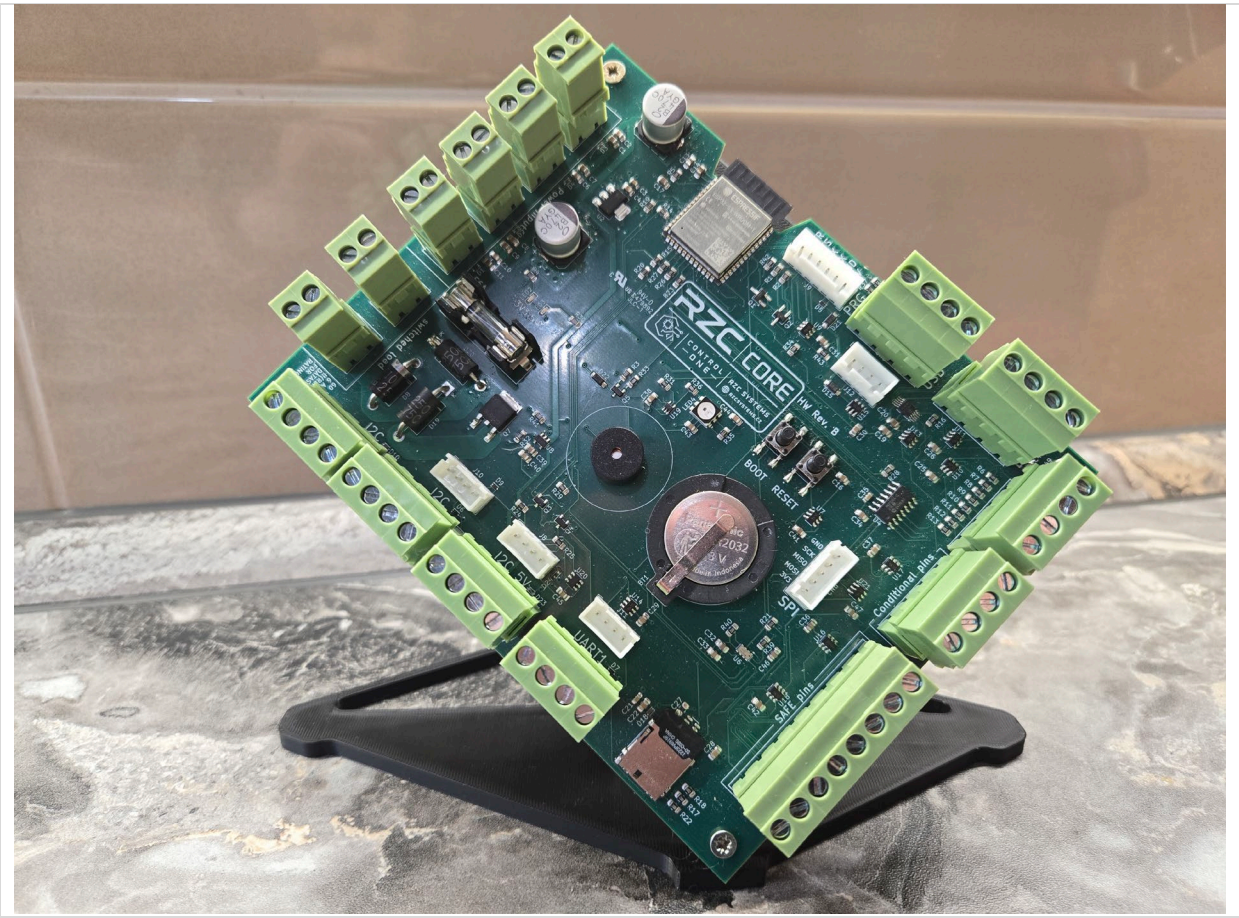
RZC CORE

Control One

Datasheet



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1. Product Overview

RZC CORE Control One is an ESP32-S3-based embedded control module designed for automation, monitoring, data acquisition, and integration into smart home systems, including Home Assistant-based applications.

The module combines processing capabilities, analog and digital interfaces, data storage and peripheral control on a single integrated platform.

The module features a four-channel analog to digital converter (ADC), four-channel digital to analog converter (DAC), a real time clock (RTC) and a microSD card interface for local data logging. Additional interfaces and peripherals include I^2C, UART, a software controlled RGB status LED and a mosfet controlled output for external loads.

