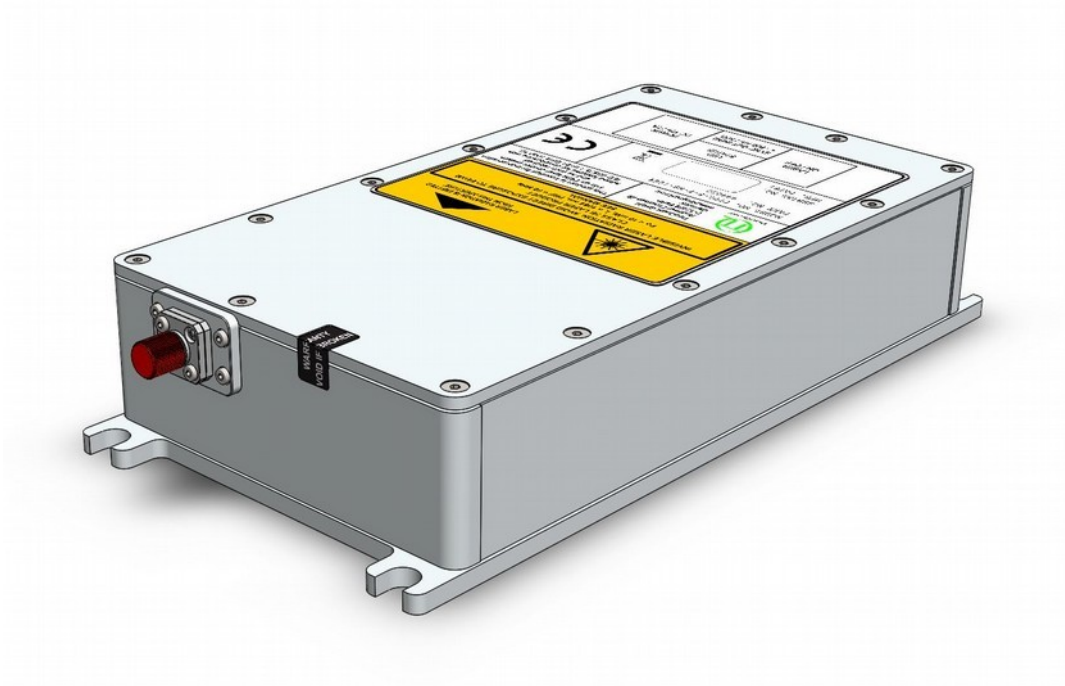# PPx 512

OEM Laser Platform

Arbitrary laser waveform generator with optical fiber output

User's Manual

Document version 1.0.3

Table of Contents

1.   General safety information

CAUTION!   Before using this device, make sure that you have read and understood the content of this user manual. Store this documentation in a safe and easily accessible place for future reference.

Incorrect handling of this product may result in personal injury or physical damage. The manufacturer assumes no responsibility and cannot be held liable for any injury / damages resulting from operating the device outside of the normal usage defined in this manual.

1.1.   Warning symbols and conventions

The following symbols and conventions will be used throughout this manual. Please take time to familiarize yourself with their meaning before proceeding.

	The **general safety alert symbol** is used to alert you to hazards that may lead to personal injury or physical damage. Follow all associated safety instructions to avoid possible injury or death.
	A **high voltage warning symbol** is used to indicate the presence of un-insulated, dangerous voltage inside the enclosure. Note that this voltage may be sufficient to constitute a risk of shock.
	The **laser radiation warning symbol** alerts you that the device can generate laser radiation. Follow all applicable laser safety instructions to avoid injury or damages.
	The device's susceptibility to electrostatic discharge (ESD) is indicated by the **ESD warning symbol**. Ensure that you follow proper ESD protection rules to avoid damaging the device.
CAUTION!	Make sure to follow any instructions prefaced with "**CAUTION!**" to avoid personal injury or damaging the device.
WARNING!	The "**WARNING!**" label prefaces any instructions that shall be followed to avoid severe injury or death.
NOTICE	Important tips and information for device operation that do not include a risk of injury or damage are prefaced with the "*NOTICE*" label.
	This symbol indicates that an earth terminal shall be connected to the ground (to avoid risks of electrical shock).

1.2.   Electrical safety instructions

WARNING! The connection of all conductive housings, electrical equipment with a grounded protective conductor and with the main earthing bar is the basis for protection against electric shock (*protective earthing*). Therefor all housings and power sockets must be grounded according to the standards **IEC 60364-4-41:2005 and DIN VDE 0100-410:2007-06** (for Germany).

The technical design for the equipotential grounding, the dimensioning of the cross-sections and the standardized terms are given in the international standard **IEC 60364-5-54: 2011** and the **DIN VDE 0100-540: 2012-06** (for Germany).

Never connect or disconnect any cable while the system is powered ON. This device contains electrical components that are not user serviceable. Servicing of these internal electrical components is restricted to qualified personnel.

Disconnect the power cord from the electrical outlet before performing any maintenance.

1.3.   Laser safety instructions

WARNING! Visible and invisible laser radiation

The PPx 512 can emit visible, infrared or UV laser light. Infrared or UV light is not visible to the eye! **This laser can emit laser light of up to class 3b / IIIb.** Please refer to the labels affixed to the laser housing for information on classification.

Lasers can be hazardous and have unique safety requirements. Permanent eye injury and blindness is possible if lasers are used incorrectly. Pay close attention to each safety related CAUTION and WARNING statement in the user manual. Read all instructions carefully BEFORE operating this device.

The lasers of the PPx 512 Series are intended for incorporation into an OEM laser control system, and as such required added features for compliance with IEC 60825-1 or 21 CFR 1040.10 which have to be provided by the integrator.

Required laser safety measures

Please observe the laser safety measures for class 3b / IIIb lasers in accordance with applicable national and federal regulations. The owner / operator is responsible for observing the laser safety regulations.

What does the owner / operator have to observe?

- The owner / operator of this product is responsible for proper and safe operation and for following all applicable safety regulations.

- The owner / operator is fully liable for all consequences resulting from the use of the laser for any purposes other than those listed in the operating manual. The laser may be operated only by persons who have been instructed in the use of this laser and the potential hazards of laser radiation.

- The owner / operator is responsible for performing and monitoring suitable safety measures (according to IEC/EN 60825-1 and the corresponding national regulations).

- The owner / operator is also responsible for naming a laser safety officer or a laser protection adviser (according to the standard IEC/EN 60825-1: "Safety of laser products, Part 1: Classification of systems, requirements and user guidelines" and the respective national regulations).

The following security instructions must be followed at all times.

General safety instructions for operation

- Never look directly into a laser beam or a reflection of the laser beam. Avoid all contact with the laser beam.

- Do not introduce any reflective objects into the laser beam path. This includes jewelry, watches, etc.

- Every person involved with the installation and operation of this device has to:
  - Be qualified
  - Follow the instructions of this manual

- As it is impossible to anticipate every potential hazard, please be careful and apply common sense when operating the laser diode heads and associated driver unit. Observe all safety precautions relevant to Class 3b / IIIb lasers.

- Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

1.4.   Laser safety labels

The safety labels are affixed to the top of the laser head housing, with an arrow pointing towards the laser emission aperture (see Fig. 1). The label states the laser product classification, certification, power, and wavelength range relevant for the classification.

