

*LIGO Laboratory / LIGO Scientific Collaboration*

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**TwinCAT Library for  
PZT Driver**

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<b>Library</b>	
Title	PztDriver
Version	1
TwinCAT version	2.11
Name space	–
Author	Daniel Sigg
Description	<p>Interfaces the PZT driver, <a href="#">D1001200</a>.</p> <p>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.</p> <p>Calibration parameters and min/max voltages are used to calibrate the voltage monitor and the offset adjustment.</p> <p>Each PZT driver also supports optional low and high limits; the user chooses which ones to enforce.</p> <p>The hardware readbacks of the power ok and external switch are daisy chained among the 4 channels of a board.</p> <p>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 functionality are supported at a fast update rate.</p>
Error codes	<p>PZT Driver:</p> <ul style="list-style-type: none"> <li>0x01 – Power supply voltages out-of-range</li> <li>0x02 – External offset adjustment switch</li> <li>0x04 – PZT gain is zero</li> <li>0x08 – PZT monitor gain is zero</li> <li>0x10 – Drive voltage out-of-range</li> <li>0x20 – PZT voltage too low</li> <li>0x40 – PZT voltage too high</li> <li>0x80 – Power limits exceeded (either too low or too high)</li> <li>0x100 – Scan/trigger error</li> </ul> <p>PZT Scan:</p> <ul style="list-style-type: none"> <li>0x01 – Illegal period</li> <li>0x02 – Trigger error</li> </ul> <p>Trigger:</p> <ul style="list-style-type: none"> <li>0x01 – Illegal parameters</li> <li>0x02 – Timeout</li> </ul>
Library dependencies	Error, ReadADC, WriteDAC, SaveRestore

<b>Hardware Input Type</b>	
TYPE PztDriverInStruct:	
STRUCT	
Monitor:	INT;
PowerOk:	BOOL;
External:	BOOL;
END_STRUCT	
END_TYPE	
Type name	PztDriverInStruct
Description	Structure of the hardware inputs that are wired up for the PZT
Definition	STRUCT
Element	Name: Monitor Type: INT Description: Monitors the PZT voltage
Element	Name: PowerOk Type: BOOL Description: Voltage monitor readback
Element	Name: External Type: BOOL Description: Monitors the external switch state

<b>Hardware Output Type</b>	
TYPE PztDriverOutStruct:	
STRUCT	
Offset:	INT;
PowerOk:	BOOL;
External:	BOOL;
END_STRUCT	
END_TYPE	
Type name	PztDriverOutStruct
Description	Structure of the hardware output that are wired up for the PZT
Definition	STRUCT
Element	Name: Offset Type: INT Description: Offset applied to the PZT
Element	Name: PowerOk Type: BOOL Description: Voltage monitor readback (daisy chained from input)
Element	Name: External Type: BOOL Description: Monitors the external switch state (daisy chained from input)

<b>User Interface Type</b>	
TYPE PztDriverEnum : (HVPZT, MVPZT, LVPZT); END_TYPE	
Type name	PztDriverEnum
Description	List of available PZT driver configurations
Definition	ENUM
Enum Tag	Name: HVPZT Description: High voltage PZT driver (-120V to +240V)
Enum Tag	Name: MVPZT Description: Medium voltage PZT driver (-10V to +200V)
Enum Tag	Name: LVPZT Description: Low voltage PZT driver (-10V to +120V)

<b>User Interface Type</b>	
TYPE PztDriverLimitsEnum : (PztLimitsNone, PztLimitsLow, PztLimitsHigh, PztLimitsHiLo); END_TYPE	
Type name	PztDriverLimitsEnum
Description	List of optional limit choices
Definition	ENUM
Enum Tag	Name: PztLimitsNone Description: No limit
Enum Tag	Name: PztLimitsLow Description: Check low limit
Enum Tag	Name: PztLimitsHigh Description: Check high limit
Enum Tag	Name: PztLimitsHiLo Description: Check low and high limit

<b>User Interface Type</b>	
TYPE PztScanWaveformEnum : (ScanSawtooth, ScanTriangle, ScanSine, ScanSquarewave); END_TYPE	
Type name	PztScanWaveformEnum
Description	List of scan waveformt choices
Definition	ENUM
Enum Tag	Name: ScanSawtooth Description: Sawtooth waveform
Enum Tag	Name: ScanTriangle Description: Trinagular waveform
Enum Tag	Name: ScanSine Description: Sinewave
Enum Tag	Name: ScanSquarewave Description: Squarewave

<b>User Interface Type</b>	
TYPE TriggerSelectionEnum : (TrigEdge, TrigLevel); END_TYPE	
Type name	TriggerSelectionEnum
Description	List of available trigger selection choices
Definition	ENUM
Enum Tag	Name: TrigEdge Description: Triggers on edges only
Enum Tag	Name: TrigLevel Description: Triggers on levele

