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 Laser Locking Library

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| **Library** |
| Title | LaserLocking |
| Version | 2 |
| TwinCAT version | V2.11.0 |
| Name space |  |
| Author | Sheila Dwyer |
| Description | Automatic locking for ALS PLL at end station and the squeezer PLL. See following section for more details. |
| Error Code | 0x0001 — Communications error (lost communication from corner PLC1 or cornerPLC2, or there is an error from the timing system)0x0002 — Reference cavity transmission PD error0x0004 — Fiber distribution error 0x0008 — Reference cavity transmission below the limit (limit set in this autolocker)0x0010 — Fiber launch PD error (in the fiber distribution box, internal.DC)0x0020 — Fiber launch power below the limit (limit set in by the autolocker)0x0040 — Fiber transmission PD error (the limits are enforced in the DC PD library for the local PDs)0x0080 — Fiber transmission PD limits not set, they need to be set correctly0x0100 — Fiber rejected polarization PD error0x0200 — Fiber rejected PD limits not set0x0400 — % of the fiber light that is in the wrong polarization is too large0x0800 — Power transmitted by fiber in the correct polarization to interfere with ALS laser is too small0x1000 — Laser IR power PD error0x2000 — Laser IR power PD limits not set0x4000 — Locking PD error0x8000 — Locking PD limits not set0x00010000 — Noise eater oscillating0x00020000 — Phase Frequency Discriminator Error0x00040000 — Beat note power too low0x00080000 — Beat note out of range of frequency comparator0x00100000 — Laser Error0x00200000 — Temperature feedback limits reached0x00400000 — Laser far above PSL, manually tune0x00800000 — Laser far below PSL, manually tune0x01000000 — Was not able to determine if ALS laser is above or below PSL frequency0x02000000 — Auto Locker Failed, check message |
| Library Dependencies | ErrorHandler, SaveRestore, ReadADC, WriteDAC, DCPower, Demodulator, ALSLaser, CommonModeServo, TTFSSv4 |

# Library Description

This library includes an autolocker for the ALS end station lasers, as well as a function block called temperature controls taken from Alexa Staley’s ALSLaser library that implements a slow servo feeding back to the laser crystal temperature.

The use of this library has been extended to lock the squeezer laser. The main difference is that the nominal beat note frequency is twice the VCO frequency, where it is half for the ALS.

It implements the following equation, which results in a 1/f filter if TemperatureControls.PF is zero OR a 1/f response with a zero at Pf, which is intended to compensate for the thermal pole of the laser crystal:

$u\_{i}=u\_{i-1}+g×\left\{\begin{matrix}e\_{i}&h\leq 0\\ (e\_{i}-e\_{i-1})/h&h>0\end{matrix}\right.$ with

$g=π f\_{ugf} ∆t$ and $h= π f\_{Pf} ∆t$.

$∆t$: sampling interval,

$f\_{ugf}$: unity gain frequency of integrator,

$f\_{Pf}$: Knee frequency of proportional gain.

There is also a polarity switch that reverses the sign of the feedback, and an enum (TemperatureControls.ErrorSignal) which allows the user to choose what to use as an error signal: the options are the beat note frequency error measured by the frequency comparator (beat.frequency-beat.vcofrequency/2), the signal sent to the laser PZT calibrated in MHz, or the fast mon from the servo, also calibrated in MHz. There is also a reset that clears the integrator, and range limits for the output of the slow feedback.

The library also includes an error checking function block called locking conditions, which checks for a large number of error conditions that may prevent the PLL from locking, and sets the bit Logic.Conditions to FALSE if any of the locking conditions are not met.

The variable ‘locked’ is set to true if the common mode servo is not saturated and the beatnote is within tolerance.

A state diagram for the autolocker is below. The user can enable the autolocker so that it will run when the locking conditions are met, or force it so that it will disregard errors from the locking conditions function block. The user can also choose a polarity to lock the ALS laser above or below the PSL in frequency. This sets the polarity on the servo, the phase frequency discriminator, and the temperature feedback.



Figure : State diagram for PLL autolocking, transitional states in purple

When the autolocker state machine begins running, it either passes to the PLLInitialize state, if the PLL is unlocked or to the PLLGainRamp state, if it is locked.

