*LIGO Laboratory / LIGO Scientific Collaboration*

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TwinCAT Library for GPS Receivers

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| **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 down16#02 — Data not valid16#04 — Waiting for GPS lock16#08 — GPS initialization error16#10 — GPS configuration error |
| Library Dependencies | Error, SaveRestore, COMlibV2 |

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| **User Interface Type**TYPE TimeTypeEnum : (TimeTypeGPS, TimeTypeUTC);END\_TYPE |
| Type Name | TimeTypeEnum |
| Description | Enumerated type for describing the time scale |
| Definition | Enum |
| Field | Name: TimeTypeGPSDescription: GPS time scale (no leap seconds) |
| Field | Name: TimeTypeUTCDescription: UTC time scale (includes leap seconds) |

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| **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: GpsTrimbleReceiverModeInvalidDescription: Invalid |
| Field | Name: GpsTrimbleReceiverModeAutomaticDescription: Automatic (2D/3D) |
| Field | Name: GpsTrimbleReceiverModeSingleSatteliteDescription: Single Satellite (Time) |
| Field | Name: GpsTrimbleReceiverModeHorizontalDescription: Horizontal (2D) |
| Field | Name: GpsTrimbleReceiverModeFullPositionDescription: Full Position (3D) |
| Field | Name: GpsTrimbleReceiverModeOverDeterminedClockDescription: Over-Determined Clock (Timing) |

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| **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: GpsTrimbleDiscipliningModeInvalidDescription: Invalid |
| Field | Name: GpsTrimbleDiscipliningModeNormalDescription: Normal (Locked to GPS) |
| Field | Name: GpsTrimbleDiscipliningModePowerUpDescription: Power Up |
| Field | Name: GpsTrimbleDiscipliningModeAutoHoldoverDescription: Auto Holdover |
| Field | Name: GpsTrimbleDiscipliningModeManualHoldoverDescription: Manual Holdover |
| Field | Name: GpsTrimbleDiscipliningModeRecoveryDescription: Recovery |
| Field | Name: GpsTrimbleDiscipliningModeDisabledDescription: Disciplining Disabled |

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| **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: GpsTrimbleDecodingStatusInvalidDescription: Invalid |
| Field | Name: GpsTrimbleDecodingStatusDoingFixesDescription: Doing fixes |
| Field | Name: GpsTrimbleDecodingStatusNoGpsTimeDescription: Don't have GPS time |
| Field | Name: GpsTrimbleDecodingStatusPDOPTooHighDescription: PDOP is too high |
| Field | Name: GpsTrimbleDecodingStatusNoSattelitesDescription: No usable sats |
| Field | Name: GpsTrimbleDecodingStatusOnly1SatteliteDescription: Only 1 usable sat |
| Field | Name: GpsTrimbleDecodingStatusOnly2SattelitesDescription: Only 2 usable sats |
| Field | Name: GpsTrimbleDecodingStatusOnly3SattelitesDescription: Only 3 usable sats |
| Field | Name: GpsTrimbleDecodingStatusSatteliteUnusableDescription: The chosen sat is unusable |
| Field | Name: GpsTrimbleDecodingStatusTRAIMRejectFixDescription: TRAIM rejected the fix |

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| **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: GpsTrimbleDiscipliningActivityInvalidDescription: Invalid |
| Field | Name: GpsTrimbleDiscipliningActivityPhaseLockingDescription: Phase locking |
| Field | Name: GpsTrimbleDiscipliningActivityOscWarmUpDescription: Oscillator warm-up |
| Field | Name: GpsTrimbleDiscipliningActivityFreqLockingDescription: Frequency locking |
| Field | Name: GpsTrimbleDiscipliningActivityPlacingPPSDescription: Placing PPS |
| Field | Name: GpsTrimbleDiscipliningActivityInitLoopFilterDescription: Initializing loop filter |
| Field | Name: GpsTrimbleDiscipliningActivityHoldoverDescription: Compensating OCXO (holdover) |
| Field | Name: GpsTrimbleDiscipliningActivityInactiveDescription: Inactive |
| Field | Name: GpsTrimbleDiscipliningActivityRecoveryDescription: Recovery mode |
| Field | Name: GpsTrimbleDiscipliningActivityCalibrationDescription: Calibration/control voltage |

