



LIGO Laboratory / LIGO Scientific Collaboration

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TwinCAT Library for the
ALS Laser

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LIGO Scientific Collaboration

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of the LIGO Laboratory.

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Library	
Title	ALSLaser
Version	4
TwinCAT version	2.11
Name space	–
Author	Alexa Staley, Daniel Sigg
Description	<p>Monitors the ALS Laser</p> <p>Controls the crystal and doubler temperature</p> <p>A slow feedback servo is implemented to offload the fast PZT feedback to the slow temperature controls. It implements the following equation:</p> $ui=(1-h)\times ui-1+ei\times(h-g)$ <p>Or if the polarity is false:</p> $ui=(1-h)\times ui-1+ei\times(h+g)$ <p>with</p> $g=\pi fugf\Delta t \quad \text{and} \quad h=\pi fPf\Delta t.$ <p>Δt: sampling interval, $fugf$: unity gain frequency of integrator, fPf: Knee frequency of proportional gain. (only used for control of the laser crystal, not the doubler)</p>
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

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

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

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

User Interface Type

TYPE ALSLaserStruct :

STRUCT

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    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;

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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

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

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			
Laser Diode 1 Power Monitor	%3.3f A	Laser Diode Power Nominal	%3.3f A
Laser Diode 2 Power Monitor	%3.3f A	Laser Diode Power Tolerance	%3.3f A
Laser Crystal TEC Error Signal	%3.5f C	TEC Tolerance (10s average)	%3.5f C
Doubling Crystal TEC Error Signal	%3.5f C		
Laser Diode 1 TEC Error Signal	%3.5f C		
Laser Diode 2 TEC Error Signal	%3.5f C	Noise Eater Nominal	%3.3f V
Noise Eater Monitor	%3.3f V	Noise Eater Tolerance	%3.3f V
PZT Frequency	%3.5f MHz	PZT Tuning Coefficient	%3.3f MHz/V
Crystal Temperature	%3.5f V	Doubler Temperature	%3.5f V
Crystal Frequency	%5.2f MHz	Temperature Coefficient	%5.2f MHz/V
Crystal Low Frequency	%5.2f MHz	Crystal High Frequency	%5.2f MHz
Slow Frequency Servo	ON	Reset	Enabled
			Running
UGF	%3.4f Hz	Knee for proportional feedback	%3.4f Hz
Laser Diode 1 Temp Guard	Laser Diode 2 Temp Guard	Interlock	
Error	%i	%s	

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