LASER RADIATION IS EMITTED FROM THIS APERTURE

INVISIBLE LASER RADIATION. AVOID DIRECT EXPOSURE TO BEAM
CLASS 3B LASER PRODUCT
Po < 450 mW, λ = 1064 nm
SEE MANUAL

PicoQuant GmbH
Rudower Chausee 29
D-12489 Berlin
Germany

This product is intended for incorporation into an OEM laser control system, and as such required added features for compliance with IEC 60825-1 or 21 CFR 1040.10

Model No.:   PPA 512-1060
Part No.:   910060

Serial No.:   123456789
Mfg. Date.:   N5

www.picoquant.com

LASER ON TTL	SYNC OUT 0,5 V / 50 Ω	OP MODE 500 Ω
STATUS	USB	POWER DC 12 V / 2A

Fig. 1: Example of laser warning, certification, and classification label.

Please refer to the *laser delivery report* in the Appendix for information on the central emission wavelength, maximum achievable optical output power, and pulse shape of the delivered PPx 512 laser.

CAUTION!	Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure!

2.   Introduction

Please take the time to read this manual carefully before using your PPx 512 laser platform product. Make sure that you have understood and follow all electrical and laser safety instructions given in section 1, General safety information.

Devices based on the PPx 512 laser platform are compact, OEM arbitrary waveform laser modules. They implement a single mode fiber coupled laser diode (PPL 512) which is emitting laser radiation or incorporate a semiconductor optical amplifier (PPA 512) with required external optical input.

The PPx 512 is based on a programmable waveform generator (DAC), that permits to generate electrical pulse patterns in a cyclic sequence of 512 bytes. The 512 bytes are stored in a special high-speed memory that can be read out at the full speed of 5 GS/s. This results in a timing resolution of 200 ps per byte (other values possible on request). By loading a data set, arbitrary pulse sequences can be defined with an amplitude resolution of 8 bits (0 to 255). This pre-defined sequence can then be run as a gap less loop at the full speed of 5 GS/s or started and stopped by an external control signal. The output of the internal DAC is amplified feed to the laser diode. The achievable optical waveform highly depends on the used laser diode. Typically gain-switching is as also possible as cw-mode.

Control input:

Additional external signal input is available to control the reading of the sequence.

Synchronization output:

A synchronization signal is output by the PPx 512, that signals the full period of all 512 bytes, i.e. every 102.4 ns.

Controlling and Programming over Virtual COM-Port:

The PPx 512 can be OS independent controlled over a human readable ascii terminal (Windows: TeraTerm; Linux: Miniterm). For sending waveform data, the interface switches to a special mode with CRC check at the end of transmission. After receiving all 512 bytes the interface switches automatic back to normal ascii mode.

Modules derived from the PPx 512 laser platform are stand-alone devices including an internal laser driver unit.

3. Hardware Description

3.1. Hardware interface – operating controls and connections
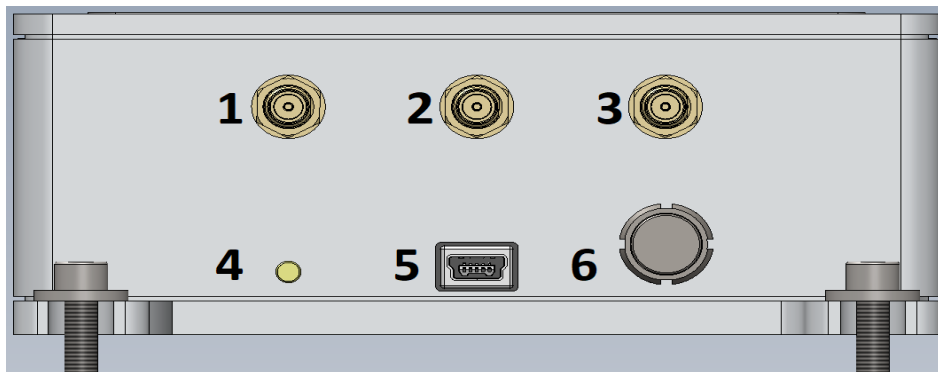
Fig. 2: Back Panel of PPx 512

1. **LASER ON**:   female SMA connector for TTL signal indicating laser operation (see section 9).
2. **SYNC OUT**:   female SMA connector for synchronization output (see section 9).
3. **OP Mode**:   female SMA connector for selecting operation mode (see section 9).
4. **STATUS LED**: turns green when Laser emission is ON (see section 4).
5. **Mini-USB**:   USB virtual COM Port
6. **POWER**:   input socket (Lemo, 2 pin, type 0B) for the power supply DC 12V / 2A.

3.2. Unused ports

In order to ensure proper Electro Magnetic Compliance (EMC), we recommend plugging an SMA terminator plug (50 Ohms) into any unused port.

3.3. Optical Interface

The PPL 512 features only one optical output FC/APC receptacle with narrow key on the front panel.

The PPA 512 comes with an additional optical input FC/APC receptable on the front panel. Please note, that sufficient optical input power in the specified wavelength range is required. Otherwise, the PPA will emit only low power broadband spontaneous emission signal.

3.4. Configurations
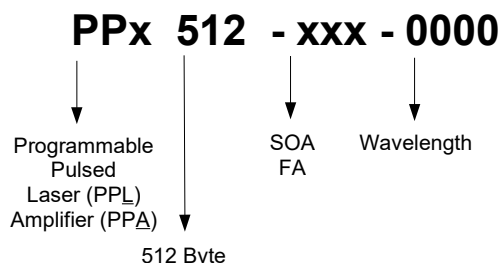
PPL 512-1550	Programmable Laser Diode – Stand alone
PPA 512-1060	Programmable Semiconductor Amplifier with requiring external optical input
PPL 512-SOA-1053	Programmable Semiconductor Amplifier using an internal seed with fixed wavelength
PPL 512-FA-1030	Programmable Laser Diode with single stage fiber amplifier

4.   System states

A detailed description of the different states is given in 5.1 .

4.1.   POWERUP

- •   STATUS LED........................... blinking orange
- •   UART...................................... print start report
- •   FUNCTION .... BIST
- •   Seed .... OFF
- •   Status Output.......................... LOW

4.2.   STANDBY

- •   STATUS LED........................... orange
- •   UART...................................... waiting for commands
- •   FUNCTION .... waiting for valid power supply
- •   Seed .... OFF
- •   Status Output.......................... LOW

4.3.   WORKING

- •   STATUS LED........................... green
- •   UART...................................... waiting for commands
- •   Seed .... ON
- •   Status Output.......................... HIGH

4.4.   ERROR

- •   STATUS LED........................... red
- •   UART...................................... waiting for commands
- •   Seed .... OFF
- •   Status Output.......................... LOW
- •   exit error state only possible with reset (power cycle or reset command)

5.   Detailed Description

The block diagram in Fig. 3 describes briefly the data flow in the PPx 512. A microcontroller receives all 512 bytes of the user defined waveform over the USB interface (VirtualCOM-Port). After all waveform data is send a CRC check is preformed. Now the microcontroller loads the waveform data into the RAM of the programmable waveform generator.

