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Additional ISC Electronics for Balanced Homodyne Readout

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1 Overview

The current BHD preliminary design, [T2000581](#), and final design, [T2200032](#), calls for an additional two WFSs in reflection of one of the OMCs, and an additional LSC detector in reflection of the other OMC. Since a second OMC is also required, two DCPDs and two QPDs will also be added. Drawing, [D2000405](#), shows a QPD in a pick-off path to the LO monitoring the position of the LO beam. Drawing, [D2100601](#), shows two 105 kHz QPD assemblies that seem to point nowhere. We ignore these for now.

The WFS nomenclature in the BHD design is somewhat unfortunate: It relabels the existing two AS port WFSs as 45-WFS-1 and 45-WFS-2, despite the fact that they are used at 36MHz, 42MHz, 45MHz and 72MHz. The existing names are ASC-AS_A and ASC-AS_B.

The two new WFSs are labeled 36-WFS-1 and 36-WFS-2, presumably since they only require demodulation at 36 MHz. A better name may be ASC-LO_A and ASC-LO_B.

The existing LSC DC monitor PD in reflection of the OMC will be eliminated.

A list of existing ISC detectors with names can be found in [T1000264](#). An updated list for HAM6 can be found in Table 1. We select to keep the existing names for the AS port sensors and use names that are compatible with the old scheme for the new detectors.

2 New Detectors

2.1 WFS

There are basically 2 ways to implement the new WFSs needed for aligning the LO beam:

1. We leave the AS WFS readout chain as is and build two new WFSs tuned to 35MHz with the second RF readout unused. This will also require new WFS demodulation and whitening chassis.
2. We eliminate the 36 MHz sensing path from the AS WFS and replace them with a 72 MHz readout. In this case, we can repurpose the existing AS port WFS for the LO path and build two new 45MHz/72MHz WFS for the AS path. This will not require new WFS demodulation and whitening chassis.

At present, neither observatory has completely eliminated the 36 MHz readout chain from the AS port. This would need to be commissioned and tested prior to any decision.

2.2 QPD

Three new QPD readout chains are required. These are ASC-OMC_C, ASC-OMC_D, and ASC_LO_C. The required in-air electronics are a dual QPD transimpedance amplifier and a whitening chassis. Potentially, the old OMCR QPD chain can be repurposed, but some or all of the electronics may have been reused elsewhere. Currently, ASC-AS_C is using half of a dual QPD chain, so the spare half could be used by ASC-LO_C.

2.3 LSC

A new RF LSC detector will be required as well as a readout chain consisting of a 2-channel demodulator and a whitening. The two new DCPDs will require another OMC DCPD whitening filter chassis. The squeezer 3.125MHz combiner chassis will need a simple modification to accommodate all 4 DCPD 3MHz signals.

Detector	Sub	Output	Freq.	DOF	Location
ASC-AS_A (45-WFS-1)	WFS	RF45	45 MHz	DIFF Hard	HAM6
		RF72	72 MHz	SRM/BS	
		RF42	42 MHz	SQZ	
		RF36	36 MHz	SRM/BS	
		DC		centering	
ASC-AS_B (45-WFS-2)	WFS	RF45	45 MHz	DIFF Hard	HAM6
		RF72	72 MHz	SRM/BS	
		RF42	42 MHz	SQZ	
		RF36	36 MHz	SRM/BS	
		DC		centering	
ASC-AS_C	QPD	DC		SR2/SR3	HAM6
ASC-LO_A (36-WFS-1)	WFS	RF36	36 MHz	LO	HAM6
		DC		centering	
ASC-LO_B (36-WFS-2)	WFS	RF36	36 MHz	LO	HAM6
		DC		centering	
ASC-LO_C	QPD	DC		LO	HAM6
OMC-REFL_A	LSC	RF36	36 MHz	LO	HAM6
		DC		Normalization	
OMC-DCPD_A	LSC	DC		DARM	HAM6
OMC-DCPD_B	LSC	DC		DARM	HAM6
OMC-DCPD_C	LSC	DC		DARM	HAM6
OMC-DCPD_D	LSC	DC		DARM	HAM6
ASC-OMC_A	QPD	DC		OMC alignment	HAM6
ASC-OMC_B	QPD	DC		OMC alignment	HAM6
ASC-OMC_C	QPD	DC		OMC alignment	HAM6
ASC-OMC_D	QPD	DC		OMC alignment	HAM6

Table 1: List of ISC detectors in HAM6.

Chassis	Description	Plan 1	Plan 2
D1101992-v5	In-vacuum LSC RF PD	1	1
D1102002-v6	In-vacuum WFS	2	2
D1100789-v1	In-vacuum QPD Assembly	1	1
D2000592-v3	In-vacuum DCPD Front-End	2	2
D1201279-v4	In-vacuum OMC QPD Mount Assembly	2	2
D1100905-v3	Wavefront Sensor Demodulator Patch Panel	0	1
D0902796-v4	Quad IQ Demodulator Chassis	0	2
D1101906-v1	WFS Interface Chassis	0	0
D1100696-v1	ASC Demodulator Concentrator	0	1
D1100956-v3	LSC RFPD Demodulator Patch Panel	1	1
D1000181-v3	Dual IQ Demodulator Chassis	1	1
D1102079-v1	LSC RFPD Interface Chassis	1	1
D1100691-v1	LSC Demodulator Concentrator	1	1
D2100759-v4	Squeezer 3.125MHz Combiner Chassis	0	0
D2200215-v1	OMC DCPD Whitening Filter Chassis	1	1
D1300485-v2	OMC Piezo Driver Chassis	1	1
D1002481-v2	ISC Dual QPD Transimpedance Amplifier Chassis	1 ^a	1 ^a
D1002559-v3	ISC Whitening Chassis Assembly	2 ^{a,b}	4 ^{a,b}
D1100251-v3	384 Channel Binary Output	0 ^c	0 ^c
D0902783-v3	AA Chassis (8x DB9)	0 ^c	1 ^d
D1101521-v1	AI Chassis (4x DB9)	1 ^d	1 ^d
	32-channel ADC	0 ^c	1 ^c
	16-channel DAC	1 ^d	1 ^d
	Slow controls terminals (EtherCAT)		
^a 1 fewer chassis required, if OMCR chain is still available, 1 additional chassis required, if ASC-AS_C chain cannot be shared with ASC-LO_C. ^b 1 fewer chassis required, if whitening in 2-chn demod is sufficient. ^c Available BIO and ADC channels depend on other DI projects such as the JAC. ^d May be able to split REFL/AS DAC channels differently and avoid new DAC chain.			

Table 2: List of additional ISC electronics required for the BHD.

3 Required Hardware

The required additional hardware is listed in Table 2. We distinguish between plan 1 that assumes the 36 MHz WFS chain on the AS port is repurposed for the LO WFS, and plan 2 that requires new hardware for the LO WFS. We assume that all current electronics in HAM6 is getting reused, if possible.