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TwinCAT Library for ISC Whitening Chassis

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| **Library** | |
| Title | IscWhitening |
| Version | 3 |
| TwinCAT version | 2.11 |
| Name space | IscWhitening |
| Author | Daniel Sigg |
| Description | Controls an ISC whitening chassis, [D1002559](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=21724), through the 384-channel binary IO chassis, [D1100251](https://dcc.ligo.org/cgi-bin/DocDB/ShowDocument?docid=33399). The binary IO chassis is controlled through a Modbus interface using four Acromag ES2113 that are connected to an EtherCAT-to-Modbus gateway, HMS AB9000. The setup instructions can be found in [T1100607](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=76566) and [C1107420](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=76567).  The ISC whitening chassis contain 8 channels of whitening, [D1001530](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=12594). Each whitening channel employs a gain slider and 3 separately switchable filter stages. The ISC whitening chassis are used to interface the I and Q readouts of an LSC demodulator to the DAQ system, they are used to interface the I and Q readouts of a ASC wavefront sensor, and they are used to interface the 4 segments of a QPD (quad photodiode). Four LSC demodulators can be controlled from a single ISC whitening chassis, or one wavefront sensor, or two QPDs. Up to 6 ISC whitening chassis are controlled from a 384-channel binary IO chassis.  This library is organized in two parts:  - An interface to the binary IO chassis that controls individual IO lines and organizes them by ISC whitening chassis, and - Individual interfaces for the LSC PDs, ASC WFSs and QPDs which interface with the above binary IO chassis data structures. |
| Error codes | 0x0001 – Illegal chassis number  0x0002 – Illegal channel index number  0x0004 – Invalid data (first channel)  0x0008 – Invalid data (second channel)  …  0x0102 – Invalid data (eighth channel) |
| Library dependencies | None |

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| **Hardware Input Type**  TYPE IscWhiteningInStruct :  STRUCT  LiveList: ARRAY[1..8] OF BYTE;  PCB: ARRAY[1..4,1..13] OF WORD;  InfoDataState: WORD;  END\_STRUCT  END\_TYPE | |
| Type name | IscWhiteningInStruct |
| Description | Structure of the hardware inputs that mapped into the EtherCAT memory space by the EtherCAT-to-Modbus gateway. For mapping see next page. |
| Definition | STRUCT |
| Element | Name: LiveList  Type: ARRAY[1..8] OF BYTE  Description: Information about the active connections, see HMS AB9000 manual |
| Element | Name: PCB  Type: ARRAY[1..4,1..13] OF WORD  Description: Readbacks form the binary IO chassis, see HMS AB9000 and ES2113 manual |
| Element | Name: InfoDataState  Type: WORD  Description: State information of the gateway. |

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| **Hardware Output Type**  TYPE IscWhiteningOutStruct :  STRUCT  PCB: ARRAY[1..4,1..6] OF WORD;  END\_STRUCT  END\_TYPE | |
| Type name | IscWhiteningOutStruct |
| Description | Structure of the hardware outputs that mapped into the EtherCAT memory space by the EtherCAT-to-Modbus gateway. For mapping see next page. |
| Definition | STRUCT |
| Element | Name: PCB  Type: ARRAY[1..4,1..6] OF WORD  Description: Controls to the binary IO chassis, see HMS AB9000 and ES2113 manual |