<b>User Interface Type</b>	
TYPE TriggerSlopeEnum : (TrigPositive, TrigNegative, TrigBoth); END_TYPE	
Type name	TriggerSlopeEnum
Description	List of available trigger slope choices
Definition	ENUM
Enum Tag	Name: TrigPositive Description: Triggers on positive edges or upon an exceeded level
Enum Tag	Name: TrigNegative Description: Triggers on negative edges or below a level
Enum Tag	Name: TrigBoth Description: Triggers on either negative edges (not relevant for level)

<b>User Interface Type</b>	
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_STRUCT	
END_TYPE	
Type name	TriggerStruct
Description	Structure of the user interface tags that is used to define a trigger
Definition	STRUCT
Output Tag	Name: Error Type: ErrorStruct Description: Error handling
In/out Tag	Name: Selection Type: TriggerSelectionEnum Description: Type of trigger (Edge or level)
In/out Tag	Name: Slope Type: TriggerSlopeEnum Description: Select the slope/level for the trigger
In/out Tag	Name: Reset Type: BOOL Description: Resets the trigger (Arm, Event and TimeoutError)
In/out Tag	Name: Arm Type: BOOL Description: Arms the trigger (value is reset when trigger is met)

In/out Tag	Name: Dearthime Type: LREAL Description: Dead time in sec after arming before trigger becomes active
Output Tag	Name: Event Type: BOOL Description: A trigger event has happened
Output Tag	Name: Elapsed Type: LREAL Description: Elapsed time in sec between arming and trigger event
Output Tag	Name: Actual Type: LREAL Description: Actual value on trigger event
In/out Tag	Name: Timeout Type: LREAL Description: Timeout for trigger in sec
Output Tag	Name: TimeoutError Type: BOOL Description: Selects between normal (FALSE) and alternate (TRUE) trigger input
In/out Tag	Name: Input Type: BOOL Description: Arms the trigger (value is reset when trigger is met)
Output Tag	Name: Value Type: LREAL Description: Trigger input signal
Output Tag	Name: ValueAlt Type: LREAL Description: Alternate trigger input signal
In/out Tag	Name: Level Type: LREAL Description: Level to trigger at, above or below
In/out Tag	Name: LevelAlt Type: LREAL Description: Alternate level to trigger at, above or below

<b>User Interface Type</b> 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_STRUCT END_TYPE	
Type name	PztScanStruct
Description	Structure of the user interface tags that sets up a PZT scan
Definition	STRUCT
Output Tag	Name: Error Type: ErrorStruct Description: Error handling
In/out Tag	Name: Enable Type: BOOL Description: Enables the scanning
In/out Tag	Name: UseTrigger Type: BOOL Description: Use the trigger to stop the scan
In/out Tag	Name: Reset Type: BOOL Description: Resets the scan (Enable, Previous, Offset and Trigger)
In/out Tag	Name: Waveform Type: PztScanWaveformEnum Description: Selects the scanning waveform
In/out Tag	Name: Period Type: LREAL Description: Period of the waveform in sec
In/out Tag	Name: Trigger Type: TriggerStruct Description: Trigger parameters



In/out Tag	Name: Start Type: LREAL Description: Start offset for the scan waveform
In/out Tag	Name: Stop Type: LREAL Description: Stop offset for the scan waveform
Output Tag	Name: Offset Type: LREAL Description: Current offset of scanning waverform
Output Tag	Name: Previous Type: LREAL Description: Offset when last trigger event happened

<b>User Interface Type</b>	
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: Error Type: ErrorStruct Description: Error handling
Output Tag	Name: PztDriverType Type: PztDriverEnum Description: PZT driver type
Output Tag	Name: Volts Type: LREAL Description: Represents the PZT driver output voltage in V
In/out Tag	Name: Offset Type: LREAL Description: Offset to the PZT driver output in V
Output Tag	Name: Monitor Type: LREAL Description: Monitor readback voltage (used to derive Volts)

Output Tag	Name: Drive Type: LREAL Description: Output drive voltage for offset (derived from Offset)
Output Tag	Name: PztLow Type: LREAL Description: Low limit of PZT drive
Output Tag	Name: PztHigh Type: LREAL Description: High limit of PZT drive
Output Tag	Name: PztGain Type: LREAL Description: Gain of the PZT drive
Output Tag	Name: PztMonGain Type: LREAL Description: Inverse of the PZT monitor gain
Output Tag	Name: PztOffset Type: LREAL Description: Intrinsic offset of the PZT drive (usually 0)
Output Tag	Name: Limits Type: PztDriverLimitsEnum Description: Specifies optional limits
Output Tag	Name: Range Type: BOOL Description: True, if limits exceeded
Output Tag	Name: Low Type: LREAL Description: Low limit for PZT output voltage
Output Tag	Name: High Type: LREAL Description: High limit for PZT output voltage
Output Tag	Name: Normalized Type: LREAL Description: Normalized output voltage, 100% is the absolute maximum of the allowed output voltage
Output Tag	Name: External Type: BOOL Description: Monitors the external switch state
In/Out Tag	Name: ExternalNom Type: BOOL Description: Nominal setting of the external switch state

