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LIGO Laboratory / LIGO Scientific Collaboration

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Advanced LIGO

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ADC and DAC Channel Usage for ISC

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1 Purpose

This document lists the specific ADC and DAC channels used within the ISC I/O expansion chassis. In the following tables, the entries given in the ‘Signal’ column are *not* meant to be the exact DAQ channel name for that signal (though they may be); rather the entries are intended as descriptors to identify the actual hardware channel that is connected to a given ADC/DAC channel.

The reference document for the actual DAQ channel names is [T1000264](#), *List of ISC Photodetectors in Advanced LIGO*.

2 ASC-IO I/O Chassis

Card	AA/AI conn.	ADC/DAC Chns.	Signal			
ADC 0	DB9_1	1	IMC-WFS_A_RF	Seg 1	Q-phase	
		2			I-phase	
		3		Seg 2	Q-phase	
		4			I-phase	
	DB9_2	5		Seg 3	Q-phase	
		6			I-phase	
		7		Seg 4	Q-phase	
		8			I-phase	
	DB9_3	9	IMC-WFS_B_RF	Seg 1	Q-phase	
		10			I-phase	
		11		Seg 2	Q-phase	
		12			I-phase	
	DB9_4	13		Seg 3	Q-phase	
		14			I-phase	
		15		Seg 4	Q-phase	
		16			I-phase	
	DB9_5	17-20	IMC-WFS_A_DC	Segs 1-4	DC Outputs of WFS	
	DB9_6	21-24	IMC-WFS_B_DC	Segs 1-4		
	DB9_7	25	ALS-C_SHG_IR_LF			Aux. signals concentrator 3 REFL PD Amp 1-4
		26	ALS-C_SHG_GR_LF			
		27	ALS-C_TRX_A_LF			
		28	ALS-C_TRY_A_LF			
	DB9_8	29-30	Unused			
		31	Duotone (DAC)			
		32	Duotone			

Card	AA/AI conn.	ADC/DAC Chs.	Signal			
ADC 1	DB9_1	1-4	IO QPD: SM2 Transmission			
	DB9_2	5-8	IO QPD: MC2 Transmission			
	DB9_3	9	PD 1: post-EOM DC		4 ch Generic PD interface: PSL/IO table	
		10	PD 2: post-power control DC			
		11	PD 1: post-EOM AC			
		12	PD 2: post-power control AC			
	DB9_4	13	PD 1: unused			
		14	PD 2: IMC-REFL_TRIG_LF			
		15-16	PD 3,4: unused			
	DB9_5	17	ASC-AS_A_RF42	Seg 1	Q-phase	
		18			I-phase	
		19		Seg 2	Q-phase	
		20			I-phase	
	DB9_6	21		ASC-AS_B_RF42	Seg 3	Q-phase
		22				I-phase
		23			Seg 4	Q-phase
		24				I-phase
	DB9_7	25	ASC-AS_B_RF42	Seg 1	Q-phase	
		26			I-phase	
		27		Seg 2	Q-phase	
		28			I-phase	
	DB9_8	29		ASC-AS_B_RF42	Seg 3	Q-phase
		30				I-phase
		31			Seg 4	Q-phase
		32				I-phase

Card	AA/AI conn.	ADC/DAC chan.	Signal			
ADC 2	DB9_1	1	ASC-REFL_A_RF9	Seg 1	Q-phase	
		2			I-phase	
		3		Seg 2	Q-phase	
		4			I-phase	
	DB9_2	5		ASC-REFL_A_RF45	Seg 3	Q-phase
		6				I-phase
		7			Seg 4	Q-phase
		8				I-phase
	DB9_3	9	ASC-REFL_B_RF9		Seg 1	Q-phase
		10				I-phase
		11			Seg 2	Q-phase
		12				I-phase
	DB9_4	13		ASC-REFL_B_RF45	Seg 3	Q-phase
		14				I-phase
		15			Seg 4	Q-phase
		16				I-phase
	DB9_5	17	ASC-REFL_A_RF9		Seg 1	Q-phase
		18				I-phase
		19			Seg 2	Q-phase
		20				I-phase
	DB9_6	21		ASC-REFL_A_RF45	Seg 3	Q-phase
		22				I-phase
		23			Seg 4	Q-phase
		24				I-phase
	DB9_7	25	ASC-REFL_B_RF9		Seg 1	Q-phase
		26				I-phase
		27			Seg 2	Q-phase
		28				I-phase
	DB9_8	29		ASC-REFL_B_RF45	Seg 3	Q-phase
		30				I-phase
		31			Seg 4	Q-phase
		32				I-phase

