Zigbee Coordinator v2.0 Datasheet

Revision A

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1 About This Document

This document outlines the technical details of the Zigbee Coordinator v2.0 device. For details on software usage, setting up, or troubleshooting the Zigbee Tracker system, refer to the Zigbee Tracker System User Guide.

2 Revision History

Changes from Original to Revision A

3 Device Overview and Functions

The Zigbee Coordinator v2.0 is designed as a mains-powered wireless device on the IEEE 802.15.4 standard (Zigbee) and IEEE 802.11 standard (WiFi). The Zigbee Coordinator v2.0 consists of a Zigbee Module (based on the CC2530 IC), ESP32 Module (4MB variant), dual source power management system, auto programming circuitry, various status indication LEDs and optional I2C pins. The device functionality is depicted in Figure 3A.

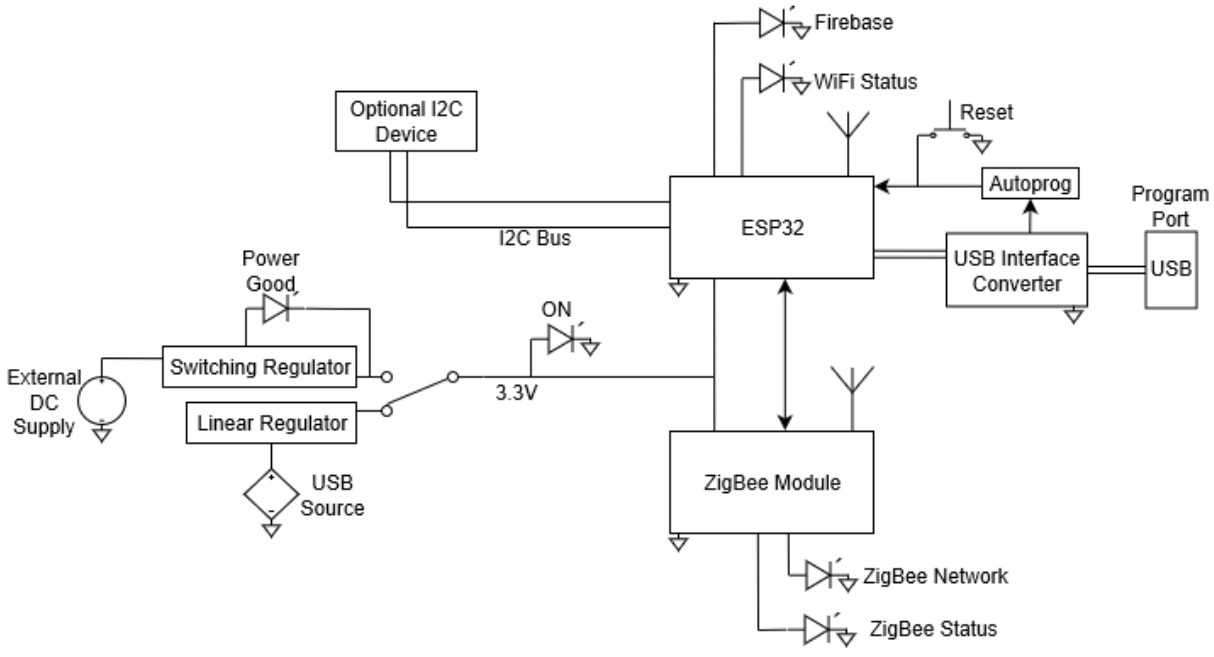

Figure 3A: Simplified Functional Block Diagram

As a mains-powered, WiFi enabled Zigbee device, the expected use case of this device is as a Zigbee Coordinator node, used to concentrate Zigbee network data to various online cloud services. The ESP32 provides internet access and should function as the main processor. The Zigbee Module contains preloaded firmware with AT/HEX command functionality via UART. However, the Zigbee Module can be reprogrammed via the FFC connector. **This will overwrite the existing firmware and is irreversible.** Details on the programming and reflashing of the Zigbee Tracker v2.0 can be found in the User Guide, as well as instructions on the required hardware and connections.

4 Specifications

4.1 Absolute Maximum Ratings

PARAMETER		MIN	MAX	UNIT
Pin Voltage		-0.3	3.6	V
Device Temperature		-10	85	°C
USB Supply Voltage, V_{bus}		-0.3	12	V
DC Supply Voltage, V_{ext}		-0.3	20	V

The device is not guaranteed to function within these ratings. Exceeding these ratings may cause permanent damage to the device.

4.2 Recommended Operating Conditions

PARAMETER		MIN	MAX	UNIT
Pin Voltage		0	3.3	V
Operating Temperature		-10	85	°C
USB Supply Voltage, V_{bus}		4.75	5.25	V
DC Supply Voltage, V_{ext}		4	17	V

4.3 Electrical Characteristics

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
System Voltage, $V_{3.3}$	USB supply enabled	3.234	3.366	V
	Mains supply enabled	2.1	3.49	V
External Peripheral Current Draw, I_{periph}	USB supply enabled	0	0.6	A
	Mains supply enabled	0	1.7	A

Regulation Efficiency, η	USB supply enabled	LINEAR RESISTIVE LOSS		%
	Mains supply enabled, V_{IN} = 12V, 20mA < $I_{3.3}$ < 310mA	85		%

4.4 Operating Characteristics

PARAMETER	TEST CONDITIONS	MIN	MAX	UNIT
Operating Current, I_{op}	WiFi TX 802.11b +19.5dBm, Zigbee TX +4dBm, ESP32 single core moderate usage	290	310	mA
	All RF inactive, microcontroller moderate usage	43	75	
Maximum Zigbee RF Transmit Power	Configured in Zigbee Module		4.5	dBm
Maximum Zigbee RF Receive Sensitivity	Configured in Zigbee Module		-97.5	dBm
Maximum ESP32 (WiFi) Transmit Power	Configured in ESP32, 802.11b @ 1MHz		20.5	dBm
Maximum ESP32 (WiFi) Receive Sensitivity	Configured in ESP32, 802.11b @ 1MHz		-98	dBm