While loading data into the RAM the laser output is turned off by generating 0x00 at the DAC output. This becomes necessary because the address decoder is still running in an endless loop and therefore its putting data to the DAC. While overwriting existing data with new content the output would mix both waveform (old and new). Also the address counter reset to byte 0.
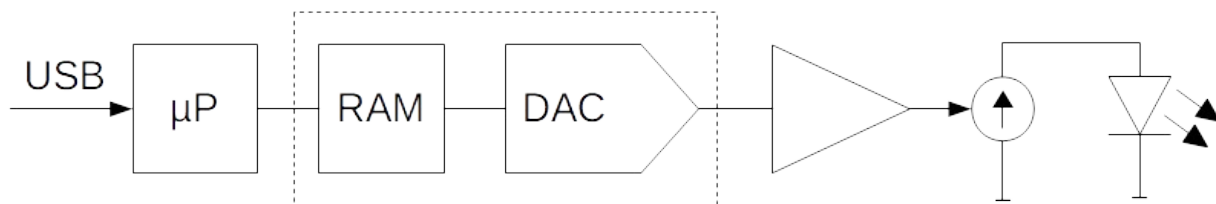
Fig. 3: Simplified Block diagram of the PPx 512

5.1.   System states

5.1.1.   POWERUP

PPx 512 switches from *STANDBY* to *POWERUP* state if a valid power supply is detected and runs a build in system test (BIST). Within this test the TEC is set to the stored temperature and waits for settling.

If BIST was successful the latest waveform date is loaded to the RAM and the laser turns on. Now PPx 512 enters the *WORKING* state and load the latest waveform in the RAM of the waveform generator.

WARNING! **Visible and invisible laser radiation**

When BIST was not successful the PPx 512 enters *ERROR* state and all power supply is turned off

5.1.2.   STANDBY

When only the USB is connected the PPx 512 is in *STANDBY* state. This means that all internal power supply is off and all measured voltages, currents or temperatures are not valid, except the values belongs to the external power supply.

Is a valid power supply attached then the PPx 512 changes to *POWERUP* state.

5.1.3. WORKING

While *WORKING* the PPx 512 is active and the laser output is on. It checks also periodically the TEC temperature and the external power supply. If one or both are out of limit the PPx 512 changes to *ERROR* state and turn off all internal power supply and also the laser output.

 WARNING! **Visible and invisible laser radiation**

5.1.4. ERROR

In *ERROR* state all internal power supply is turned off. To exit this state a power cycle or a software reset (UART: SYS:RES!) is needed.

5.2. Write waveform to PPx 512

For writing new waveform data to PPx 512 the interface have to be set to data mode. This is done by sending *SYS:DATA!* The interface responses with *ACK* and now accepts only characters which are used for hexadecimal representation (0..9, A..F, a..f, x).

Now the PPx 512 waits for 512 bytes (waveform) and 2 bytes (CRC). The PPx 512 expects the data in 8 bit hexadecimal form with semicolon as separation character between each bytes. After sending the last character the PPx 512 will respond with *ACK* or *NACK (see Fig. 4).*

CRC checksum is preformed on all 512 bytes which represents the amplitude values. For how to calculate the CRC checksum see 8.2.

Only when the PPx 512 response with *ACK* after the CRC checksum was sent, the new waveform is stored in the nonvolatile memory of the PPx 512 and is loaded to the RAM of the waveform generator. If the transfer was not successful, the previous waveform is still active. To readout the active waveform use *SYS:DATA?*.

For designing a waveform see also 8.3.

Fig. 4: Terminal output after successfully sending a new waveform. Note that 0xfa and 0x30 (0xfa30) is the CRC checksum.

5.3.   Synchronization output

The 50 Ohm synchronization output toggles between 0 and 500 mV. When the address counter reach address 253 the sync produce a falling edge and if it reached address 508 the sync produce a rising edge. For proper timing keep in mind that different cable length can yield to time shift.

Fig. 5 shows the relation between SYNC and optical out. OP Mode is left open so PPx 512 is in free-running mode. The optical output is measured with Tektronix SA-42 optical to electrical converter. For correct understanding of Fig. 5 it is to say that the laser diode need some time to build up enough energy to emit some light.

The programmed waveform in Fig. 5 consist of:
- Byte 0..253   = 0x00

- Byte 254..508   = 0xFF

- Byte 509..511   = 0x00
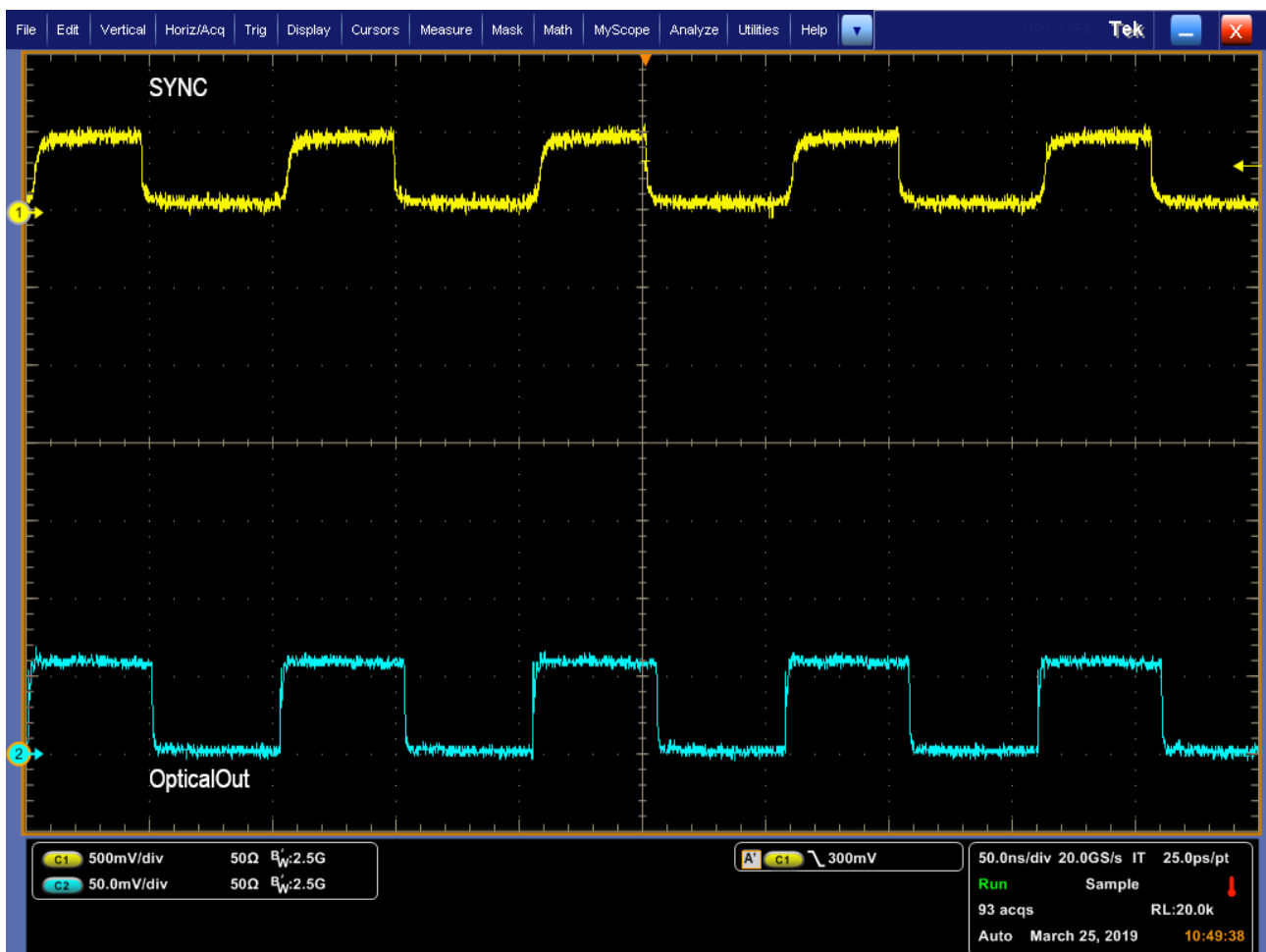
Fig. 5: Relationship between sync and optical output

5.4.   Operation Mode (OP Mode)

The *OP Mode* input is intend for generating a single run or a burst of the programmed waveform. Because of the read cycle period of 102.4 ns the repetition is limited to ~9.766 MHz.