Card	AA/AI conn.	ADC/DAC chan.	Signal			
ADC 3	DB9_1	1	ASC-POP_X_RF	Seg 1	Q-phase	
		2			I-phase	
		3		Seg 2	Q-phase	
		4			I-phase	
	DB9_2	5		ASC-POP_X_RF	Seg 3	Q-phase
		6				I-phase
		7			Seg 4	Q-phase
		8				I-phase
	DB9_3	9	Unused		Seg 1	Q-phase
		10				I-phase
		11			Seg 2	Q-phase
		12				I-phase
	DB9_4	13		Unused	Seg 3	Q-phase
		14				I-phase
		15			Seg 4	Q-phase
		16				I-phase
	DB9_5	17	ASC-AS_A_RF72		Seg 1	Q-phase
		18				I-phase
		19			Seg 2	Q-phase
		20				I-phase
	DB9_6	21		ASC-AS_A_RF72	Seg 3	Q-phase
		22				I-phase
		23			Seg 4	Q-phase
		24				I-phase
	DB9_7	25	ASC-AS_B_RF72		Seg 1	Q-phase
		26				I-phase
		27			Seg 2	Q-phase
		28				I-phase
	DB9_8	29		ASC-AS_B_RF72	Seg 3	Q-phase
		30				I-phase
		31			Seg 4	Q-phase
		32				I-phase

Card	AA/AI conn.	ADC/DAC chan.	Signal			
ADC 4	DB9_1	1	ASC-AS_A_RF45	Seg 1	Q-phase	
		2			I-phase	
		3		Seg 2	Q-phase	
		4			I-phase	
	DB9_2	5		ASC-AS_A_RF36	Seg 3	Q-phase
		6				I-phase
		7			Seg 4	Q-phase
		8				I-phase
	DB9_3	9	ASC-AS_B_RF45		Seg 1	Q-phase
		10				I-phase
		11			Seg 2	Q-phase
		12				I-phase
	DB9_4	13		ASC-AS_B_RF36	Seg 3	Q-phase
		14				I-phase
		15			Seg 4	Q-phase
		16				I-phase
	DB9_5	17	ASC-AS_A_RF45		Seg 1	Q-phase
		18				I-phase
		19			Seg 2	Q-phase
		20				I-phase
	DB9_6	21		ASC-AS_A_RF36	Seg 3	Q-phase
		22				I-phase
		23			Seg 4	Q-phase
		24				I-phase
	DB9_7	25	ASC-AS_B_RF45		Seg 1	Q-phase
		26				I-phase
		27			Seg 2	Q-phase
		28				I-phase
	DB9_8	29		ASC-AS_B_RF36	Seg 3	Q-phase
		30				I-phase
		31			Seg 4	Q-phase
		32				I-phase

Card	AA/AI conn.	ADC/DAC Chs.	Signal
ADC 5	DB9_1	1-4	ASC-REFL_A_DC
	DB9_2	5-8	ASC-REFL_B_DC
	DB9_3	9-12	ASC-AS_A_DC
	DB9_4	13-16	ASC-AS_B_DC
	DB9_5	17-20	ASC-POP_X_DC
	DB9_6	21-24	Unused
	DB9_7	25-28	PSL-BES_A_DC
	DB9_8	29-32	Unused

Card	AA/AI conn.	ADC/DAC Chs.	Signal
ADC 6	DB9_1	1-4	ASC-POP_A (QPD)
	DB9_2	5-8	ASC-POP_B (QPD)
	DB9_3	9-12	ASC-AS_C (QPD)
	DB9_4	13-16	ASC-OMC_A (QPD)
	DB9_5	17-20	ASC-OMC_B (QPD)
	DB9_6	21-24	ASC-OMCR_A (QPD)
	DB9_7	25-28	ASC-OMCR_B (QPD)
	DB9_8	29-32	Unused

Card	AA/AI conn.	ADC/DAC Chs.	Signal
DAC 0	DB9_1	1-4	Unused
	DB9_2	5-6	Unused
		7-8	Unused
	DB9_3	9	IO Input beam tip-tilt PZT drive: pitch
		10	IO Input beam tip-tilt PZT drive: yaw
		11	ASC-POP_X_PIT
		12	ASC-POP_X_YAW
	DB9_4	13-15	Unused
		16	DuoTone

