WL-IPD4A

Digital Integrating Photodiode with USB Interface

Features

- **simultaneous** integration of up to **4 inputs** at up to **1.15 kHz**
- each measurement includes **signal** and **background** acquisition
- high accuracy, low drift
- gate time **8µs** to **64µs** with internal timer
- tunable full scale range **12pC** to **350pC**
- easy-to-use **USB interface**
- very high **20 bit** ADC resolution
- extremely **low noise** integrator:
  <10ppm noise at 350pC full-scale range
  <20ppm noise down to 50pC FSR
- external trigger rising or falling edge
- small form factor: 60 x 83 x 21 mm^3
- Comes with easy to use **LabView drivers**

Applications

- laser pulse monitoring and signal measurement in systems up to 1kHz
- digtial 2 or 4 segment photodiodes
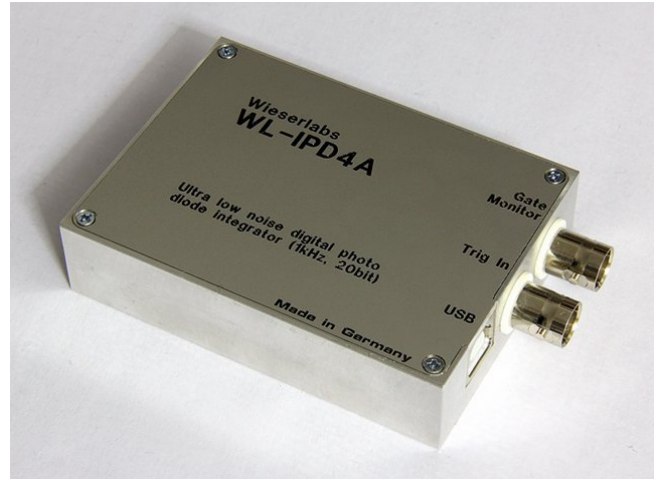- shot-to-shot pulse noise measurements

Photo from top; integrated photodiodes not visible.

General Description

The WL-IPD4A is a highly-integrated true gated charge integrator to be attached directly to up to 4 photo diodes. After a trigger pulse, all 4 inputs are integrated simultaneously for an adjustable amount of time (boxcar integrator). The measurement is digitized with integrated 20bit analog-to-digital converters and transferred over the USB link to a computer. The IPD4A can continuously acquire 4 signal and 4 background measurements and transfer them over the USB link at a rate of up to 1.15kHz without losing pulses. This allows shot-ot-shot measurements in systems with up to 1kHz repetition rate.

The USB interface registers itself as virtual serial port (VCP) for direct and easy integration into lab control software such as LabView.

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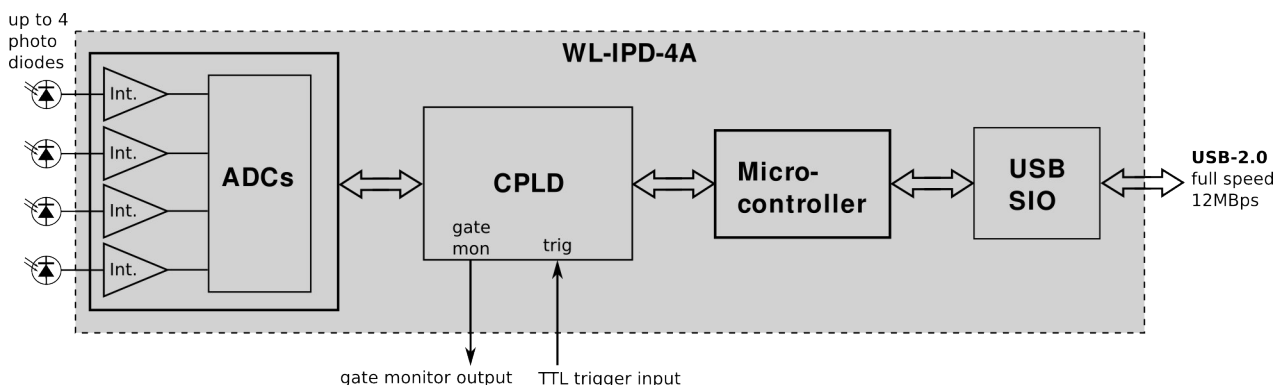Different typical configurations (single-channel).