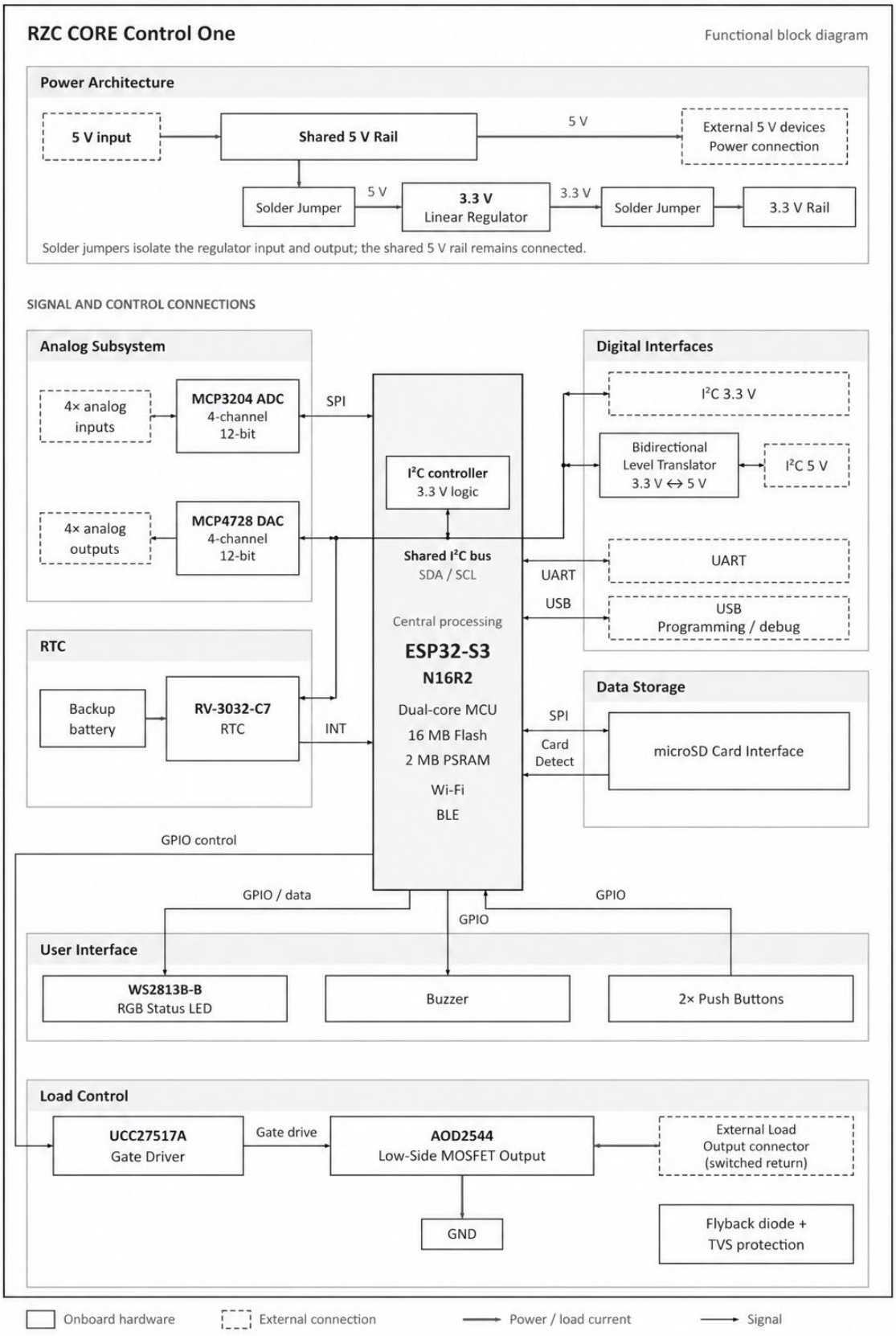
The ESP32-S3 provides dual core processing capabilities together with integrated Wi-Fi and Bluetooth Low Energy (BLE), enabling both standalone operation and integration into connected embedded systems.

Control One is designed as part of the RZC CORE modular platform and can be used together with the RZC CORE Power Sense module or integrated into other compatible embedded systems. Typical applications include industrial monitoring, environmental data acquisition, automated irrigation systems and custom embedded control solutions.

2. Features

- ESP32-S3 dual core microcontroller.
- Integrated 2.4 GHz Wi-Fi and Bluetooth Low Energy (BLE) connectivity.
- 16 MB Flash memory and 2 MB PSRAM.
- 4-channel, 12-bit analog to digital converter (ADC)(MCP3204).
- 4-channel, 12-bit digital to analog converter (DAC)(MCP4728).
- RV-3032-C7 real time clock (RTC) with backup battery support.
- microSD card interface with card detection.
- I^2C interface with 3.3 V and 5 V connections
- UART communication interface.
- USB firmware programming interface.
- Low-side MOSFET output with dedicated gate driver for external load control.
- Inductive load protection with flyback diode and TVS suppression.
- Programmable RGB status LED (WS2813B-B).
- Integrated buzzer and two push buttons.
- 4-layer PCB design.
- Pluggable terminal blocks for external connection.
- Compatible with RZC CORE Power Sense module.
- Designed for standalone and modular embedded applications.
- Shared 5 V power rail for onboard and external peripherals.
- Onboard 3.3 V linear voltage regulator with configurable connections via solder jumper on the bottom side.

3. Block Diagram



4. Absolute Maximum Ratings

Stresses beyond the absolute maximum ratings may cause permanent damage to the device. Operation at these limits is not recommended.

Parameter	Symbol	Min	Max	Unit
5 V supply voltage	V5V_IN	—	5.3	V
3.3 V supply voltage	V3V3_IN	-0.3	3.5	V
GPIO input voltage	VGPIO	-0.3	3.6	V
ADC input voltage	VADC	-0.3	5.54	V
DAC output current	IDAC	-25	25	mA
Load output voltage	VLOAD	0	60	V
Load output current	ILOAD	0	6	A
Storage temperature	TSTG	TBD	TBD	°C

Values derived from component specifications and subject to verification against complete board design.

The onboard LDI1117-3.3H linear voltage regulator is connected to the shared 5 V and 3.3 V power rails through two separate solder jumpers, located at its input and output. Both jumpers must be configured identically: either both closed to enable the onboard regulator or both open to isolate it from the power rails. Opening the jumpers does not disconnect the shared 5 V rail. When both jumpers are open, an external regulated 3.3 V power supply must be provided.

Note: Maximum ratings do not imply guaranteed functional operation. Refer to the recommended operating conditions section for normal operating limits.

5. Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
5 V supply voltage	V5V	4.75	5	5.1	V
3.3 V supply voltage[1]	V3V3	3.135	3.3	3.4	V
GPIO logic voltage	VGPIO	0	3.3	3.3	V
ADC input voltage[2]	VADC	0	—	5.0	V
DAC output voltage[3]	VDAC	0	—	3.3	V
I^2C logic voltage	VI2C	—	3.3 / 5.0	—	V
Load supply voltage	VLOAD	0	—	50	V
Continuous load current	ILOAD	0	—	4	A
Ambient operating temperature	TA	TBD	25	TBD	°C

Notes:

1. Applies to an external **3.3 V** power supply when the onboard voltage regulator is disconnected.
2. Voltage range at the analog input connector of the onboard **MCP3204 ADC**, with **a 6.8 kΩ / 10 kΩ** resistor divider and **VREF = 3.3 V**.
3. Assumes the DAC output is configured for a voltage range of **0–3.3 V.**

6. Electrical Characteristics

6.1 Power supply configuration

The RZC CORE Control One requires both **5 V** and **3.3 V power rails for normal operation.** The module includes an onboard **LDI1117-3.3H** linear voltage regulator to simplify prototyping and standalone applications by generating the required **3.3 V** supply from the **5 V rail.**

The regulator is connected **through two solder jumpers located on the bottom side of the PCB.** One jumper connects the regulator input to the 5 V rail, while the other connects its output to the 3.3 V rail.

Both solder jumpers must be configured identically:

- **Both closed:** The onboard regulator **is enabled and supplies the 3.3 V rail.**
- **Both open:** The onboard regulator is disconnected, and an external regulated 3.3 V power supply must be provided.

When the onboard regulator is enabled, the 3.3 V terminals can also be used to power external peripherals, with a maximum external current draw of 250 mA. The available output current is subject to the total onboard power consumption and thermal limitations of the regulator.

Note: Do not connect an external 3.3 V power supply while the onboard regulator is enabled. Doing so may cause current to flow between the power sources and result in damage to the module.

6.2 Power Supply Characteristics

Unless otherwise specified: V5V = 5.0 V, V3V3 = 3.3 V, TA = 25 °C, onboard regulator enabled, no external load connected.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
3.3 V regulated output voltage	V3V3	V5V = 5.0 V	TBD	3.3	TBD	V
Supply current, idle	I_IDLE	Wi-Fi disabled	—	TBD	—	mA
Supply current, Wi-Fi active	I_WIFI	Wi-Fi connected	—	TBD	—	mA
Supply current, Light Sleep	I_LIGHT	ESP32-S3 Light Sleep	—	TBD	—	mA
Supply current, Deep Sleep	I_DEEP	ESP32-S3 Deep Sleep	—	TBD	—	mA
Maximum supply current	I_MAX	TBD	—	TBD	TBD	mA
Regulator dropout voltage	VDROP	TBD	—	TBD	TBD	V

6.3 Analog input characteristics (MCP3204)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
ADC resolution	NADC	—	—	12	—	Bit
Analog input channels	CH_ADC	—	—	4	—	—
External analog input voltage	VIN_ADC	VREF = 3.3 V	0	—	5.0	V
ADC reference voltage	VREF	—	—	3.3	—	V
Input voltage divider ratio	KADC	6.8 kΩ / 10 kΩ	—	0.5952	—	—
Equivalent input voltage per LSB	VLSB	VREF = 3.3 V	—	1.35	—	mV
ADC measurement accuracy	EADC	TBD	—	TBD	—	%

Note: The analog inputs are connected to the onboard MCP3204 through **6.8 kΩ / 10 kΩ** resistor dividers. The specified input voltage range applies to the module input connectors. The listed resolution is a nominal calculated value and does not represent measurement accuracy.

6.4 Analog output characteristics (MCP4728)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
DAC resolution	NDAC	—	—	12	—	Bit
Analog output channels	CH_DAC	—	—	4	—	—
DAC output voltage	VOUT_DAC	VDD reference, gain 1x	0	—	3.3	V
DAC output voltage per LSB	VLSB_DAC	3.3 V output range	—	0.806	—	mV
DAC output accuracy	EDAC	TBD	—	TBD	—	%
Recommended output load	RLOAD	TBD	TBD	—	—	Ω

6.5 Digital I/O Characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
GPIO logic supply voltage	VDDIO	—	—	3.3	—	V
Input LOW voltage	VIL	VDDIO = 3.3 V	—	—	0.825	V
Input HIGH voltage	VIH	VDDIO = 3.3 V	2.475	—	—	V

Note: GPIO output drive strength is software configurable. The ESP32-S3 supports a typical GPIO source current of up to 40 mA at the highest drive strength setting (GPIO_DRIVE_CAP_3), under the conditions specified by Espressif. The default drive strength is GPIO_DRIVE_CAP_2.

For detailed GPIO electrical characteristics, current limitations and drive strength configuration, refer to the official Espressif ESP32-S3 Series Datasheet and ESP-IDF documentation.

6.6 Load Output Characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Load output topology	—	—	—	Low-side mosfet	—	—
MOSFET on-state voltage drop	VDS_ON	ILOAD = 2 A	—	TBD	—	mV
MOSFET on-state voltage drop	VDS_ON	ILOAD = 4 A	—	TBD	—	mV
MOSFET on-state resistance	RDS_ON	Operating conditions TBD	—	TBD	—	mΩ
MOSFET switching time	TSW	TBD	—	TBD	—	µs

Note: Load output characteristics are dependent on the operating temperature, gate-drive conditions and connected load. Maximum continuous current is subject to PCB and thermal limitations.

