*LIGO Laboratory / LIGO Scientific Collaboration*

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TwinCAT Library   
for the Advanced LIGO Timing System

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Distribution of this document:

LIGO Scientific Collaboration

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of the LIGO Laboratory.

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| **Library** | |
| Title | TimingMasterFanout |
| Version | 1 |
| TwinCAT version | 2.11 |
| Name space | Timing |
| Author | Daniel Sigg |
| Description | The Advanced LIGO timing system consists of timing master synchronized to GPS with sixteen fanout ports, a set of timing fanout chassis and numerous timing slaves. The master and fanouts are the same same chassis configured differently. They contain serial RS422 ports which transmit the status information of the master-fanout chassis and each of its slave once every second. By reading the serial ports of all master-fanout chassis the health of the entire timing system can be monitored.  The Advanced LIGO timing system has a [wiki](https://awiki.ligo-wa.caltech.edu/aLIGO/Timing).  It is described in [E090003](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=483), [E080541](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=485), [E0900036](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=604), [T070173](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=95795) and [T0900032](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=459). |
| Error Codes | As part of the TimingMasterFanoutStruct (master-fanout chassis):  0x0001 – Communication error  0x0002 – Data CRC  0x0004 – Data missing  0x0008 – Loss-of-signal  0x0010 – Uplink  0x0020 – Uplink CRC  0x0040 – VCXO control voltage  0x0080 – OCXO not locked  0x0100 – OCXO control voltage  0x0200 – GPS not locked  0x0400 – GPS time error  0x0800 – External PPS time eror  0x1000 – Uplink time error  0x2000 – Firmware error (not in svn or wrong revision)  0xnnnn0000 – PORT\_i (bit encoded slave or port error)  As part of the TimingFanoutStruct (port and slave module):  0x0001 – Downlink loss-of-signal  0x0002 – Downlink down  0x0004 – Downlink CRC error  0x0008 – Delay error  0x0010 – Missing delay  0x0020 – Ignored slave  0x0040 – SLAVE (implicates a slave error)  As part of the TimingSlaveStruct (slave module):  0x0001 – Invalid or no data  0x0002 – Uplink loss-of-signal  0x0004 – Uplink down  0x0008 – Uplink CRC  0x0010 – VCXO control voltage  0x0020 – GPS time  0x0040 – Unknown slave  0x0080 – Firmware error (not in svn or wrong revision)  0x0100 – FANOUT (Indicates an error in the fanout slave)  0x0200 – DUOTONE (Indicates an error in the DuoTone slave)  0x0400 – CFC (Indicates an error in the CFC slave)  0x0800 – XOLOCKING (Indicates an error in the XOLOCKING slave)  0x1000 – IRIGB (Indicates an error in the IRIGB slave)  As part of the TimingSlaveFanoutStruct (through the port):  Not used at this time  As part of the TimingSlaveDuoToneStruct slave:  Not used at this time  As part of the TimingSlaveCFCStruct slave:  Not used at this time  As part of the TimingSlaveIrigBStruct slave:  Not used at this time  As part of the TimingSlaveXOLockingStruct slave:  Not used at this time |
| Library dependencies | SaveRestore, Error, ComlibV2 |

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| **Software Input/Output Type**  TYPE TimingSerialPortBufferStruct :  STRUCT  RxBuffer: ComBuffer;  TxBuffer: ComBuffer;  COMportControlError: BOOL;  COMportControlErrorID: ComError\_t;  END\_STRUCT  END\_TYPE | |
| Type name | TimingSerialPortBufferStruct |
| Description | This structure facilitates the communication between the serial ports and the MasterTimingFanoutFB function block.  The TimingSerialPortControlFB function block is used to communicate with the hardware. |
| Definition | STRUCT |
| Element | Name: RxBuffer  Type: ComBuffer  Description: Receive buffer of the serial port |
| Element | Name: TxBuffer  Type: ComBuffer  Description: Transmit buffer of the serial port |
| Element | Name: COMportControlError  Type: BOOL  Description: Communication error flag of the serial port hardware |
| Element | Name: COMportControlErrorID  Type: ComError\_t  Description: Communication error code |

