Position-sensitive device

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Contents

1 Introduction

The performance of high-precision optical setups is determined by the magnitude of the variations of some critical parameters. One of these critical parameters is the beam alignment. The initial beam alignment is crucial in order to reduce optical aberrations by i.e. diffraction. Once performed temperature fluctuations, mechanical strain or human interaction can alter the beam alignment or render the initial beam alignment obsolete.

Given these circumstances it is therefore an obvious step to integrate a control loop into the optical setup that corrects for errors in the beam alignment. The control loop comprises a position-sensitive device to gather the current state of the beam alignment as well as a mechanical mirror to compensate for errors.

In the present document we want to summarise the design process of such a position-sensitive device.

1.1 Requirements

Parameter	Symbol	Values		Unit
		Best	Worst	
Spatial resolution	Δx	0.7		µm

Table 1: Technical requirements of the position-sensitive device.

1. Dual power supply $V_{\pm} = \pm 15\,\mathrm{V}$
2. Ethernet network interface
3. Analogue interface

1.2 Overview

Components of the device.

2 Position-sensitive detector

The position-sensitive detector (PSD) constitutes the heart of the position-sensitive device. Its characteristics give the upper bound of the performance of our device. In the following section we will give an overview of the available methods for optical position measurement in order to motivate the selection of a tetra-lateral PSD photodiode. The arguments given are an excerpt of Ref. [1]. To the end of this section we describe how the PSD can be integrated into the framework of electrical circuit analysis.

2.1 Detector overview

2.2 Operating principle

Motivate the choice of the PSD to be an improved tetra-lateral PSD photodiode compared to i.e. quadrant diodes and explain the working principle [1].

For high speed applications one usually connects the cathode to a reverse bias voltage. However, in our case we are interested in a high spatial resolution. In this case ...ref... the PSD cathode should be connected to ground.

2.3 Detector selection

We have chosen the S5990 as the position-sensitive detector. The parameters of the S5990 are reported in Table 2.

Parameter	Symbol	Values		Unit
		Typical	Maximum	
Dark current	I_{dark}	0.5	10	nA
Interelectrode resistance	R_{ie}	7	15	kΩ
Terminal capacitance	C_t	150	300	pF
Position resolution	Δx	0.7		µm

Table 2: Important parameters of the S5990 extracted from the datasheet [2].

2.4 Equivalent circuit

The output terminals of the PSD can be modelled as a current source with internal resistance and capacitance [2].

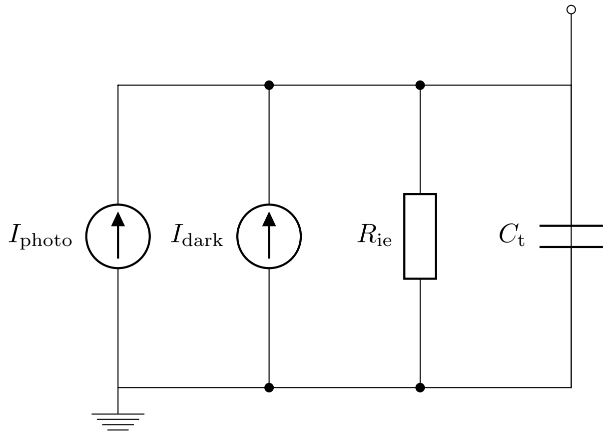

Figure 1: Equivalent circuit of one of the PSD output terminals according to [2].

3 Analogue signal processing

3.1 Preamplifier

Glossary

PSD position-sensitive detector. 3, 4

S5990 Hamamatsu two-dimensional PSD. 3

References

[1] Date Noorlag. "Lateral-photoeffect position-sensitive detectors". PhD thesis. Delft University of Technology, 1974.

[2] *PSD*. Hamamatsu.