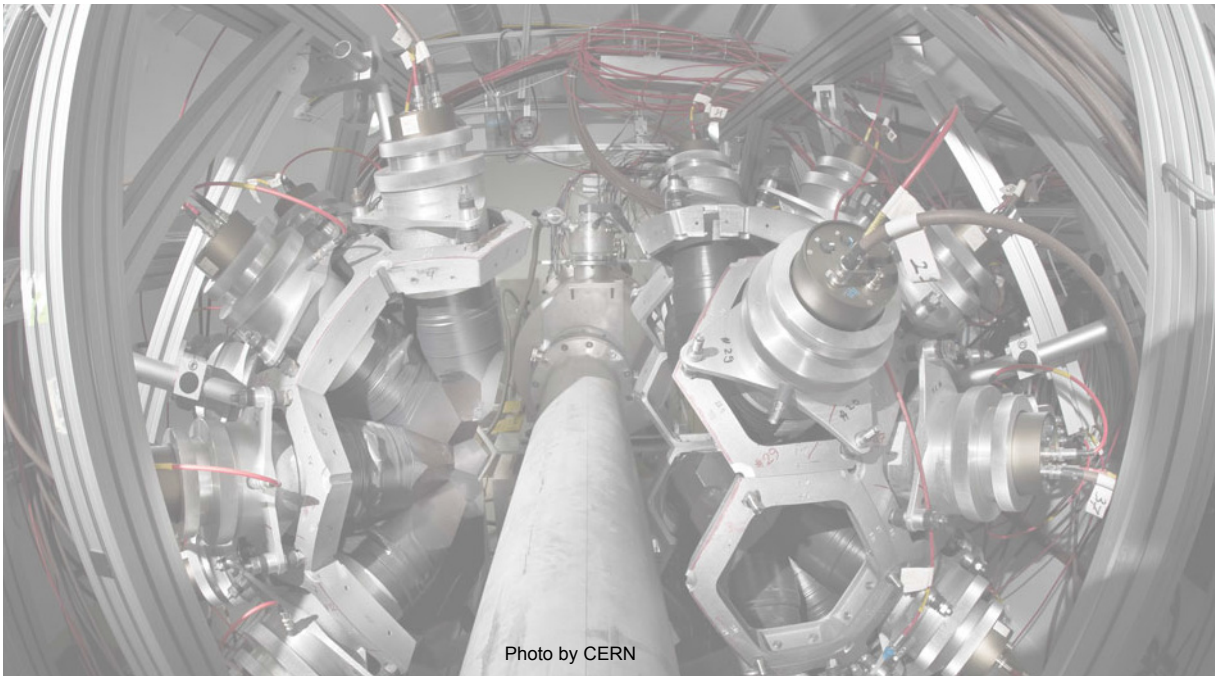
ADQ14–FWPD Datasheet

The pulse detection firmware option –FWPD equips ADQ14 with sophisticated tools to identify, analyze, and collect pulsed input data streams in real-time.



