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ADC and DAC Channel Usage for ISC

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# 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\_RFSpare 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\_RFSpare 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\_ERRPFD signal for ALS Common |
| 3 | ALS\_C\_DIFF\_ERRPFD signal for ALS Differential |
| 4 | Unused |
| DB9\_2 | 5 | LSC-REFL\_A\_RF9\_ICM: Demodulator signal REFL AIR | CM Summing Module Readback |
| 6 | LSC-REFLAIR\_A\_RF9\_ICM: Demodulator signal REFL |
| 7 | ALS\_C\_COMM\_ERR (duplicate)CM: PFD signal ALS Common |
| 8 | ALS\_C\_REFL\_DC\_ERRCM: 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\_FREQOffset for ALS Common VCO |
| 6 | ALS\_C\_DIFF\_FREQOffset for ALS Differential VCO |
| 7 | ALS\_C\_REFL\_DC\_BIASCM 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\_ERRCM Servo: ALS phase-locking, I monitor |
| 2 | ALS\_X(Y)\_FIBR\_SERVO\_CTRLCM Servo: ALS phase-locking, Fast monitor |
| 3 | ALS\_X(Y)\_FIBR\_SERVO\_SLOWCM Servo: ALS phase-locking, Slow monitor |
| 4 | Unused |
| DB9\_2 | 5 | ALS\_X(Y)\_REFL\_SERVO\_ERRCM Servo: ALS PDH-locking, I monitor |
| 6 | ALS\_X(Y)\_REFL\_SERVO\_CTRLCM Servo: ALS PDH-locking, Fast monitor |
| 7 | ALS\_X(Y)\_FIBR\_SERVO\_SLOWCM 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\_PITMCL PZT Tip-tilt 1: pitch |
| 2 | ALS\_X(Y)\_PZT1\_YAWMCL PZT Tip-tilt 1: yaw |
| 3 | ALS\_X(Y)\_PZT2\_PITMCL PZT Tip-tilt 2: pitch |
| 4 | ALS\_X(Y)\_PZT2\_YAWMCL 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.