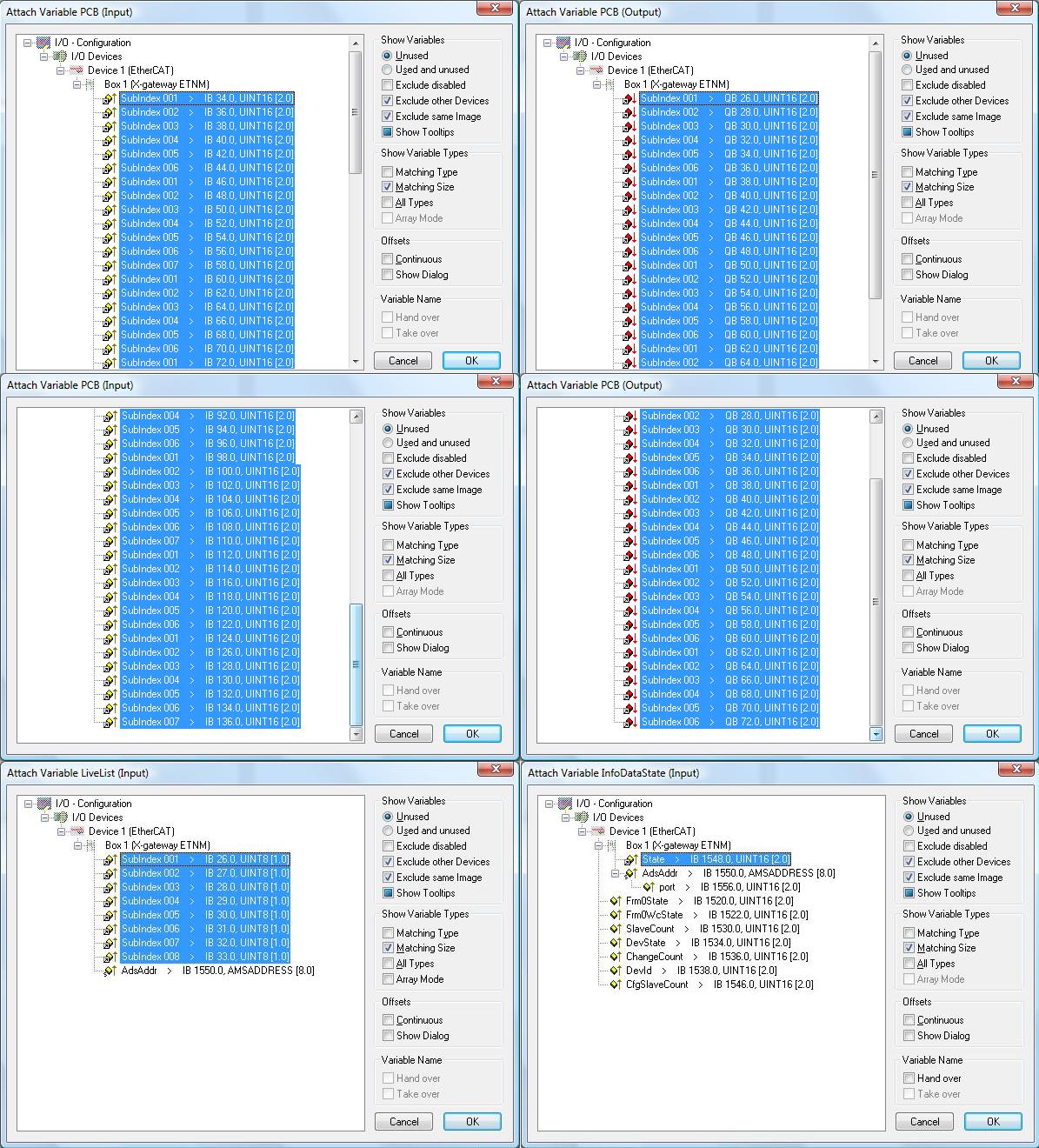


Fig 1. Mapping of IO structures into the EtherCAT memory space.

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| **Internal Interface Type**  TYPE IscWhiteningStruct :  STRUCT  Chassis: ARRAY[1..6] OF IscWhiteningRawChassisStruct;  END\_STRUCT  END\_TYPE | |
| Type name | IscWhiteningStruct |
| Description | Internal interface structure between the binary IO chassis function blocks and the ISC whitening chassis function blocks |
| Definition | STRUCT |
| Input/Output Tag | Name: Chassis  Type: ARRAY[1..6] OF IscWhiteningRawChassisStruct  Description: Contains the binary IO data organized by chassis and channel. |

