V1.0 2608

T1000 Series Embedded RF Transmitter Quick Start Guide

HAROGIC

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Contents

1. Document Purpose and Scope

This document is intended to help users complete the initial setup and operation of the embedded RF transmitter. By following this guide, users should be able to power on the device, establish a network connection, access the embedded host, connect the control software, use SGStudio to generate RF signals and waveforms, configure modulation modes and Fast Waveform mode, run API examples, and check GNSS, PPS, timestamp, and trigger-related status.

Item	Description
Applicable Model	T1060
Core Tasks	Complete device power-on, network connection, software connection, RF signal generation and transmission, modulation and Fast Waveform operation, and the first API example within 30 minutes
Related Documents	T1000 Series User Manual, SGStudio User Guide, H2 API Programming Guide, and H2 API Example User Guide

2. Operating Environment Requirements

The T1000 uses 1GbE Ethernet for remote control, data transfer, and API access. The control software and API client can run on a host computer or, depending on the factory system image, on the T1000 embedded host. The following table lists the recommended operating environment. For systems below the recommended configuration, actual performance should be determined through testing.

Table 1 Operating Environment Requirements

Operating System	Windows 11/10 (requires VS2019 C++ redistributables)
Architecture	Windows: x64
Processor	Intel i3 or higher
Memory	8 GB; 16 GB is recommended when generating digitally modulated waveforms with PN > 15 to improve performance and processing aility
Storage	SSD recommended; sustained read/write speed greater than 250 MBytes/s
Data Interface	1GbE Ethernet interface; Streaming Mode is limited by the data interface bandwidth
Display Resolution	At least 1280 × 768 pixels
Other	Some antivirus software may prevent the system from operating properly

3. Safety and Precautions Before Use

3.1 Power Adapter Selection

1. **Adapter Selection:** Use the original power adapter supplied with the device. The POWER port uses a USB Type-C connector. Only use the supplied power adapter and cable that match the voltage, current, and power delivery protocol specified on the device nameplate.
2. **DC Power Requirements:** The USB Type-C port supports wide-range voltage input. The voltage/current requirements are 9 V / 3 A or 12 V / 2.5 A.

Note: Using a power supply that does not meet the specified requirements may prevent the device from starting, cause unexpected restarts, or damage the device.

3.2 RF Output

The T1000 RF OUT and optional medium-power output use SMA(F) connectors with an impedance of 50 Ω. Before connecting external equipment to the RF output, ensure that any DC voltage present at the connection does not exceed 10 V.

3.3 Cooling and Installation Environment

Ensure adequate ventilation during operation and do not cover the heat-dissipation surfaces. When the device is installed in an enclosure, backpack, test box, or unattended node, provide sufficient airflow and evaluate the cooling conditions according to the ambient temperature.


T1060
10 MHz-6 GHz Tx1
Embedded RF Transmitter
HAROGIC
POWER
AUDIO
USB 3.0
HDMI
1 GbE
RF OUT 50Ω
GNSS Antenna

4. Unpacking and Interface Overview

4.1 Unpacking Inspection

Item	Quantity	Description
T1000 Series Unit	1	Refer to the device label for the specific model.
Power Adapter	1	35 W PD power adapter with a single USB Type-C port
Power Cable	1	Connects the USB Type-C port of the power adapter to the POWER USB Type-C port of the T1000 Series unit.
1GbE Ethernet Cable	1	Used to connect to a host computer, network switch, or LAN.
Documentation USB Flash Drive	1	Contains the product manual, user manual, software, drivers, SDK, example applications, and other materials.

4.2 Interface Overview

Interface	Purpose	Required for Initial Use
RF OUT, SMA (F)	RF signal output, 50 Ω	Yes
HP OUT, SMA (F)	Medium-power RF signal output, maximum 25 dBm, 50 Ω	No
LF OUT, SMA (F)	Reserved interface	No
Power	Device power input; USB Type-C wide-range input, 9 V / 3 A or 12 V / 2.5 A	Yes
1GbE	LAN interface for remote control, data transfer, and API access. Recommended as the primary connection for initial use.	Yes
HDMI	Micro HDMI interface for connecting a display during standalone operation.	Optional
USB 3.0	Peripheral and storage expansion for standalone operation; use of a USB hub is recommended.	Optional
RI	External reference input, MMCX(F), amplitude ≥ 1.5 Vpp, input impedance 200 Ω	Optional
RO	Reference clock output, MMCX(F), output impedance 50 Ω, 100 MHz	Optional
AU	Reserved interface	No

AUXIO	Multifunction I/O interface supporting GPIO, triggering, and expansion functions. For detailed pinout information, refer to the *T1000 Series User Manual*.	Optional
GNSS	GNSS antenna input, SMA(F)	Optional
Device Status Indicator	Only one indicator color is displayed at a time. Green: Normal status; Red: Abnormal status; Yellow: Remote update failure.	Yes

4.3 Product Documentation Overview

Document	Purpose
HAROGIC T1000 Series RF Transmitter Product Manual	Provides a product overview, key features, application areas, and technical specifications.
HAROGIC T1000 Series RF Transmitter Quick Start Guide	This document. Provides a quick-start guide for the initial setup and operation of the product.
HAROGIC T1000 Series RF Transmitter User Manual	Provides the complete T1000 user workflow, including interfaces, power supply, network configuration, desktop software, IQ, GNSS, triggering, and hardware/software troubleshooting.
HAROGIC H2 API Programming Guide	Provides detailed H2 API/SDK programming instructions and API usage for application development.
HAROGIC H2 API Example User Guide	Provides instructions for using the API example applications, including C/C++, C#, Python, MATLAB, and other examples.
HAROGIC SGStudio User Guide	Provides detailed instructions for the software supplied with T Series products, including transmitter hardware configuration and verification, signal and waveform generation, modulated signal generation, and custom IQ waveform playback. For initial use, it is recommended to read the HAROGIC T1000 Series RF Transmitter User Manual first.

