LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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EOM Combiner Requirements and Specifications

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1 Overview

The EOM combiner amplifier adds the modulation signals from the 45.5 MHz and 24.1 MHz sources. Its design documents can be found in LIGO-E1800124.

2 Isolation

The 45.5 MHz EOM driver is using an RF power detector at its output to stabilize the intensity noise. Any signal back feeding into this power detector will offset the error signal of the stabilization servo and introduces noise. The EOM driver output uses a ZMSC-2-1W splitter to send half the power towards the RF detectors. It has an isolation of 29 dB at the frequencies of interest. We derive the requirement for the total required isolation from the measured EOM noise spectrum and required that it is 10 dB above the phase noise of the OCXO generating the 24.1 MHz signal. We assume that these signals are of similar strength and that the OCXO amplitude noise is equivalent to the phase noise. Subtracting the isolation provided by the power splitter we derive the requirement of the combiner for the isolation from the 24.1 MHz signal into the 45.5 MHz signal. The table below lists the corresponding numbers for frequencies between 10 Hz and 10 kHz.

Frequency (Hz)	EOM Noise (dBc/Hz)	24.1 MHz OCXO Noise (dBc/Hz)	Total Required Isolation (dB)	Combiner Isolation (dB)
10	−164	−100	74	45
100	−184	−130	64	35
1k	−186	−155	41	12
10k	−178	−165	23	0

Since the requirement at 10 Hz is relaxed we set the overall requirement at 35 dB of isolation.

3 Voltage Standing Wave Ratio

The presence of RF return power, when the EOM driver is not exactly 50 Ω terminated, creates an offset on the RF power detectors. In turn, the servo will adjust, which results in an offset error. However, even under the assumption that all the power is returned, this effect is estimated to be about 5%. This is negligible in most cases.

4 Specifications

The specifications for the RF combiner and amplifier are as follows:

Frequency range:

24.1 MHz and 45.5 MHz

Input:

+30 dBm maximum (45.5 MHz)

10 dBm or less (24.1 MHz)

2 x N female

Isolation:

>35dB from 24.1 MHz amplifier output to 45.5 MHz input

Output:

Sum of RF signals

Up to 30 dBm at 45.5 MHz

Up to 28 dBm at 24.1 MHz

N female

Loss:

<2dB inline loss for 45.5 MHz

Gain:

>18dB for 24.1 MHz

<12dB noise figure for 24.1 MHz

RF power monitors (1 used):

Monitor after 24.1 MHz

Rear output: 0V - 10V single ended

Physical:

1U rack mount, vented

Power supply:

±24V

±16.5V