If no signal is applied to *OP Mode* the PPx 512 reads periodically the RAM content, i. e. after reading byte 511, reading starts again at byte 0. This is also true for a high signal (0.75 to 1.1 V) at *OP Mode*.

If *OP Mode* changes to Low (0 to 0.2 V) the reading process will be stopped by the next time the internal counter reaches byte 505. To make sure that the laser is off after reading, every byte beyond 505 should be zero.

In Fig. 6 burst generation is shown. The signal at *OP Mode* has a frequency of 1 kHz and an on-time of 250 ns, that's why the PPx 512 generates every 1 ms 3 pulses. The programmed waveform consist of:

- •   Byte 0..225   = 0x00
- •   Byte 226..506 = 0xFF
- •   Byte 505..511 = 0x00

For proper operation shift the falling edge of *OP Mode* in the middle of the programmed waveform. I.e. to generate a single run (102.4 ns) select an on-time of 50 ns.
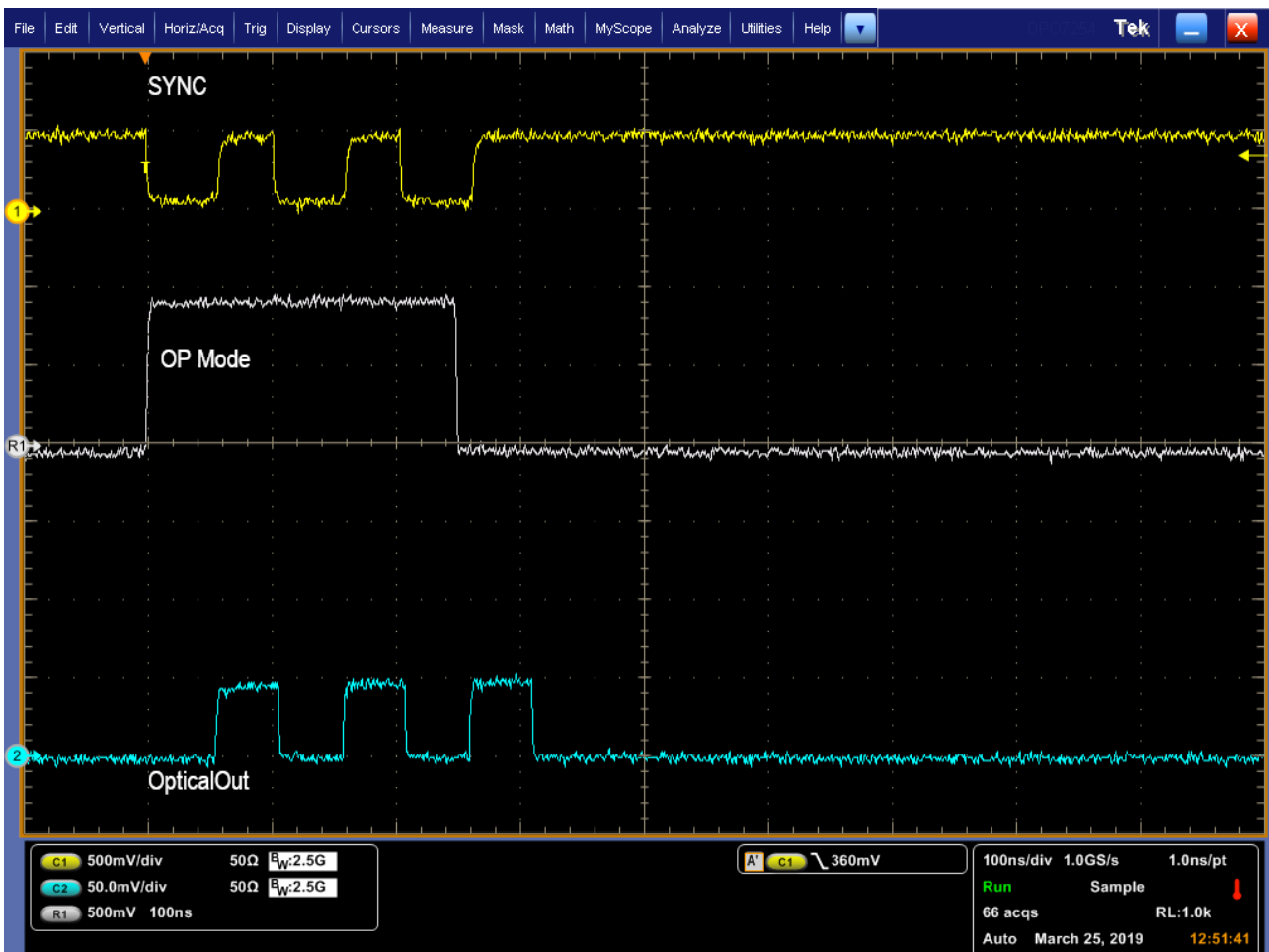
Fig 6: Generating Burst by using OP Mode.

6.   UART-Control Interface

- • Use only uppercase letters, numbers and special character '!' and '?'
- • single white space is also possible depending on command but not in numerical values
- • only use short form (uppercase part) of command
- • command processing starts with *newline*
- • system response:
  - ○ *BUSY*   system is busy and can therefore not handle command
  - ○ *ACK*   response for every correct set command (ends with '!')
  - ○ NACK   response for commands with wrong parameter
  - ○ *COMMAND UNKNOWN*   wrong or misspelled command