6.7 Communication Interface Characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
I^2C 3.3 V logic voltage	VI2C_3V3	—	—	3.3	—	V
I^2C 5 V logic voltage	VI2C_5V	Level-shifted interface	—	5.0	—	V
I^2C clock frequency (DAC)	FI2C_DAC	MCP4728	—	400	400	kHz
I^2C clock frequency (RTC)	FI2C_RTC	RV-3032-C7	—	200	400	kHz
SPI logic voltage	VSPI	—	—	3.3	—	V
SPI clock frequency (ADC)	FSPI_ADC	MCP3204	—	1	1	MHz
SPI clock frequency (microSD)	FSPI_SD	SPI mode	—	10	20	MHz
UART logic voltage	VUART	—	—	3.3	—	V

Note: The 3.3 V and 5 V I^2C interfaces share the same logical bus. The 5 V interface uses bidirectional voltage-level translation.

I^2C and SPI clock frequencies are individually configurable for each peripheral. Typical values represent the recommended configuration. Maximum supported frequencies depend on the connected devices and bus electrical characteristics.

7. Processing System

The RZC CORE Control One is based on the ESP32-S3 dual core microcontroller, providing necessary processing capabilities for embedded automation, monitoring and control applications.

7.1 Microcontroller

Parameter	Specification
Microcontroller	ESP32-S3
CPU architecture	Xtensa LX7
CPU cores	2
CPU word length	32-bit
Maximum CPU frequency	240 MHz
Floating-point unit	Single-precision FPU
Hardware acceleration	Vector instruction
Main oscillator	40 MHz

7.2 Memory

Parameter	Specification
Internal SRAM	512 KB
Internal ROM	384 KB
RTC SRAM	16 KB
Flash memory	16 MB (Quad SPI)
PSRAM	2 MB (Quad SPI)

Note: Available application memory depends on firmware configuration, memory allocation and partition layout.

7.3 Wireless Connectivity

Parameter	Specification
Wi-Fi standard	IEEE 802.11 b/g/n
Wi-Fi frequency band	2.4 GHz
Bluetooth	Bluetooth 5 Low Energy (BLE)
Wi-Fi / BLE coexistence	Supported

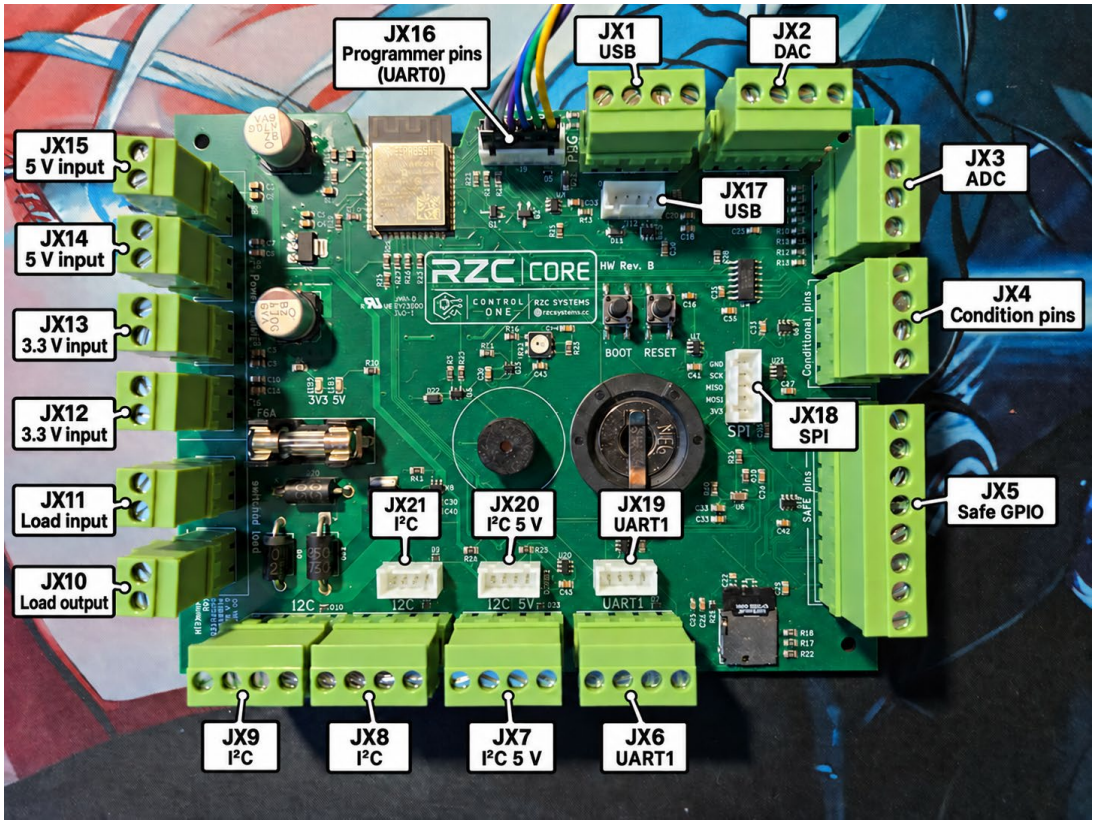
For detailed processing architecture, memory specifications and wireless characteristics, refer to the official Espressif ESP32-S3-WROOM-1 datasheet.

