PixelScope

HOW WELL DO YOU KNOW YOUR PIXELS?

Gain insights and understanding of your pixel modulation process

Optimise drive signal parameters and diagnose modulation drive issues

Accelerate pixel development cycle with rapid accurate characterisation

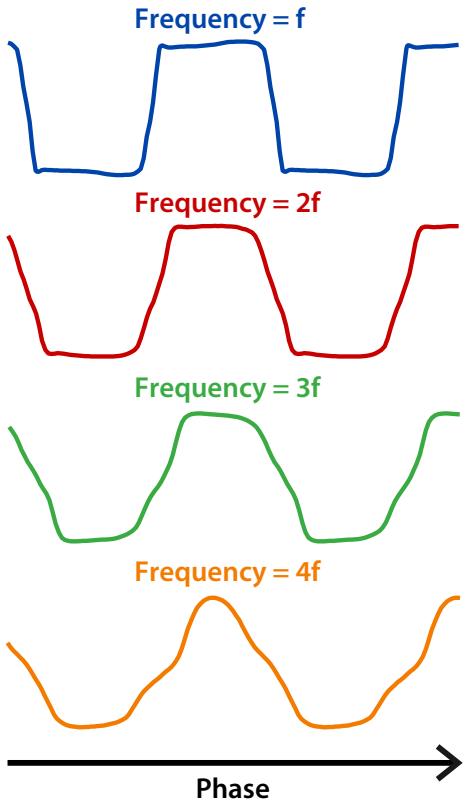
Calibrate based on actual modulation waveform shape and harmonic content

The PixelScope is like an oscilloscope for measuring the true optical response of gain modulated pixels and sensors.

Specifically designed to provide detailed characterization of pixel modulation, the PixelScope is a must have tool for developing Time-of-Flight sensors, designing Time-of-Flight cameras or implementing Time-of-Flight in your hardware platforms.

Used by leading Time-of-Flight camera and sensor manufacturers, PixelScope has proven value in improving performance through gaining a deeper understanding of the pixel modulation process, helping optimise modulation drive signals, and for testing experimental pixels to help accelerate the pixel development cycle.

The examples (right) show changes in optical response of pixels modulated at various frequencies.



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Key Benefits

The PixelScope measures the optical pixel modulation of Time-of-Flight sensor pixels, allowing you to quantify, visualise and compare the optical response and important characteristics of your pixels.

- Quickly, easily and accurately measure the optical modulation response of your pixels.
- Compare optical modulation waveform shape across all pixels simultaneously.
- Quantify modulation waveform, perform advanced waveform and harmonic analysis, and measure modulation changes as the drive signal propagates through the sensor.
- Compare modulation performance and characteristics, such as modulation depth, rise/fall time, duty cycle, relative delays, and analyse how these parameters vary across the sensor.
- Visualise the effective modulation response, including the impact of intended or unintended modulation signal variations during the integration period.
- Characterise and compare the response of standalone test pixels and experimental pixel designs without the need for full time-of-flight system integration.

Specifications

Max Pixel Modulation Clock	> 1 GHz
Effective Measurement Bandwidth	10 GHz
Effective Sampling Rate	100 GS/s
Sample Resolution	50 ps (laser pulse width)
Sample Sweep Resolution	50 ps with 10 ps option
Max Laser Pulse Repetition Rate	80 MHz [1]
Total System Jitter	Less than 16 ps
Laser Wavelength	Fixed, but selectable
Software Control	Matlab, Python, and serial port API through USB [2]
Signal Inputs [3]	LVDS modulation clock; Single ended frame sync (optional)

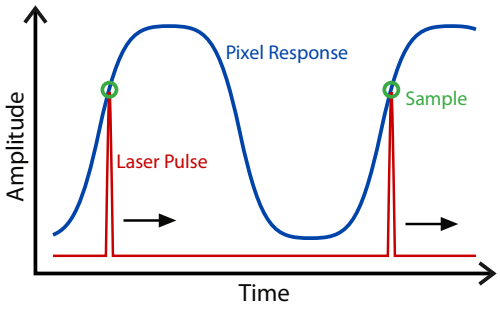
[1] Pulse skipping function provides support for modulation frequencies well beyond maximum laser repetition rate.
[2] Some flexibility for customer specified API format.
[3] Some flexibility for customer specified signal format.

Operating Principle

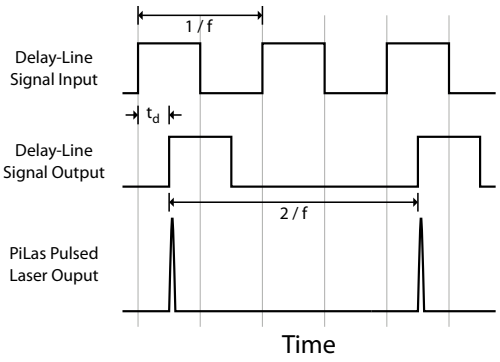
The PixelScope measures the temporal pixel modulation optical response by generating short pulses of laser light synchronised with a modulation reference signal (typically the illumination modulation drive). The laser pulses are aligned at the same phase value for each modulation clock cycle. When these light pulses are directed onto a Time-of-Flight image sensor, the raw intensity pixel values represent a temporal sample of each pixel's optical modulation response at a point in the modulation cycle corresponding to the timing of the laser pulse. With each successive frame acquired, the PixelScope sweeps the light pulse delay (t_d), thereby repeating samples at successive temporal locations, and building up the full waveform of the pixels' optical modulation response verses time.

