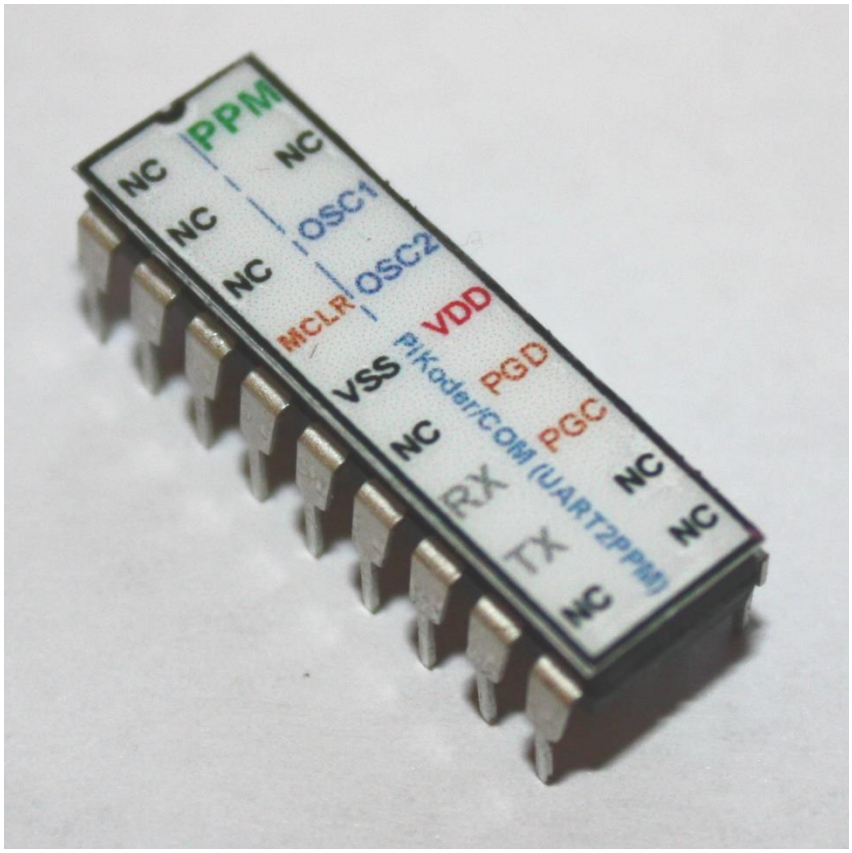

UART2PPM

User's Guide

Version 2.6a

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Content

1

Overview

The UART2PPM (aka PiKoder/COM) is a single chip converter for serial data (UART) to an eight channel PPM signal with a resolution of 1 µs. This User's Guide covers the features, the programming, and the serial interface of the UART2PPM.

Just add an off-the-shelf "USB to UART converter" to connect your computer's USB port to the PiKoder/COM's input and the PPM stream generated can be used by many R/C transmitters for flying with computer joystick, mouse, etc. by simply connecting the PiKoder output to the trainer connector of the R/C transmitter.

Also, a microcontroller such as e.g., your Arduino or Raspberry Pi could take over control: both controllers can connect directly to the PiKoder's UART. In addition, the controller's wide range of operating voltage from 3.3 to 5.0V allows you to use an existing power source in your application rather than adding hardware.

In section 2 you will find a brief description of key features, the overall function and an overview of the interfaces supported. It is recommended to carefully read this section to get a good basic understanding of the UART2PPM.

The next two sections 3 and 4 deal with the controller hardware. Section 3 provides the pinning and section 4 describes the reference schematic for the encoder. **Please note that the applications and interfaces described in the following sections assume that the UART2PPM is setup in line with this reference schematic.**

Your next step is most likely to commission and test your UART2PPM. Rather than using the "bits and bytes"-serial interfaces directly, which are laid out in section 6, you may consider using the more elegant PCC (PiKoder Control Center) Windows 10 software with a graphical user interface.

Section 7 demonstrates how you would interface your UART2PPM to a Raspberry PI and Section 8 focusses on connecting the UART2PPM to an Arduino.

This User's Guide is based on the most recent hard- and firmware version 2.6 available for the UART2PPM and the related programming software "PCC PiKoder Control Center". Please check for updated information and new software releases on www.pikoder.com.