3 LSC I/O Chassis

Card	AA/AI conn.	ADC/DAC Chns.	Signal	
ADC 0	DB9_1	1	PD 1: ALS-C_DIFF_A_LF	
		2	PD 2: ALS-C_COMM_A_LF	
		3	PD 3: LSC-REFLAIR_B_LF	
		4	PD 4: LSC-POPAIR_B_LF	
	DB9_2	5	LSC-POPAIR_A	
		6	LSC-REFLAIR_A	
		7	LSC-POP_A	
		8	LSC-REFL_A	
	DB9_3	9	OMC-BIAS_DCPD_A	
		10	OMC-BIAS_DCPD_B	
		11	OMC PZT1 Monitor: HV DC path (PZT3)	
		12	OMC PZT1 Monitor: HV AC path (PZT3)	
	DB9_4	13	Unused	
		14	Unused	
		15	Unused	
		16	Unused	
	DB9_5	17	OMC PZT1 Monitor: LV DC path	
		18	OMC PZT1 Monitor: LV AC path	
		19	OMC PZT2 Monitor: HV DC path	
		20	OMC PZT2 Monitor: HV AC path	
	DB9_6	21	LSC-REFL_SERVO_ERR, CM Servo, I monitor	
		22	LSC-REFL_SERVO_CTRL, CM Servo, Fast monitor	
		23	LSC-REFL_SERVO_SLOW, CM Servo, Slow monitor	
		24	Unused	
	DB9_7	25	IMC-I, IMC Servo, I monitor	
		26	IMC-F, IMC Servo, Fast monitor	
		27	IMC-L, IMC Servo, Slow monitor	
		28	Unused	
	DB9_8	29	OMC-REFL_A_LF	
		30	LSC-AS_SPARE_A_LF	
		31	Duotone (DAC)	
		32	Duotone	
			4 ch Generic PD interface: ISCT1	
			DC Outputs w/ whitening	
			4 ch Generic PD interface: ISCT6	

Card	AA/AI conn.	ADC/DAC Chns.	Signal		
ADC 1	DB9_1	1	LSC-POPAIR_B	RF18	Q-phase
		2			I-phase
		3		RF90	Q-phase
		4			I-phase
	DB9_2	5	LSC-REFLAIR_B	RF27	Q-phase
		6			I-phase
		7		RF135	Q-phase
		8			I-phase
	DB9_3	9	SQZ-OMC_TRANS	RF3	Q-phase
		10			I-phase
		11	SQZ-HD_DIFF	RF3	Q-phase
		12			I-phase
	DB9_4	13	SQZ-OPO_REFL	RF80	Q-phase
		14			I-phase
		15	SQZ-SHG_TRANS	RF24	Q-phase
		16			I-phase
	DB9_5	17	LSC-POPAIR_A	RF9	Q-phase
		18			I-phase
		19		RF45	Q-phase
		20			I-phase
	DB9_6	21	LSC-REFLAIR_A	RF9	Q-phase
		22			I-phase
		23		RF45	Q-phase
		24			I-phase
	DB9_7	25	LSC-POP_A	RF9	Q-phase
		26			I-phase
		27		RF45	Q-phase
		28			I-phase
	DB9_8	29	LSC-REFL_A	RF9	Q-phase
		30			I-phase
		31		RF45	Q-phase
		32			I-phase

Card	AA/AI conn.	ADC/DAC Chns.	Signal		
ADC 2	DB9_1	1	IMC-REFL_A_DC		
		2	LSC-REFL_B_LF		
		3	Unused		
		4	PSL TTFSS PD (power only)		
	DB9_2	5	ALS-C_COMM_A_RF_ERR (PFD signal ALS Comm)		
		6	LSC-REFL_B_RF9_ERR (Demod signal REFL)		
		7	ALS-C_REFL_DC_ERR (DC signal from REFL_A PD)		
		8	LSC-REFL_A_RF9_ERR (Demod signal REFL)		
	DB9_3	9	LSC EXTRA_AI_1		
		10	LSC EXTRA_AI_2		
		11	LSC EXTRA_AI_3		
		12	LSC EXTRA_AI_4		
	DB9_4	13	ALS-C_COMM_PLL_ERR		
		14	ALS-C_COMM_PLL_CTRL		
		15	ALS-C_DIFF_PLL_ERR		
		16	ALS-C_DIFF_PLL_CTRL		
	DB9_5	17	LSC-MOD_RF9_AM_ERR		
		18	LSC-MOD_RF9_AM_CTRL		
		19	LSC-MOD_RF9_AM_AC		
		20	LSC-MOD_RF9_AM_DC		
	DB9_6	21	LSC-MOD_RF45_AM_ERR		
		22	LSC-MOD_RF45_AM_CTRL		
		23	LSC-MOD_RF45_AM_AC		
		24	LSC-MOD_RF45_AM_DC		
	DB9_7	25	SQZ-OPO_ISS_ERR		
		26	SQZ-OPO_ISS_CTRL		
		27	SQZ-CLF_ISS_ERR		
		28	SQZ-CLF_ISS_CTRL		
	DB9_8	29	IMC_REFL_A	RF24	Q-phase
		30			I-phase
		31	LSC-REFL_B	RF9	Q-phase
		32			I-phase

