*LIGO Laboratory / LIGO Scientific Collaboration*

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Communication Library Documentation

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| **Library** |
| Title | ALSCommunication |
| Version | 3 |
| TwinCAT version |  |
| Name space |  |
| Author | Sheila Dwyer |
| Description | Library that passes information needed to automate the ALS system between different PLCs in the beckhoff system, and from and to the real time system.  |
| Error Code | 0x001 Timing system error0x002 communication lost 16#002 — Corner Timing System16#004 — EX Timing System16#008 — EY Timing System |
| Library Dependencies | DCPower, DelayLogic, Demodulator, Error, FiberDistribution, IscWhitening, Photodetectors, ReadADC, SaveRestore, WriteADC |

Function blocks provided that pass signals needed for ALS communication between PLCs. PLC2 in the corner receives information from the timing system on corner PLC1, and from each end station, and sends information to each end station. PLC1 also sends information from the timing system to the end stations. This library will also implement communication from the real time system to the beckhoff eventually.

There are not hardware in and out data structures in this library, instead there is a structure for each link which will be used as the output structure on the sending side and the input structure on the receiving side. The user interface structure is used for error messages only.

Each send function block generates a keep alive bit, which toggles between 1 and 0 every 100ms. Each receive function block uses a TOF (Off delay timer), which is a standard function block defined in the IEC 1131-3 standard. There is an explanation on pg 234 of the red Programming Industrial Control Systems Using IEC 1131-1 book by R W Lewis, but the timing diagrams for the on delay timer and off delay timer are mixed up. The general function of this part is to check set a flag (KeepAliveTimeout.Q) if KeepAlive has not toggled in the time KeepAliveTimeout (10 seconds), which causes the error ‘Communication Lost’. When this happened the values of the variables to be received are set to some values that should be clearly invalid.

Example usage:

CASE IfoId OF

 IfoH1:

 SendtoEndYFB(Request:=Request, VarStruct=>SendtoEndY,

 VCOFreq:=Ifo.SYS.Timing.Y.FO\_A.Port[9].Slave.CFC.Frequency[1],

 BeatFreq:=Ifo.SYS.Timing.Y.FO\_A.Port[9].Slave.CFC.Frequency[2],

 TimingError:=Ifo.SYS.Timing.Y.FO\_A.Port[9].Slave.Error,

 ALSCommunication:=Ifo.SYS.Communication.C.toEndY);

 IfoL1: ;

END\_CASE;

The timing structures are not sent to any other PLC to avoid library dependencies that causing naming conflicts with some of the libraries used by the timing system. This means that each port and each input connector needs to be specified in the PLC, which adds flexibility.

Example usage of send function block:

ReceiveFromCornerPLC1FB(Request:=Request, ALSCommunication:=Ifo.SYS.Communication.C.fromPLC1,

 VarStruct:=ReceiveFromCornerPLC1);

The user interface type is only for error handling.

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| **User Interface Type**TYPE ALSCommunicationStruct :STRUCT Error: ErrorStruct;END\_STRUCT;END\_TYPE; |
| Type Name | ALSCommunicationStruct |
| Description | Structure used in the user interface type monitor the communication between ALS machines  |
| Definition | STRUCT |
| Output Tag | Name: ErrorType: ErrorStructDescription: Calls the error handler |

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| **User Interface Type**TYPE ALSCornerStateEnum : (ALSCornerSafe, ALSCornerInvalidState)END\_TYPE; |
| Type Name | ALSCornerStateEnum |
| Description | Monitors the state of the corner station  |
| Definition | ENUM |
| Element | Name: ALSCornerSafeDescription: Safe state |
| Element | Name: ALSCornerInvalidStateDescription: Invalid state |

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| **User Interface Type**TYPE ALSEndStateEnum : (ALSEndSafe, ALSEndInvalidState, ALSEndPLLDisengaged, ALSEndPLLAcquire, ALSENDPLLLocked, ALSEndReflAcquiring, ALSEndReflLockedSlowOff, ALSEndReflLockedSlowOn)END\_TYPE; |
| Type Name | ALSEndStateEnum |
| Description | Monitors the state of the end station  |
| Definition | ENUM |
| Element | Name: ALSEndSafeDescription: Safe state |
| Element | Name: ALSEndInvalidStateDescription: Invalid state |
| Element | Name: ALSENDPLLDisengagedDescription: ALS END PLL is disengaged |
| Element | Name: ALSENDPLLAcquireDescription: ALS END PLL is acquiring lock |
| Element | Name: ALSENDPLLLockedDescription: ALS END PLL is locked |
| Element | Name: ALSENDREflAcquiringDescription: ALS END Refl is acquiring lock |
| Element | Name: ALSENDReflLockedSlowOffDescription: ALS END Refl is locked with slow off |
| Element | Name: ALSENDReflLockedSlowOnDescription: ALS END PLL is locked with slow on |

