



LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

*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		4 ch Generic PD interface: PSL/IO table	
		10	PD 2: post-power control			
		11	PD 3: unused			
		12	PD 4: unused			
	DB9_4	13	PD 1: SM1 Transmission		4 ch Generic PD interface: IOT1	
		14	PD 2: IMC_PDH DC out			
		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_A_RF45 (POP_X in vacuum)	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	ASC-POP_B_RF45	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	ASC-AS_A_RF72	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	ASC-AS_B_RF72	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 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_A_DC
	DB9_6	21-24	ASC-POP_B_DC
	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/JAC-QPD_A (QPD)
	DB9_2	5-8	ASC-POP_B/JAC-QPD_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	JAC-PZT_A (placeholder)
		7-8	JAC-PZT_B (placeholder)
	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/ IO_PZT_B_PIT MCL PZT Tip-tilt 1: pitch
		12	ASC-POP_X_YAW/ IO_PZT_B_YAW MCL PZT Tip-tilt 1: 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			4 ch Generic PD interface: ISCT1
		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			DC Outputs
		6	LSC-REFLAIR_A			
		7	LSC-POP_A			
		8	LSC-REFL_A			
	DB9_3	9	PD1: SQZ-FIBR_PD_LF			4 ch Generic PD interface: ISCT6
		10	PD2: SQZ-SHG_TRANS_LF			
		11	PD3: SQZ-LASER_IR_LF			
		12	PD4: SQZ-SHG_GR_LF			
	DB9_4	13	OMC-DCPD_A			
		14	OMC-DCPD_B			
		15	OMC-PI_DCPD_A			
		16	OMC-PI_DCPD_B			
	DB9_5	17	OMC PZT Monitor: Slow DC path			
		18	OMC PZT Monitor: Slow AC path			
		19	OMC PZT Monitor: Fast DC path			
		20	OMC PZT Monitor: Fast 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	SQZ-CLF_REFL	RF6	Q-phase	
	DB9_7	25	IMC-I, IMC Servo, I monitor			
		26	IMC-F, IMC Servo, Fast monitor			
		27	IMC-L, IMC Servo, Slow monitor			
		28	SQZ-CLF_REFL	RF6	I-phase	
	DB9_8	29	MOTION_C_SHUTTER_H_TRIGGER (CLF path trigger PD)		4 ch Generic PD interface: SQZT6	
		30	Unused			
		31	Duotone (DAC)			
		32	Duotone			

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	RF35	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, RF PD DC output (whitened)		
		2	ALS-C_DIFF_A_RF_ERR PFD signal for ALS Differential		
		3	PD3: JAC-REFL_A		
		4	PD4: Unused		
	DB9_2	5	ALS-C_REFL_DC_ERR (DC signal from REFL_A PD)		
		6	LSC-REFL_A_RF9_ERR (Demodulator signal REFL)		
		7	ALS-C_COMM_A_RF_ERR (PFD signal ALS Comm)		
		8	LSC-REFLAIR_A_RF9_ERR (Demod signal REFLAIR)		
	DB9_3	9	LSC EXTRA_AI_1		
		10	LSC EXTRA_AI_2		
		11	ALS-REQSTATE_A (EtherCAT interface)		
		12	ALS-REQSTATE_B (EtherCAT interface)		
	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	JAC_TRANS_A_LF		
		26	JAC_PWR_A_LF		
		27	Unused		
		28	Unused		
	DB9_8	29	LSC-IMC_REFL_A	RF24	Q-phase
		30			I-phase
		31	JAC-REFL_A	RF23	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-SHG_SERVO_ERR, CM Servo, I monitor	
	DB9_2	5	SQZ-SHG_SERVO_CTRL, CM Servo, Fast monitor	
		6	SQZ-SHG_SERVO_SLOW, CM Servo, Slow monitor	
		7	SQZ-LO_SERVO_ERR, CM Servo, I monitor	
		8	SQZ-LO_SERVO_CTRL, CM Servo, Fast monitor	
	DB9_3	9	SQZ-LO_SERVO_SLOW, CM Servo, Slow monitor	
		10	SQZ-CLF_SERVO_ERR, CM Servo, I monitor	
		11	SQZ-CLF_SERVO_CTRL, CM Servo, Fast monitor	
		12	SQZ-CLF_SERVO_SLOW, CM Servo, Slow monitor	
	DB9_4	13	SQZ-HD_A_DC	
		14	SQZ-HD_B_DC	
		15	SQZ-HD_DIFF_DC	
		16	Unused	
	DB9_5	17	SQZ-FIBR_MIXER	
		18	SQZ-FIBR_PZT	
		19	SQZ-FIBR_EOMRMS	
		20	SQZ-FIBR_SLOW	
	DB9_6	21	SQZ-CLF_REFL_LF	DC Outputs
		22	SQZ-OPO_REFL_LF	
		23	Unused	
		24	Unused	
	DB9_7	25	SQZ-OPO_TRANS_LF	DC Outputs
		26	SQZ-OPO_REFL_REJECTED_LF	
		27	SQZ-FIBR_TRANS_LF	
		28	SQZ-SPARE_DC_B_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 Chs.	Signal
DAC 0	DB9_1	1	SQZ-EXTRA_AO_1
		2	SQZ-EXTRA_AO_2
		3	SQZ-EXTRA_AO_3
		4	SQZ-OPO-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	ALS-C_REFL_DC_BIAS CM Summing module control
		10	LSC EXTRA_AO_2
		11	ALS STATE_A (EtherCAT interface)/JAC_L
		12	ALS STATE_B (EtherCAT interface)
	DB9_4	13	OMC PZT Dither
		14	OMC PZT Drive (feedback)
		15	Fast Shutter control
		16	Duotone

## 4 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 0	DB9_1	1-4	ASC-TRX(Y)_A			
	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	Unused		
			30	Unused		
			31	Unused		
			32	Unused		

Card	AA/AI conn.	ADC/DAC Chs.	Signal	
ADC 1	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		
ADC1	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
DAC 0	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

## 5 ADC/DAC Channel Concentrator

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 OUT	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		

## 6 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.