Card	AA/AI conn.	ADC/DAC Chns.	Signal	
ADC 3	DB9_1	1	SQZ-OPO_SERVO_ERR, CM Servo, I monitor	
		2	SQZ-OPO_SERVO_CTRL, CM Servo, Fast monitor	
		3	SQZ-OPO_SERVO_SLOW, CM Servo, Slow monitor	
		4	SQZ-CLF_SERVO_ERR, CM Servo, I monitor	
	DB9_2	5	SQZ-SHG_SERVO_ERR, CM Servo, I monitor	
		6	SQZ-SHG_SERVO_CTRL, CM Servo, Fast monitor	
		7	SQZ-SHG_SERVO_SLOW, CM Servo, Slow monitor	
		8	SQZ-CLF_SERVO_CTRL, CM Servo, Fast monitor	
	DB9_3	9	SQZ-LO_SERVO_ERR, CM Servo, I monitor	
		10	SQZ-LO_SERVO_CTRL, CM Servo, Fast monitor	
		11	SQZ-LO_SERVO_SLOW, CM Servo, Slow monitor	
		12	SQZ-CLF_SERVO_SLOW, CM Servo, Slow monitor	
	DB9_4	13	SQZ-HD_B_DC	
		14	SQZ-HD_DIFF_DC	
		15	SQZ-HD_A_DC	
		16	Unused	
	DB9_5	17	SQZ-FIBR_MIXER	
		18	SQZ-FIBR_PZT	
		19	SQZ-FIBR_EOMRMS	
		20	SQZ-FIBR_SLOW	
	DB9_6	21	PD1: SQZ-PMC_TRANS_LF	4 ch Generic PD interface: SQZT0 w/ whitening
		22	PD2: SQZ-SHG_TRANS_LF	
		23	PD3: SQZ-LASER_IR_LF	
		24	PD4: SQZ-SHG_GR_LF	
	DB9_7	25	SQZ-OPO_TRANS_LF	DC Outputs w/ whitening
		26	SQZ-OPO_REFL_REJECTED_LF	
		27	SQZ- FIBR_TRANS_LF	
		28	SQZ-FC_REFL_REJECTED_LF	
	DB9_8	29	SQZ-EXTRA_AI_1	
		30	SQZ-EXTRA_AI_2	
		31	SQZ-EXTRA_AI_3	
		32	SQZ-EXTRA_AI_4	

Card	AA/AI conn.	ADC/DAC Chns.	Signal		
ADC 4	DB9_1	1	SQZ-FC_SERVO_ERR, CM Servo, I monitor		
		2	SQZ-FC_SERVO_CTRL, CM Servo, Fast monitor		
		3	SQZ-FC_SERVO_SLOW, CM Servo, Slow monitor		
		4	Unused		
	DB9_3	5	SQZ-CLF_REFL	RF6	Q-phase
		6			I-phase
		7	SQZ-FC_REFL	RF40	Q-phase
		8			I-phase
	DB9_3	9	Unused		
		10	SQZ-PMC_REFL_LF		
		11	SQZ-FIBR_PD_LF		
		12	SQZ-ADF_VCXO_RF203_I		
	DB9_4	13	SQZ-PMC_REFL	RF35	Q-phase
		14			I-phase
		15	Spare	RF	Q-phase
		16			I-phase
	DB9_5	17	SQZ-PMC_SERVO_ERR, CM Servo, I monitor		
		18	SQZ-PMC_SERVO_CTRL, CM Servo, Fast monitor		
		19	SQZ-PMC_SERVO_SLOW, CM Servo, Slow monitor		
		20	Unused		
	DB9_6	21	MOTION_C_SHUTTER_H_TRIGGER (CLF path trigger PD)		4 ch Generic PD interface: SQZT7
		22	SQZ-OPO_IR		
		23	SQZ-CLF_DC		
		24	SQZ-OPO_DC		
	DB9_7	25	SQZ-CLF_REFL_LF		DC Outputs w/ whitening
		26	SQZ-OPO_REFL_LF		
		27	SQZ-FC_REFL_LF		
		28	SQZ-FC_BEAT_LF		
	DB9_8	29	Unused		
		30	Unused		
		31	Unused		
		32	Unused		

