
ArduRPC Documentation

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PhiBo (DinoTools.org)

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ArduRPC brings [remote procedure calls\(RPC\)](#) to microcontrollers. It has been developed for [Arduino](#) based projects but can also be used with other platforms. The protocol has been designed to be simple and flexible.

Users:

Getting started

1.1 Setup

First of all download the base library from the [ArduRPC repository](#) and extract the ArduRPC directory into your Arduino library path.

After that you can download additional handlers from the [ArduRPC handler repository](#) or from any other source. Copy the handler files to your Arduino library path. Make sure you have downloaded and installed all dependencies before using a handler.

Example: Adafruit_NeoPixel

1. Download [base library](#)
 - Extract the files
 - Copy the ArduRPC directory to your Arduino library path
2. Download the [ArduRPC handler repository](#)
 - Extract the files
 - Copy the ArduRPC_Adafruit_NeoPixel directory to your Arduino library path
3. Download the [Adafruit_NeoPixel library](#)
 - Extract the files
 - Copy the Adafruit_NeoPixel directory to you Arduino library path.

1.2 Usage

The easiest way to get started is to use one of the available examples and to modify only the required parts.

To use the Adafruit_NeoPixel library with ArduRPC follow the examples below.

```
1 #include <Adafruit_NeoPixel.h>
2 #include <ArduRPC.h>
3 #include <ArduRPC_Adafruit_NeoPixel.h>
4
5 Adafruit_NeoPixel strip = Adafruit_NeoPixel(14, 6, NEO_GRB + NEO_KHZ800);
6
7 ArduRPC rpc = ArduRPC(2, 0);
8 ArduRPC_Serial rpc_serial = ArduRPC_Serial(Serial, rpc);
9
```

```
10 ArduRPC_Adafruit_Neopixel Strip_Wrapper(rpc, "strip", strip);
11
12 void setup() {
13     Serial.begin(9600);
14
15     strip.begin();
16     strip.show();
17 }
18
19 void loop() {
20     rpc_serial.loop();
21 }
```

Line 1: Include the Adafruit_NeoPixel library.

Line 2: Include the ArduRPC base library.

Line 3: Include the ArduRPC handler for the Adafruit_NeoPixel.

Line 5: Initialize the NeoPixel strip.

Line 7: Initialize the RPC manager with a limit of 2 handlers and 0 functions.

Line 8: Initialize the RPC data processor for a serial communication.

Line 10: Initialize the handler for the strip and name it 'strip'.

Line 13: Initialize the serial port and set baud to 9600.

Line 15 and 16: Setup the strips.

Line 18: Run the ArduRPC processing loop.

1.3 Additional examples

At least one example should be included with every library/handler.

Handler

A handler provides one or more callable functions. Before the functions are accessible over the remote procedure call interface the handler must be connected to the system. A handler can be identified by the handler type.

2.1 Handler types

A handler type belongs always to a group with a base type. Functions defined in the base type must be available in all subtypes. This ensures that a client with support for a base type can at least access the basic functionality of a handler even if that specific subtype isn't supported.

The development process of an API can be classified by three states:

Experimental: Currently under development and the API might be changed in the next release.

Beta: The API should be changed only if there is a good reason for this.

Stable: The existing API must not be changed.

To register a new handler type feel free to open a new request by using the [issue tracker](#) on github.

Start	End	Mask	Name	Status
0x0100	0x01FF	8	<i>Base Pixel Strip</i>	Beta
0x0180	0x01FF	9	<i>Extended Pixel Strip</i>	Experimental
0x0200	0x02FF	8	<i>Base Matrix</i>	Beta
0x0280	0x02FF	9	<i>Extended Matrix</i>	Beta
0x0300	0x03FF	8	<i>Base Text-LCD</i>	Experimental
0x0380	0x03FF	8	<i>Extended Text-LCD</i>	Experimental
0x0400	0x04FF	8	<i>Base Sensor</i>	Experimental
0x0401			<i>Temperature Sensor</i>	Experimental
0x0402			<i>Humidity Sensor</i>	Experimental
0x0403			<i>Temperature-Humidity Sensor</i>	Experimental
0x0500	0x05FF	8	<i>Base Board</i>	Experimental
0x0501		16	<i>Arduino Board</i>	Experimental
0xFF00	0xFFFF	8	<i>Custom handlers</i>	n/a