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| **Function Block**  FUNCTION\_BLOCK IscWhiteningInterfaceFB  VAR\_INPUT  In: IscWhiteningInStruct;  END\_VAR  VAR\_OUTPUT  Out: IscWhiteningOutStruct;  END\_VAR  VAR\_IN\_OUT  Val: IscWhiteningStruct;  END\_VAR | |
| Name | IscWhiteningInterfaceFB |
| Description | Controls a 384-channel binary IO chassis. |
| Input argument | Name: In  Type: IscWhiteningInStruct  Description: Input hardware structure |
| Output argument | Name: Out  Type: IscWhiteningOutStruct  Description: Output hardware structure |
| In/out argument | Name: Val  Type: IscWhiteningStruct  Description: Internal interface structure |

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| **User Interface Type**  TYPE IscWhiteningChannelStruct :  STRUCT  Error: ErrorStruct;  Gain: INT;  GainStep: INT;  Filter: ARRAY [1..3] OF BOOL;  Set: ARRAY [1..3] OF BOOL;  Toggle: ARRAY [1..3] OF BOOL;  Readback: BYTE;  END\_STRUCT  END\_TYPE | |
|  | IscWhiteningChannelStruct |
| Description | Structure of the user interface tags that are used to control a single channel of the ISC whitening chassis |
| Definition | STRUCT |
| Output Tag | Name: Error  Type: ErrorStruct  Description: Calls error handler |
| In/Out Tag | Name: Gain  Type: INT  Description: Whitening gain in dB from 0 dB to 45 dB in 3 dB steps.  This value is tight to GainStep. Any change in one of the two variables will updated the other. |
| In/Out Tag | Name: GainStep  Type: INT  Description: Whitening gain in steps from 0 to 15.  This value is tight to Gain. Any change in one of the two variables will updated the other. |
| Output Tag | Name: Filter  Type: ARRAY [1..3] OF BOOL  Description: True if the whitening filter is on. Each array index represents a filter section. |
| Input Tag | Name: Set  Type: ARRAY [1..3] OF BOOL  Description: Set value for the whitening filters. Each array index represents a filter section. |
| Input Tag | Name: Toggle  Type: ARRAY [1..3] OF BOOL  Description: Set to True to toggle the state of a whitening filter. Each array index represents a filter section. |
| Output Tag | Name: Readback  Type: BYTE  Description: Bit encoded readback value from the whitening chassis |

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| **Function Block**  FUNCTION\_BLOCK IscWhiteningChannelFB  VAR\_INPUT  Chassis: INT; (\* 1 to 6 \*)  Index: INT; (\* 1 to 8 \*)  END\_VAR  VAR\_IN\_OUT  IscWhitening: IscWhiteningStruct;  Channel: IscWhiteningChannelStruct;  END\_VAR  VAR  END\_VAR | |
| Name | IscWhiteningChannelFB |
| Description | Controls a single channel in the whitening chassis (1 byte)  Call this function block before IscWhiteningInterfaceFB. |
| In/Out argument | Name: IscWhitening  Type: IscWhiteningStruct  Description: Internal interface structure |
| Input argument | Name: Chassis  Type: INT  Description: Select the chassis: Values from 1 to 6 |
| Input argument | Name: Index  Type: INT  Description: Select the channel: Index from 1 to 8 |
| In/out argument | Name: Channel  Type: IscWhiteningChannelStruct  Description: User Interface structure for a single channel of ISC whitening |

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| **User Interface Type**  TYPE IscWhiteningDemodIQStruct :  STRUCT  Error: ErrorStruct;  I: IscWhiteningChannelStruct;  Q: IscWhiteningChannelStruct;  END\_STRUCT  END\_TYPE | |
| Type name | IscWhiteningDemodIQStruct |
| Description | Structure of the user interface tags that are used to control two channels of the ISC whitening chassis which are used for an LSC demodulator |
| Definition | STRUCT |
| Output Tag | Name: Error  Type: ErrorStruct  Description: Calls error handler |
| In/Out Tag | Name: I  Type: IscWhiteningChannelStruct  Description: |
| In/Out Tag | Name: Q  Type: IscWhiteningChannelStruct  Description: Whitening gain in steps from 0 to 15.  This value is tight to Gain. Any change in one of the two variables will update the other. |

