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TwinCAT Library for the  
ALS Laser

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| **Library** | |
| Title | ALSLaser |
| Version | 4 |
| TwinCAT version | 2.11 |
| Name space | – |
| Author | Alexa Staley, Daniel Sigg |
| Description | Monitors the ALS Laser  Controls the crystal and doubler temperature  A slow feedback servo is implemented to offload the fast PZT feedback to the slow temperature controls. It implements the following equation:  Or if the polarity is false:  with  and .  : sampling interval,  : unity gain frequency of integrator,  : Knee frequency of proportional gain.  (only used for control of the laser crystal, not the doubler) |
| Error codes | 0x0001 – Safety interlock engaged  0x0002 – Laser diode 1 guard alarm  0x0004 – Laser diode 2 guard alarm  0x0008 – Laser diode 1 current out-of-range  0x0010 – Laser diode 2 current out-of-range  0x0020 – Laser crystal TEC error signal out-of-range  0x0040 – Doubler crystal TEC error signal out-of-range  0x0080 – Laser diode 1 TEC error signal out-of-range  0x0100 – Laser diode 2 TEC error signal out-of-range  0x0200 – Noise eater readback signal out-of-range  0x0400 – Unity gain frequency too high  0x0800 – Proportional gain knee frequency too high  0x1000 – 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\_STRUCT  END\_TYPE | |
| Type name | ALSLaserInStruct |
| Description | Structure of the hardware input that are wired up for the ALS laser |
| Definition | STRUCT |
| Element | Name: LaserDiode1PowerMonitor  Type: INT  Description: Laser diode 1 power monitor |
| Element | Name: LaserDiode2PowerMonitor  Type: INT  Description: Laser diode 2 power monitor |
| Element | Name: LaserCrystalTECErrorSignal  Type: INT  Description: Laser crystal, TEC error signal |
| Element | Name: DoublingCrystalTECErrorSignal  Type: INT  Description: Doubling crystal, TEC error signal |
| Element | Name: LaserDiode1TECErrorSignal  Type: INT  Description: Laser diode 1, TEC error signal |
| Element | Name: LaserDiode2TECErrorSignal  Type: INT  Description: Laser diode 2, TEC error signal |
| Element | Name: NoiseEaterMonitor  Type: INT  Description: Noise eater monitor |
| Element | Name: LaserDiode1TempGuard  Type: BOOL  Description: Laser diode 1, temp guard |
| Element | Name: LaserDiode2TempGuard  Type: BOOL  Description: Laser diode 2, temp guard |
| Element | Name: InterLock  Type: BOOL  Description: InterLock |

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

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| **User Interface Type**  TYPE ALSLaserFrequencyControlsStruct:  STRUCT  On: BOOL;  Enabled: BOOL;  Run: BOOL;  Reset: BOOL;  Low: LREAL;  High: LREAL;  Range: BOOL;  Ugf: LREAL;  Pf: LREAL;  Polarity: BOOL;  END\_STRUCT  END\_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: On  Type: BOOL  Description: On/Off button for temperature feedback |
| Output Tag | Name: Enabled  Type: BOOL  Description: Enabled by the autolocker |
| Output Tag | Name: Run  Type: BOOL  Description: Servo is running |
| In/out Tag | Name: Reset  Type: BOOL  Description: Reset the integrator and zero the output |
| In/out Tag | Name: Low  Type: LREAL  Description: Low limit for feedback controls in Hz |
| In/out Tag | Name: High  Type: LREAL  Description: High limit for feedback controls in Hz |
| Output Tag | Name: Range  Type: BOOL  Description: Feedback controls exceeds range |
| In/out Tag | Name: Ugf  Type: LREAL  Description: Unity gain frequency of temperature servo in Hz |
| In/out Tag | Name: Pf  Type: LREAL  Description: Knee frequency of proportional feedback in Hz; zero is none |