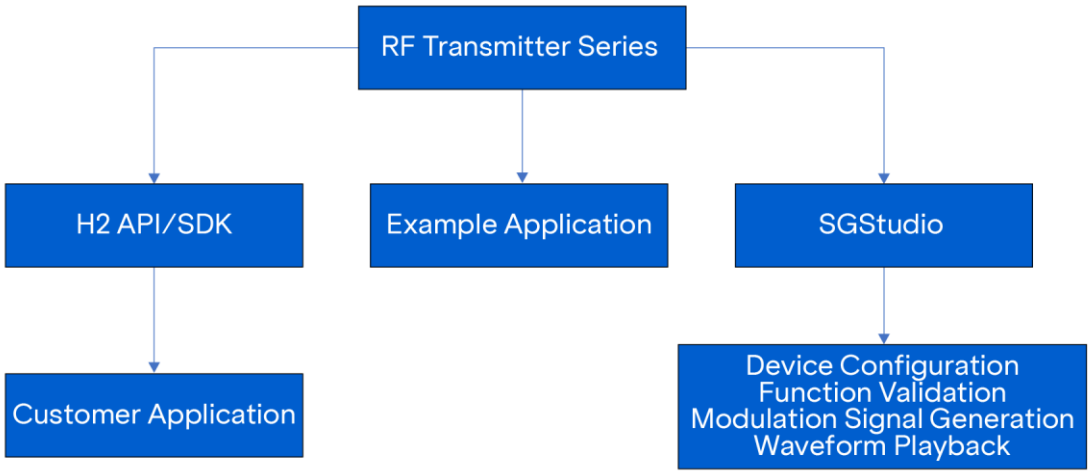


Figure 4-1 Relationship Between T1000 Series Software and SDK

5. Initial Connection and Power-On

5.1 Minimum Connection Setup

1. Place the T1000 on a stable, well-ventilated surface. Connect the supplied power adapter to the T1000 using the USB Type-C cable, and plug the adapter into a power outlet.
2. Connect the T1000 LAN (1GbE) port directly to the computer using an Ethernet cable. The interface operates at 1 Gbps. It is recommended to confirm that the computer also has a 1GbE Ethernet port to ensure maximum data throughput. The default IP address is 192.168.1.100. The host computer generally needs to be configured with an IP address on the same subnet to establish a connection.
3. For standalone operation, Step 2 can be skipped. Connect a display to the HDMI port, and connect a USB Type-C hub to the USB 3.0 port for a keyboard and mouse.
4. If GNSS or time synchronization is required, connect a GNSS antenna and place it in a clear-sky environment with an unobstructed view of the sky.
5. After power is applied, the fan will briefly run at high speed. Wait for the system to complete startup.

Figure 5-1 T1000 Series Device Connection

6. Network Configuration and Host Access

6.1 Network Configuration

The T1000 can connect to a network through the 1GbE Ethernet (LAN) interface. When the T1000 Series is connected to a network, the built-in logic first searches for a DHCP server. If an active DHCP server is detected, an IP address is assigned automatically. If no DHCP server is detected, the device retains its default IP address of 192.168.1.100.

For the initial connection, it is recommended to configure the host computer on the same subnet as the T1000, as shown below.

Item	Default Value / Description
Static IPv4 Address	192.168.1.100
Subnet Mask	255.255.255.0
Example Host IP	192.168.1.102, Subnet Mask: 255.255.255.0, Gateway: 192.168.1.1

6.2 Verifying a Direct Connection to the Computer

- Open Windows "Settings " -> "Network & Internet" -> "Ethernet".
- Open the Ethernet settings, locate the IP settings, and click "Edit".
- Select "Manual", enable IPv4, set the IP address to "192.168.1.102", and set the subnet mask to "255.255.255.0".
- Open Command Prompt and run ping 192.168.1.100. If replies are received, the network connection has been successfully established.

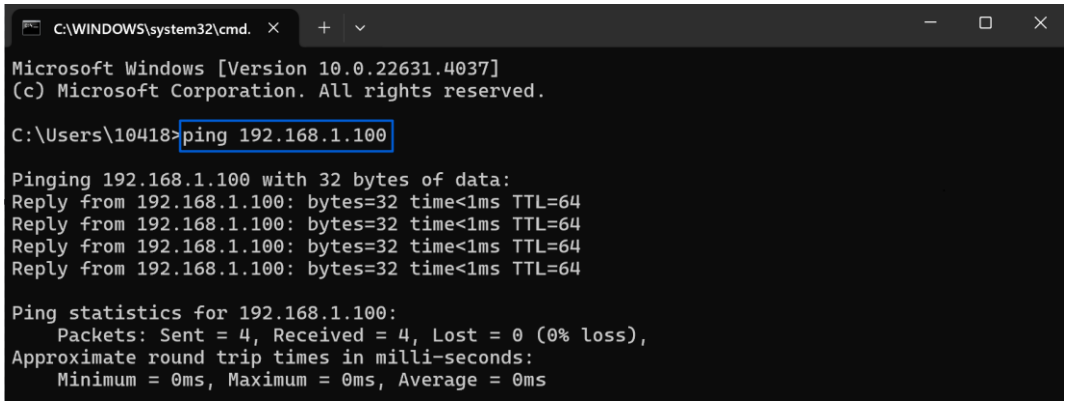


Figure 6-1 Verifying the Device Network Connection Using the ping Command

6.3 Logging In to the T1000 Embedded Host

The T1000 integrates a Raspberry Pi 5 host, which can be accessed via SSH or through a locally connected display.

The default SSH username is htra, and the default password is htra. MobaXterm is recommended as the SSH client.

ssh htra@192.168.1.100

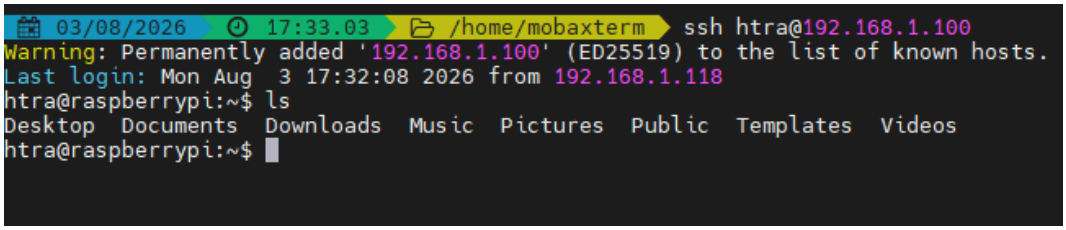


Figure 6-2 SSH Login Interface in MobaXterm

6.3.1 Network Configuration

The default network configuration of the T1000 Series is as follows:

- **IPv4 Address:** 192.168.1.100
- **Subnet Mask:** 255.255.255.0

6.3.2 Changing the Static IP Address

To change the default static IP address of the T1000 Series, follow the steps below. The following example sets the IP address to 192.168.1.100:

- Log in with the username root and the default password htra.
- Access the Raspberry Pi host via SSH and enter *hlc --set-static-ip 192.168.1.100/24* to set the IP address. A reboot is required for the new IP address to take effect.
- Enter *reboot* and wait for the system to restart. Note: The Raspberry Pi host must be logged in as the root user to perform the reboot.