2.2 Base types

2.2.1 Base/Extended Pixel Strip

ID	Function	Strip Type	
		Base	Extended
0x01	<code>pixel_strip::getColorCount()</code>	X	x
0x02	<code>pixel_strip::getPixelCount()</code>	X	x
0x11	<code>pixel_strip::setPixelColor()</code>	X	x
0x12	<code>pixel_strip::setRangeColor()</code>	X	x

`uint8_t pixel_strip::getColorCount()`

Get the number of colors. Return value should be 1, 2 or 3.

Returns Number of colors.

`uint16_t pixel_strip::getPixelCount()`

Get the number of available pixels.

Returns Number of pixels

`void pixel_strip::setPixelColor(uint16_t n, uint8_t color1, uint8_t color2, uint8_t color3)`

Set the color of a pixel. All color values MUST be given and spare colors will be ignored by the device.

Parameters

- **n** – The number of the LED. Range from 0 to `pixel_count - 1`
- **color1** – First color. Red if `color_count = 3`.
- **color2** – Second color. Green if `color_count = 3`.
- **color3** – Third color. Blue if `color_count = 3`.

`void pixel_strip::setRangeColor(uint16_t start, uint16_t end, uint8_t color1, uint8_t color2, uint8_t color3)`

Set the color of a range of pixels.

Parameters

- **start** – The position to start. Range from 0 to `pixel_count - 1`
- **end** – The position to stop. Range from `start` to `pixel_count - 1`
- **color1** – First color. Red if `color_count = 3`.
- **color2** – Second color. Green if `color_count = 3`.
- **color3** – Third color. Blue if `color_count = 3`.

2.2.2 Base/Extended Matrix

The Base Matrix handler is inspired by the Adafruit_GFX library and it is intended to be used with libraries based on Adafruit_GFX. But it might also be possible to wrap any other library.

ID	Function	Matrix Type	
		Base	Extended
0x01	<i>matrix_gfx::getColorCount()</i>	X	X
0x02	<i>matrix_gfx::getWidth()</i>	X	X
0x03	<i>matrix_gfx::getHeight()</i>	X	X
0x11	<i>matrix_gfx::drawPixel()</i>	X	X
0x21	<i>matrix_gfx::drawLine()</i>	X	X
0x22	<i>matrix_gfx::drawFastVLine()</i>		X
0x23	<i>matrix_gfx::drawFastHLine()</i>		X
0x24	<i>matrix_gfx::drawRect()</i>		X
0x25	<i>matrix_gfx::fillRect()</i>		X
0x26	<i>matrix_gfx::fillScreen()</i>	X	X
0x27	<i>matrix_gfx::invertDisplay()</i>		X
0x31	<i>matrix_gfx::drawCircle()</i>		X
0x32	<i>matrix_gfx::fillCircle()</i>		X
0x33	<i>matrix_gfx::drawTriangle()</i>		X
0x34	<i>matrix_gfx::fillTriangle()</i>		X
0x35	<i>matrix_gfx::drawRoundRect()</i>		X
0x36	<i>matrix_gfx::fillRoundRect()</i>		X
0x41	<i>matrix_gfx::drawChar()</i>		X
0x42	<i>matrix_gfx::setCursor()</i>		X
0x43	<i>matrix_gfx::setTextColor()</i>		X
0x44	<i>matrix_gfx::setTextColor()</i>		X
0x45	<i>matrix_gfx::setTextSize()</i>		X
0x46	<i>matrix_gfx::setTextWrap()</i>		X
0x47	<i>matrix_gfx::write()</i>		X
0x51	<i>matrix_gfx::setRotation()</i>		X
0x52	<i>matrix_gfx::swapBuffers()</i>		X
0x53	<i>matrix_gfx::setAutoSwapBuffers()</i>		X
0x61	<i>matrix_gfx::drawImage()</i>		X

uint8_t matrix_gfx::getColorCount()

Get the number of colors. Return value should be 1, 2 or 3.