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| **Function Block**  FUNCTION\_BLOCK IscWhiteningDemodIQFB  VAR\_INPUT  Chassis: INT; (\* 1 to 6 \*)  Index: INT; (\* 1, 3, 5 or to 7 \*)  END\_VAR  VAR\_IN\_OUT  IscWhitening: IscWhiteningStruct;  Demod: IscWhiteningDemodIQStruct;  END\_VAR  VAR  END\_VAR | |
| Name | IscWhiteningDemodIQFB |
| Description | Controls two channels in the whitening chassis (2 bytes)  Call this function block before IscWhiteningInterfaceFB. |
| In/Out argument | Name: IscWhitening  Type: IscWhiteningStruct  Description: Internal interface structure |
| Input argument | Name: Chassis  Type: INT  Description: Select the chassis: Values from 1 to 6 |
| Input argument | Name: Index  Type: INT  Description: Select the channel: Index is 1, 3, 5, or 7  The selected index represents the quad-phase channel, whereas Index+1 represents the in-phase channel. |
| In/out argument | Name: Demod  Type: IscWhiteningDemodIQStruct  Description: User Interface structure for two channels of ISC whitening describing the I and Q channels of a LSC demodulator. |

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| **User Interface Type**  TYPE IscWhiteningDemodWfsStruct :  STRUCT  Error: ErrorStruct;  Seg: ARRAY [1..4] OF IscWhiteningDemodIQStruct;  END\_STRUCT  END\_TYPE | |
| Type name | IscWhiteningDemodWfsStruct |
| Description | Structure of the user interface tags that are used to control eight channels of the ISC whitening chassis which are used for an ASC wavefront sensor demodulator |
| Definition | STRUCT |
| Output Tag | Name: Error  Type: ErrorStruct  Description: Calls error handler |
| In/Out Tag | Name: Seg  Type: ARRAY [1..4] OF IscWhiteningDemodIQStruct  Description: The four segments of a wavefront sensor |

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| **Function Block**  FUNCTION\_BLOCK IscWhiteningDemodWfsFB  VAR\_INPUT  Chassis: INT; (\* 1 to 6 \*)  END\_VAR  VAR\_IN\_OUT  IscWhitening: IscWhiteningStruct;  DemodWfs: IscWhiteningDemodWfsStruct;  END\_VAR  VAR  END\_VAR | |
| Name | IscWhiteningDemodWfsFB |
| Description | Controls eight channels in a whitening chassis (8 bytes)  Call this function block before IscWhiteningInterfaceFB. |
| In/Out argument | Name: IscWhitening  Type: IscWhiteningStruct  Description: Internal interface structure |
| Input argument | Name: Chassis  Type: INT  Description: Select the chassis: Values from 1 to 6 |
| In/out argument | Name: DemodWfs  Type: IscWhiteningDemodWfsStruct  Description: User Interface structure for eight channels of ISC whitening describing the I and Q channels of a four segment ASC wavefront sensor demodulator. |

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| **User Interface Type**  TYPE IscWhiteningQpdStruct :  STRUCT  Error: ErrorStruct  Seg: ARRAY [1..4] OF IscWhiteningChannelStruct;  END\_STRUCT  END\_TYPE | |
| Type name | IscWhiteningQpdStruct |
| Description | Structure of the user interface tags that are used to control eight channels of the ISC whitening chassis which are used for an ASC wavefront sensor demodulator |
| Definition | STRUCT |
| Output Tag | Name: Error  Type: ErrorStruct  Description: Calls error handler |
| In/Out Tag | Name: Seg  Type: ARRAY [1..4] OF IscWhiteningChannelStruct  Description: The four segments of a QPD sensor |

