VSD

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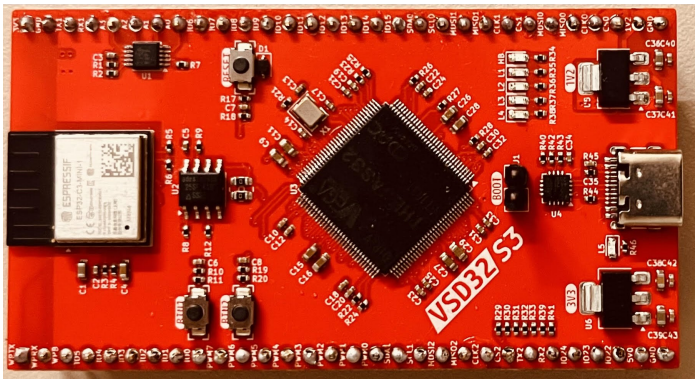
VLSI System Design (VSD)

VSD32-S3

powered by CDAC

The VSD32-S3 is an Indian RISC-V board featuring THEJAS32 RISC-V SoC, alongwith 2.4 GHz Wi-Fi and Bluetooth 5 module



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1 Getting Started

The VSD32-S3 is an indigenous RISC-V development board designed for IoT, education, and embedded systems prototyping. Key features and specifications include:

- **Dual-Core Architecture for Modular Learning**: Combines the Indian-made THEJAS32 RISC-V core with wireless module, allowing students to explore both core computation and connectivity.
- **Complete Wi-Fi + BLE Stack**: The wireless module supports IEEE 802.11b/g/n Wi-Fi and Bluetooth Low Energy 5.0, making it suitable for smart home, wearable, and industrial IoT applications.
- **Accessible Programming Interface**: The CP2102N USB-UART bridge offers seamless programming and debugging from any USB-enabled host.
- **Rich Peripheral Ecosystem**: Offers 32 GPIOs, 8 PWM, 4 SPI, 3 I2C, 3 UARTs, and support for ADCs via external modules—ideal for sensor interfacing and peripheral experimentation.
- **FPGA-Prototypable and Breadboard-Friendly**: Compact 40mm × 40mm layout with castellated GPIOs allows easy integration into breadboards or daughterboards.
- **Power-Efficient Design**: 1.2V and 3.3V LDO regulators optimize power delivery across critical sections, aiding in low-power system design training.
- **Educational Focus**: Designed for academic curricula, competitions, and project-based learning across RISC-V architecture, communication protocols, and embedded applications.

With its modular design, educational compatibility, and dual-core architecture, the VSD32-S3 provides a versatile platform for students, developers, and innovators entering the world of RISC-V and connected embedded systems.

1.1 Kit Contents

The following table number 1 lists the contents of the VSD32-S3 RISC-V development board.

Item	Quantity
VSD32-S3 RISC-V development board featuring the 32-bit THEJAS32 RISC-V SoC from CDAC	1

Table 1: Kit Contents

1.2 Block Diagram

The block diagram shown in Figure 1 shows the key components of the VSD32-S3 RISC-V development board.

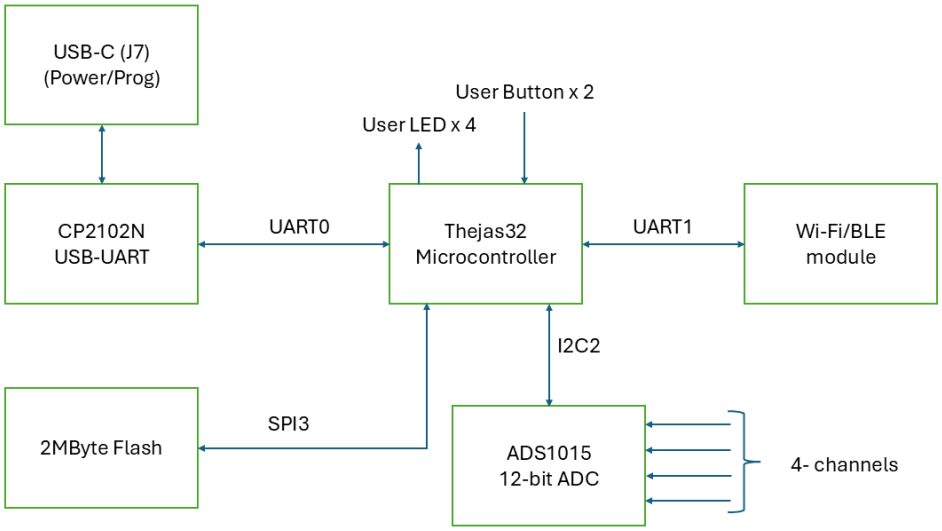

Figure 1: VSD32-S3 RISC-V development board Block Diagram

1.3 Web Resources

For more information about the VSD32-S3 RISC-V SoC device, refer to THEJAS32 RISC-V SoC Datasheet and VEGA ET1031 Manual

1.4 Board Overview

The VSD32-S3 RISC-V development board integrates a modular dual-chip architecture combining the THEJAS32 SoC and WiFi/BLE module, with the following key features:

- 128-lead LQFP package for THEJAS32 and shielded WiFi/Bluetooth module
- On-board 100MHz crystal oscillator for core system clock
- Up to 32 Digital IO pins with support for PWM, SPI, I2C, UART
- 3 UART, 3 I2C, and 4 SPI interfaces available via expansion headers
- Dedicated QSPI flash interface with 2MB AT25SF161B SPI Flash
- On-board I2C ADC (ADS1015) supporting 4-channel, 12-bit resolution
- USB-C port for power, programming, and serial communication via CP2102N bridge
- Breadboard-compatible castellated GPIO headers for easy prototyping

The following illustration in Figure 2 highlights various components of the VSD32-S3 RISC-V development board.