Returns Number of colors.

uint16_t matrix_gfx::getWidth()

Get width in pixels.

Returns Number of pixels

uint16_t matrix_gfx::getHeight()

Get height in pixels.

Returns Number of pixels

void matrix_gfx::drawPixel(int16_t x, int16_t y, uint8_t color1, uint8_t color2, uint8_t color3)

Draw a pixel.

Parameters

- **x** – Pixel x position
- **y** – Pixel y position
- **color1** – First color. Red if color_count = 3.
- **color2** – Second color. Green if color_count = 3.
- **color3** – Third color. Blue if color_count = 3.

`void matrix_gfx::drawLine (int16_t x0, int16_t y0, int16_t x1, int16_t y1, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw a line.

`void matrix_gfx::drawFastVLine (int16_t x, int16_t y, int16_t h, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw a vertical line.

`void matrix_gfx::drawFastHLine (int16_t x, int16_t y, int16_t w, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw a horizontal line.

`void matrix_gfx::drawRect (int16_t x, int16_t y, int16_t w, int16_t h, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw the boarder of rectangle.

`void matrix_gfx::fillRect (int16_t x, int16_t y, int16_t w, int16_t h, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw a filled rectangle.

`void matrix_gfx::fillScreen (uint8_t color1, uint8_t color2, uint8_t color3)`

Fill the screen with the given color.

`void matrix_gfx::invertDisplay (boolean i)`

Invert the display.

`void matrix_gfx::drawCircle (int16_t x0, int16_t y0, int16_t r, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw the border of a circle.

`void matrix_gfx::fillCircle (int16_t x0, int16_t y0, int16_t r, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw a filled circle.

`void matrix_gfx::drawTriangle (int16_t x0, int16_t y0, int16_t x1, int16_t y1, int16_t x2, int16_t y2, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw the boarder of a triangle.

`void matrix_gfx::fillTriangle (int16_t x0, int16_t y0, int16_t x1, int16_t y1, int16_t x2, int16_t y2, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw a filled triangle.

`void matrix_gfx::drawRoundRect (int16_t x0, int16_t y0, int16_t w, int16_t h, int16_t radius, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw the boarder of a round rectangle.

`void matrix_gfx::fillRoundRect (int16_t x0, int16_t y0, int16_t w, int16_t h, int16_t radius, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw a filled round rectangle.

`void matrix_gfx::drawChar (int16_t x, int16_t y, unsigned char c, uint8_t color1, uint8_t color2, uint8_t color3)`

Draw a character.

`void matrix_gfx::setCursor (int16_t x, int16_t y)`

Set the cursor position.

`void matrix_gfx::setTextColor (uint8_t color1, uint8_t color2, uint8_t color3)`

Set the text color.

`void matrix_gfx::setTextColor (uint8_t color1, uint8_t color2, uint8_t color3, uint8_t bg_red, uint8_t bg_green, uint8_t bg_blue)`

Set the text color.

`void matrix_gfx::setTextSize (uint8_t s)`

Set the text size.

`void matrix_gfx::setTextWrap (boolean w)`

Set the text wrap.

`void matrix_gfx::setRotation (uint8_t r)`

Set the rotation.

`uint8_t matrix_gfx::swapBuffers (uint8_t copy)`

Parameters `copy` 0 = False | 1 = True

Swap buffers and copy new front buffer into the back buffer.

`uint8_t matrix_gfx::setAutoSwapBuffers (uint8_t auto_swap)`

Parameters `auto_swap` 0 = False | 1 = True

Set option to swap buffers after each command.

`void matrix_gfx::drawImage (int16_t x, int16_t y, int16_t width, int16_t height, uint8_t color_encoding, uint8_t *image)`

Parameters

- **x** – x-position
- **y** – y-position
- **width** – Image width
- **height** – Image height
- **color_encoding** – The color encoding. For more information have a look at the list below.
- **image** – The image data

Color encoding:

Mode 0: 8-Bit encoding. From MSB to LSB:

- 2-Bit - red
- 3-Bit - green
- 3-Bit - blue

Mode 1: 16-Bit encoding. From MSB to LSB:

- 5-Bit - red
- 6-Bit - green
- 5-Bit - blue

Mode 2: 24-Bit encoding. From MSB to LSB:

- 8-Bit - red
- 8-Bit - green
- 8-Bit - blue

2.2.3 Base/Extended Text-LCD

ID	Function	Text-LCD Type	
		Base	Extended
0x01	<i>text_lcd::getWidth()</i>	X	X
0x02	<i>text_lcd::getHeight()</i>	X	X
0x11	<i>text_lcd::clear()</i>	X	X
0x12	<i>text_lcd::home()</i>	X	X
0x13	<i>text_lcd::setCursor()</i>	x	X
0x21	<i>text_lcd::write()</i>	X	X
0x22	<i>text_lcd::print()</i>	X	X

`uint8_t text_lcd::getWidth()`

Get the width as number of characters.

`uint8_t text_lcd::getHeight()`

Get the height as number of characters.

`void text_lcd::clear()`

Clear the LCD screen and set the cursor position to the upper-left corner.

`void text_lcd::home()`

Set the cursor position to the upper-left corner.

`void text_lcd::setCursor(uint8_t col, uint8_t row)`

Parameters

- **col** – The column
- **row** – The row

Position the cursor.

`void text_lcd::write(char c)`

Parameters **c** The character to display

Print a single character to the LCD.

`void text_lcd::print(uint8_t num, char[] text)`

Parameters

- **num** – Number of characters
- **text** – The text to display

Print text to the LCD.

2.2.4 Base Sensor

2.2.5 Temperature/Humidity Sensor

The Temperature and the Humidity Sensors share the same API. Temperatures are always in Celsius.

ID	Function
0x11	<i>sensor_temperature::getMinValue()</i>
0x12	<i>sensor_temperature::getMaxValue()</i>
0x13	<i>sensor_temperature::getAccuracy()</i>
0x14	<i>sensor_temperature::getValue()</i>

float sensor_temperature::getMinValue()

Get the value of the lowest possible temperature/humidity measured by the sensor.

float sensor_temperature::getMaxValue()

Get the value of the highest possible temperature/humidity measured by the sensor.

float sensor_temperature::getAccuracy()

Get the best accuracy of the measured values.

float sensor_temperature::getValue()

Get the current temperature/humidity.

2.2.6 Temperature-Humidity Sensor

ID	Function
0x11	<i>sensor_temp_humidity::getMinTempValue()</i>
0x12	<i>sensor_temp_humidity::getMaxTempValue()</i>
0x13	<i>sensor_temp_humidity::getTempAccuracy()</i>
0x14	<i>sensor_temp_humidity::getTemperature()</i>
0x21	<i>sensor_temp_humidity::getMinHumidityValue()</i>
0x22	<i>sensor_temp_humidity::getMaxHumidityValue()</i>
0x23	<i>sensor_temp_humidity::getHumidityAccuracy()</i>
0x24	<i>sensor_temp_humidity::getHumidity()</i>

float sensor_temp_humidity::getMinTempValue()

Get the value of the lowest possible temperature measured by the sensor.

float sensor_temp_humidity::getMaxTempValue()

Get the value of the highest possible temperature measured by the sensor.

float sensor_temp_humidity::getTempAccuracy()

Get the best accuracy of the measured temperature.

float sensor_temp_humidity::getTemperature()

Get the current temperature.

float sensor_temp_humidity::getMinHumidityValue()

Get the value of the lowest possible humidity measured by the sensor.

float sensor_temp_humidity::getMaxHumidityValue()

Get the value of the highest possible humidity measured by the sensor.

float sensor_temp_humidity::getHumidityAccuracy()

Get the best accuracy of the measured humidity.

float sensor_temp_humidity::getHumidity()

Get the current humidity.

2.2.7 Base Board

At the moment only Arduino based boards are supported.

2.2.8 Arduino Board

A handler of this type is used to control Arduino based boards.

ID	Function
0x11	<i>board_arduino::getAnalogInput()</i>
0x21	<i>board_arduino::getDigitalInput()</i>
0x22	<i>board_arduino::setDigitalOutput()</i>
0x31	<i>board_arduino::setPWMOutput()</i>

uint16 board_arduino::**getAnalogInput**(uint8_t pin)

Get the value of an analog input pin.

