



EmuCore User Manual

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Warning

⚠ Safety Warnings: Before working on any equipment, it is crucial to be aware of the hazards involved with electrical circuitry and to be familiar with standard practices to prevent accidents. Follow these safety guidelines to ensure safe operation and installation of your EmuCore device. Handle the ultimate disposal of this product in accordance with all national laws and regulations. Ensure that the installation of the equipment complies with local and national electrical codes. This product is intended for indoor installation only. Keep it away from water, fire, humidity, and hot environments to prevent damage and ensure safe operation. Use only the power supply and accessories approved by the manufacturer, which are provided in the original packaging of this product. Carefully read the installation instructions before connecting the system to the power source to ensure proper setup and to avoid potential hazards. We cannot guarantee that no accidents or damage will occur due to improper use of the device. Please use this product with care and operate at your own risk. In the event of device failure, disconnect it from power immediately. The fastest way to do so is by unplugging the power plug from the power outlet. It is the customer's responsibility to follow local country regulations regarding the installation and use of this product. By following these safety warnings, you can help ensure the safe and effective operation of your EmuCore device. If you have any questions or concerns, please contact our customer support team for assistance.

⚠ Non-Compliance Notice: This device has not yet passed CE or FCC emissions certification testing, so it might not be compliant with industry standards and regulations. Users should take appropriate precautions and use the device at their own risk.

Future Compliance Updates: QCi is committed to continuous improvement and may release updates or revisions to enhance compliance with standards and regulations. Users are advised to regularly check for updated documents on our website and follow any recommendations provided by Quantum Computing Inc.

Contact Information: All questions or concerns regarding the compliance status or safe use of this device should be directed to the QCi customer support team.

1 Get started

1.1 What's in the Box?

- EmuCore Device
- Micro USB cable
- USB-C DC Power Adapter
- AC Power Cord (will vary by country)

If any of the parts are incorrect, missing, or damaged, contact your QCi Support representative or reseller. Keep the carton, including the original packaging material, in case you need to return the product for repair.

1.2 Label

View the label on the back of the package box to identify the serial number and mac address details.



Figure 1: Label

1.3 Back of EmuCore

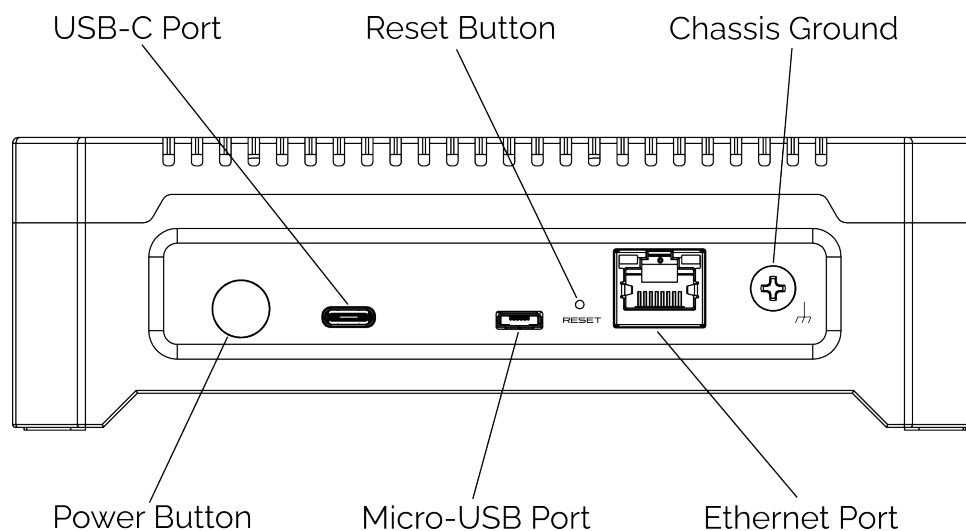


Figure 2: Back of EmuCore

1.3.1 Device Interfaces

From left to right, along the back face of the device, you will find the following interfaces:

- **Power Button:** Used to turn the device on or off.
- **USB-C Port:** Used for powering the device.
- **Micro-USB Port:** Used for firmware updates.
- **Device Reset Button:** Located through a pinhole, used for resetting the device if it hangs.
- **Ethernet Port:** Communication interface.
- **Chassis Ground:** Used for grounding the device.

1.3.2 Power Button Functionality

The power button has different functions based on how long you press it:

- **Short Press:** Safely shuts down the device, similar to turning off a computer. The device completes its tasks before powering off.

- **Long Press:** Cuts power to the device immediately, useful if the device is not responding.

The power button also has an internal LED that indicates when the device is powered correctly.

1.3.3 Reset Button

The reset button, located through a pinhole, can be used to reset the processor. Press the reset button once to reset a non responsive device.

