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TwinCAT Library for the
ALS Laser

Alexa Staley, Daniel Sigg

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| **California Institute of Technology****LIGO Project – MS 18-34****1200 E. California Blvd.****Pasadena, CA 91125**Phone (626) 395-2129Fax (626) 304-9834E-mail: info@ligo.caltech.edu | **Massachusetts Institute of Technology****LIGO Project – NW22-295****185 Albany St****Cambridge, MA 02139**Phone (617) 253-4824Fax (617) 253-7014E-mail: info@ligo.mit.edu |
| **LIGO Hanford Observatory****P.O. Box 159****Richland WA 99352**Phone 509-372-8106Fax 509-372-8137 | **LIGO Livingston Observatory****P.O. Box 940****Livingston, LA 70754**Phone 225-686-3100Fax 225-686-7189 |

http://www.ligo.caltech.edu/

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| **Library** |
| Title | ALSLaser |
| Version | 4 |
| TwinCAT version | 2.11 |
| Name space | – |
| Author | Alexa Staley, Daniel Sigg |
| Description | Monitors the ALS LaserControls the crystal and doubler temperatureA slow feedback servo is implemented to offload the fast PZT feedback to the slow temperature controls. It implements the following equation:$$u\_{i}=(1-h)×u\_{i-1}+e\_{i}×(h-g)$$Or if the polarity is false:$$u\_{i}=(1-h)×u\_{i-1}+e\_{i}×(h+g)$$ with$g=πf\_{ugf}∆t$ and $h= πf\_{Pf}∆t$.$∆t$: sampling interval,$f\_{ugf}$: unity gain frequency of integrator,$f\_{Pf}$: Knee frequency of proportional gain.(only used for control of the laser crystal, not the doubler) |
| Error codes | 0x0001 – Safety interlock engaged0x0002 – Laser diode 1 guard alarm0x0004 – Laser diode 2 guard alarm0x0008 – Laser diode 1 current out-of-range0x0010 – Laser diode 2 current out-of-range0x0020 – Laser crystal TEC error signal out-of-range0x0040 – Doubler crystal TEC error signal out-of-range0x0080 – Laser diode 1 TEC error signal out-of-range0x0100 – Laser diode 2 TEC error signal out-of-range0x0200 – Noise eater readback signal out-of-range0x0400 – Unity gain frequency too high0x0800 – Proportional gain knee frequency too high0x1000 – Temperature feedback limit exceeded |
| Library dependencies | ReadADC, WriteADC, SaveRestore, Error |

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| **Hardware Input Type**TYPE ALSLaserInStruct :STRUCT LaserDiode1PowerMonitor: INT;LaserDiode2PowerMonitor: INT;LaserCrystalTECErrorSignal: INT;DoublingCrystalTECErrorSignal: INT;LaserDiode1TECErrorSignal: INT;LaserDiode2TECErrorSignal: INT;NoiseEaterMonitor: INT;LaserDiode1TempGuard: BOOL;LaserDiode2TempGuard: BOOL;InterLock: BOOL; END\_STRUCTEND\_TYPE |
| Type name | ALSLaserInStruct |
| Description | Structure of the hardware input that are wired up for the ALS laser |
| Definition | STRUCT |
| Element | Name: LaserDiode1PowerMonitorType: INTDescription: Laser diode 1 power monitor |
| Element | Name: LaserDiode2PowerMonitorType: INTDescription: Laser diode 2 power monitor |
| Element | Name: LaserCrystalTECErrorSignalType: INTDescription: Laser crystal, TEC error signal |
| Element | Name: DoublingCrystalTECErrorSignalType: INTDescription: Doubling crystal, TEC error signal |
| Element | Name: LaserDiode1TECErrorSignalType: INTDescription: Laser diode 1, TEC error signal |
| Element | Name: LaserDiode2TECErrorSignalType: INTDescription: Laser diode 2, TEC error signal |
| Element | Name: NoiseEaterMonitorType: INTDescription: Noise eater monitor |
| Element | Name: LaserDiode1TempGuardType: BOOLDescription: Laser diode 1, temp guard |
| Element | Name: LaserDiode2TempGuardType: BOOLDescription: Laser diode 2, temp guard |
| Element | Name: InterLockType: BOOLDescription: InterLock |

