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TwinCAT Library for
PZT Driver

Daniel Sigg

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

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

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| **Library** |
| Title | PztDriver |
| Version | 1 |
| TwinCAT version | 2.11 |
| Name space | – |
| Author | Daniel Sigg |
| Description | Interfaces the PZT driver, [D1001200](https://dcc.ligo.org/LIGO-D1001200).This library provides a function block to support a single channel of the 4‑channel PZT driver. The board has a voltage monitor that represents the PZT output driver voltage, and an offset adjustment. The offset adjustment is controlled locally or externally using the front panel D-sub connector.Calibration parameters and min/max voltages are used to calibrate the voltage monitor and the offset adjustment.Each PZT driver also supports optional low and high limits; the user chooses which ones to enforce.The hardware readbacks of the power ok and external switch are daisy chained among the 4 channels of a board.Each PZT implements a scan feature with an option trigger to stop the scan. This can be used to scan an optical resonator and trigger on the transmitted power to find a resonance. Both scan and trigger fuinctionality are supported at a fast update rate. |
| Error codes | PZT Driver:0x01 – Power supply voltages out-of-range0x02 – External offset adjustment switch0x04 – PZT gain is zero0x08 – PZT monitor gain is zero0x10 – Drive voltage out-of-range0x20 – PZT voltage too low0x40 – PZT voltage too high0x80 – Power limits exceeded (either too low or too high)0x100 – Scan/trigger errorPZT Scan:0x01 – Illegal period0x02 – Trigger errorTrigger:0x01 – Illegal parameters0x02 – Timeout |
| Library dependencies | Error, ReadADC, WriteDAC, SaveRestore |

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| **Hardware Input Type**TYPE PztDriverInStruct:STRUCT Monitor: INT; PowerOk: BOOL; External: BOOL;END\_STRUCTEND\_TYPE |
| Type name | PztDriverInStruct |
| Description | Structure of the hardware inputs that are wired up for the PZT |
| Definition | STRUCT |
| Element | Name: MonitorType: INTDescription: Monitors the PZT voltage |
| Element | Name: PowerOkType: BOOLDescription: Voltage monitor readback |
| Element | Name: ExternalType: BOOLDescription: Monitors the external switch state |

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| **Hardware Output Type**TYPE PztDriverOutStruct:STRUCT  Offset: INT; PowerOk: BOOL; External: BOOL;END\_STRUCTEND\_TYPE |
| Type name | PztDriverOutStruct |
| Description | Structure of the hardware output that are wired up for the PZT |
| Definition | STRUCT |
| Element | Name: OffsetType: INTDescription: Offset applied to the PZT |
| Element | Name: PowerOkType: BOOLDescription: Voltage monitor readback (daisy chained from input) |
| Element | Name: ExternalType: BOOLDescription: Monitors the external switch state (daisy chained from input) |
| **User Interface Type**TYPE PztDriverEnum : (HVPZT, MVPZT, LVPZT);END\_TYPE |
| Type name | PztDriverEnum |
| Description | List of available PZT driver configurations |
| Definition | ENUM |
| Enum Tag | Name: HVPZTDescription: High voltage PZT driver (-120V to +240V) |
| Enum Tag | Name: MVPZTDescription: Medium voltage PZT driver (-10V to +200V) |
| Enum Tag | Name: LVPZTDescription: Low voltage PZT driver (-10V to +120V) |

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| **User Interface Type**TYPE PztDriverLimitsEnum : (PztLimitsNone, PztLimitsLow, PztLimitsHigh, PztLimitsHiLo);END\_TYPE |
| Type name | PztDriverLimitsEnum |
| Description | List of optional limit choices |
| Definition | ENUM |
| Enum Tag | Name: PztLimitsNoneDescription: No limit |
| Enum Tag | Name: PztLimitsLowDescription: Check low limit |
| Enum Tag | Name: PztLimitsHighDescription: Check high limit |
| Enum Tag | Name: PztLimitsHiLoDescription: Check low and high limit |

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| **User Interface Type**TYPE PztScanWaveformEnum : (ScanSawtooth, ScanTriangle, ScanSine, ScanSquarewave);END\_TYPE |
| Type name | PztScanWaveformEnum |
| Description | List of scan waveformt choices |
| Definition | ENUM |
| Enum Tag | Name: ScanSawtoothDescription: Sawtooth waveform |
| Enum Tag | Name: ScanTriangleDescription: Trinagular waveform |
| Enum Tag | Name: ScanSineDescription: Sinewave |
| Enum Tag | Name: ScanSquarewaveDescription: Squarewave |