Hyperlinks were integrated into the text for convenience. You would also find all downloads referenced on the UART2PPM webpage.

Please share with me any comments, improvement ideas or errors you will find or encounter in working with your UART2PPM. I can be reached at webmaster@pikoder.com. Thank you very much!

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Features

This section will familiarize you with the feature set and a high-level overview of the intended use of the UART2PPM allowing you to customize the controller to your specific needs and requirements.

The UART2PPM is a single chip converter for serial data (UART) to an eight channel PPM signal. The key features are:

- resolution 1 µs with a precision of 0,5 µs or better
- operating voltage range 3.3-5.0 V
- non-volatile memory for application specific parameters
- miniSSC protocol supported
- bi-directional ASCII protocol enabling line monitoring
- optional failsafe position when connection to host is lost
- ICSP pins available for software upgrades
- Sample software and source code for PC application available

You can connect a controller board such as your Arduino or Raspberry Pi without any additional interface hardware directly to the PiKoder's UART (please refer to sections 7 and 8 for more details). In this capacity the PiKoder would free up the Arduino or an Raspberry Pi of responding to real-time events such as generating pulses in a given time frame and also free up resources such as internal timers and PWM generators ('Set and Forget'-function). Thereby intermittent problems due to internal collisions are avoided.

With the addition of a simple off-the-shelf "USB to UART converter" you control the UART2PPM directly from your computer.

In addition, the controller's wide range of operating voltage from 3.3 to 5.0V allows you to use an existing power source in your application rather than adding hardware.

The UART2PPM supports two protocols:

- MiniSSC protocol representing a very common protocol for controlling SSCs and
- a two-way ASCII-Protocol designed to support controlling the SSC with standard terminal programs such as (but not limited to) Tera Term and TTY

The UART2PPM would automatically detect the protocol used and no user interaction would be required.

A free graphical and intuitive configuration and control program, the "PCC PiKoder Control Center" is available for Windows 10, making it simple to test and program the controller over USB (please refer to section 5 for more details).

The UART2PPM also has non-volatile (EEPROM) data storage for retaining application specific operating parameters such as startup position after powering up, neutral position and upper as well as lower limits for servo pulse width.

The UART2PPM does support a failsafe position for the use in autonomous and RC applications. You can activate a timer for 0.1 s to 99.9 s to monitor the communication. If no message is received within this preset time frame, then the UART2PPM would set all servo outputs to the neutral position.

If you were to use this function, you might want to implement a regular "ping" in your application to make sure that the failsafe function is not triggered by a period of inactivity.

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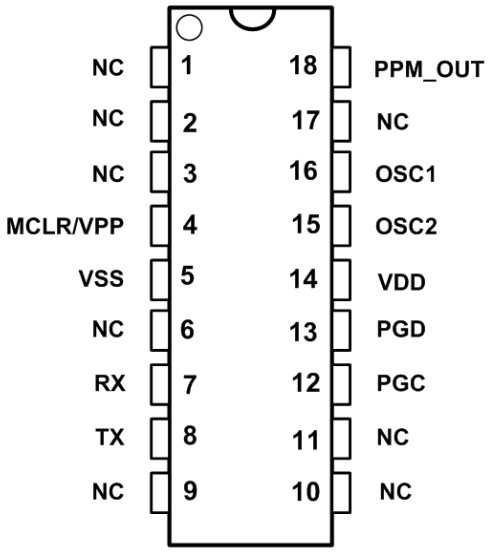
Pin Description and Packaging

The PiKoder/COM comes in an 18 pin DIP package (see below). The device operates from 3.3 – 5 Volts. Please refer to the PIC 16F628A data sheet from Microchip (www.microchip.com) for complete electrical and physical specifications.

A complete description of the pins is given on the following page. If a different package would be required for your application then please contact sales@pikoder.com for more information.

For evaluating the UART2PPM a pcb and a complete kit is available at www.pikoder.com. This kit can make your development process more efficient and provides for modularity in your design.