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| **User Interface Type**TYPE CornerPLC1toCornerPLC2Struct :STRUCT KeepAlive: BOOL; DiffVCOFrequency: LREAL; CommVCOFrequency: LREAL; PSLVCOFrequency: LREAL; FiberAOMFrequnecy: LREAL; ExVCOFrequency: LREAL; ExBeatFrequency: LREAL; ExTimingError: DWORD; EyVCOFrequency: LREAL; EyBeatFrequency: LREAL; EyTimingError: DWORD;END\_STRUCT;END\_TYPE; |
| Type Name | CornerPLC1toCornerPLC2Struct |
| Description | Structure used in the user interface type monitoring the communication between the corner PLC1 and PLC2  |
| Definition | STRUCT |
| Output Tag | Name: KeepAliveType: BOOLDescription:  |
| Output Tag | Name: DiffVCOFrequencyType: LREALDescription: Diff. VCO frequency |
| Output Tag | Name: CommVCOFrequencyType: LREALDescription: Comm. VCO frequency |
| Output Tag | Name: PSLVCOFrequencyType: LREALDescription: PSL VCO frequency |
| Output Tag | Name: FiberAOMFrequencyType: LREALDescription: Fiber AOM frequency |
| Output Tag | Name: TimingErrorType: LREALDescription: Monitors the timing error |
| Output Tag | Name: ExCOFrequencyType: LREALDescription: EX VCO frequency |
| Output Tag | Name: ExBeatFrequencyType: LREALDescription: EX beatn note frequency |
| Output Tag | Name: ExTimingErrorType: DWORDDescription: EX timing error monitor |
| Output Tag | Name: EyCOFrequencyType: LREALDescription: EY VCO frequency |
| Output Tag | Name: EyBeatFrequencyType: LREALDescription: EY beat note frequency |
| Output Tag | Name: EyTimingErrorType: DWORDDescription: EY timing error monitor |

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| **User Interface Type**TYPE CornerPLC1toEndStruct :STRUCT KeepAlive: BOOL; VCOFrequency: LREAL; BeatFrequency: LREAL; TimingError: DWORD;END\_STRUCT;END\_TYPE; |
| Type Name | CornerPLC1toeEnStruct |
| Description | Structure used in the user interface type monitoring the communication between the corner PLC1 and end station  |
| Definition | STRUCT |
| Output Tag | Name: KeepAliveType: BOOLDescription:  |
| Output Tag | Name: VCOFrequencyType: LREALDescription: VCO frequency |
| Output Tag | Name: BeatFrequencyType: LREALDescription: Beat note frequency |
| Output Tag | Name: TimingErrorType: LREALDescription: Monitors the timing error |

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| **User Interface Type**TYPE CornerPLC2toEndStruct :STRUCT KeepAlive: BOOL; RefCavTransError: DWORD; RefCavTransNorm: LREAL; FiberLaunchError: DWORD; FiberLaunchNorm: LREAL: FiberDistErr: BOOL; GreenArmTransNorm: LREAL; GreenArmTransPDError: DWROD: StateRequest: ALSEndStateEnum; END\_STRUCT;END\_TYPE; |
| Type Name | CornerPLC2toEndStruct |
| Description | Structure used in the user interface type monitoring the communication between the corner PLC2 and end station  |
| Definition | STRUCT |
| Output Tag | Name: KeepAliveType: BOOLDescription:  |
| Output Tag | Name: RefCavTransErrorType: DWORDDescription: Reference cavity transmission error |
| Output Tag | Name: RefCavTransNormType: LREALDescription: Normal power level of the reference cavity transmission |
| Output Tag | Name: FiberLaunchTransErrorType: DWORDDescription: Fiber launch transmission error |
| Output Tag | Name: FiberLaunchTransNormType: LREALDescription: Normal power level of the fiber launch transmission |
| Output Tag | Name: FiberDistErrorType: BOOLDescription: Fiber distribution error |
| Output Tag | Name: GreenArmTransNormType: LREALDescription: Normal power level of the green arm transmission |
| Output Tag | Name: GreenArmTransPDErrorType: DWORDDescription: PD error monitoring the green arm transmission |
| Output Tag | Name: StateRequestType: ALSEndStateEnumDescription: Request the ALS end station state |

