IRIV PiControl

IR4.0 CM4 Industrial Controller

Datasheet

Rev 1.0
July 2023

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1. Features

Features	Description
CPU	Broadcom BCM2711, Quad-Core Cortex-A72 64-bit SoC @ 1.5GHz
RAM	1GB/2GB/4GB/8GB
Storage	8GB/16GB/32GB eMMC, expandable via M.2 NVMe SSD
Wireless	2.4GHz / 5.0GHz IEEE 802.11 b/g/n/ac WiFi, Bluetooth 5.0, BLE
Interfaces	1x full size HDMI 2.0 (up to 4K@60Hz)
	2x USB 2.0 port
	1x USB-C (for boot and debug)
	1x RJ45 Gigabit Ethernet (10/100/1000M)
	1x RJ45 Ethernet (10/100M)
	4x isolated digital input (up to 50V)
	4x isolated digital output (up to 50V)
	4x isolated analog input (0-5V / 0-10V / 0-20mA, Common GND)
	1x isolated RS232
	1x isolated RS485
	1x M.2 Key-M socket for NVMe SSD
	1x mini PCIe socket for 4G/LoRa modules (Only USB2.0 & SPI signals are connected to this port. PCIe signal is not available).
Power Supply	DC 10-30V surge protected
Additional Features	PCF85063A Real Time Clock
	ATECC608B Crypto Authentication
	SSD1306 0.96” OLED Display
	1x reset button & 1x programmable button
	2x programmable LED
	1x active buzzer
Enclosure	Metal enclosure, fanless design, DIN rail mountable
Dimension	141.2mm x 83.5mm x 39.5mm (metal enclosure only, excluding antenna, DIN socket & connectors)

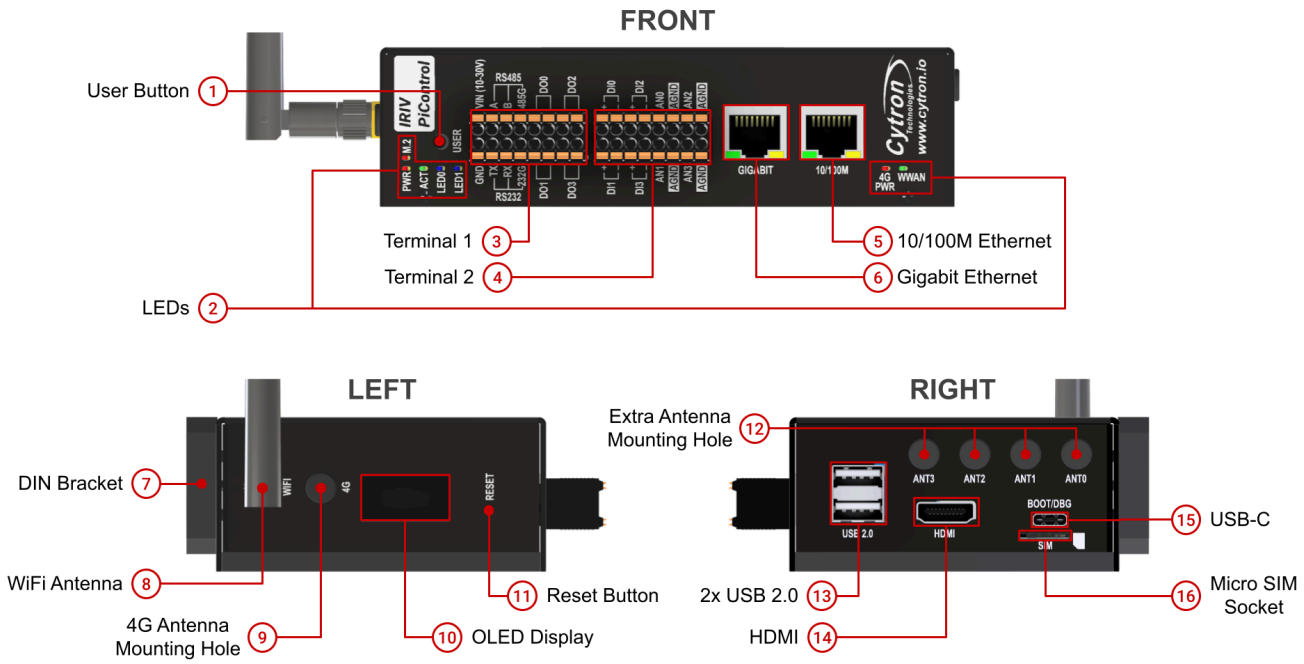
2. Specifications

No.	Parameters		Min	Max	Unit
1	Power Input Voltage	Terminal 1 (Surge Protected up to 60V 20ms)	10	30	VDC
		USB-C	4.9	5.2	VDC
2	Power Consumption ** USB load not included.*	When running stress test command *"stress-ng --cpu 4 --cpu-method fft"*	-	6	W
3	Isolated Digital Input	Low Level (V_{IL})	-50	0.8	V
		High Level (V_{IH})	3	50	V
		Isolation Voltage	3750		Vrms
4	Isolated Analog Input	Voltage Mode	0	10	V
		Current Mode	0	20	mA
		Input Impedance (Voltage Mode)	25		kΩ
		Input Impedance (Current Mode)	250		Ω
		Isolation Voltage	3000		Vrms
5	Isolated Digital Output	Voltage	-	50	V
		Current	-	500	mA
		Isolation Voltage	1500		Vrms
6	Isolated RS485	Maximum Baud Rate	500		kbps
		Isolation Voltage	5000		Vrms
7	Isolated RS232	Maximum Baud Rate	120		kbps
		Isolation Voltage	3000		Vrms
8	Operating Temperature *		-20	60	℃