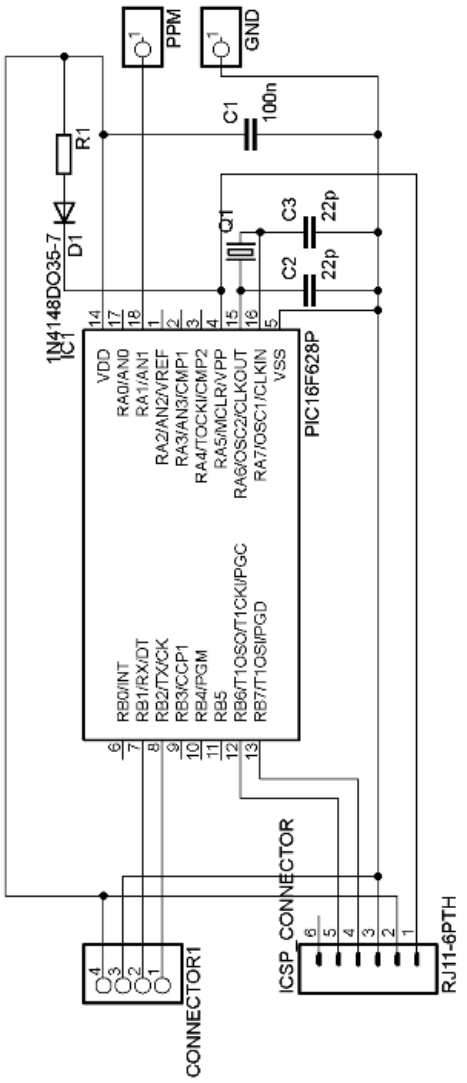
Description of pins

Pin	Symbol	Description
1	NC	Not connected (reserved for later use)
2	NC	Not connected (reserved for later use)
3	NC	Not connected (reserved for later use)
4	MCLR/VPP	Reset pin, active low. Connects directly to Vss for automatic reset at power up.
5	VSS	Supply voltage. Connect to 3,3 – 5 V DC
6	NC	Not connected (reserved for later use)
7	RX	Serial receive input
8	TX	Serial transmit output
9	NC	Not connected (reserved for later use)
10	NC	Not connected (reserved for later use)
11	NC	Not connected (reserved for later use)
12	PGC	Clock pin for In-Circuit-Serial-Programming
13	PGD	Data pin for In-Circuit-Serial-Programming
14	VDD	Ground connection
15	OSC2	Crystal 4 MHz. Please refer to Microchip documentation for details
16	OSC1	Crystal 4 MHz. Please refer to Microchip documentation for details
17	NC	Not connected (reserved for later use)
18	PPM_OUT	Output pin with PPM signal

4

Standard application

The following schematic shows the standard application of the UART2PPM. The evaluation board which is available as a kit on **www.pikoder.com** is a full representation of the above reference schematic.



- **Room for notes -**

5

The PiKoder Control Center PCC

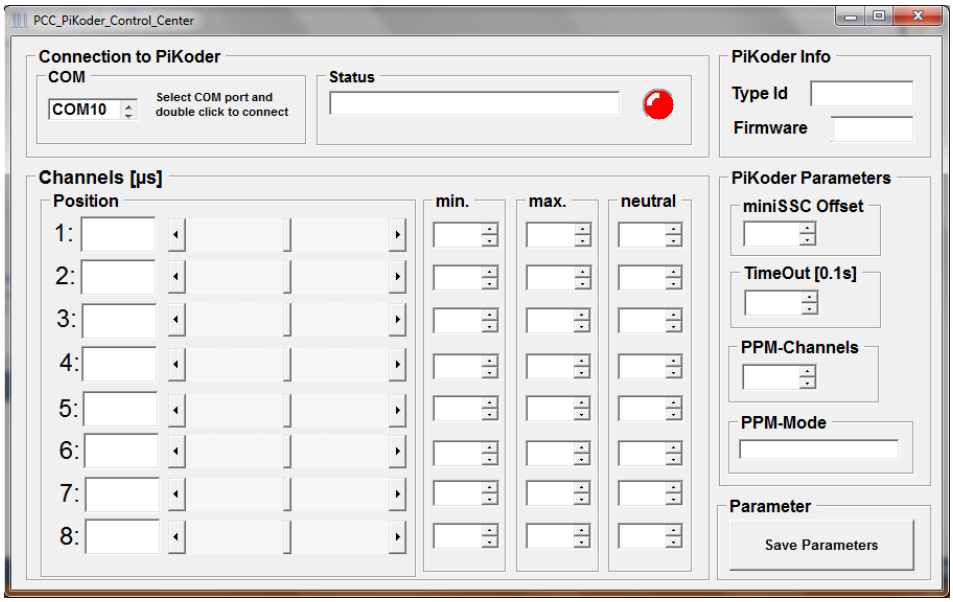
The UART2PPM's serial interface provides access to configuration options as well as support for real time control. The PCC PiKoder Control Center is a graphical tool that makes it easy for you to use this interface. For almost any project you will start by using the PCC PiKoder Contol Center to set up and test your PiKoder. This section explains the features of the PCC PiKoder Control Center.