Structure, Continuous Operation Without Loss of Samples

The IPD4A integrates a high performance ADC, a microcontroller and a USB interface. Conversion results are immediately transferred to the host computer via USB at a baud rate of 500 kbaud. To prevent sample loss due to latencies in the host computer, the IPD4A integrates a 800 byte FIFO storage. Even with older computers running LabView, millions of integration samples can typically be acquired without losing a single sample at maximum rate (1.15 kHz).

This means: If you have e.g. the task to ingegrate e.g. 10 000 pulses from a 1 kHz TiSa laser, simply supply 10 000 trigger events into the IPD4A and your host computer will end up with 10 000 samples, i.e. a measurement result of each of the 10 000 pulses.

Photo Diodes

Photo diodes are integrated into the case of the IPD4A on a per-customer basis. The integration into the case is required to reduce noise and electrical pick-up from lab environment. The IPD4A is generally compatible with any type of photo diode (including Si and InGaAs) and different detector sizes. Customers can either provide their own photo diodes or standard ones can be integrated. Here is a list of particularly useful photo diodes which are frequently used:

Photo Diode	Manufacturer	Area (mm)	Wavelength nm	Intended use
S1336-5BQ	Hamamatsu	2.4 x 2.4	190 – 1100	UV to near IR for precision photometry
S1336-8BQ	Hamamatsu	5.8 x 5.8	190 – 1100	UV to near IR for precision photometry
S1336-44BQ	Hamamatsu	3.6 x 3.6	190 – 1100	UV to near IR for precision photometry
S2386-44K	Hamamatsu	3.6 x 3.6	320 – 1100	visible to near IR general purpose
FGA21	Thorlabs	2.0 (round)	800 – 1800	IR general purpose photometry
BPX61	Osram	2.65 x 2.65	400 – 1100	Low-cost (use only if diode is at risk of optical damage)

Resolution, Full Scale Range (FSR)

The IPD4A integrates a high performance 20 bit ADC with very low noise. For added flexibility, the IPD4A features a selectable full-scale range (FSR) between 50 and 350 pC in 7 software-configurable steps. This means that the IPD4A can easily be adopted to different conditions without having to carefully select e.g. optical filters in front of the photo diode for optimum range converage. Also, the 20 bit ADC has very high dynamic range and low noise. Hence, even in a setup where only 10% of the full scale range is used, the IPDA's typically still provides more than enough resolution.

Electrical Specifications

Parameter	Conditions	Min	Typ	Max	Units
Supply Voltage (V$_S$)	Provided by USB	4.5	5	5.5	V
Supply Current	Normal operation (1 kHz)		120	150	mA
Trigger input logic level		3.3		5	V
Gate monitor output logic level			3.3		V
Gate time	Controlled via USB (software)	8		64	µs
Conversion rate	External trigger frequency	0	1	1.15	kHz
Integrator noise[1]	No photodiode attached, 350 pC FSR		4	7	ppm[2]
	No photodiode attached, 50 pC FSR		6.5	12	ppm[2]
Integrator noise[1]	WIth BPW34 photodiode, 350 pC FSR		5		ppm[2]
	WIth BPW34 photodiode, 350 pC FSR		20		ppm[2]
Channel crosstalk	90% FSR step on neigh. chan., 350 pC FSR, 45 µs integration time		1		ppm

[1]unless otherwise specified: 10µs integration time, 1kHz repetition rate.
[2]ppm means 10^{-6} of the full-scale range. For a 20 bit ADC, the full-scale range is 2^{20}=1048576 counts. A noise level of e.g. 4ppm hence translates into 4.16 counts.