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| **User Interface Type**TYPE TriggerSelectionEnum : (TrigEdge, TrigLevel);END\_TYPE |
| Type name | TriggerSelectionEnum |
| Description | List of available trigger selection choices |
| Definition | ENUM |
| Enum Tag | Name: TrigEdgeDescription: Triggers on edges only |
| Enum Tag | Name: TrigLevelDescription: Triggers on levele |

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| **User Interface Type**TYPE TriggerSlopeEnum : (TrigPositive, TrigNegative, TrigBoth);END\_TYPE |
| Type name | TriggerSlopeEnum |
| Description | List of available trigger slope choices |
| Definition | ENUM |
| Enum Tag | Name: TrigPositiveDescription: Triggers on positive edges or upon an exceeded level  |
| Enum Tag | Name: TrigNegativeDescription: Triggers on negative edges or below a level |
| Enum Tag | Name: TrigBothDescription: Triggers on either negative edges (not relevant for level) |

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| **User Interface Type**TYPE TriggerStruct :STRUCT Error: ErrorStruct; Selection: TriggerSelectionEnum;  Slope: TriggerSlopeEnum;  Reset: BOOL;  Arm: BOOL;  Deadtime: LREAL; Event: BOOL; Elapsed: LREAL; Actual: LREAL; Timeout: LREAL;  TimeoutError: BOOL;  Input: BOOL; Value: LREAL;  ValueAlt: LREAL;  Level: LREAL;  LevelAlt: LREAL; END\_STRUCTEND\_TYPE |
| Type name | TriggerStruct |
| Description | Structure of the user interface tags that is used to define a trigger |
| Definition | STRUCT |
| Output Tag | Name: ErrorType: ErrorStructDescription: Error handling |
| In/out Tag | Name: SelectionType: TriggerSelectionEnumDescription: Type of trigger (Edge or level) |
| In/out Tag | Name: SlopeType: TriggerSlopeEnumDescription: Select the slope/level for the trigger |
| In/out Tag | Name: ResetType: BOOLDescription: Resets the trigger (Arm, Event and TimeoutError) |
| In/out Tag | Name: ArmType: BOOLDescription: Arms the trigger (value is reset when trigger is met) |
| In/out Tag | Name: DeadtimeType: LREALDescription: Dead time in sec after arming before trigger becomes active |
| Output Tag | Name: EventType: BOOLDescription: A trigger event has happened |
| Output Tag | Name: ElapsedType: LREALDescription: Elapsed time in sec between arming and trigger event |
| Output Tag | Name: ActualType: LREALDescription: Actual value on trigger event |
| In/out Tag | Name: TimeoutType: LREALDescription: Timeout for trigger in sec |
| Output Tag | Name: TimeoutErrorType: BOOLDescription: Selects between normal (FALSE) and alternate (TRUE) trigger input |
| In/out Tag | Name: InputType: BOOLDescription: Arms the trigger (value is reset when trigger is met) |
| Output Tag | Name: ValueType: LREALDescription: Trigger input signal |
| Output Tag | Name: ValueAltType: LREALDescription: Alternate trigger input signal |
| In/out Tag | Name: LevelType: LREALDescription: Level to trigger at, above or below |
| In/out Tag | Name: LevelAltType: LREALDescription: Alternate level to trigger at, above or below |

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| **User Interface Type**TYPE PztScanStruct :STRUCT Error: ErrorStruct; Enable: BOOL;  UseTrigger: BOOL;  Reset: BOOL;  Waveform: PztScanWaveformEnum;  Period: LREAL; Trigger: TriggerStruct; Start: LREAL; Stop: LREAL; Offset: LREAL;  Previous: LREAL;END\_STRUCTEND\_TYPE |
| Type name | PztScanStruct |
| Description | Structure of the user interface tags that sets up a PZT scan |
| Definition | STRUCT |
| Output Tag | Name: ErrorType: ErrorStructDescription: Error handling |
| In/out Tag | Name: EnableType: BOOLDescription: Enables the scanning |
| In/out Tag | Name: UseTriggerType: BOOLDescription: Use the trigger to stop the scan |
| In/out Tag | Name: ResetType: BOOLDescription: Resets the scan (Enable, Previous, Offset and Trigger) |
| In/out Tag | Name: WaveformType: PztScanWaveformEnumDescription: Selects the scanning waveform |
| In/out Tag | Name: PeriodType: LREALDescription: Period of the waveform in sec |
| In/out Tag | Name: TriggerType: TriggerStructDescription: Trigger parameters |
| In/out Tag | Name: StartType: LREALDescription: Start offset for the scan waveform |
| In/out Tag | Name: StopType: LREALDescription: Stop offset for the scan waveform |
| Output Tag | Name: OffsetType: LREALDescription: Current offset of scanning waverform |
| Output Tag | Name: PreviousType: LREALDescription: Offset when last trigger event happened |