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| **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; DACVoltage: LREAL; Temperature: LREAL; Latitude: LREAL; Longitude: LREAL; Altitude: LREAL; PPSQuantizationError: LREAL;END\_STRUCTEND\_TYPE |
| Type Name | GpsTrimbleStruct |
| Description | Structure used in the user interface for a Trimble GPS device |
| Definition | STRUCT |
| Ouput Tag | Name: ErrorType: ErroStructDescription: Set by the error handler |
| Ouput Tag | Name: ModelType: STRING(80)Description: Name of GPS model |
| Ouput Tag | Name: GpsType: UDINTDescription: GPS time in seconds |
| Ouput Tag | Name: TowType: UDINTDescription: Time of week in seconds |
| Ouput Tag | Name: WeekType: UDINTDescription: Weeks since January 6, 1980 |
| Ouput Tag | Name: LeapType: INTDescription: Number of leap seconds |
| Ouput Tag | Name: TimeSourceType: TimeTypeEnumDescription: Time scale (UTC includes leap sec) |
| Ouput Tag | Name: PPSSourceType: TimeTypeEnumDescription: Alignment of 1 PPS signal |
| Ouput Tag | Name: TimeValidType: BOOLDescription: Time has been set from GPS receiver |
| Ouput Tag | Name: UtcOffsetType: BOOLDescription: Leap seconds are valid |
| Ouput Tag | Name: TestModeType: BOOLDescription: Unit is in test mode |
| Ouput Tag | Name: YearType: UINTDescription: Year (4 digits) |
| Ouput Tag | Name: MonthType: UINTDescription: Month (1-12) |
| Ouput Tag | Name: DayType: UINTDescription: Day (1-31) |
| Ouput Tag | Name: HourType: UINTDescription: Hours (0-23) |
| Ouput Tag | Name: MinuteType: UINTDescription: Minutes (0-59) |
| Ouput Tag | Name: SecondType: UINTDescription: Second (0-59) |
| Ouput Tag | Name: ReceiverModeType: GpsTrimbleReceiverModeEnumDescription: Current receiver mode |
| Ouput Tag | Name: DiscipliningModeType: GpsTrimbleDiscipliningModeEnumDescription: Oscillator disciplining mode |
| Ouput Tag | Name: SurveyProgressType: UINTDescription: Survey progress in percent |
| Ouput Tag | Name: HoldoverDurationType: UDINT Description: Time ins sec spend in holdover mode |
| Ouput Tag | Name: DacAtRailType: BOOLDescription: Critical error: DAC at rail |
| Ouput Tag | Name: DacNearRailType: BOOLDescription: Warning: DAC near rail |
| Ouput Tag | Name: AntennaOpenType: BOOLDescription: Warning: Antenna cable open |
| Ouput Tag | Name: AntennaShortedType: BOOLDescription: Warning: Antenna cable shorted |
| Ouput Tag | Name: NotTrackingSattelitesType: BOOLDescription: Warning: Not tracking sattelites |
| Ouput Tag | Name: NotDiscipliningOscillatorType: BOOLDescription: Warning: No XO disciplining |
| Ouput Tag | Name: SurveyInProgressType: BOOLDescription: Warning: Survey in progres |
| Ouput Tag | Name: NoStoredPositionType: BOOLDescription: Warning: No stored position |
| Ouput Tag | Name: LeapSecondPendingType: BOOLDescription: Warning: Leap second pending |
| Ouput Tag | Name: InTestModeType: BOOLDescription: Warning: GPS in test mode |
| Ouput Tag | Name: PositionQuestionableType: BOOLDescription: Warning: Position questionable |
| Ouput Tag | Name: AlmanacIncompleteType: BOOLDescription: Warning: Almanac incomplete |
| Ouput Tag | Name: NoPPSType: BOOLDescription: Warning: No 1PPS signa |
| Ouput Tag | Name: DecodingStatusType: GpsTrimbleDecodingStatusEnumDescription: Decoding status |
| Ouput Tag | Name: DiscipliningActivityType: GpsTrimbleDiscipliningActivityEnumDescription: Disciplining activity |
| Ouput Tag | Name: PPSOffsetType: LREALDescription: PPS offset in ns |
| Ouput Tag | Name: ClockOffsetType: LREALDescription: Clock offset in ppb |
| Ouput Tag | Name: DACValueType: UDINTDescription: DAC value (bits) |
| Ouput Tag | Name: DACVoltageType: LREALDescription: DAC value in Volts |
| Ouput Tag | Name: TemperatureType: LREALDescription: Temperature in °C |
| Ouput Tag | Name: LatitudeType: LREALDescription: GPS latitude -90° to +90° |
| Ouput Tag | Name: LongitudeType: LREALDescription: GPS longitude -180° to +180° |
| Ouput Tag | Name: AltitudeType: LREALDescription: GPS height -1000m to +18000m |
| Ouput Tag | Name: PPSQuantizationErrorType: LREALDescription: PPS quantization error in ns |

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| **Function Block**FUNCTION\_BLOCK GpsTrimbleFBVAR\_INPUT Request: SaveRestoreEnum;END\_VARVAR\_OUTPUTEND\_VARVAR\_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: RequestType: SaveRestoreEnumDescription: Request for save/restore/safe mode or noop |
| In/out Argument | Name: GpsType: GpsTrimbleStructDescription: User interface structure |
| In/out Argument | Name: GpsInitType: GpsTrimbleStructDescription: Save/restore variable in persistent memory |
| In/out Argument | Name: ComPortDataType: GpsSerialPortBufferStructDescription: Serial port buffers |

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| **Function Block**FUNCTION\_BLOCK GpsSerialPortControlFBVAR\_INPUT Mode: ComSerialLineMode\_t; pComIn: POINTER TO ARRAY[0..65] OF BYTE; pComOut: POINTER TO ARRAY[0..65] OF BYTE; SizeComIn: UINT;END\_VARVAR\_OUTPUTEND\_VARVAR\_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: ModeType: ComSerialLineMode\_tDescription: Serial port decription (check COMlibV2 doc)  |
| Input Argument | Name: pComIn:Type: POINTER TO ARRY [0..65] OF BYTEDescription: pointer to input buffer of serial terminal |
| Input Argument | Name: pComOut:Type: POINTER TO ARRY [0..65] OF BYTEDescription: pointer to output buffer of serial terminal |
| Input Argument | Name: SizeComIn:Type: UNITDescription: Size of buffers |
| In/out Argument | Name: ComType: GpsSerialPortBufferStructDescription: Serial port buffers |

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| **Program Example:**(\* Global variables \*)VAR\_GLOBAL SysTimingComPortDataM2: GpsSerialPortBufferStruct; SysTimingCOMinM2 AT %I\*: EL6inData22B;  SysTimingCOMoutM2 AT %Q\*: EL6outData22B; SysTimingComPortM2FB: GpsSerialPortControlFB; SysTimingCGPS\_AFB: GpsTrimbleFB;END\_VARVAR\_GLOBAL PERSISTENT SysTimingCGPS\_AInit: GpsTrimbleStruct;END\_VAR(\* Call from fast task with 1 ms update rate \*)PROGRAM TimingFast SysTimingComPortM2 ( Mode := SERIALLINEMODE\_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 TimingVAR 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\_AInit);END\_PROGRAM |