Card	AA/AI conn.	ADC/DAC Chns.	Signal		
ADC 5 526kHz	DB37	1	SQZ-OMC_TRANS	RF3	I-phase
		2			Q-phase
		3	SQZ-HD_DIFF	RF3	I-phase
		4			Q-phase
		5	Unused		
		6	Unused		
		7	SQZ-FC_BEAT_MF		
		8	SQZ-RLF_VCXO_RF200_I_MF		
		9	SQZ-FC_QPD_A	Seg 3	MF
		10		Seg 4	MF
		11		Seg 1	MF
		12		Seg 2	MF
		13	SQZ-FC_QPD_B	Seg 3	MF
		14		Seg 4	MF
		15		Seg 1	MF
		16		Seg 2	MF

Card	AA/AI conn.	ADC/DAC Chs.	Signal
DAC 0	DB9_1	1	SQZ-FC_BEAT_CTRL
		2	SQZ-RLF_VCXO_CTRL
		3	SQZ-ADF_VCXO_CTRL
		4	SQZ-SEED-PZT
	DB9_2	5	SQZ-OPO_SERVO_EXC
		6	SQZ-SHG_SERVO_EXC
		7	SQZ-LO_SERVO_EXC
		8	SQZ-CLF_SERVO_EXC
	DB9_3	9	OMC PZT1 Dither (LV)
		10	OMC PZT2 Drive (HV, servo)
		11	OMC PZT1 Drive (HV, bias only, PZT3)
		12	OMC_TEST_DCPD
	DB9_4	13	ALS-C_REFL_DC_BIAS CM Summing module control
		14	LSC EXTRA_AO_2
		15	LSC-EXTRA_AO_3
		16	Duotone

4 OMC I/O Chassis

The OMC I/O chassis is located in the SQZ-C1 rack.

Card	AA/AI conn.	ADC/DAC Chns.	Signal
ADC 0	DB9_1	1/5/9/13	OMC-BIAS_DCPD_A
		2/6/10/14	OMC-BIAS_DCPD_B
		3/7/11/15	OMC-BIAS_DCPD_C
		4/8/12/16	OMC-BIAS_DCPD_D
	DB9_2	17/21/25/29	Unused
		18/22/26/30	Unused
		19/23/27/31	Unused
		20/24/28/32	Unused

5 Filter Cavity End Station

The front-end is shared between all systems interfacing HAM8 in the filter cavity end station: SEI, SUS, PEM and SQZ/ISC. Furthermore, PEM and ISC share an ADC. Only the first 12 channels are for ISC, the remainder for PEM.

Card	AA/AI conn.	ADC/DAC Chs.	Signal	
ADC 1	DB9_1	1-4	SQZ-FC_TRANS_A	Quad Photodiodes
	DB9_2	5-8	SQZ_FC_TRANS_B	
	DB9_3	9	Unused	4 ch Generic PD interface: SQZT8
		10	Unused	
		11	Unused	
		12	Unused	

6 End Stations

PEM and Photon Calibrator are using the first ADC card (ADC 0). This card implements the DuoTone readbacks. The first ISC card is ADC 1 (but the model calls it ADC0). The same is true for the DAC cards, where PEM and Photon Calibrator are using the first DAC.