Figure 6-3 Linux Commands for Configuring a Static IP Address on the Raspberry Pi 5

7. Launching the Software and Connecting to the T1000

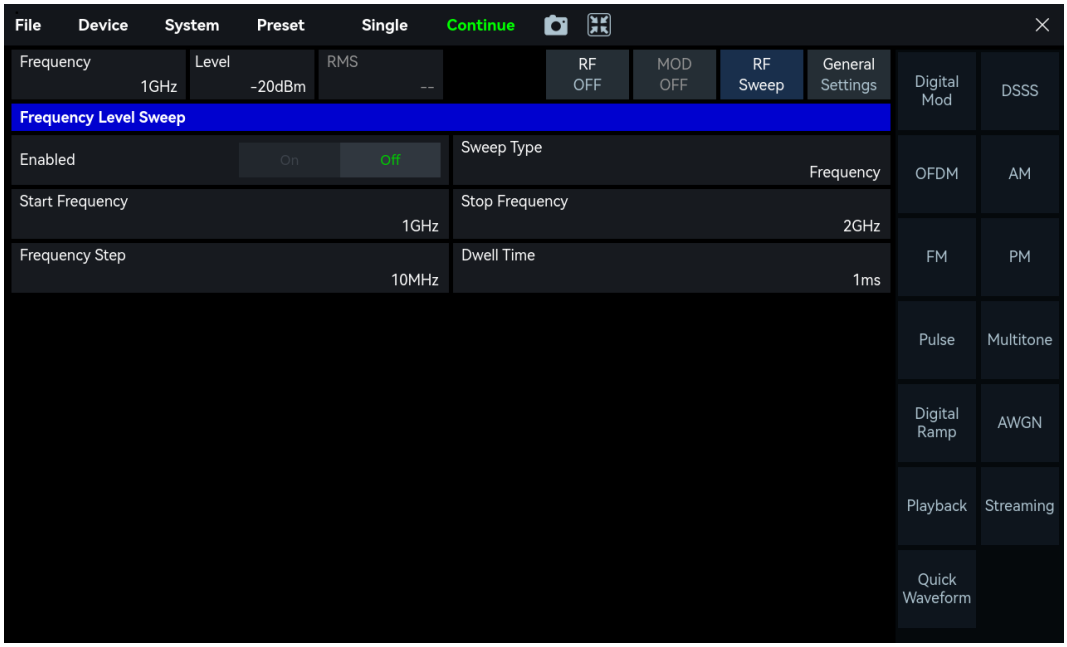
The T1000 can be controlled using SGStudio or the H2 API.

On a Windows host computer, SGStudio is included with the software package supplied with the product. The executable is located at:

SGStudio\SGStudio\bin\SGStudio.exe

7.1 Running the Software on a Host Computer

On the user's host PC, SGStudio or the H2 API can be used to connect to and control the T1000 through the 1GbE Ethernet interface. After SGStudio is launched successfully, the main interface appears as shown below.



SGStudio Interface During Normal Operation

Click Device on the menu bar, select ETH to connect to the device, and confirm the device IP address and local host address.

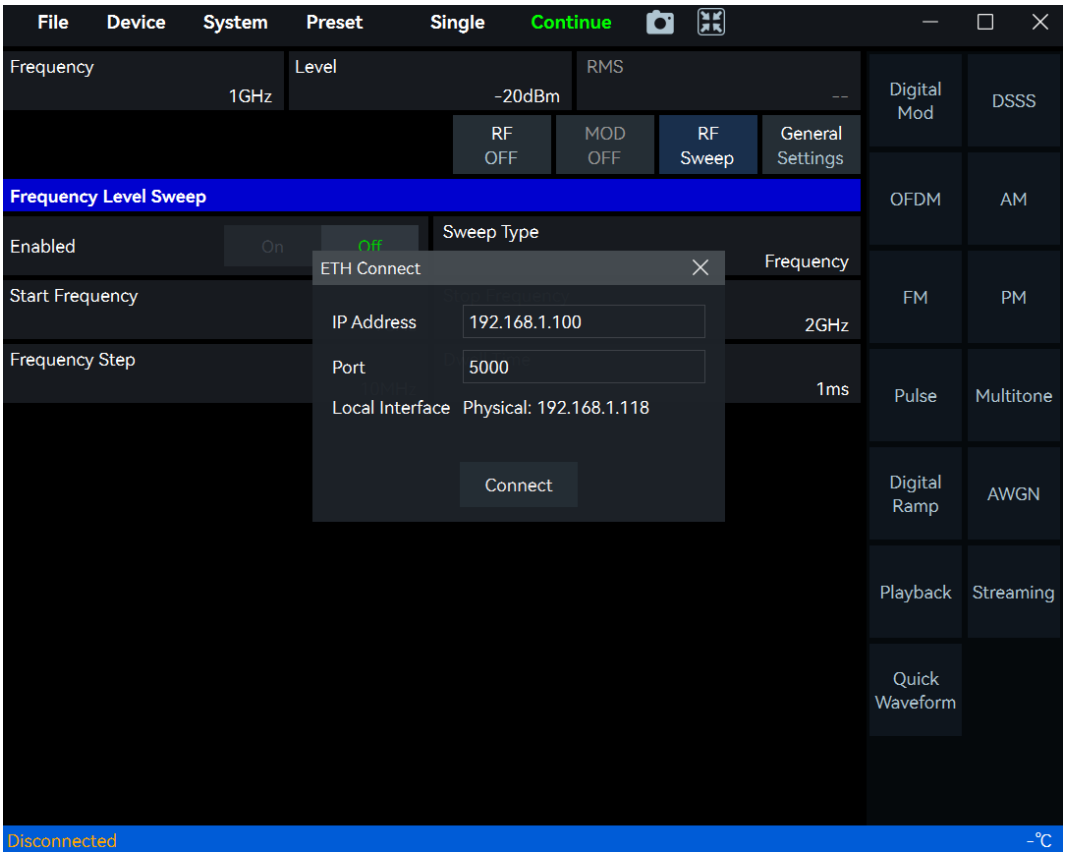


Figure 7-1 Connecting to the Device via ETH

In the example above, the status bar at the bottom of the interface displays the following information from left to right: ETH IP address, device UID, device core model, hardware version, MCU version, FPGA version, API version, GUI version, and instrument operating temperature.

