LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Beam Diverter Library documentation

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Library	
Title	BeamDiverter
Version	1
TwinCAT version	2.11.0
Name space	
Author	Sheila Dwyer and Jax Sanders
Description	Controls a beam diverter D1100642. The beam diverter moves an optic into or out of a beam using a coil and magnets. There are two reed switches that sense the current position of the beam diverter. The coil current is driven by the beckhoff module EL7332. According to T1100252-v2 the beam diverter needs about half of an Amp of current. The EL7332 used in the "direct velocity" mode, with the Motor nominal resistance set to 10 Ohms, produces 1mA per 0.066 units of "velocity" when a 10 Ohm resistor and 330uH inductor are attached. The maximum current seems to be 1 Amp, or -1.2 Amps, reached for velocity settings above ±20,000.
	The readbacks under info setting for both coil current and voltage do not work, at least not in the direct velocity operating mode. To move the beam diverter this library sets the velocity to ±7250 when the user asks to either open or close the beam diverter, applies this voltage for 5 seconds then uses the reed switches to check that the beam diverter has moved. The time could be shortened if desired.
	Each beam diverter can be locked (the DC motor disabled).
Error Code	0x0001 Beam diverter open/close error
	0x0002 Beam diverter was stopped
	0x0004 DC motor controller error (Beckhoff module EL7332)

Hardware Input Type

```
TYPE BeamDiverterInStruct :
STRUCT
        ClosedPositionSwitch:        BOOL;           (* closed position reed switch *)
        OpenPositionSwitch:          BOOL;           (* open position reed switch *)
        DCMReady:                    BOOL;
        DCMWarning:                  BOOL;
        DCMError:                    BOOL;
END_STRUCT
END_TYPE;
```

Type name	BeamDiverterInStruct
Description	Structure of the hardware inputs that mapped into the EtherCAT memory space by the EtherCAT-to-Modbus gateway. There are two switches used as sensors for a readback of the diverter position , and readbacks from the DC motor controller.
Definition	STRUCT
Element	Name: ClosedPositionSwitch Type: BOOL Description: Indicates that beam diverter is closed
Element	Name: OpenPostionSwitch Type: BOOL Description: Indicates that beam diverter is open
Element	Name: DCMReady Type: BOOL Description: Readback from EL7332 indicating that the motor is ready
Element	Name: DCMWarning Type: BOOL Description: Readback from EL7332 indicating that the motor is ready
Element	Name: DCMError Type: BOOL Description: Readback from EL7332 indicating that the motor has an error

Hardware Output Type

```
TYPE BeamDiverterOutStruct :
STRUCT
        DCMVelocity:            INT:=0.0;
        DCMEnable:              BOOL;
END_STRUCT
END_TYPE;
```

Type name	BeamDiverterOut
Description	Structure of the hardware output that is mapped into the EtherCAT memory space by the EtherCAT-to-Modbus gateway.
Definition	STRUCT
Element	Name: DCMVelocity Type: INT Description: Proportional to the current through the coil.
Element	Name: DCMEnable Type: BOOL Description: Enables the DCM

Enumerated Type	
TYPE BDivPositionEnum : (BDivOpen, DivClosed, BDivUnknown); END_TYPE	
Type Name	BDivPositionEnum
Description	Specifies the beam diverter position
Definition	ENUM
Element	Name: BDivOpen Description: Beam diverter is open
Element	Name: DivClosed Description: Beam diverter is closed
Element	Name: BDivUnknown Description: The beam diverter state is unknown

Enumerated Type	
TYPE NonWorkingSwitchEnum : (BDivNone, BDivOpenSwitch, BDivClosedSwitch); END_TYPE;	
Type Name	NonWorkingSwitchEnum
Description	Specifies if the beam diverter has a broken switch
Definition	ENUM
Element	Name: BDivNone Description: Switches are good
Element	Name: BDivOpenSwitch Description: Open switch is broken
Element	Name: BDivClosedSwitch Description: Closed switch is broken

Enumerated Type	
TYPE BDivActivityEnum : (BDivInactive , BDivOpening, BDivClosing, BDivStopped); END_TYPE;	
Type Name	BDivActivityEnum
Description	Specifies the current activity of the beam diverter
Definition	ENUM
Element	Name: BDivInactive Description: No activity by beam diverter
Element	Name: BDivOpening Description: Opening the beam diverter
Element	Name: BDivClosing Description: Closing the beam diverter
Element	Name: BDivStopped Description: Beam diverter state change was stopped by user

