*LIGO Laboratory / LIGO Scientific Collaboration*

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TwinCAT Library for Demodulators

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| **Library** | |
| Title | Demodulator |
| Version | 2 |
| TwinCAT version | 2.11 |
| Name space | Demodulator |
| Author | Daniel Sigg |
| Description | Monitors the 4-channel demodulator, [D0902796](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=7742), the 2-channel demodulator, [D1000181](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=8795), and the 2-channel phase-frequency discriminator, [D1002476](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=21102).  Demodulators are used by ISC for length and alignment sensing, whereas phase-frequency demodulators are used for laser locking. Each channels comes with an RF monitor of the LO and the RF inputs. The 2-channel chassis implement an additional power supply monitor, which indicates that the supply voltages are within range. Each channel of the phase-frequency discriminator has a monitor of the sign of the frequency comparison.  The RF detector measures the power off a -20 dB directional coupler. It is a logarithmic device and has the following equation:  LO:  RF:  The 4-channel demodulator chassis used for ASC has the LO split between all channels, whereas the LO for the LSC is per channel. |
| Error codes | 1 – Power supply voltages out-of-range  2 – LO power level out-of-range  3 – RF power level overload  4 – Sign is wrong |
| Library dependencies | Error |

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| **Demodulator Type**  TYPE DemodulatorTypeEnum :  (Quad, Single, SingleFast, PhaseFrequency);  END\_TYPE | |
| Type name | DemodulatorTypeEnum |
| Description | Enumerates the different types of available demodulators |
| Definition | ENUM |
| Element | Name: Quad  Description: Denotes an ASC quad demodulator chassis used for wavefront sensing |
| Element | Name: Single  Description: Denotes a single channel of an LSC quad demodulator chassis used for length sensing |
| Element | Name: SingleFast  Description: Denotes a single channel of a fast LSC dual demodulator chassis used for length sensing |
| Element | Name: PhaseFrequency  Description: Denotes a single channel of an LSC dual phase-frequency discriminator chassis used for laser locking |

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| **Hardware Input Type**  TYPE DemodulatorInStruct :  STRUCT  RFMon: INT;  LOMon: INT;  Sign: BOOL;  PowerOk: BOOL;  END\_STRUCT  END\_TYPE | |
| Type name | DemodulatorInStruct |
| Description | Structure of the hardware inputs that are wired up for a demodulator channel. The phase-frequency discriminator only uses the sign. The 2-channel chassis share a power ok bit. The power ok bit is reflected in the hardware output structure. The second channel daisy chains its power ok input from the output of the first channel. |
| Definition | STRUCT |
| Element | Name: RFMon  Type: INT  Description: Monitors the RF power at the RF input |
| Element | Name: LOMon  Type: INT  Description: Monitors the RF power at the LO input |
| Element | Name: Sign  Type: BOOL  Description: Sign of phase-frequency discriminator |
| Element | Name: PowerOk  Type: BOOL  Description: Voltage monitor readback |

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| **Hardware Input Type**  TYPE DemodulatorQuadInStruct:  STRUCT  Seg: ARRAY [1..4] OF DemodulatorInStruct;  END\_STRUCT  END\_TYPE | |
| Type name | DemodulatorQuadInStruct |
| Description | An array of four DemodulatorInStruct used to describe a four channel demodulator chassis used for wavefront sensing |
| Definition | STRUCT |
| Element | Name: Seg  Type: ARRAY [1..4] OF DemodulatorInStruct  Description: Quad array of demodulator channels |

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| **Hardware Output Type**  TYPE DemodulatorOutStruct :  STRUCT  PowerOk: BOOL;  END\_STRUCT  END\_TYPE | |
| Type name | DemodulatorOutStruct |
| Description | Structure of the hardware outputs that are wired up for a demodulator channel. The power ok bit is a simple reflection of the power ok bit at the input. It is used for daisy chaining multiple channels. |
| Definition | STRUCT |
| Element | Name: PowerOk  Type: BOOL  Description: Voltage monitor readback |

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| **User Interface Type**  TYPE DemodulatorLscStruct :  STRUCT  Error: ErrorStruct;  DemodulatorType: DemodulatorTypeEnum;  RFMon: LREAL;  RFMax: LREAL;  LOMon: LREAL;  LONom: LREAL;  Sign: BOOL;  SignNom: BOOL;  PowerOk: BOOL;  END\_STRUCT  END\_TYPE | |
| Type name | DemodulatorLscStruct |
| Description | Structure of the user interface tags that are used to control a single channel of a demodulator or a phase-frequency discriminator |
| Definition | STRUCT |
| Output Tag | Name: Error  Type: ErrorStruct  Description: For error handler |
| Output Tag | Name: DemodulatorType  Type: DemodulatorTypeEnum  Description: Demotes the type of demodulator or phase-frequency discriminator channel |
| Output Tag | Name: RFMon  Type: LREAL  Description: Monitors the RF power at the RF input in dBm |
| Input Tag | Name: RFMax  Type: LREAL  Description: Maximum value for the RF power at the RF input in dBm |
| Output Tag | Name: LOMon  Type: LREAL  Description: Monitors the RF power at the LO input in dBm |
| Input Tag | Name: LONom  Type: LREAL  Description: Nominal value for the RF power at the LO input in dBm  Set to -100 to disable test. |
| Output Tag | Name: Sign  Type: BOOL  Description: Monitors the sign of a phase-frequency discriminator |
| Input Tag | Name: SignNom  Type: LREAL  Description: Nominal value for the sign of a phase-frequency discriminator |
| Output Tag | Name: PowerOk  Type: BOOL  Description: Voltage monitor readback |