** Guaranteed by components' specification. Not tested.*

3. Layout

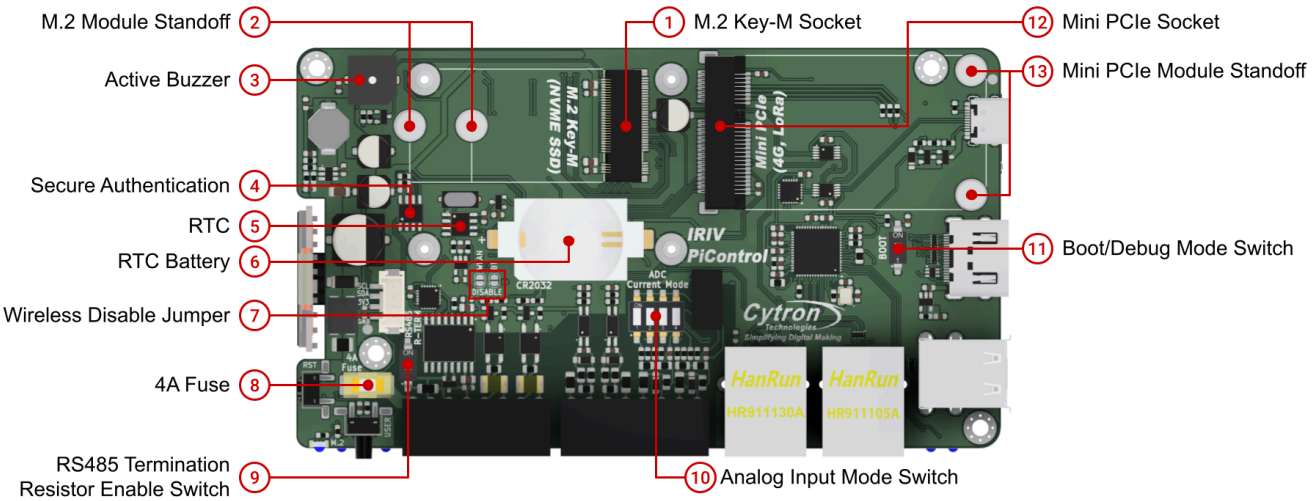
3.1 External Layout



No.	Function	Description
1	**User Button**	User programmable button. Connected to GPIO4. Can be programmed to be a safe shutdown button.
2	**LEDs**	**PWR** - CM4 power. Same as the red LED on Pi 4. **ACT** - CM4 activity. Same as the green LED on Pi 4. **LED0** - User programmable LED 0. Controlled by GPIO20. **LED1** - User programmable LED 1. Controlled by GPIO21. **M.2** - NVME SSD activity. **4G PWR** - Power indicator for the 4G module. **WWAN** - Indicator for the 4G WWAN activity.
3	**Terminal 1**	Pluggable terminal 1. See here for more details.
4	**Terminal 2**	Pluggable terminal 2. See here for more details.
5	**10/100M Ethernet**	The 10/100M Ethernet is extended via a USB ethernet controller. Mapped to eth1 in Raspberry Pi OS.
6	**Gigabit Ethernet**	This is the default 10/100/1000M Gigabit Ethernet of CM4. Mapped to eth0 in Raspberry Pi OS.
7	**DIN Bracket**	For mounting on DIN rail. Can be moved to the bottom of the IRIV PiControl as well.
8	**WiFi Antenna**	Antenna for CM4 WiFi and Bluetooth.
9	**4G Antenna Mounting Hole**	Mounting hole for 4G antenna.