6.1.   Command-Tree
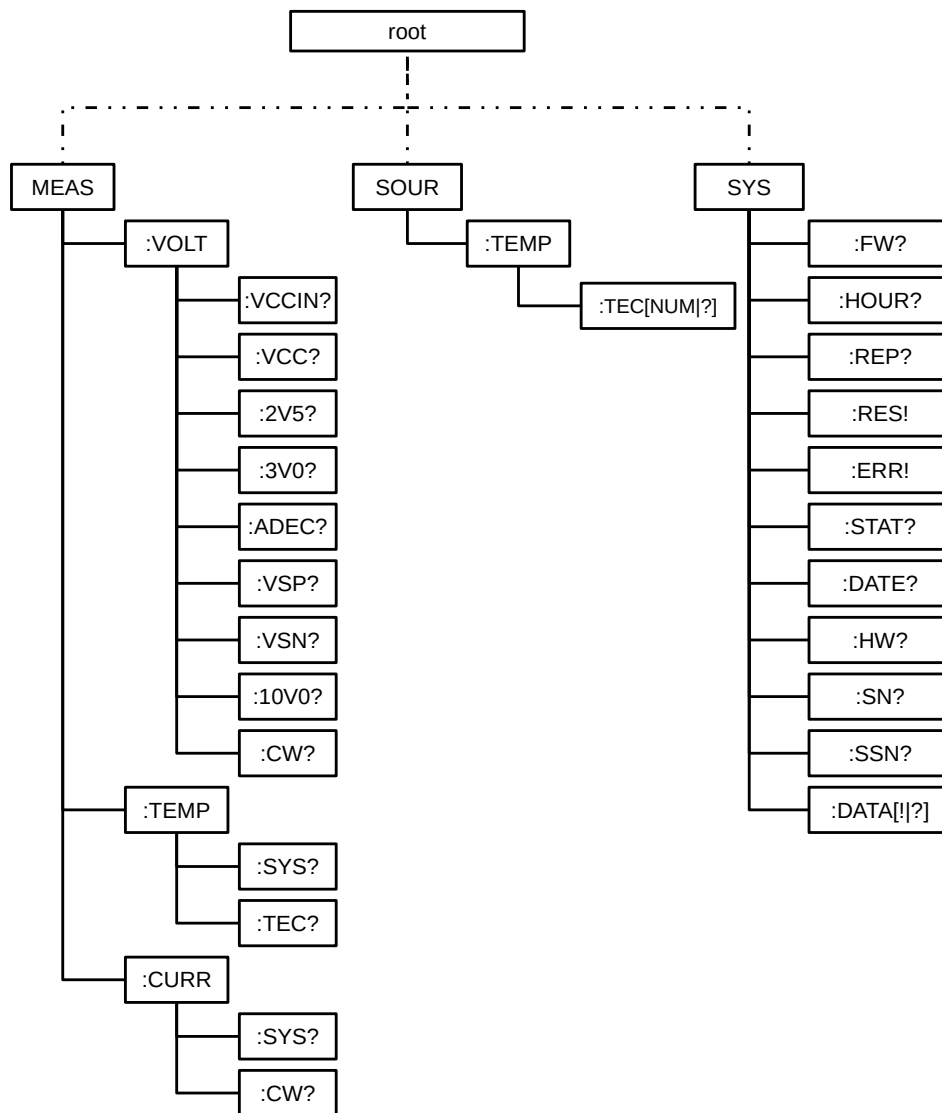
Fig. 7: UART Command Tree

6.2.   Command Reference

- **SYS**tem
  - **:FW?**
    - Print firmware version
  - **:HOUR?**
    - Print total uptime
  - **:REP**ort**?**
    - print report
  - **:RES!**
    - Reset System
    - Switch laser components off
    - system restarts with stored values
  - **:ERR**or**!**
    - Change to error state
  - **:STAT**us**?**
    - Print current state
  - **:DATE?**
    - Print production date
  - **:HW?**
    - Print hardware revision
  - **:SN?**
    - Print serial number
  - **:SSN?**
    - Print serial number of seed diode
  - **:DATA!**
    - Switch to data mode
  - **:DATA?**
    - Print active waveform without CRC checksum
- **MEAS**ure
  - **:VOLT**age
    - **:VCC**in**?**
      - Voltage external power supply in mV
    - **:VCC?**
      - Internal power supply
    - **:2V5?**
      - Internal power supply 2.5 V
    - **:3V0?**
      - Internal power supply 3.0 V
    - **:ADEC?**
      - Internal power supply for address decoder
    - **:VSP?**

- • Internal positive power supply for internal amplifier
  - ▪ **:VSN?**
    - • Internal negative power supply for internal amplifier
  - ▪ **:10V0?**
    - • Power supply for laser diode cw current source
  - ▪ **:CW?**
    - • Voltage at cw current source
  - ○ **:TEMP**erature
    - ▪ **:TEC?**
      - • Seed temperature in m°C
    - ▪ **:SYS?**
      - • Internal system temperature in m°C
  - ○ **:CURR**ent
    - ▪ **:SYS**tem**?**
      - • Current drawn from external power supply in mA
    - ▪ :**CW!**
      - • Equivalent CW current through laser diode
- • **SOUR**ce
  - ○ **:TEMP**erature
    - ▪ **:TEC?**
      - • Print stored seed temperature in m°C
    - ▪ **:TEC** <num>
      - • set seed temperature in m°C (max. 50000)

6.3.   Command Examples

- • MEAS:VOLT:VCC?
  - ○ Print measured voltage from external power supply
- • SOUR:TEMP:TEC 22123!
  - ○ set TEC temperature to 22.123 °C
  - ○ system response: *ACK*

7. PPx512 Control

PPx512 Control is a LabView based frontend to programm a desired waveform into the PPx 512.

7.1. Installation

The PPx512 Controller software can be distributed on CD, via download or via email. If you received the package via download or email, it may be packed in a zip-file. Unzip that file and place the distribution setup files in a temporary disk folder. In order to avoid problems with strict mail filters, the setup program setup.exe may have been renamed to setup.ex_. In that case, please rename it back to setup.exe.

Do not connect the device before completion of the software setup.

Dependent on your version of Windows you may need to log on as administrator in order to perform the soft-ware setup.

The setup program will install the PPx512 Controller software PPx512_Control.exe (GUI) and corresponding manuals. Depending on your system, the setup program might also install LabVIEW Runtime-Engine 2017. In that case a reboot of your system is necessary. The setup program will also copy LabVIEW VIs in the install directory. In order to run these VIs you'll need the LabVIEW IDE (version 2017 or later). If needed additional components like the runtime environment will be downloaded and installed.
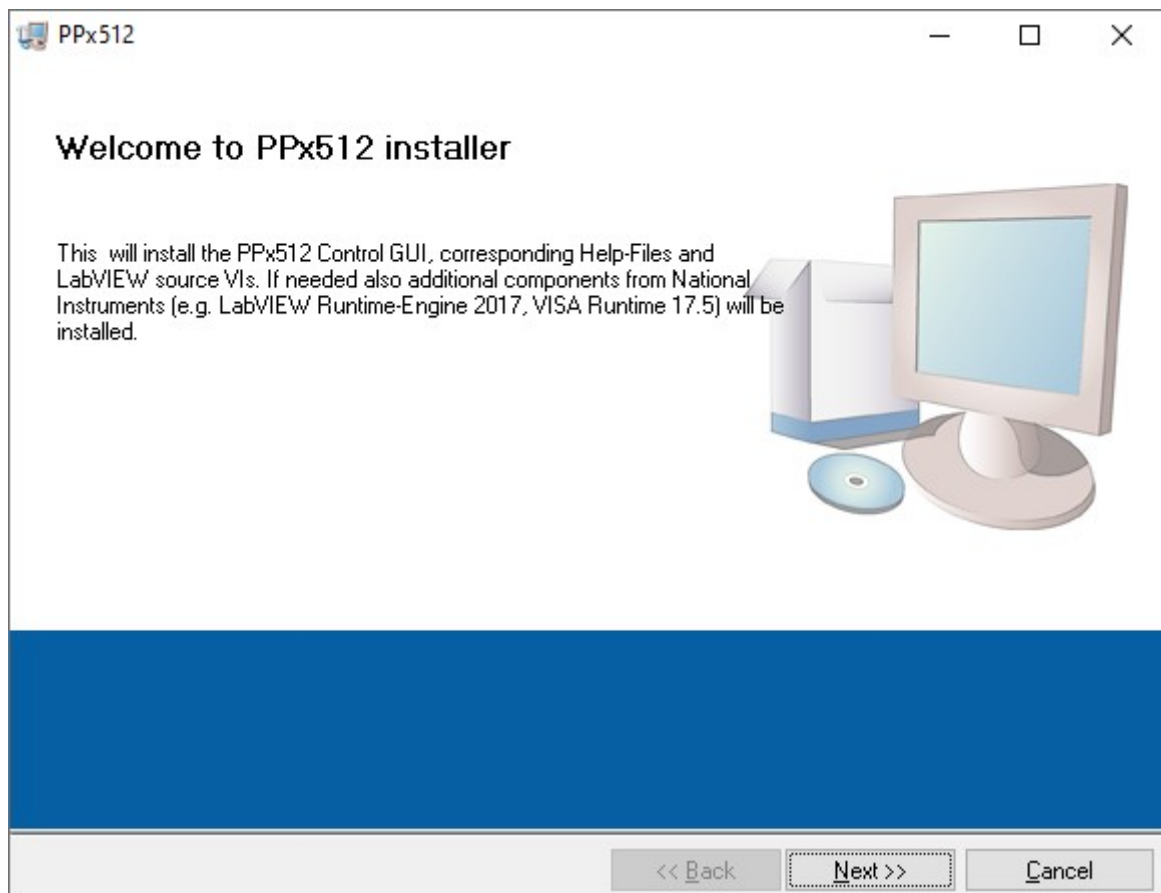
Fig. 8: Installation