Parameters pin Pin number

uint16 board_arduino::**getDigitalInput**(uint8_t pin)

Get the value of a digital input pin.

Parameters pin Pin number

uint16 board_arduino::**setDigitalOutput**(uint8_t pin, uint8_t value)

Set the value of a digital output pin.

Parameters

- **pin** – Pin number
- **value** – The value (0, 1)

uint16 board_arduino::**setPWMOutput**(uint8_t pin, uint8_t value)

Set the value of a PWM output pin.

Parameters

- **pin** – Pin number
- **value** – The PWM value (0-255)

2.2.9 Custom handlers

This range of IDs is reserved for custom handlers e.g. for testing or prototyping purposes.

Buildin system handler

The system handler is available by default and is included in the base ArduRPC library.

3.1 Function overview

ID	Function
0x01	<i>getProtocolVersion()</i>
0x02	<i>getLibraryVersion()</i>
0x03	<i>getMaxPacketSize()</i>
0x10	<i>getFunctionList()</i>
0x20	<i>getHandlerList()</i>
0x21	<i>getHandlerName()</i>

3.2 Function details

`uint8_t getProtocolVersion()`

Get the protocol version. At the moment this should be 0.

`RPC_ARRAY getLibraryVersion()`

Return the library version as `RPC_ARRAY` with three elements of `uint8` type.

1. Major version

2. Minor version

3. Patch level

`uint16_t getMaxPacketSize()`

Return the maximum packet size (header + data) in bytes.

`RPC_VARRAY getFunctionList()`

Get a list of all functions. The result has 2 columns.

1. The first column is a unsigned char and represents the internal ID.

2. The second column is a unsigned char and represents the type of the function.

`RPC_VARRAY getHandlerList()`

Get a list of all handlers. The result has 2 columns.

1. The first column is a unsigned char and represents the internal ID of the handler.

2. The second column is an unsigned short and represents the type of the handler.

RPC_CARRAY **getHandlerName** (uint8_t *handler_id*)

Get the handler name by a given ID.

Additional handlers

Developers:

Protocol

ArduRPC brings remote procedure calls to microcontrollers. The binary protocol has been designed to be simple and flexible. Basic and also complex data types are supported.

5.1 Communication

5.1.1 Request

Name	Type	Comment
Version	uint8	Protocol version (default: 0)
Handler ID	uint8	ID of the handler
Command ID	uint8	ID of the command to call
Length	uint8	Length of data in bytes
Data		List of parameters

Version: This is the version of the protocol. At the moment only version 0 is supported.

Handler ID: The ID of the handler to use.

Command ID: The ID of the command to call.

Length: Length of the data in bytes.

Data: A list of parameters. See Data Types for more information.

5.1.2 Response

Name	Type	Comment
Return code	uint8	The return code. See <i>Return codes</i>
Data	Mixed	The result

Data: The result data. Only one type of data is allowed.

5.2 Data Types

5.2.1 Basic data types

Basic data types have a fixed length like a signed Integer.

Data Types

Identifier	Data Type	Size in Bytes
0x00	None	0
0x01	Signed Char	1
0x02	Unsigned Char	1
0x03	Signet Short	2
0x04	Unsigned Short	2
0x05	Signed Long	4
0x06	Unsigned Long	4
0x07	Signed Long Long	8
0x08	Unsigned Long Long	8
0x09	Float ¹	4

Data structure:

Name	Type	Comment
Identifier	uint8	The identifier. See Data types for more information.
Data		The data specified by the identifier.

5.2.2 Complex data types

At the moment the following data types are supported.

Identifier	Data Type
0x10	Simple array
0x11	String
0x12	Multicolumn array
0x13	Value array

Array:

Name	Type	Comment
Identifier	uint8	Set to 0x10. See data types for more information.
Data Identifier	uint8	Basic data type of the elements.
Length	uint8	Length of the string in bytes.
Data		The string.

String:

Name	Type	Comment
Identifier	uint8	Set to 0x11. See data types for more information.
Length	uint8	Length of the string in bytes.
Data		The string.