1.3.4 Ethernet Port LED's

The Ethernet port has two built-in LED's, green and yellow, which indicate communication status. The table below describes the LED behaviors:

Green LED	Yellow LED	Link (Mbps)	Status
ON	OFF	1000	No Activity
BLINKING	OFF	1000	Activity (TX / RX)
OFF	ON	100	No Activity
OFF	BLINKING	100	Activity (TX / RX)
ON	ON	10	No Activity
BLINKING	BLINKING	10	Activity (TX / RX)

Table 1: Ethernet port LED status.

1.4 Top Of EmuCore

1.4.1 Device Status Indicator

On the top of the EmuCore device, the QCI logo indicates the current status of the device through different LED colors. See the table below for details:

Device Status	LED Color
Device Available (execution lock available)	White
Resetting Reservoir	Red
Modeling Data	Green
Device Unavailable(execution lock in use)	Blue

Table 2: Device status for LED colors displayed from EmuCore.

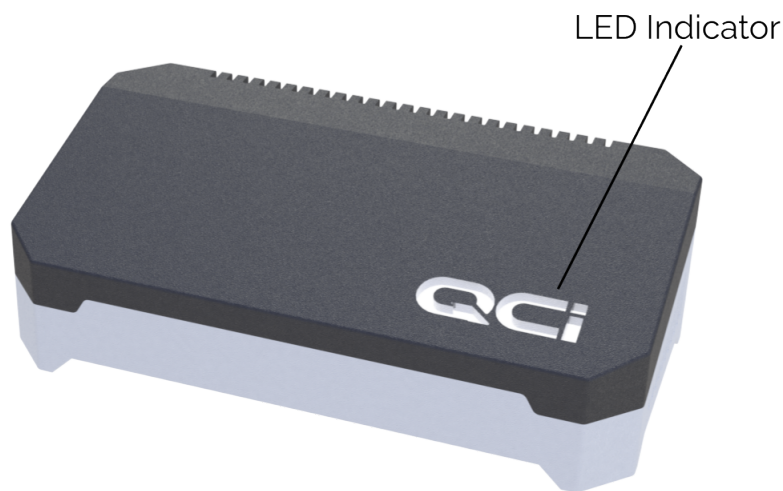
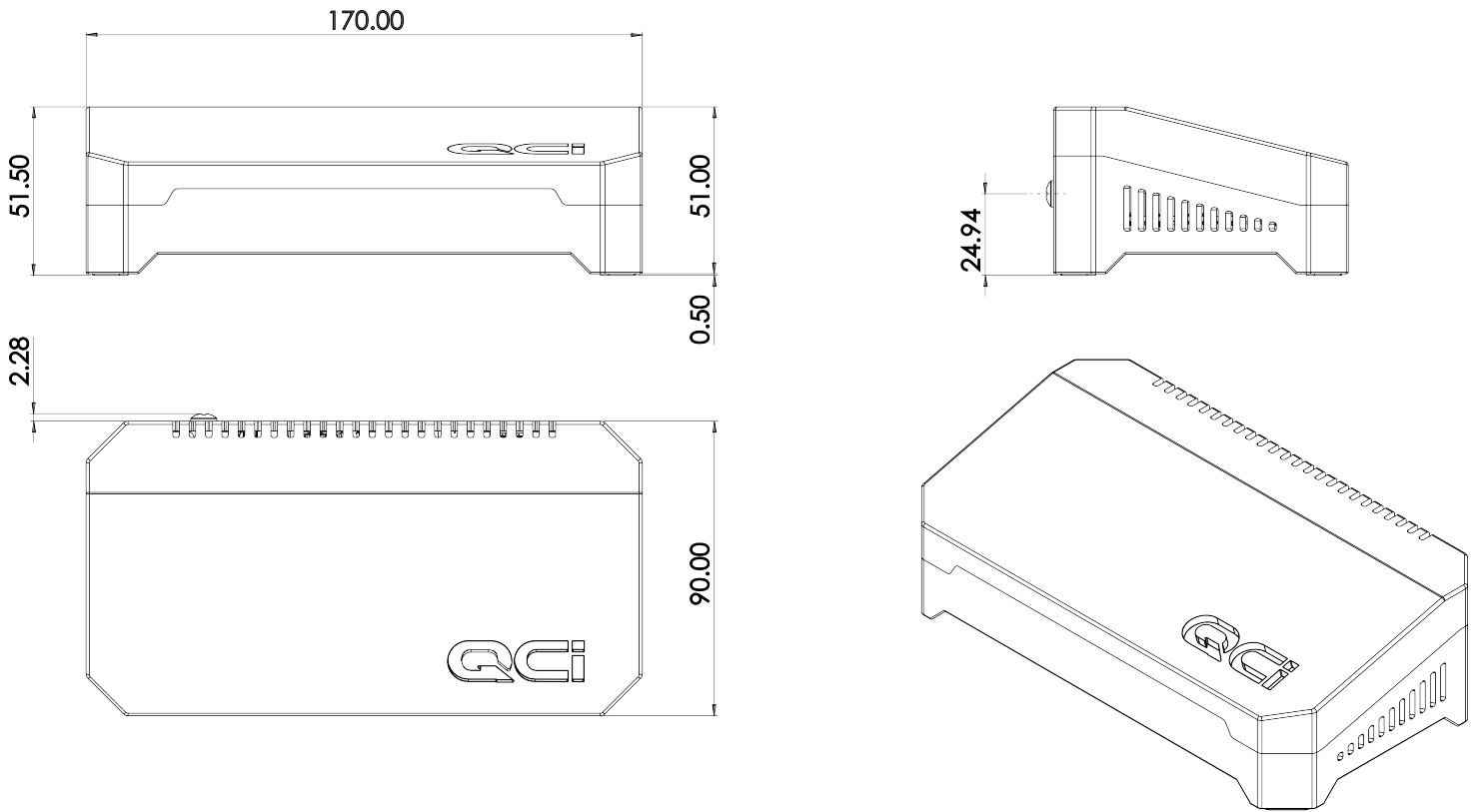