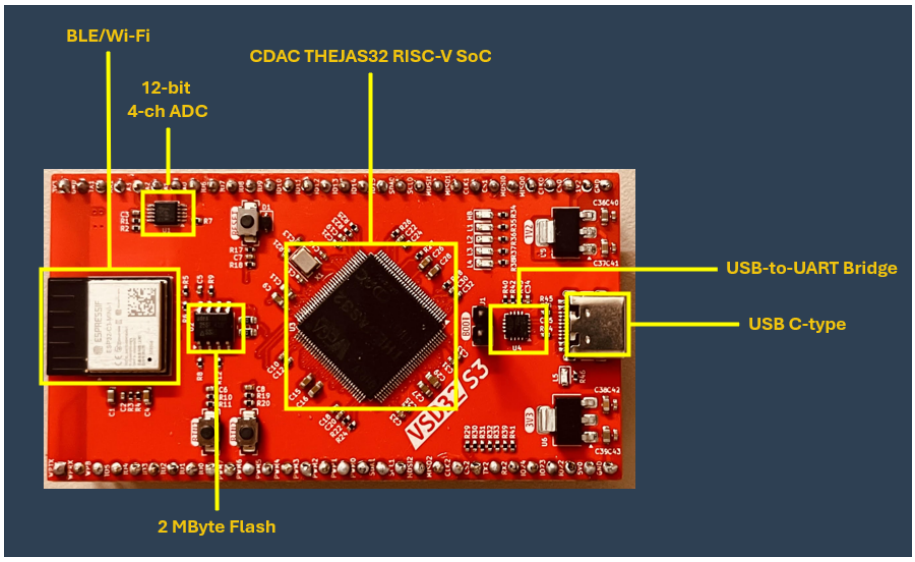

Figure 2: VSD32-S3 RISC-V development board

1.4.1 Form Factor

The following are the dimensions of the VSD32-S3 RISC-V development board.

- Form factor is 77.5 x 71.9 mm
- Maximum height of the component at the top side: 8mm
- Maximum height of the component at the bottom side: 1mm

1.4.2 VSD32-S3 Board Pinout

Figure 3 shows the VSD32-S3 board pinout. Refer to Appendix Table 5 for THEJAS32 SoC IO assignments.

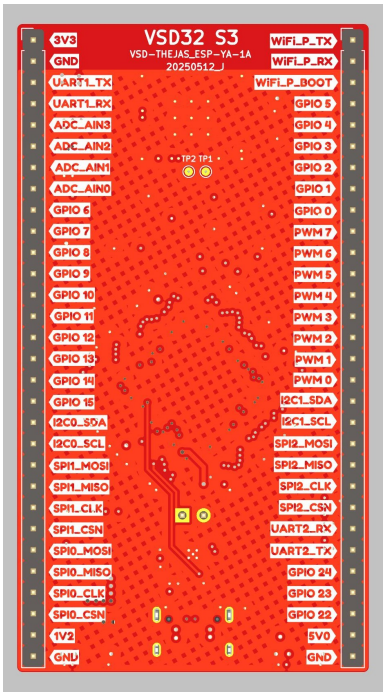

Figure 3: VSD32-S3 Pinout Diagram

Table 2: VSD32-S3 Board Pinout Description

Left Pin	Function	Right Pin	Function
3V3	3.3V Power Supply	WiFi_P_TX	WiFi UART TX
GND	Ground	WiFi_P_RX	WiFi UART RX
UART1_TX	UART1 Transmit	WiFi_P_BOOT	WiFi Boot Mode
UART1_RX	UART1 Receive	GPIO5	General Purpose IO 5
ADC_AIN3	ADC Input Channel 3	GPIO4	General Purpose IO 4
ADC_AIN2	ADC Input Channel 2	GPIO3	General Purpose IO 3
ADC_AIN1	ADC Input Channel 1	GPIO2	General Purpose IO 2
ADC_AIN0	ADC Input Channel 0	GPIO1	General Purpose IO 1
GPIO6	General Purpose IO 6	GPIO0	General Purpose IO 0
GPIO7	General Purpose IO 7	PWM7	PWM Output Channel 7
GPIO8	General Purpose IO 8	PWM6	PWM Output Channel 6
GPIO9	General Purpose IO 9	PWM5	PWM Output Channel 5
GPIO10	General Purpose IO 10	PWM4	PWM Output Channel 4
GPIO11	General Purpose IO 11	PWM3	PWM Output Channel 3
GPIO12	General Purpose IO 12	PWM2	PWM Output Channel 2
GPIO13	General Purpose IO 13	PWM1	PWM Output Channel 1