8. Interfaces

The RZC CORE Control One provides communication interfaces for connecting external devices, sensors and embedded systems. The module supports **SPI, I²C, UART and USB communication.**

All accessible pins can be connected using **detachable terminal blocks or JST XH headers** (with the exception of SPI, which is routed only to a JST XH header).

8.1 Board Interface Overview



8.2 I²C Interface

The Control One provides external I²C connections supporting both **3.3 V and 5 V logic levels.** The 3.3 V and 5 V connections share the **same logical I²C bus**. Bidirectional voltage level translation is used for communication with 5 V devices.

8.3 UART interface

The Control One provides two UART interfaces for serial communication. **UART0 (marked as PRG on the PCB)** is reserved for communication with the PC and programming MCU with external UART programmer. **UART1 is free to use**.

Both UART interfaces operate at 3.3 V logic levels and are intended for direct connection to compatible logic-level devices and is **not electrically compatible with RS-232 voltage levels.**

8.4 SPI Interface

The Control One provides an SPI interface for communication with onboard and external peripherals. The onboard **MCP3204 ADC** and **microSD** card interface use SPI communication. External SPI compatible devices can also be connected through the available interface connector.

The SPI interface operates at **3.3 V logic levels.** Clock frequency and communication parameters are software configurable and depend on the connected peripherals.

8.5 USB Interface

The Control One includes a USB interface for firmware programming and communication with the ESP32-S3. The USB interface allows the system integrator to upload application firmware and communicate with the module using compatible development tools.

9. Analog Subsystem

The RZC CORE Control One integrates independent **analog-to-digital (ADC)** and **digital-to-analog (DAC)** converters, providing four analog input channels and analog output channels.

Both converters offer **12-bit resolution** and communicate with the ESP32-S3 through digital interfaces.

9.1 Analog-to-Digital Converter (MCP3204)

The Control One features an onboard **MCP3204 12-bit ADC from Microchip Technology**, providing four single-ended analog input channels.

The ADC communicates with the ESP32-S3 through the SPI interface. Each analog input channel is connected to an external input terminal through a dedicated resistor voltage divider.

Each analog input is connected through a resistor voltage divider consisting of a **6.8 kΩ** series resistor and a **10 kΩ** resistor connected to ground. This allows measurement of external analog signals in the recommended **0–5 V range when using a 3.3 V reference.**

Parameter	Specification
ADC device	MCP3204
Resolution	12-bit
Input channels	4
Input configuration	Single-ended
Communication interface	SPI
Reference voltage	3.3 V
Recommended input range	0 – 5 V
Input voltage divider	6.8 kΩ / 10 kΩ

The conversion results can be processed by the ESP32-S3 for sensor monitoring, data acquisition and other analog measurement applications.

9.2 Digital-to-Analog Converter (MCP4728)

The Control One features an onboard **MCP4728 12-bit DAC from Microchip Technology**, providing four independently **configurable analog voltage outputs.**

The DAC communicates with the ESP32-S3 through the I^2C interface.

The MCP4728 supports an internal **2.048 V voltage reference or the 3.3 V** supply rail as its reference source. Reference selection and output configuration can be controlled individually for each channel.

The device includes non-volatile EEPROM memory for storing output values and configuration settings.

Parameter	Specification
DAC device	MCP4728
Resolution	12-bit
Output channels	4
Output type	Buffered voltage output
Communication interface	I^2C
Supply voltage	3.3 V
Voltage reference	Internal 2.048 V / VDD
Output voltage range	0 – 3.3 V (VDD reference)
Non-volatile memory	Integrated EEPROM

The DAC outputs can be used for analog setpoint generation, control signals, calibration and other voltage-output applications.

10. Onboard Peripherals

The RZC CORE Control One integrates several onboard peripherals for timekeeping, data storage, visual and acoustic indication, and local user interaction.

These peripherals are connected to the ESP32-S3 and can be configured and controlled through application firmware.

10.1 Real-Time Clock (RV-3032-C7)

The Control One features an **RV-3032-C7** real-time clock (RTC) providing timekeeping and calendar functionality independently of the main microcontroller.

The RTC communicates with the ESP32-S3 through **the I²C interface** and provides an **interrupt output** for time-based events and wake-up functionality.

An onboard backup battery holder allows the RTC to maintain timekeeping when the main power supply is disconnected.

The **RV-3032-C7** features an integrated, **configurable trickle charger with charge pump**, supporting compatible rechargeable backup power sources. The charging function is disabled by default and must be configured by the system integrator.

Note: Charging must remain disabled when using non-rechargeable batteries. For detailed information regarding backup power management, charging configurations and supported battery types, refer to the official **Micro Crystal RV-3032-C7 datasheet and application manual.**

10.2 microSD Card Interface

The Control One includes an onboard microSD card slot for removable data storage.

The microSD card communicates with the ESP32-S3 through the **SPI interface**. A dedicated **Card Detect signal** allows firmware to determine whether a card is inserted.

The interface can be used for data logging, configuration storage and other application-specific storage requirements.

File system support and data management are determined by the application firmware.

10.3 RGB Status LED (WS2813B-B)

The Control One integrates a **WS2813B-B** addressable **RGB LED** for visual status indication.

The LED is controlled by the ESP32-S3 through a dedicated digital signal and supports software-configurable color and brightness.

LED behavior and indication patterns are defined by the application firmware.

10.4 Buzzer and Push Buttons

The Control One includes an onboard buzzer for acoustic indication and two push buttons for local control and system interaction.

