*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: $P=-69 dBm+16.667 dBm/V×U$RF: $P=-72 dBm+16.667 dBm/V×U$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-range2 – LO power level out-of-range3 – RF power level overload4 – 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: QuadDescription: Denotes an ASC quad demodulator chassis used for wavefront sensing |
| Element | Name: SingleDescription: Denotes a single channel of an LSC quad demodulator chassis used for length sensing |
| Element | Name: SingleFastDescription: Denotes a single channel of a fast LSC dual demodulator chassis used for length sensing |
| Element | Name: PhaseFrequencyDescription: 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\_STRUCTEND\_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: RFMonType: INTDescription: Monitors the RF power at the RF input |
| Element | Name: LOMonType: INTDescription: Monitors the RF power at the LO input |
| Element | Name: SignType: BOOLDescription: Sign of phase-frequency discriminator |
| Element | Name: PowerOkType: BOOLDescription: Voltage monitor readback |

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| **Hardware Input Type**TYPE DemodulatorQuadInStruct:STRUCT Seg: ARRAY [1..4] OF DemodulatorInStruct;END\_STRUCTEND\_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: SegType: ARRAY [1..4] OF DemodulatorInStructDescription: Quad array of demodulator channels |

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| **Hardware Output Type**TYPE DemodulatorOutStruct :STRUCT PowerOk: BOOL;END\_STRUCTEND\_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: PowerOkType: BOOLDescription: 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\_STRUCTEND\_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: ErrorType: ErrorStructDescription: For error handler |
| Output Tag | Name: DemodulatorTypeType: DemodulatorTypeEnumDescription: Demotes the type of demodulator or phase-frequency discriminator channel  |
| Output Tag | Name: RFMonType: LREALDescription: Monitors the RF power at the RF input in dBm |
| Input Tag | Name: RFMaxType: LREALDescription: Maximum value for the RF power at the RF input in dBm |
| Output Tag | Name: LOMonType: LREALDescription: Monitors the RF power at the LO input in dBm |
| Input Tag | Name: LONomType: LREALDescription: Nominal value for the RF power at the LO input in dBmSet to -100 to disable test. |
| Output Tag | Name: SignType: BOOLDescription: Monitors the sign of a phase-frequency discriminator |
| Input Tag | Name: SignNomType: LREALDescription: Nominal value for the sign of a phase-frequency discriminator |
| Output Tag | Name: PowerOkType: BOOLDescription: 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\_STRUCTEND\_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: ErrorType: ErrorStructDescription: For error handler |
| Output Tag | Name: RFMonType: ARRAY [1..4] OF LREALDescription: Monitors the RF power at each RF input in dBm |
| Input Tag | Name: RFMaxType: LREALDescription: Maximum value for the RF power at the RF inputs in dBm |
| Output Tag | Name: LOMonChannelType: LREALDescription: RF power at each of the LO inputs in dBm |
| Output Tag | Name: LOMonType: LREALDescription: RF power at the LO input in dBm (sum of all channels) |
| Input Tag | Name: LONomType: LREALDescription: Nominal value for the RF power at the LO input in dBmSet to -100 to disable test. |

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| **Function Block**FUNCTION\_BLOCK DemodulatorLscFBVAR\_INPUT Request: SaveRestoreEnum; DemodulatorType: DemodulatorTypeEnum; DemodulatorIn: DemodulatorInStruct;END\_VARVAR\_OUTPUT DemodulatorOut: DemodulatorOutStruct;END\_VARVAR\_IN\_OUT DemodulatorLscInit: DemodulatorLscStruct; DemodulatorLsc: DemodulatorLscStruct;END\_VARVAREND\_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: RequestType: SaveRestoreEnumDescription: Request for save/restore/safemode or noop |
| Input argument | Name: DemodulatorTypeType: DemodulatorTypeEnumDescription: Defines the used demodulator chassis |
| Input argument | Name: DemodulatorInType: DemodulatorInStructDescription: Input hardware structure |
| Output argument | Name: DemodulatorOutType: DemodulatorOutStructDescription: Output hardware structure |
| In/out argument | Name: DemodulatorLscInitType: DemodulatorLscStructDescription: Save/restore variable in persistent memory |
| In/out argument | Name: DemodulatorLscType: DemodulatorLscStructDescription: User Interface structure |

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| **Function Block**FUNCTION\_BLOCK DemodulatorAscFBVAR\_INPUT Request: SaveRestoreEnum DemodulatorQuadIt: DemodulatorQuadInStruct;END\_VARVAR\_IN\_OUT DemodulatorAscInit: DemodulatorAscStruct; DemodulatorAsc: DemodulatorAscStruct;END\_VARVAREND\_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: DemodulatorQuadItType: DemodulatorQuadInStructDescription: Input hardware structure |
| In/out argument | Name: DemodulatorAscInitType: DemodulatorAscStructDescription: Save/restore variable in persistent memory |
| In/out argument | Name: DemodulatorAscType: DemodulatorAscStructDescription: 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: DemodulatorAscType: DemodulatorAscStructDescription: 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: DemodulatorLscType: DemodulatorLscStructDescription: 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: DemodulatorLscType: DemodulatorLscStructDescription: 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: DemodulatorLscType: DemodulatorLscStructDescription: 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: DemodulatorLscType: DemodulatorLscStructDescription: Single Fast Lsc Demodulator structure |