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ADQ14–FWPD Datasheet

Features

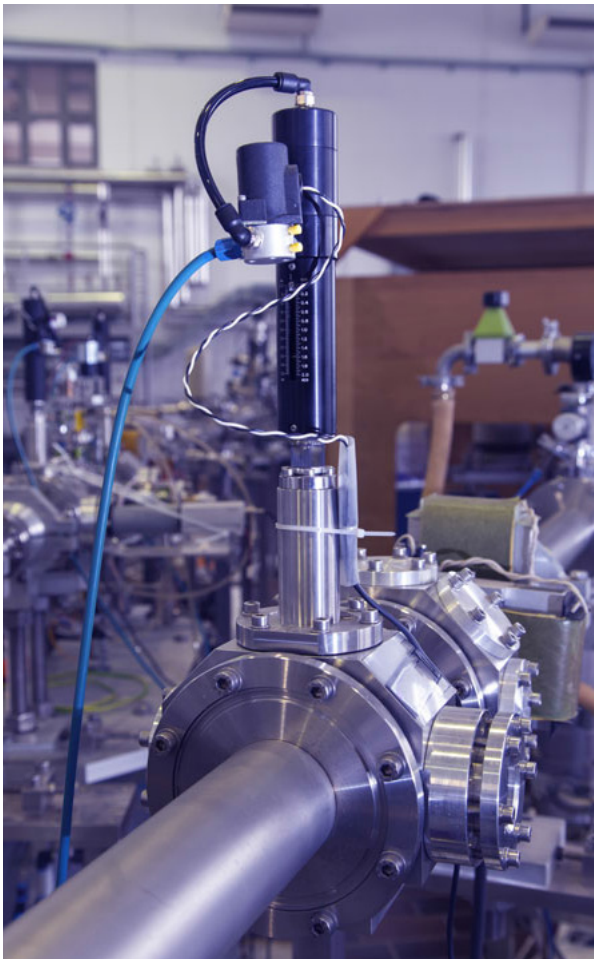
- 1 / 2 / 4 analog channels
- 0.5 / 1 / 2 GSPS per channel
- 14 bits vertical resolution
- Adaptive record length for zero suppression and optimal memory usage
- External, internal, and software trigger
- Per-channel individual level trigger
- Detection window to select pulses
- Multi-unit synchronization
- Real-time data analysis
- Histogram of pulse data
- Padding to ensure a minimum level of activity
- Flexible data collection
- Coincidence trigger for channels interaction

Applications

- Big Physics
- Time-of-flight
- Scientific instruments
- LIDAR
- RADAR
- Neutron time-of-flight

Advantages

- Advanced analog front-end, trigger functions, and high sampling rates for meeting systems requirements.
- Efficient utilization of dynamic rage with an optional DC offset.
- Highly accurate and stable baseline provided for pulse applications.
- Possibility to impose additional conditional to make the channel triggers depend on each other with coincidence.
- Data multiplexing allows for raw data and metadata to be output simultaneously from the same channel.
- Histogram calculation of pulse width and peak value.
- SP Devices' design services are available for fast integration to lower time-to-market.



–FWPD is available for these ADQ14 models:

ADQ14DC-2A	ADQ14AC-2A
ADQ14DC-4A	ADQ14AC-4A
ADQ14DC-2C	ADQ14AC-2C
ADQ14DC-4C	ADQ14AC-4C
ADQ14DC-1X	ADQ14AC-1X
ADQ14DC-2X	ADQ14AC-2X

–FWPD is available for form factors:

PCIe	cPCIe / PXIe
SSPCIe	USB3.0
10 GbE	Micro-TCA.4

Functional summary

The purpose of the firmware option –FWPD is to automatically analyze random pulse data and limit the acquired data to the actually interesting regions and parameters. The firmware can detect pulses and adapt the data capture to the properties of the pulses.

For a high-level block diagram with the main functionality, see **Figure 1**. The firmware consist of two parts; pulse identification and pulse analysis. The pulse identification tracks the baseline and identify when pulses start and end. The recording includes dynamic record length which suppresses zeros, that is, signal without information is discarded and disk space is saved. The pulse analysis finds the peak value and the width of a pulse. There is also built-in histogram functions for pulse peak value and pulse width. Real-time calculations are enabled by the high-performance FPGA.

Custom pulse analysis is enabled through the ADQ Development Kit which opens the FPGA for the user. ADQ Development Kit is a separate tool that is purchased separately

Software support

The –FWPD is supported by Windows and a number of Linux distributions. For a detailed list of operating systems, see (15-1494). The software development kit (SDK) contains the ADQAPI, drivers, examples and documentation.

There is a start-up GUI tool for Python environment.

The recommended programming environment for high performance is c/c++, but also Python and MATLAB is supported for less demanding applications. Note that there is *NO* LabVIEW support.

Ordering information

The –FWPD can either be ordered together with an ADQ14, or separately, for loading into an existing unit. To get the correct version of –FWPD when ordering, the model of the existing ADQ14 need to be indicated.

Order ADQ Development Kit for –FWPD separately. Note that the development kit is tied to a digitizer model and a firmware option.