Left Pin	Function	Right Pin	Function
GPIO14	General Purpose IO 14	PWM0	PWM Output Channel 0
GPIO15	General Purpose IO 15	I2C1_SDA	I2C Bus 1 Data Line
I2C0_SDA	I2C Bus 0 Data Line	I2C1_SCL	I2C Bus 1 Clock Line
I2C0_SCL	I2C Bus 0 Clock Line	SPI2_MOSI	SPI Bus 2 MOSI
SPI1_MOSI	SPI Bus 1 MOSI	SPI2_MISO	SPI Bus 2 MISO
SPI1_MISO	SPI Bus 1 MISO	SPI2_CLK	SPI Bus 2 Clock
SPI1_CLK	SPI Bus 1 Clock	SPI2_CSN	SPI Bus 2 Chip Select
SPI1_CSN	SPI Bus 1 Chip Select	UART2_RX	UART2 Receive
SPI0_MOSI	SPI Bus 0 MOSI	UART2_TX	UART2 Transmit
SPI0_MISO	SPI Bus 0 MISO	GPIO24	General Purpose IO 24
SPI0_CLK	SPI Bus 0 Clock	GPIO23	General Purpose IO 23
SPI0_CSN	SPI Bus 0 Chip Select	GPIO22	General Purpose IO 22
1V2	Internal 1.2V Supply	5V0	5V Power Input
GND	Ground	GND	Ground

See Appendix Table 5 for THEJAS32 SoC pin mapping.

1.4.3 THEJAS32 based VSD32-S3 RISC-V development board components

Board	THEJAS32
Microcontroller	VEGA ET1031 (32-bit RISC-V RV32IM) running at 100MHz
USB Connector	UART-to-USB (using typical application circuit)
Digital I/O Pins	32 General Purpose I/O (3.3V tolerant)
PWM Pins	8 channels, 32-bit programmable PWM
External Interrupt Pins	12 GPIOs with interrupt capability
External Wakeup Pins	BOOT_SEL configurable pin
UART	3 UARTs (UART0, UART1, UART2)
I2C	3 I2C Master Interfaces
SPI Controllers / HW CS Pins	4 SPI Master Interfaces
I/O Voltage	5V
Input Voltage (nominal)	Core: 1.2V, IO: 3.3V (external supply)
Clock Speed	100 MHz
Flash Memory	External SPI Flash support

Table 3: THEJAS32 based VSD32-S3 Board Features Summary

1.5 Handling the Board

To avoid causing any damage or malfunctions, it is important to be mindful of the following points when handling or operating the board:

- To prevent any damage, make sure to handle the board while taking electrostatic discharge (ESD) precautions.
- Power down the board by disconnecting the board from USB port

1.6 Operating Temperature

Designed for Room Temperature. The standard range for room temperature in Celsius is typically considered to be between 0 to 70 degrees Celsius (or 32 to 158 degrees Fahrenheit).

1.7 Powering Up the Board

Connect the Type-C end of USB cable to the board as shown in below image and refer to programming:Programming VSD32-S3 section for programming the board.

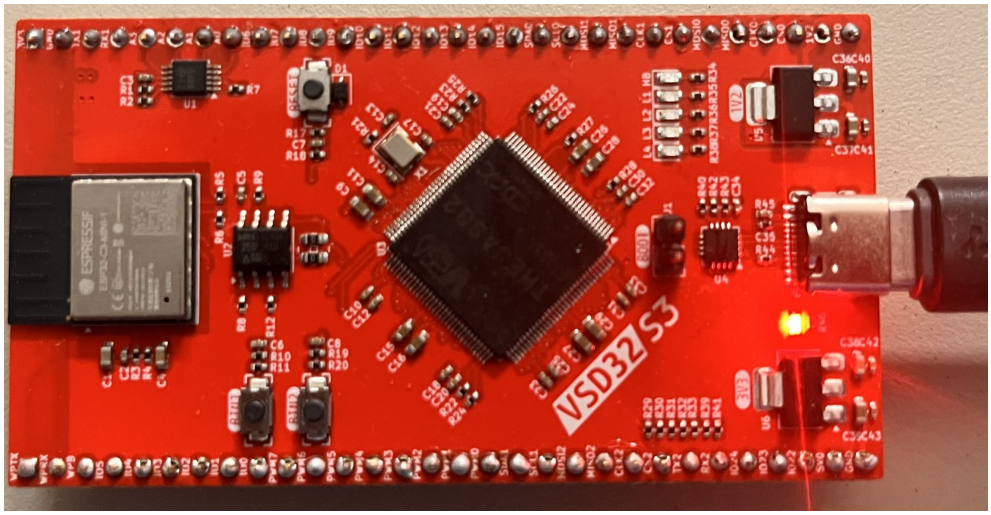

Figure 4: Micro-C end of USB cable connected to board

2 Programming VSD32-S3

We are going to use the Arduino IDE for this demo. First, you need to add the following URL to the Arduino package index. Open Arduino IDE and navigate to **File → Preferences → Additional Boards Manager URLs**.

`https://raw.githubusercontent.com/VSD-Systems/VSD_IDF/main/package_vsd_index.json`

