



LIGO Laboratory / LIGO Scientific Collaboration

LIGO-E1200784-v2

Advanced LIGO

4/3/2015

TwinCAT Library
for the Advanced LIGO Timing System

Maggie Tse, Daniel Sigg

Distribution of this document:
LIGO Scientific Collaboration

This is an internal working note
of the LIGO Laboratory.

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

<http://www.ligo.caltech.edu/>

Library	
Title	TimingMasterFanout
Version	1
TwinCAT version	2.11
Name space	Timing
Author	Daniel Sigg
Description	<p>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.</p> <p>The Advanced LIGO timing system has a wiki. It is described in E090003, E080541, E0900036, T070173 and T0900032.</p>
Error Codes	<p>As part of the TimingMasterFanoutStruct (master-fanout chassis):</p> <ul style="list-style-type: none"> 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 error 0x1000 – Uplink time error 0x2000 – Firmware error (not in svn or wrong revision) 0xn timer 0000 – PORT_i (bit encoded slave or port error) <p>As part of the TimingFanoutStruct (port and slave module):</p> <ul style="list-style-type: none"> 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)

	<p>As part of the TimingSlaveStruct (slave module):</p> <ul style="list-style-type: none"> 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) <p>As part of the TimingSlaveFanoutStruct (through the port):</p> <p>Not used at this time</p> <p>As part of the TimingSlaveDuoToneStruct slave:</p> <p>Not used at this time</p> <p>As part of the TimingSlaveCFCStruct slave:</p> <p>Not used at this time</p> <p>As part of the TimingSlaveIrigBStruct slave:</p> <p>Not used at this time</p> <p>As part of the TimingSlaveXOLockingStruct slave:</p> <p>Not used at this time</p>
Library dependencies	SaveRestore, Error, ComlibV2

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

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

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

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

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

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

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

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

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

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

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

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 hardware. 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 SERIALLINE_MODE_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

