build. It is possible to adapt them for remote control via the Internet or to connect them to a home automation system. Any intelligent system is based on an energy-saving system, with a focus on the potential of intelligent home automation systems. Modern air conditioners are usually equipped with a Wi-Fi module that allows the unit to be remotely controlled or connected to a home automation system. The problem arises with slightly older air conditioners that are already installed and operating in rooms where there is not even a built-in connector for the Wi-Fi module. One such example is the popular and very good MSZ-HJ series of air conditioners from Mitsubishi Electric.

**Keywords:** control, air conditioning, Smart Home, automation.

## INTRODUCTION

Today's air conditioners can be controlled not only by a remote control or controller, but also via Wi-Fi [1, 2]. This provides the opportunity to control the air conditioner remotely and integrate it into a smart home project. Some models of air conditioners have an Internet modem preinstalled, while others require the purchase of an additional Wi-Fi module. In this respect, older air conditioners that have been installed and operated in homes and rooms and do not have a CN105 communication connector to connect the network module pose a problem. Replacing an air conditioner is a significant and costly undertaking. However, it is possible to adapt some popular Mitsubishi Electric air conditioners, such as the MSZ-HJ series, for remote control as shown in [3, 4]. Panasonic air conditioners are also controlled in a similar way. The design of an advanced home automation system using a simple web server and Wi-Fi technology has already been proposed in [5]. Based on available solutions, this is one of many possible development paths. Another very interesting solution is a system based on Bluetooth Low Energy (BLE) communication with peripheral devices and a central Android hub as coordinator of the whole [6]. The solution proposed by the authors has the advantages offered by Google Firebase Cloud Messaging (FCM). An analysis of the feasibility of today's web-based technologies in relation to traditional comfort, security and energy efficiency solutions, which are supported by many existing systems as complex islands that are difficult to extend and adapt, is discussed in [7]. The authors propose web technology to remedy this situation for future home automation solutions. A different approach to the problem of smart homes and their grid-based automation, which has the potential to provide flexible solutions to challenges such as energy awareness, energy conservation and the integration of

future smart homes into the smart grid, is discussed in the article [8]. It does not close the topic for discussion, but opens up many new avenues for debate. The paper [9] presents an integrated framework for developing home automation systems using a model-based approach, where a given environment allows developers to generate executable code for specific platforms. The tools presented in this work help developers to model home automation systems using a domain-specific language, which is then transformed into code for home automation-specific platforms. The next in the series of articles presents a new three-stage domestic energy control system [10]. The authors present aspects capable of both satisfying the maximum available electricity reduction and maximising end-user comfort criteria. The control mechanism presented allows flexible control of the total energy consumption of the building using natural heat accumulation. In the publication [11], the research developed a novel remote control system for use with air conditioning systems using adsorption dehumidifiers. The proposed system uses multiple information technologies such as sensor fusion, digital input/output communication and mobile technologies to monitor and control the internal conditions of air-conditioned buildings. The proposed solution provides collection of all relevant data, processing, control of the whole system and mobile access.

The solution presented in this article makes it possible to remotely control the air conditioner and adjust its operation according to your needs. The main objective of this article is to analyse the possibilities and practical implementation of an optimal solution for controlling MSZ-HJ series air conditioners in home automation systems based on the CN105 smart home connector.

## Problem description

The popularity of Mitsubishi's MSZ-HJ series air conditioners is influenced by the inverter technology used [12], which enables automatic regulation of the unit's load according to energy demand, efficient start-up and quiet operation of the unit, as well as compact indoor and outdoor units in terms of size [13] (Figure 1).

The MSZ-HJ series high efficiency air conditioners are controlled from the factory only by a remote control, e.g. MP13A or RU18A, which allows the air conditioner to be switched on and off, temperature settings, air speed, Econo Cool mode, airflow account setting and a timer. The DM00N685B motherboard, which is factory fitted with a CN104 connector and an infrared receiver, is responsible for control. The infrared receiver receives control signals from the remote control, while the CN104 connector allows the air conditioner to be wired on/off and controls the 12V relay that indicates air conditioner operation.