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| **User Interface Type**TYPE PztDriverStruct:STRUCT Error: ErrorStruct; PztDriverType: PztDriverEnum;  Volts: LREAL;  Offset: LREAL;  Monitor: LREAL;  Drive: LREAL;  PztLow: LREAL;  PztHigh: LREAL;  PztGain: LREAL;  PztMonGain: LREAL;  PztOffset: LREAL;  Limits: PztDriverLimitsEnum;  Range: BOOL;  Low: LREAL;  High: LREAL;  Normalized: LREAL;  External: BOOL;  ExternalNom: BOOL;  PowerOk: BOOL; END\_TYPE |
| Type name | PztDriverStruct |
| Description | Structure of the user interface tags that are used to control the PZT driver |
| Definition | STRUCT |
| Output Tag | Name: ErrorType: ErrorStructDescription: Error handling |
| Output Tag | Name: PztDriverTypeType: PztDriverEnumDescription: PZT driver type |
| Output Tag | Name: VoltsType: LREALDescription: Represents the PZT driver output voltage in V |
| In/out Tag | Name: OffsetType: LREALDescription: Offset to the PZT driver output in V |
| Output Tag | Name: MonitorType: LREALDescription: Monitor readback voltage (used to derive Volts) |
| Output Tag | Name: DriveType: LREALDescription: Output drive voltage for offset (derived from Offset) |
| Output Tag | Name: PztLowType: LREALDescription: Low limit of PZT drive |
| Output Tag | Name: PztHighType: LREALDescription: High limit of PZT drive |
| Output Tag | Name: PztGainType: LREALDescription: Gain of the PZT drive |
| Output Tag | Name: PztMonGainType: LREALDescription: Inverse of the PZT monitor gain |
| Output Tag | Name: PztOffsetType: LREALDescription: Intrinsic offset of the PZT drive (usually 0) |
| Output Tag | Name: LimitsType: PztDriverLimitsEnumDescription: Specifies optional limits |
| Output Tag | Name: RangeType: BOOLDescription: True, if limits exceeded |
| Output Tag | Name: LowType: LREALDescription: Low limit for PZT output voltage |
| Output Tag | Name: HighType: LREALDescription: High limit for PZT output voltage |
| Output Tag | Name: NormalizedType: LREALDescription: Normalized output voltage, 100% is the absolute maximum of the allowed output voltage |
| Output Tag | Name: ExternalType: BOOLDescription: Monitors the external switch state |
| In/Out Tag | Name: ExternalNomType: BOOLDescription: Nominal setting of the external switch state |
| Output Tag | Name: PowerOkType: BOOLDescription: Voltages are ok |

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| **Function Block**FUNCTION\_BLOCK TriggerFBVAR\_INPUT Request: SaveRestoreEnum := NoOp;END\_VARVAR\_IN\_OUT Trigger: TriggerStruct; TriggerInit: TriggerStruct;END\_VAR |
| Name | TriggerFB |
| Description | Controls the setup of a trigger and checks for errors, but does not evaluate the trigger condition |
| Input argument | Name: RequestType: SaveRestoreEnumDescription: Save/restore command |
| In/out argument | Name: TriggerType: TriggerStructDescription: Trigger parameters |
| In/out argument | Name: TriggerInitType: TriggerStructDescription: Trigger initialization parameters |

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| **Function Block**FUNCTION\_BLOCK TriggerFastFBVAR\_INPUT Tick: LREAL := 0.001; Value: LREAL; ValueAlt: LREAL := 0;END\_VARVAR\_IN\_OUT Trigger: TriggerStruct;END\_VARVAR\_OUTPUT Event: BOOL;END\_VAR |
| Name | TriggerFastFB |
| Description | Evaluates the trigger condition (called by a fast updating task)  |
| Input argument | Name: TickType: LREALDescription: Cycle time in sec |
| Input argument | Name: ValueType: LREALDescription: Signal to trigger on |
| Input argument | Name: ValueAltType: LREALDescription: Alternate signal to trigger on |
| In/out argument | Name: TriggerType: TriggerStructDescription: Trigger parameters |
| Output argument | Name: EventType: BOOLDescription: Indicates a trigger has happened |