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 := SERIALLINE_MODE_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
```

Visuals (master-fanout chassis)

Master-fanout chassis with GPS receiver (timing master):

Board ID	Rev	Serial	Code ID	Rev	GPS	Address
070011	1	0	080534A0	68	1029533060	0

MSR Master A

Com Err		Is Master	
Count	2219	Has Fanout	
CRC Err		Fanout Ports	16
Count	0	Has OCXO	
Com Missing		Has External PPS	
Count	2219	Has GPS	
Down Time		Use External PPS	
Count	0 s	Use GPS	
Com Count		Use Uplink	
Count	249903	GPS Locked	
Com Length		OCXO Locked	
Count	584773020		
DIP		0x00FF	

VcxO Control	2.333V
OCXO Control	1.216V
OCXO Error	0.000000007 s
Uplink Delay	0.000000000 s
External PPS Delay	0.000000000 s
GPS Delay	0.000000007 s
Timing Tolerance	0.000001000 s

Uplink Up	
Uplink LOS	
Uplink Error Count	15
Uplink CRC Errors	214

Fanouts

Click number to activate visualization

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
UP	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LOS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Missing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Delay Err	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Visual	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Master

GPS

GPSError	
Count	0
GPS Latitude	
Count	46.4549 °
GPS Longitude	
Count	-119.4074 °
GPS Height	
Count	169.9 m
GPS 3D Speed	
Count	0.100 m/s
GPS 2D Speed	
Count	0.030 m/s
GPS Heading	
Count	323.300 °
GPS DOP	
Count	0.3
Visible Satellites	
Count	7
Tracked Satellites	
Count	7
GPS Status	
Count	0xE001
GPS Fix	
Count	3D Fix
GPS Narrowband	
GPS Antenna	
GPS Serial	
Count	JQ4064

Previous MFO Visual

Error	0
-------	---

Master-fanout chassis without GPS receiver (timing fanout):

Board ID	Rev	Serial	Code ID	Rev	GPS	Address
070011	1	0	080534A0	68	1029533213	0.15

H2 EY FANOUT A

<p>Com Err</p> <p>Count: 2219</p> <p>CRC Err</p> <p>Count: 0</p> <p>Com Missing</p> <p>Count: 2219</p> <p>Down Time: 0 s</p> <p>Com Count: 250056</p> <p>Com Length: 585131040</p> <p>DIP: 0x00FF</p>	<p>Is Master</p> <p>HasFanout: </p> <p>FanoutPorts: 16</p> <p>Has OCXO</p> <p>Has External PPS</p> <p>Has GPS</p> <p>Use External PPS</p> <p>Use GPS</p> <p>Use Uplink: </p> <p>GPS Locked</p> <p>OCXO Locked</p>	<p>VCXO Control: -0.000 V</p> <p>OCXO Control: 0.000 V</p> <p>OCXO Error: 0.000000000 s</p> <p>Uplink Delay: 0.000000030 s</p> <p>External PPS Delay: 0.000000000 s</p> <p>GPS Delay: 0.000000000 s</p> <p>Timing Tolerance: 0.000001000 s</p> <p>Uplink Up: </p> <p>Uplink LOS</p> <p>Uplink Error Count: 0</p> <p>Uplink CRC Errors: 11</p>
--	--	--

Fanouts

Click number to activate visualization

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
UP	●	●	●	●	●	○	○	●	●	●	○	●	○	○	○	○
LOS	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Missing	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Delay Err	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Visual	D	D	D	D	I	D		X	X	C		D				

Error: 0

Previous MFO Visual

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.

Visuals (slave modules)

Comparator/frequency counter:

Board ID	Rev	Serial	Code ID	Rev	Id	GPS	Address
070071	1	0	070568E0	84	PARATOR_FREQCOUN	1029533822	0.15.9

Uplink Up **Uplink LOS**

Uplink Error Count: 0

Uplink CRC Errors: 12

VCXO Control: 2.330 V

DIP: 0x00FF

CFC

Has Input: ●●●●●●●●●●●●●●●● ●●●●●●●●●●●●●●●●

Time Difference:

Frequency:

Error 0

Port

Active

Downtime: 0 s

Up **Delay**

LOS **Missing**

Error Count: 215

Return CRC Error

Count: 0

Measured Delay: 0.000000067 s

Measured Advance: 0.000000034 s

Used Advance: 0.000000030 s

Previous Visual

Error 0

DuoTone:

Board ID	Rev	Serial	Code ID	Rev	Id	GPS	Address
070071	1	0	080335B0	0	DUOTONE	1029533481	0.15.0

Uplink Up **Uplink LOS**

Uplink Error Count: 0

Uplink CRC Errors: 156

VCXO Control: 2.353 V

DIP: 0x02FF

Duotone

Error 0

Port

Active

Downtime: 0 s

Up **Delay**

LOS **Missing**

Error Count: 24

Return CRC Error

Count: 1

Measured Delay: 0.000000142 s

Measured Advance: 0.000000071 s

Used Advance: 0.000000075 s

Previous Visual

Error 0

Fanout:

Board ID	Rev	Serial	Code ID	Rev	Id	GPS	Address
070011	1	0	080534A0	68	FANOUT	1029533877	0.3

Uplink Up | Uplink LOS

Uplink Error Count: 0

Uplink CRC Errors: 7

VCXO Control: 2.415 V

DIP: 0x00FF

Fanout VISTIMINGYFO_A

Previous Visual

Error: 0

Fanout

Is Master | Use PPS | GPS Error

Has OCXO | Use GPS | Count: 5

Has Ext PPS | **Use Uplink** | OCXO Control: 0.031 V

Has GPS | GPS Locked | OCXO Error: -0.000000015 s