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| **User Interface Type**TYPE CornerPLC2Struct :STRUCT KeepAlive: BOOL; RedArmTransNorm: LREAL; RedArmTransError: DWROD: ALSEndState: ALSEndStateEnum; END\_STRUCT;END\_TYPE; |
| Type Name | CornerPLC1toCornerPLC2Strcut |
| Description | Structure used in the user interface type monitoring the corner PLC2  |
| Definition | STRUCT |
| Output Tag | Name: KeepAliveType: BOOLDescription:  |
| Output Tag | Name: RedArmTransNormType: LREALDescription: Normal power level of the red arm transmission |
| Output Tag | Name: RedArmTransErrorType: DWORDDescription: Error monitoring the red arm transmission |
| Output Tag | Name: ALSEndStateType: ALSEndStateEnumDescription: Request the ALS end station state |

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| **Function Block**TYPE ReceiveCornerPLC1toCornerPLC2FB:VAR\_INPUT Request: SaveRestoreEnum;END\_VAR;VAR\_IN\_OUT ALSCommunication: ALSCommunicationStruct; VarStruct; CornerPLC1toCornerPLC2Struct;END\_VAR:END\_TYPE; |
| Type Name | RecieveCornerPLC1toCornerPLC2FB |
| Description | Function block used to communicate between corner PLC1 and PLC2  |
| Definition | Function Block |
| Input Argument | Name: RequestType: SaveRestoreEnumDescription: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunicationType: ALSCommunicationStructDescription: User interface structure |
| In/out Argument | Name: VarStructType: CornerPLC1toCornerPLC2StructDescription: User interface structure |

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| **Function Block**TYPE ReceiveCornerPLC1toEndFB:VAR\_INPUT Request: SaveRestoreEnum;END\_VAR;VAR\_IN\_OUT ALSCommunication: ALSCommunicationStruct; VarStruct; CornerPLC1toEndStruct;END\_VAR:END\_TYPE; |
| Type Name | RecieveCornerPLC1toEndFB |
| Description | Function block used to communicate between corner PLC1 and end station  |
| Definition | Function Block |
| Input Argument | Name: RequestType: SaveRestoreEnumDescription: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunicationType: ALSCommunicationStructDescription: User interface structure |
| In/out Argument | Name: VarStructType: CornerPLC1toEndStructDescription: User interface structure |

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| **Function Block**TYPE ReceiveCornerPLC2toEndFB:VAR\_INPUT Request: SaveRestoreEnum;END\_VAR;VAR\_IN\_OUT ALSCommunication: ALSCommunicationStruct; VarStruct; CornerPLC2oEndStruct;END\_VAR:END\_TYPE; |
| Type Name | RecieveCornerPLC2toEndFB |
| Description | Function block used to communicate between corner PLC2 and end station  |
| Definition | Function Block |
| Input Argument | Name: RequestType: SaveRestoreEnumDescription: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunicationType: ALSCommunicationStructDescription: User interface structure |
| In/out Argument | Name: VarStructType: CornerPLC2toEndStructDescription: User interface structure |

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| **Function Block**TYPE ReceiveEndtoCornerPLC2FB:VAR\_INPUT Request: SaveRestoreEnum;END\_VAR;VAR\_IN\_OUT ALSCommunication: ALSCommunicationStruct; VarStruct; EndtoCornerPLC2Struct;END\_VAR:END\_TYPE; |
| Type Name | RecieveCornerPLC1toEndFB |
| Description | Function block used to communicate between corner PLC2 and end station  |
| Definition | Function Block |
| Input Argument | Name: RequestType: SaveRestoreEnumDescription: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunicationType: ALSCommunicationStructDescription: User interface structure |
| In/out Argument | Name: VarStructType: EndtoCornerPLC2StructDescription: User interface structure |