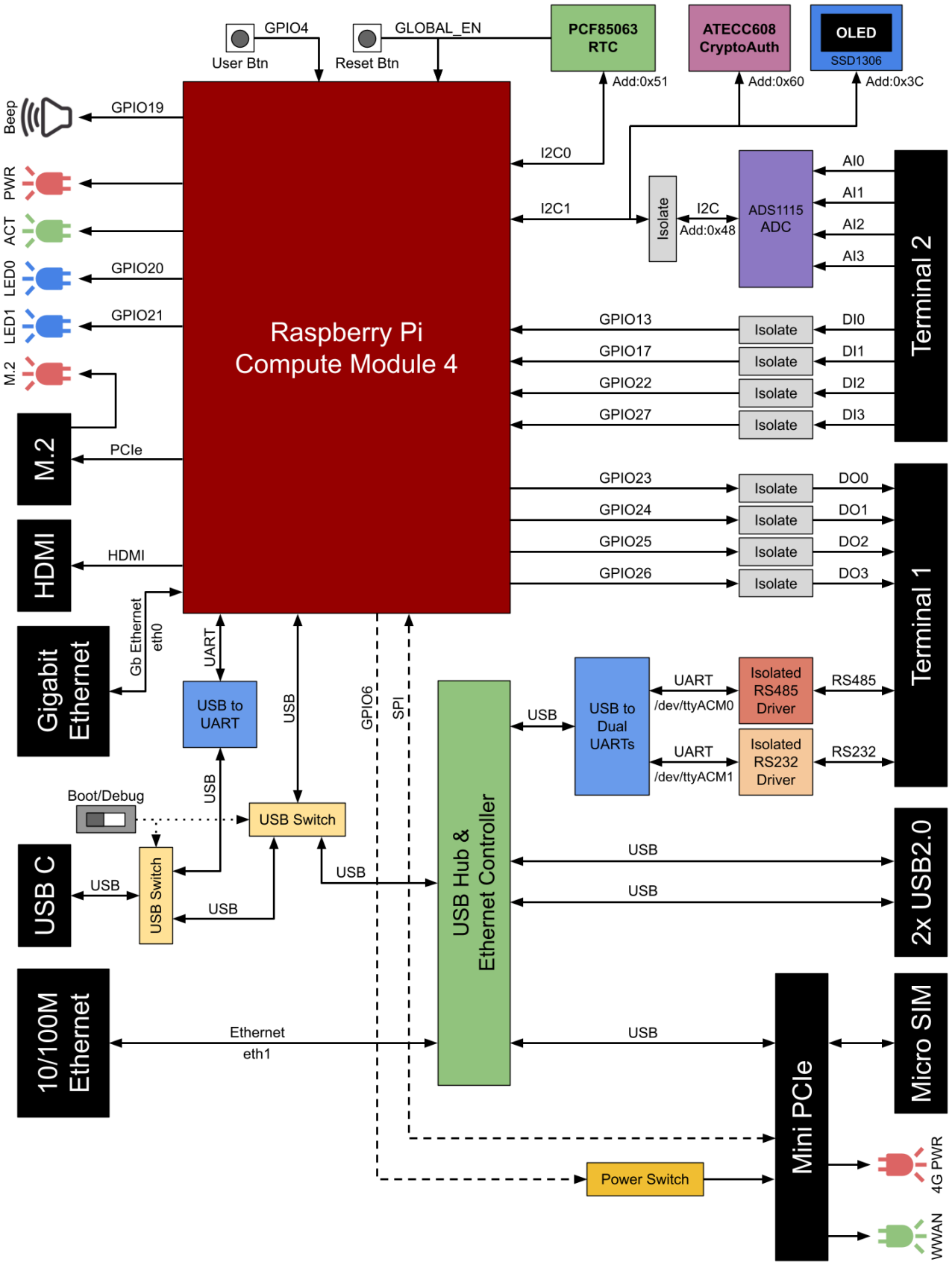
10	**OLED Display**	0.96” SSD1306 OLED display (I2C Slave Address = 0x3C).
11	**Reset Button**	Hard reset the Raspberry Pi CM4. Can also be used to wake up the CM4 after shutting down.
12	**Extra Antenna Mounting Hole**	Extra mounting holes for the antennas.
13	**USB 2.0 Ports**	2x USB 2.0 host capable of running at 480Mbps. Maximum current for both ports are 1000mA.
14	**HDMI**	Full size Type-A HDMI for external display. Up to 4K resolutions.
15	**USB-C**	This port is dual function and selectable via the onboard boot/debug switch. **Boot** - Used to load the OS image into the EMMC of CM4. **Debug** - Connected to the UART port of the CM4 via a USB-UART chip. Can be used to show the console of the CM4. This port can be used to power up the IRIV PiControl too.
16	**Micro SIM Socket**	Insert SIM card for the 4G module.

3.2 Internal Board Layout



No.	Function	Description
1	**M.2 Key-M Socket**	M.2 Key-M Socket for PCIe module (Gen 2 1-lane PCIe). Support NVME SSD size 2230 & 2242 (Bootable). * *M.2 SATA SSD is not supported.*
2	**M.2 Module Standoff**	Standoff for mounting the 2230 or 2242 M.2 PCIE module.
3	**Active Buzzer**	User programmable active piezo buzzer. Controlled by GPIO19. Beep when output is high.
4	**Secure Authentication**	ATECC608B Secure Authentication (I2C Slave Address = 0x60).
5	**RTC**	PCF85063A Real Time Clock (I2C Slave Address = 0x51).
6	**RTC Battery**	Insert a CR2032 coin cell to keep the RTC running when the system is powered off.
7	**Wireless Disable Jumper**	Solder and short the jumper together to disable WiFi or Bluetooth (BT).
8	**4A Fuse**	4 Amp replaceable fuse for the power input.
9	**RS485 Termination Resistor Enable Switch**	Connect/disconnect the 120 Ohm termination resistor for RS485.
10	**Analog Input Mode Switch**	Configure the analog inputs to measure voltage (0-10V) or current (0-20mA).
11	**Boot/Debug Mode Switch**	Select whether to use the USB-C for boot or debug mode.
12	**Mini PCIe Socket**	Mini PCIe Socket for 4G or LoRa module. Only USB 2.0 and SPI are available. There is no PCIe connection. Power to the Mini PCIe socket can be turned on/off via GPIO6.
13	**Mini PCIe Module Standoff**	Standoff for mounting the mini PCIe module.