The buzzer is controlled by the ESP32-S3, allowing application-specific acoustic signals.

The push-button functions depend on their hardware connections and, where applicable, application firmware configuration.

11. Load Output

The RZC CORE Control One features an integrated low-side MOSFET switching stage designed for controlling external DC loads, including resistive and inductive devices.

The output stage consists of an **AOD2544** N-channel MOSFET controlled by a dedicated **UCC27517A** gate driver. The gate driver provides the switching signal required for MOSFET operation.

The output circuit includes an **SB10150** Schottky diode for inductive load protection and a **1.5KE75CA** transient voltage suppression (TVS) diode for limiting voltage transients.

11.1 Mosfet Output Stage

Parameter	Specification
Output topology	Low-side switching
MOSFET	AOD2544
Gate driver	UCC27517A
Control interface	ESP32-S3 GPIO
Inductive load protection	SB10150 Schottky diode
Transient suppression	1.5KE75CA TVS diode
Maximum load supply voltage	60 V DC
Maximum load current	6 A
Continuous current load	4 A

The output operates as a low-side switch, connecting the load return path to ground when the MOSFET is activated.

The load must be powered by an appropriate external DC supply. The load power supply and Control One must share a common ground reference.

11.2 Operating limits

The load output is designed for a maximum supply voltage of **60 V** DC and a maximum load current of **6 A**.

These limits are determined by the PCB design, switching components, protection circuitry and connector specifications.

The maximum continuous current depends on ambient temperature, PCB thermal conditions and operating duty cycle.

Note: The specified voltage and current values represent the module design limits. Continuous operation at maximum load current requires thermal verification.

For inductive loads, transient suppression capability depends on the stored energy of the connected load and the characteristics of the external wiring.

12. Pinout and Signal Mapping

This section provides an overview of the external connector assignments, ESP32-S3 GPIO mapping and onboard I²C device addresses

12.1 Connector Pinout

The RZC CORE Control One provides multiple connectors for power distribution, communication, analog signals and external load control.

Connector	Interface	Description	Available pins
JX1	USB	USB connection	VBUS, D+, D−, GND
JX2	DAC	Four analog output channels	DAC A, DAC B, DAC C, DAC D
JX3	ADC	Four analog input channels	ADC0, ADC1, ADC2, ADC3
JX4	Conditional Pins	GPIO connections with usage restrictions	GPIO35, GPIO36, GPIO37, GPIO39
JX5	General-purpose GPIO	GPIO connections	GPIO1, GPIO2, GPIO4, GPIO5, GPIO6, GPIO7, GPIO18, GPIO38
JX6	UART1	UART communication interface	TX, RX, 3V3, GND
JX7	I²C 5 V	Level-shifted I²C interface	SDA, SCL, 5V, GND
JX8	I²C	3.3 V I²C interface	SDA, SCL, 3V3, GND
JX9	I²C	3.3 V I²C interface	SDA, SCL, 3V3, GND
JX10	Load Output + GND	Switched external load connection	LOAD+, LOAD−
JX11	Load Input + GND	External load power supply connection	VIN+, GND
JX12	3.3 V Input + GND	3.3 V power connection	3V3, GND
JX13	3.3 V Input + GND	3.3 V power connection	3V3, GND
JX14	5 V Input + GND	5 V power connection	5V, GND
JX15	5 V Input + GND	5 V power connection	5V, GND
JX16	UART0	Programming interface	TX0, RX0, DTR, RTS, GND, 5V
JX17	USB	USB connection	VBUS, D+, D−, GND
JX18	SPI	External SPI interface	GND, SCK, MISO, MOSI, 3V3
JX19	UART1	UART communication interface	TX, RX, 3V3, GND
JX20	I²C 5 V	Level-shifted I²C interface	SDA, SCL, 5V, GND
JX21	I²C	3.3 V I²C interface	SDA, SCL, 3V3, GND

Note: Connector signal assignments and pin numbering must be verified against the corresponding hardware revision.

12.2 ESP32-S3 GPIO Assignment

The RZC CORE Control One provides general-purpose GPIO connections divided into two categories: Safe GPIO and Conditional GPIO.

12.2.1 Safe GPIO (JX5)

Connector	Available GPIO Pins
JX5	GPIO1, GPIO2, GPIO4, GPIO5, GPIO6, GPIO7, GPIO18, GPIO38

Note: GPIO35, GPIO36 and GPIO37 are available on the ESP32-S3-WROOM-1-N16R2 module used by Control One. Their availability may differ on other ESP32-S3 module variants.

12.2.2 Conditional GPIO (JX4)

The following GPIO pins are available with additional considerations regarding peripheral functions and compatibility.

Connector	GPIO	Notes
JX4	GPIO35	Reserved for Octal PSRAM on certain ESP32-S3 variants
JX4	GPIO36	Reserved for Octal PSRAM on certain ESP32-S3 variants
JX4	GPIO37	Reserved for Octal PSRAM on certain ESP32-S3 variants
JX4	GPIO39	Alternative JTAG function (MTCK)

Note: GPIO35, GPIO36 and GPIO37 are available on the ESP32-S3-WROOM-1-N16R2 module used by Control One. Their availability may differ on other ESP32-S3 module variants.