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| **User Interface Type**  TYPE TimingMasterFanoutStruct :  STRUCT  Error: ErrorStruct;  Name: STRING;  ComErr: BOOL;  ComErrCount: INT;  CRCErr: BOOL;  CRCErrCount: INT;  ComMissing: BOOL;  ComMissCount: INT;  DownTime: UDINT;  ComCount: UDINT;  ComLength: UDINT;  BoardId: STRING(10);  BoardRev: INT;  Serial: UDINT;  CodeId: STRING(10);  CodeRev: UDINT;  GPS: UDINT;  Addr: UDINT;  StrAddr: STRING(24);  DIP: WORD;  IsMaster: BOOL;  HasFanout: BOOL;  FanoutPorts: INT;  HasOCXO: BOOL;  HasExtPPS: BOOL;  HasGPS: BOOL;  UseExt: BOOL;  UseGPS: BOOL;  UseUplink: BOOL;  GPSLocked: BOOL;  OCXOLocked: BOOL;  UplinkUp: BOOL;  UplinkLOS: BOOL;  UplinkErrCount: INT;  UplinkCRCErr: BOOL;  UplinkCRCErrCount: INT;  VCXOCtrl: LREAL;  OCXOCtrl: LREAL;  OCXOErr: LREAL;  UplinkDelay: LREAL;  ExtPPSDelay: LREAL;  TimingTolerance: LREAL;  GPSErr: BOOL;  GPSErrCount: INT;  GPSLatitude: LREAL;  GPSLongitude: LREAL;  GPSHeight: LREAL;  GPS3DSpeed: LREAL;  GPS2DSpeed: LREAL;  GPSHeading: LREAL;  GPSDOP: LREAL;  GPSVisSatellites: INT;  GPSTrackSatellites: INT;  GPSStatus: WORD;  GPSFix: STRING(25);  GPSNarrowband: BOOL;  GPSAntenna: BOOL;  GPSSerial: STRING(10);  FanoutUp: WORD;  FanoutLOS: WORD;  FanoutMissing: WORD;  FanoutDelayErr: WORD;  Port: ARRAY[0..15] OF TimingFanoutStruct;  Visual: STRING;  END\_STRUCT  END\_TYPE | |
| Type name | TimingMasterFanoutStruct |
| Description | This is the main user interface structure containing all releventa information of a master-fanout chassis and the slave modules attached to it. |
| Definition | STRUCT |
| Input Tag | Name: Error  Type:ErrorStruct  Description: Error handling |
| In/out Tag | Name: Name  Type: STRING  Description: Name/location of MFO unit |
| Input Tag | Name: ComErr  Type: BOOL  Description: Communication error flag |
| Input Tag | Name: ComErrCount  Type: INT  Description: Count of the communication errors |
| Input Tag | Name: CRCErr  Type: BOOL  Description: CRC error in data from MFO |
| Input Tag | Name: CRCErrCount  Type: INT  Description: CRC error counter |
| Input Tag | Name: ComMissing  Type: BOOL  Description: Communication missing |
| Input Tag | Name: ComMissCount  Type: INT  Description: Communication missing count |
| Input Tag | Name: DownTime  Type: UDINT  Description: Time since last valid communication |
| Input Tag | Name: ComCount  Type: UDINT  Description: Number of received communication buffers |
| Input Tag | Name: ComLength  Type: UDINT  Description: Number of received bytes(will overflow) |
| Input Tag | Name: BoardId  Type: STRING(10)  Description: Board type |
| Input Tag | Name: BoardRev  Type: INT  Description: Board revision number |
| Input Tag | Name: Serial  Type: UDINT  Description: Board serial number |
| Input Tag | Name: CodeId  Type: STRING(10)  Description: Code type |
| Input Tag | Name: CodeRev  Type: UDINT  Description: Code revision number |
| Input Tag | Name: GPS  Type: UDINT  Description: GPS time in sec |
| Input Tag | Name: Addr  Type: UDINT  Description: Board address |
| Input Tag | Name: StrAddr  Type: STRING(24)  Description: Board address as string |
| Input Tag | Name: DIP  Type: WORD  Description: DIP switch settings |
| Input Tag | Name: IsMaster  Type: BOOL  Description: This is a timing master |
| Input Tag | Name: HasFanout  Type: BOOL  Description: Fanout ports are available |
| Input Tag | Name: FanoutPorts  Type: INT  Description: Number of fanout ports |
| Input Tag | Name: HasOCXO  Type: BOOL  Description: Contains an OCXO |
| Input Tag | Name: HasExtPPS  Type: BOOL  Description: An external PPS is available |
| Input Tag | Name: HasGPS  Type: BOOL  Description: Has an internal GPS receiver |
| Input Tag | Name: UseExt  Type: BOOL  Description: Uses the external PPS for timing source |
| Input Tag | Name: UseGPS  Type: BOOL  Description: Uses the internal GPS for timing source |
| Input Tag | Name: UseUplink  Type: BOOL  Description: Uses the uplink for timing source |
| Input Tag | Name: GPSLocked  Type: BOOL  Description: GPS receiver is locked |
| Input Tag | Name: OCXOLocked  Type: BOOL  Description: OCXO is locked to timing source |
| Input Tag | Name: UplinkUp  Type: BOOL  Description: Uplink port is up and running |
| Input Tag | Name: UplinkLOS  Type: BOOL  Description: Loss of signal in uplink port |
| Input Tag | Name: UplinkErrCount  Type: INT  Description: Error counter for uplink port |
| Input Tag | Name: UplinkCRCErr  Type: BOOL  Description: CRC error in uplink data |
| Input Tag | Name: UplinkCRCErrCount  Type: INT  Description: CRC error counter for uplink data |
| Input Tag | Name: VCXOCtrl  Type: LREAL  Description: VCXO control voltage |
| Input Tag | Name: OCXOCtrl  Type: LREAL  Description: OCXO control voltage |
| Input Tag | Name: OCXOErr  Type: LREAL  Description: OCXO Error |
| Input Tag | Name: UplinkDelay  Type: LREAL  Description: Uplink delay in sec |
| Input Tag | Name: ExtPPSDelay  Type: LREAL  Description: Ext PPS delay in sec |
| Input Tag | Name: TimingTolerance  Type: LREAL  Description: Timing tolerance in sec |
| Input Tag | Name: GPSErr  Type: BOOL  Description: GPS error flag |
| Input Tag | Name: GPSErrCount  Type: INT  Description: Error counter for GPS errors |
| Input Tag | Name: GPSLatitude  Type: LREAL  Description: GPS latitude -90° to +90° |
| Input Tag | Name: GPSLongitude  Type: LREAL  Description: GPS longitude -180° to +180° |
| Input Tag | Name: GPSHeight  Type: LREAL  Description: GPS height -1000m to +18000m |
| Input Tag | Name: GPS3DSpeed  Type: LREAL  Description: GPS 3D speed 0m/s to 514m/s |
| Input Tag | Name: GPS2DSpeed  Type: LREAL  Description: GPS 2D speed 0m/s to 514m/s |
| Input Tag | Name: GPSHeading  Type: LREAL  Description: GPS heading 0° to 360° |
| Input Tag | Name: GPSDOP  Type: LREAL  Description: GPS dilution of precision 0 to 99.9 |
| Input Tag | Name: GPSVisSatellites  Type: INT  Description: Number of visible satellites |
| Input Tag | Name: GPSTrackSatellites  Type: INT  Description: Number of tracked satellites |
| Input Tag | Name: GPSStatus  Type: WORD  Description: GPS status |
| Input Tag | Name: GPSFix  Type: STRING(25)  Description: GPS fix message |
| Input Tag | Name: GPSNarrowband  Type: BOOL  Description: GPS in narrowband mode |
| Input Tag | Name: GPSAntenna  Type: BOOL  Description: GPS antenna OK |
| Input Tag | Name: GPSSerial  Type: STRING(10)  Description: GPS receiver serial number |
| Input Tag | Name: FanoutUp  Type: WORD  Description: Port up and running (bit encoded) |
| Input Tag | Name: FanoutLOS  Type: WORD  Description: Loss-of-signal in ports (bit encoded) |
| Input Tag | Name: FanoutMissing  Type: WORD  Description: Missing delay in ports (bit encoded) |
| Input Tag | Name: FanoutDelayErr  Type: WORD  Description: Delay error in port (bit encoded) |
| Mixed | Name: Port  Type: ARRAY[0..15] OF TimingFanoutStruct  Description: Array of port information (16 ports) |
| Input Tag | Name: Visual  Type: STRING  Description: Name of the uplink MFO visual |