4. Block Diagram

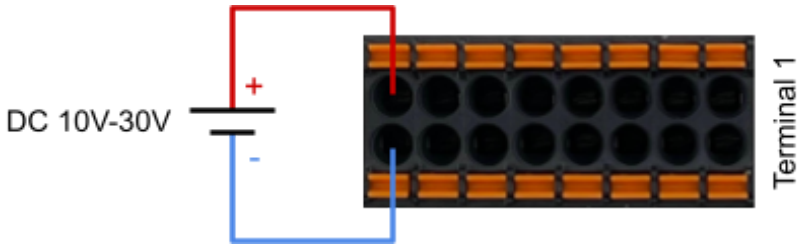


5. Interfaces and Functions

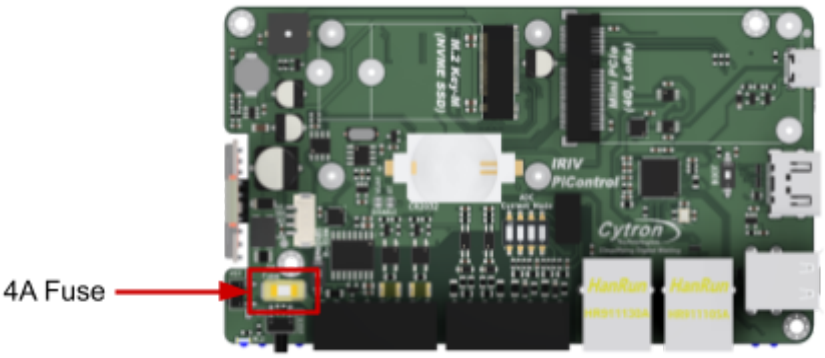
5.1 Terminal 1

5.1.1 Power Supply Input

The power supply input is compatible with DC voltage from 10V to 30V. Diagram below shows the connection to the power supply. No earth connection is required for this device.

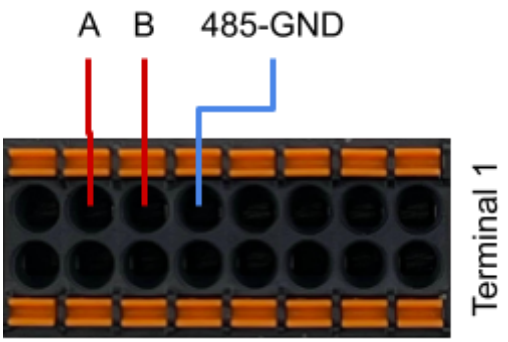


The power supply input is fuse protected. The fuse might break in the event of surge or overcurrent. If the device is unable to power up, check the 4 Amp fuse and replace it if needed.



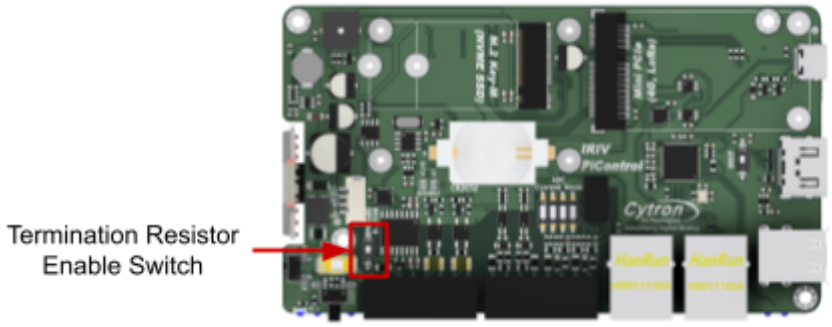
5.1.2 Isolated RS485

The RS485 interface is isolated from the system and other interfaces.
It has a maximum baud rate of 500kbps, automatic direction control and it's mapped to /dev/ttyACM0 in the Raspberry Pi.



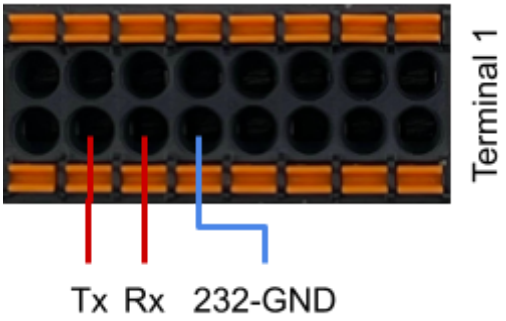
RS485 can work by only connecting the A-B signal. However, we do also recommend connecting the GND too for better noise immunity.

The RS485 also comes with a 120Ω termination resistor which can be switched on/off via a switch.



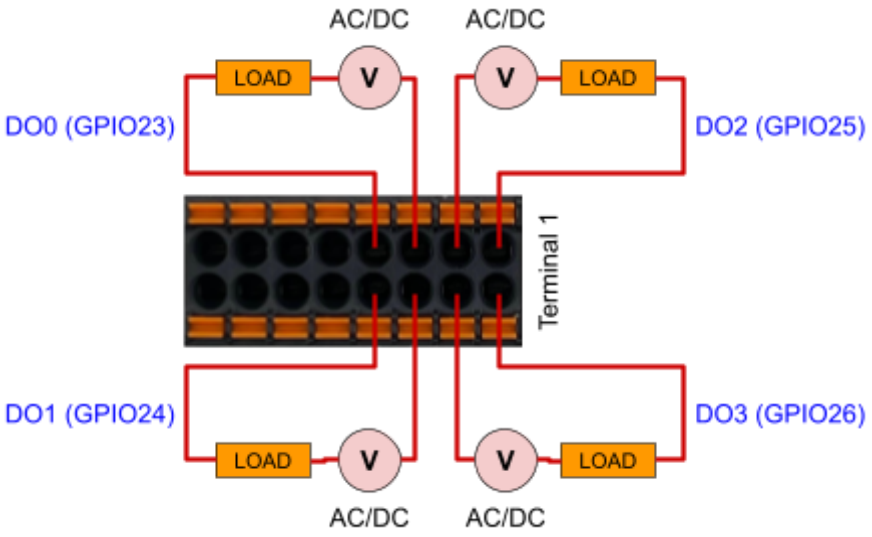
5.1.3 Isolated RS232

The RS232 interface is isolated from the system and other interfaces.
It has a maximum baud rate of 120kbps and it's mapped to /dev/ttyACM1 in the Raspberry Pi.