Getting started

The hardware setup for the interface is simple and straight forward: You have to connect your UART2PPM with the USB port of your PC using a suitable USB converter and cable. This cable will provide also for the power supply of the UART2PPM.

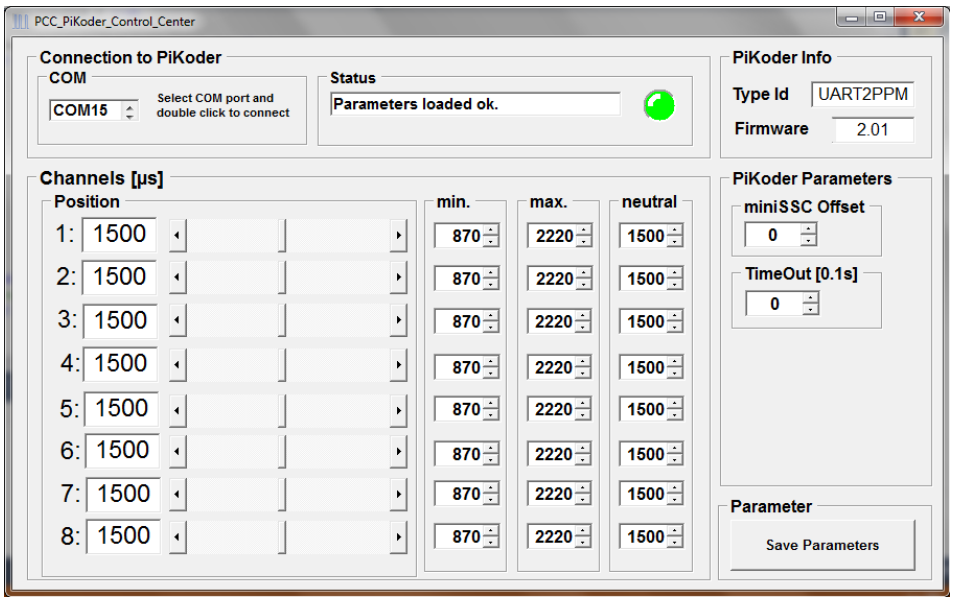
It is highly recommended that you download the latest version of the PCC PiKoder Control Center to enjoy the complete feature set of your PiKoder. The PCC PiKoder Control Center software is Open Source and released under the Apache License version 2.0. The source code is available through github (https://github.com/Pikoder/PCC_PiKoder_Control_Center), the executable for Windows 10 is available in the Microsoft app store free of charge.

After installing and starting the app, you will see the window as shown on the following page.



The PCC PiKoder Control Center application would show COM10 to be the first available port in your computer. Select the COM port your UART2PPM is connected to (in this example COM15, see below) and then click on the box to indicate your selection and communication to the controller will be established.

The LED color would change to green for an online indication and the current parameters and settings of the UART2PPM would be loaded and displayed as shown on the following page. The firmware version of your PiKoder would be displayed in the respective field.



You would now have full control of your PiKoder: either for real-time control by the sliders or for changing the settings and save the new parameters.

Real-time Control

The sliders are used for controlling the UART2PPM's outputs and the respective numerical fields monitor the status in real time displaying the current channel value in µs. A separate row of controls is displayed for each of the PiKoder's channels.

The key parameters for each channel such as min. and max. pulse width and neutral position can be set individually in the respective row. The PCC PiKoder Control Center will limit the slider value to the min. and max. value shown. This feature however is implemented in the Control Center. The PiKoder itself does not perform a parameter check and would therefore accept channel values outsite of the shown boundaries.

miniSSC Offset

This field is used in combination with the miniSSC protocol to determine the base offset for the actual controller. Please refer to "AN02 Daisy Chanining" for more information.