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| **User Interface Subtype**  TYPE TimingFanoutStruct :  STRUCT  Error: ErrorStruct;  Active: BOOL;  DownTime: UDINT;  MeasuredDelay: LREAL;  MeasuredAdvance: LREAL;  UsedAdvance: LREAL;  Up: BOOL;  LOS: BOOL;  DelayErr: BOOL;  Missing: BOOL;  ErrCount: INT;  CRCErr: BOOL;  CRCErrCount: INT;  Slave: TimingSlaveStruct;  END\_STRUCT  END\_TYPE | |
| Type name | TimingFanoutStruct |
| Description | This structure describes a single port of the master-fanout chassis. It includes the both the port information itself as well as the slave information received through the port. |
| Definition | STRUCT |
| Input Tag | Name: Error  Type: ErrorStruct  Description: Error handler |
| In/Out Tag | Name: Active  Type: BOOL  Description: Port is actively used |
| Input Tag | Name: DownTime  Type: UDINT  Description: Port down time in sec |
| Input Tag | Name: MeasuredDelay  Type: LREAL  Description: Measured fiber round-trip delay in sec |
| Input Tag | Name: MeasuredAdvance  Type: LREAL  Description: Timing advance from measured delay |
| Input Tag | Name: UsedAdvance  Type: LREAL  Description: Used timing advance |
| Input Tag | Name: Up  Type: BOOL  Description: Port is up and running |
| Input Tag | Name: LOS  Type: BOOL  Description: Loss of signal in port |
| Input Tag | Name: DelayErr  Type: BOOL  Description: Delay error in port |
| Input Tag | Name: Missing  Type: BOOL  Description: Missing delay measurement in port |
| Input Tag | Name: ErrCount  Type: INT  Description: Error counter for port |
| Input Tag | Name: CRCErr  Type: BOOL  Description: CRC error in downlink data |
| Input Tag | Name: CRCErrCount  Type: INT  Description: CRC error counter for downlink data |
| In/Out Tag | Name: Slave  Type: TimingSlaveStruct  Description: Describes the slave information received by the port |

