
PSL photodetector design document

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The photodetectors used in the PSL area are described in this document.

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1 Introduction

For various purposes photodetectors are required in order to analyze and stabilize the beam in the PSL area. This document gives an overview of the four types of photodetectors that are built and utilized.

2 Photodetectors

In order to analyze beam parameters various photodetectors (PDs) are used in the PSL area. Indium-Gallium-Arsenide (InGaAs) photodiodes are utilized because of their high efficiency at the operating wavelength of 1064 nm. The design of these PDs is such that most of the parts are the same and mainly operational amplifiers (OPs) and photodiodes are different for locking, monitor and power monitor photodetector. All PDs are mounted in a case with a 60 mm edge length (see mechanical design) and operate with 18-24 V input voltage. The PD used for the first loop power stabilization needs to fulfill special requirements and has therefore a different design as described in Section 2.4.

The other three PD types (Sec. 2.1,2.2,2.3) have a similar circuit diagram of the electronics. The photocurrent is converted with a transimpedance amplifier into a voltage provided at the $50\ \Omega$ coupled DC output port. Low frequencies are suppressed with a high pass and a non-inverting amplifier provides a gain for the detection of AC signals. To avoid too much thermal load on the chip the bias voltage is set to 5 V.

2.1 Locking photodetector

For Pound-Drever-Hall locking a PD with a high bandwidth is required, such that it can detect the beat signals of the sidebands with the carrier and therefore the transimpedance amplifier is a low-noise LMH6624 OP with a gain-bandwidth product of 1.5 GHz. The photodiode used for the Pound-Drever-Hall locking PD is a 1 mm FCI (Tab. 1) one. Considering the transfer function from a power modulated laser to the AC output of the PD a bandwidth up to 100 MHz was measured. This kind of PD is used as sensing unit for the PMC and injection locking. The technical documentation can be found in D1002163.

Photodiode	Chip diameter	Responsivity at 1064 nm
FCI-InGaAs-1000	1 mm	0.74 A/W
Perkin Elmer C30642GH	2 mm	0.78 A/W
EPIGAP EPD 1300-3.0	3 mm	0.65 A/W

Table 1: Properties of the photodiodes used on the PSL table

2.2 Monitor photodetector

The second class of PDs is designed for monitoring power levels at various places in the PSL. Such PDs are not tuned for a specific application so that 3 mm EPIGAP photodiodes (Tab. 1), an AD8675 transimpedance amplifier and a THS4031 for the AC amplification are used within the circuit diagram (D1002164). This kind of PD can be utilized for general purposes.

2.3 Power monitor photodetector

For the monitoring of the output power of the laser system a Perkin Elmer photodiode (Tab. 1) is used. An AD8675 OP provides a high long term stability. The photodetector is placed outside the laser box to shield it from 808 nm pump light and 1064 nm stray light. The technical documentation can be under D1002929

2.4 ISS first loop power stabilization photodetector

T1000634 describes the photodetector for the inner-loop power stabilization of the aLIGO PSL. It contains design notes and simulations performed with LISO. Document D1001998-v2 contains the schematic and layout of the photodetector.