12.2.3 Onboard Peripheral GPIO Assignment

GPIO	Function	Peripheral
GPIO8	I^2C SDA	I^2C
GPIO9	I^2C SCL	I^2C
GPIO10	SPI CS	microSD
GPIO11	SPI MOSI	SPI
GPIO12	SPI CLK	SPI
GPIO13	SPI MISO	SPI
GPIO16	Card Detect	microSD
GPIO17	SPI CS	MCP3204 ADC
GPIO19	USB D−	Native USB
GPIO20	USB D+	Native USB
GPIO21	Interrupt	RV-3032-C7 RTC
GPIO40	UART1 TX	UART1

GPIO	Function	Peripheral
GPIO41	UART1 RX	UART1
GPIO42	MOSFET Control	Load Output
GPIO43	UART0 TX	External programmer
GPIO44	UART0 RX	External programmer
GPIO47	Buzzer Control	Buzzer
GPIO48	RGB LED Data	WS2813B-B

Note: GPIO assignments are hardware-defined. The Safe GPIO designation indicates pins without additional board-specific functional restrictions; it does not imply protection against overvoltage or overcurrent.

All externally accessible GPIO signals operate at 3.3 V logic levels and are not 5 V tolerant.

12.3 Communication Interface Pin Assignment

The onboard I^2C and SPI peripherals are connected to hardware-defined ESP32-S3 GPIO pins. Application firmware must configure the corresponding interfaces using the pin assignments listed below.

Interface	Signal	ESP32-S3 GPIO	Connected Peripheral
I^2C	SDA	GPIO8	Shared I^2C bus
I^2C	SCL	GPIO9	Shared I^2C bus
SPI	MOSI	GPIO11	Shared SPI bus
SPI	MISO	GPIO13	Shared SPI bus
SPI	SCLK	GPIO12	Shared SPI bus
SPI	CS	GPIO17	MCP3204 ADC
SPI	CS	GPIO10	microSD card
Digital input	Card Detect	GPIO16	microSD card

The onboard MCP3204 ADC and microSD card interface share the same SPI data and clock lines, with independent chip-select signals.

The onboard I^2C devices and external 3.3 V / 5 V I^2C connectors share the same logical I^2C bus. The 5 V connectors use bidirectional voltage-level translation.

SPI and I^2C communication parameters are software configurable. The GPIO assignments for the onboard peripherals are fixed by the PCB design.

12.4 Onboard I^2C Device Addresses

Device	I^2C Address (7-bit)	Example Firmware Configuration
MCP4728 DAC	0x60	400 kHz
RV-3032-C7 RTC	0x51	200 kHz

13. Protection Features

The RZC CORE Control One incorporates protection components designed to reduce the risk of damage caused by electrostatic discharge (ESD), overcurrent conditions and voltage transients.

The integrated protection features are summarized below.

Interface	Protection	Implementation
5 V power input	ESD protection	Nexperia PESD5Z5.0
3.3 V power input	ESD protection	Nexperia PESD5Z3.3
External signal interfaces	ESD protection	STMicroelectronics USBLC6-4SC6
USB and programming interfaces	ESD protection	STMicroelectronics USBLC6-4SC6
Load power path	Overcurrent protection	Replaceable 6 A fuse
Load output	Inductive load protection	SB10150 Schottky flyback diode
Load output	Transient suppression	1.5KE75CA TVS diode

ESD immunity target: IEC 61000-4-2 level 4, ±8 kV contact discharge and ±15 kV air discharge.

Notes:

- System-level ESD immunity of the complete module has not yet been **independently tested or certified**. Component-level ESD ratings do not guarantee equivalent system-level performance.
- ESD protection components are intended for transient events and do not provide continuous overvoltage or reverse-polarity protection.
- The fuse rating does not represent an instantaneous current interruption threshold.
- The effectiveness of inductive load protection depends on load characteristics, wiring and operating conditions.

14. Programming and Software

The RZC CORE Control One is **supplied without application firmware.** The system integrator is responsible for firmware development, peripheral configuration and application-specific functionality.

The module supports firmware programming and debugging through the interfaces provided by the ESP32-S3.

14.1 Programming interfaces

The Control One provides multiple interfaces for firmware programming and development.

Interface	Description
Native USB	ESP32-S3 USB Serial/JTAG interface
USB-to-UART	Serial programming through the onboard CP2102 converter
UART0	External 3.3 V UART programming interface with automatic boot and reset support via DTR/RTS

The native USB interface supports firmware programming and debugging without requiring an external USB-to-UART converter.

The UART0 interface allows firmware programming using compatible external programming tools.

14.2 Boot and Recovery

The ESP32-S3 includes an internal ROM bootloader that supports firmware downloading and recovery.

Firmware download mode can be entered by holding GPIO0 (boot button pressed) during reset.

Signal	Function
GPIO0	Boot mode selection
EN	Chip reset / enable
UART0	Serial firmware programming
USB Serial / JTAG	USB firmware programming and debugging

The module can be programmed using Espressif development tools, including **esptool**. For detailed information regarding boot modes, firmware downloading and recovery procedures, refer to the official Espressif ESP32-S3 documentation.

14.3 Software Development Support

The Control One is designed for embedded firmware development using the ESP32-S3 software ecosystem.

Software / framework	Description
ESP-IDF	Primary development framework
RZC CORE Libraries	Hardware abstraction and peripheral control libraries
Other ESP32-S3-compatible frameworks	Subject to framework and peripheral support

The **RZC CORE Libraries** provide reusable software components for communication interfaces and onboard peripherals.

Software availability, supported versions and documentation may vary depending on the library release.

Note: The Control One is supplied without application firmware. Hardware functionality, communication interfaces and peripheral operation must be initialized and configure by the system integrator.