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| **User Interface Subtype**  TYPE TimingSlaveStruct :  STRUCT  Error: ErrorStruct;  Name: STRING;  IsFanout: BOOL;  IsDuotone: BOOL;  IsCFC: BOOL;  IsXOLocking: BOOL;  IsIRIGB: BOOL;  BoardId: STRING(10);  BoardRev: INT;  Serial: UDINT;  CodeId: STRING(10);  CodeRev: UDINT;  GPS: UDINT;  Addr: UDINT;  StrAddr: STRING(24);  DIP: WORD;  UplinkUp: BOOL;  UplinkLOS: BOOL;  UplinkErrCount: INT;  UplinkCRCErr: BOOL;  UplinkCRCErrCount: INT;  VCXOCtrl: LREAL;  Id: TimingSlaveEnum;  Generic: TimingSlaveGenericStruct;  Fanout: TimingSlaveFanoutStruct;  DuoTone: TimingSlaveDuoToneStruct;  CFC: TimingSlaveCfcStruct;  XOLock: TimingSlaveXoLockingStruct;  IRIGB: TimingSlaveIrigBStruct;  END\_STRUCT  END\_TYPE | |
| Type name | TimingSlaveStruct |
| Description | This structure describes a slave module. It contains information about a particular slave which is identified by the Id tag. All slaves use fill out the generic structure as well as the one corresponding to their type. Inappropriate slave structures are filled with zeroes. |
| Definition | STRUCT |
| Input Tag | Name: Error  Type: ErrorStruct  Description: Error handling |
| In/Out Tag | Name: Name  Type: STRING  Description: Name/location of MFO unit |
| Input Tag | Name: IsFanout  Type: BOOL  Description: This is a fanout chassis |
| Input Tag | Name: IsDuotone  Type: BOOL  Description: This is a DuoTone |
| Input Tag | Name: IsCFC  Type: BOOL  Description: This is a comparator/frequency counter |
| Input Tag | Name: IsXOLocking  Type: BOOL  Description: This is an RF source |
| Input Tag | Name: IsIRIGB  Type: BOOL  Description: This is an IRIG-B |
| Input Tag | Name: BoardId  Type: STRING(10)  Description: Board type |
| Input Tag | Name: BoardRev  Type: INT  Description: Board revision number |
| Input Tag | Name: Serial  Type: UDINT  Description: Board serial number |
| Input Tag | Name: CodeId  Type: STRING(10)  Description: Code type |
| Input Tag | Name: CodeRev  Type: UDINT  Description: Code revision number |
| Input Tag | Name: GPS  Type: UDINT  Description: GPS time in sec |
| Input Tag | Name: Addr  Type: UDINT  Description: Board address |
| Input Tag | Name: StrAddr  Type: STRING(24)  Description: Board address as string |
| Input Tag | Name: DIP  Type: WORD  Description: DIP settings |
| Input Tag | Name: UplinkUp  Type: BOOL  Description: Uplink port is up and running |
| Input Tag | Name: UplinkLOS  Type: BOOL  Description: Loss of signal in uplink port |
| Input Tag | Name: UplinkErrCount  Type: INT  Description: Error counter for uplink port |
| Input Tag | Name: UplinkCRCErr  Type: BOOL  Description: CRC error in uplink data |
| Input Tag | Name: UplinkCRCErrCount  Type: INT  Description: CRC error in uplink data |
| Input Tag | Name: VCXOCtrl  Type: LREAL  Description: VCXO control voltage |
| Input Tag | Name: Id  Type: TimingSlaveEnum  Description: Timing slave identifier |
| Input Tag | Name: Generic  Type: TimingSlaveGenericStruct  Description: Describes the slave payload (generic) |
| Input Tag | Name: Fanout  Type: TimingSlaveFanoutStruct  Description: Describes a fanout connected to the port |
| Input Tag | Name: DuoTone  Type: TimingSlaveDuoToneStruct  Description: Describes a DuoTone connected to the port |
| Input Tag | Name: CFC  Type: TimingSlaveCfcStruct  Description: Describes a comparator/frequency counter connected to the port |
| Input Tag | Name: XOLock  Type: TimingSlaveXoLockingStruct  Description: Describes an RF source connected to the port |
| Input Tag | Name: IRIGB  Type: TimingSlaveIrigBStruct  Description: Describes an IRIG-B connected to the port |