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| **Hardware Output Type**TYPE ALSLaserOutStruct :STRUCT CrystalTemperature: INT;DoublerTemperature: INT; END\_STRUCTEND\_TYPE |
| Type name | ALSLaserOutStruct |
| Description | Structure of the hardware output that are wired up for the ALS laser |
| Definition | STRUCT |
| Element | Name: CrystalTemperatureType: INTDescription: Crystal Temperature |
| Element | Name: DoublerTemperatureType: INTDescription: Doubler Temperature |

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| **User Interface Type**TYPE ALSLaserFrequencyControlsStruct:STRUCTOn: BOOL;Enabled: BOOL;Run: BOOL;Reset: BOOL;Low: LREAL;High: LREAL;Range: BOOL;Ugf: LREAL;Pf: LREAL;Polarity: BOOL;END\_STRUCTEND\_TYPE |
| Type name | ALSLaserFrequencyControlsStruct |
| Description | Structure used in the user interface that are used for the slow temperature controls |
| Definition | STRUCT |
| In/out Tag | Name: OnType: BOOLDescription: On/Off button for temperature feedback |
| Output Tag | Name: EnabledType: BOOLDescription: Enabled by the autolocker |
| Output Tag | Name: RunType: BOOLDescription: Servo is running |
| In/out Tag | Name: ResetType: BOOLDescription: Reset the integrator and zero the output |
| In/out Tag | Name: LowType: LREALDescription: Low limit for feedback controls in Hz |
| In/out Tag | Name: HighType: LREALDescription: High limit for feedback controls in Hz |
| Output Tag | Name: RangeType: BOOLDescription: Feedback controls exceeds range |
| In/out Tag | Name: UgfType: LREALDescription: Unity gain frequency of temperature servo in Hz |
| In/out Tag | Name: PfType: LREALDescription: Knee frequency of proportional feedback in Hz; zero is none |

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| **User Interface Type**TYPE ALSLaserStruct :STRUCTError: ErrorStruct;LaserDiode1PowerMonitor: LREAL;LaserDiode2PowerMonitor: LREAL;LaserDiodePowerNominal: LREAL;LaserDiodePowerTolerance: LREAL;LaserCrystalTECErrorSignal: LREAL;DoublingCrystalTECErrorSignal: LREAL;LaserDiode1TECErrorSignal: LREAL;LaserDiode2TECErrorSignal: LREAL;TECTolerance: LREAL;NoiseEaterMonitor: LREAL;NoiseEaterNominal: LREAL;NoiseEaterTolerance: LREAL;LaserDiode1TempGuard: BOOL;LaserDiode2TempGuard: BOOL;InterLock: BOOL; CrystalTemperature: LREAL;CrystalCalibration: LREAL;CrystalFrequency: LREAL;FrequencyControl: ALSLaserFrequencyControlsStruct;PZTTuningCoefficient: LREAL;PZTFrequency: LREAL;DoublerTemperature: LREAL;END\_STRUCTEND\_TYPE |
| Type name | ALSLaserStruct |
| Description | Structure of the user interface tags that are used to control the ALS Laser |
| Definition | STRUCT |
| Output Tag | Name: ErrorType: ErrorStructDescription: For error handler |
| Output Tag | Name: LaserDiode1PowerMonitorType: LREALDescription: Laser diode 1 power monitor in A |
| Output Tag | Name: LaserDiode2PowerMonitorType: LREALDescription: Laser diode 2 power monitor in A |
| Input Tag | Name: LaserDiodePowerNominalType: LREALDescription: Laser diode power nominal in A |
| Input Tag | Name: LaserDiodePowerToleranceType: LREALDescription: Laser diode power tolerance in A |
| Output Tag | Name: LaserCrystalTECErrorSignalType: LREALDescription: Laser crystal, TEC error signal in C |
| Output Tag | Name: DoublingCrystalTECErrorSignalType: LREALDescription: Doubling crystal, TEC error signal in C |
| Output Tag | Name: LaserDiode1TECErrorSignalType: LREALDescription: Laser diode 1, TEC error signal in C |
| Output Tag | Name: LaserDiode2TECErrorSignalType: LREALDescription: Laser diode 2, TEC error signal in C |
| Input Tag | Name: TECToleranceType: LREALDescription: TEC error signal tolerance in C |
| Output Tag | Name: NoiseEaterMonitorType: LREALDescription: Noise eater monitor in V |
| Input Tag | Name: NoiseEaterNominalType: LREALDescription: Noise eater nominal value in V |
| Input Tag | Name: NoiseEaterToleranceType: LREALDescription: Noise eater tolerance in V |
| Output Tag | Name: LaserDiode1TempGuardType: BOOLDescription: Laser diode 1, temp guard, high is alarm |
| Output Tag | Name: LaserDiode2TempGuardType: BOOLDescription: Laser diode 2, temp guard, high is alarm |
| Output Tag | Name: InterLockType: BOOLDescription: InterLock, high represent an interlock  |