Card	AA/AI conn.	ADC/DAC Chs.	Signal				
ADC 1	DB9_1	1-4	ASC-TRX(Y)_A		In-Vac Quad Photodiodes		
	DB9_2	5-8	ASC-TRX(Y)_B				
	DB9_3	9-12	ALS-X(Y)_QPD_A				
	DB9_4	13-16	ALS-X(Y)_QPD_B				
	DB9_5		17	ALS-X(Y)_WFS_A		Seg 1	DC
			18			Seg 2	DC
			19			Seg 3	DC
			20			Seg 4	DC
	DB9_6		21	ALS-X(Y)_WFS_B		Seg 1	DC
			22			Seg 2	DC
			23			Seg 3	DC
			24			Seg 4	DC
	DB9_7		25	LSC-X(Y) EXTRA_AI_1			
			26	LSC-X(Y) EXTRA_AI_2			
			27	LSC-X(Y) EXTRA_AI_3			
			28	ALS-X(Y) REQSTATE_A (EtherCAT interface)			
	DB9_8		29	Used by Electric Field Meter (PEM)			
			30	Used by Electric Field Meter (PEM)			
			31	Unused			
			32	Unused			

Card	AA/AI conn.	ADC/DAC Chs.	Signal	
ADC 2	DB9_1	1	ALS-X(Y)_FIBR_SERVO_ERR CM Servo: ALS phase-locking, I monitor	
		2	ALS-X(Y)_FIBR_SERVO_CTRL CM Servo: ALS phase-locking, Fast monitor	
		3	ALS-X(Y)_FIBR_SERVO_SLOW CM Servo: ALS phase-locking, Slow monitor	
		4	Unused	
	DB9_2	5	ALS-X(Y)_REFL_SERVO_ERR CM Servo: ALS PDH-locking, I monitor	
		6	ALS-X(Y)_REFL_SERVO_CTRL CM Servo: ALS PDH-locking, Fast monitor	
		7	ALS-X(Y)_FIBR_SERVO_SLOW CM Servo: ALS PDH-locking, Slow monitor	
		8	Unused	
	DB9_3	9	ALS-X(Y)_REFL_B_LF PD1: DC from REFL power mon.	4 ch. PD interface chassis: ALS Table
		10	LSC-TRX(Y)_A_LF PD2: Red transmitted beam	
		11	ALS-X(Y)_LASER_GR_LF PD3: Green power monitor	
		12	ALS-X(Y)_FIBR_A_LF PD4: DC from BBPD	
	DB9_4	13	ALS-X(Y)_LASER_IR_LF PD1: IR power monitor	4 ch. Aux. signals concentrator 5: Field rack
		14	ALS-X(Y)_FIBR_REJECTED_LF PD2: Rejected fiber power	
		15	ALS-X(Y)_FIBR_TRANS_LF PD3: Trans. fiber power	
		16	ALS-X(Y)_SPARE_B_LF PD4: unused	

Card	AA/AI conn.	ADC/DAC Chs.	Signal		
ADC2	DB9_5	17	ALS-X(Y)_WFS_A	Seg 1	Q-phase
		18			I-phase
		19		Seg 2	Q-phase
		20			I-phase
	DB9_6	21		Seg 3	Q-phase
		22			I-phase
		23		Seg 4	Q-phase
		24			I-phase
	DB9_7	25	ALS-X(Y)_WFS_B	Seg 1	Q-phase
		26			I-phase
		27		Seg 2	Q-phase
		28			I-phase
	DB9_8	29		Seg 3	Q-phase
		30			I-phase
		31		Seg 4	Q-phase
		32			I-phase

Card	AA/AI conn.	ADC/DAC Chs.	Signal
DAC1	DB9_1	1	ALS-X(Y)_PZT1_PIT MCL PZT Tip-tilt 1: pitch
		2	ALS-X(Y)_PZT1_YAW MCL PZT Tip-tilt 1: yaw
		3	ALS-X(Y)_PZT2_PIT MCL PZT Tip-tilt 2: pitch
		4	ALS-X(Y)_PZT2_YAW MCL PZT Tip-tilt 2: yaw
	DB9_2	5	LSC-X(Y) EXTRA_AO_1
		6	LSC-X(Y) EXTRA_AO_2
		7	LSC-X(Y) EXTRA_AO_3
		8	ALS-X(Y) REQSTATE_A (EtherCAT interface)
	DB9_3	9	ALS-X(Y)_PZT3_PIT MCL PZT Tip-tilt 3 for WFS_A: pitch
		10	ALS-X(Y)_PZT3_YAW MCL PZT Tip-tilt 3 for WFS_A: yaw
		11	ALS-X(Y)_PZT4_PIT MCL PZT Tip-tilt 4 for WFS_B: pitch
		12	ALS-X(Y)_PZT4_YAW MCL PZT Tip-tilt 4 for WFS_B: yaw
	DB9_4	13	Unused
		14	Unused
		15	Unused
		16	Unused