The user can choose to skip initialization or to initialize the autolocker, in which case it begins by increasing the laser crystal temperature, waiting 30 seconds and determining based on the response of the beat note measured by the frequency comparator if the laser is above or below the PSL in frequency. If the laser is on the wrong side, or the autolocker cannot determine what side it is on, it goes to the failed state, and the user needs to manually tune the crystal temperature. Once the temperature is manually tuned the user can disengage the autolocker and re-engage it to begin the locking process.

When the laser is on the correct side, the autolocker passes to the PLLSearch state, and uses the temperature servo with the beat note measured by the frequency comparator as an error signal, with the common mode board feedback to the PZT disengaged. If the beat note error become less than beat.LockingRange the state machine passes to PLLacquire, or if 20 minutes pass without the beatnote coming into range the autolocker goes to the PLLfailed state.

In the PLLacquire state the common mode board feedsback to the laser PZT with low gain and the temperature servo continues to use the beatnote error as measured by the frequency comparator as an error signal. If the beat notes goes out of the locking range, the state returns to PLLSearch, if the PLL locks it passes to PLLRampGain.

In PLLRampGain the temperature servo error signal is switched to the PZT feedback, and the input gain of the common mode board is ramped at 1dB per second until it reaches the gain used for locking. If the PLL is locked at the locking gain for 1 second, the state transitions to PLLLocked,

It will stay in the locked state unless the PLL becomes unlocked for more than 1 second, in which case it passes to PLLaquire, or if the locking conditions are no longer met it will pass to disengaged.

# Example:

Comm.CommunicationError := Ifo.Sys.Communication.Y.Error <> 16#03;

Comm.VCOFrequency := RecieveFromCornerPLC1.VCOFrequency;

Comm.BeatFrequency:= RecieveFromCornerPLC1.BeatFrequency;

Comm.SplitMonFrequency:=

 Ifo.ALS.End.Fibr.Servo.SplitMon\*(-0.979)\*

 EXP(Ifo.ALS.End.Fibr.Servo.FastGain\*LN(10)/20)\*

 Ifo.ALS.End.Laser.Head.PZTTuningCoefficient;

Comm.CoarseFrequencyCheck := Ifo.ALS.End.Refl.Servo.In1En;

Comm.PZTVoltageInRange:= Abs(Ifo.ALS.End.Fibr.Servo.FastMon) < 9.99;

Comm.RefCavTransError := RecieveFromCornerPLC2.RefCavTransError;

…

AlsEndFibrLockFB (

 LaserType:=LLTypeALS,

 Request:=Request,

 Comm:=Comm,

 LaserLocking := Ifo.ALS.End.Fibr.Lock,

 LaserLockingInit := AlsEndFibrLockInit,

 FiberTrans:=Ifo.ALS.End.Fibr.Trans.Dc,

 FiberRejected:=Ifo.ALS.End.Fibr.Rejected.Dc,

 LaserIR:=Ifo.ALS.End.Laser.Ir.Dc,

 Fiber\_A:=Ifo.ALS.End.Fiber\_A.Dc,

 ALSLaser:=Ifo.ALS.End.Laser.Head,

 Demod := Ifo.ALS.End.Fibr\_A.Demod,

 Servo := Ifo.ALS.End.Fibr.Servo);

# LaserLocking Interface

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| **Laser Type**TYPE LaserLockingTypeEnum : (LLTypeALS, LLTypeSqueezer)END\_TYPE; |
| Type Name | LaserLockingTypeEnum |
| Description | Specifies the laser that has to be locked: ALS or Squeezer |
| Definition | ENUM |
| Element | Name: LLTypeALSDescription: ALS laser |
| Element | Name: LLTypeSqueezerDescription: Squeezer laser |

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| **Laser Locking State**TYPE LaserLockingStateEnum : (PLLDisengaged, PLLInitialize, PLLSearch, PLLAcquire, PLLRampGain, PLLLocked, PLLFailed)END\_TYPE; |
| Type Name | LaserLockingStateEnum |
| Description | Specifies the state for the PLL |
| Definition | ENUM |
| Element | Name: PLLDisengagedDescription: The autolocker is disengaged |
| Element | Name: PLLInitializeDescription: Initialize the PLL autolocker |
| Element | Name: PLLSearchDescription: Searching for resonance |
| Element | Name: PLLAcquireDescription: PLL lock is acquired |
| Element | Name: PLLRampGainDescription: Increase the gain of the PLL Common Mode Board |
| Element | Name: PLLLockedDescription: PLL is locked |
| Element | Name: PLLFailedDescription: Autolocker has failed to lock the auxiliary laser |

