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Greenhouse CO2 controller

User manual

Third-year Hardware Project

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1. Introduction

The Greenhouse CO2 Controller project aims to develop a sophisticated system capable of integrating both local and remote user interfaces. This gives the user convenient and versatile control over the CO2 controller system, easing the burden of managing a greenhouse environment.

This manual will guide you through the setup and operation of the system. Through these instructions, you will be able to configure and use this system to optimize the CO2 levels of your greenhouse as well as effectively monitor the environment.

Table 1. presents the peripherals in the system and their general functionalities.

Peripherals & Components	Purpose/Functionalities
Rotary encoder	Navigate the selection in the menu
BACK Button (SW_2)	Return to main menu from a sub-menu
OK Button (SW_0)	Confirm the selection on the menu
OLED Display	Local user interface on the microcontroller (Raspberry Pi Pico W)
ThingSpeak Cloud Service	Cloud platform for data visualization and remote control of CO2 setpoint

Table 1: Peripherals, components, and their functionalities.

2. Local UI

This section covers the local user interface on the microcontroller. Local UI is an LCD screen where users can interact with the system like viewing the system stats or changing the parameters.

2.1. Initial display

Upon booting the system, the welcome screen is displayed which introduces the team members. The screen will then automatically transition to the SELECTION screen where users can select an appropriate submenu like Showing the system info, Setting CO₂ screen, or Changing the Wi-Fi credentials.



Figure 1: Welcome screen at boot

After showing this screen for 5 seconds, the screen will change to Selection screen. During the Welcome screen, TLS task establishes a Wi-Fi connection based on the Wi-Fi credentials read back from the EEPROM.

2.2. SELECTION screen



Figure 2: Selection screen

From the Selection screen, the user will be presented with three selections which allow users to navigate to other sub-menus. Rotate the knob to move between different selections. The display highlights the current selection to indicate which option the user is currently on. Confirm the selection by pressing the OK button (SW_0).

Table 2. below lists the sub-menus shown in the main menu and their descriptions.

Main Menu Selection	Description
SHOW INFO	Displays current CO2 levels, humidity, temperature, and other system metrics
SET CO2 LEVEL	Enters the CO2 level setting mode, allowing users to specify a target CO2 concentration
CONFIG WIFI	Allows users to view and edit WiFi credentials for network connectivity

Table 2: Main menu selections

2.3. ‘Set CO2 Level’ Sub-menu

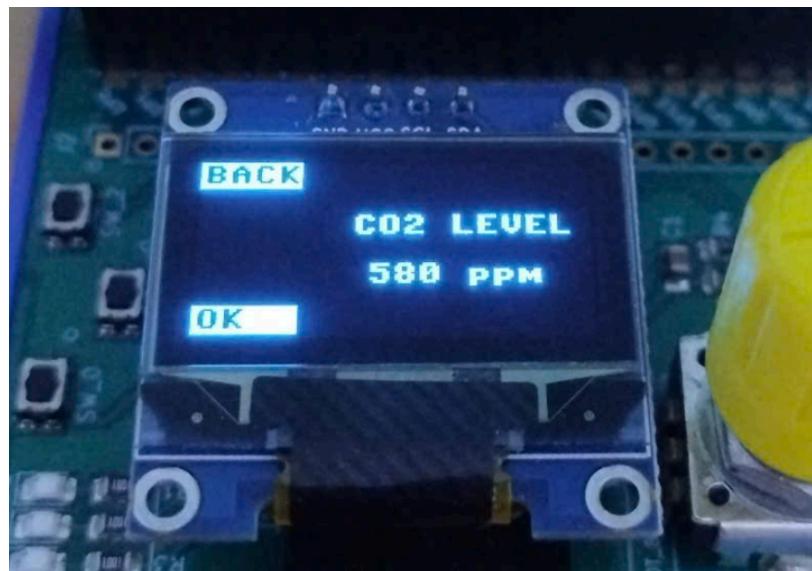


Figure 3: Setting CO2 level screen

In the sub-menu ‘Set CO2 Level’, the user can modify the CO2 setpoint. The display will show text “CO2 LEVEL” and the current target value in ppm. Users can adjust the CO2 setpoint using the rotary. To increase the CO2 setpoint, rotate the knob clockwise. To decrease the CO2 setpoint, rotate the knob counter-clockwise. The

minimum and maximum values of CO₂ setpoint are 200 ppm and 1500 ppm respectively.

After pressing the OK button, a new setpoint is confirmed and stored into the EEPROM. In order to exit this menu, users have to press the BACK button (SW_2) to return to the SELECTION screen.