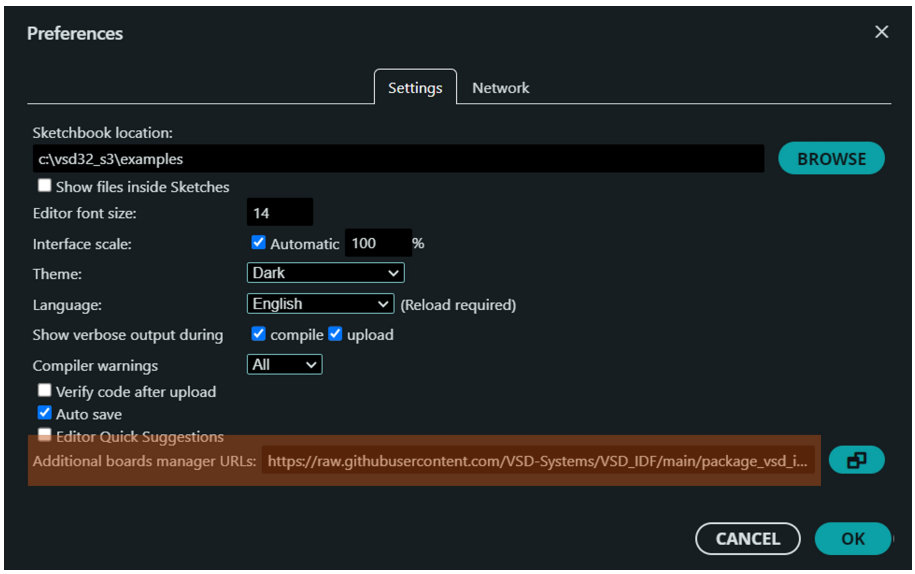

Figure 5: Adding VSD32-S3 board URL in Arduino IDE

Add the URL to a new line. The Arduino package for VSD32-S3 boards is available at VSD-IDF GitHub link. After saving the URL, the Arduino IDE will begin fetching board information.

2.1 Installing the Board

Once fetching is complete, go to **Tools → Board → Board Manager**, search for `vsd`, and install the package titled **VSD32 Boards by VSD**.

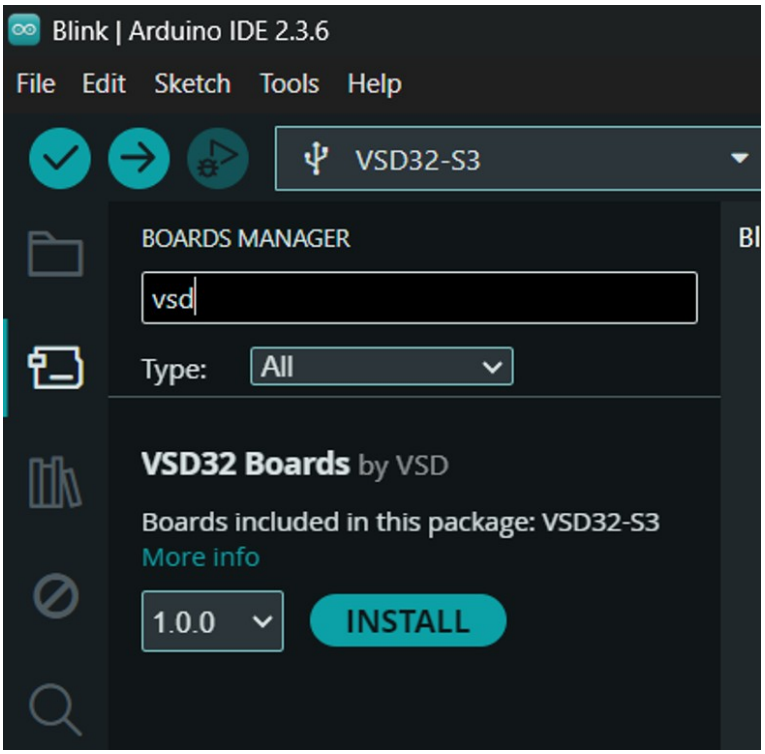

Figure 6: Installing VSD32 Board Package

Once installed, the VSD32 boards and examples will be available in the Arduino IDE.

2.2 Connecting the Board

Connect your VSD32-S3 board to your computer using a USB-C cable. On Windows, a new COM port will be enumerated, thanks to the onboard CP210x USB-to-UART bridge.

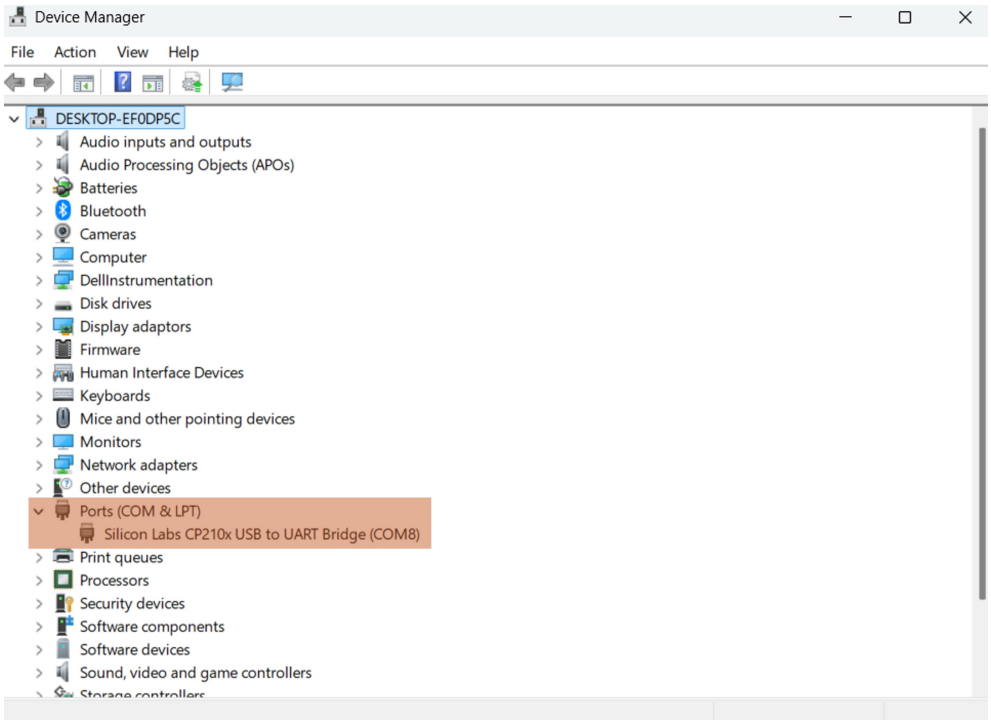

Figure 7: Detected COM Port (e.g., COM8) via CP210x bridge

This COM port should be selected in **Tools → Port** when uploading code from the Arduino IDE.