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| **User Interface Type**  TYPE TimingSlaveGenericStruct :  STRUCT  Payload: ARRAY[0..23] OF DWORD;  END\_STRUCT  END\_TYPE | |
| Type name | TimingSlaveGenericStruct |
| Description |  |
| Definition | STRUCT |
| Input Tag | Name: Payload  Type: ARRAY[0..23] OF DWORD  Description: Data from timing slave |

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| **User Interface Type**  TYPE TimingSlaveCfcStruct :  STRUCT  Error: ErrorStruct;  HasInput: DWORD;  TimeDiff: ARRAY[1..7] OF LREAL;  Frequency: ARRAY[1..6] OF LREAL;  END\_STRUCT  END\_TYPE | |
| Type name | TimingSlaveCfcStruct |
| Description | This structure describes a comparator/frequency counter slave module. |
| Definition | STRUCT |
| Input Tag | Name: Error  Type: ErrorStruct  Description: Error handling |
| Input Tag | Name: HasInput  Type: DWORD  Description: Active inputs (bit encoded) |
| Input Tag | Name: TimeDiff  Type: ARRAY[1..7] OF LREAL  Description: Comparator difference in sec |
| Input Tag | Name: Frequency  Type: ARRAY[1..6] OF LREAL  Description: Measured frequency |

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| **User Interface Type**  TYPE TimingSlaveDuoToneStruct :  STRUCT  Error: ErrorStruct;  END\_STRUCT  END\_TYPE | |
| Type name | TimingSlaveDuoToneStruct |
| Description | This structure describes a DuoTone slave module. |
| Definition | STRUCT |
| Input Tag | Name: Error  Type: ErrorStruct  Description: Error handling |