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| **Temperature Servo Error Signal**TYPE TemperatureErrorSignalEnum : (PZTfrequency, BeatNoteError, SplitMon)END\_TYPE; |
| Type Name | TemperatureErrorSignalEnum |
| Description | Allows the user to specify what to use as an error signal for the temperature feedback  |
| Definition | ENUM |
| Element | Name: PZTFrequencyDescription: Laser PZT actuation |
| Element | Name: BeatNoteErrorDescription: Difference between the beat neat and half the VCO frequency |
| Element | Name: SplitMonDescription: Split mon of the common mode board which can be used when fast feedback is engaged |

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| **Laser Locking Servo Request**TYPE LaserLockingServoRequestEnum : (LLServoNoOp, LLServoTurnOff, LLServoTurnOn, LLServoRampGain);END\_TYPE; |
| Type Name | LaserLockingServoRequestEnum |
| Description | Request to the laser locking servo  |
| Definition | ENUM |
| Element | Name: LLServoNoOpDescription: No operation |
| Element | Name: LLServoTurnOffDescription: Turn servo off |
| Element | Name: LLServoTurnOnDescription: Turn servo on in acquire mode |
| Element | Name: LLServoTurnRampGainDescription: Ramp servo gain up and engage booosts |

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| **Laser Locking Servo State**TYPE LaserLockingServoStateEnum : (LLServoInactive, LLServoBusy, LLServoFail);END\_TYPE |
| Type Name | LaserLockingServoStateEnum |
| Description | State of the laser locking servo  |
| Definition | ENUM |
| Element | Name: LLServoInactiveDescription: No operation |
| Element | Name: LLServoBusyDescription: Servo locking logic is busy |
| Element | Name: LLServoFailDescription: Servo locking logic has failed |

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| **Laser Locking Servo State**TYPE LaserLockingTtFssRequestEnum : (LLTtFssNoOp, LLTtFssFastBoostWait, LLTtFssLockWait, LLTtFssFastFilterWait, LLTtFssEomWait, LLTtFssComBoostWait);END\_TYPE |
| Type Name | LaserLockingTtFssRequestEnum |
| Description | Internal state of the servo locking logic |
| Definition | ENUM |
| Element | Name: LLTtFssNoOpDescription: No operation |
| Element | Name: LLTtFssFastBoostWaitDescription: Wait before engaging the fast boost |
| Element | Name: LLTtFssLockWaitDescription: Wait for the servo to lock properly |
| Element | Name: LLTtFssFastFilterWaitDescription: Wait before engaging the fast filter |
| Element | Name: LLTtFssEomWaitDescription: Wait before engaging the eom path |
| Element | Name: LLTtFssComBoostWaitDescription: Wait before engaging the common boost |

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| **Laser Type**TYPE FiberTransMonitorEnum: (FiberTransMonitorTotal, FiberTransMonitorCorrectPol)END\_TYPE; |
| Type Name | FiberTransMonitorEnum |
| Description | Specifies if the fiber trans PD measures the total power out of the fiber or just the light in the correct polarization |
| Definition | ENUM |
| Element | Name: FiberTransMonitorTotalDescription: Fiber Trans PD measures the total power out of the fiber |
| Element | Name: FiberTransMonitorCorrectPolDescription: Fiber Trans PD measures the power in the correct polarization |

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| **User Interface Type**TYPE LaserLockingStatusStruct:STRUCT Message: STRING; Locked: BOOL; CoarseLocked: BOOL; LockLosses: INT; ResetLockLosses: BOOL;END\_STRUCT;END\_TYPE; |
| Type Name | LaserLockingStatusStruct |
| Description | Structure used to represent status of laser locking |
| Definition | STRUCT |
| Output Tag | Name: MessageType: STRINGDescription: Message for operator |
| Output Tag | Name: LockedType: BOOLDescription: PLL is locked |
| Output Tag | Name: CoarseLockedType: BOOLDescription: PLL is coarsely locked |
| Output Tag | Name: LockLossesType: INTDescription: Counts the number of times lock has been lost |
| Input Tag | Name: ResetLockLossesType: BOOLDescription: Resets the lock loss counter |