TimeOut [0.1s]

This field can be used to activate to program a time out fail-safe configuration. The time out value is shown in multiples of 0.1 s. The maximum input would be 999 resulting in a time out of 99.9 s.

As soon as you change the field value from zero the time out would be activated. From this point onwards the PiKoder/COM would be monitoring the UART input and expect to receive at least one character within each timeout interval. As soon as a message is received the time out interval is restarted. Please note that the PCC PiKoder Control Center does line monitoring in the background making sure that the time out does not occur while you are programming the PiKoder.

If the PiKoder input would be timed out, then the PiKoder would copy the neutral values to the respective channel to create a predetermined output situation.

- **Room for notes** -

6

Serial Interface

The PiKoder's serial interface is based on TX and RX lines, which allow the controller to send and receive non-inverted, TTL (0 – 5V) serial bytes. The parameters for the serial transmission are 9600 Baud, 8 data bits, one stop bit, with no parity.

The bytes sent to the UART2PPM are commands which allow you to control the program and control the PiKoder. The UART2PPM supports two protocols:

- MiniSSC protocol representing a very common protocol for controlling Serial Servo Controllers
- a two-way ASCII-Protocol designed to support controlling the UART2PPM with standard terminal programs such as (but not limited to) TerraTerm, Putty, hyperterm

The PiKoder does automatically detect the terminal protocol; no user interaction would be required.

Mini SSC Protocol

This protocol is mostly used for servo controllers (SSC) but could also be deployed to control a UART2PPM.

It only takes three serial bytes to set the value for a channel, so that this protocol is suitable if need to send many commands rapidly. The Mini SSC protocol is to transmit 0xFF as the first (command) byte, followed by a servo number byte, and then the 8-bit servo target byte for the servo position.

A servo target byte of 127 (0x7F) will always indicate the neutral position maintained as a PiKoder parameter.

The actual position taken by sending a servo target byte to the controller is calculated depending on the actual parameters. If you wanted to move the servo from neutral towards the upper limit, then the increment in pulse length *du* is calculated based on:

du = (Upper Limit – Neutral) / 127 Steps

This means for example, that with an upper limit of 2008 µs and a neutral position of 1500 µs an increment of one in the servo target byte would result in:

du = (2008 – 1500) µs / 127 Steps = 4 µs/Step

Therefore, a servo target byte of 0x80, which is an increment of one to the neutral position would result in a pulse length of 1500 µs + 4 µs = 1504 µs.

The same procedure is applied when you wanted to move the servo from neutral towards the lower limit; then the decrement in pulse length *dl* is calculated based on:

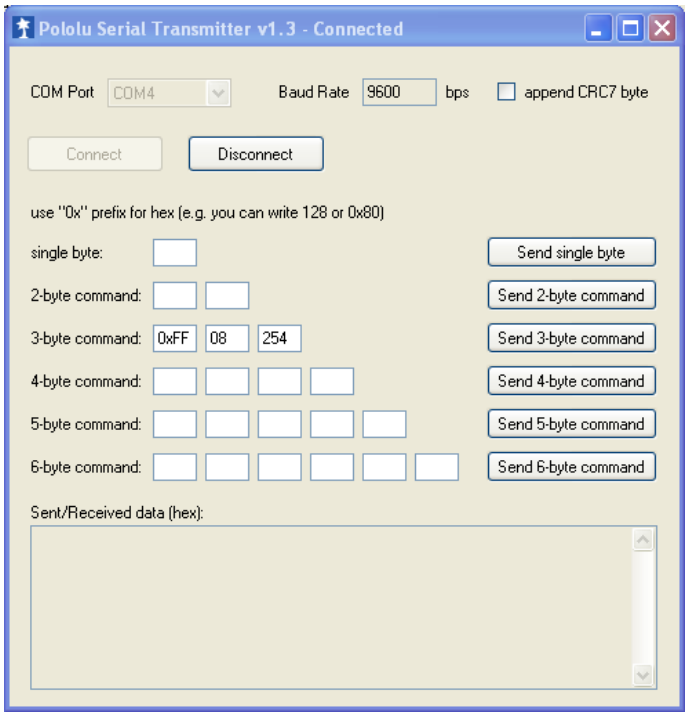
dl = (Neutral - Lower Limit) / 127 Steps

Please note the following with respect to *du* and *dl*:

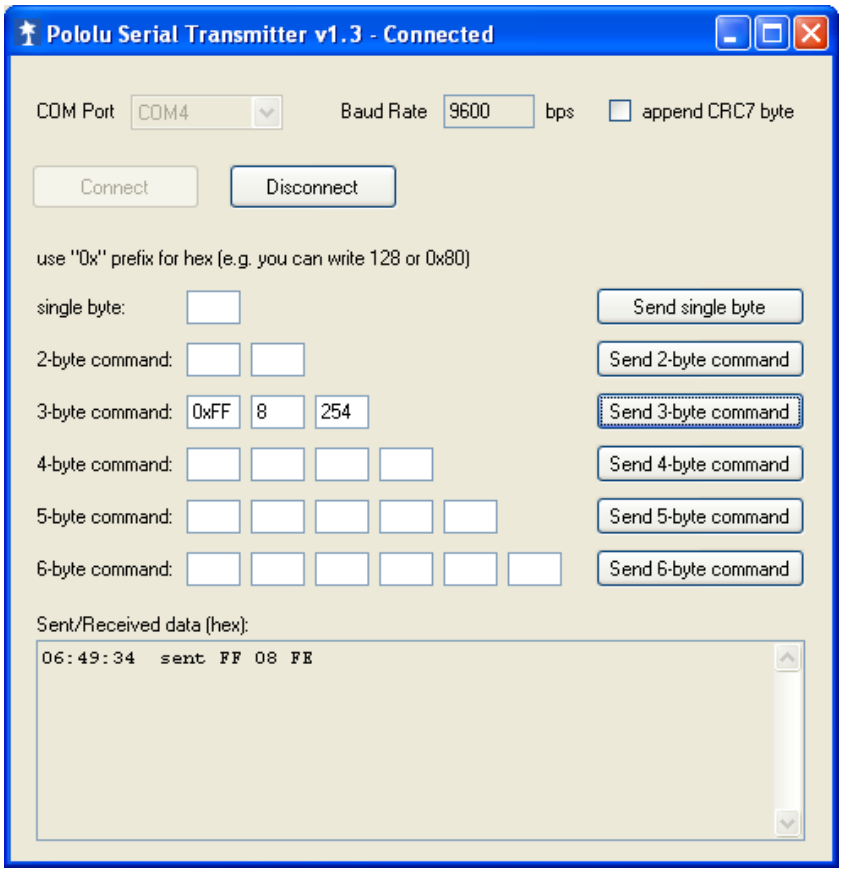
- *du* and *dl* are calculated per channel and may differ per channel allowing for asymmetric ranges and a neutral position outside of the mechanical central position of the servo
- *du* and *dl* are calculated during controller startup. With firmware release 2.4 these parameters are updated when you change the values of neutral, upper, or lower limit without resetting the controller.
- *du* and *dl* are calculated based on 8 bit arithmetic. Depending on the numbers a slight overrun over the upper limit resp. a slight underrun of the lower limit may occur.

For testing the miniSSC protocol you may want to use a byte oriented tool such as the "Pololu Serial Transmitter" utility for Windows (see http://www.pololu.com/docs/0J23 for more details).

After installing and starting the software you would have to connect to the UART2PPM by selecting the COM port and pushing the connect button. The miniSSC-protocol is a three-byte command and should be entered in the respective column as shown below.



Once you hit the "Send 3-byte command"-button the bytes are sent to the PiKoder (see below); as per protocol definition there is no response by the UART2PPM.



ASCII Command Interface

The ASCII Command Interface (ACI) is probably the most versatile way to program the PiKoder without any specific host software such as the "PCC PiKoder Control Center". All commands are simple ASCII and are sent using a Windows based terminal program such as Hyperterm or Tera Term. The commands can be typed in right away and the response of the controller is readable without referring to any specific code tables. Please note that neither 'CR' nor 'LF' is needed to send the command to the controller.

There are two basic types of commands: commands for querying parameters and for setting parameters.

If a parameter is read the PiKoder will provide for proper formatting by sending a "CRLF" prior to sending the parameter value and support readability by sending another "CRLF" after the parameter value.

If a parameter is set the PiKoder will acknowledge the proper execution by sending an "!" framed by "CRLF".

If a command could not be interpreted at all then a question mark '?' framed by 'CR' 'LF' would be echoed. Please note that protocol syntax checking is very limited.