7.2.   Using PPx 512 Control

Connect the PPx 512 to the PC by using the USB cable and power up the device. If the status LED at the PPx 512 is green, the PPx512 Control software can be started. The actual waveform is read out and will be displayed.
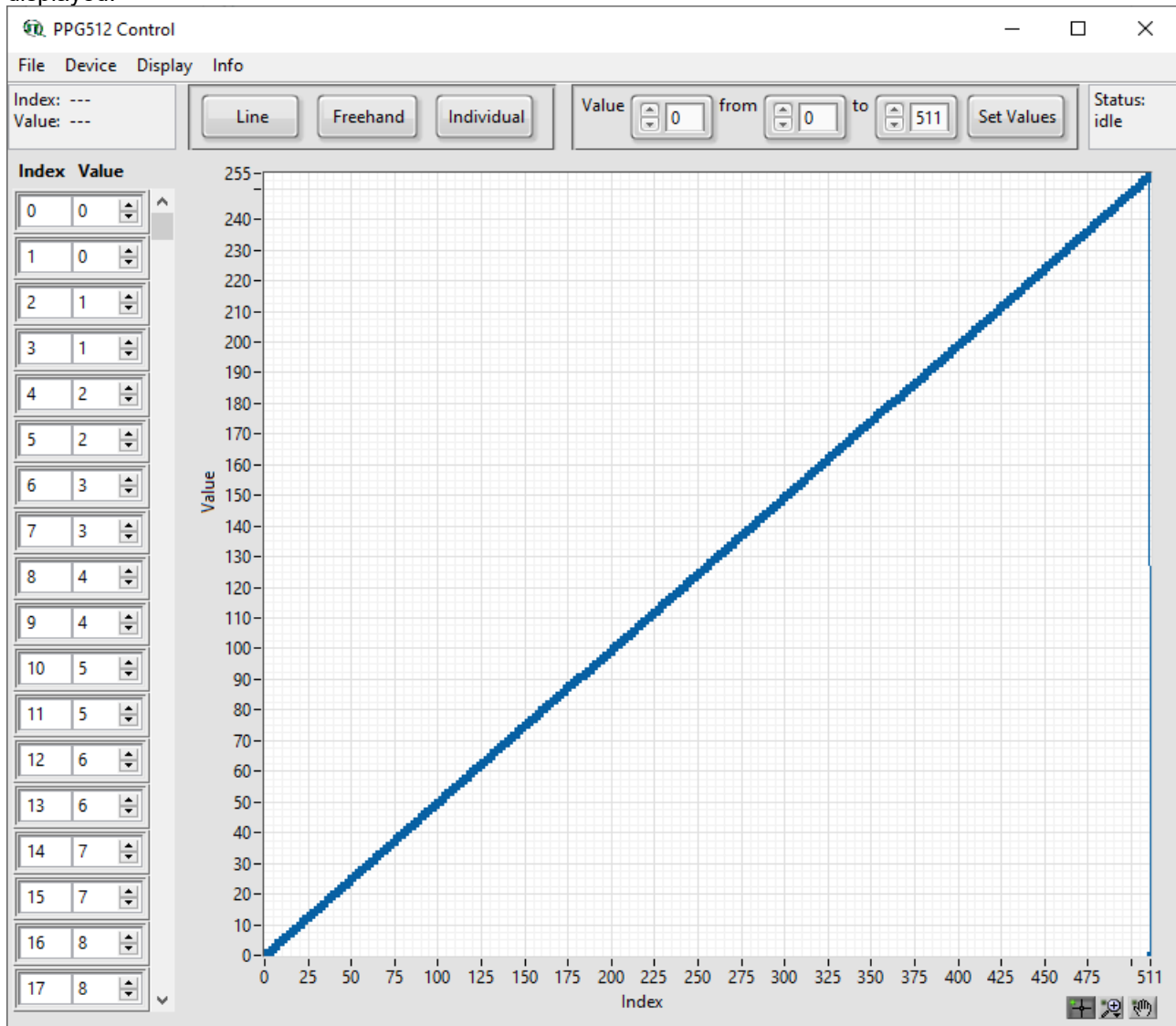
Fig. 9: PPX512 Control

The waveform can be manipulated in different ways:

* Individual values can be entered using the array display on the left side of the GUI

* One or more values in a given index range can be set by using the control group on the upper right side of the GUI. The value entered in the numerical control 'Value' is assigned to all bytes within a range of indices defined by the numerical controls 'from' and 'to'. Changes have to be confirmed by pressing the button 'Set Values'.

* Values can also be drawn on the graph display canvas by pressing one of the three buttons on the upper left button control group of the GUI. Their use is:

    ○ 'Line': straight lines can be drawn in any direction

    ○ 'Freehand': freehand curves can be drawn

    ○ 'Individual': individual points can be set (hold the Ctrl-key to lock vertical manipulation)

- ○ If one of these buttons is pressed all other controls and the menu items are deactivated (using keyboard shortcuts is still possible).
  Zooming and panning on the canvas is provided by either using the appropriate buttons on the lower left corner of the graph display or by using the mouse wheel (scroll for zoom; press for pan).
- • Entire curves can be loaded from a CSV file by selecting the menu item File → Open or keyboard shortcut Ctrl + O.

The manipulated values can also be saved as a CSV file by selecting the menu item File → Save or keyboard shortcut Ctrl + S.

The current values displayed in the graph display are not directly transferred to the hardware. In order to update the RAM of the PPx 512 one has to select the menu item Device → Write or keyboard shortcut Ctrl + W. The hardware RAM values can also be read by selecting the menu item File → Read or keyboard shortcut Ctrl + R.

