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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\_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 | 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 | ASC-REFL\_A\_DC | DC Outputs of WFS |
| DB9\_6 | 21-24 | ASC-REFL\_B\_DC |
| 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 | 29-32 | 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 | DC Outputs of WFS |
| DB9\_2 | 5-8 | ASC-REFLAIR\_B\_DC |
| DB9\_3 | 9-12 | ASC-ASAIR\_A\_DC |
| DB9\_4 | 13-16 | ASC-ASAIR\_B\_DC |
| DB9\_5 | 17-20 | ASC-AS\_A\_DC |
| DB9\_6 | 21-24 | ASC-AS\_B\_DC |
| 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 | 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\_ERRPFD signal for ALS Differential |
| 3 | PD3: Unused |
| 4 | PD4: Unused |
| DB9\_2 | 5 | ALS-C\_REFL\_DC\_ERRCM: DC signal from REFL\_A PD | CM Summing Module Readback |
| 6 | LSC-REFL\_A\_RF9\_ERRCM: Demodulator signal REFL |
| 7 | ALS-C\_COMM\_A\_RF\_ERRCM: PFD signal ALS Common |
| 8 | LSC-REFLAIR\_A\_RF9\_ERRCM: 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 | 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 | Unused |
| 6 | Unused |
| 7 | Unused |
| 8 | Unused |
| DB9\_3 | 9 | ALS-C\_REFL\_DC\_BIASCM 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 |

# 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 | 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 | 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\_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 |
| 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\_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 | ALS-X(Y)\_ PZT3\_PITMCL PZT Tip-tilt 3 for WFS\_A: pitch |
| 10 | ALS-X(Y)\_PZT3\_YAWMCL PZT Tip-tilt 3 for WFS\_A: yaw |
| 11 | ALS-X(Y)\_PZT4\_PITMCL PZT Tip-tilt 4 for WFS\_B: pitch |
| 12 | ALS-X(Y)\_PZT4\_YAWMCL PZT Tip-tilt 4 for WFS\_B: yaw |
| DB9\_4 | 13 | Unused |
| 14 | Unused |
| 15 | Unused |
| 16 | Unused |

# 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.