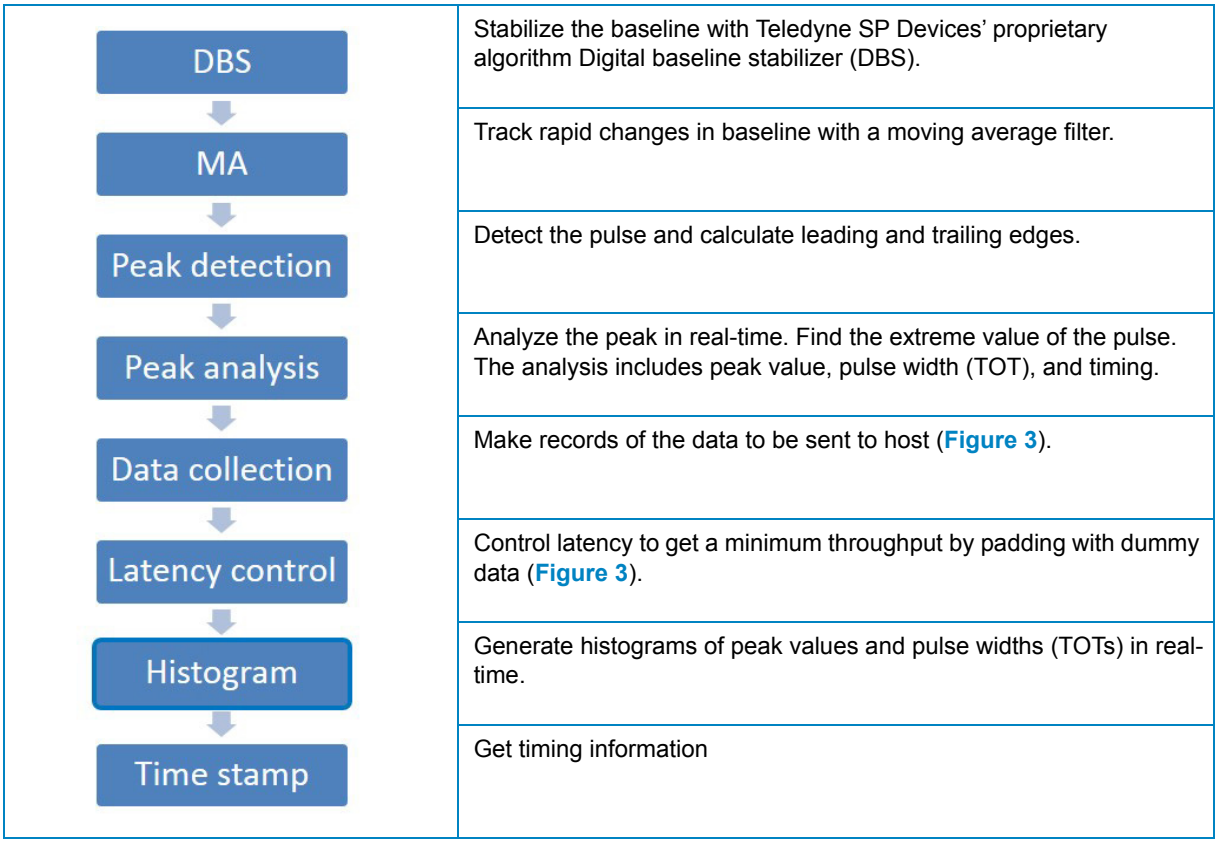


Figure 1: Block diagram of the main functionality of –FWPD.

Technical data

Note that the 14-bit ADQ14 digitizer uses an MSB-aligned 16 bits data representation. The digital signal processing, for example DBS, will affect also the 2 LSBs making them non-zero. For the general specification of the ADQ14 digitizer, please refer to the ADQ14 datasheet (14-1290). Specification, definition and acronyms are listed in **Table 1** and **Table 2** .

