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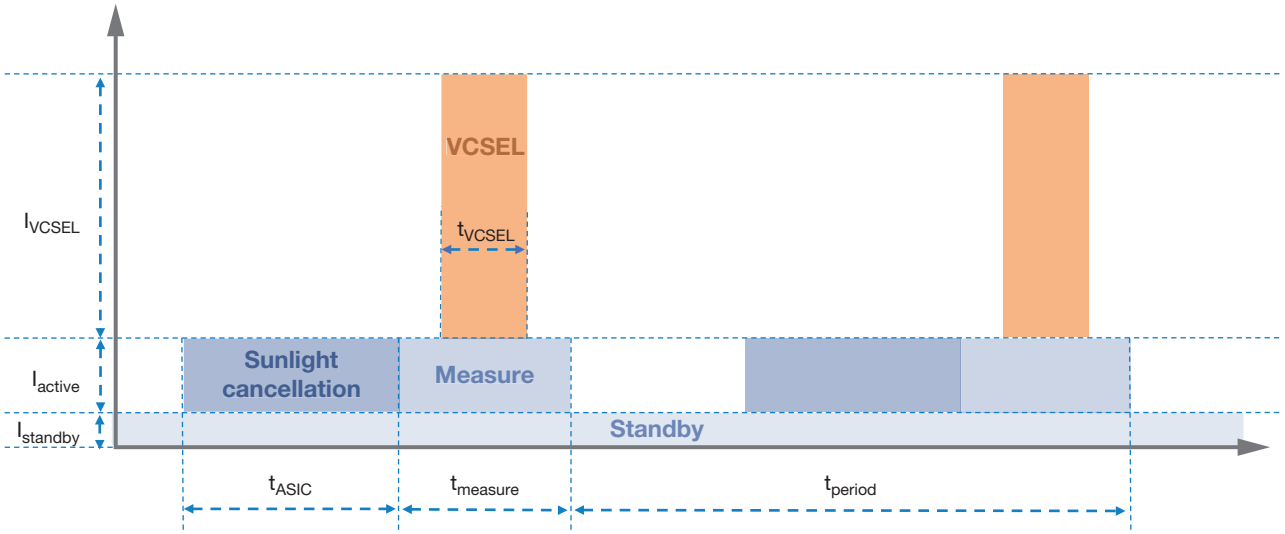
# DID YOU KNOW?

# LOW POWER – 6 µA PROXIMITY SENSING

## Overview of a Measure Cycle

Low power consumption is a key focus of our proximity sensor development and crucial in many battery-powered applications. With our latest generation IC in the VCNL3682x proximity sensor series, we are able to offer best in class power consumption down to under 6 µA of average current draw. Battery-powered devices require strict control, understanding, and management of their power consumption. This guide aims to explain the exact measure cycle of a digital proximity sensor and how to calculate and utilize it.




$$P_{total} = \frac{I_{standby} + (t_{active} + 2 \times t_{VCSEL}) \times I_{active} + t_{VCSEL} \times I_{VCSEL}}{t_{period}}$$

The below explanation for the graphs, power, and time setting refer to register settings of the sensor. All register settings are in square brackets, e.g. [PS_ITB], as to not be confused with the formula parameters. At the end of this document is an overview of all register settings mentioned and their respective options.

## Understanding Power Levels

Each measure cycle has three different power levels:

- **$I_{standby}$ - 5 µA** - minimum power consumption if the sensor is on. The value is always at 5 µA; between two measurements the sensor will go into standby mode due to its automatic low power mode feature
- **$I_{active}$ - 330 µA** - the IC active current is always at 330 µA. The sensor is in this state when preparing measurements and results, as well as during pre-measure features such as sunlight cancellation
- **$I_{VCSEL}$** - the VCSEL current depends on the register settings [PS_VCSEL], which are between 7 mA and 20 mA. Standard settings are set to 7 mA [PS_VCSEL = 0]. The height of the VCSEL current has a direct impact on the light received by the sensor, and therefor on the count output