Figure 3: EmuCore LED Indicator

2 Mechanical Dimensions



All dimensions are in mm

Figure 4: Dimensions of EmuCore

3 Connecting EmuCore to a Network

This section explains how to connect your EmuCore device to a network in two different modes: Direct to Host and Via Router. Follow the instructions below to set up your device and find its IP address.

3.1 Direct to Host Mode

In this mode, the EmuCore device is connected directly to a host computer, which acts as a DHCP server. Here's how to set up the host as a DHCP server on windows operating systems:

3.1.1 Windows Setup

1. Download and Install Tftpd64:

- Download the Tftpd64 application from the official website: [Tftpd64 Download](#).
- Install the application by following the on-screen instructions.

2. Configure Tftpd64 as a DHCP Server:

- Open the Tftpd64 application.
- Go to the DHCP tab.
- Check the box next to DHCP Server to enable the DHCP server function.

3. Set Up DHCP Settings:

- IP Pool Starting Address: Enter the starting IP address for the DHCP pool (e.g., 192.168.1.100).
- Size of Pool: Enter the number of IP addresses in the pool (e.g., 50).
- Boot File: Leave this field blank unless you need to specify a boot file for network booting.
- WINS/DNS Server: Enter the IP address of your DNS server (usually the router's IP address).
- Default Router: Enter the IP address of your router (if applicable).
- Mask: Enter the subnet mask (usually 255.255.255.0).

4. Start the DHCP Server:

- Click the Save button to save the settings.
- Ensure that the Tftpd64 application remains open and running to serve as the DHCP server.

5. Finding the IP Address of EmuCore

Once the DHCP server is running, you can find the IP address assigned to the EmuCore device using the Tftpd64 application:

- In the Tftpd64 application, go to the **DHCP** tab.
- Look for the **DHCP Leases** section to find the IP address assigned to the EmuCore device.

3.2 Via Router Mode

In this mode, the EmuCore device is connected to a network via a router, which assigns the IP address to the device.

Setting Up the Connection

1. Connect the EmuCore device to the router using an Ethernet cable.
2. Ensure the router's DHCP server is enabled (usually enabled by default).

Finding the IP Address of EmuCore

You can locate the IP address assigned to your EmuCore device using the router's web interface or network commands. Follow the instructions below for each method.

Router Web Interface

1. Log In: Access the router's web interface, typically available at `http://192.168.1.1` or a similar address.
2. Check Connected Devices: Navigate to the section that displays connected devices. This is usually found under "Device List," "Connected Devices," or a similar heading.
3. Find EmuCore Device: Search *EmuCore* device in the "Device List". The IP address assigned to it will be displayed next to the device name "emucore".

Using Network Commands

You can also find the IP address using network commands on your host computer. This method varies slightly between Windows and Linux/Mac systems.

Windows

1. Open Command Prompt: Press `Win + R`, type `cmd`, and press `Enter`.
2. Execute Command: Type the following command and press `Enter`:

```
arp -a | findstr -i <MAC-Address>
```

Replace `<MAC-Address>` with the actual MAC address of your EmuCore device. The IP address associated with this MAC address will be displayed.

Linux/Mac

1. Open Terminal: On Linux, press `Ctrl + Alt + T`; on Mac, press `Cmd + Space`, type `Terminal`, and press `Enter`.
2. Execute Command: Type the following command and press `Enter`:

```
arp -a | grep -i <MAC-Address>
```

Replace `<MAC-Address>` with the actual MAC address of your EmuCore device. The IP address associated with this MAC address will be displayed.

