

## HiFive1 Rev B IoT demo

### SiFive RISC-V SoC with FreeRTOS and Amazon S3

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SH Consulting Group

SH Consulting Group (SHC) consists of engineers in US, Vietnam and in Japan specialized in providing stability and sustainable code to RTOS, device drivers, and wireless connectivity for MCUs such as H8s, SHs, ARMs and RISC-Vs. The company has been integrating OSES such as QNX, .NETMF, UEFI, Linux, and Windows for MCUs and wireless solutions such as Lora, WiFi and Bluetooth for many years. They worked on Windows, QNX, Android and iOS platforms. In recent years SHC engineers enabled FreeRTOS for large semiconductor companies on ARM platforms and direct this effort to RISC-Vs.

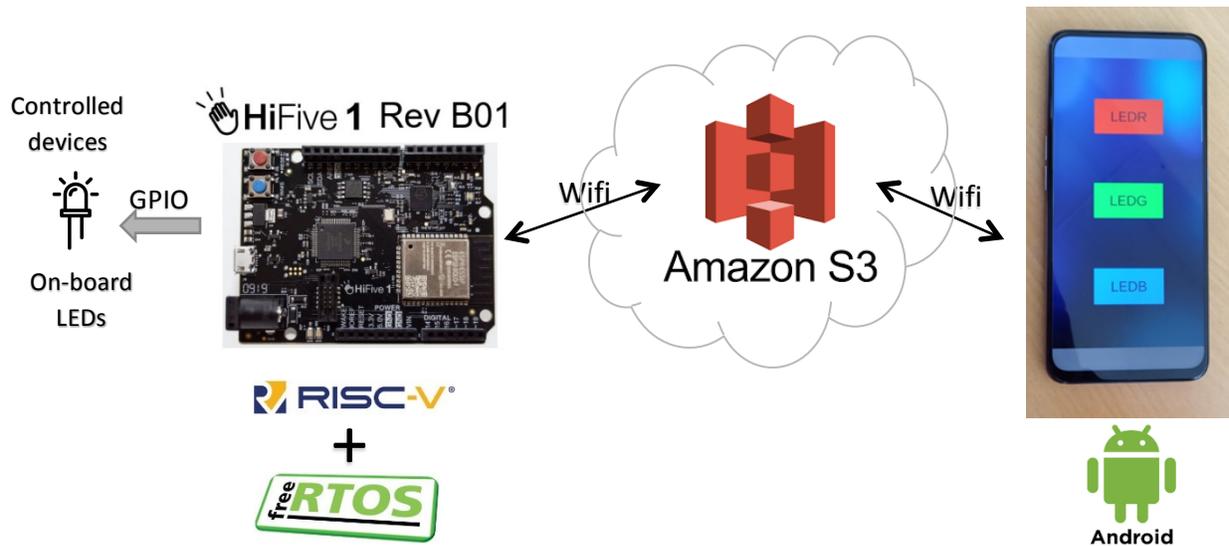


Figure 1: HiFive1 Rev B with Amazon S3 demonstration

## HiFive1 Rev B01 from SiFive

### The Second Generation HiFive1 Dev Board and the Freedom Everywhere SoC, FE310

“Since the launch of the original HiFive1 and the FE310 in 2016, we have received lots of great community feedback. The FE310-G002 is an upgrade to the Freedom Everywhere SoC, that adds support for the latest RISC-V Debug Spec 0.13, hardware I<sup>2</sup>C, two UARTs, and power gating the core rail in low power sleep modes. Like the original FE310, the FE310-G002 features SiFive’s E31 CPU core complex, a high-performance, 32-bit RV32IMAC core with a 16 KB L1 instruction cache, a 16 KB data SRAM scratchpad, and hardware multiply/divide. Running at 320+ MHz, the FE310 is among the fastest microcontrollers on the market.

The HiFive1 dev board has also been upgraded. Powered by the FE310-G002, the new HiFive1 Rev B has wireless connectivity through an onboard Wi-

Fi/Bluetooth module. The USB debugger has been upgraded to Segger J-Link, with support for drag & drop code download. In favor of driving GPIO directly from the FE310, the HiFive1 Rev B supports 3.3 V I/O only.”

