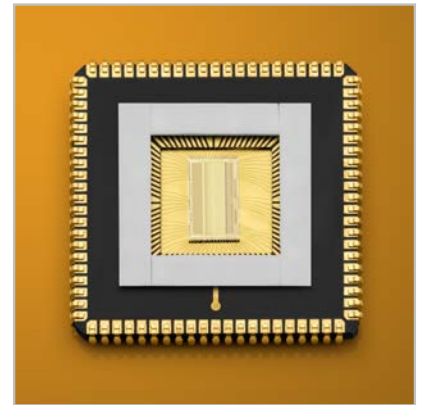


## Flash LiDAR Sensor

### Description

SPAD2L192 is a 192 x 2 pixel solid-state CMOS sensor for flash LiDAR applications. The distance measurement is based on the first-photon direct time-of-flight principle. The single-photon detectors offer very high sensitivity and high timing resolution. The in-pixel time-to-digital converter with a resolution of 312.5 ps and a full scale range of 1.28  $\mu$ s enables flash ranging with a nominal operating range of 192 m and 4.7 cm resolution. Four detector cells in each pixel enable the detection of temporal correlated photons for ambient light rejection. On-chip pixel-individual correlation parameter adjustment allows real-time adaption of the light rejection to the actual ambient light conditions and target characteristics. The counting mode allows the per-pixel counting of single photons or correlated photon events by an integrated 8-bit-counter.



### Features

- Solid-state CMOS sensor
- High sensitive single-photon avalanche diodes
- TDC with 312.5 ps resolution in each pixel
- Adjustable background light rejection
- Timing and counting mode

### Applications

- Automotive
- Surveillance
- Industry
- Robotics

### Generic Characteristics

	Value	Units
Dimension	8960 x 5200	µm
Technology	0.35 µm CMOS	
Pixel count	192 x 2	
SPADs per pixel	4	
Pixel size (SPADs only)	40.56 x 209.6	µm
Fill factor	5.32	%
Line spacing	1019.78	µm
Frame rate @ 20 MHz readout clock	52	kHz

### Absolute Maximum Ratings

	Value			Units
	Min	Typ	Max	
Storage temperature	5		70	°C
Operating temperature	10		50	°C

### Electrical Characteristics

	Value	Units
Power Supply $V_{DD} / V_{SPAD}$	3.3 / 31	V

## SPAD Characteristics

	Value			Units
	Min	Typ	Max	
Diameter		12		µm
Breakdown voltage $V_{BD}$		26		V
Temperature coefficient of breakdown voltage $V_{BD}$		37.8		mV/K
Operation voltage ( $V_{BD} + V_{EX}$ )		31		V
Photon detection efficiency @ 905 nm		2		%
Dead time	16	20		ns
Dark count rate @ 25 °C, $V_{EX} = 5$ V		10		Hz
Dynamic range		134		dB

## TDC Characteristics

	Value			Units
	Min	Typ	Max	
Temporal resolution		312.5		ps
Full scale range		1.28		µs
Raw data length		16		Bit