5.1.4 Isolated Digital Output

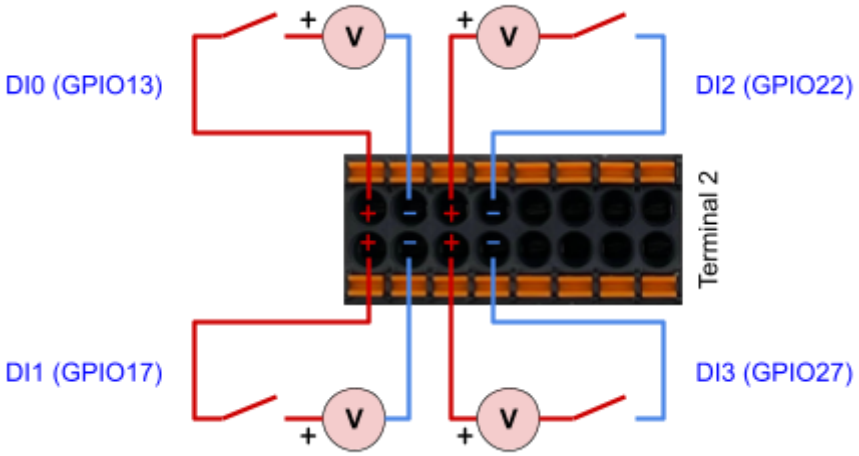
There are four digital outputs which are isolated from the system as well as among the different output channels. The outputs are active high and controlled directly from the Raspberry Pi GPIO. They are dry contact outputs driven by a solid state relay and able to handle DC or AC load at maximum 50V 500mA.



5.2 Terminal 2

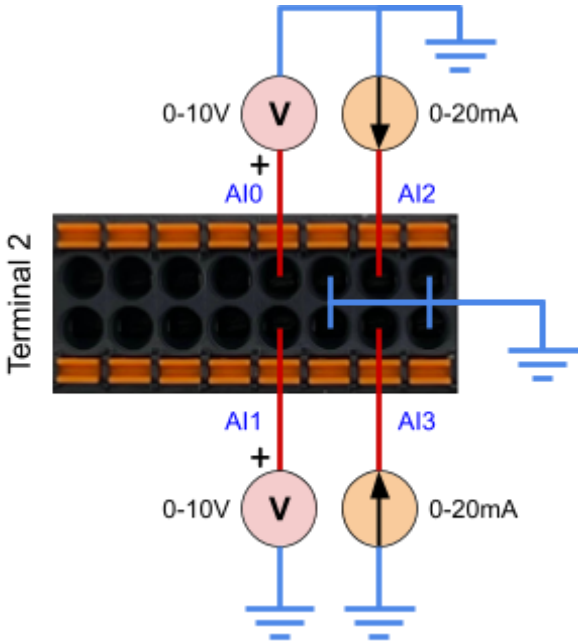
5.2.1 Isolated Digital Input

There are four digital inputs which are isolated from the system as well as among the different input channels. The inputs are active high and accessible directly from the Raspberry Pi GPIOs. They are only compatible with **wet contacts** and require a minimum of DC 3.0V 0.2mA to turn on. The maximum input voltage is DC 50V.



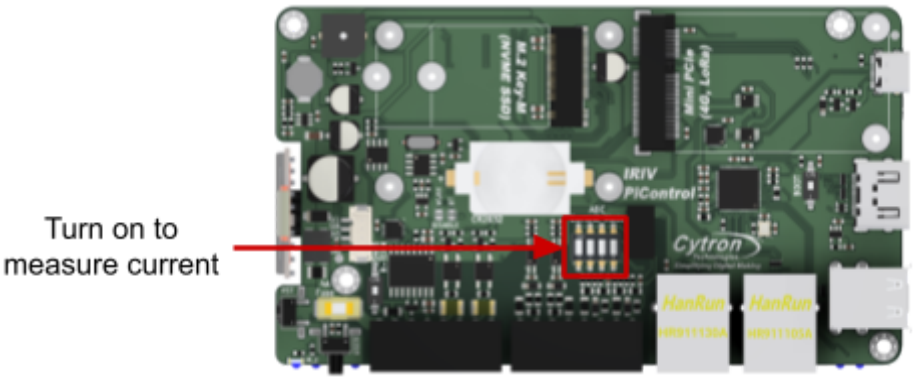
5.2.2 Isolated Analog Input

IRIV PiControl has a built- in **ADS1115** I2C ADC (Address = 0x48). There are four isolated analog inputs which are compatible with 0-5V, 0-10V and 0-20mA input.