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| **User Interface Type**  TYPE ALSLaserStruct :  STRUCT  Error: 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\_STRUCT  END\_TYPE | |
| Type name | ALSLaserStruct |
| Description | Structure of the user interface tags that are used to control the ALS Laser |
| Definition | STRUCT |
| Output Tag | Name: Error  Type: ErrorStruct  Description: For error handler |
| Output Tag | Name: LaserDiode1PowerMonitor  Type: LREAL  Description: Laser diode 1 power monitor in A |
| Output Tag | Name: LaserDiode2PowerMonitor  Type: LREAL  Description: Laser diode 2 power monitor in A |
| Input Tag | Name: LaserDiodePowerNominal  Type: LREAL  Description: Laser diode power nominal in A |
| Input Tag | Name: LaserDiodePowerTolerance  Type: LREAL  Description: Laser diode power tolerance in A |
| Output Tag | Name: LaserCrystalTECErrorSignal  Type: LREAL  Description: Laser crystal, TEC error signal in C |
| Output Tag | Name: DoublingCrystalTECErrorSignal  Type: LREAL  Description: Doubling crystal, TEC error signal in C |
| Output Tag | Name: LaserDiode1TECErrorSignal  Type: LREAL  Description: Laser diode 1, TEC error signal in C |
| Output Tag | Name: LaserDiode2TECErrorSignal  Type: LREAL  Description: Laser diode 2, TEC error signal in C |
| Input Tag | Name: TECTolerance  Type: LREAL  Description: TEC error signal tolerance in C |
| Output Tag | Name: NoiseEaterMonitor  Type: LREAL  Description: Noise eater monitor in V |
| Input Tag | Name: NoiseEaterNominal  Type: LREAL  Description: Noise eater nominal value in V |
| Input Tag | Name: NoiseEaterTolerance  Type: LREAL  Description: Noise eater tolerance in V |
| Output Tag | Name: LaserDiode1TempGuard  Type: BOOL  Description: Laser diode 1, temp guard, high is alarm |
| Output Tag | Name: LaserDiode2TempGuard  Type: BOOL  Description: Laser diode 2, temp guard, high is alarm |
| Output Tag | Name: InterLock  Type: BOOL  Description: InterLock, high represent an interlock |

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| In/out Tag | Name: CrystalTemperature  Type: LREAL  Description: Crystal Temperature in C or V |
| Output Tag | Name: CrystalCalibration  Type: LREAL  Description: Crystal temperature coefficient at 1064nm in MHz/C; nominal -3000 MHz/C |
| In/out Tag | Name: CrystalFrequency  Type: LREAL  Description: Laser frequency as set by crystal temperature in MHz; updating the CrystalFrequency will update the CrystalTemperature and vis versa |
| In/out Tag | Name: FrequencyControl  Type: ALSLaserFrequencyControlsStruct  Description: Controls parameters for slow temperature feedback network |
| Output Tag | Name: PZTTuningCoefficient  Type: LREAL  Description: PZT tuning coefficient at 1064nm in MHz/V; nominal 1.5 MHz/V |
| Output Tag | Name: PZTFrequency  Type: LREAL  Description: Laser frequency as set by the PZT actuator in MHz |
| Input Tag | Name: DoublerTemperature  Type: LREAL  Description: Doubler Temperature |

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| **Function Block**  FUNCTION\_BLOCK ALSLaserFB  VAR\_INPUT  Request: SaveRestoreEnum;  ALSLaserIn: ALSLaserInStruct;  ConstrolsEnable: BOOL:= FALSE;  PZTVoltage: LREAL := 0.0;  END\_VAR  VAR\_OUTPUT  ALSLaserOut: ALSLaserOutStruct;  END\_VAR  VAR\_IN\_OUT  ALSLaserInit: ALSLaserStruct;  ALSLaser: ALSLaserStruct;  END\_VAR | |
| Name | ALSLaserFB |
| Description | Monitors the ALS laser and computes the slow controls feedback |
| Input argument | Name: Request  Type: SaveRestoreEnum  Description: Request for save/restore/safemode or noop |
| Input argument | Name: ALSLaserIn  Type: ALSLaserInStruct  Description: Input hardware structure |
| Input argument | Name: ControlsEnable  Type: BOOL  Description: Enables the slow controls feedback  Default: FALSE |
| Input argument | Name: PZTVoltage  Type: LREAL  Description: PZT controls voltage in V (error signal for slow controls feedback)  Default: 0 |
| Output argument | Name: ALSLaserOut  Type: ALSLaserOutStruct  Description: Output hardware structure |
| In/out argument | Name: ALSLaser  Type: ALSLaserStruct  Description: User Interface structure |
| In/out argument | Name: ALSLaserInit  Type: ALSLaserStruct  Description: 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: ALSLaser  Type: ALSLaserStruct  Description: ALS laser structure |