Table 1: Specification

		MIN	MAX
Moving average filter			
Filter length [1]	[samples]	0	100
Filter delay [1]	[samples]	0	100
Thresholds [2]			
Analog DC-offset level	[codes]	-2^{15}	$+2^{15}-1$
DBS DC target	[codes]	-2^{15}	$+2^{15}-1$
Trigger level	[codes]	-2^{15}	$+2^{15}-1$
Reset level	[codes]	-2^{15}	$+2^{15}-1$
Trigger arm hysteresis	[codes]	0	$+2^{15}-1$
Reset arm hysteresis	[codes]	0	$+2^{15}-1$
General			
Pulse width (TOT)	[samples]	1	-
Pulse separation	[samples]	1	-
Record length[3]	[samples]	4	$2^{32}-1$
Record length[4]	[samples]	8	$2^{32}-1$
LEW	[samples]	0	2^{14}
LEW granularity[5]	[samples]	4	4
TEW	[samples]	0	2^{30}
Pulse characterization			
Computed pulse width[6]	[samples]	1	$2^{16}-1$
Pulse peak time stamp[7]	[samples]	-	$2^{32}-1$
Average pulse rate[3]	[10^6 pulses/s]	-	250
Average pulse rate[4]	[10^6 pulses/s]	-	500
Average pulse rate for histograms	[10^6 pulses/s]	-	33
Histogram bin value		-	$2^{20}-1$
Pulses per record	[samples]	1	-
Peak histogram size	[bins]	2^{14}	2^{14}
TOT histogram size	[bins]	2^{12}	2^{12}

1. Filter length + filter delay ≤ 100
2. The 14 bits data word is mapped MSB aligned to a 16 bits signed integer
3. For devices with sample rate 500 MSPS and 1 GSPS.
4. For devices with sample rate 2 GSPS.
5. The LEW (pre-trigger) has to be set in multiples of 4.
6. The number of samples between the pulse trigger and the reset level.
7. The number of samples between the detection window trigger and the extreme value.

Table 2: Definitions and acronyms, Figure 2.

	DEFINITION	COMMENT
Acronyms		
DBS	Digital baseline stabilizer	Teledyne SP Devices' proprietary IP.
LEW	Leading edge window	Samples before trigger (pre-trigger).
TEW	Trailing edge window	Samples after end of pulse.
MA	Moving average filter	Calculate the average of a set of samples.
ADC	Analog-to-digital converter	
API	Application programming interface	
FWPD	Pulse detection firmware for Teledyne SP Devices digitizers.	
GUI	Graphical user interface	
MSPS	10^6 samples per second	
GSPS	10^9 samples per second	
TOT	Time over threshold	Same as Pulse width, see below.
SDK	Software development kit	
Definitions		
Header	Information about the record.	
Peak	Extreme value of a pulse.	Max value if triggering on rising edges. Min value if triggering on falling edges.
Pulse	The samples between a trigger event and a reset event.	
Record	A set of data belonging to a trigger	The data set can be consecutive samples (raw data), metadata, or padding.
Reset event	An event that defines the end of a pulse.	The last reset event defines the end of a record.
Time stamp	A value that gives a real-time value of a record.	
Trigger event	An event that defines the start of a pulse.	The first trigger event starts the acquisition of a record.
Pulse width	Time between trigger event and reset event of a pulse.	This is also called time-over-threshold (TOT).