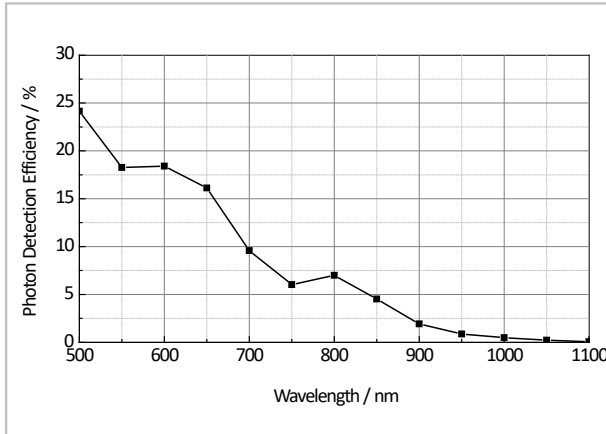


Fig. 1: Photon Detection Efficiency vs. Wavelength

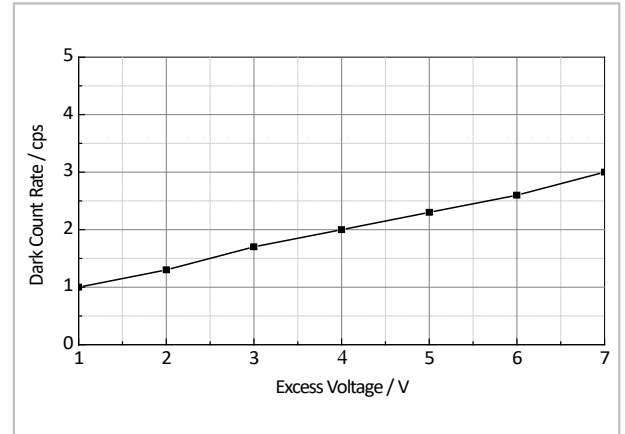
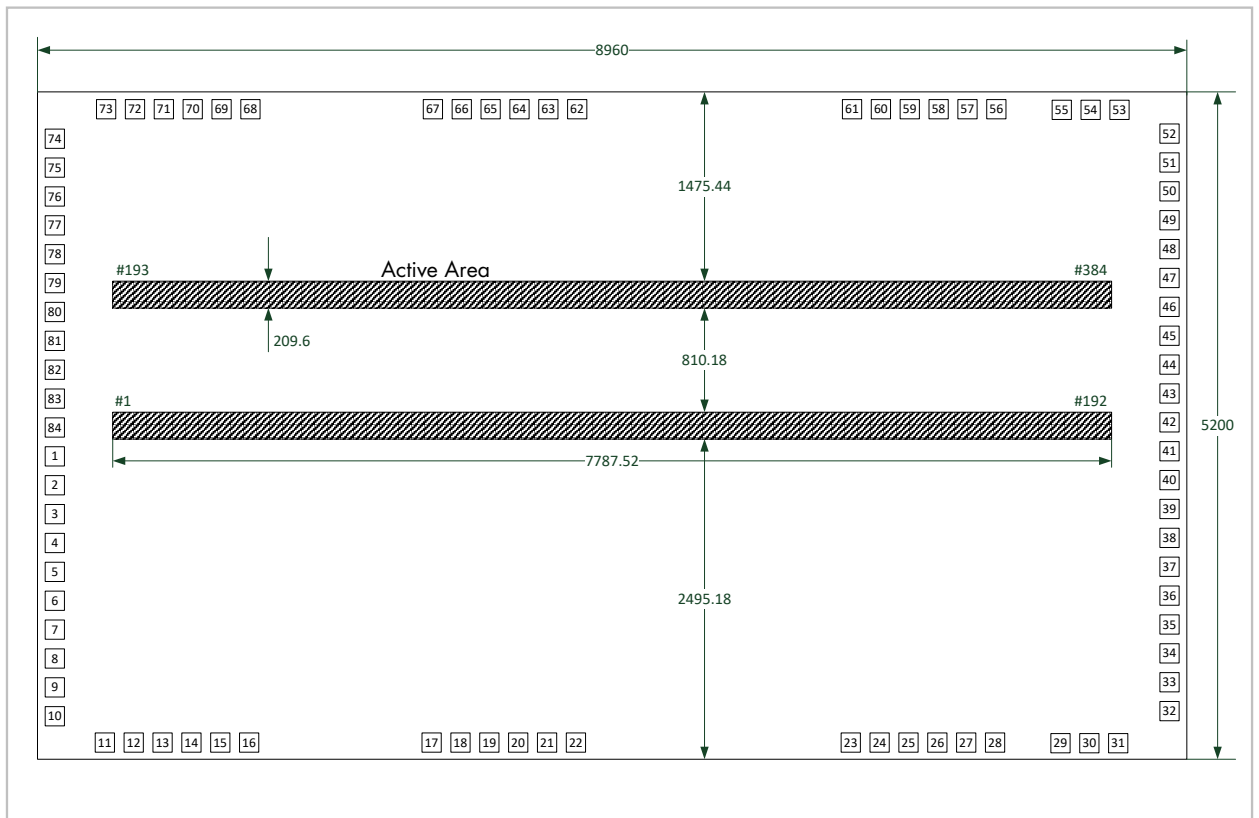


Fig. 2: Dark Count Rate @ 10 μm SPAD Diameter vs. Excess Voltage



Die Drawing (all metrics are given in μm)