2.3 Board Selection and LED Indicators

Once the VSD32-S3 board package is installed, it will appear in the Arduino IDE's board list. Navigate to **Tools → Board** and select **VSD32-S3**.

You can verify the board is connected by going to **Tools → Get Board Info**, which will display the board name and other USB details.

The VSD32-S3 board includes:

- A **green LED** indicating power.
- An **orange LED** labeled `PROC_BEAT` that blinks continuously when the processor is active.

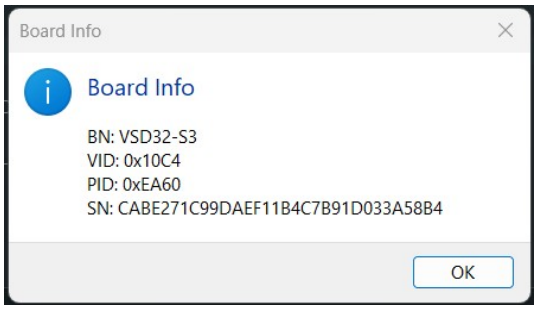

Figure 8: VSD32-S3 board selected and LED indicators

2.4 Accessing Example Sketches

After selecting the board, example sketches specific to VSD32-S3 become available under **File → Examples**. These include various templates, such as the basic `Blink` sketch.

Note: If the examples are not visible immediately, close and reopen the Arduino IDE.

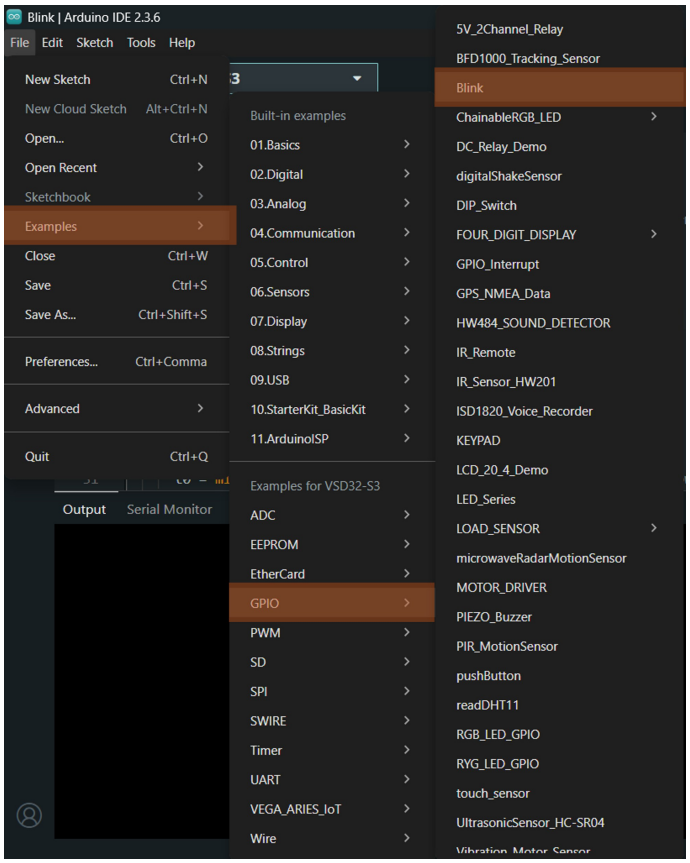

Figure 9: Accessing example sketches for VSD32-S3

2.5 Demo: 4-bit LED Up Counter

One of the example sketches is a 4-bit LED up-counter that uses GPIO pins 16 to 19. It cycles through values from 0 to 15, blinking the connected LEDs accordingly.

```
/* 4-bit LED Up-Counter  (GPIO 16,17,18,19)
 * Yatharth's "binary blinkenlights" demo - one tick every 250 ms.
 */
const uint8_t ledPins[4] = {16, 17, 18, 19};   // LSB to MSB
uint8_t count = 0;                             // 0-15 and wrap

void setup() {
  for (uint8_t i = 0; i < 4; ++i) {
    pinMode(ledPins[i], OUTPUT);
    digitalWrite(ledPins[i], HIGH);   // start with everything OFF
  }
}

void loop() {
  // show count (invert bits because LEDs are active-LOW)
  for (uint8_t bit = 0; bit < 4; ++bit) {
    digitalWrite(ledPins[bit], bitRead(count, bit) ? LOW : HIGH);
  }

  delay(250);                          // quarter-second tick
  count = (count + 1) & 0x0F;          // next value, wrap at 15
}
```

Listing 1: 4-bit LED Up-Counter Demo

The code configures 4 GPIO pins as outputs, and the loop continuously updates them to show a binary count. Since the LEDs are active-LOW, the logic is inverted.

2.6 Programming Mode Selection

Before uploading the sketch, ensure the **BOOT SEL (J1)** jumper is set correctly. This jumper determines the boot mode of the processor.