The following ACI commands are available:

- '?': query the PiKoder type information; the PiKoder/COM will respond with "T=UART2PPM".
- '0': query the firmware version; PiKoder will respond in a format 'n.nn' framed by 'CR' 'LF'
- 'i?': query the current pulse width for channel i (i = 1..8); PiKoder will respond 'CR' 'LF' 'xxxx' 'CR' 'LF' with xxxx representing the pulse width in µs
- 'i=xxxx': set the pulse width for channel i to xxxx µs (xxxx in decimal format, i = 1..8); PiKoder will acknowledge execution of the program by sending an 'CR' 'LF' '!' 'CR' 'LF'
- 'S','s': will save the current parameters to the controller's EEPROM making the current servo positions the start up positions after powering up; returns a '!' upon successful completion framed by 'CR' 'LF'
- 'Ui?': query the upper limit for pulse width for channel i; PiKoder will respond 'xxxx' with xxxx representing the pulse width in µs (xxxx in decimal format, i = 1..8) - the command is not case sensitive; the output is formatted with 'CR' 'LF'
- 'Ui=xxxx': set the upper limit for pulse width for channel i to xxxx µs (xxxx in decimal format, i = 1..8); PiKoder will acknowledge execution with a '!' framed by 'CR' 'LF'.

- 'Li?': query the lower limit for pulse width for channel i; PiKoder will respond 'xxxx' with xxxx representing the pulse width in µs (xxxx in decimal format, i = 1..8) - the command is not case sensitive; the output is formatted with 'CR' 'LF'
- 'Li=xxxx': set the lower limit for pulse width for channel i to xxxx µs (xxxx in decimal format, i = 1..8); PiKoder will acknowledge execution with a '!' framed by 'CR' 'LF'.
- 'Ni?': query the pulse width for the neutral position for channel i; PiKoder will respond 'xxxx' with xxxx representing the pulse width in µs (xxxx in decimal format, i = 1..8) - the command is not case sensitive
- 'Ni=xxxx': set the pulse width for the neutral position for channel i to xxxx µs (xxxx in decimal format, i = 1..8); - the command is not case sensitive and the PiKoder will acknowledge execution with a '!' framed by 'CR' 'LF'.
- 'M?' or 'm?': query the current channel offset for the miniSSC-protocol.
- 'M=iii' or 'm=iii': set the channel offset for the miniSSC-protocol.
- 'T=iii','t=iii': enables the fail safe timer. 'iii' is given in multiples of 0.1 s. Please note that input is always given in three decimal digits ranging from '001' (= 0.1 s) to '999' (= 99.9 s). In the factory default configuration the fail safe timer is not active. You would activate the monitoring by sending a time out value > 0, a value of 0 would disable the timer function. Command execution is acknowledged by the PiKoder with a '!'.
- 'T?','t?': query the current time out value in multiples of 0.1 s. A response of '000' indicates that the fail-safe function is not activated.

- **Room for notes** -

7

Connect the UART2PPM to a Raspberry Pi

The UART2PPM releases your Raspberry Pi from generating real-time pulses for controlling servos ('Set and forget'-function).

This is advantageous when using elaborate operating system such as LINUX, because their real-time capabilities are limited due to the number of concurrent tasks. This might limit the precision of the signals generated.

The UART2PPM connects to your Raspberry's UART and is operating with 3.3 Volts, which is supplied by your Raspberry Pi.

The schematic is shown on the next page.