## Pin List

	Name	Type	Default	Description
1	Stop	DI	0	Time measurement stop, coarse clock disable
2	Clock	DI	-	TDC clock signal
3	GND	PS	-	-
4	VDD	PS	-	-
5	Test0	DO	-	TDC phase signal for testing
6	Coarse1	DO	-	Data output coarse time / counter
7	Clockout	DO	-	PLL output clock divided by 8 for testing
8	Test1	DO	-	TDC phase signal for testing
9	VcDLLReset	AI	1 V	Reset voltage global DLL
10	VpDLLx2	AI	1.3 V	Clock doubling DLL external control voltage
11	Coarse0	DO	-	Data output coarse time / counter
12	Test2	DO	-	DLL sampling signal for testing
13	Coarse2	DO	-	Data output coarse time / counter
14	Coarse3	DO	-	Data output coarse time / counter
15	VDDPAD	PS	-	-
16	GNDPAD	PS	-	-
17	Coarse4	DO	-	Data output coarse time / counter
18	Coarse5	DO	-	Data output coarse time / counter
19	Coarse6	DO	-	Data output coarse time / counter
20	Coarse7	DO	-	Data output coarse time / counter
21	VDDPAD	PS	-	-
22	GNDPAD	PS	-	-
23	StartOut0	DO	-	Data output start interpolator
24	StartOut1	DO	-	Data output start interpolator
25	StartOut2	DO	-	Data output start interpolator
26	StartOut3	DO	-	Data output start interpolator
27	VDDPAD	PS	-	-
28	GNDPAD	PS	-	-

	Name	Type	Default	Description
29	StopOut0	DO	-	Data output stop interpolator
30	StopOut1	DO	-	Data output stop interpolator
31	StopOut2	DO	-	Data output stop interpolator
32	StopOut3	DO	-	Data output stop interpolator
33	VDDPAD	PS	-	-
34	GNDPAD	PS	-	-
35	VDD	PS	-	-
36	GND	PS	-	-
37	VcDLLOut	AO	-	Global DLL control voltage for testing
38	EnDLL	DI	1	Enable control voltage, high during time measurement
39	Latch	DI	0	Apply coincidence parameters
40	EnSPAD	DI	0	Pre enable SPADs
41	ReWrClk	DI	-	Read / write clock signal
42	EnWrite	DI	0	Write enable, high during write process
43	VDD	PS	-	-
44	GND	PS	-	-
45	SelDT	AI	2 V	SPAD dead time adjustment
46	EnRead	DI	0	Read enable, high during readout
47	VDD	PS	-	-
48	GND	PS	-	-
49	VcDLLx2Out	AO	-	Clock doubling DLL internal control voltage for testing
50	GNDPAD	PS	-	-
51	VDDPAD	PS	-	-
52	ClkSel	DI	0	Clock doubling DLL bypass
53	-	-	-	NC
54	-	-	-	NC
55	-	-	-	NC
56	GNDPAD	PS	-	-
57	VDDPAD	PS	-	-
58	-	-	-	NC
59	-	-	-	NC

	Name	Type	Default	Description
60	-	-	-	NC
61	Mode	DI	0	Mode selection, low timing, high counting
62	GNDPAD	PS	-	-
63	VDDPAD	PS	-	-
64	-	-	-	NC
65	-	-	-	NC
66	TDCStart	DI	0	Start TDC in test mode
67	TDCTest	DI	0	Test mode enable
68	GNDPAD	PS	-	-
69	VDDPAD	PS	-	-
70	DataN1		0	Data input for upper line active SPADs adjustment
71	DataCT1		0	Data input for upper line coincidence time adjustment
72	DataCD1		0	Data input for upper line coincidence depth adjustment
73	DataNO		0	Data input for lower line active SPADs adjustment
74	-	-	-	NC
75	VcDLLx2Reset	AI	1.3 V	Reset voltage for clock doubling DLL
76	DataCT0	DI	0	Data input for lower line coincidence time adjustment
77	DataCDO	DI	0	Data input for lower line coincidence depth adjustment
78	Set	DI	0	Coarse clock enable, required prior to time measurement
79	Reset	DI	1	Global sensor reset, high active
80	Cathode	HV	-	SPAD cathode voltage
81	Cathode	HV	-	SPAD cathode voltage
82	Gate	DI	0	Enables SPAD operation, high during measurement
83	GND	PS	-	-
84	VDD	PS	-	-

AI = Analog Input, AO = Analog Output, DI = Digital Input, DO = Digital Output, HV = High Voltage, NC = Not Connected, PS = Power Supply