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| In/out Tag | Name: CrystalTemperatureType: LREALDescription: Crystal Temperature in C or V |
| Output Tag | Name: CrystalCalibrationType: LREALDescription: Crystal temperature coefficient at 1064nm in MHz/C; nominal -3000 MHz/C |
| In/out Tag | Name: CrystalFrequencyType: LREALDescription: Laser frequency as set by crystal temperature in MHz; updating the CrystalFrequency will update the CrystalTemperature and vis versa |
| In/out Tag | Name: FrequencyControlType: ALSLaserFrequencyControlsStructDescription: Controls parameters for slow temperature feedback network |
| Output Tag | Name: PZTTuningCoefficientType: LREALDescription: PZT tuning coefficient at 1064nm in MHz/V; nominal 1.5 MHz/V |
| Output Tag | Name: PZTFrequencyType: LREALDescription: Laser frequency as set by the PZT actuator in MHz |
| Input Tag | Name: DoublerTemperatureType: LREALDescription: Doubler Temperature |

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| **Function Block**FUNCTION\_BLOCK ALSLaserFBVAR\_INPUTRequest: SaveRestoreEnum;ALSLaserIn: ALSLaserInStruct;ConstrolsEnable: BOOL:= FALSE;PZTVoltage: LREAL := 0.0;END\_VARVAR\_OUTPUTALSLaserOut: ALSLaserOutStruct;END\_VARVAR\_IN\_OUTALSLaserInit: ALSLaserStruct; ALSLaser: ALSLaserStruct;END\_VAR |
| Name | ALSLaserFB |
| Description | Monitors the ALS laser and computes the slow controls feedback |
| Input argument | Name: RequestType: SaveRestoreEnumDescription: Request for save/restore/safemode or noop |
| Input argument | Name: ALSLaserInType: ALSLaserInStructDescription: Input hardware structure |
| Input argument | Name: ControlsEnableType: BOOLDescription: Enables the slow controls feedbackDefault: FALSE |
| Input argument | Name: PZTVoltageType: LREALDescription: PZT controls voltage in V (error signal for slow controls feedback)Default: 0 |
| Output argument | Name: ALSLaserOutType: ALSLaserOutStructDescription: Output hardware structure |
| In/out argument | Name: ALSLaserType: ALSLaserStructDescription: User Interface structure |
| In/out argument | Name: ALSLaserInitType: ALSLaserStructDescription: Save/restore variable in persistent memory |

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| **Visual** |
| Name | ALSLaserVis |
| Description | Displays power monitors, TEC error signals, noise eater status, crystal temperatures, slow temperature controls parameters, and alarms for temperature guards, interlock and error. |
| Placeholder | Name: ALSLaserType: ALSLaserStructDescription: ALS laser structure |