8.   Tips and tricks

8.1.   Quick start guide

1.   Setup the optical output properly according to the laser safety!

2.   The PPx 512 programmend whith all 0x00 by factory default, so no laser should be emitted.

3.   For controlling the PPx 512 with your PC, we have to determine the COM-Port

     ○   first open the device manager by hitting *Windows-Key + R*

     ○   type *devmgmt.msc* and click OK
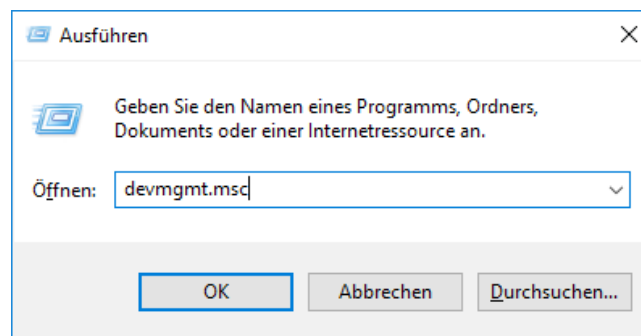
Fig. 10: Run – Device Manager

     ○   in the device manager find the line *Ports (COM & LPT)* and expand this line

     ○   connect the PPx 512 with your PC
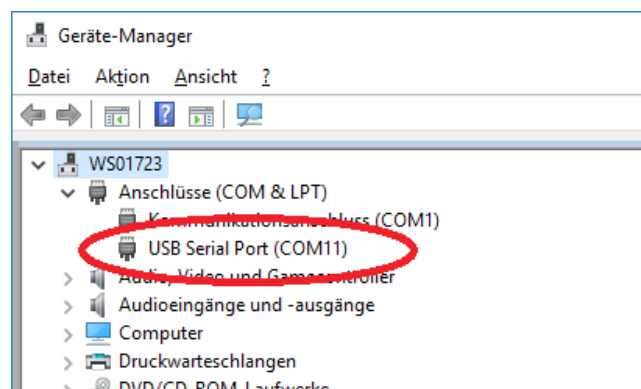
Fig. 11: Device Manager showing connected PPx 512 at Port 11

     ○   a new COM-Port should appear. The number is arbitrary and is enumerate by the operating sys-
         tem. However, on reconnect Windows should assign the same number to the same device.

     ○   Windows installs the necessary driver automatically[1]

4.   Start your favorite terminal program e. g. *PuTTY*[2] or *TeraTerm*

     ○   set the correct settings for the UART connection (115200 - 8N1)

     ○   for setting up PuTTY see Fig. 12

     ○   click Open and an empty terminal screen should appear

---

1 When Windows doesn't find the driver, download the correct driver according to your operating system from
   https://www.ftdichip.com/Drivers/VCP.htm

2 https://www.putty.org/
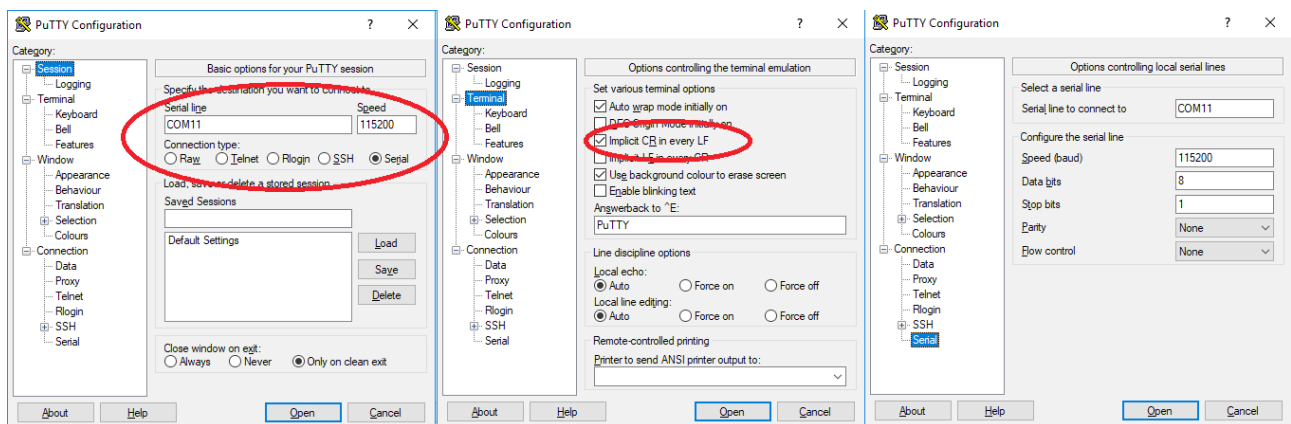
Fig. 12: PuTTY - settings

5. Plug in the external power supply
    ○ PPx 512 starts with a build in test, while testing the status LED blinks orange
    ○ after test is finished the LED flashes 3 times green
    ○ if no external trigger is detected the PPx 512 goes in *IDLE* state (LED: orange)
    ○ in Fig. 7 output the start up message is shown

8.2.   Calculating CRC

For generating the CRC checksum use the following python script. The script loads all data from *filename*. The file should only contain one row each value have to be separated by a '**;**'. The CRC calculation is performed by the PyCRC module[1].

With the example waveform.csv (see below) the script should return a **0xB326.**

crc.py:

```
import csv
from PyCRC.CRCCCITT import CRCCCITT

# CRC-CCITT
# polynom: 0x1021
# seed: 0xFFFF

filename='waveform.csv'
f = open(filename)
data = csv.reader(f, delimiter=';')

amplitude = bytearray()

for row in data:
    for column in row:
        amplitude.append(int(column,16))
        # because crc is handled bytewise in OWG-512 a zero padding byte is needed
        amplitude.append(0)
```

1For more information about PyCRC see: https://pypi.org/project/PyCRC/

f.close()

hex(CRCCCITT(version="FFFF").calculate(bytes(amplitude)))

waveform.csv:

0x23;0x23

8.3.   Waveform design

The actual optical waveform may be differ from the set signal. In addition every laser diode may produce a different optical output while the set signal is the same. That's why every PPx 512 will generate a slightly different optical waveform.

Also keep in mind that every laser diode has its own threshold. As shown in Fig. 13 it is normal that below some specific amplitude no optical output is generated. This restricts the dynamic of the waveform but gives the possibility of fully turn off the laser diode.

Fig. 13: Fullscale sawtooth to detect laser threshold. (left: programmed waveform; right: optical output)

8.4.   Adjusting the laser wavelength

For fine tuning of the output wavelength, the seed laser diode temperature can be changed.

The wavelength shift is typically in the range of 70-100 pm / °C.

Temperature range is limited to factory set ± 8°C and also limited to maximum 50°C.

- SOUR:TEMP:TEC?
  - print stored seed temperature in m°C
  - system response example: 45000
- SOUR:TEMP:TEC <num>
  - set temperature for seed in m°C.
  - system response ACK if in valid range. NACK if outside of range.