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| **User Interface Type**  TYPE DemodulatorAscStruct :  STRUCT  Error: ErrorStruct;  RFMon: ARRAY [1..4] OF LREAL;  RFMax: LREAL;  LOMonChannel: ARRAY [1..4] OF LREAL;  LOMon: LREAL;  LONom: LREAL;  END\_STRUCT  END\_TYPE | |
| Type name | DemodulatorAscStruct |
| Description | Structure of the user interface tags that are used to control a four channel demodulator chassis used for wavefront sensing |
| Definition | STRUCT |
| Output Tag | Name: Error  Type: ErrorStruct  Description: For error handler |
| Output Tag | Name: RFMon  Type: ARRAY [1..4] OF LREAL  Description: Monitors the RF power at each RF input in dBm |
| Input Tag | Name: RFMax  Type: LREAL  Description: Maximum value for the RF power at the RF inputs in dBm |
| Output Tag | Name: LOMonChannel  Type: LREAL  Description: RF power at each of the LO inputs in dBm |
| Output Tag | Name: LOMon  Type: LREAL  Description: RF power at the LO input in dBm (sum of all channels) |
| Input Tag | Name: LONom  Type: LREAL  Description: Nominal value for the RF power at the LO input in dBm  Set to -100 to disable test. |

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| **Function Block**  FUNCTION\_BLOCK DemodulatorLscFB  VAR\_INPUT  Request: SaveRestoreEnum;  DemodulatorType: DemodulatorTypeEnum;  DemodulatorIn: DemodulatorInStruct;  END\_VAR  VAR\_OUTPUT  DemodulatorOut: DemodulatorOutStruct;  END\_VAR  VAR\_IN\_OUT  DemodulatorLscInit: DemodulatorLscStruct;  DemodulatorLsc: DemodulatorLscStruct;  END\_VAR  VAR  END\_VAR | |
| Name | DemodulatorLscFB |
| Description | Controls a single channel of a demodulator or phase-frequency discriminator chassis. One function block for each demodulator channel needs to be instantiated. |
| Input argument | Name: Request  Type: SaveRestoreEnum  Description: Request for save/restore/safemode or noop |
| Input argument | Name: DemodulatorType  Type: DemodulatorTypeEnum  Description: Defines the used demodulator chassis |
| Input argument | Name: DemodulatorIn  Type: DemodulatorInStruct  Description: Input hardware structure |
| Output argument | Name: DemodulatorOut  Type: DemodulatorOutStruct  Description: Output hardware structure |
| In/out argument | Name: DemodulatorLscInit  Type: DemodulatorLscStruct  Description: Save/restore variable in persistent memory |
| In/out argument | Name: DemodulatorLsc  Type: DemodulatorLscStruct  Description: User Interface structure |

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| **Function Block**  FUNCTION\_BLOCK DemodulatorAscFB  VAR\_INPUT  Request: SaveRestoreEnum  DemodulatorQuadIt: DemodulatorQuadInStruct;  END\_VAR  VAR\_IN\_OUT  DemodulatorAscInit: DemodulatorAscStruct;  DemodulatorAsc: DemodulatorAscStruct;  END\_VAR  VAR  END\_VAR | |
| Name | DemodulatorAscFB |
| Description | Controls a quad channel demodulator chassis. One function block for each ASC demodulator chassis needs to be instantiated. |
| Input argument | Name: DemodulatorQuadIt  Type: DemodulatorQuadInStruct  Description: Input hardware structure |
| In/out argument | Name: DemodulatorAscInit  Type: DemodulatorAscStruct  Description: Save/restore variable in persistent memory |
| In/out argument | Name: DemodulatorAsc  Type: DemodulatorAscStruct  Description: User Interface structure |

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| **Visual** | |
| Name | DemodulatorAscVis |
| Description | Displays RF Max and Mon, LO Mon and Nom, power status, sign status, and error status |
| Placeholder | Name: DemodulatorAsc  Type: DemodulatorAscStruct  Description: Asc Demodulator structure |

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| **Visual** | |
| Name | DemodulatorLscPhaseFrequencyVis |
| Description | Displays RF Max and Mon, LO Mon and Nom, power status, sign status, and error status |
| Placeholder | Name: DemodulatorLsc  Type: DemodulatorLscStruct  Description: Phase frequency Lsc Demodulator structure |

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| **Visual** | |
| Name | DemodulatorLscQuadVis |
| Description | Displays RF Max and Mon, LO Mon and Nom, and error status |
| Placeholder | Name: DemodulatorLsc  Type: DemodulatorLscStruct  Description: Quad Lsc Demodulator structure |

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| **Visual** | |
| Name | DemodulatorLscSingleVis |
| Description | Displays RF Max and Mon, LO Mon and Nom, and error status |
| Placeholder | Name: DemodulatorLsc  Type: DemodulatorLscStruct  Description: Single Lsc Demodulator structure |

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| **Visual** | |
| Name | DemodulatorLscSingleFastVis |
| Description | Displays RF Max and Mon, LO Mon and Nom, power status, and error status |
| Placeholder | Name: DemodulatorLsc  Type: DemodulatorLscStruct  Description: Single Fast Lsc Demodulator structure |