UART Programming Mode (BOOT SEL Open)

If the BOOT SEL jumper is **not shorted**, the CPU boots from the UART interface.

- Set **Flash Mode → Disabled**
- Select **Tools → Programmer → VEGA XMODEM**

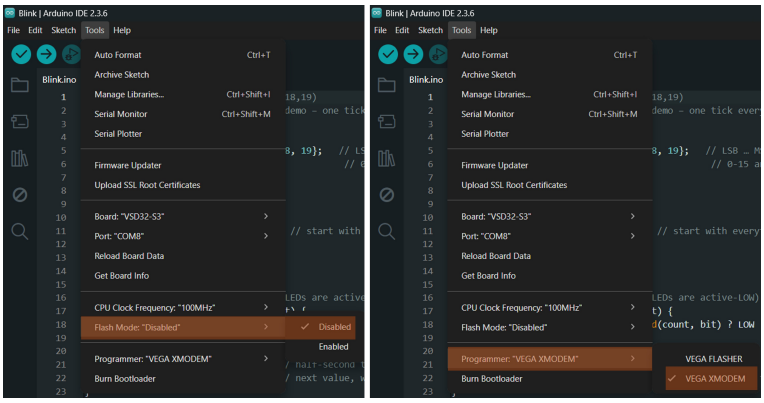

Figure 10: BOOT SEL not shorted – UART Boot Mode

Flash Programming Mode (BOOT SEL Shorted)

If the BOOT SEL jumper is **shorted**, the CPU boots from external SPI flash memory.

- Set **Flash Mode → Enabled**
- Select **Tools → Programmer → VEGA FLASHER**

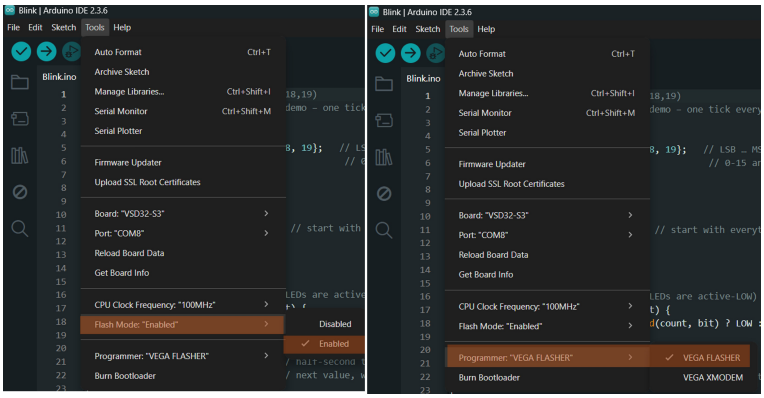

Figure 11: BOOT SEL shorted – Flash Boot Mode

2.7 Upload and Verify

After setting the correct mode and selecting the COM port, you can compile and upload the sketch. If successful, you will observe the 4 onboard blue LEDs blinking in a binary up-counter pattern, visually indicating the processor's activity.

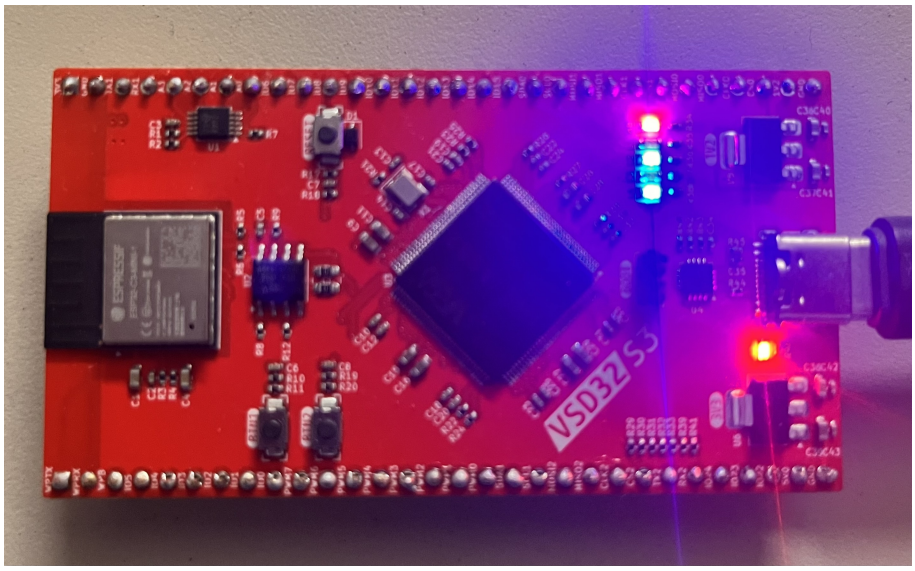

Figure 12: Successful upload – LEDs showing binary count

3 Board Component Placement

The following figure shows the placement of various components on the VSD32-S3 RISC-V development board.

3.1 VSD32-S3 top view

The following Figure shows the top view of the VSD32-S3 RISC-V development board.