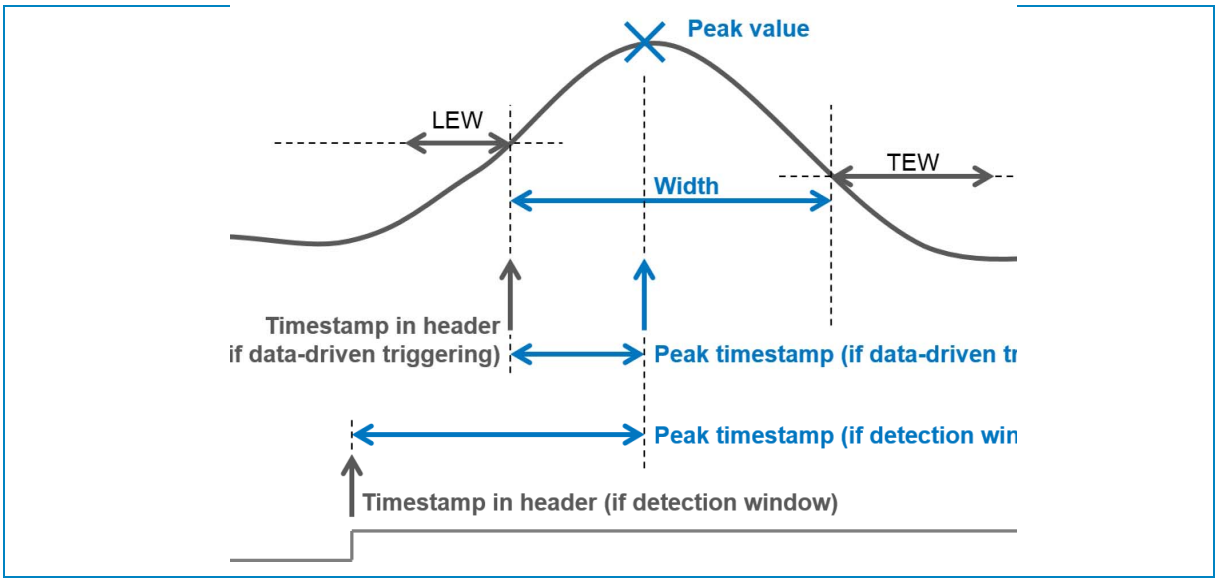


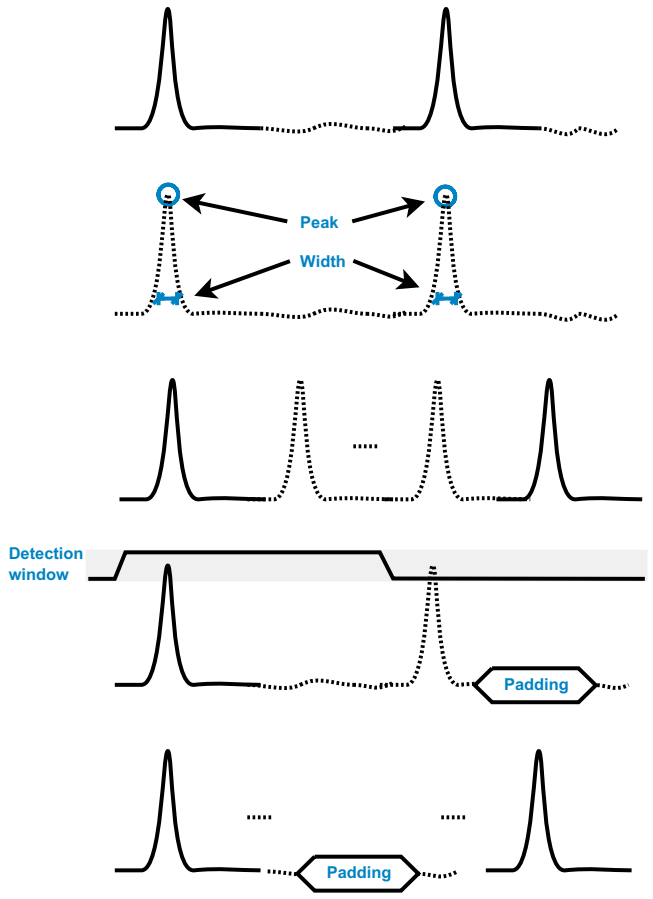
Figure 2: Pulse definition

Trigger and collection modes supported by –FWPD

Table 3 shows all valid combinations of operational modes and triggers. Note that all modes support multi-unit synchronization for large sensor arrays. Figure 3 illustrates and describes the five available data collection modes. The padding feature in the two latter modes is for application where the pulses are sparse. By padding with records of dummy data (zeros), it allows for a guaranteed minimum throughput.

Table 3: Trigger modes

TRIGGER MODE	CHANNELS	RECORD
Level trigger	individual	variable or fixed length
Software trigger	simultaneous triggering	fixed length
External trigger	simultaneous triggering	fixed length
Internal trigger	simultaneous triggering	fixed length



Mode 0. Raw pulse data (default).
Mode 1. Only pulse metadata is collected.
Mode 2. Every *N*th pulse is collected.
Mode 3. Raw pulse data with padding, detection window enabled. A padding record is added to ensure an minimum latency of the system, independently on how frequent the pulses are.
Mode 4. Raw pulse data with padding (see above), detection window disabled.

Figure 3: Data collection modes of –FWPD. Continuous pulse lines illustrate collected data. Dotted pulse lines correspond to suppress data.

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