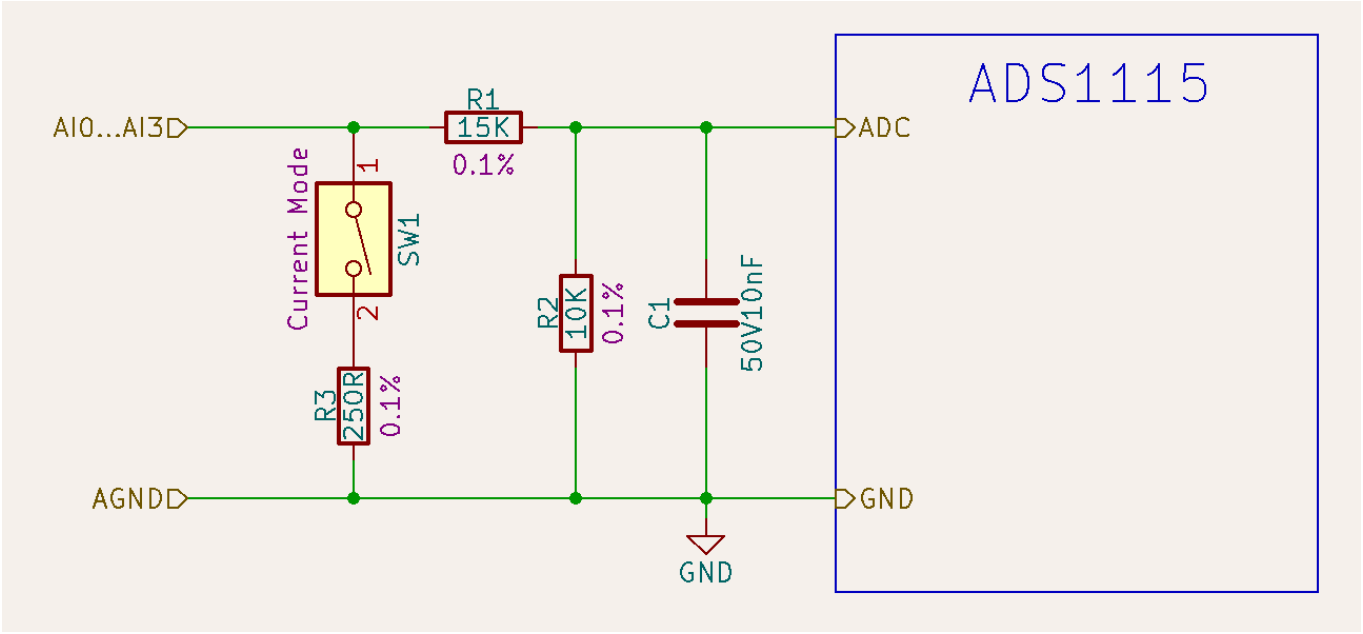


⚠The AGND is isolated from the system ground, but it's common among all the analog input channels.

To measure the 0-20mA current input, the internal shunt resistor needs to be enabled.



The input impedance is 25kΩ for voltage mode and 250Ω for current mode.
Below is the simplified schematic of the analog inputs.



5.2.2.1 ADC Python Library

The ADS1115 is a very popular ADC and its library is commonly available. We recommend Adafruit's python library “Adafruit_ADS1x15” due to its simplicity.

To install the library, run the following command from the console:

```
pip install Adafruit_ADS1x15
```

Example of python code to read the analog input for 0-10V, 0-5V and 0-20mA (Shunt resistor must be enabled via internal DIP switch).

```
import Adafruit_ADS1x15

# Initialize the ADC.
adc = Adafruit_ADS1x15.ADS1115(address = 0x48, busnum = 1)


##################################
# 0-10V Voltage Input
##################################
# Read the ADC.
# Param 1 = Analog Input Channel (0-3).
# Param 2 = ADC Gain (Gain 1 for 0-10V, Gain 2 for 0-5V or 0-20mA).
val = adc.read_adc(0, gain=1)

# Calculate the analog voltage (V).
# Full scale value = 32767
# Full scale voltage = 4.096V
# Voltage divider scale = 2.5
# voltage(V) = val / 32767 * 4.096 * 2.5
voltage = val / 3200


##################################
# 0-5V Voltage Input
##################################
# Read the ADC.
# Param 1 = Analog Input Channel (0-3).
# Param 2 = ADC Gain (Gain 1 for 0-10V, Gain 2 for 0-5V or 0-20mA).
val = adc.read_adc(0, gain=2)

# Calculate the analog voltage (V).
# Full scale value = 32767
# Full scale voltage = 2.048V
# Voltage divider scale = 2.5
# voltage(V) = val / 32767 * 2.048 * 2.5
voltage = val / 6400


##################################
# 0-20mA Current Input
# (DIP Switch must be ON)
##################################
# Read the ADC.
# Param 1 = Analog Input Channel (0-3).
# Param 2 = ADC Gain (Gain 1 for 0-10V, Gain 2 for 0-5V or 0-20mA).
val = adc.read_adc(0, gain=2)

# Calculate the current.
# Full scale value = 32767
# Full scale voltage = 2.048V
# Voltage divider scale = 2.5
# Shunt resistor value = 250 ohm
# voltage(V) = val / 32767 * 2.048 * 2.5
# current(mA) = voltage * 1000 / 250
voltage = val / 1600
```

6. Configure the IRIV PiControl

To fully utilize all the features on IRIV PiControl, some configuration is needed. This should be pre-configured if your unit is shipped with CM4 included.

To make life easier, we've prepared a setup script for you.
(Only script for Raspberry Pi OS is available).

Boot into the Raspberry Pi OS, launch the terminal and run the following command. You may SSH into your pi and run the command too.

```
curl -L tinyurl.com/setup-iriv-picontrol | sudo bash
```

Reboot the CM4 when done.

What does the script do?

1. Add the following settings to /boot/config.txt:
   a. Disable USB OTG by commenting out this line:
   `#otg_mode=1`

   b. By default, the USB host on CM4 is disabled to save power. We need to turn it ON.
   `dtoverlay=dwc2,dr_mode=host`

   c. Enable I2C0 for RTC.
   `dtparam=i2c_vc=on`
   `dtoverlay=i2c-rtc,pcf85063a,i2c_csi_dsi`