However, the board has a slot for the CN105 connector, which is disabled at the factory. The Mitsubishi CN105 connector communicates at 2400 bits per second and allows an additional factory module to be connected to enable Wi-Fi

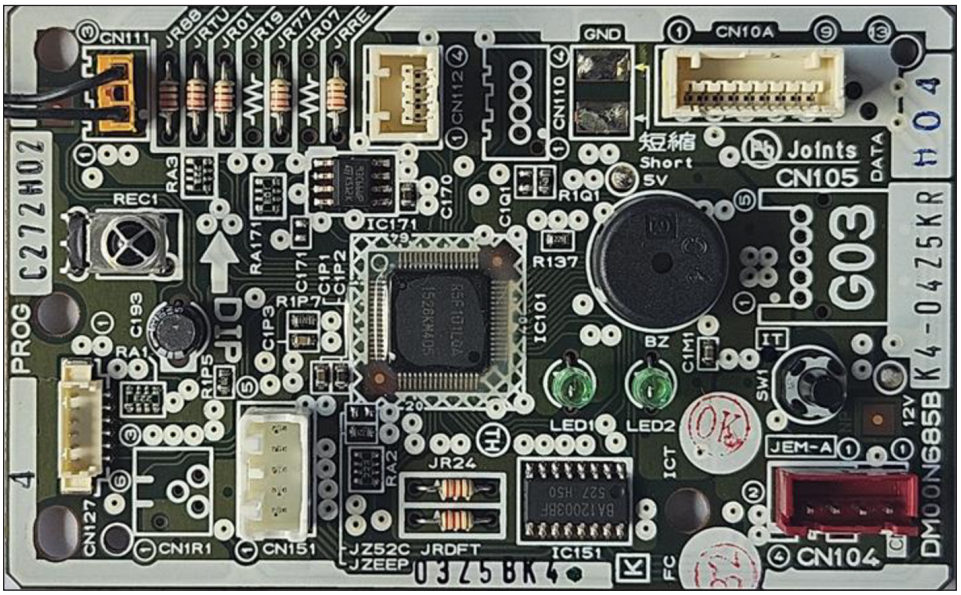


**Figure 1.** View of the control panel of the MSZ-HJ25 air conditioner. Image credit: Mariusz Śniadkowski

communication. The manufacturer offered the MAC 558IF-E, MAC559IF-A, MAC-568IF-E modules.

The existing but inactive CN105 connector can be adapted to communicate with an additional Wi-Fi module, such as the ESP32 from Espressif Systems, allowing remote control of the air conditioner [14]. The ESP32 module belongs to the SoC, or system-on-a-chip, family that allows communication not only via Wi-Fi in 802.11 b/g/n 2.4GHz dual mode, but also via Bluetooth BLE [5, 6]. It is compatible with UART, SPI and I2C interfaces [15]. The module has three built-in UART connectors, allowing more devices to be controlled (Figure 2).

## System implementation

The Mitsubishi CN105 connector on the DM-00N685B motherboard has 5 pins as described: 12 V power supply, ground, 5 V power supply, TX signal, RX signal. To connect an additional Wi-Fi module we use the 4 pins of the CN105 connector: 5V power supply, ground and TX and RX signals.

To activate the connector, add the missing resistors. A resistor of approx. 1–1.2 kΩ should be added to the 5$^{th}$ RX pin and a resistor of approx. 220Ω to the 4th TX pin as shown on Figure 3.

The next step is to connect the 5V power supply and connect the TX pin of the CN105 connector to the RX pin of the Wi-Fi module and the RX pin of the connector to the RT pin of the ESP32 module. The next step to improve the control of the air conditioner is to adjust the data transmission protocol. The Mitsubishi CN105 communication protocol works on a question and answer basis. Before this can be done, the ESP32 module must be programmed.

