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LIGO-T1100472-v8

*LIGO*

May 9, 2013

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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	Seg 1	Q-phase	
		2			I-phase	
		3		Seg 2	Q-phase	
		4			I-phase	
	DB9_2	5		IMC_WFS_B	Seg 3	Q-phase
		6				I-phase
		7			Seg 4	Q-phase
		8				I-phase
	DB9_3	9	IMC_WFS_B		Seg 1	Q-phase
		10				I-phase
		11			Seg 2	Q-phase
		12				I-phase
	DB9_4	13		IMC_WFS_B	Seg 3	Q-phase
		14				I-phase
		15			Seg 4	Q-phase
		16				I-phase
	DB9_5	17-20	IMC_WFS_A		Segs 1-4	DC Outputs of WFS
	DB9_6	21-24	IMC_WFS_B		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(AIR)_A_RF9	Seg 1	Q-phase	
		2			I-phase	
		3		Seg 2	Q-phase	
		4			I-phase	
	DB9_2	5		ASC_REFL(AIR)_A_RF45	Seg 3	Q-phase
		6				I-phase
		7			Seg 4	Q-phase
		8				I-phase
	DB9_3	9	ASC_REFL(AIR)_B_RF9		Seg 1	Q-phase
		10				I-phase
		11			Seg 2	Q-phase
		12				I-phase
	DB9_4	13		ASC_REFL(AIR)_B_RF45	Seg 3	Q-phase
		14				I-phase
		15			Seg 4	Q-phase
		16				I-phase
	DB9_5	17	ASC_REFL(AIR)_A_RF9		Seg 1	Q-phase
		18				I-phase
		19			Seg 2	Q-phase
		20				I-phase
	DB9_6	21		ASC_REFL(AIR)_A_RF45	Seg 3	Q-phase
		22				I-phase
		23			Seg 4	Q-phase
		24				I-phase
	DB9_7	25	ASC_REFL(AIR)_B_RF9		Seg 1	Q-phase
		26				I-phase
		27			Seg 2	Q-phase
		28				I-phase
	DB9_8	29		ASC_REFL(AIR)_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_REFL_C_RF Spare Set of WFS Channels (1)	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_AS_D_RF Spare Set of WFS Channels (2)	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	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 4	DB9_1	1	ASC_AS(AIR)_A_RF45	Seg 1	Q-phase	
		2			I-phase	
		3		Seg 2	Q-phase	
		4			I-phase	
	DB9_2	5		ASC_AS(AIR)_A_RF36	Seg 3	Q-phase
		6				I-phase
		7			Seg 4	Q-phase
		8				I-phase
	DB9_3	9	ASC_AS(AIR)_B_RF45		Seg 1	Q-phase
		10				I-phase
		11			Seg 2	Q-phase
		12				I-phase
	DB9_4	13		ASC_AS(AIR)_B_RF36	Seg 3	Q-phase
		14				I-phase
		15			Seg 4	Q-phase
		16				I-phase
	DB9_5	17	ASC_AS(AIR)_A_RF45		Seg 1	Q-phase
		18				I-phase
		19			Seg 2	Q-phase
		20				I-phase
	DB9_6	21		ASC_AS(AIR)_B_RF45	Seg 3	Q-phase
		22				I-phase
		23			Seg 4	Q-phase
		24				I-phase
	DB9_7	25	ASC_AS(AIR)_B_RF36		Seg 1	Q-phase
		26				I-phase
		27			Seg 2	Q-phase
		28				I-phase
	DB9_8	29		ASC_AS(AIR)_A_RF45	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_REFLAIR_A	DC Outputs of WFS
	DB9_2	5-8	ASC_REFLAIR_B	
	DB9_3	9-12	ASC_ASAIR_A	
	DB9_4	13-16	ASC_ASAIR_B	
	DB9_5	17-20	Spare Set 1	
	DB9_6	21-24	Spare Set 2	
	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
		11-12	Unused
	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	LSC_OMC_A
		14	LSC_OMC_B
		15-16	Unused
	DB9_5	17	OMC PZT Monitor: Slow path
		18	OMC PZT Monitor: AC path
		19-20	Unused
	DB9_6	21	CM Servo, I monitor (error signal)
		22	CM Servo, Fast monitor
		23	CM Servo, Slow monitor
		24	Unused
	DB9_7	25	IMC Servo, I monitor (error signal)
		26	IMC Servo, Fast monitor (MC_F)
		27	IMC Servo, Slow monitor (MC_L)
		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 RF PD, DC output (whitened)	
		2	ALS_C_COMM_ERR PFD signal for ALS Common	
		3	ALS_C_DIFF_ERR PFD signal for ALS Differential	
		4	Unused	
	DB9_2	5	LSC-REFL_A_RF9_I CM: Demodulator signal REFL AIR	CM Summing Module Readback
		6	LSC-REFLAIR_A_RF9_I CM: Demodulator signal REFL	
		7	ALS_C_COMM_ERR (duplicate) CM: PFD signal ALS Common	
		8	ALS_C_REFL_DC_ERR CM: DC signal from REFL_A PD	
	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	Unused	
		14	Unused	
		15	Unused	
		16	Unused	
	DB9_5	17	Unused	
		18	Unused	
		19	Unused	
		20	Unused	
DB9_6	21-24	Unused		
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	ALS_C_COMM_FREQ Offset for ALS Common VCO
		6	ALS_C_DIFF_FREQ Offset for ALS Differential VCO
		7	ALS_C_REFL_DC_BIAS CM Summing module control
		8	Unused
	DB9_3	9	LSC EXTRA_AO_1
		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. The first ISC card is ADC 1.

Card	AA/AI conn.	ADC/DAC Chs.	Signal
ADC 1	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	17-20	Unused
	DB9_6	21-24	Unused
	DB9_7	25-28	Unused
	DB9_8	29	Unused
		30	Unused
		31	Duotone (DAC)
		32	Duotone

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	LSC_X(Y) EXTRA_AI_1
		18	LSC_X(Y) EXTRA_AI_2
		19	LSC_X(Y) EXTRA_AI_3
		20	ALS_X(Y) REQSTATE_A (EtherCAT interface)
	DB9_6	21-24	Unused
	DB9_7	25-28	Unused
	DB9_8	29-32	Unused



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	9-12	Unused
	DB9_4	13-15	Unused
		16	Duotone

## 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 via the Anti-Alias (AA) chassis on open DB9 connectors; the other channels are found on AA DB9 connectors

I/O Chassis	# ADC cards	# DAC cards	Unused ADC chans	Unused DAC chans	Available I/O slots
Vertex: ASC-IO	8	2	35 (32)	9	0
Vertex: LSC	3	1	31 (5)	5	6
End X	2	1	28 (26)	7	5
End Y	2	1	28 (26)	7	5
Totals	15	5	122 (89)	28	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.