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| **Function Block**FUNCTION\_BLOCK PztScanFBVAR\_INPUT Request: SaveRestoreEnum; PztMin: LREAL := -1E9; PztMax: LREAL := +1E9;END\_VARVAR\_IN\_OUT Scan: PztScanStruct; ScanInit: PztScanStruct;END\_VAR |
| Name | PztScanFB |
| Description | Controls the setup of a PZT scan, but does not calculate the waveform |
| Input argument | Name: RequestType: SaveRestoreEnumDescription: Save/restore command |
| Input argument | Name: PztMinType: LREALDescription: Minimum voltage of the PZT output |
| Input argument | Name: PztMaxType: LREALDescription: Maximum voltage of the PZT output |
| In/out argument | Name: ScanType: PztScanStructDescription: PZT scan parameters |
| In/out argument | Name: ScanInitType: PztScanStructDescription: PZT scan initialization parameters |

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| **Function Block**FUNCTION\_BLOCK PztScanFastFBVAR\_INPUT Value: LREAL := 0; ValueAlt: LREAL := 0; Tick: LREAL := 0.001; END\_VARVAR\_IN\_OUT Scan: PztScanStruct;END\_VAR |
| Name | PztScanFastFB |
| Description | Calculates the scan waveform (called by a fast updating task)  |
| Input argument | Name: ValueType: LREALDescription: Signal to trigger on |
| Input argument | Name: ValueAltType: LREALDescription: Alternate signal to trigger on |
| Input argument | Name: TickType: LREALDescription: Tick of update task in sec |
| In/out argument | Name: ScanType: PztScanStructDescription: Scan parameters |

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| **Function Block**FUNCTION\_BLOCK PztDriverFBVAR\_INPUT Request: SaveRestoreEnum; PztDriverIn: PztDriverInStruct;END\_VARVAR\_IN\_OUT PztDriverInit: PztDriverStruct; PztDriver: PztDriverStruct;END\_VAR |
| Name | PztDriverFB |
| Description | Sets up a channel of the PZT driver and checks for errors, but doesn’t apply the offset |
| Input argument | Name: RequestType: SaveRestoreEnumDescription: Save/restore command |
| Input argument | Name: PztDriverInType: PztDriverInStructDescription: Input hardware structure |
| In/out argument | Name: PztDriverInitType: PztDriverStructDescription: Interface structure for save/restore |
| In/out argument | Name: PztDriverType: PztDriverStructDescription: User Interface structure |

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| **Function Block**FUNCTION\_BLOCK PztDriverFastFBVAR\_INPUT PztType: PztDriverEnum := LVPZT; PztMin: LREAL := -1E9; PztMax: LREAL := +1E9; PztGain: LREAL := 0; PztMonGain: LREAL := 0; PztOffset: LREAL := 0; Value: LREAL := 0; ValueAlt: LREAL := 0; Tick: LREAL := 0.001;END\_VARVAR\_OUTPUT PztDriverOut: PztDriverOutStruct;END\_VARVAR\_IN\_OUT PztDriver: PztDriverStruct;END\_VAR |
| Name | PztDriverFastFB |
| Description | Outputs the PZT voltage and applies the scan and trigger functions.Called by a fast updating task.The values for min, max, gain, mongain and offset will be initialized according to the selected PZT driver type, if left untouched. |
| Input argument | Name: PztTypeType: PztDriverEnumDefault: LVPZTDescription: PZT driver type |
| Input argument | Name: PztDriverInType: PztDriverInStructDescription: Input hardware structure |
| Input argument | Name: PztMinType: LREALDescription: Minimum voltage of the PZT output |
| Input argument | Name: PztMaxType: LREALDescription: Maximum voltage of the PZT output |
| Input argument | Name: PztGainType: LREALDescription: PZT gain |
| Input argument | Name: PztMonGainType: LREALDescription: Inverse of PZT monitor gain |
| Input argument | Name: PztOffsetType: LREALDescription: Intrinsic PZT offset (usually 0) |
| Input argument | Name: ValueType: LREALDescription: Signal to trigger on (used by the scan/trigger feature) |
| Input argument | Name: ValueAltType: LREALDescription: Alternate signal to trigger on |
| Input argument | Name: TickType: LREALDescription: Tick of update task in sec (used by the scan) |
| Output argument | Name: PztDriverOutType: PztDriverOutStructDescription: Output hardware structure |
| In/out argument | Name: PztDriverType: PztDriverStructDescription: User Interface structure |