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| **User Interface Type**  TYPE TimingSlaveFanoutStruct :  STRUCT  Error: ErrorStruct;  IsMaster: BOOL;  HasFanout: BOOL;  FanoutPorts: INT;  HasOCXO: BOOL;  HasExtPPS: BOOL;  HasGPS: BOOL;  UseExt: BOOL;  UseGPS: BOOL;  UseUplink: BOOL;  GPSLocked: BOOL;  OCXOLocked: BOOL;  GPSErr: BOOL;  GPSErrCount: INT;  OCXOCtrl: LREAL;  OCXOErr: LREAL;  UplinkDelay: LREAL;  ExtPPSDelay: LREAL;  GPSDelay: LREAL;  FanoutUp: WORD;  FanoutLOS: WORD;  Missing: WORD;  DelayErr: WORD;  Visual: STRING;  END\_STRUCT  END\_TYPE | |
| Type name | TimingSlaveFanoutStruct |
| Description | This structure describes a fanout seen as a slave module through the port. |
| Definition | STRUCT |
| Input Tag | Name: Error  Type: ErrorStruct  Description: Error handling |
| Input Tag | Name: IsMaster  Type: BOOL  Description: This is a timing master |
| Input Tag | Name: HasFanout  Type: BOOL  Description: Fanout ports are available |
| Input Tag | Name: FanoutPorts  Type: INT  Description: Number of fanout ports |
| Input Tag | Name: HasOCXO  Type: BOOL  Description: Contains an OCXO |
| Input Tag | Name: HasExtPPS  Type: BOOL  Description: An external PPS is available |
| Input Tag | Name: HasGPS  Type: BOOL  Description: Has an internal GPS receiver |
| Input Tag | Name: UseExt  Type: BOOL  Description: Uses the external PPS for timing source |
| Input Tag | Name: UseGPS  Type: BOOL  Description: Uses the internal GPS for timing source |
| Input Tag | Name: UseUplink  Type: BOOL  Description: Uses the uplink for timing source |
| Input Tag | Name: GPSLocked  Type: BOOL  Description: GPS receiver is locked |
| Input Tag | Name: OCXOLocked  Type: BOOL  Description: OCXO is locked to timing source |
| Input Tag | Name: GPSErr  Type: BOOL  Description: GPS error flag |
| Input Tag | Name: GPSErrCount  Type: INT  Description: Error counter for GPS errors |
| Input Tag | Name: OCXOCtrl  Type: LREAL  Description: OCXO control voltage |
| Input Tag | Name: OCXOErr  Type: LREAL  Description: OCXO Error |
| Input Tag | Name: UplinkDelay  Type: LREAL  Description: Uplink delay in sec |
| Input Tag | Name: ExtPPSDelay  Type: LREAL  Description: Ext PPS delay in sec |
| Input Tag | Name: GPSDelay  Type: LREAL  Description: GPS delay in sec |
| Input Tag | Name: FanoutUp  Type: WORD  Description: Port up and running (bit encoded) |
| Input Tag | Name: FanoutLOS  Type: WORD  Description: Loss-of-signal in ports (bit encoded) |
| Input Tag | Name: Missing  Type: WORD  Description: Missing delay in ports (bit encoded) |
| Input Tag | Name: DelayErr  Type: WORD  Description: Delay error in port (bit encoded) |
| Input Tag | Name: Visual  Type: STRING  Description: Name of the MFO visual hooked up to the port |

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| **User Interface Type**  TYPE TimingSlaveIrigBStruct :  STRUCT  Error: ErrorStruct;  LeapSec: INT;  TimeZone: LREAL;  DST: BOOL;  LeapPend: BOOL;  LeapSub: BOOL;  IrigErrCountA: INT;  IrigDiffA: LREAL;  IrigErrCountB: INT;  IrigDiffB: LREAL;  IrigErrCountC: INT;  IrigDiffC: LREAL;  END\_STRUCT  END\_TYPE | |
| Type name | TimingSlaveIrigBStruct |
| Description | This structure describes a IRIG-B slave module. |
| Definition | STRUCT |
| Input Tag | Name: Error  Type: ErrorStruct  Description: Error handling |
| Input Tag | Name: LeapSec  Type: INT  Description: Number of leap second |
| Input Tag | Name: TimeZone  Type: LREAL  Description: Local time zone |
| Input Tag | Name: DST  Type: BOOL  Description: Daylight saving time |
| Input Tag | Name: LeapPend  Type: BOOL  Description: Leap second is pending |
| Input Tag | Name: LeapSub  Type: BOOL  Description: Leap second will be subtracted |
| Input Tag | Name: IrigErrCountA  Type: INT  Description: Error counter in channel A |
| Input Tag | Name: IrigDiffA  Type: LREAL  Description: IRIG-B time difference in channel A |
| Input Tag | Name: IrigErrCountB  Type: INT  Description: Error counter in channel B |
| Input Tag | Name: IrigDiffB  Type: LREAL  Description: IRIG-B time difference in channel B |
| Input Tag | Name: IrigErrCountC  Type: INT  Description: Error counter in channel C |
| Input Tag | Name: IrigDiffC  Type: LREAL  Description: IRIG-B time difference in channel C |

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| **User Interface Type**  TYPE TimingSlaveXoLockingStruct :  STRUCT  Error: ErrorStruct;  PresetFreq: LREAL;  MeasuredFreq: LREAL;  HasOCXO: BOOL;  OCXOLocked: BOOL;  OCXOCtrl: LREAL;  OCXOErr: LREAL;  END\_STRUCT  END\_TYPE | |
| Type name | TimngSlaveXoLockingStruct |
| Description | This structure describes an RF source slave module. |
| Definition | STRUCT |
| Input Tag | Name: Error  Type: ErrorStruct  Description: Error handling |
| Input Tag | Name: PresetFreq  Type: LREAL  Description: Preset frequency |
| Input Tag | Name: MeasuredFreq  Type: LREAL  Description: Measured frequency |
| Input Tag | Name: HasOCXO  Type: BOOL  Description: Contains an OCXO |
| Input Tag | Name: OCXOLocked  Type: BOOL  Description: OCXO is locked to timing source |
| Input Tag | Name: OCXOCtrl  Type: LREAL  Description: OCXO control voltage |
| Input Tag | Name: OCXOErr  Type: LREAL  Description: OCXO Error |