All voltages are measured with respect to V_{ss}

5 Detailed Description and Functionality

5.1 ESP32 Module

The Zigbee Coordinator v2.0 utilizes the ESP32 Module (based on the ESP32 IC) to provide WiFi connectivity, along with dual Tensilica 32-bit microprocessors.
The ESP32 Module's reset pin is connected to the Autoprog circuit and a pushbutton.
The ESP32 Module's UART 12/13 pins are connected to the Zigbee Module to be used as an interface for issuing commands to the Zigbee Module, and UART 21/24 pins are connected to the USB Interface Converter for programming.

5.2 Zigbee Module

The Zigbee Tracker v2.0 utilizes a low-cost E18-MS1 Zigbee Module based on the CC2530 SoC. The module is preloaded with firmware which allows for AT/HEX UART commands to control the module, bypassing the need for writing code for the CC2530. More information on the commands and their functionality can be found in the E18 Software Datasheet <insert link>. If the preloaded firmware is deemed unsuitable for the application, the Zigbee Module can be reprogrammed via the DEBUG FFC connector with a Texas Instruments CC debugger. **Reprogramming the Zigbee Module will erase the preloaded firmware and is irreversible.**

5.3 USB Interface Converter & Autoprog

The USB Interface Converter converts the ESP32 Module's UART program interface to USB. The Autoprog allows for the automatic resetting and configuration of the ESP32 GPIO0 (boot) pin.

5.4 Switching Converter

The onboard TPS62132 is used to regulate the input DC supply voltage to 3.3V. The converter uses a DCS control topology to minimize interference with RF, while providing high efficiency. The wide input voltage range of the TPS62132 allows the Zigbee Coordinator v2.0 to accept standard 5V and 12V DC supplies, up to 17V. More details can be found in the manufacturer's datasheet.

5.5 Linear Converter

The onboard AMS1117-3.3 is used to regulate the USB supply voltage to 3.3V during programming. More details can be found in the manufacturer's datasheet.

5.6 Optional I2C Device

The Zigbee Coordinator v2.0 provides solder points for attaching an external I2C device to interface with the ESP32 Module. The I2C device can be used to acquire user inputs. The I2C device must not expose the I2C pins to any voltage higher than in the Absolute Maximum Ratings.

5.7 Indicator LEDs

The Zigbee Coordinator has 6 indicator LEDs as shown in Figure 5.6A.
The behavior of the LEDs is outlined in Table 5.6A.

	State	Meaning
Power Good LED	Off	Battery not charging
	On	Battery charging
	Flashing at 2Hz	Charger safety timers expired
On LED	Off	Voltage not present on 3V3 rail
	On	Voltage present on 3V3 rail
WiFi Status LED	Off	Controlled by ESP32 pin
	On	
Firebase LED	Off	Controlled by ESP32 pin
	On	
Zigbee Network LED	Off	Zigbee network connected
	On	Zigbee network disconnected
Zigbee Status LED	Off	Zigbee no error
	On	Zigbee error

Table 5.6A: Indicator LED behavior

6 Application and Implementation

6.1 Debugging and Programming

The Zigbee Coordinator v2.0 has an onboard USB interface which allows the ESP32 to be programmed directly via the USB port. Additionally, the onboard autoprog circuit automatically selects the boot mode of the ESP32 such that no intervention from the user is needed.
During programming, the slide switch should be set to USB mode, to take power from the USB host.

The Zigbee Coordinator v2.0 has a RESET switch which is used to hard reset the ESP32.

The USB port on the Zigbee Coordinator v2.0 in Figure 6.1A is compliant with USB 2.0 and higher. As per USB specifications, the bus voltage should not exceed 5.25V (12V is the Absolute Maximum for this device).

6.2 External Enclosures

As with any wireless device, it is highly inadvisable to use metal enclosures without substantial research on its effects on device performance. Placing any metal or conductor directly above or around the region in Figure 6.2A is likely to detune and absorb RF transmissions from the Zigbee Module PCB antenna.

It is also recommended to have clear sections of the enclosure for the indication LEDs in Section 5.8 to be visible to the user.
As an always-on device, the Zigbee Coordinator should be housed in an enclosure with sufficient airflow, especially if powered from 12V or higher (DC jack).

6.3 Power Source

The Zigbee Coordinator v2.0 should be powered from an external DC supply for long term operation. The DC supply should output a voltage as stated in the Recommended Operating Conditions, and be able to supply a current of at least 1.5 x I_{SYS}. Additionally, the DC supply should have less than 150mVpp of ripple. It is recommended to use a DC supply with protection against lightning discharge or surges - many low cost DC supplies do not.

7 Related Documentation

Documents related to the Zigbee Coordinator v2.0

Zigbee Tracker v2.0 Datasheet
Technical documentation of the Zigbee Tracker v2.0 device.

Zigbee Tracker System User Guide
User-friendly set-up guide for Zigbee Tracker system (including Zigbee Tracker v2.0 as both end device and router nodes, and Zigbee Coordinator v2.0 as coordinator node).

Documents related to the hardware components of the Zigbee Coordinator v2.0

TPS62140
Low-power buck converter
AMS1117
LDO regulator
ESP32 WROOM Module
ESP32 module with PCB antenna and SPI flash
E18-MS1-PCB
CC2530 module with PCB antenna
CH340G
USB to UART converter