9.   Technical Data / Specifications

Mainframe

Power Input Voltage............................	12 V (max. 18 V)
Current..	max. 1.7 A
External Power supply.........................	100 to 240 VAC, 50/60 Hz, max 100 Watt
Connector type...................................	LEMO EXG0B302HLN-A
Dimensions..	210 x 118 x 47.4 mm (W x D x H)
Net weight laser head.........................	0.8 kg
Total weight incl. power supply, etc..…	1.6 kg
Power Dissipation..............................	max. 20 W
Operating Temperature.......................	15 to 35 °C

Pulse Pattern

Length...	512 bytes
Readout speed...................................	5 GS / s; 200 ps time bins;
....	other sampling rates < 5 GS / s on request

OP Mode Input

Amplitude...	> 0.75 and < 1.1 V continues pattern generation with byte 0 after reading all 511 bytes
....	< 0.2 V: pattern generation stops after reading 508 bytes
....	unconnected: free-running mode
Impedance...	500 Ohm
Connector type...................................	SMA (female)

Synchronization Output

Amplitude...	+500 mV into 50 Ohm;
....	falling edge at byte 253; rising edge at byte 508
Impedance...	50 Ohm
Connector type...................................	SMA (female)

Status Output

Amplitude...	5 V for Laser ON; 0 V OFF
Impedance...	min. 10 kOhm
Connector type...................................	SMA (female)

USB 2.0 UART (Virtual COM-Port)

Connector type...................................	Mini-USB 2, type B
Baud rate...	115200
Data	8 bit
Parity...	none
Stop...	1 bit

Optical Output

Fiber receptacle.................................	FC/APC, narrow key, PM single mode optical fiber
....	built in optical isolator
Max reverse launched power...............	< 50 mW

Optical Input (PPA versions only)

Fiber receptacle................................... FC/APC, narrow key, PM single mode optical fiber
Max launched average power.............. 30 mW
Input wavelength range per model:
PPA 512-1030.................................... 1030 ± 5 nm
PPA 512-1060.................................... 1060 ± 10 nm
PPA 512-1550.................................... 1550 ± 20 nm

Retraction of Old Devices

Waste electrical products must not be disposed of with household waste. This equipment
should be taken to your local recycling center for safe treatment.
WEEE–Reg.–No. DE 96457402
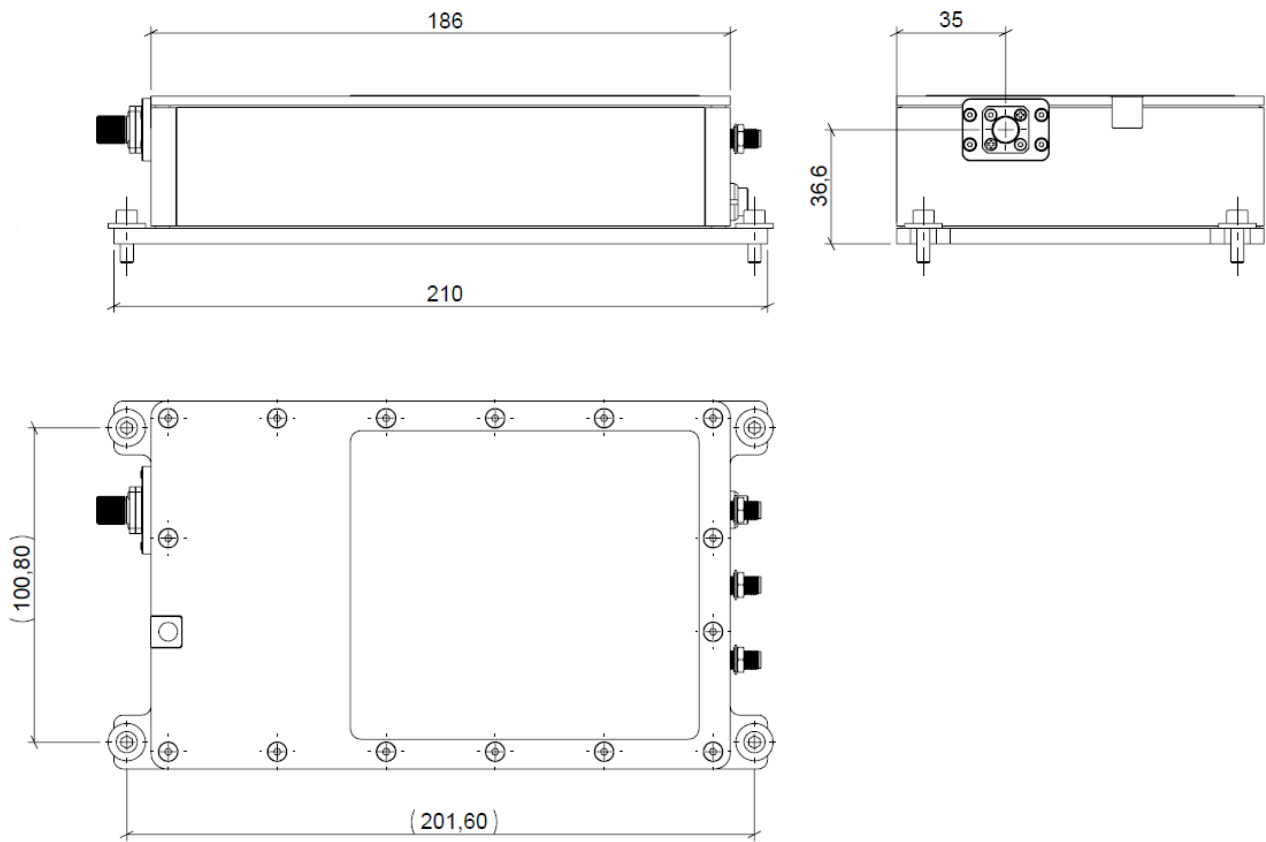
9.1.   Dimensions of the PPx 512 laser module:

Fig. 14: Dimensions of the laser module. Note that all values are given in mm.

10. Support

10.1. Returning Products for Repair

Should you encounter problems that require sending the device in for inspection / repair, please contact us first at: https://support.picoquant.com or support@picoquant.com and request an RMA number before shipping the device. Please include the serial number of your device. Observe precautions against static discharge under all circumstances during handling, packaging and shipping. Use original or equally protective packaging material. Inappropriate packaging voids any warranty.

11. Legal Terms

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12. Further Reading

12.1. PicoQuant Bibliography

PicoQuant maintains a database of publications mentioning PicoQuant devices. It can be found at our website https://www.picoquant.com/scientific/references. It is a valuable source if you would like to know which laboratories are using PicoQuant products or how broad the field of various applications is.

12.2. Download of Technical Notes / Application Notes

PicoQuant, along with our customers, continuously writes and publishes short documents about techniques, methods and applications that are possible with our hardware or software. The download section can be found at https://www.picoquant.com/scientific/technical-and-application-notes

13. Appendix

13.1. Abbreviations

AWG	arbitrary waveform generator
BNC	British Naval Connector or Bayonet Nut Connector or Bayonet Neill Concelman
BIST	Build In System Test
CAMAC	Corporations and Markets Advisory Committee
CRC	cyclic redundancy check
DAC	Digital to analog converter
EMC	Electromanetic compatibility
FWHM	Full Width at Half Maximum
IEC	International Electrotechnical Commission
IR	Infra-red
IRF	Instrument Response Function
LED	Light Emitting Diode
MOFA	Master Oscillator Fiber Amplifier
NIM	Nuclear Instrumentation Methods
OEM	Original Equipment Manufacturer
PM	Polarization Maintaining
RMA	Return Merchandise Authorization
SMA	Sub-Miniature version A (connector type)
STED	STimulated Emission Depletion
TCSPC	Time-Correlated Single Photon Counting
TTL	Transistor-Transistor Logic
UART	Universal Asynchronous Receiver Transmitter
UV	Ultra-violet
VIS	Visible
WEEE	Waste Electrical and Electronic Equipment

13.2. System Delivery Report

The delivery report of your lasers, including all final production test results for pulse shape, optical power, and line width is attached to this user manual. A PDF copy can be provided on request.

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