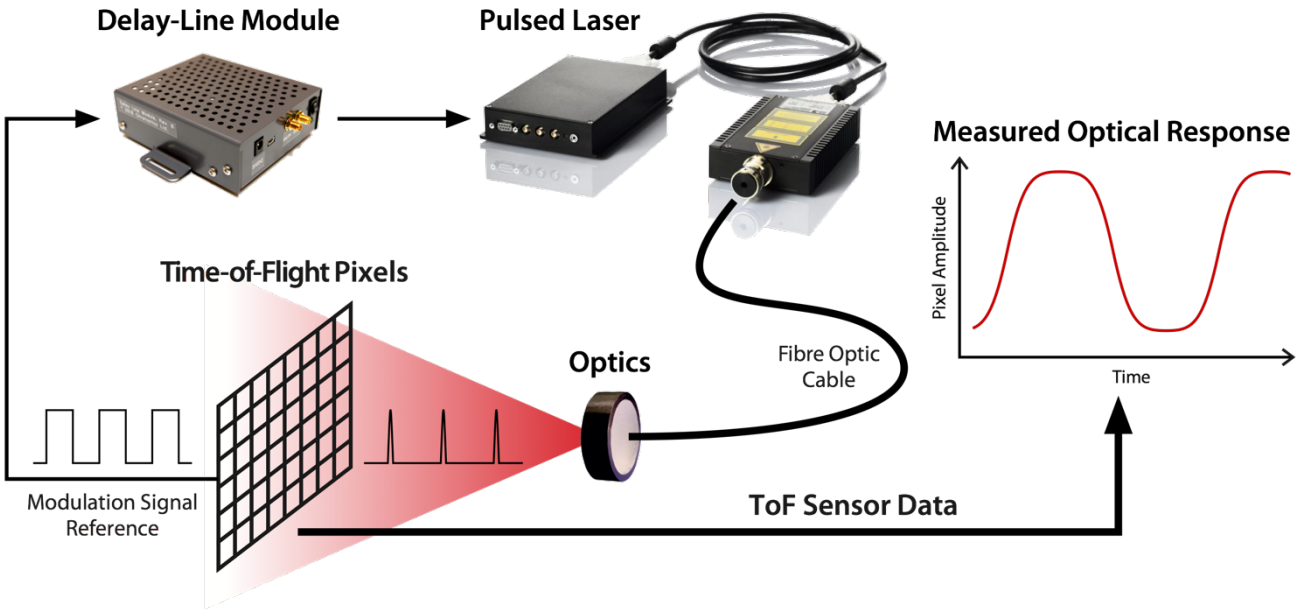
To provide a meaningful comparison across a range of modulation frequencies, the PixelScope uses a customised frequency division and pulse skipping mechanism to maintain a constant number of laser pulses, and hence constant total optical energy, presented during the integration period regardless of modulation frequency.

PixelScope Operating Principle



Example Signal Timing



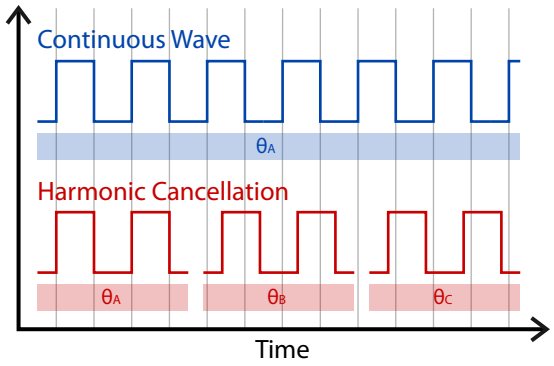


Application Example – Harmonic Cancellation

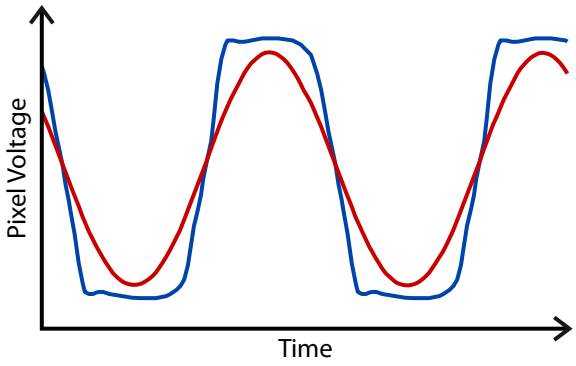
Consider “Harmonic Cancellation” modulation, which uses a series of phase adjusted square waves applied during one integration period. Because the integration period effectively averages all modulation waveforms, carefully selecting modulation signals with out-of-phase harmonics can reduce effective harmonic content of the sensor modulation. Without an instrument like the PixelScope, the effectiveness of this approach can only be inferred and not directly measured.

All light pulses produced by the PixelScope are also averaged during the integration period, meaning the true effective combined modulation waveform for the full integration period is measured and can be analysed.

Example Pixel Modulation



Measured Effective Pixel Responses



For the Harmonic Cancellation modulation mode, it is expected that modulation harmonics are reduced. The PixelScope reveals that this is indeed the case, and shows the near sinusoidal effective optical response, even though actual modulation is still only a combination of square waves. Furthermore, this result can be easily and quickly compared to the standard continuous square wave modulation response.

NOW AVAILABLE FOR PURCHASE

Please contact Adrian Dorrington to discuss pricing and ordering details.

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