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| **Function Block**  FUNCTION\_BLOCK IscWhiteningQpdFB  VAR\_INPUT  Chassis: INT; (\* 1 to 6 \*)  Index: INT; (\* 1 or 5 \*)  END\_VAR  VAR\_IN\_OUT  IscWhitening: IscWhiteningStruct;  Qpd: IscWhiteningQpdStruct;  END\_VAR  VAR  END\_VAR | |
| Name | IscWhiteningQpdFB |
| Description | Controls four channels in a whitening chassis (4 byte)  Call this function block before IscWhiteningInterfaceFB. |
| In/Out argument | Name: IscWhitening  Type: IscWhiteningStruct  Description: Internal interface structure |
| Input argument | Name: Chassis  Type: INT  Description: Select the chassis: Values from 1 to 6 |
| Input argument | Name: Index  Type: INT  Description: Select the channel: Index from 1 or 5  The selected index represents the first channel of a QPD, whereas Index+1, Index+2 and Index+3 represent the second, third and forth channel, respectively. |
| In/out argument | Name: Qpd  Type: IscWhiteningQpdStruct  Description: User Interface structure for four channels of ISC whitening describing the channels of a four segment ASC quad photodiode. |

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| **Program Example:**  PROGRAM Whitening  VAR  IscWhiteningIn AT %IB0: IscWhiteningInStruct;  IscWhiteningOut AT %QB0: IscWhiteningOutStruct;  IscWhitening: IscWhiteningStruct;  IscWhiteningChassis: IscWhiteningInterfaceFB;  LenSensor: ARRAY [1..4] OF IscWhiteningDemodIQStruct;  Power: IscWhiteningChannelStruct;  Wfs: ARRAY [1..2] OF IscWhiteningDemodWfsStruct;  Qpd: ARRAY [1..2] OF IscWhiteningQpdStruct;  DemodLen: ARRAY [1..4] OF IscWhiteningDemodIQFB;  MonitorPower: IscWhiteningChannelFB;  DemodWfs: ARRAY [1..2] OF IscWhiteningDemodWfsFB;  MonitorQpd: ARRAY [1..2] OF IscWhiteningQpdFB;  I: INT;  END\_VAR  (\* Process individual sensors \*)  FOR I := 1 TO 4 DO  DemodLen[I] (IscWhitening := IscWhitening, Chassis := 1, Index := I, Demod := LenSensor[I]);  END\_FOR;  MonitorPower (IscWhitening := IscWhitening, Chassis := 1, Index := 5, Channel := Power);  FOR I := 1 TO 2 DO  DemodWfs[I] (IscWhitening := IscWhitening, Chassis := I+1, DemodWfs := Wfs[I]);  END\_FOR;  FOR I := 1 TO 2 DO  MonitorQpd[I] (IscWhitening := IscWhitening, Chassis := 4, Index := I+4, Qpd := Qpd[I]);  END\_FOR;  (\* Process whitening chassis after individual sensors \*)  IscWhiteningChassis (In := IscWhiteningIn, Out => IscWhiteningOut, Val := IscWhitening); |

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| **Visual**  **IscWhiteningVis.jpg** | |
| Name | IscWhiteningVis |
| Description | Displays the tags of an 384-channel binary IO chassis organized in six ISC whitening chassis which in turn show a list of 8 channels each. Each channel has 8 bits (1 byte) and shows the readback value. It lets you choose a new set value or apply a toggle value. The channel background turns red if the value is invalid. |
| Placeholder | Name: whitening  Type: IscWhiteningStruct  Description: Internal interface structure |

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| **Visual** | |
| Name | IscWhiteningChannelVis |
| Description | Displays the tags of single channel of whitening |
| Placeholder | Name: channel  Type: IscWhiteningChannelStruct  Description: ISC whitening channel structure |

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| **Visual** | |
| Name | IscWhiteningDemodIQVis |
| Description | Displays the tags of two channels of whitening |
| Placeholder | Name: demod  Type: IscWhiteningDemodIQStruct  Description: ISC whitening IQ demodulator structure |

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| **Visual** | |
| Name | IscWhiteningDemodWfsVis |
| Description | Displays the tags of eight channels of whitening |
| Placeholder | Name: wfs  Type: IscWhiteningDemodWfsStruct  Description: ISC whitening WFS demodulator structure |

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| **Visual** | |
| Name | IscWhiteningQpdVis |
| Description | Displays the tags of four channels of whitening |
| Placeholder | Name: qpd  Type: IscWhiteningQpdStruct  Description: ISC whitening quad photodiode structure |