*LIGO Laboratory / LIGO Scientific Collaboration*

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Communication Library Documentation

Sheila Dwyer

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

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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 error  0x002 communication lost  16#002 — Corner Timing System  16#004 — EX Timing System  16#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: Error  Type: ErrorStruct  Description: 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: ALSCornerSafe  Description: Safe state |
| Element | Name: ALSCornerInvalidState  Description: 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: ALSEndSafe  Description: Safe state |
| Element | Name: ALSEndInvalidState  Description: Invalid state |
| Element | Name: ALSENDPLLDisengaged  Description: ALS END PLL is disengaged |
| Element | Name: ALSENDPLLAcquire  Description: ALS END PLL is acquiring lock |
| Element | Name: ALSENDPLLLocked  Description: ALS END PLL is locked |
| Element | Name: ALSENDREflAcquiring  Description: ALS END Refl is acquiring lock |
| Element | Name: ALSENDReflLockedSlowOff  Description: ALS END Refl is locked with slow off |
| Element | Name: ALSENDReflLockedSlowOn  Description: 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: KeepAlive  Type: BOOL  Description: |
| Output Tag | Name: DiffVCOFrequency  Type: LREAL  Description: Diff. VCO frequency |
| Output Tag | Name: CommVCOFrequency  Type: LREAL  Description: Comm. VCO frequency |
| Output Tag | Name: PSLVCOFrequency  Type: LREAL  Description: PSL VCO frequency |
| Output Tag | Name: FiberAOMFrequency  Type: LREAL  Description: Fiber AOM frequency |
| Output Tag | Name: TimingError  Type: LREAL  Description: Monitors the timing error |
| Output Tag | Name: ExCOFrequency  Type: LREAL  Description: EX VCO frequency |
| Output Tag | Name: ExBeatFrequency  Type: LREAL  Description: EX beatn note frequency |
| Output Tag | Name: ExTimingError  Type: DWORD  Description: EX timing error monitor |
| Output Tag | Name: EyCOFrequency  Type: LREAL  Description: EY VCO frequency |
| Output Tag | Name: EyBeatFrequency  Type: LREAL  Description: EY beat note frequency |
| Output Tag | Name: EyTimingError  Type: DWORD  Description: 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: KeepAlive  Type: BOOL  Description: |
| Output Tag | Name: VCOFrequency  Type: LREAL  Description: VCO frequency |
| Output Tag | Name: BeatFrequency  Type: LREAL  Description: Beat note frequency |
| Output Tag | Name: TimingError  Type: LREAL  Description: 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: KeepAlive  Type: BOOL  Description: |
| Output Tag | Name: RefCavTransError  Type: DWORD  Description: Reference cavity transmission error |
| Output Tag | Name: RefCavTransNorm  Type: LREAL  Description: Normal power level of the reference cavity transmission |
| Output Tag | Name: FiberLaunchTransError  Type: DWORD  Description: Fiber launch transmission error |
| Output Tag | Name: FiberLaunchTransNorm  Type: LREAL  Description: Normal power level of the fiber launch transmission |
| Output Tag | Name: FiberDistError  Type: BOOL  Description: Fiber distribution error |
| Output Tag | Name: GreenArmTransNorm  Type: LREAL  Description: Normal power level of the green arm transmission |
| Output Tag | Name: GreenArmTransPDError  Type: DWORD  Description: PD error monitoring the green arm transmission |
| Output Tag | Name: StateRequest  Type: ALSEndStateEnum  Description: 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: KeepAlive  Type: BOOL  Description: |
| Output Tag | Name: RedArmTransNorm  Type: LREAL  Description: Normal power level of the red arm transmission |
| Output Tag | Name: RedArmTransError  Type: DWORD  Description: Error monitoring the red arm transmission |
| Output Tag | Name: ALSEndState  Type: ALSEndStateEnum  Description: 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: Request  Type: SaveRestoreEnum  Description: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunication  Type: ALSCommunicationStruct  Description: User interface structure |
| In/out Argument | Name: VarStruct  Type: CornerPLC1toCornerPLC2Struct  Description: 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: Request  Type: SaveRestoreEnum  Description: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunication  Type: ALSCommunicationStruct  Description: User interface structure |
| In/out Argument | Name: VarStruct  Type: CornerPLC1toEndStruct  Description: 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: Request  Type: SaveRestoreEnum  Description: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunication  Type: ALSCommunicationStruct  Description: User interface structure |
| In/out Argument | Name: VarStruct  Type: CornerPLC2toEndStruct  Description: 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: Request  Type: SaveRestoreEnum  Description: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunication  Type: ALSCommunicationStruct  Description: User interface structure |
| In/out Argument | Name: VarStruct  Type: EndtoCornerPLC2Struct  Description: 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: Request  Type: SaveRestoreEnum  Description: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunication  Type: ALSCommunicationStruct  Description: User interface structure |
| Output Argument | Name: VarStruct  Type: CornerPLC1toEndStruct  Description: User interface structure |
| Input Argument | Name: DiffVCOFreq  Type: LREAL  Description: Diff. VCO frequency |
| Input Argument | Name: CommVCOFreq  Type: LREAL  Description: Comm. VCO frequency |
| Input Argument | Name: PSLVCOFreq  Type: LREAL  Description: PSL VCO frequency |
| Input Argument | Name: FiberAOMFreq  Type: LREAL  Description: Fiber AOM frequency |
| Input Argument | Name: TimingError  Type: LREAL  Description: Monitors the timing error |
| Input Argument | Name: ExCOFreq  Type: LREAL  Description: EX VCO frequency |
| Input Argument | Name: ExBeatFreq  Type: LREAL  Description: EX beatn note frequency |
| Input Argument | Name: ExTimingError  Type: DWORD  Description: EX timing error monitor |
| Input Argument | Name: EyCOFreq  Type: LREAL  Description: EY VCO frequency |
| Input Argument | Name: EyBeatFreq  Type: LREAL  Description: EY beat note frequency |
| Input Argument | Name: EyTimingError  Type: DWORD  Description: 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: Request  Type: SaveRestoreEnum  Description: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunication  Type: ALSCommunicationStruct  Description: User interface structure |
| Output Argument | Name: VarStruct  Type: CornerPLC1toEndStruct  Description: User interface structure |
| Input Argument | Name: VCOFreq  Type: LREAL  Description: VCO frequency |
| Input Argument | Name: BeatFreq  Type: LREAL  Description: Beat note frequency |
| Input Argument | Name: TimingError  Type: LREAL  Description: 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: Request  Type: SaveRestoreEnum  Description: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunication  Type: ALSCommunicationStruct  Description: User interface structure |
| Output Argument | Name: VarStruct  Type: CornerPLC2toEndStruct  Description: User interface structure |
| Input Argument | Name: GreenArmTransPD  Type: DCPowerStruct  Description: User interface structure |
| Input Argument | Name: FiberDist  Type: FiberDistributionStruct  Description: User interface structure |
| Input Argument | Name: ALEndStateRequest  Type: ALSEndStateEnum  Description: 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: Request  Type: SaveRestoreEnum  Description: Request save/restore/safemood or noop |
| In/out Argument | Name: ALSCommunication  Type: ALSCommunicationStruct  Description: User interface structure |
| Output Argument | Name: VarStruct  Type: EndtoCornerPLC2Struct  Description: User interface structure |
| Input Argument | Name: RedArmTransPD  Type: DCPowerStruct  Description: User interface structure |
| Input Argument | Name: ALEndStateRequest  Type: ALSEndStateEnum  Description: Request the state |