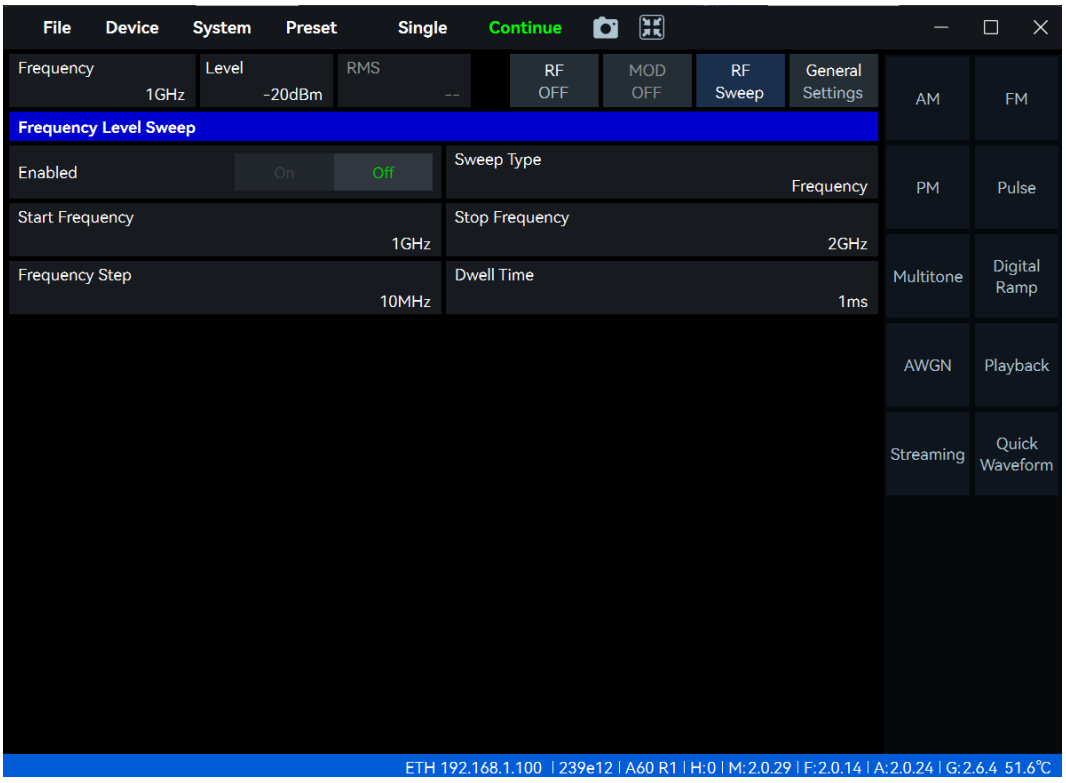


Figure 7-2 Status Information Bar

Click System -> About on the menu bar to view the device model, serial number, software version, and hardware version.

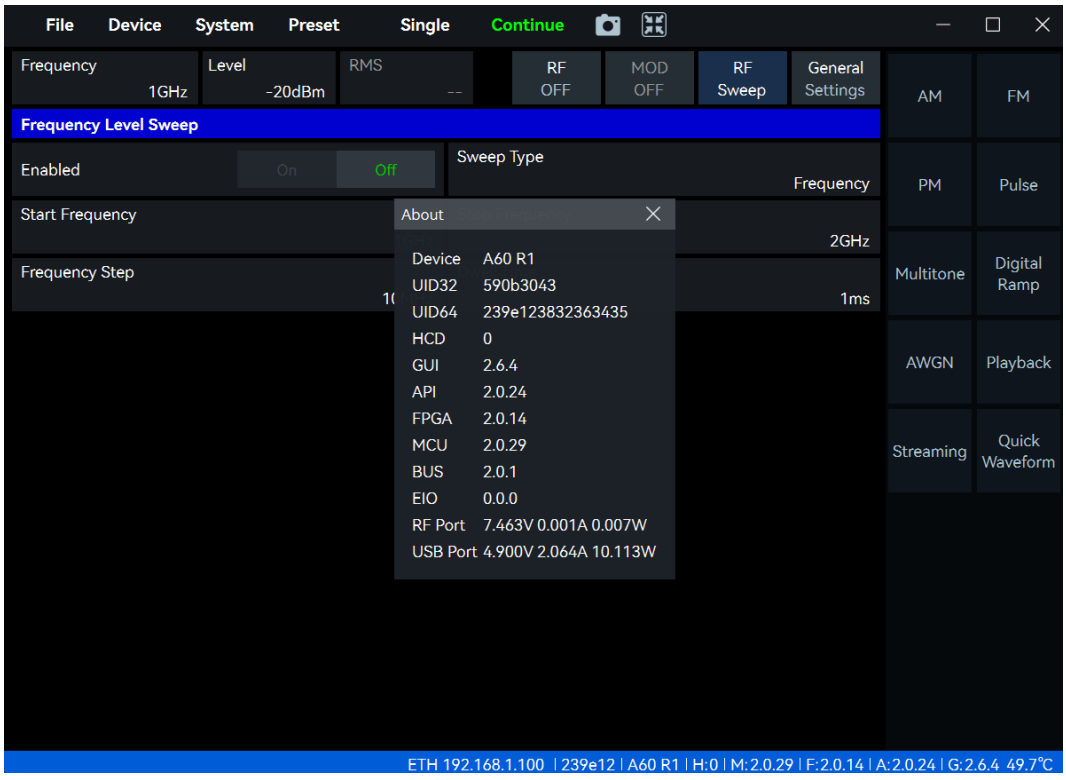


Figure 7-3 Device Model, Software Version, API Version, and Firmware Information

7.2 Standalone Operation (Running the Software on the T1000 Raspberry Pi)

Close all software described in Section 7.1. Connect the HDMI interface to a display, connect a USB Type-C hub to the T1000 USB 3.0 interface, and connect a keyboard and mouse to the hub.