7 ADC/DAC Channel Concentrator

7.1 Variant 1

Chas.	Conn.	ADC Chns.	Signal	Jumper
1 Front	DB9_1 IN	1	SQZ-OPO_SERVO_ERR, CM Servo, I monitor	
		2	SQZ-OPO_SERVO_CTRL, CM Servo, Fast monitor	
		3	SQZ-OPO_SERVO_SLOW, CM Servo, Slow monitor	
		4	Unused	
	DB9_2 IN	5	SQZ-SHG_SERVO_ERR, CM Servo, I monitor	
		6	SQZ-SHG_SERVO_CTRL, CM Servo, Fast monitor	
		7	SQZ-SHG_SERVO_SLOW, CM Servo, Slow monitor	
		8	Unused	
	DB9_3 IN	9	SQZ-LO_SERVO_ERR, CM Servo, I monitor	
		10	SQZ-LO_SERVO_CTRL, CM Servo, Fast monitor	
		11	SQZ-LO_SERVO_SLOW, CM Servo, Slow monitor	
		12	Unused	
	DB9_4 IN	13	SQZ-CLF_SERVO_ERR, CM Servo, I monitor	
		14	SQZ-CLF_SERVO_CTRL, CM Servo, Fast monitor	
		15	SQZ-CLF_SERVO_SLOW, CM Servo, Slow monitor	
		16	Unused	
	DB9_1 OUT	1	SQZ-OPO_SERVO_ERR, CM Servo, I monitor	IN1-1&6/OUT1-1&6
		2	SQZ-OPO_SERVO_CTRL, CM Servo, Fast monitor	IN1-2&7/OUT1-2&7
		3	SQZ-OPO_SERVO_SLOW, CM Servo, Slow monitor	IN1-3&8/OUT1-3&8
		4	SQZ-CLF_SERVO_ERR, CM Servo, I monitor	IN4-1&6/OUT1-4&9
	DB9_2 OUT	5	SQZ-SHG_SERVO_ERR, CM Servo, I monitor	IN2-1&6/OUT2-1&6
		6	SQZ-SHG_SERVO_CTRL, CM Servo, Fast monitor	IN2-2&7/OUT2-2&7
		7	SQZ-SHG_SERVO_SLOW, CM Servo, Slow monitor	IN2-3&8/OUT2-3&8
		8	SQZ-CLF_SERVO_CTRL, CM Servo, Fast monitor	IN4-2&7/OUT2-4&9
DB9_3 OUT	9	SQZ-LO_SERVO_ERR, CM Servo, I monitor	IN3-1&6/OUT3-1&6	
	10	SQZ-LO_SERVO_CTRL, CM Servo, Fast monitor	IN3-2&7/OUT3-2&7	
	11	SQZ-LO_SERVO_SLOW, CM Servo, Slow monitor	IN3-3&8/OUT3-3&8	
	12	SQZ-CLF_SERVO_SLOW, CM Servo, Slow monitor	IN4-3&8/OUT3-4&9	
DB9_4	13-16	Unused		

Chas.	Conn.	ADC Chns.	Signal	Jumper
1 Rear	DB9 IN1	1	LSC-REFL_SERVO_ERR, CM Servo, I monitor	
		2	LSC-REFL_SERVO_CTRL, CM Servo, Fast	
		3	LSC-REFL_SERVO_SLOW, CM Servo, Slow	
		4	Unused	
	DB9 IN2	5	IMC-I, IMC Servo, I monitor	
		6	IMC-F, IMC Servo, Fast monitor	
		7	IMC-L, IMC Servo, Slow monitor	
		8	Unused	
	DB9 IN3	9	SQZ-CLF_REFL_RF6_Q	
		10	SQZ-CLF_REFL_RF6_I	
		11	Unused	
		12	Unused	
	DB9 IN4	13	Unused	
		14	Unused	
		15	Unused	
		16	Unused	
	DB9 OUT1	1	LSC-REFL_SERVO_ERR, CM Servo, I monitor	IN1-1&6/OUT1-1&6
		2	LSC-REFL_SERVO_CTRL, CM Servo, Fast	IN1-2&7/OUT1-2&7
		3	LSC-REFL_SERVO_SLOW, CM Servo, Slow	IN1-3&8/OUT1-3&8
		4	SQZ-CLF_REFL_RF6_Q	IN3-1&6/OUT1-4&9
DB9 OUT2	5	IMC-I, IMC Servo, I monitor	IN2-1&6/OUT2-1&6	
	6	IMC-F, IMC Servo, Fast monitor	IN2-2&7/OUT2-2&7	
	7	IMC-L, IMC Servo, Slow monitor	IN2-3&8/OUT2-3&8	
	8	SQZ-CLF_REFL_RF6_I	IN3-2&7/OUT2-4&9	
DB9 OUT3	9	Unused		
	10	Unused		
	11	Unused		
	12	Unused		
DB9 OUT4	13	Unused		
	14	Unused		
	15	Unused		
	16	Unused		