2.4. ‘Show Info’ Sub-menu

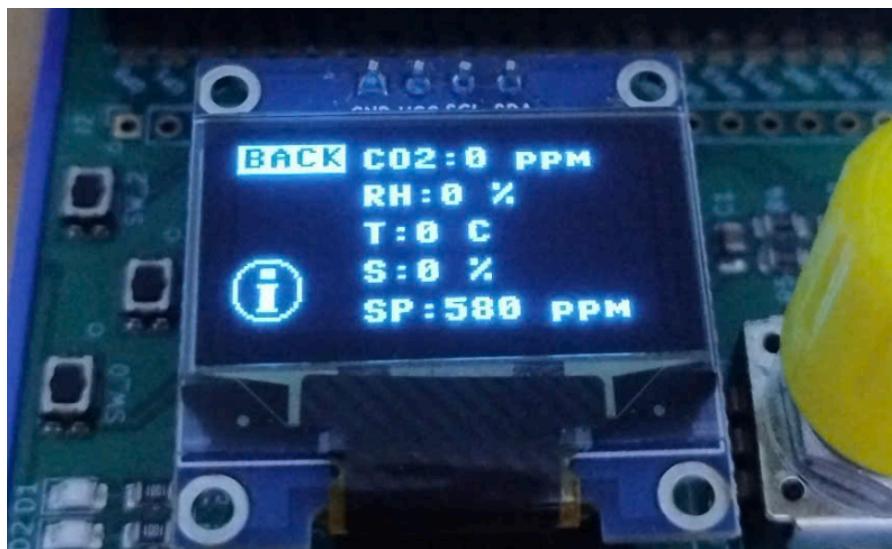


Figure 4: INFO screen

In the sub-menu ‘Show Info’, all measured environmental parameters are listed in read-only mode. Return to the SELECTION screen by pressing the BACK button (SW_2). The CO₂ parameter shows the current CO₂ level, the SP parameter shows the target CO₂ concentration set by the user.

Table 3. below lists the parameters displayed on the Info-menu and in which unit they're measured in, followed by a short description.

Parameters in Info-menu	Description
CO ₂ (ppm)	Show current measured CO ₂ level of the Greenhouse
Relative Humidity (RH) (%)	Show current measured humidity of the Greenhouse
Temperature (T) (C)	Show current measured temperature of the Greenhouse

Fan Speed (S) (0%, 50%, 100%)	Show the set fan speed if current CO2 level exceeds the setpoint at a certain level or when Emergency happens when CO2 level suddenly surpasses the limit (2000 ppm). Fan stops (speed 0%), Fan starts at 50% speed when CO2 level exceeds the setpoint at a certain level, and 100% speed in case of Emergency.
Setpoint (SP) (ppm)	User's predefined CO2 level to be maintained for the Greenhouse

Table 3: Measurement parameters in Info-menu

2.5. ‘Config WiFi’ Sub-menu

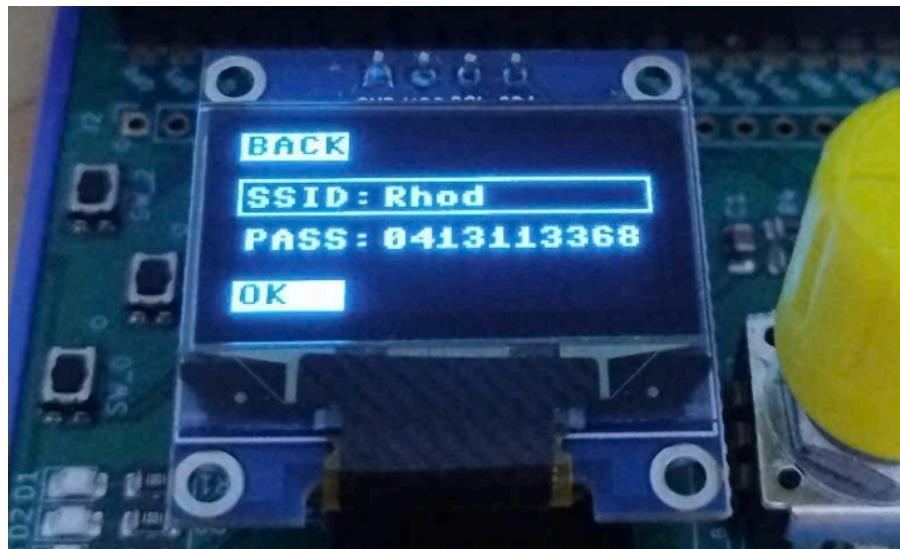


Figure 5: Config Wi-Fi screen

In the sub-menu ‘Config WiFi’, the user is shown the current SSID and password for connecting to the network. The user can change both fields in this sub-menu.

Editing process:

- Rotate the rotary knob to select the desired field
- To edit, press OK button (SW_0) for at least 1.5 seconds when that field becomes empty
- Rotate the rotary knob to change characters
- Confirm the selected character by pressing SW_0 shortly (less than 1.5s)
- Press and hold OK for a minimum of 1.5s to exit the edit mode
- To save the changes, pressing the OK button (less than 1.5s) to save the current credentials to the EEPROM.

- To cancel the input or return to SELECTION screen, press BACK button (SW_2)

3. Cloud service

3.1. ThinkSpeak IoT cloud service (Publishing data)

The system updates the data to Thinkspeak cloud at every 1 minute. The data is published using RESTful API with a hard-coded user's credentials. The published data is then presented to the user channel on different fields: CO2, Temperature, RH, Fan speed, and CO2 setpoint

Figure 6. shows an example of a user channel with five fields.

Channel Stats

Created: 18 days ago
Last entry: 8 days ago
Entries: 445



Figure 6: Thinkspeak channel stats of the project

3.2. Thinkspeak IoT cloud service (Subscribing data):

The CO₂ setpoint can also be configured remotely through Thinkspeak's apps called TalkBack.

Users can create a TalkBack app in their account to send CO₂ setpoints remotely from the cloud to the system. Users can add 1 or more commands to be sent to the system using the “Add a new command” button.

The screenshot shows the configuration page for a TalkBack app named "CO2". The page includes fields for Name (CO2), TalkBack ID (53272), API Key (5U9WXY13SX01SER), and a "Regenerate API Key" button. It also displays creation details (Created: 2024-10-02 1:50 pm) and the channel it is logged to (FreeRTOS_Ventilation). Below this, a "Commands" section lists two entries with columns for Position, Command ID, and Command string. A green "Add a new command" button is at the bottom.

Position	Command ID	Command string
1	44622427	300
2	44622428	500

Figure 7: TalkBack app to set CO₂ setpoints to the system remotely