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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		IMC-WFS_B_RF	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		IMC-WFS_B_RF	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	Unused			
		26	Unused			
		27	Unused			
		28	Unused			
	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	PD 1: SM2 Fwd Trans		4 ch Generic PD interface: IOT2
		18	PD 2: SM2 Bwd Trans		
		19-20	PD 3,4: unused		
	DB9_6	21-24	Unused		
	DB9_7	25-28	Unused		
DB9_8	29-32	Unused			

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_A_RF45		Seg 1	Q-phase
		10				I-phase
		11			Seg 2	Q-phase
		12				I-phase
	DB9_4	13		ASC-REFL_B_RF9	Seg 3	Q-phase
		14				I-phase
		15			Seg 4	Q-phase
		16				I-phase
	DB9_5	17	ASC-REFL_B_RF45		Seg 1	Q-phase
		18				I-phase
		19			Seg 2	Q-phase
		20				I-phase
	DB9_6	21		ASC-REFL_B_RF45	Seg 3	Q-phase
		22				I-phase
		23			Seg 4	Q-phase
		24				I-phase
	DB9_7	25	ASC-REFL_B_RF45		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_RF36	Seg 1	Q-phase		
		2			I-phase		
		3		Seg 2	Q-phase		
		4			I-phase		
	DB9_2	5		ASC-AS_A_RF90 (LHO only)	Seg 3	Q-phase	
		6				I-phase	
		7			Seg 4	Q-phase	
		8				I-phase	
	DB9_3	9	ASC-AS_B_RF90 (LHO only)		Seg 1	Q-phase	
		10				I-phase	
		11			Seg 2	Q-phase	
		12				I-phase	
	DB9_4	13		ASC-C_SHG_IR_LF	Seg 3	Q-phase	
		14				I-phase	
		15			Seg 4	Q-phase	
		16				I-phase	
	DB9_5	17	ALS-C_SHG_GR_LF		Seg 1	Q-phase	
		18				I-phase	
		19			Seg 2	Q-phase	
		20				I-phase	
	DB9_6	21		ALS-C_TRX_A_LF	Seg 3	Q-phase	
		22				I-phase	
		23			Seg 4	Q-phase	
		24				I-phase	
	DB9_7	25	ALS-C_TRY_A_LF		Aux. signals concentrator 3: REFL PD Amp 1-4		
		26					
		27					
		28					
DB9_8	29-32	unused					

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	DC Outputs of WFS
	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	ASC-AS_D_DC (spare)	
	DB9_7	25-28	REFL TT1	Tip-Tilt Coil driver readbacks
	DB9_8	29-32	REFL TT2	

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	
ADC 7	DB9_1	1-4	AS TT1	Tip-Tilt BOSEM sensor signals
	DB9_2	5-8	AS TT2	
	DB9_3	9-12	AS TT3	
	DB9_4	13-16	REFL TT1	
	DB9_5	17-20	REFL TT2	
	DB9_6	21-24	AS TT1	Tip-Tilt Coil driver readbacks
	DB9_7	25-28	AS TT2	
	DB9_8	29-32	AS TT3	



Card	AA/AI conn.	ADC/DAC Chs.	Signal
DAC 0	DB9_1	1-4	AS TT1 Coil drives (UL, LL, UR, LR)
	DB9_2	5-8	AS TT2 Coil drives (UL, LL, UR, LR)
	DB9_3	9-12	AS TT3 Coil drives (UL, LL, UR, LR)
	DB9_4	13-15	Unused
		16	Duotone

Card	AA/AI conn.	ADC/DAC Chs.	Signal
DAC 1	DB9_1	1-4	REFL TT1 Coil drives (UL, LL, UR, LR)
	DB9_2	5-8	REFL TT2 Coil drives (UL, LL, UR, LR)
	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 MCL PZT Tip-tilt 1: pitch
		12	ASC-POP_X_YAW MCL PZT Tip-tilt 1: yaw
	DB9_4	13-16	Unused

### 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	PD1: LSC-ASAIR_A_LF
		10	PD2: LSC-ASAIR_B_LF
		11	PD3: Unused
		12	PD4: Unused
	DB9_4	13	OMC-DCPD_A
		14	OMC-DCPD_B
		15-16	Unused
	DB9_5	17	OMC PZT Monitor: Slow path
		18	OMC PZT Monitor: AC path
		19-20	Unused
	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	Unused
		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	LSC-ASAIR_B	RF18	Q-phase
		10			I-phase
		11		RF90	Q-phase
		12			I-phase
	DB9_4	13	LSC-ASAIR_A	RF45	Q-phase
		14			I-phase
		15	Unused	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: Unused	
		4	PD4: Unused	
	DB9_2	5	ALS-C_REFL_DC_ERR CM: DC signal from REFL_A PD	CM Summing Module Readback
		6	LSC-REFL_A_RF9_ERR CM: Demodulator signal REFL	
		7	ALS-C_COMM_A_RF_ERR CM: PFD signal ALS Common	
		8	LSC-REFLAIR_A_RF9_ERR CM: Demodulator 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	25-28	Unused		
DB9_8	29-32	Unused		

Card	AA/AI conn.	ADC/DAC Chs.	Signal
DAC 0	DB9_1	1	OMC PZT Dither
		2	OMC PZT Drive (feedback)
		3	Fast Shutter control
		4	Unused
	DB9_2	5	Unused
		6	Unused
		7	Unused
		8	Unused
	DB9_3	9	ALS-C_REFL_DC_BIAS CM Summing module control
		10	LSC EXTRA_AO_2
		11	ALS STATE_A (EtherCAT interface)
		12	ALS STATE_B (EtherCAT interface)
	DB9_4	13	Unused
		14	Unused
		15	Unused
		16	Duotone

## 4 End Stations

The first ADC card (ADC 0) is used by PEM and Photon Calibrator. This is the card which implements the DuoTone readbacks. The first ISC card is ADC 1, but is called ADC0 in the model. The same is true for the DAC cards, where the first DAC is used by PEM and Photon Calibrator.

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 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-IO	8	2	38 (36)	9	0
Vertex: LSC	3	1	26 (16)	8	6
End X	2	1	28 (24)	3	5
End Y	2	1	28 (24)	3	5
Totals	15	5	120 (100)	31	16

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 includes these PEM cards.