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| **Auxiliary Interface Type**TYPE LaserLockingRefCavStruct :STRUCT TransLim: LREAL;END\_STRUCT;END\_TYPE; |
| Type Name | LaserLockingRefCavStruct |
| Description | Structure used in the user interface type to check the reference cavity |
| Definition | STRUCT |
| Input Tag | Name: TransLimType: LREALDescription: Lower limit for ref cav power |

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| **Auxiliary Interface Type**TYPE LaserLockingFiberStruct :STRUCT LaunchLim: LREAL; PolarizationPercent: LREAL; PolLim: LREAL = 30; TransRightPol: LREAL; TransRightPolLim: LREAL;END\_STRUCT;END\_TYPE; |
| Type Name | LaserLockingFiberStruct |
| Description | Structure used in the user interface type to check the fiber transmission |
| Definition | STRUCT |
| Input Tag | Name: LaunchLimType: LREALDescription: Lower limit for launched fiber power |
| Input Tag | Name: PolarizationPercentType: LREALDescription: Fiber trans in the wrong polarization |
| Input Tag | Name: PolLimType: LREALDescription: Limit for wrong polarization light |
| Output Tag | Name: TransRightPolType: LREALDescription: Fiber trans power in right polarization |
| Input Tag | Name: TransRightPolLimType: LREALDescription: Fiber trans power in right polarization limit |

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| **Auxiliary Interface Type**TYPE LaserLockingBeatNoteStruct :STRUCT RFAmp: LREAL; RFMin: LREAL; Frequency: LREAL; VcoFrequency: LREAL; Tolerance: LREAL; LockingRange: LREAL; Low: LREAL; High: LREAL; FrequencyError: LREAL;END\_STRUCT;END\_TYPE; |
| Type Name | LaserLockingBeatNoteStruct |
| Description | Structure used in the user interface type to control the autolocker  |
| Definition | STRUCT |
| Output Tag | Name: RFAmpType: LREALDescription: Beat note strength in dBm |
| In/Out Tag | Name: RFMinType: LREALDescription: Beat note threshold |
| Output Tag | Name: FrequencyType: LREALDescription: Beat note frequency |
| Output Tag | Name: VcoFrequencyType: LREALDescription: VCO frequency |
| In/Out Tag | Name: ToleranceType: LREALDescription: Beat note frequency tolerance |
| Output Tag | Name: LockingRangeType: LREALDescription: Frequency range for locking |
| Output Tag | Name: LowType: LREALDescription: Low cut-off for acquisition  |
| Output Tag | Name: HighType: LREALDescription: High cut-off for acquisition  |
| Input Tag | Name: FrequencyErrorType: LREALDescription: Frequency error of beat note |

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| **Auxiliary Interface Type**TYPE LaserLockingLogicStruct :STRUCT Conditions: BOOL; Enable: BOOL; Force: BOOL; IgnorePSL: BOOL; On: BOOL; Polarity: BOOL; SkipInitialization: BOOL;END\_STRUCT;END\_TYPE; |
| Type Name | LaserLockingLogicStruct |
| Description | Structure used in the user interface type to control the laser locking logic  |
| Definition | STRUCT |
| Output Tag | Name: ConditionsType: BOOLDescription: Pre-conditions for locking |
| Input Tag | Name: EnableType: BOOLDescription: Enable autolocker |
| Input Tag | Name: ForceType: BOOLDescription: Force autolocker on even if conditions are not met |
| Input Tag | Name: IgnorePSLType: BOOLDescription: Ignored PSL conditions |
| Output Tag | Name: OnType: BOOLDescription: Autolocker is on |
| Input Tag | Name: PolarityType: BOOLDescription: Polarity for laser PLL |
| Input Tag | Name: SkipInitializationType: BOOLDescription: Check laser on right size |