To program the ESP 32 module, use the widely available Arduino IDE, designed for writing code for Arduino Project single-chip microcontrollers and compatible devices. In the Arduino IDE, go to Tools → Tile Manager, type esp32 in the search engine, and click on the install esp32 board button.

Then download the zip libraries from the link: https://codeload.github.com/SwiCago/HeatPump/zip/refs/heads/master [16] and:

https://codeload.github.com/Pedroalbuquerque/ESP32WebServer/zip/refs/heads/master [17]

Once downloaded, import the libraries by selecting Draft > Attach Library in the Arduino IDE. Add ZIP library. Next, select Tools> Board> DOIT ESP32 DEVKITV1. We load the source code by selecting File > Examples > HeatPump > HP_cntrl_esp8266. We modify the source code by entering our network name and Wi-Fi password and adapt to the ESP32 board. Change the data in the code. The code is shown in the Appendix.

The next step is to connect the ESP32 board to the computer via USB, compile the source code and program the ESP32. After a while, the board should connect to our home network and a web page should be available to manage the air conditioner as shown on Figure 4 and 5.

Finally, we connect the ESP32 board to the CN105 connector according to the diagram.

The control of the air conditioner in question is now ready. The HeatPump library provides source code that can be adapted to our smart home system, for example to communicate via the MQTT protocol with both Domoticz and Home Assistant.

