*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO-T1100472-v8 *LIGO* May 9, 2013

ADC and DAC Channel Usage for ISC

Rich Abbott, Peter Fritschel

Distribution of this document:

LIGO Scientific Collaboration

This is an internal working note

of the LIGO Laboratory.

|  |  |
| --- | --- |
| **California Institute of Technology**  **LIGO Project – MS 18-34**  **1200 E. California Blvd.**  **Pasadena, CA 91125**  Phone (626) 395-2129  Fax (626) 304-9834  E-mail: info@ligo.caltech.edu | **Massachusetts Institute of Technology**  **LIGO Project – NW22-295**  **185 Albany St**  **Cambridge, MA 02139**  Phone (617) 253-4824  Fax (617) 253-7014  E-mail: info@ligo.mit.edu |
| **LIGO Hanford Observatory**  **P.O. Box 159**  **Richland WA 99352**  Phone 509-372-8106  Fax 509-372-8137 | **LIGO Livingston Observatory**  **P.O. Box 940**  **Livingston, LA 70754**  Phone 225-686-3100  Fax 225-686-7189 |

http://www.ligo.caltech.edu/

# 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](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=11847), *List of ISC Photodetectors in Advanced LIGO.*

# 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 | 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 | 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 | Seg 3 | | Q-phase | |
| 6 | I-phase | |
| 7 | Seg 4 | | Q-phase | |
| 8 | I-phase | |
| DB9\_3 | 9 | ASC\_REFL(AIR)\_A\_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\_REFL(AIR)\_B\_RF9 | 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\_REFL(AIR)\_B\_RF45 | 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 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 | | Seg 3 | Q-phase |
| 6 | | I-phase |
| 7 | | Seg 4 | Q-phase |
| 8 | | I-phase |
| DB9\_3 | | 9 | | ASC\_AS(AIR)\_A\_RF36 | | 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(AIR)\_B\_RF45 | | 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(AIR)\_B\_RF36 | | 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 | | | |
| 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 |

# 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: LSC\_ASAIR\_A\_LF | 4 ch Generic PD interface: ISCT6 |
| 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 |

# 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 | 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 | 17-20 | 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 |

# 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.