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| **Auxiliary Interface Type**TYPE TemperatureControlsStruct :STRUCT On: BOOL; Enabled: BOOL; Run: BOOL; Reset: BOOL; Low: LREAL; High: LREAL; Range: BOOL; Ugf: LREAL; Pf: LREAL; Polarity: BOOL; ErrorSignal: TemperatureErrorSignalEnum;END\_STRUCT;END\_TYPE; |
| Type Name | TemperatureControlsStruct |
| Description | Structure used in the user interface type to control the laser temperature |
| Definition | STRUCT |
| Input Tag | Name: OnType: BOOLDescription: On/off button |
| Input Tag | Name: EnabledType: BOOLDescription: Controls enabled button  |
| Output Tag | Name: RunType: BOOLDescription: Temperature feedback running |
| Input Tag | Name: ResetType: BOOLDescription: Reset the integrator |
| Input Tag | Name: LowType: LREALDescription: Low control value in Hz |
| Input Tag | Name: HighType: LREALDescription: High control value in Hz |
| Input Tag | Name: RangeType: BOOLDescription: Controls range exceeded |
| Output Tag | Name: UgfType: LREALDescription: Unity gain frequency in Hz |
| Output Tag | Name: PfType: LREALDescription: Knee of proportional gain in Hz |
| Output Tag | Name: PolarityType: BOOLDescription: Polarity of slow feedback |
| Input/Output Tag | Name: ErrorSignalType: TemerpatureErrorSignalEnumDescription: Error signal for temperature feedback |

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| **Auxiliary Input Type**TYPE LaserLockingCommStruct :STRUCT CommunicationError: BOOL := TRUE; VCOFrequency: LREAL := 0; BeatFrequency: LREAL := 0; RfAmp: LREAL := -100; SplitMonFrequency: LREAL := 0; CoarseFrequencyCheck: BOOL := FALSE; PZTVoltageInRange: BOOL := TRUE; RefCavTransError: BOOL := TRUE; RefCavTransNorm: LREAL := 0; FiberLaunchError: BOOL := TRUE; FiberLaunchNorm: LREAL := 0; FiberDistErr: BOOL := TRUE; END\_STRUCTEND\_TYPE; |
| Type Name | LaserLockingCommStruct |
| Description | Structure used as input to the laser locking function block. It contains frequency readbacks and the state of the reference cavity. |
| Definition | STRUCT |
| Input Tag | Name: CommunicationErrorType: BOOLDescription: True, if a communication error prevented good input data |
| Input Tag | Name: VCOFrequencyType: LREALDescription: Readback of the VCO frequency  |
| Input Tag | Name: BeatFrequencyType: LREALDescription: Readback of the beat note frequency |
| Input Tag | Name: RfAmpType: LREALDescription: Readback of the beat note strength |
| Input Tag | Name: SplitMonFrequencyType: LREALDescription: PZT frequency offset derived from the CM split monitor |
| Input Tag | Name: CoarseFrequencyCheckType: BOOLDescription: Uses a coarser frequency check for lock condition. Useful, when VCO is used as a laser frequency actuator. |
| Input Tag | Name: PZTVoltageInRangeType: BOOLDescription: True, when the PZT voltage isn’t railed. |
| Input Tag | Name: RefCavTransErrorType: BOOLDescription: Reference cavity transmission PD is in error |
| Input Tag | Name: RefCavTransNormType: LREALDescription: Normalized reference cavity transmission |
| Input Tag | Name: FiberLaunchErrorType: BOOLDescription: Fiber launch PD is in error |
| Input Tag | Name: FiberLaunchNormType: LREALDescription: Normalized fiber launching power |
| Input Tag | Name: FiberDistErrType: BOOLDescription: Error in the fiber distribution subsystem |

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| **User Interface Type**TYPE LaserLockingStruct :STRUCT Error: ErrorStruct; State: LaserLockingEnum; Status: LaserLockingStatusStruct; RefCav: LaserLockingRefCavStruct; Fiber: LaserLockingFiberStruct; Beat: LaserLockingBeatNoteStruct; Logic: LaserLockingLogicStruct; TemperatureControls: TemperatureControlsStruct;END\_STRUCT;END\_TYPE; |
| Type Name | LaserLockingStruct |
| Description | Structure used in the user interface type to control the laser locking |
| Definition | STRUCT |
| Output Tag | Name: ErrorType: ErrorStructDescription: Error information |
| Output Tag | Name: StateType: LaserLockingEnumDescription: Autolocker state |
| Input/Output Tag | Name: StatusType: LaserLockingRefCavStructDescription: Structure of limits and calculations for the reference cavity |
| Input/Output Tag | Name: RefCavType: LaserLockingStatusStructDescription: Structure of limits and calculations for the reference cavity |
| Input/Output Tag | Name: FiberType: LaserLockingFiberStructDescription: Structure of limits and calculations for fiber transmission |
| Input/Output Tag | Name: BeatType: LaserLockingBeatNoteStructDescription: Structure for achieving a beat note |
| Input/Output Tag | Name: LogicType: LaserLockingLogicStructDescription: Structure for logic behind autolocker |
| Input/Output Tag | Name: TemperatureControlsType: TemperatureControlsStructDescription: Temperature controls structure |