### Open Source RTL

The FE310 is the first open source CPU which is also commercially available RISC-V SoC. SiFive has contributed the FE310 RTL code to the open source community. Now you can see what’s inside the chip and completely understand how the hardware works.

By releasing the RTL code, SiFive wants to encourage open source development of both software that runs on RISC-V, as well as new RISC-V-based hardware.

The RTL code empowers chip designers with the ability to customize their own SoC on top of the base

FE310. For system architects, developers, or companies without chip design capabilities, SiFive's "chips-as-a-service" can customize the FE310 to meet their unique needs.

### More Peripherals

With this second-generation version, the FE310 chip now has a built-in hardware I<sup>2</sup>C peripheral and an extra UART (two total), which opens the door to connecting to all sorts of third-party sensors, actuators, and other devices. In addition, the USB debug interface has been upgraded to Segger J-Link.

### Wireless Co-processor

The HiFive1 Rev B board has both Wi-Fi and Bluetooth capabilities, thanks to a single-core ESP32 co-processor (ESP32-SOLO-1) that serves as a wireless modem for the FE310-G002 processor.



Figure 2: HiFive1 Rev B01 board (top and bottom view)

## FreeRTOS

FreeRTOS is an open source, real-time operating system for microcontrollers that makes small, low-power edge devices easy to program, deploy, secure, connect, and manage. Distributed freely under the MIT open source license, FreeRTOS includes a kernel and a growing set of software libraries suitable for use across industry sectors and applications. This includes securely connecting your small, low-power devices to AWS cloud services like AWS IoT Core or to more powerful edge devices running AWS IoT Greengrass. FreeRTOS is built with an emphasis on reliability and ease of use.

### What's new in the chip?

	FE310-G000	FE310-G002
<b>CPU</b>	SiFive E31	SiFive E31
<b>RISC-V Debug Spec</b>	version 0.11	version 0.13
<b>Low-power Sleep Mode</b>	No	Yes
<b>Always-on Domain</b>	1.8 V	3.3 V
<b>Hardware I<sup>2</sup>C</b>	None	1
<b>UART</b>	1	2
<b>QSPI/SPI</b>	1/1 with 3 chip selects	1/1 with 3 chip selects
<b>PWM</b>	9	9
<b>GPIO</b>	19	19

### What's new on the dev board?

	Original HiFive1	HiFive1 Rev B
<b>Processor</b>	SiFive FE310-G000	SiFive FE310-G002
<b>USB Debug</b>	FTDI FT2232	Segger J-Link
<b>Wireless Network</b>	None	Wi-Fi & Bluetooth
<b>Low-power Domain</b>	No	Yes
<b>I/O Voltage</b>	3.3 V, level-shifted 5.0 V	3.3 V
<b>Code Storage*</b>	16 MB QSPI NOR Flash	4 MB QSPI NOR Flash
<b>Form Factor</b>	68 x 51 mm	68 x 51 mm

\* The original HiFive1's 16 MB of code storage was overkill — there's still plenty of room in 4 MB.

A microcontroller contains a simple, resource-constrained processor that can be found in many devices, including appliances, sensors, fitness trackers, industrial automation, and automobiles. Many of these small devices can benefit from connecting to the cloud or locally to other devices, but have limited compute power and memory capacity and typically perform simple, functional tasks. Microcontrollers frequently run operating systems that may not have built-in functionality to connect to local networks or the cloud, making IoT applications a challenge. FreeRTOS helps solve this problem by providing the kernel to run low-power devices as well as software libraries that make it easy

to securely connect to the cloud or other edge devices, so you can collect data from them for IoT

## Amazon S3

Amazon Simple Storage Service (Amazon S3) is an object storage service that offers industry-leading scalability, data availability, security, and performance. This means customers of all sizes and industries can use it to store and protect any amount of data for a range of use cases, such as websites, mobile applications, backup and restore, archive, enterprise applications, IoT devices, and big data