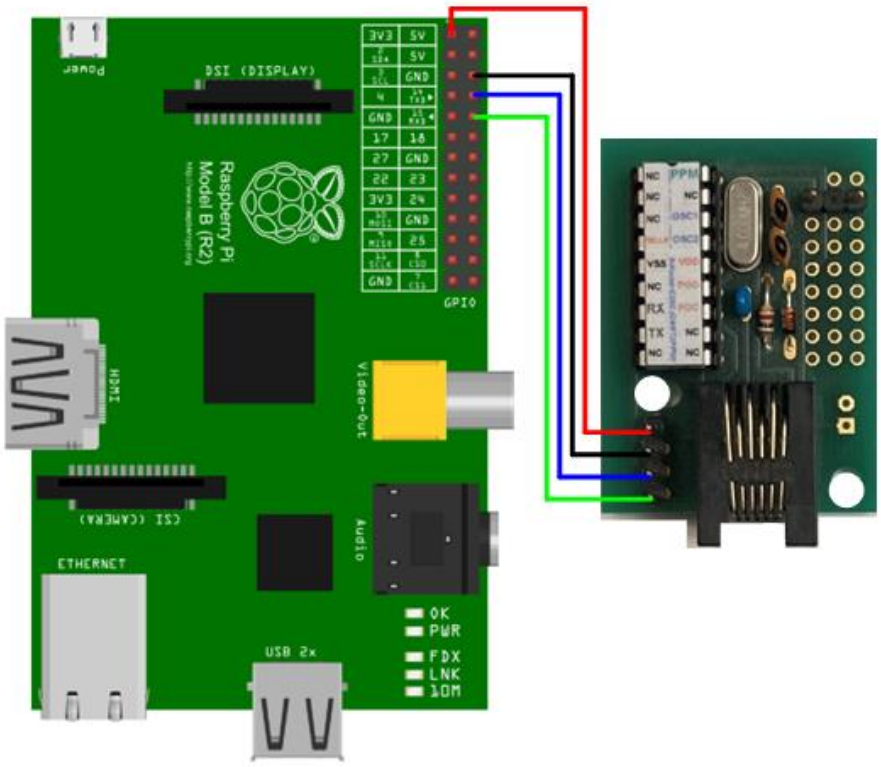
Software configuration and hardware setup

The software configuration and the hardware setup require three simple steps:

- Turning of the UART as a serial console
- Wiring
- Installing terminal software such as Minicom

Turning of the UART as a serial console

In your Raspberry Pi's default configuration, the UART is used as a serial console. This function must be deactivated to use this port to control the UART2PPM with e.g., a terminal software or a Python script. The process of turning of the serial console is described in various blogs and may vary slightly depending on your distribution.



Wiring scheme for connecting your UART2PPM to a Raspberry Pi

Wiring

The wiring is shown in the schematic at the top of this page. Please turn of all components to avoid damage by unintended shorts.

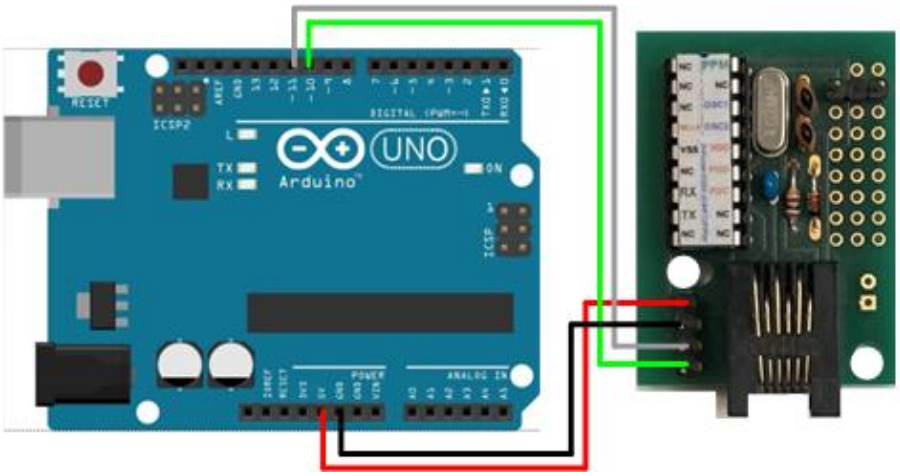
Installing terminal software such as Minicom

You will also find more information about the installation of Minicom in various Raspberry Pi related blogs. When starting the software please make sure to set the baud rate of the UART to 9600 Baud required by the UART2PPM. For your convenience it is recommended that you activate the local echo (command "E"). After setting these parameters you can control your UART2PPM using the ASCII commands listed in section 6 of this User's Guide.

8

Connect the UART2PPM to an Arduino

The UART2PPM releases the Arduino from generating time critical pulses required for a PPM frame. The setup is shown below.



Interface Software

ASCII-based interface

The following sketch would allow you to test the servo shield by entering UART2PPM commands (please refer to section 6 for a full interface description). The Sketch Interface_Test (.ino-Datei) can be downloaded here. This sketch is Open Source and is released under a GNU General Public License Version 3.

.