   d. `Enable I2C1 for other devices.`
   `dtparam=i2c_arm=on`

   e. Switch the WiFi/Bluetooth antenna to external antenna.
   `dtparam=ant2`

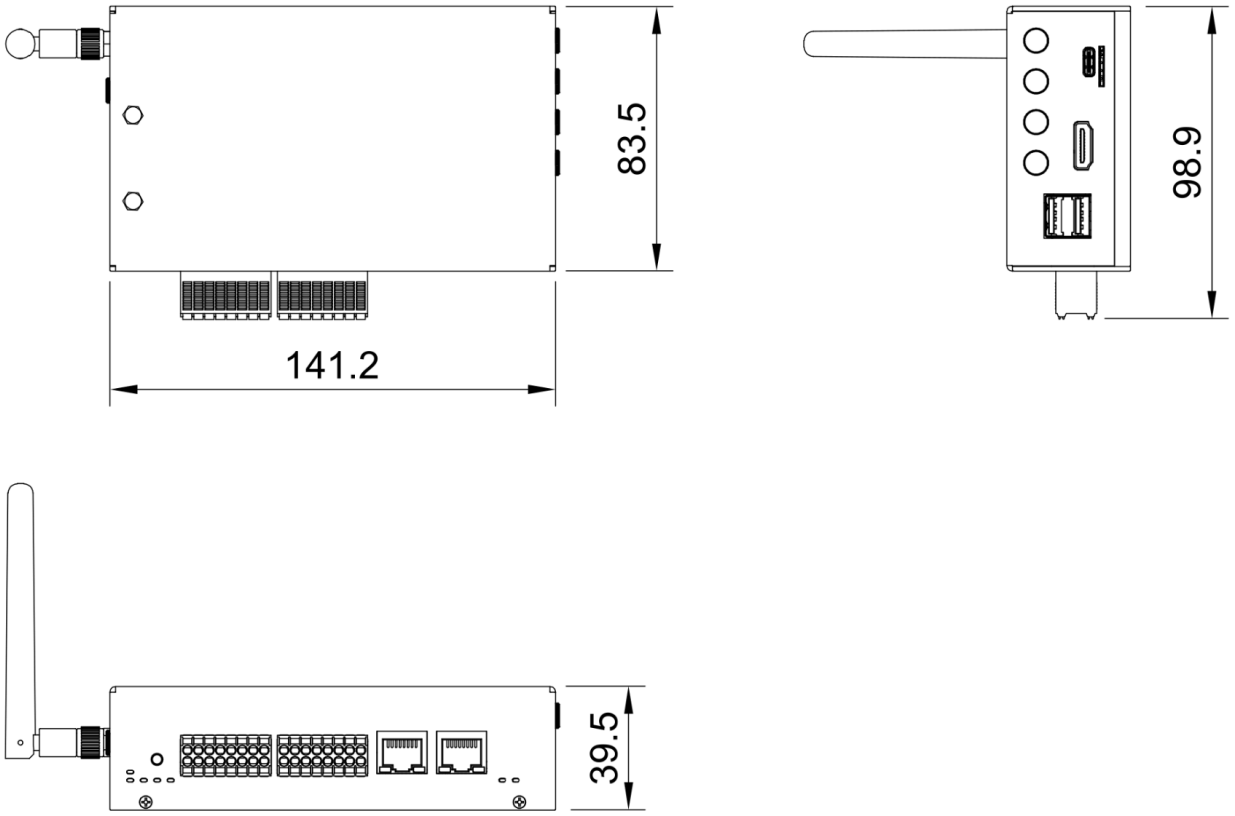
2. Setup a script to run in the background to display the IP address and system status (CPU load & temperature, RAM and storage usage) on the OLED. It also monitors the state of the power button and shutdown the Pi safely when the button is pressed.

   The script is downloaded to:
   `/usr/local/bin/iriv_pi_control/background_script.py`

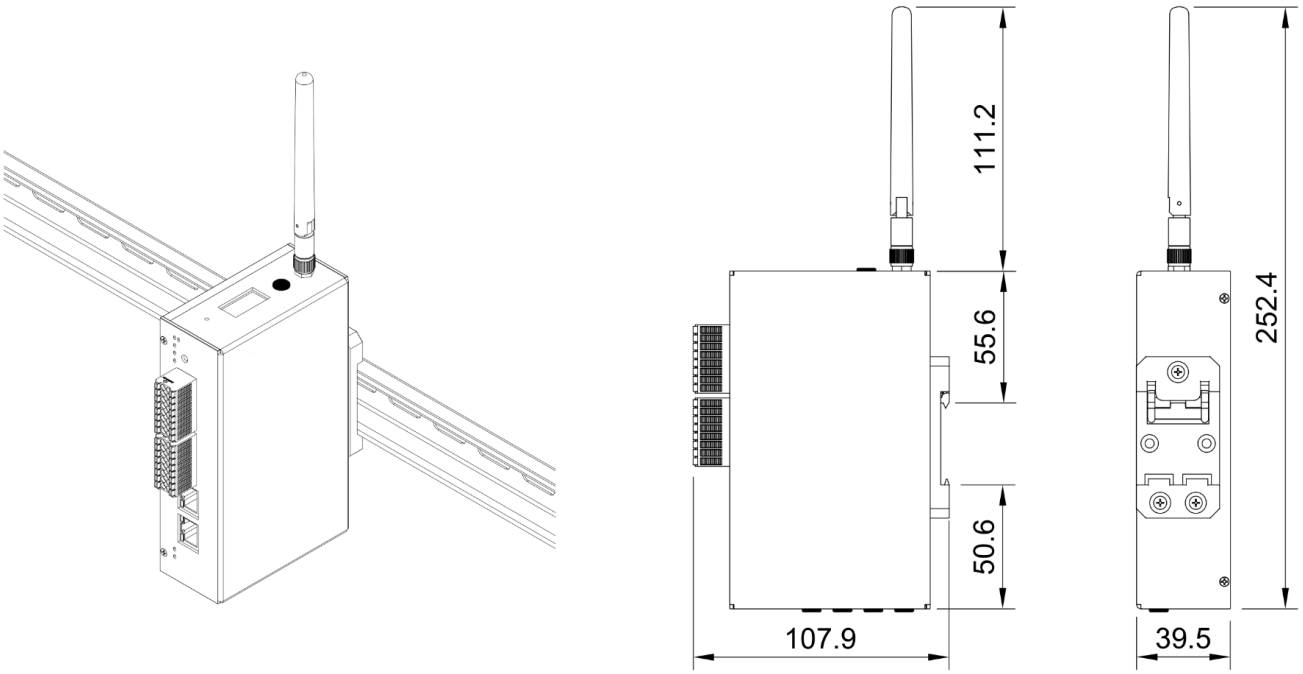
   This script runs automatically after boot.