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| **Global constant**  TimingMagicString: STRING := 'LIGO TIMING SYSTEM VERSION 1.0$R$N'; | |
| Variable name | TimingMagicString |
| Type | STRING |
| Initialization | 'LIGO TIMING SYSTEM VERSION 1.0$R$N' |
| Description | Magic string which marks the beginning of a transmission from the timing master-fanout chassis through the serial port |

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| **Global constant**  TimingDataLen: DINT := 2308; | |
| Variable name | TimingDataLen |
| Type | DINT |
| Initialization | 2308 |
| Description | Length of data sent by the master fanout in bytes |

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| **Global constant**  TimingFanoutBoardId: DWORD := 16#070011; | |
| Variable name | TimingFanoutBoardId |
| Type | DWORD |
| Initialization | 16#070011 |
| Description | Identification of a master-fanout chassis |

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| **Global constant**  TimingSlaveBoardId: DWORD := 16#070071; | |
| Variable name | TimingSlaveBoardId |
| Type | DWORD |
| Initialization | 16#070071 |
| Description | Identification of a slave module |

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| **Global constant**  TimingSlaveDuoToneCodeId: DWORD := 16#080335; | |
| Variable name | TimingSlaveDuoToneCodeId |
| Type | DWORD |
| Initialization | 16#080335 |
| Description | Identification of a DuoTone slave |

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| **Global constant**  TimingSlaveCfcCodeId: DWORD := 16#070568; | |
| Variable name | TimingSlaveCfcCodeId |
| Type | DWORD |
| Initialization | 16#070568 |
| Description | Identification of a comparator/frequency counter slave |

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| **Global constant**  TimingSlaveXoLockingCodeId: DWORD := 16#080665; | |
| Variable name | TimingSlaveXoLockingCodeId |
| Type | DWORD |
| Initialization | 16#080665 |
| Description | Identification of an RF source slave |

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| **Global constant**  TimingSlaveIrigBCodeId: DWORD := 16#090305; | |
| Variable name | TimingSlaveIrigBCodeId |
| Type | DWORD |
| Initialization | 16#090305 |
| Description | Identification of an IRIG-B slave |

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| **Global constant**  TimingSlaveIrigBCode2Id: DWORD := 16#090030; | |
| Variable name | TimingSlaveIrigBCode2Id |
| Type | DWORD |
| Initialization | 16#090030 |
| Description | Wrong identification of an IRIG-B slave |

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| **Function Block**  FUNCTION\_BLOCK TimingMasterFanoutFB  VAR\_INPUT  Request: SaveRestoreEnum;  END\_VAR  VAR\_IN\_OUT  ComPortData: TimingSerialPortBufferStruct;  MFO: TimingMasterFanoutStruct;  MFOInit: TimingMasterFanoutStruct;  END\_VAR | |
| Name | TimingMasterFanoutFB |
| Description | Main function block to read the serial port information from the serial port and fill out the TimingMasterFanoutStruct.  This function block is called from the standard task running at 10ms update rate. |
| Input argument | Name: Request  Type: SaveRestoreEnum  Description: Request for save/restore/safemode or noop. |
| In/out argument | Name: ComPortData  Type: TimingSerialPortBufferStruct  Description: Serial port buffers |
| In/out argument | Name: MFO  Type: TimingMasterFanoutStruct  Description: User interface structure |
| In/out argument | Name: MFOInit  Type: TimingMasterFanoutStruct  Description: Save/restore variable in persistent memory |