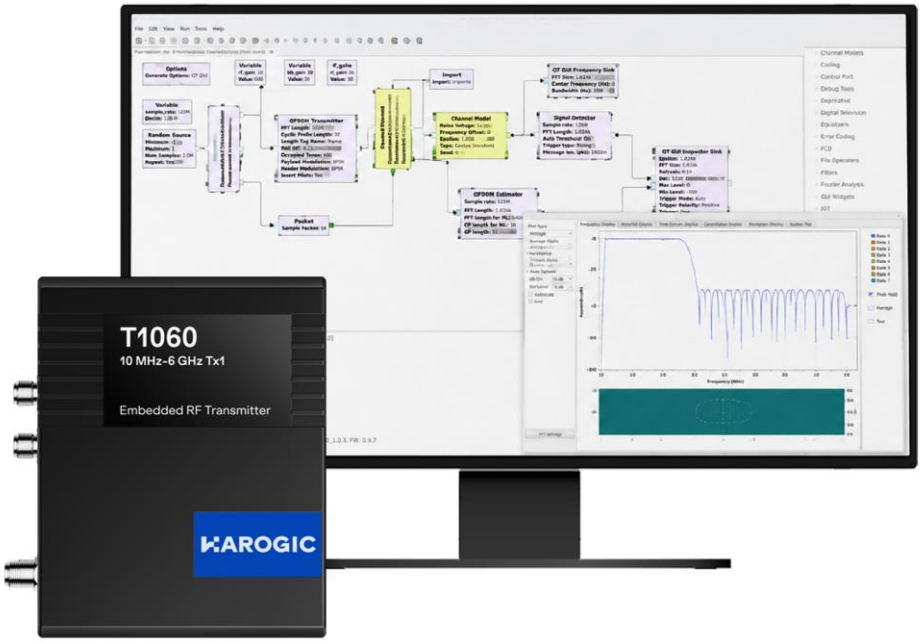


Figure 7-4 GNU Radio Development Environment Running on the T1000 Host

After power-on, the system automatically enters the desktop. Double-click the SGStudio icon in the upper-left corner of the desktop. SGStudio will launch and connect to the device automatically.

8. RF Signal Generation

The following example demonstrates operation from a host computer. Connect suitable RF measurement equipment or an antenna to the T1000 RF OUT, launch SGStudio, and click RF ON using the following example settings:

Parameter	Example Value
Frequency	1 GHz
Level	-20 dBm

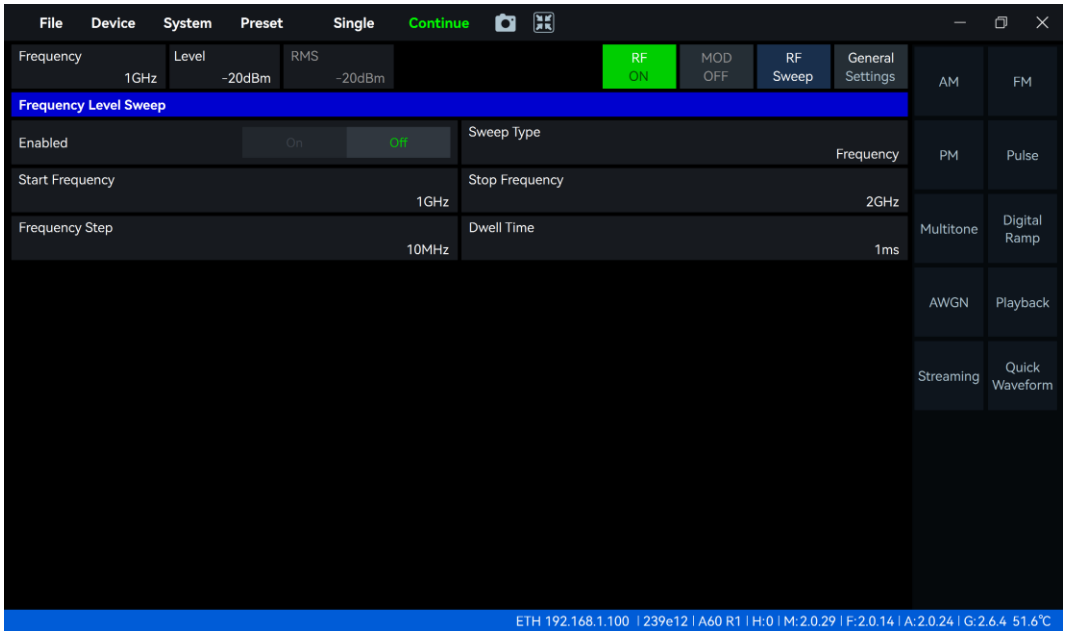


Figure 8-1 Enabling RF ON in SGStudio

A HAROGIC R1090 RF Receiver can be used to observe the output signal.

Figure 8-2 IQ Streaming Test Results Measured with the R1090 RF Receiver

9. Modulated Signal Generation

The T1000 supports modulated signal generation, including single tone, multitone, frequency sweep, power sweep, amplitude modulation, frequency modulation, phase modulation, pulse modulation, digital ramp sweep, Gaussian white noise, IQ playback, and real-time IQ streaming.

9.1 Generating an FM Signal Using SGStudio

The following example generates an FM signal with a carrier frequency of 1 GHz, peak power of −20 dBm, modulation rate of 5 kHz, frequency deviation of 75 kHz, and a sine-wave modulation waveform.

Parameter Description: The following table describes the key frequency modulation parameters.

Table 9-1 Frequency Modulation Parameter Description

Frequency Modulation	
Modulation Rate	Specifies the FM modulation frequency.
Frequency Deviation	Sets the maximum deviation of the instantaneous carrier frequency from the center frequency during modulation.
Signal Type	Sine/Square/Triangle/Ramp

Operating Procedure

1. Click "FM" in the Mode Selection Area;
2. In the Frequency Modulation Control Area, set "Modulation Rate" to 5 kHz, "Frequency Deviation" to 75 kHz, select "Sine" as the Signal Type, and enable frequency modulation;
3. Set the carrier "Frequency" to 1 GHz and "Power" to −20 dBm, and enable the RF output;
4. The signal generator outputs an FM signal with a carrier frequency of 1 GHz, peak power of −20 dBm, modulation rate of 5 kHz, frequency deviation of 75 kHz, and a sine-wave modulation waveform.