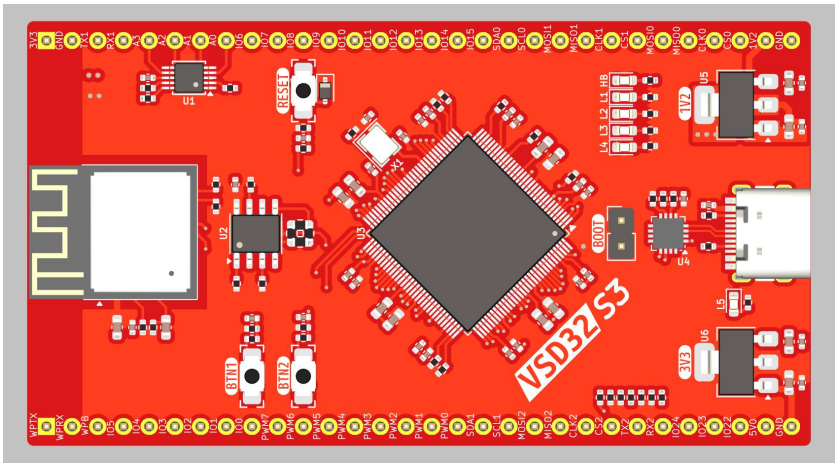

Figure 13: Silkscreen Top View

3.2 VSD32-S3 bottom view

The following Figure shows the bottom view of the VSD32-S3 RISC-V development board silkscreen.

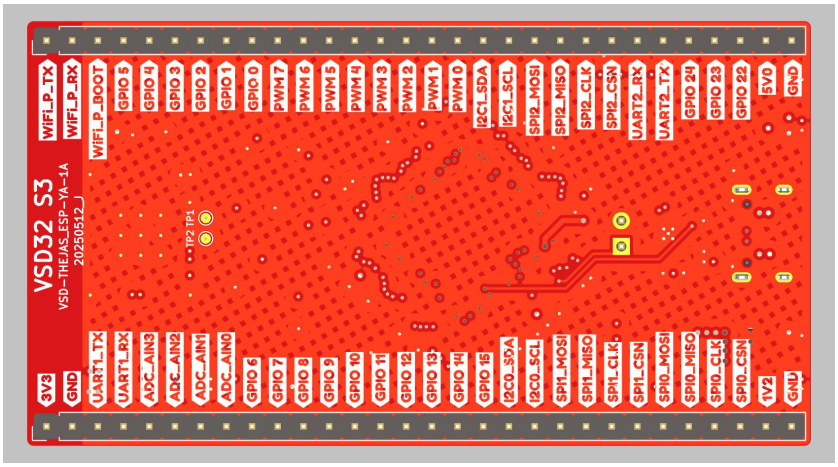

Figure 14: Silkscreen Top View

4 Revision History

The document's revision history provides a record of the alterations made to it, listed in chronological order, with the most recent revision first.

Revision	Date	Description
1.0	-	This is the first publication of this document

Table 4: Revision History

5 Help and support

- Contact email ID - vsd@vlsisystemdesign.com
- Online GitHub support - If you encounter any issues, please raise a ticket using this link

Appendix

Table 5 shows THEJAS32 RISC-V SoC IO Bank Assignment for communication Interfaces

Table 5: THEJAS32 SoC pin definitions

Pin no.	Pin Name	Pin Description	Type
1	GPIO19	General purpose IO GPIO1(3).	I/O
2	GPIO18	General purpose IO GPIO1(2).	I/O
3	VSSIO	Ground reference for IO pins.	S
4	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
5	GPIO17	General purpose IO GPIO1(1).	I/O
6	GPIO16	General purpose IO GPIO1(0).	I/O
7	SPI_MOSI3	SPI 3 Master Out Slave In.	O
8	VDD	Positive supply for logic. Connect to 1.2V supply.	S
9	VSS	Ground reference for logic.	S
10	SPI_MISO3	SPI 3 Master In Slave Out.	I
11	SPI_SCLK3	SPI 3 Clock.	O
12	SPI_SS3	SPI 3 Chip Select.	O
13	VSSIO	Ground reference for IO pins.	S
14	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
15	BOOT_SEL	Boot select.	I
16	PROC_HB	Heartbeat signal.	O
17	RFIU1	Connect to GND.	NA
18	VDD	Positive supply for logic. Connect to 1.2V supply.	S
19	VSS	Ground reference for logic.	S
20	RFIU2	Connect to GND through a 1K resistor.	NA
21	RFIU3	JTAG TDO. Left unconnected.	NA
22	RFIU4	JTAG TMS. Connect to GND through a 1K resistor.	NA
23	RFIU5	JTAG TDI. Connect to GND through a 1K resistor.	NA
24	VSSIO	Ground reference for IO pins.	S
25	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
26	VDD	Positive supply for logic. Connect to 1.2V supply.	S
27	VSS	Ground reference for logic.	S