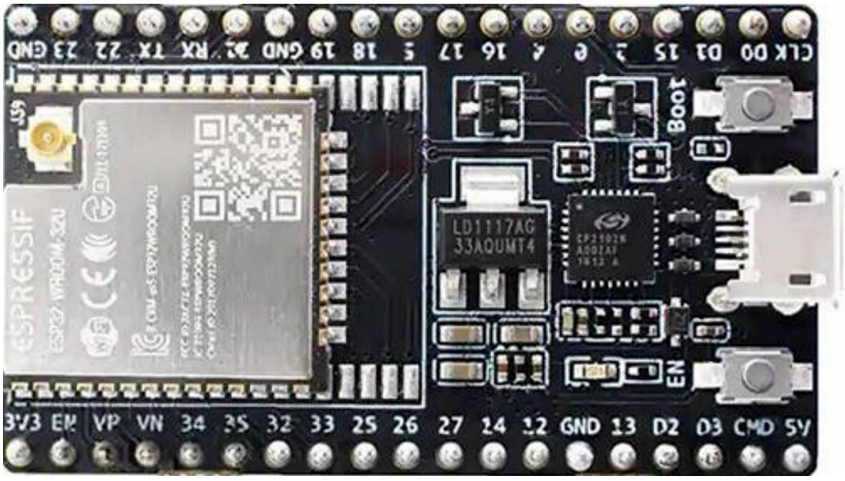


**Figure 2.** ESP32 module. Image credit: Mariusz Śniadkowski

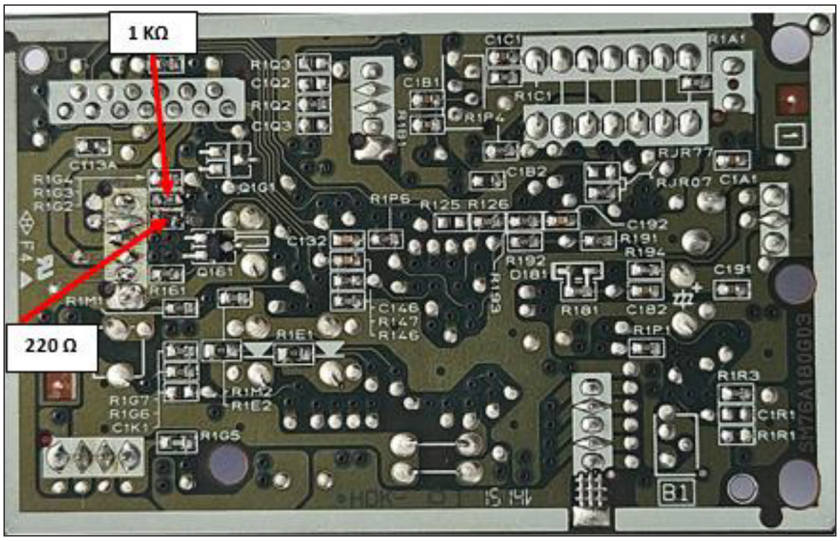


**Figure 3.** Adapting the CN105 connector. Image credit: Mariusz Śniadkowski

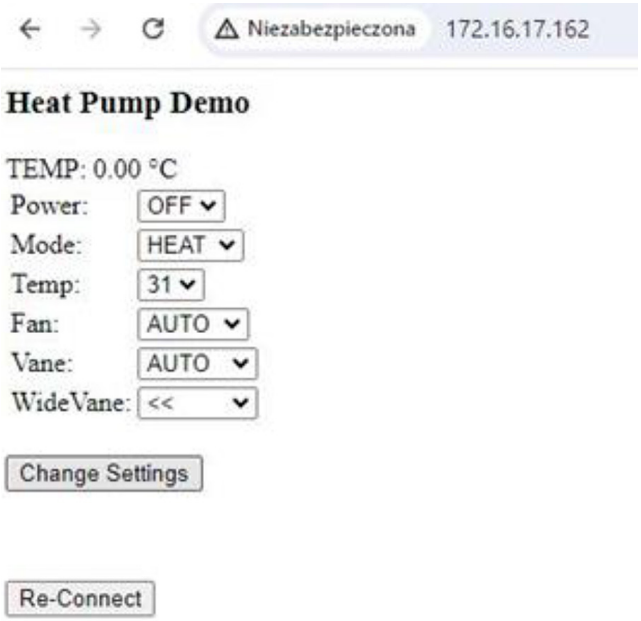


**Figure 4.** Web page for air conditioner management

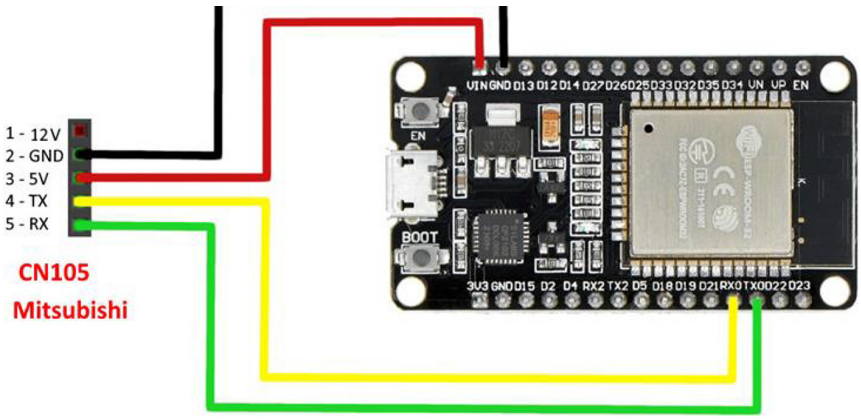


**Figure 5.** Connection of the ESP32 board to the CN105 connector. Image credit: Mariusz Śniadkowski

## CONCLUSIONS

It is possible to adapt the Mitsubishi MSZ-HJ25, MSZ-HJ35, MSZ-HJ50 air conditioner controller to smart homes. Additional Wi-Fi modules are available for Mitsubishi air conditioners and must be installed outside the air conditioner. The ESP32 chip fits easily inside the air conditioner under the control board and allows you to program and control the various functions of the air conditioner, such as ON, OFF; setting the operating mode: HEAT, DRY, COOL, FAN, AUTO; temperature setting between 16–31 degrees, air speed: AUTO, QUIET 1–4; vertical air direction: AUTO, SWING 1–5.

When building a smart home, it is therefore not necessary to replace the air conditioner in question, but it can be successfully adapted using the existing but unsoldered CN105 connector from the factory and a circuit that allows connection to the home or local Wi-Fi network.

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