Multi column array:

Name	Type	Comment
Identifier	uint8	Set to 0x12. See data types for more information.
Columns	uint8	Number of columns.
Column Identifier 1	uint8	The identifier for column 1
Column Identifier m	uint8	The identifier for column m
Length	uint8	Number of rows
Row 1		Data of row 1
Row n		Data of row n

¹Float values MUST use the IEEE 754 binary32 representation format.

Value array:

Name	Type	Comment
Identifier	uint8	Set to 0x13. See data types for more information.
Length	uint8	Length of the array in bytes.
Data		List of identifiers and values

5.3 Return codes

Code	Comment
0	Success
122	Error in the package data
123	Error while parsing the header
124	Function not found
125	Handler not found
126	Command not found
127	Failure no reason given

5.4 Example

5.4.1 Basic data types

Request:

Data	Comment
0x00	Protocol version (default: 0)
0x03	ID of the handler.
0x02	ID of the command to call
0x05	Length of data in bytes
0x10	Value: 16 (Type: uint8)
0x00	Value: 1 (Type: uint16)
0x01	

Response:

Data	Comment
0x00	Success
0x01	Identifier for Unsigned Char
0x10	Value: 16

Communication

6.1 Serial (Hex-Mode)

- Use a serial port like UART (Arduino: Serial or SoftwareSerial)
- Read/Write data line by line
- Every package/line must start with a colon (':')
- Lines without a colon must be ignored
- Data is encoded as hex string

Example:**Line 1:** The Request**Line 2:** A comment or debug information**Line 3:** The response

```
1 :000302050110030001
2 This is a comment or debug info
3 :0110
```

Additional information:

License

The code is licensed under the terms of [GNU Lesser General Public License](#).

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Version 3, 29 June 2007

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"The Library" refers to a covered work governed by this License,
other than an Application or a Combined Work as defined below.

An "Application" is any work that makes use of an interface provided
by the Library, but which is not otherwise based on the Library.
Defining a subclass of a class defined by the Library is deemed a mode
of using an interface provided by the Library.

A "Combined Work" is a work produced by combining or linking an
Application with the Library. The particular version of the Library
with which the Combined Work was made is also called the "Linked
Version".

The "Minimal Corresponding Source" for a Combined Work means the
Corresponding Source for the Combined Work, excluding any source code
for portions of the Combined Work that, considered in isolation, are
based on the Application, and not on the Linked Version.

The "Corresponding Application Code" for a Combined Work means the
object code and/or source code for the Application, including any data
and utility programs needed for reproducing the Combined Work from the
Application, but excluding the System Libraries of the Combined Work.

1. Exception to Section 3 of the GNU GPL.

You may convey a covered work under sections 3 and 4 of this License without being bound by section 3 of the GNU GPL.

2. Conveying Modified Versions.

If you modify a copy of the Library, and, in your modifications, a facility refers to a function or data to be supplied by an Application that uses the facility (other than as an argument passed when the facility is invoked), then you may convey a copy of the modified version:

- a) under this License, provided that you make a good faith effort to ensure that, in the event an Application does not supply the function or data, the facility still operates, and performs whatever part of its purpose remains meaningful, or
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Changelog

8.1 Version 0.4.0 (02.08.2014)

- Docs: New handler type for temperature and humidity sensors
- Protocol: Support float types
- Feature: Set max packet size to 256 byte
- Feature: New ArduRPC_Ethernet lib
- Feature: Handlers have to be a class
- Core: Rename ArduRPCSerial to ArduRPC_Serial
- Docs: New handler type for Arduino based boards

8.2 Version 0.3.0 (25.02.2014)

- Improvements to lower memory usage
 - Shared buffers
- Feature: ArduRPCSerial class
- Feature: Macros to get version information
- Feature: Functions to write result data with type identifier

8.3 Version 0.2.0 (no public release)

- Protocol improvements
- Feature: Handler names
- Feature: Possibility to register functions
- Feature: None value
- Feature: Return codes

8.4 Version 0.1.0 (no public release)

- Initial version

Handlers

- Official handler repository
 - Colorduino_GFX
 - Adafruit NeoPixel
 - ...

Client libraries

Python:

- `python-ardurpc`

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