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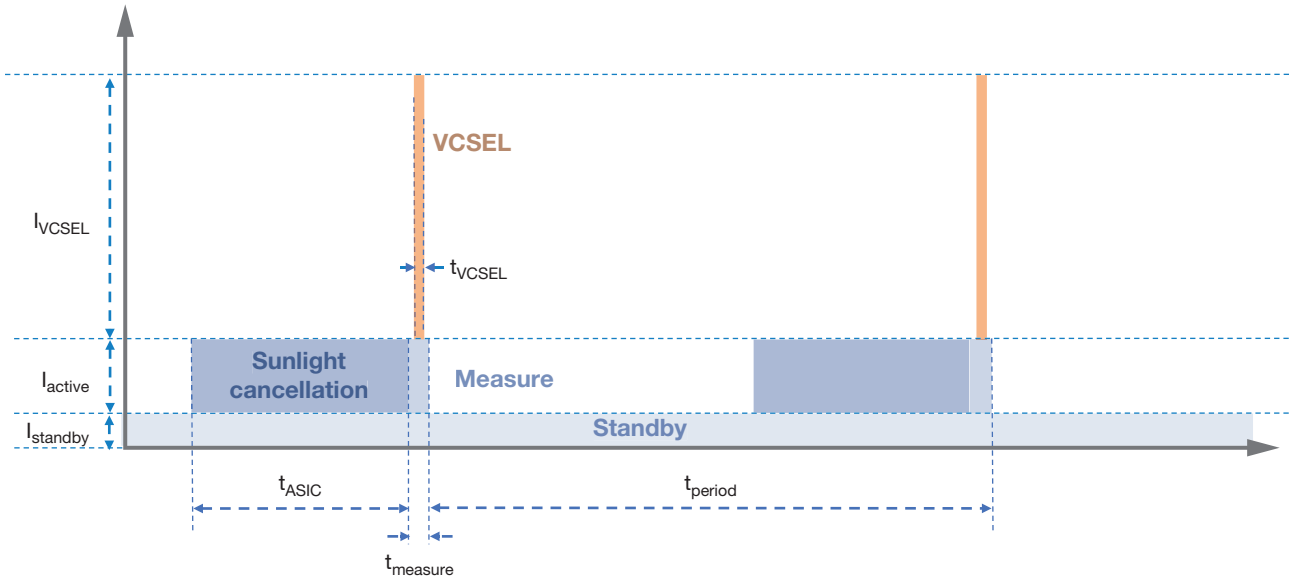
## Understanding Timings

Each measure cycle has three different power levels:

- **$t_{VCSEL}$ - 450 µs / 900 µs** - the turn-on phase for the IC and photodiode. The initiation of measurment parameters as well as the sunlight cancellation procedure are performed in this period. Timing depends on the base integration time setting [PS_ITB], with the standard setting in this phase being 450 µs [PS_ITB = 0]. With [PS_ITB = 50 µs] this phase will need 900 µs to complete
- **$t_{active}$ - 25 µs - 400 µs** - the time of $t_{ASIC}$, in which the VCSEL is active, depends on two registers - the base integration time [PS_ITB] multiplied by the lintegration Ttime [PS_IT]. Please note that the base integration time [PS_ITB] also affects the above $t_{VCSEL}$ time. For low power applications, it is recommend to keep [PS_ITB = 25 µs] and then adjµst [PS_IT] accordingly if needed
- **$t_{measure}$ = 2 x $t_{VCSEL}$ - 50 µs - 800 µs** - this phase is part of the actµal VCSEL measurment phase and is always double the time of the VCSEL active time T_IT. Pre- and post-measurements improve the result by including the ambient light conditions at the time of measuring
- **$t_{period}$ - 6.25 ms - 400 ms** - the period time setting [PS_PERIOD] sets how often each measure cycle is performed. The standard period time is set to 50 ms [PS_PERIOD = 0]. The most power-friendly setting is [PS_PERIOD = 3], which results in a 400 ms period time. If shorter period times than 50 ms are needed, the register [PS_SPERIOD] needs to be activated with a minimum of 6.25 ms period time