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| **Function Block**TYPE LaserLockingFB :VAR\_INPUT LaserType: LaserLockingTypeEnum; Request: SaveRestoreEnum; Comm: LaserLockingCommStruct; Demod: DemodulatorLscStruct; FiberTransMon: FiberTransMonitorEnum := FiberTransMonitorTotal; FiberTrans: DCPowerStruct; FiberRejected: DCPowerStruct; LaserIR: DCPowerStruct; Fibr\_A: DCPowerStruct; ServoState: LaserLockingServoStateEnum := LLServoInactive;END\_VAR;VAR\_IN\_OUT Laser: LaserStruct; LaserLockingInit: LaserLockingStruct; LaserLocking: LaserLockingStruct;END\_VAR;VAR\_OUTPUT ServoRequest: LaserLockingServoRequestEnum;END\_VAREND\_TYPE; |
| Type Name | LaserLockingFB |
| Description | Function block for the autolocker |
| Definition | Function Block |
| Input Argument | Name: RequestType: SaveRestoreEnumDescription: Request save/restore/safemood or noop |
| Input Argument | Name: CommType: LaserLockingCommStructDescription: Common external parameters for laser locking |
| Input Argument  | Name: DemodType: DemodulatorLscStructDescription: Demodulator structure for laser locking error signal |
| Input Argument  | Name: FiberTransMonType: FiberTransMonitorEnumDescription: Specifies what light the Fiber Trans PD measures |
| Input Argument | Name: FiberTransType: DCPowerStructDescription: PD monitoring total fiber transmission power |
| Input Argument | Name: FiberRejectedType: DCPower StructDescription: PD monitoring total fiber rejected power |
| Input Argument | Name: LaserIRType: DCPowerStructDescription: PD monitoring the ALS laser power in IR path |
| Input Argument | Name: Fibr\_AType: DCPowerStructDescription: DC output of broad band PD |
| Input Argument | Name: ServoStateType: LaserLockingServoStateEnumDescription: State of top level servo controller |
| Input Argument | Name: PDHServoType: CommonModeStructDescription: User interface structure |
| In/Out Argument | Name: LaserType: ALSlaserStructDescription: User interface structure |
| In/Out Argument | Name: LaserLockingInitType: AlsLaserLockingStructDescription: Save/restore variable in persistent memory |
| In/Out Argument | Name: LaserLockingType: ALSLaserLockingStructDescription: User interface structure |
| Out Argument | Name: ServoRequestType: LaserLockingServoRequestEnumDescription: Request to top level servo controller |

# Configurations

## Common Mode Servo

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| **User Interface Type**TYPE LaserLockingCMConfStruct:STRUCT ServoRequest: LaserLockingServoRequestEnum; SelectInput: BOOL; AcquireGain: INT; LockedGain: INT; BoostOn: BOOL;END\_STRUCT;END\_TYPE; |
| Type Name | LaserLockingCMConfStruct |
| Description | Structure used in the user interface the servo board |
| Definition | STRUCT |
| Output Tag | Name: ServoRequestType: LaserLockingServoRequestEnumDescription: Request by the (generic) auto locker to the PLL servo locking logic |
| Input Tag | Name: SelectInputType: BOOLDescription: Use In2 (True) or In1 (False) of the servo board |
| Input Tag | Name: AcquireGainType: INTDescription: Acquire gain in dB |
| Input Tag | Name: LockedGainType: INTDescription: Gain when locked in dB |
| Input Tag | Name: BoostOnType: BOOLDescription: Use boost gain stage in servo |

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| **User Interface Type**TYPE LaserLockingCMStruct :STRUCT Error: ErrorStruct; State: LaserLockingEnum; Status: LaserLockingStatusStruct; RefCav: LaserLockingRefCavStruct; Fiber: LaserLockingFiberStruct; Beat: LaserLockingBeatNoteStruct; Logic: LaserLockingLogicStruct; TemperatureControls: TemperatureControlsStruct; Conf: LaserLockingCMConfStruct;END\_STRUCT;END\_TYPE; |
| Type Name | LaserLockingCMStruct |
| Description | Extends the Laser Locking Structure |
| Definition | STRUCT |
| Input/Output Tag | Name: ConfType: LaserLockingCMConfStructDescription: Structure of servo parameters for acquiring lock |