Has Fanout | **OCXO Locked** | Uplink Delay: 0.000000030 s

Fanout Ports: 16 | PPS Delay: 0.320386566 s

GPS Delay: -0.000000015 s

Fanouts

Up | LOS | Missing | Delay Error

Error: 0

Port

Active

Downtime: 0 s

Up | Delay

LOS | Missing

Error Count: 81

Return CRC Error

Count: 6

Measured Delay: 0.000000961 s

Measured Advance: 0.000000481 s

Used Advance: 0.000000477 s

IRIG-B:

Board ID	Rev	Serial	Code ID	Rev	Id	GPS	Address
070071	1	0	0900305A	133	IRIGB	1029533560	0.15.4

Uplink Up | Uplink LOS

Uplink Error Count: 0

Uplink CRC Errors: 16

VCXO Control: 2.424 V

DIP: 0x02FF

Previous Visual

Error: 0

IRIG-B

Leap Seconds: 15 sec | IRIG-B Input A

Time Zone: -8.0 h | Error Count: 100

DST | Time Difference: 0.000000 s

Leap Pending | IRIG-B Input B

Leap Subtraction | Error Count: 100

Time Difference: 0.000000 s

IRIG-B Input C

Error Count: 100

Time Difference: 0.000000 s

Error: 0

Port

Active

Downtime: 0 s

Up | Delay

LOS | Missing

Error Count: 26

Return CRC Error

Count: 151

Measured Delay: 0.000000246 s

Measured Advance: 0.000000123 s

Used Advance: 0.000000119 s

RF source:

Board ID	Rev	Serial	Code ID	Rev	Id	GPS	Address
070071	1	0	080665A0	83	XOLOCKING	1029533779	0.15.7

EY OCXO 24.5MHz	XOLocking	Port																																										
<table border="1"> <tr> <td>Uplink Up</td> <td>Uplink LOS</td> </tr> <tr> <td>Uplink Error Count</td> <td>0</td> </tr> <tr> <td>Uplink CRC Errors</td> <td>16</td> </tr> <tr> <td>VCXO Control</td> <td>2.392 V</td> </tr> <tr> <td>DIP</td> <td>0x02FF</td> </tr> </table>	Uplink Up	Uplink LOS	Uplink Error Count	0	Uplink CRC Errors	16	VCXO Control	2.392 V	DIP	0x02FF	<table border="1"> <tr> <td>Preset Frequency</td> <td>24515730 Hz</td> </tr> <tr> <td>Measured Frequency</td> <td>24515730 Hz</td> </tr> <tr> <td>Has OCXO</td> <td></td> </tr> <tr> <td>OCXO Locked</td> <td></td> </tr> <tr> <td>OCXO Control</td> <td>-5.107 V</td> </tr> <tr> <td>OCXO Error</td> <td>0.000000022 s</td> </tr> </table>	Preset Frequency	24515730 Hz	Measured Frequency	24515730 Hz	Has OCXO		OCXO Locked		OCXO Control	-5.107 V	OCXO Error	0.000000022 s	<table border="1"> <tr> <td>Active</td> <td></td> </tr> <tr> <td>Downtime</td> <td>0 s</td> </tr> <tr> <td>Up</td> <td>Delay</td> </tr> <tr> <td>LOS</td> <td>Missing</td> </tr> <tr> <td>Error Count</td> <td>42</td> </tr> <tr> <td>Return CRC Error</td> <td></td> </tr> <tr> <td>Count</td> <td>146</td> </tr> <tr> <td>Measured Delay</td> <td>0.000000082 s</td> </tr> <tr> <td>Measured Advance</td> <td>0.000000041 s</td> </tr> <tr> <td>Used Advance</td> <td>0.000000045 s</td> </tr> </table>	Active		Downtime	0 s	Up	Delay	LOS	Missing	Error Count	42	Return CRC Error		Count	146	Measured Delay	0.000000082 s	Measured Advance	0.000000041 s	Used Advance	0.000000045 s
Uplink Up	Uplink LOS																																											
Uplink Error Count	0																																											
Uplink CRC Errors	16																																											
VCXO Control	2.392 V																																											
DIP	0x02FF																																											
Preset Frequency	24515730 Hz																																											
Measured Frequency	24515730 Hz																																											
Has OCXO																																												
OCXO Locked																																												
OCXO Control	-5.107 V																																											
OCXO Error	0.000000022 s																																											
Active																																												
Downtime	0 s																																											
Up	Delay																																											
LOS	Missing																																											
Error Count	42																																											
Return CRC Error																																												
Count	146																																											
Measured Delay	0.000000082 s																																											
Measured Advance	0.000000041 s																																											
Used Advance	0.000000045 s																																											
<table border="1"> <tr> <td>Previous Visual</td> <td></td> </tr> <tr> <td>Error</td> <td>0</td> </tr> </table>	Previous Visual		Error	0	<table border="1"> <tr> <td>Error</td> <td>0</td> </tr> </table>	Error	0																																					
Previous Visual																																												
Error	0																																											
Error	0																																											

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.