Mechanical Specifications

Size	60 x 83 x 21	mm^2
Weight (approx.)	200	g

USB VCP Interface

The USB interface is a USB-1.1 full speed (12Mbps) link applying an FTDI USB-to-serial converter. With the appropriate Windows-drivers from www.ftdichip.com, the USB link presents itself as a virtual COM port (VCP) on the host computer. On recent Windows-7 installations, automatic driver installation will download the driver fully automatic from the internet. Linux VCP drivers are part of every recent Linux kernel (module ftdi_sio).

The VCP has to be initialized for 500kbaud (divisor 48), raw transmission, no echo, 8 bit, no parity, 1 stop bit ("8n1"). The corresponding initialization commands unter Linux are:

```
stty –F /dev/ttyUSB0 38400 raw pass8 –echo
setserial /dev/ttyUSB0 spd_cust divisor 48
```

In LabView (Windows), simply use VISA serial open and initialize the associated COM port to 500 000 baud, 1 stop bit, no parity bit.

NOTE: LabView support routines are provided by Wieserlabs free of charge.

USB Data Format

After every trigger event, the IPD4A sends the measurement results of all 4 channels over the USB link. Each result consists of 25 bytes and has the following format (each character representing one byte):

```
H AAA BBB CCC DDD aaa bbb ccc ddd
```

Meaning of the fields:

H: Header character, always '='

AAA,BBB,CCC,DDD: Signal measurement results for channels 1,2,3 and 4.

The value for each channel consists of 3 bytes, MSB-aligned with LSB first.

Hence, data range is 0 to 2^24 but since the ADC has only 20 bit resolution, the 4 least significant bits are always 0.

aaa,bbb,ccc,ddd: Dark background measurement for channels 1,2,3,4. The background frames are acquired **directly** after the signal measurement and represent the amount of charge (light) present directly after the first gate.

USB Commands

The IPD4A can be configured by sending commands over the USB link. The command format is binary and consists always of 3 bytes:

```
'*' CMD VAL
```

The first character is a '*' denoting a command start.

CMD is one of the command characters from the list below.

VAL is a 1 byte value interpreted by the command.

CMD	Description
'g'	Set gate time for both signal and dark frame measurement. For standard 4MHz internal clock, VAL is the gate time in µs and the valid range is 8 to 64. Default: 10µs
'r'	Set the integrator's full-scale charge range: VAL (0..7) is the range: 0: 12pC full scale range (not recommended) 1: 50pC full scale range 7: 350pC full scale range (default)
't'	Set trigger. Possible values are: 0: external trigger, rising edge (default) 1: external trigger, falling edge 2,3: internal trigger at fixed rate of about 120 Hz (useful for alignment) Bits 2-7 of VAL are ignored.
'o'	Switch integrator on (VAL=1) or off (VAL=0). The switch-off takes place after the next trigger event, so when switching off, wait at least one trigger event.
'c'	Set clock source. *Do not use this command; leave the factory default.* 1: 4MHz uC clock (default; recommended setting, least jitter) 2: 4MHz USB clock (do not use) 3: 16MHz fast USB clock (do not use)
'T'	Activate test mode with VAL=1 or change to normal mode with VAL=0. In test mode, the integrator is disconnected from the photo diodes and integrates null charge. This can be used for integrator noise measurements and zero charge calibration measurements.
'R'	Reset the IPD4A. In order for the reset to be executed, VAL has to be assigned the magic value 23.

Note that it is recommended to switch off (command 'o') the IPD4A before using commands 't' or 'c'.

USB Status Response

Each accepted command is acknowledged by the IPD4A by sending back a response code.

NOTE: Before sending the next command, always wait for the appropriate response command. If no response is received within 5ms, the command was lost and can be re-sent. Note also that the response to the on/off ('o') command is sent back immediately but will take affect only after the following trigger.

All response codes consist of 2 bytes and have the following format:

```
'$' CODE
```

The CODE is the response code. Valid response codes for commands are in the range 0 to 0xef. 0 means "success", all other values "error".

NOTE: There are special response codes which are sent by the IPD4A itself but not as a response to a command:

0xff: Sent upon startup or reset to report that the IPD4A is ready.

0xf0, 0xf1: Sent upon detection of an integrator error. Reported measurements can be invalid when receiving these commands.