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| **Function Block**TYPE LaserLockingCMFB :VAR\_INPUT LaserType: LaserLockingTypeEnum; Request: SaveRestoreEnum; Comm: LaserLockingCommStruct; Demod: DemodulatorLscStruct; FiberTransMon: FiberTransMonitorEnum := FiberTransMonitorTotal; FiberTrans: DCPowerStruct; FiberRejected: DCPowerStruct; LaserIR: DCPowerStruct; Fibr\_A: DCPowerStruct;END\_VAR;VAR\_IN\_OUT Laser: ALSLaserStruct; LaserLockingInit: LaserLockingCMStruct; LaserLocking: LaserLockingCMStruct; Servo: CommonModeStruct;END\_VAR;END\_TYPE; |
| Type Name | LaserLockingCMFB |
| Description | Function block for the autolocker using a common mode boardExtends the functionality of the LaserLocking FB by adding the specific locking controls for a common mode board. The two parameters ServoRequest and ServoBusy have been dropped, but a parameter for the servo controls has been added. |
| Definition | Function Block |
| In/Out Argument | Name: ServoType: CommonModeStructDescription: Controls for the servo board |

## TTFSS V4 Servo

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| **User Interface Type**TYPE LaserLockingTtFssConfStruct:STRUCT ServoRequest: LaserLockingServoRequestEnum;  LockingRequest: LaserLockingTtFssRequestEnum;  ComAcquireGain: LREAL;  ComSwitchGain: LREAL;  ComLockedGain: LREAL; FastAcquireGain: LREAL;  FastLockedGain: LREAL;  UseFastBoost: BOOL;  FastBoostDelay: LREAL;  FastLockTimeout: LREAL; UseFastFilter: BOOL;  FastFilterDelay: LREAL; UseEomPath: BOOL; EnableEomDelay: LREAL;  UseComBoost: BOOL;  DisableAntiBoost: BOOL;  ComBoostDelay: LREAL;END\_TYPE; |
| Type Name | LaserLockingTtFssConfStruct |
| Description | Structure used in the user interface the servo board |
| Definition | STRUCT |
| Output Tag | Name: ServoRequestType: LaserLockingServoRequestEnumDescription: Request by the (generic) auto locker to the PLL servo locking logic |
| Output Tag | Name: LockingRequestType: LaserLockingTtFssRequestEnumDescription: State of the servo locking logic |
| Input Tag | Name: ComAcquireGainType: LREALDescription: Common gain during acquire in dB |
| Input Tag | Name: ComSwitchGainType: LREALDescription: Common gain when switching on the EOM path in dB |
| Input Tag | Name: ComLockedGainType: LREALDescription: Common gain when locked in dB |
| Input Tag | Name: FastAcquireGainType: LREALDescription: Fast gain during acquire and EOM switch in dB |
| Input Tag | Name: FastLockedGainType: LREALDescription: Fast gain when locked in dB |
| Input Tag | Name: UseFastBoostType: BOOLDescription: Use the fast boost gain stage of the servo |
| Input Tag | Name: FastBoostDelayType: LREALDescription: Time to wait before engaging the fast boost in sec |
| Input Tag | Name: FastLockTimeoutType: LREALDescription: Timeout in sec for the beat note frequency to reach the locked state after fast boost is engaged |
| Input Tag | Name: UseFastFilterType: BOOLDescription: Use the fast filter stage of the servo |
| Input Tag | Name: FastFilterDelayType: LREALDescription: Time to wait before engaging the fast filter stage in sec |
| Input Tag | Name: UseEomPathType: BOOLDescription: Use the EOM path of the servo |
| Input Tag | Name: EnableEomDelayType: LREALDescription: Time to wait before engaging the EOM path in sec |
| Input Tag | Name: UseComBoostType: BOOLDescription: Use the common boost stage of the servo |
| Input Tag | Name: DisableAntiBoostType: BOOLDescription: Disable the anti-boost stage of the servo, the anti-boost stage is required to make a PFD loop stable (compared to the demodulator locking to a cavity). When the anti-boost is disabled it acts as an additional boost. |
| Input Tag | Name: ComBoostDelayType: LREALDescription: Time to wait before engaging the common boost stage and disabling the anti-boost stage in sec |