User Interface Type
TYPE BeamDiverterStruct :
STRUCT
        Error: ErrorStruct;
        Open: BOOL;
        Close: BOOL;
        Stop: BOOL;
        OpenSwitch: BOOL;
        ClosedSwitch: BOOL;
        Position: BDivPositionEnum;
        Busy: BOOL;
        Activity: BDivActivityEnum;
        Locked: BOOL;
        Message: STRING;
        FailedAttempts: INT;
        ResetFailedAttempts: BOOL;
        NonWorkingSwitch: NonWorkingSwitchEnum;
        AlternativeBeam: BOOL;
        CoilPolarity: BOOL;
END_STRUCT
END_TYPE;

Type name	BeamDiverterStruct
Description	User interface variables for controlling a beam diverter
Definition	STRUCT
Output tags	Name: Error Type: ErrorStruct Description: Errors
Input tags	Name: Open Type: BOOL Description: Request to move to open position
Input tags	Name: Close Type: BOOL Description: Request to move beam diverter to close position
Output tags	Name: OpenSwitch Type: BOOL Description: Beam diverter is in the open position
Output tags	Name: ClosedSwitch Type: BOOL Description: Beam diverter is in the closed position

Output tags	Name: Position Type: BDivPositionEnum Description: Position of the beam diverter
Output tags	Name: Busy Type: BOOL Description: Beam diverter is busy (moving)
Output tags	Name: Activity Type: BDivActivityEnum Description: position of the beam diverter
Output tags	Name: Locked Type: BOOL Description: Disable DC motor controller
Output tags	Name: Message Type: String Description: A message displays weather the beam diverter is ready to be moved, or waiting for a move to finish.
Output tags	Name: FailedAttempts Type: INT Description: Count of times the beam diverter has tried to move unsucsefully
Input tags	Name: ResetFailedAttempts Type: BOOL Description: Set count back to zero
Output tags	Name: NonWorkingSwitch Type: NonWorkingSwitchEnum Description: Describes the broken switch , if any
Output tags	Name: AlternativeBeam Type: BOOL Description: The beam diverter uses the alternative configuration to pass the beam through, ie., open is closed.
Output tags	Name: CoilPolarity Type: BOOL Description: Coil actuator has opposite polarity

Function Block

Function Block
FUNCTION_BLOCK BeamDiverterFB
VAR_INPUT
      Request: SaveRestoreEnum;
      BeamDiverterIn: BeamDiverterInStruct;
      NonWorkingSwitch: NonWorkingSwitchEnum := BDivNone;
      AlternativeBeam: BOOL := FALSE;
      CoilPolarity: BOOL := FALSE;
END_VAR
VAR_OUTPUT
      BeamDiverterOut: BeamDiverterOutStruct;
END_VAR
VAR_IN_OUT
      BeamDiverter: BeamDiverterStruct;
      BeamDiverterInit: BeamDiverterStruct;
END_VAR
VAR
      ErrorB: BOOL;
      ErrorCode: DWORD;
      ErrorMsg: STRING;
      ErrorHandler: ErrorHandlerFB;
      TimerIndex: INT :=0;
END_VAR

Name	BeamDiverterFB
Description	Controls a single beam diverter.
Input argument	Name: Request Type: SaveRestoreEnum Description: Save/restore request
Input argument	Name:BeamDiverterIn Type:BeamDiverterInStruct Description: Hardware inputs (sensor readouts)
Input argument	Name: NonWorkingSwitch Type: NonWorkingSwitchEnum Description: Describes the broken switch , if any
Input argument	Name: AlternativeBeam Type: BOOL Description: The beam diverter uses the alternative configuration to pass the beam through, ie., open is closed.
Input argument	Name: CoilPolarity Type: BOOL Description: Coil actuator has opposite polarity

Output argument	Name: BeamDiverterOut
	Type:BeamDiverterOutStruct
	Description: Hardware outout (coil voltage)
In/out argument	Name:BeamDiverter
	Type: BeamDiverterStruct
	Description:User interface inputs and outputs
In/out argument	Name:BeamDiverterInit
	Type: BeamDiverterStruct
	Description:User interface initialization

Visual

Name	BeamDiverterVis
Description	Displays current position, as well as the readout of both sensors, error messages, a message indicating if the diverter is ready to move or waiting for a move to complete, and the number of times the beam diverter has failed to move when requested. Also has inputs to request that the beam diverter opens, closes, or flips position, and to reset the count of failed attempts to move.
Placeholder	Name:$BeamDiverter$ Type:BeamDiverterStruct Description: