



LIGO Laboratory / LIGO Scientific Collaboration

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TwinCAT Library for GPS Receivers

Daniel Sigg

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This is an internal working note
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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

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

Library	
Title	GpsInterface
Version	1
TwinCAT version	V2.11.0
Name space	
Author	Daniel Sigg
Description	Monitors the Trimble GPS
Error Code	16#01 — Serial link down 16#02 — Data not valid 16#04 — Waiting for GPS lock 16#08 — GPS initialization error 16#10 — GPS configuration error
Library Dependencies	Error, SaveRestore, COMlibV2

User Interface Type TYPE TimeTypeEnum : (TimeTypeGPS, TimeTypeUTC); END_TYPE	
Type Name	TimeTypeEnum
Description	Enumerated type for describing the time scale
Definition	Enum
Field	Name: TimeTypeGPS Description: GPS time scale (no leap seconds)
Field	Name: TimeTypeUTC Description: UTC time scale (includes leap seconds)

User Interface Type TYPE GpsTrimbleReceiverModeEnum : (GpsTrimbleReceiverModeInvalid, GpsTrimbleReceiverModeAutomatic, GpsTrimbleReceiverModeSingleSattelite, GpsTrimbleReceiverModeHorizontal, GpsTrimbleReceiverModeFullPosition, GpsTrimbleReceiverModeOverDeterminedClock); END_TYPE	
Type Name	GpsTrimbleReceiverModeEnum
Description	Enumerated type for describing the receiver operating mode
Definition	Enum
Field	Name: GpsTrimbleReceiverModeInvalid Description: Invalid
Field	Name: GpsTrimbleReceiverModeAutomatic Description: Automatic (2D/3D)
Field	Name: GpsTrimbleReceiverModeSingleSattelite Description: Single Satellite (Time)
Field	Name: GpsTrimbleReceiverModeHorizontal Description: Horizontal (2D)
Field	Name: GpsTrimbleReceiverModeFullPosition Description: Full Position (3D)
Field	Name: GpsTrimbleReceiverModeOverDeterminedClock Description: Over-Determined Clock (Timing)

User Interface Type	
TYPE GpsTrimbleDiscipliningModeEnum : (GpsTrimbleDiscipliningModeInvalid, GpsTrimbleDiscipliningModeNormal, GpsTrimbleDiscipliningModePowerUp, GpsTrimbleDiscipliningModeAutoHoldover, GpsTrimbleDiscipliningModeManualHoldover, GpsTrimbleDiscipliningModeRecovery, GpsTrimbleDiscipliningModeDisabled); END_TYPE	
Type Name	GpsTrimbleDiscipliningModeEnum
Description	Enumerated type for describing the clock disciplining mode
Definition	Enum
Field	Name: GpsTrimbleDiscipliningModeInvalid Description: Invalid
Field	Name: GpsTrimbleDiscipliningModeNormal Description: Normal (Locked to GPS)
Field	Name: GpsTrimbleDiscipliningModePowerUp Description: Power Up
Field	Name: GpsTrimbleDiscipliningModeAutoHoldover Description: Auto Holdover
Field	Name: GpsTrimbleDiscipliningModeManualHoldover Description: Manual Holdover
Field	Name: GpsTrimbleDiscipliningModeRecovery Description: Recovery
Field	Name: GpsTrimbleDiscipliningModeDisabled Description: Disciplining Disabled

User Interface Type	
TYPE GpsTrimbleDecodingStatusEnum : (GpsTrimbleDecodingStatusInvalid, GpsTrimbleDecodingStatusDoingFixes, GpsTrimbleDecodingStatusNoGpsTime, GpsTrimbleDecodingStatusPDOPTooHigh, GpsTrimbleDecodingStatusNoSattelites, GpsTrimbleDecodingStatusOnly1Sattelite, GpsTrimbleDecodingStatusOnly2Sattelites, GpsTrimbleDecodingStatusOnly3Sattelites, GpsTrimbleDecodingStatusSatteliteUnusable, GpsTrimbleDecodingStatusTRAIMRejectFix); END_TYPE	
Type Name	GpsTrimbleDecodingStatusEnum
Description	Enumerated type for describing the decoding status of the GPS receiver
Definition	Enum
Field	Name: GpsTrimbleDecodingStatusInvalid Description: Invalid
Field	Name: GpsTrimbleDecodingStatusDoingFixes Description: Doing fixes
Field	Name: GpsTrimbleDecodingStatusNoGpsTime Description: Don't have GPS time
Field	Name: GpsTrimbleDecodingStatusPDOPTooHigh Description: PDOP is too high
Field	Name: GpsTrimbleDecodingStatusNoSattelites Description: No usable sats
Field	Name: GpsTrimbleDecodingStatusOnly1Sattelite Description: Only 1 usable sat
Field	Name: GpsTrimbleDecodingStatusOnly2Sattelites Description: Only 2 usable sats
Field	Name: GpsTrimbleDecodingStatusOnly3Sattelites Description: Only 3 usable sats
Field	Name: GpsTrimbleDecodingStatusSatteliteUnusable Description: The chosen sat is unusable
Field	Name: GpsTrimbleDecodingStatusTRAIMRejectFix Description: TRAIM rejected the fix

User Interface Type	
TYPE GpsTrimbleDiscipliningActivityEnum : (GpsTrimbleDiscipliningActivityInvalid, GpsTrimbleDiscipliningActivityPhaseLocking, GpsTrimbleDiscipliningActivityOscWarmUp, GpsTrimbleDiscipliningActivityFreqLocking, GpsTrimbleDiscipliningActivityPlacingPPS, GpsTrimbleDiscipliningActivityInitLoopFilter, GpsTrimbleDiscipliningActivityHoldover, GpsTrimbleDiscipliningActivityInactive, GpsTrimbleDiscipliningActivityRecovery, GpsTrimbleDiscipliningActivityCalibration); END_TYPE	
Type Name	GpsTrimbleDiscipliningActivityEnum
Description	Enumerated type for describing the current activity of the disciplining mechanism
Definition	Enum
Field	Name: GpsTrimbleDiscipliningActivityInvalid Description: Invalid
Field	Name: GpsTrimbleDiscipliningActivityPhaseLocking Description: Phase locking
Field	Name: GpsTrimbleDiscipliningActivityOscWarmUp Description: Oscillator warm-up
Field	Name: GpsTrimbleDiscipliningActivityFreqLocking Description: Frequency locking
Field	Name: GpsTrimbleDiscipliningActivityPlacingPPS Description: Placing PPS
Field	Name: GpsTrimbleDiscipliningActivityInitLoopFilter Description: Initializing loop filter
Field	Name: GpsTrimbleDiscipliningActivityHoldover Description: Compensating OCXO (holdover)
Field	Name: GpsTrimbleDiscipliningActivityInactive Description: Inactive
Field	Name: GpsTrimbleDiscipliningActivityRecovery Description: Recovery mode
Field	Name: GpsTrimbleDiscipliningActivityCalibration Description: Calibration/control voltage

User Interface Type

TYPE GpsTrimbleStruct :

STRUCT

Error:	ErrorStruct;
Model:	STRING(80);
Gps:	UDINT;
Tow:	UDINT;
Week:	UDINT;
Leap:	INT;
TimeSource:	TimeTypeEnum;
PPSSource:	TimeTypeEnum;
TimeValid:	BOOL;
UtcOffset:	BOOL;
TestMode:	BOOL;
Year:	UINT;
Month:	UINT;
Day:	UINT;
Hour:	UINT;
Minute:	UINT;
Second:	UINT;
ReceiverMode:	GpsTrimbleReceiverModeEnum;
DiscipliningMode:	GpsTrimbleDiscipliningModeEnum;
SurveyProgress:	UINT;
HoldoverDuration:	UDINT;
DacAtRail:	BOOL;
DacNearRail:	BOOL;
AntennaOpen:	BOOL;
AntennaShorted:	BOOL;
NotTrackingSattelites:	BOOL;
NotDiscipliningOscillator:	BOOL;
SurveyInProgress:	BOOL;
NoStoredPosition:	BOOL;
LeapSecondPending:	BOOL;
InTestMode:	BOOL;
PositionQuestionable:	BOOL;
AlmanacIncomplete:	BOOL;
NoPPS:	BOOL;
DecodingStatus:	GpsTrimbleDecodingStatusEnum;
DiscipliningActivity:	GpsTrimbleDiscipliningActivityEnum;
PPSOffset:	LREAL;
ClockOffset:	LREAL;
DACValue:	UDINT;

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DACVoltage: LREAL; Temperature: LREAL; Latitude: LREAL; Longitude: LREAL; Altitude: LREAL; PPSQuantizationError: LREAL; END_STRUCT END_TYPE	
Type Name	GpsTrimbleStruct
Description	Structure used in the user interface for a Trimble GPS device
Definition	STRUCT
Ouput Tag	Name: Error Type: ErroStruct Description: Set by the error handler
Ouput Tag	Name: Model Type: STRING(80) Description: Name of GPS model
Ouput Tag	Name: Gps Type: UDINT Description: GPS time in seconds
Ouput Tag	Name: Tow Type: UDINT Description: Time of week in seconds
Ouput Tag	Name: Week Type: UDINT Description: Weeks since January 6, 1980
Ouput Tag	Name: Leap Type: INT Description: Number of leap seconds
Ouput Tag	Name: TimeSource Type: TimeTypeEnum Description: Time scale (UTC includes leap sec)
Ouput Tag	Name: PPSSource Type: TimeTypeEnum Description: Alignment of 1 PPS signal
Ouput Tag	Name: TimeValid Type: BOOL Description: Time has been set from GPS receiver
Ouput Tag	Name: UtcOffset Type: BOOL

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	Description: Leap seconds are valid
Ouput Tag	Name: TestMode Type: BOOL Description: Unit is in test mode
Ouput Tag	Name: Year Type: UINT Description: Year (4 digits)
Ouput Tag	Name: Month Type: UINT Description: Month (1-12)
Ouput Tag	Name: Day Type: UINT Description: Day (1-31)
Ouput Tag	Name: Hour Type: UINT Description: Hours (0-23)
Ouput Tag	Name: Minute Type: UINT Description: Minutes (0-59)
Ouput Tag	Name: Second Type: UINT Description: Second (0-59)
Ouput Tag	Name: ReceiverMode Type: GpsTrimbleReceiverModeEnum Description: Current receiver mode
Ouput Tag	Name: DiscipliningMode Type: GpsTrimbleDiscipliningModeEnum Description: Oscillator disciplining mode
Ouput Tag	Name: SurveyProgress Type: UINT Description: Survey progress in percent
Ouput Tag	Name: HoldoverDuration Type: UDINT Description: Time ins sec spend in holdover mode
Ouput Tag	Name: DacAtRail Type: BOOL Description: Critical error: DAC at rail
Ouput Tag	Name: DacNearRail Type: BOOL Description: Warning: DAC near rail

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Ouput Tag	Name: AntennaOpen Type: BOOL Description: Warning: Antenna cable open
Ouput Tag	Name: AntennaShorted Type: BOOL Description: Warning: Antenna cable shorted
Ouput Tag	Name: NotTrackingSattelites Type: BOOL Description: Warning: Not tracking sattelites
Ouput Tag	Name: NotDiscipliningOscillator Type: BOOL Description: Warning: No XO disciplining
Ouput Tag	Name: SurveyInProgress Type: BOOL Description: Warning: Survey in progres
Ouput Tag	Name: NoStoredPosition Type: BOOL Description: Warning: No stored position
Ouput Tag	Name: LeapSecondPending Type: BOOL Description: Warning: Leap second pending
Ouput Tag	Name: InTestMode Type: BOOL Description: Warning: GPS in test mode
Ouput Tag	Name: PositionQuestionable Type: BOOL Description: Warning: Position questionable
Ouput Tag	Name: AlmanacIncomplete Type: BOOL Description: Warning: Almanac incomplete
Ouput Tag	Name: NoPPS Type: BOOL Description: Warning: No 1PPS signa
Ouput Tag	Name: DecodingStatus Type: GpsTrimbleDecodingStatusEnum Description: Decoding status
Ouput Tag	Name: DiscipliningActivity Type: GpsTrimbleDiscipliningActivityEnum Description: Disciplining activity

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Ouput Tag	Name: PPSOffset Type: LREAL Description: PPS offset in ns
Ouput Tag	Name: ClockOffset Type: LREAL Description: Clock offset in ppb
Ouput Tag	Name: DACValue Type: UDINT Description: DAC value (bits)
Ouput Tag	Name: DACVoltage Type: LREAL Description: DAC value in Volts
Ouput Tag	Name: Temperature Type: LREAL Description: Temperature in °C
Ouput Tag	Name: Latitude Type: LREAL Description: GPS latitude -90° to +90°
Ouput Tag	Name: Longitude Type: LREAL Description: GPS longitude -180° to +180°
Ouput Tag	Name: Altitude Type: LREAL Description: GPS height -1000m to +18000m
Ouput Tag	Name: PPSQuantizationError Type: LREAL Description: PPS quantization error in ns

Function Block FUNCTION_BLOCK GpsTrimbleFB VAR_INPUT Request: SaveRestoreEnum; END_VAR VAR_OUTPUT END_VAR VAR_IN_OUT Gps: GpsTrimbleStruct; (* User interface structure *) GpsInit: GpsTrimbleStruct; (* User interface save/restore data *) ComPortData: GpsSerialPortBufferStruct;(* Receive and transmit buffers *) END_VAR	
Type Name	GpsTrimbleFB
Description	Function block used to interface a Trimble Thunderbolt E GPS device through a serial cable
Definition	Function Block
Input Argument	Name: Request Type: SaveRestoreEnum Description: Request for save/restore/safe mode or noop
In/out Argument	Name: Gps Type: GpsTrimbleStruct Description: User interface structure
In/out Argument	Name: GpsInit Type: GpsTrimbleStruct Description: Save/restore variable in persistent memory
In/out Argument	Name: ComPortData Type: GpsSerialPortBufferStruct Description: Serial port buffers

Function Block FUNCTION_BLOCK GpsSerialPortControlFB 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_OUTPUT END_VAR VAR_IN_OUT Com: GpsSerialPortBufferStruct; END_VAR	
Type Name	GpsSerialPortControlFB
Description	Function block used to read the serial interface for a GPS device
Definition	Function Block
Input Argument	Name: Mode Type: ComSerialLineMode_t Description: Serial port decription (check COMlibV2 doc)
Input Argument	Name: pComIn: Type: POINTER TO ARRY [0..65] OF BYTE Description: pointer to input buffer of serial terminal
Input Argument	Name: pComOut: Type: POINTER TO ARRY [0..65] OF BYTE Description: pointer to output buffer of serial terminal
Input Argument	Name: SizeComIn: Type: UNIT Description: Size of buffers
In/out Argument	Name: Com Type: GpsSerialPortBufferStruct Description: Serial port buffers

Program Example:

```
(* Global variables *)
```

```
VAR_GLOBAL
```

```
    SysTimingComPortDataM2:          GpsSerialPortBufferStruct;
    SysTimingCOMinM2   AT %I*:       EL6inData22B;
    SysTimingCOMoutM2  AT %Q*:       EL6outData22B;
    SysTimingComPortM2FB:            GpsSerialPortControlFB;
    SysTimingCGPS_AFB:               GpsTrimbleFB;
```

```
END_VAR
```

```
VAR_GLOBAL PERSISTENT
```

```
    SysTimingCGPS_Alnit:             GpsTrimbleStruct;
```

```
END_VAR
```

```
(* Call from fast task with 1 ms update rate *)
```

```
PROGRAM TimingFast
```

```
    SysTimingComPortM2 (
        Mode := SERIALINEMODE_EL6_22B,
        pComIn := ADR (SysTimingCOMinM2),
        pComOut := ADR (SysTimingCOMoutM2),
        SizeComIn := SIZEOF (SysTimingCOMinM2),
        Com := SysTimingComPortDataM2);
```

```
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 );
```

```
    SysTimingCGPS_AFB (
        ComPortData := SysTimingComPortDataM2,
        Gps := H1.Sys.Timing.C.GPS_A,
        Request := Request,
        GpsInit := SysTimingCGPS_Alnit);
```

```
END_PROGRAM
```