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| **Function Block**TYPE SendCornerPLC1toCornerPLC2FB:VAR\_INPUT Request: SaveRestoreEnum; DiffVCOFreq: LREAL; CommVCOFreq: LREAL; PSLVCOFreq: LREAL; FiberAOMFreq: LREAL; ExVCOFreq: LREAL; ExBeatFreq: LREAL; ExTimingError: DWORD; EyVCOFreq: LREAL; EyBeatFreq: LREAL; EyTimingError: DWORD;END\_VAR;VAR\_IN\_OUT ALSCommunication: ALSCommunicationStruct;END\_VAR;VAR\_OUTPUT VarStruct; CornerPLC1toEndStruct;END\_VAR:END\_TYPE; |
| Type Name | SendCornerPLC1toCornerPLC2FB |
| Description | Function block used to communicate between corner PLC1 and PLC2  |
| Definition | Function Block |
| Input Argument | Name: RequestType: SaveRestoreEnumDescription: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunicationType: ALSCommunicationStructDescription: User interface structure |
| Output Argument | Name: VarStructType: CornerPLC1toEndStructDescription: User interface structure |
| Input Argument | Name: DiffVCOFreqType: LREALDescription: Diff. VCO frequency |
| Input Argument | Name: CommVCOFreqType: LREALDescription: Comm. VCO frequency |
| Input Argument | Name: PSLVCOFreqType: LREALDescription: PSL VCO frequency |
| Input Argument | Name: FiberAOMFreqType: LREALDescription: Fiber AOM frequency |
| Input Argument | Name: TimingErrorType: LREALDescription: Monitors the timing error |
| Input Argument | Name: ExCOFreqType: LREALDescription: EX VCO frequency |
| Input Argument | Name: ExBeatFreqType: LREALDescription: EX beatn note frequency |
| Input Argument | Name: ExTimingErrorType: DWORDDescription: EX timing error monitor |
| Input Argument | Name: EyCOFreqType: LREALDescription: EY VCO frequency |
| Input Argument | Name: EyBeatFreqType: LREALDescription: EY beat note frequency |
| Input Argument | Name: EyTimingErrorType: DWORDDescription: EY timing error monitor |

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| **Function Block**TYPE SendCornerPLC1toEndFB:VAR\_INPUT Request: SaveRestoreEnum; VCOFreq: LREAL; BeatFreq: LREAL; TimingError: DWORD;END\_VAR;VAR\_IN\_OUT ALSCommunication: ALSCommunicationStruct;END\_VAR;VAR\_OUTPUT VarStruct; CornerPLC1toEndStruct;END\_VAR:END\_TYPE; |
| Type Name | SendCornerPLC1toEndFB |
| Description | Function block used to communicate between corner PLC1 and end station  |
| Definition | Function Block |
| Input Argument | Name: RequestType: SaveRestoreEnumDescription: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunicationType: ALSCommunicationStructDescription: User interface structure |
| Output Argument | Name: VarStructType: CornerPLC1toEndStructDescription: User interface structure |
| Input Argument | Name: VCOFreqType: LREALDescription: VCO frequency |
| Input Argument | Name: BeatFreqType: LREALDescription: Beat note frequency |
| Input Argument | Name: TimingErrorType: LREALDescription: Monitors the timing error |

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| **Function Block**TYPE SendCornerPLC2toEndFB:VAR\_INPUT Request: SaveRestoreEnum; GreenArmTransPD: DCPowerStruct; FiberDist: FiberDistributionStruct; ALSEndStateRequest: ALSEndStateEnum;END\_VAR;VAR\_IN\_OUT ALSCommunication: ALSCommunicationStruct;END\_VAR;VAR\_OUTPUT VarStruct; CornerPLC2toEndStruct;END\_VAR:END\_TYPE; |
| Type Name | SendCornerPLC2toEndFB |
| Description | Function block used to communicate between corner PLC2 and end station  |
| Definition | Function Block |
| Input Argument | Name: RequestType: SaveRestoreEnumDescription: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunicationType: ALSCommunicationStructDescription: User interface structure |
| Output Argument | Name: VarStructType: CornerPLC2toEndStructDescription: User interface structure |
| Input Argument | Name: GreenArmTransPDType: DCPowerStructDescription: User interface structure |
| Input Argument | Name: FiberDistType: FiberDistributionStructDescription: User interface structure |
| Input Argument | Name: ALEndStateRequestType: ALSEndStateEnumDescription: Request the state |

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| **Function Block**TYPE SendCornerPLC2FB:VAR\_INPUT Request: SaveRestoreEnum; RedArmTransPD: DCPowerStruct; ALSEndStateRequest: ALSEndStateEnum;END\_VAR;VAR\_IN\_OUT ALSCommunication: ALSCommunicationStruct;END\_VAR;VAR\_OUTPUT VarStruct; EndtoCornerPLC2Struct;END\_VAR:END\_TYPE; |
| Type Name | SendCornerPLC2FB |
| Description | Function block used to send information to corner PLC2 |
| Definition | Function Block |
| Input Argument | Name: RequestType: SaveRestoreEnumDescription: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunicationType: ALSCommunicationStructDescription: User interface structure |
| Output Argument | Name: VarStructType: EndtoCornerPLC2StructDescription: User interface structure |
| Input Argument | Name: RedArmTransPDType: DCPowerStructDescription: User interface structure |
| Input Argument | Name: ALEndStateRequestType: ALSEndStateEnumDescription: Request the state |