7.2 Variant 2

Chas.	Conn.	ADC Chns.	Signal	Jumper
2 Front	DB9_1 IN	1	SQZ-OPO_ISS_ERR	
		2	SQZ-OPO_ISS_CTRL	
		3	Unused	
		4	Unused	
	DB9_2 IN	5	SQZ-CLF_ISS_ERR	
		6	SQZ-CLF_ISS_CTRL	
		7	Unused	
		8	Unused	
	DB9_3 IN	9	ALS-C_REFL_DC_BIAS	
		10	LSC EXTRA_AO_2	
		11	LSC-EXTRA_AO_3	
		12	LSC-EXTRA_AO_4	
	DB9_4 IN	13	OMC_TEST_	
		14	Unused	
		15	Unused	
		16	Unused	
	DB9_1 OUT	1	SQZ-OPO_ISS_ERR	IN1-1&6/OUT1-1&6
		2	SQZ-OPO_ISS_CTRL	IN1-2&7/OUT1-2&7
		3	SQZ-CLF_ISS_ERR	IN2-1&6/OUT1-3&8
		4	SQZ-CLF_ISS_CTRL	IN2-2&7/OUT1-4&9
DB9_2 OUT	5	Unused		
	6	Unused		
	7	Unused		
	8	Unused		
DB9_3 OUT	9	ALS-C_REFL_DC_BIAS	IN3-1&6/OUT3-1&6	
	10	LSC EXTRA_AO_2	IN3-2&7/OUT3-2&7	
	11	LSC-EXTRA_AO_3	IN3-3&8/OUT3-3&8	
	12		IN4-1&6/OUT3-4&9	
DB9_4 OUT	13-16	Unused		

Chas.	Conn.	ADC Chns.	Signal	Jumper
2 Rear	DB9 IN1	1	Unused	
		2	Unused	
		3	Unused	
		4	Unused	
	DB9 IN2	5	Unused	
		6	Unused	
		7	Unused	
		8	Unused	
	DB9 IN3	9	Unused	
		10	Unused	
		11	Unused	
		12	Unused	
	DB9 IN4	13	Unused	
		14	Unused	
		15	Unused	
		16	Unused	
	DB9 OUT1	1	Unused	
		2	Unused	
		3	Unused	
		4	Unused	
DB9 OUT2	5	Unused		
	6	Unused		
	7	Unused		
	8	Unused		
DB9 OUT3	9	Unused		
	10	Unused		
	11	Unused		
	12	Unused		
DB9 OUT4	13	Unused		
	14	Unused		
	15	Unused		
	16	Unused		

8 Summary

Below is a summary of the number of I/O cards, unused channels, and available I/O slots for the ISC I/O Expansion Chassis. This assumes there are a total of 10 slots available in the I/O chassis for ADC and/or DAC cards. For the unused ADC channel column, the number in parentheses is the subset of these channels that are available Anti-Alias (AA) chassis on free DB9 connectors; the other channels are found on AA DB9 connectors which are only partially used.

I/O Chassis	# ADC cards	# DAC cards	Unused ADC chans	Unused DAC chans	Available I/O slots
Vertex: ASC	7	1	12 (8)	6 (4)	2
Vertex: LSC	4	1	11 (0)	0 (0)	5
End X	2	1	7 (4)	4 (4)	5
End Y	2	1	7 (4)	4 (4)	5
Totals	15	4	37 (16)	14 (12)	17

At the end stations, the I/O Expansion Chassis is shared with PEM. PEM has one ADC card, of which 14 channels are used, and one DAC card. The DAC card provides 8 channels (18 bit) of general purpose test outputs. The 'available slots' number takes these PEM cards into account.