7. Dimension & Mounting Options

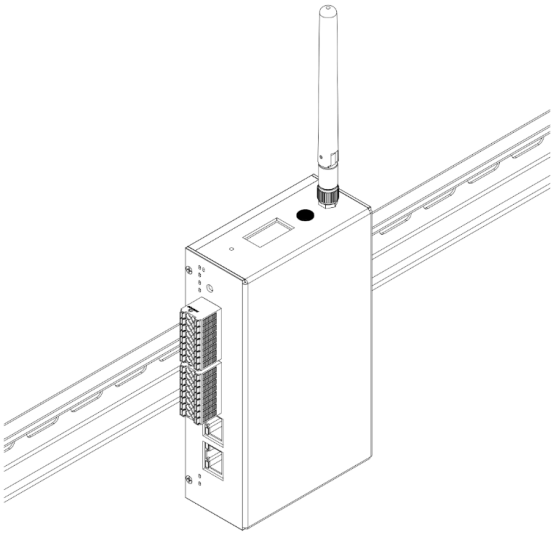
7.1 Without DIN Rail Socket

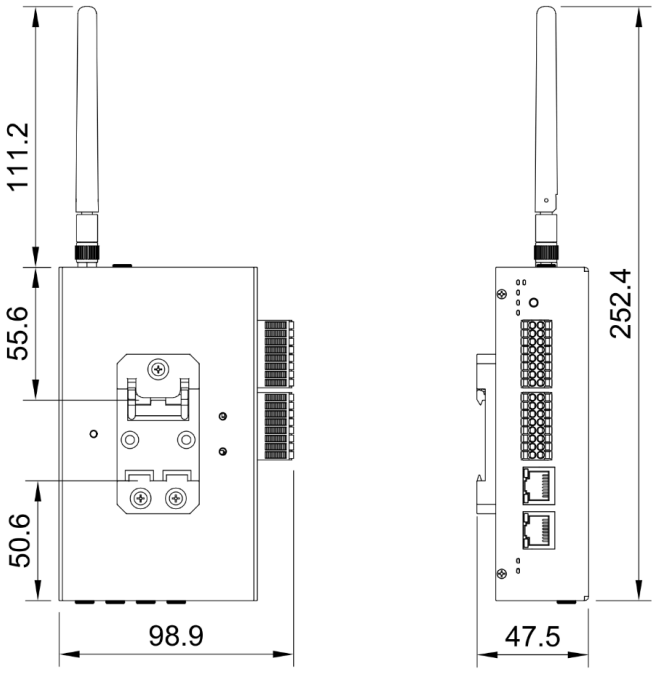


7.2 DIN Rail Mount Position 1 (Default)

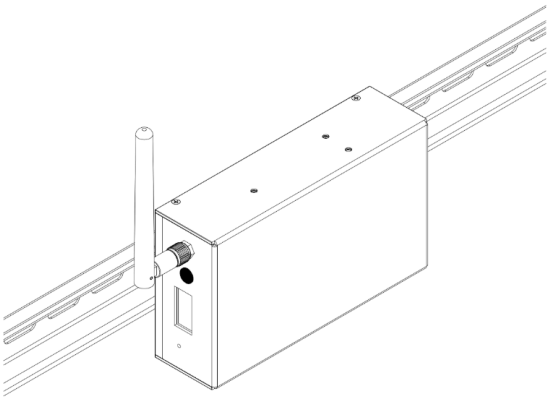


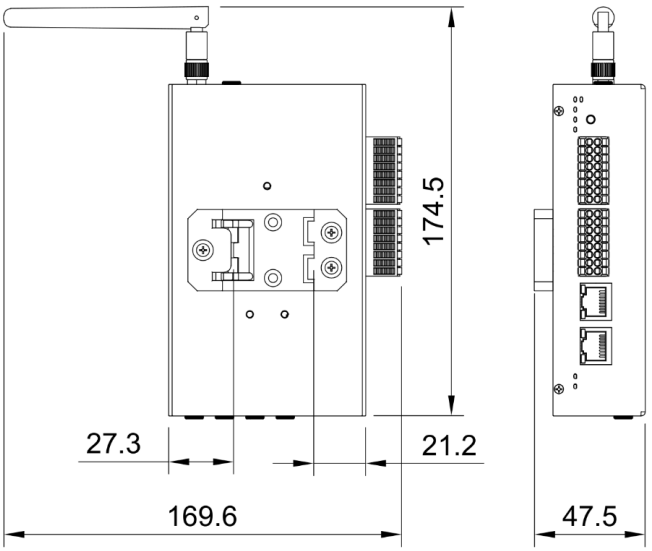
7.3 DIN Rail Mount Position 2





7.4 DIN Rail Mount Position 3





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