Output Tag	Name: PowerOk Type: BOOL Description: Voltages are ok
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<b>Function Block</b> FUNCTION_BLOCK TriggerFB VAR_INPUT Request:       SaveRestoreEnum := NoOp; END_VAR VAR_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: Request Type: SaveRestoreEnum Description: Save/restore command
In/out argument	Name: Trigger Type: TriggerStruct Description: Trigger parameters
In/out argument	Name: TriggerInit Type: TriggerStruct Description: Trigger initialization parameters

<b>Function Block</b> FUNCTION_BLOCK TriggerFastFB VAR_INPUT Tick:            LREAL := 0.001; Value:           LREAL; ValueAlt:       LREAL := 0; END_VAR VAR_IN_OUT Trigger:        TriggerStruct; END_VAR VAR_OUTPUT Event:            BOOL; END_VAR	
Name	TriggerFastFB
Description	Evaluates the trigger condition (called by a fast updating task)
Input argument	Name: Tick Type: LREAL Description: Cycle time in sec
Input argument	Name: Value Type: LREAL Description: Signal to trigger on
Input argument	Name: ValueAlt Type: LREAL Description: Alternate signal to trigger on
In/out argument	Name: Trigger Type: TriggerStruct Description: Trigger parameters
Output argument	Name: Event Type: BOOL Description: Indicates a trigger has happened

<b>Function Block</b> FUNCTION_BLOCK PztScanFB VAR_INPUT Request:                SaveRestoreEnum; PztMin:                LREAL := -1E9; PztMax:                LREAL := +1E9; END_VAR VAR_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: Request Type: SaveRestoreEnum Description: Save/restore command
Input argument	Name: PztMin Type: LREAL Description: Minimum voltage of the PZT output
Input argument	Name: PztMax Type: LREAL Description: Maximum voltage of the PZT output
In/out argument	Name: Scan Type: PztScanStruct Description: PZT scan parameters
In/out argument	Name: ScanInit Type: PztScanStruct Description: PZT scan initialization parameters

<b>Function Block</b> FUNCTION_BLOCK PztScanFastFB VAR_INPUT Value:                LREAL := 0; ValueAlt:             LREAL := 0; Tick:                  LREAL := 0.001; END_VAR VAR_IN_OUT Scan:                  PztScanStruct; END_VAR	
Name	PztScanFastFB
Description	Calculates the scan waveform (called by a fast updating task)
Input argument	Name: Value Type: LREAL Description: Signal to trigger on
Input argument	Name: ValueAlt Type: LREAL Description: Alternate signal to trigger on
Input argument	Name: Tick Type: LREAL Description: Tick of update task in sec
In/out argument	Name: Scan Type: PztScanStruct Description: Scan parameters



<b>Function Block</b> FUNCTION_BLOCK PztDriverFB VAR_INPUT Request:        SaveRestoreEnum; PztDriverIn:   PztDriverInStruct; END_VAR VAR_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: Request Type: SaveRestoreEnum Description: Save/restore command
Input argument	Name: PztDriverIn Type: PztDriverInStruct Description: Input hardware structure
In/out argument	Name: PztDriverInit Type: PztDriverStruct Description: Interface structure for save/restore
In/out argument	Name: PztDriver Type: PztDriverStruct Description: User Interface structure

<b>Function Block</b>	
FUNCTION_BLOCK PztDriverFastFB	
VAR_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_VAR	
VAR_OUTPUT	
PztDriverOut: PztDriverOutStruct;	
END_VAR	
VAR_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: PztType Type: PztDriverEnum Default: LVPZT Description: PZT driver type
Input argument	Name: PztDriverIn Type: PztDriverInStruct Description: Input hardware structure
Input argument	Name: PztMin Type: LREAL Description: Minimum voltage of the PZT output
Input argument	Name: PztMax Type: LREAL Description: Maximum voltage of the PZT output
Input argument	Name: PztGain Type: LREAL Description: PZT gain

Input argument	Name: PztMonGain Type: LREAL Description: Inverse of PZT monitor gain
Input argument	Name: PztOffset Type: LREAL Description: Intrinsic PZT offset (usually 0)
Input argument	Name: Value Type: LREAL Description: Signal to trigger on (used by the scan/trigger feature)
Input argument	Name: ValueAlt Type: LREAL Description: Alternate signal to trigger on
Input argument	Name: Tick Type: LREAL Description: Tick of update task in sec (used by the scan)
Output argument	Name: PztDriverOut Type: PztDriverOutStruct Description: Output hardware structure
In/out argument	Name: PztDriver Type: PztDriverStruct Description: User Interface structure