Pin no.	Pin Name	Pin Description	Type
28	RFIU6	JTAG TCK. Connect to GND through a 1K resistor	NA
29	RFIU7	JTAG TRST. Connect to GND through a 1K resistor	NA
30	RFIU8	Test mode select. Connect to GND through a 1K resistor.	NA
31	I2C_SDA2	I2C 2 Serial Data.	I/O
32	I2C_SCL2	I2C 2 Serial Clock.	I/O
33	I2C_SCL0	I2C 0 Serial Clock.	I/O
34	I2C_SDA0	I2C 0 Serial Data.	I/O
35	VSS	Ground reference for logic.	S
36	VDD	Positive supply for logic. Connect to 1.2V supply.	S
37	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
38	VSSIO	Ground reference for IO pins.	S
39	SPI_SS1	SPI 1 Chip Select.	O
40	SPI_SCLK1	SPI 1 Clock.	O
41	SPI_MISO1	SPI 1 Master In Slave Out.	I
42	SPI_MOSI1	SPI 1 Master Out Slave In.	O
43	PUSH_RESETN	Reset. (ACTIVE LOW)	I
44	CLK	System Clock.	I
45	UART_TX1	UART 1 Serial Out / Transmit.	O
46	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
47	VSSIO	Ground reference for IO pins.	S
48	VSS	Ground reference for logic.	S
49	VDD	Positive supply for logic. Connect to 1.2V supply.	S
50	UART_RX1	UART 1 Serial In / Receive.	I
51	GPIO15	General purpose IO GPIO0(15).	I/O
52	GPIO14	General purpose IO GPIO0(14).	I/O
53	GPIO13	General purpose IO GPIO0(13).	I/O
54	GPIO12	General purpose IO GPIO0(12).	I/O
55	GPIO11	General purpose IO GPIO0(11).	I/O
56	VSS	Ground reference for logic.	S
57	VDD	Positive supply for logic. Connect to 1.2V supply.	S
58	GPIO10	General purpose IO GPIO0(10).	I/O

Pin no.	Pin Name	Pin Description	Type
59	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
60	VSSIO	Ground reference for IO pins.	S
61	GPIO9	General purpose IO GPIO0(9).	I/O
62	GPIO8	General purpose IO GPIO0(8).	I/O
63	GPIO7	General purpose IO GPIO0(7).	I/O
64	GPIO6	General purpose IO GPIO0(6).	I/O
65	GPIO5	General purpose IO GPIO0(5).	I/O
66	GPIO4	General purpose IO GPIO0(4).	I/O
67	VSS	Ground reference for logic.	S
68	VDD	Positive supply for logic. Connect to 1.2V supply.	S
69	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
70	VSSIO	Ground reference for IO pins.	S
71	GPIO3	General purpose IO GPIO0(3).	I/O
72	GPIO2	General purpose IO GPIO0(2).	I/O
73	GPIO1	General purpose IO GPIO0(1).	I/O
74	GPIO0	General purpose IO GPIO0(0).	I/O
75	PWM_7	Pulse Width Modulation.	O
76	PWM_6	Pulse Width Modulation.	O
77	PWM_5	Pulse Width Modulation.	O
78	VSS	Ground reference for logic.	S
79	VDD	Positive supply for logic. Connect to 1.2V supply.	S
80	PWM_4	Pulse Width Modulation.	O
81	PWM_3	Pulse Width Modulation.	O
82	PWM_2	Pulse Width Modulation.	O
83	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
84	VSSIO	Ground reference for IO pins.	S
85	PWM_1	Pulse Width Modulation.	O
86	PWM_0	Pulse Width Modulation.	O
87	SPI_MOSI0	SPI 0 Master Out Slave In.	O
88	VSS	Ground reference for logic.	S
89	VDD	Positive supply for logic. Connect to 1.2V supply.	S
90	SPI_MISO0	SPI 0 Master In Slave Out.	I
91	SPI_SCLK0	SPI 0 Clock.	O
92	SPI_SS0	SPI 0 Chip Select.	O

Pin no.	Pin Name	Pin Description	Type
93	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
94	VSSIO	Ground reference for IO pins.	S
95	I2C_SDA1	I2C 1 Serial Data.	I/O
96	I2C_SCL1	I2C 1 Serial Clock.	I/O
97	SPI_MOSI2	SPI 2 Master Out Slave In.	O
98	SPI_MISO2	SPI 2 Master In Slave Out.	I
99	VDD	Positive supply for logic. Connect to 1.2V supply.	S
100	VSS	Ground reference for logic.	S
101	SPI_SCLK2	SPI 2 Clock.	O
102	SPI_SS2	SPI 2 Chip Select.	O
103	VSSIO	Ground reference for IO pins.	S
104	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
105	UART_RX2	UART 2 Serial In / Receive.	I
106	UART_TX2	UART 2 Serial Out / Transmit.	O
107	UART_RX0	UART 0 Serial In / Receive.	I
108	UART_TX0	UART 0 Serial Out / Transmit.	O
109	GPIO31	General purpose IO GPIO1(15).	I/O
110	GPIO30	General purpose IO GPIO1(14).	I/O
111	GPIO29	General purpose IO GPIO1(13).	I/O
112	VDD	Positive supply for logic. Connect to 1.2V supply.	S
113	VSS	Ground reference for logic.	S
114	VSSIO	Ground reference for IO pins.	S
115	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
116	GPIO28	General purpose IO GPIO1(12).	I/O
117	GPIO27	General purpose IO GPIO1(11).	I/O
118	GPIO26	General purpose IO GPIO1(10).	I/O
119	GPIO25	General purpose IO GPIO1(9).	I/O
120	GPIO24	General purpose IO GPIO1(8).	I/O
121	GPIO23	General purpose IO GPIO1(7).	I/O
122	GPIO22	General purpose IO GPIO1(6).	I/O
123	VSSIO	Ground reference for IO pins.	S
124	VDDIO	Positive supply for IO pins. Connect to 3.3V supply.	S
124	VDD	Positive supply for logic. Connect to 1.2V supply.	S

Pin no.	Pin Name	Pin Description	Type
126	VSS	Ground reference for logic.	S
127	GPIO21	General purpose IO GPIO1(5).	I/O
128	GPIO20	General purpose IO GPIO1(4).	I/O

Table 5: THEJAS32 SoC pin definitions