

# WCS4000

## Wide Dynamic Range CMOS Photo Sensor with Auto-gain Adjust Feedback

### Design Description

The WCS4000 is an integrated photo sensor that provides a wide range of optical sensitivity. The photo diode converts light signal to electrical signal. A trans-impedance amplifier will gain the signal and convert it to a voltage output. The trans-impedance gain is auto-adjustable to meet the required device sensitivity 3uW to 65uW. The low pass filter (LPF) and high pass filter (HPF) filter out the low and high frequency noise and provide the auto-gain adjustment over the required sensitivity. Conditioning circuit is added to generate a 128 KHz digital output signal with constant duty cycle. The output buffer will provide a maximum output current drive of 2mA.

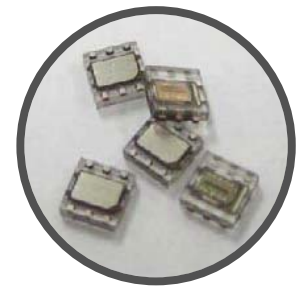
### Functional Block Description

The WCS4000 is an integrated photo sensor that provides the following functional blocks:

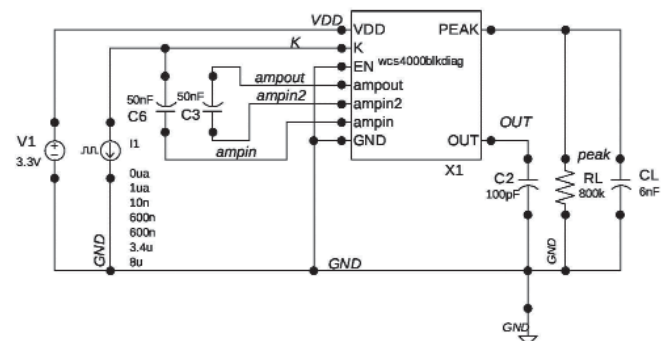
- On die photo diode converts the light signal to electrical signal.
- Trans-impedance with a low-pass filter with 1.4MHz cutoff frequency and an integrator feedback circuit that amplifies the signal and attenuates the low frequency component of the signal (i.e. DC, sunlight and indoor/outdoor lights).
- High-pass filter to remove the DC offset and further amplifies the signal.
- Automatic gain control circuit determines the gain level of the trans-impedance amplifier and high-pass filter.
- Peak detector, comparator and output driver convert the peak signal into digital output signals.
- Voltage reference and clock generator circuits generate the reference voltage and internal clock for the ASIC.

### Product Features

- On die photo diode
- 2mA output buffer
- Operate from 150 Hz to 128 KHz
- Auto Adjustable Gain up to 35dB
- 2KV ESD Protection
- Ambient Light Immunity
- 3uW to 65W Input Power
- Meets ANSIC 12-18 Port Req



### Functional Diagram



## Pin Function Description

PIN	Symbol	Description
1	OUT	Digital
2	VDD	Power Supply
3	GND	Ground
4	K	PD Cathode
5	EN	ENABLE
6	AMP0UT	Connect 50nF cap(Pos)
7	AMPIN2	Connect 50nF cap(Neg)
8	AMPIN	Connect 50nF cap(Neg)
9	PEAK	$R_L = 800k, C_L = 6nF$

Electrical characteristics over recommended operating conditions,  $T_A=25^{\circ}C$  (unless otherwise noted)

Absolute maximum ratings over operating free-air temperature range (unless otherwise noted).

Parameter	Symbol	Rating		Unit
		Min	Max	
Digital Supply Voltage (Compared to DGND)	$V_{DD}$	0.3	5.5	V
Digital input		-0.3	$V_{DD}+0.3$	V
Operating Temperature Range	$T_{amb}$	-40	100	$^{\circ}C$
Thermal Resistance			TBD	$^{\circ}C/W$
Storage Temperature	$T_{STG}$	-60	150	$^{\circ}C$
Lead Temperature (soldering, 10 seconds)	$T_L$		220	$^{\circ}C$
ESD HBM protection on digital input	$V_{ESD}$		4	KV

## Normal Operation Parameters

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Positive Supply Voltage	$V_{DD}$		3	3.3	5.5	V
Positive Supply Current	$I_{DD\text{active}}$	$V_{DD}=3$ to 5.5V			10	mA
Positive Supply Current	$I_{DD\text{inactive}}$	$V_{DD}=3$ to 5.5V			1	mA
Power Supply Rejection Ratio	PSRR	$V_{DD}=3.3V, f=1-1MHz, V_{DIN}>3.0V$		51		dB
Positive Threshold Irr	$E_{ST(+)}$	$V_{DD}=3.3V, \lambda_p=940nm; \text{collimated radiation}$	0.5		75	mW/cm <sup>2</sup>

## Digital Section

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Low Level Output Voltage	$V_{OL}$	$V_{DD}=3$ to 5.5V, $I_o = 1mA, E_e=0mW/cm^2$			0.4	V
High Level Output Voltage	$V_{OH}$	$V_{DD}=3$ to 5.5V, $I_o = 1mA, E_e=7.5mW/cm^2$	$V_{DD}-0.3$			V
Propagation delay	$t_{pHL}, t_{pLH}$	$V_{DD} = 3.3V, f = 1kHz, E_e = 75mW/cm^2, \text{Decouple Cap (VDD to GND)} = 0.1\mu F$			550	ns
Rise/Fall time	$t_r, t_f$	$V_{DD} = 3.3V, f = 1kHz, E_e = 75mW/cm^2, \text{Decouple Cap (VDD to GND)} = 0.1\mu F$			150	ns
Input Leakage	$I_{in}$	$V_{DIN}=3.3V$	-10		10	$\mu A$
Output Current Drive	$I_o$	$V_{DD}=3.3V$			2	mA

## Photo Diode

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Spectral range	$\lambda_p$		800	940	1000	nm
Spectral sensitivity		$\lambda_p = 800 - 1000nm$		0.3		A/W
Diode Area	$A_{D}$			0.196		mm <sup>2</sup>

## Analog

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
1.2V	$V_{REF}$	$E_e = 0mW/cm^2, V_{DD} = 3.3V$		1.22		V
1.5V	$V_{REF}$	$E_e = 0mW/cm^2, V_{DD} = 3.3V$		1.55		V
1.65V	$V_{REF}$	$E_e = 0mW/cm^2, V_{DD} = 3.3V$		1.65		V
1.75V	$V_{REF}$	$E_e = 0mW/cm^2, V_{DD} = 3.3V$		1.75		V
1.90V	$V_{REF}$	$E_e = 0mW/cm^2, V_{DIN} = 3.3V$		1.90		V
Sunlight current interference		$f=DC$			500	$\mu A$
Fluorescent current interference		$f<=120Hz$			2.5	$\mu A$
Signal current sensitivity					20	$\mu A$
Signal power sensitivity		$\lambda_p = 800 - 1000nm$	0.15		65	$\mu W$
Signal Bandwidth	BW		150		128k	Hz
Max. noise peak of frontend		RMS output noise*6		80	100	mV
Lower fc of frontend			60			kHz
Upper fc of frontend					1200	kHz