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| **Function Block**  FUNCTION\_BLOCK TimingSerialPortControlFB  VAR\_INPUT  Mode: ComSerialLineMode\_t;  pComIn: POINTER TO ARRAY[0..65] OF BYTE;  pComOut: POINTER TO ARRAY[0..65] OF BYTE;  SizeComIn: UINT;  END\_VAR  VAR\_IN\_OUT  Com: TimingSerialPortBufferStruct;  END\_VAR | |
| Name | TimingSerialPortControlFB |
| Description | Main function block to communicate with the serial port hadrware.  This function block must be called from the fast task running at 1ms update rate. If not buffer overflows will occur. |
| Input argument | Name: Mode  Type: ComSerialLineMode\_t  Description: Should be set to SERIALLINEMODE\_EL6\_22B for EL6xxx EtherCAT terminals for serial ports |
| Input argument | Name: pComIn  Type: POINTER TO ARRAY[0..65] OF BYTE  Description: Input buffer of serial port. Should point to a EL6inData22B structure in the input memory region. |
| Input argument | Name: pComOut  Type: POINTER TO ARRAY[0..65] OF BYTE  Description: Output buffer of serial port. Should point to a EL6outData22B structure in the output memory region. |
| Input argument | Name: SizeComIn  Type: UINT  Description: Length of input and output buffers |
| In/out argument | Name: Com  Type: TimingSerialPortBufferStruct  Description: Serial port buffers |

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| **Program Example:**  (\* Global variables \*)  VAR\_GLOBAL  CdsTimingComPortDataM5: TimingSerialPortBufferStruct;  CdsTimingCOMinM5 AT %I\*: EL6inData22B;  CdsTimingCOMoutM5 AT %Q\*: EL6outData22B;  CdsTimingComPortM5: TimingSerialPortControlFB;  CdsTimingCMA\_AFB: TimingMasterFanoutFB;  END\_VAR  (\* Call from fast task with 1 ms update rate \*)  PROGRAM TimingFast  CdsTimingComPortM5 (  Mode := SERIALLINEMODE\_EL6\_22B,  pComIn := ADR (CdsTimingCOMinM5),  pComOut := ADR (CdsTimingCOMoutM5),  SizeComIn := SIZEOF (CdsTimingCOMinM5),  Com := CdsTimingComPortDataM5);  END\_PROGRAM  (\* Call from standard task with 10 ms update rate \*)  PROGRAM Timing  VAR  SaveRestore: SaveRestoreFB;  GotoSafe: BOOL;  Request: SaveRestoreEnum;  END\_VAR  SaveRestore( SaveInterval := T#1m,  GotoSafe := GotoSafe,  Request => Request );  CdsTimingCMA\_AFB (ComPortData := CdsTimingComPortDataM5,  MFO := H1.Cds.Timing.C.MA\_A,  Request := Request,  MFOInit := CdsTimingCMA\_AInit);  END\_PROGRAM |

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| **Visuals (master-fanout chassis)**  Master-fanout chassis with GPS receiver (timing master):  C:\Users\magzo\Hanford 2012\Slow Controls\TwinCAT\Library\Timing\Snapshots\SnapMaster.jpg  Master-fanout chassis without GPS receiver (timing fanout):  **SnapFanout.jpg** | |
| Name | TimingMasterFanoutVis |
| Description | This is the visual for the timing master-fanout chassis. At the bottom each fanout-put port is listed. They can be turned made active or inactive. A link to the visual of the slave module is also provided. The name of the master-fanout chassis can be chosen freely. |
| Placeholder | Name: MFO  Type: TimingMasterFanoutStruct  Description: Master-fanout information to be displayed. |

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| **Visuals (slave modules)**  Comparator/frequency counter:  C:\Users\magzo\Hanford 2012\Slow Controls\TwinCAT\Library\Timing\Snapshots\SnapSlaveCFC.jpg  DuoTone:  **C:\Users\magzo\Hanford 2012\Slow Controls\TwinCAT\Library\Timing\Snapshots\SnapSlaveDuoTone.jpg**  Fanout:C:\Users\magzo\Hanford 2012\Slow Controls\TwinCAT\Library\Timing\Snapshots\SnapSlaveFanout.jpg  IRIG-B:C:\Users\magzo\Hanford 2012\Slow Controls\TwinCAT\Library\Timing\Snapshots\SnapSlaveIrigB.jpg  RF source:  **C:\Users\magzo\Hanford 2012\Slow Controls\TwinCAT\Library\Timing\Snapshots\SnapSlaveXOLocking.jpg** | |
| Name | TimingSlaveVis |
| Description | This visual contains the information about a slave module. A link to the previous visual (master-fanout chassis) is also provided. The name of the slave module can be chosen freely. The fanout slave interface also provides a link to the visual of the actual master-fanout chassis hooked up to this port. |
| Placeholder | Name: Port  Type: TimingFanoutStruct  Description: Port and slave information to be displayed. |