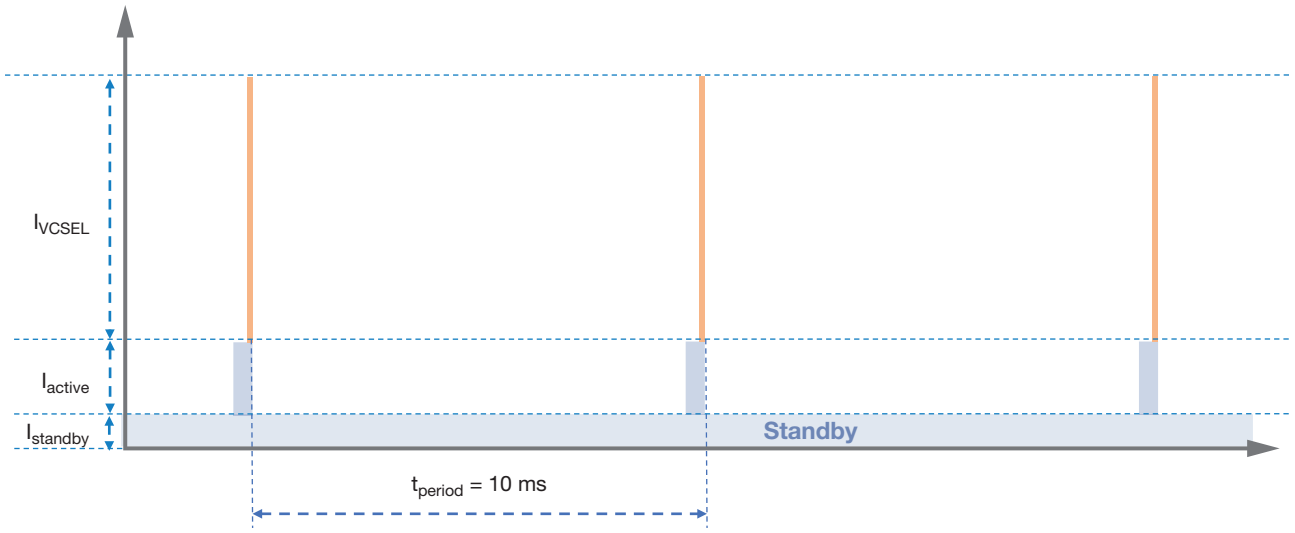
## Optimizing Parameters

The first picture shows a relatively long VCSEL time of 200 µs and an IC turn-on time of 450 µs [PS_ITB = 0; PS_IT = 8]. A power-saving scenario could look closer to the below picture, where the VCSEL time is set to 25 µs. [PS_ITB = 25 µs; PS_IT = 1T]. Note that the IC turn-on time stays the same in both pictures at 450 µs; only the VCSEL time and the dependent PD set-up time are significantly shorter.



In the next picture we see these settings applied to a scaled time with a period time of 10 ms. Notice that 10 ms is still very fast for period time, but the total active time of the sensor becomes very short in comparison. Typical period times, dependent on the application, are around 5 to 10 measurements per second → period time of 200 ms to 100 ms. The sensor spends most of the time in standby mode, waiting for the next measurements.

We focus our development efforts on a optimal standby mode, setting a new standard with only 5 µA



## Example Calculation With the Part VCNL36828P

The below table shows the results of different period times with all other settings set to be the most power economical possible. The longer the period time, the closer the average power consumption will get to 5 µA, which is the standby current.

Other sensors in the market have a standby current of 30 µA or more, which has a direct impact on the minimum power consumption, which will always be higher than the standby current.

The register settings used for the below table are: [PS_IT = 1T]; [PSITB = 25 µs]; [PS_VCSEL = 7 mA]

Note that not all applications can be designed at the lowest possible settings. Given various factors, such as measuring distance and required response speed in terms of measurment frequency, adjustments might be needed that increase the overall current consumption.

| VCNL36828P PARAMETER | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Standby** | (µA) | 5 | 5 | 5 | 5 | 5 | 5 |
| $I_{VCSEL}$ | (mA) | 7 | 7 | 7 | 7 | 7 | 7 |
| $I_{active}$ | (µA) | 330 | 330 | 330 | 330 | 330 | 330 |
| $t_{VCSEL}$ | (µs) | 25 | 25 | 25 | 25 | 25 | 25 |
| $t_{ASIC}$ | (µs) | 450 | 450 | 450 | 450 | 450 | 450 |
| $t_{period}$ | (ms) | 12.5 | 25 | 50 | 100 | 200 | 400 |
| **Result** | (µA) | 32.20 | 18.60 | 11.80 | 8.40 | 6.70 | 5.85 |

## Appendix: Register Settings Mentioned in This Document

| REGISTER SETTINGS MENTIONED IN THIS DOCUMENT | | | | |
|---|---|---|---|---|
| **ITEM** | **DESCRIPTION** | | **ITEM** | **DESCRIPTION** |
| PS_IT | Integration time setting | | PS_VCSEL | VCSEL current driving setting |
| | 0: 1T | | | 0: 7 mA |
| | 1: 2T | | | 1: 9 mA |
| | 2: 4T | | | 2: 11 mA |
| | 3: 8T | | | 3: 12 mA |
| PS_ITB | Integration time setting | | | 4: 15 mA |
| | 0: 25 µs | | | 5: 17 mA |
| | 1: 50 µs | | | 6: 19 mA |
| PS_PERIOD | Period started | | | 7: 20 mA |
| | 0: 50 ms | | PS_SPERIOD | PS short period setting |
| | 1: 100 ms | | | 0: follow PS_PERIOD setting |
| | 2: 200 ms | | | 1: 6.25 ms |
| | 3: 200 ms | | | 2: 12.5 ms |
| | | | | 3: 25 ms |