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| **User Interface Type**TYPE LaserLockingTtFssStruct :STRUCT Error: ErrorStruct; State: LaserLockingEnum; Status: LaserLockingStatusStruct; RefCav: LaserLockingRefCavStruct; Fiber: LaserLockingFiberStruct; Beat: LaserLockingBeatNoteStruct; Logic: LaserLockingLogicStruct; TemperatureControls: TemperatureControlsStruct; Conf: LaserLockingTtFssConfStruct;END\_STRUCT;END\_TYPE; |
| Type Name | LaserLockingTtFssStruct |
| Description | Extends the Laser Locking Structure |
| Definition | STRUCT |
| Input/Output Tag | Name: ConfType: LaserLockingTtFssConfStructDescription: Structure of servo parameters for acquiring lock |

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| **Function Block**TYPE LaserLockingTtFssFB :VAR\_INPUT LaserType: LaserLockingTypeEnum; Request: SaveRestoreEnum; Comm: LaserLockingCommStruct; Demod: DemodulatorLscStruct; FiberTrans: DCPowerStruct; FiberRejected: DCPowerStruct; LaserIR: DCPowerStruct; Fibr\_A: DCPowerStruct;END\_VAR;VAR\_IN\_OUT Laser: LaserStruct; LaserLockingInit: LaserLockingTtFssStruct; LaserLocking: LaserLockingTtFssStruct; Servo: TtFssV4Struct;END\_VAR;END\_TYPE; |
| Type Name | LaserLockingTtFssFB |
| Description | Function block for the autolocker using a TTFSS V4 servo.Extends the functionality of the LaserLocking FB by adding the specific locking controls for a TTFSS servo. The two parameters ServoRequest and ServoBusy have been dropped, but a parameter for the servo controls has been added. |
| Definition | Function Block |
| In/Out Argument | Name: ServoType: TtFssV4StructDescription: Controls for the servo board |

# Auxiliary Functions

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| **Function Block**TYPE LockingConidtionsFB :VAR\_IN\_OUT LaserLocking: LaserLockingStruct; ErrorHandler: ErrorHandlerFB;END\_VARVAR\_INPUT FiberTrans: DCPowerStruct; FiberRejected: DCPowerStruct; LaserIR: DCPowerStruct; Fibr\_A: DCPowerStruct; Comm: LaserLockingCommStruct; Laser: ALSLaserStruct; Demod: DemodulatorLscStruct;END\_VAR END\_TYPE; |
| Type Name | LockingConditionsFB |
| Description | Function block for the conditions of the autolocker |
| Definition | Function Block |
| In/Out Argument | Name: LaserLockingType: LaserLockingStructDescription: Laser locking user interface |
| In/Out Argument | Name: ErrorHandlerType: ErrorHandlerFBDescription: Error handler |
| Input Argument | Name: FiberTransType: DCPowerStructDescription: PD monitoring total fiber transmission power |
| Input Argument | Name: FiberRejectedType: DCPower StructDescription: PD monitoring total fiber rejected power |
| Input Argument | Name: LaserIRType: DCPowerStructDescription: PD monitoring the ALS laser power in IR path |
| Input Argument | Name: Fibr\_AType: DCPowerStructDescription: DC output of broad band PD |
| Input Argument | Name: CommType: LaserLockingCommStructDescription: Interace structure for external parameters |
| Input Argument | Name: LaserType: ALSlaserStructDescription: User interface structure |
| Input Argument | Name: DemodType: DemodulatorLscStructDescription: User interface structure |

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| **Function Block**TYPE TemperatureControlsFB :VAR\_INPUT Request: SaveRestoreEnum; SplitMonFrequency: LREAL;END\_VAR;VAR\_IN\_OUT Laser: ALSLaserStruct; LaserLocking: LaserLockingStruct;END\_VAR;END\_TYPE; |
| Type Name | TemperatureControlsFB |
| Description | Function block for laser temperature controller |
| Definition | Function Block |
| Input Argument | Name: RequestType: SaveRestoreEnumDescription: Request save/restore/safemood or noop |
| Input Argument | Name: SplitMonFrequencyType: LREALDescription: Frequency as measured by the split monitor (CM board) |
| In/out Argument | Name: ALSLaserType: ALSLaserStructDescription: User interface type |
| In/out Argument | Name: ALSLaserLockingType: ALSLaserLockingStructDescription: User interface type |