15. Typical Application

The RZC CORE Control One is designed for embedded automation, monitoring, data acquisition, and educational applications.

The module can operate as a standalone control unit or as part of the RZC CORE modular platform. Its integrated analog and digital interfaces allow connection of external sensors, actuators and communication devices.

Typical applications include:

- **Smart Greenhouse Automation** – automated irrigation, environmental monitoring, soil moisture measurement and data logging.
- **Home Automation** – smart home control and monitoring systems, including projects based on ESPHome.
- **Industrial Monitoring** – data acquisition, environmental monitoring and control of external devices.
- **Educational applications** – teaching embedded systems, microcontroller programming, digital communication protocols and analog signal processing.
- **Custom Embedded Systems** – development of application-specific controllers, monitoring equipment and automation solutions.

15.1 Standalone Operation

The Control One can operate independently using an external regulated power supply. External sensors and peripheral devices can be connected through the available ADC, DAC, I^2C, SPI, UART and GPIO interfaces.

The integrated microSD card interface and real-time clock provide hardware support for time-stamped data logging, while the MOSFET output enables control of compatible external DC loads.

15.2 RZC CORE Modular System

The Control One can be combined with the RZC CORE Power Sense module to create an integrated control and power monitoring system.

The Power Sense module provides regulated 5 V and 3.3 V power rails, a dedicated load power path and independent voltage, current and power monitoring.

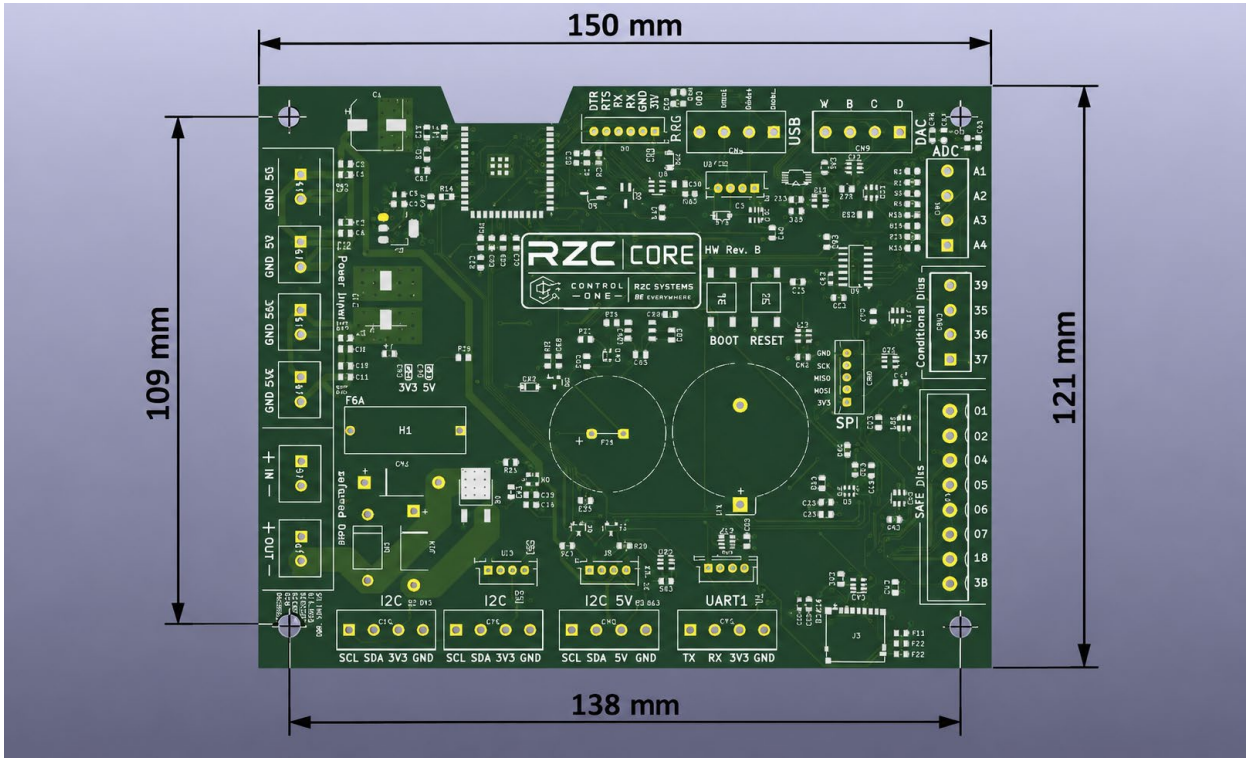
The Control One performs application-specific processing, sensor acquisition, communication and load control.

Communication between the modules allows the Control One to access power measurements provided by Power Sense.

Note: The Control One is supplied without application firmware. System functionality depends on the firmware developed and configured by the system integrator. Compatibility with third-party software platforms, including ESPHome may require additional configuration or custom components.

Power supply connections, load current limits, and voltage ratings must comply with the specifications of the individual modules.

16. Mechanical Information



17. Ordering Information

Order Code	Product name	Variant	Description
RZCCO-B	RZC CORE Control One	Basic	Fully assembled standard module
RZCCO-C	RZC CORE Control One	Coated	Fully assembled module with protective conformal coating
RZCCO-EDU	RZC CORE Control One	Educational Kit	Control One with educational accessories and sensors
RZCCO-EDU-P	RZC CORE Control One	Educational Kit Plus	Educational kit including RZC CORE EDU expansion boards

18. Revision history

Revision	Date	Description
0.1	October 2026	Preliminary