### How it works —S3 Access Points

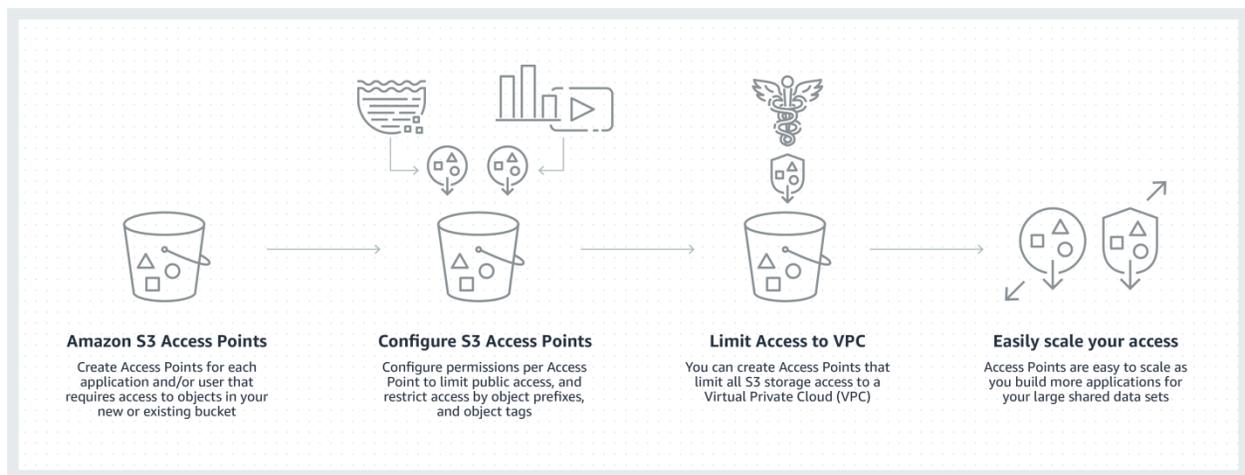


Figure 3: Amazon S3 Access Points

Amazon S3 Access Points simplifies managing data access at scale for applications using shared data sets on S3. With S3 Access Points, you can now easily create hundreds of access points per bucket, representing a new way of provisioning access to shared data sets. Access Points provide a customized path into a bucket, with a unique hostname and access policy that enforces the specific permissions and network controls for any request made through the access point.

### Advantages of using Amazon S3

Amazon S3 is intentionally built with a minimal feature set that focuses on simplicity and robustness. Following are some of the advantages of using Amazon S3:

- **Creating buckets** – Create and name a bucket that stores data. Buckets are the fundamental containers in Amazon S3 for data storage.
- **Storing data** – Store an infinite amount of data in a bucket. Upload as many objects as you like into an Amazon S3 bucket. Each object can contain up to 5 TB of data. Each object is stored and retrieved using a unique developer-assigned key.
- **Downloading data** – Download your data or enable others to do so. Download your data anytime you like, or allow others to do the same.
- **Permissions** – Grant or deny access to others who want to upload or download data into your Amazon S3 bucket. Grant upload and download permissions to three types of users. Authentication mechanisms can help keep data secure from unauthorized access.
- **Standard interfaces** – Use standards-based REST and SOAP interfaces designed to work with any internet-development toolkit.

applications and take action.

analytics. Amazon S3 provides easy-to-use management features so you can organize your data and configure finely-tuned access controls to meet your specific business, organizational, and compliance requirements. Amazon S3 is designed for 99.999999999% (11 9's) of durability, and stores data for millions of applications for companies all around the world.

Note: SOAP support over HTTP is deprecated, but it is still available over HTTPS. New Amazon S3

## **SH Consulting Demo**

In SH Consulting's demo, HiFive1 Rev B board, from SiFive using RISC-V CPU core, we ported FreeRTOS on RISC-V to control IoT devices – on-board LEDs for example, and update status to Amazon Web Service S3. The board uses a WiFi module (ESP32-SOLO-1 onboard chip) to connect to AWS S3. User can remotely turns on/off LEDs via Internet by an Android smart phone which has already installed a control application and connected to Internet. This demo shows you how to build an IoT applications on the HiFive1 Rev B board and

features will not be supported for SOAP. We recommend that you use either the REST API or the AWS SDKs.

accelerated AWS S3 services. Starting with this IoT demo, IoT developers can easily complete their IoT service projects using only high-level languages and high-level APIs.

Since 2014, SHC has been an embedded connectivity specialists providing stabilities to embeds systems of many mass-produced systems. Frequently the source of instability reside in both the IoT's internal and its local gateways such as Windows, IOS, and Android. The engineers are ready to handle those situations frequently appear on mass-produced IoT systems.