4 Reservoir Modeling with EmuCore

This section provides a detailed guide on how to use the EmuCore Reservoir Computer for reservoir modeling. To ensure that your EmuCore server is accessible, you need to utilize the system monitoring capabilities of the Python package `emucore-direct`.

4.1 Installation

To install `emucore-direct` on your host computer, use the wheel file that can be downloaded from the web. Open your terminal and run the following command:

```
pip install emucore_direct
```

The package supports Python version 3.8, 3.9, and 3.10.

4.2 Verifying Connection

After powering on the device, the next step is to verify its availability for processing. You can do this using the `system_version` call from `emucore-direct` package to check if the connection to the device over the Ethernet cord has been established.

4.3 Basic Usage

For more detailed information on functions or usage patterns, refer to `emucore-direct` documentation.

The basic process for modeling using EmuCore involves feeding data to the reservoir sequentially, which creates an expanded representation based on the current reservoir configuration. This expanded representation is easier to model and may require simpler models to achieve good prediction results.

4.3.1 Example: Modeling a Sine Wave

To illustrate this process, we'll use a sine wave to demonstrate how the reservoir functions.

Step 1: Instantiate the Client

First, you need to instantiate the EmuCore client. Replace the values for `IP_ADDR` and `PORT` with those specific to your system:

```
#!/usr/bin/env python
from emucore_direct.client import EmuCoreClient
from time import time

IP_ADDR = "172.18.41.70"
PORT = "50051"
# Instantiate an EmuCore instance
ec_client = EmuCoreClient(ip_addr=IP_ADDR, port = PORT)
```

Step 2: Acquire the Execution Lock

Reservoirs require state during processing, so to prevent collisions, a locking mechanism is available. To acquire the execution lock, run:

```
lock_id, start, end = ec_client.wait_for_lock()
```

This function waits for the execution lock indefinitely until it becomes available.

Step 3: Configure the Reservoir Model

There are various parameters that can be tuned for better prediction results. Here's an example configuration:

```
vbias=0.3
gain=0.5
num_nodes=800
num_taps=400
input_scaling=0.33
density=0.5

ec_client.reservoir_reset(lock_id=lock_id)
print("Reservoir config")
# Configure
ec_client.rc_config(
    lock_id=lock_id,
    vbias=vbias,
    gain=gain,
    num_nodes=num_nodes,
    num_taps=num_taps,
)
```

Step 4: Generate and Split Data

Generate data from the sine wave and split it into training and testing sets:

```

import numpy as np
# predict for future values using lagged series
x = np.linspace(0, 6 * np.pi, 2400)
y = np.sin(x)
y_all = y[10:]
x_all = y[: (len(y)-10)]
x_all = x_all.reshape(-1,1)
trainInput = x_all[:len(x_all)//2]
testInput = x_all[len(x_all)//2:]
train_y = y_all[:len(x_all)//2]
test_y = y_all[len(x_all)//2:]
discard_size = 200
X_train = train_x[discard_size:, :]
y_train = train_y[discard_size:]

```

Step 5: Transform and Expand Data

Now that the reservoir is configured, use it to transform and expand the data:

```

train_x, trn_max_scale_val, trn_wgt = ec_client.process_all_data(
    input_data=trainInput,
    num_nodes=num_nodes,
    density=density,
    feature_scaling=input_scaling,
    lock_id=lock_id,
    seed_val_weights =13,
    max_scale_val=None)

test_x, test_max_scale_val, trn_wgt = ec_client.process_all_data(
    input_data=testInput,
    num_nodes=num_nodes,
    density=density,
    feature_scaling=input_scaling,
    lock_id=lock_id,
    seed_val_weights = 13,
    max_scale_val=trn_max_scale_val)

```

Next Steps

For further details and advanced configurations, refer to the [emucore-direct documentation](#). This guide provides a foundation for using EmuCore for reservoir computing, enabling you to leverage its capabilities for your modeling tasks.

5 Warranty

For warranty information and support services, please visit our [website](#) or contact our customer support team.

6 Troubleshooting and Support

If you encounter any issues with the EmuCore device or have questions about its operation, refer to this manual, the software package documentation, or contact our customer support for assistance at <https://quantumcomputinginc.ladesk.com/>

6.1 FAQ

What should I do if I can't access my EmuCore device at the identified IP address?

If connected to the device via ethernet check if ethernet cord is still connected and has not come loose. If connecting over network. Attempt to ping device IP address to see if it is accessible. If it is not accessible this may indicate that there are networking restrictions that have been configured in your private network that are blocking access to the device.