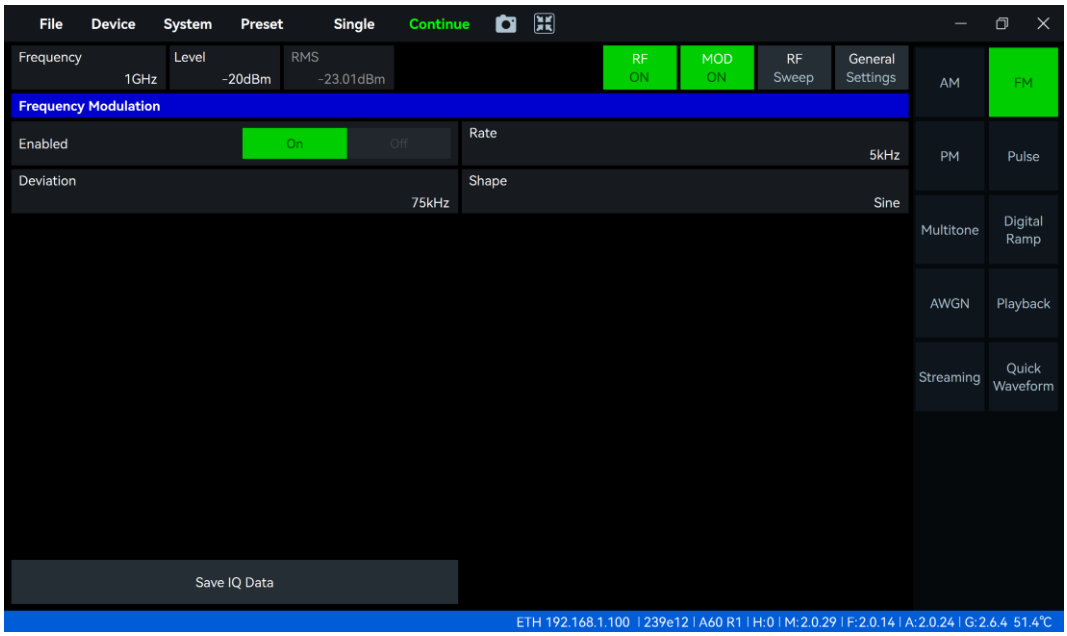


Figure 9-1 FM Signal Generation Using SGStudio

5. Connect the SMA RF output directly to the RF input of an R1000 Series RF Receiver to observe the IQ stream and time-frequency waterfall of the generated signal.

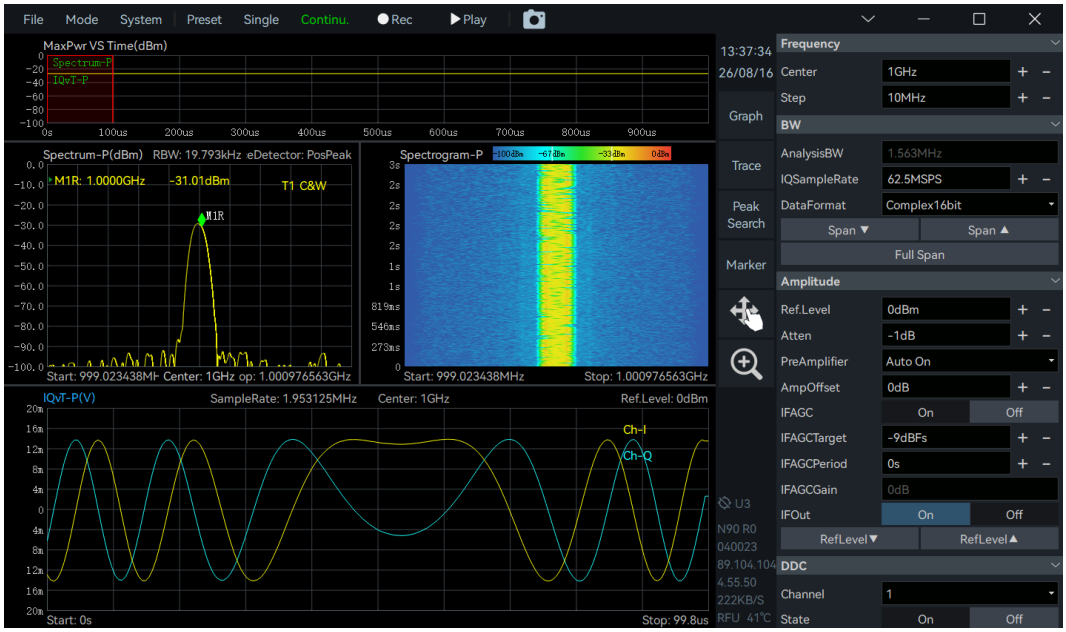


Figure 9-2 T1060 RF Output Observed with an R1000 Series RF Receiver Using SAStudio

10. Quick Waveform and IQ Playback

The T1000 supports IQ waveform playback. Quick Waveform mode provides a selection of preset waveform files in .wav format, allowing the required waveform to be selected and output quickly. The preset waveforms include common digital modulation signals such as ASK, DPSK, FSK, PSK, and QAM, as well as three wireless protocol signals for quick access.

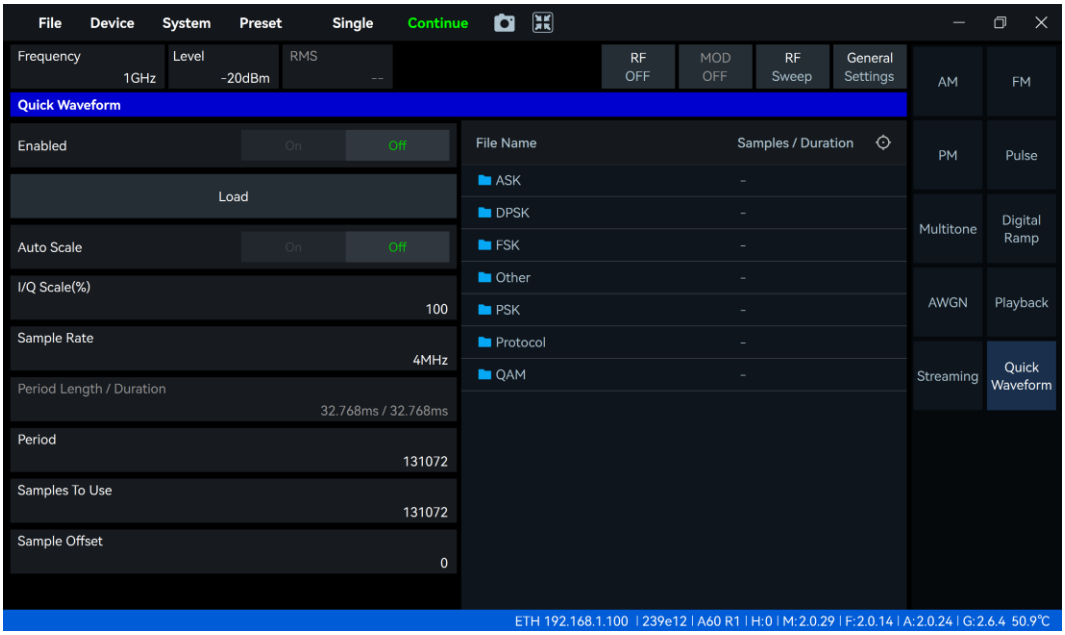


Figure 10-1 Typical Waveform Playback Interface Using the Quick Waveform Function in SGStudio

10.1 Playing Back a Preset Waveform Using SGStudio

This section uses a preset Bluetooth signal as an example to introduce the basic operation of "Quick Waveform" mode.

1. Select "Quick Waveform" in the Mode Selection Area;
2. Select "Protocol/Bluetooth_7.5 MHz.wav" from the file list and click "Load File" to load the selected waveform into the T1060 internal memory;
3. After the file is successfully loaded, the software automatically parses and displays parameters such as the sample rate, total number of samples, and signal duration. Adjust the parameters as required and enable "Quick Waveform" mode;
4. Set the carrier frequency to 2.4 GHz and the peak power to −20 dBm, and enable the RF output;

5. The T1060 then outputs the preset Bluetooth waveform at a carrier frequency of 2.4 GHz and a peak power of −20 dBm.

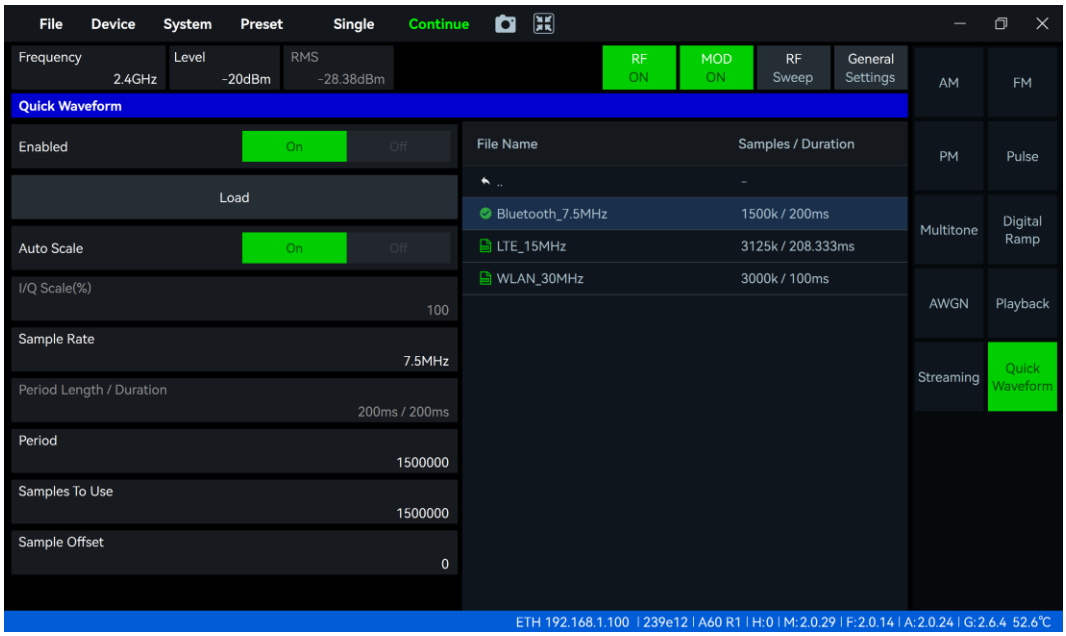


Figure 10-2 Quick Playback of a Bluetooth Waveform

6. Connect the T1060 RF output directly to the RF IN of an R1000 Series RF Receiver using an RF cable to observe the signal in SAStudio. Set the receiver to IQ Streaming mode, enable the time-frequency waterfall in Graph, set the center frequency to 2.4 GHz, and set the reference level to −10 dBm.

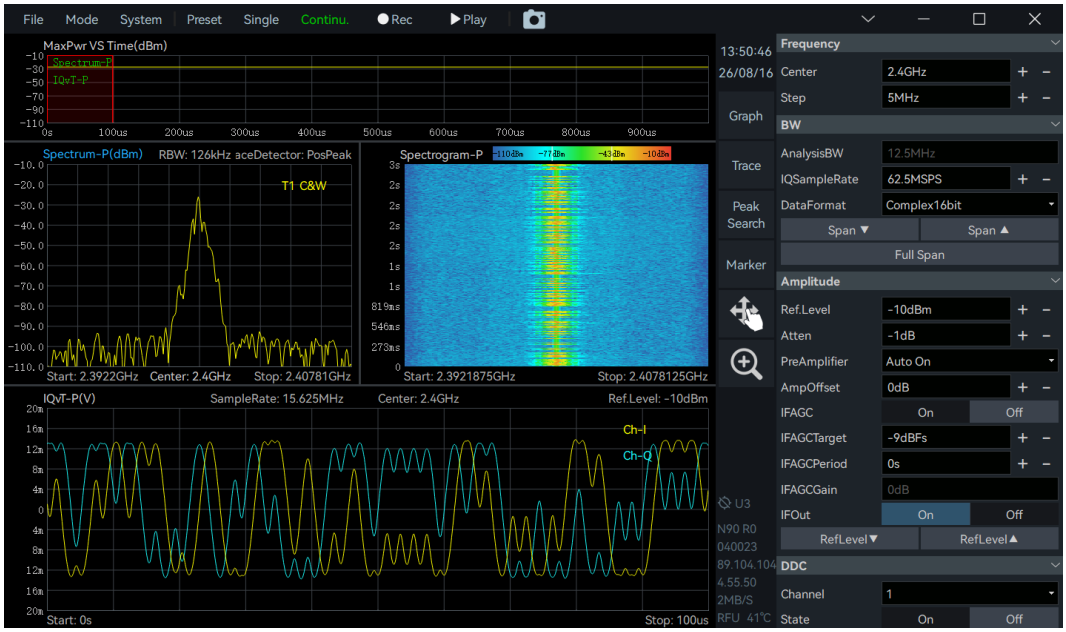


Figure 10-3 Signal Acquired by an R1000 Series RF Receiver in SAStudio IQ Streaming Mode

11. Locating the API Example Applications

The API example applications and the corresponding API Example Application Guide are provided on the USB flash drive supplied with the product. To obtain the latest API and example applications, visit the download center on the HAROGIC website.

The API package provides signal generation examples for C++, C#, Python, MATLAB, and Qt. The following uses C++ as an example.

Software Option: H2 API

Description: Provides APIs for interacting with T1000 Series devices and supports standard CPU host operations required by most applications.

Use Cases: Device discovery, RF transmitter configuration, RF signal generation, modulated signal generation, IQ waveform playback, and other applications.

Location:

Windows\example\Cpp_Examples\C++_Example

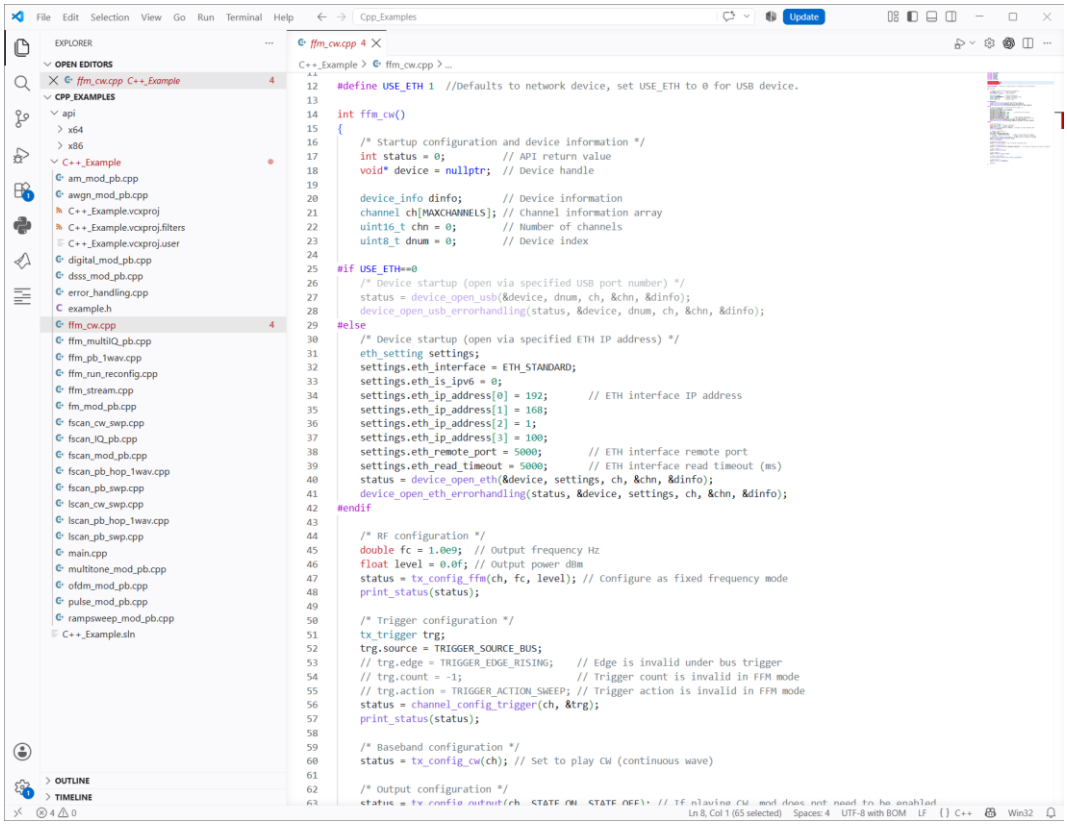


Figure 11-1 C++ Example Code for CW Signal Generation Opened in VS Code

12. Common Issues and Quick Troubleshooting

12.1 ice Does Not Power On

Check whether the green power indicator is illuminated. A brief fan sound can normally be heard after power-on. Confirm that the power adapter is a HAROGIC-recommended model, the power cable is securely connected, and the power input specifications match the current hardware version. Also check the device for abnormal heating or odor. If the issue persists, contact HAROGIC Technical Support.

12.2 Unable to Access the T1000 over the Network

Confirm that a 1GbE Ethernet cable is being used and that the computer is connected to a 1GbE LAN port. Ensure that the host computer and the T1000 are configured on the same subnet as described in this guide. Also check whether the firewall is blocking the software connection.

12.3 SGStudio Cannot Detect the Device

Ensure that the SGStudio version is 2.6.4 or later. From the Device drop-down menu, select Connect ETH Device, confirm the IP address, and then connect to the device. After a successful connection, the status bar at the bottom of the software interface displays device information such as the device status, IP address, and UID.

If the connection fails, check whether the device can be reached using ping. If the device responds to ping but SGStudio still cannot connect, restart the T1000, wait approximately 3 minutes, and try again.

12.4 No RF Signal Output

If no RF signal is output after clicking RF ON in SGStudio, first confirm that the device has been successfully connected to SGStudio.

12.5 GNSS Does Not Lock

Confirm that the GNSS antenna is properly connected and placed in a clear-sky environment with an unobstructed view of the sky. Allow sufficient time for GNSS to acquire lock, and confirm whether the antenna requires active power.

12.6 Custom Raspberry Pi System Images

The T1000 Series uses an ultra-compact hardware design and currently does not support user-defined Raspberry Pi system images. Do not install or flash a custom Raspberry Pi system image, as this may prevent the device from booting properly and may invalidate RF parameters. If you encounter system-related issues, contact HAROGIC Technical Support

13. Further Reading

Task	Document
Learn about the complete product operation, including interfaces, power supply, network configuration, desktop software, GNSS, triggering, and other functions	HAROGIC T1000 Series RF Transmitter User Manual
Develop applications using GNU Radio and obtain the latest GNU Radio and SoapySDR examples via Git (continuously maintained)	HAROGIC Git Repo.
Learn the complete operation of SGStudio	HAROGIC SGStudio User Guide
Develop applications	HAROGIC H2 API Programming Guide
Run example applications	HAROGIC H2 API Example User Guide

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