*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO-E1300124-v2 *Advanced LIGO* 4/23/2019

Beam Diverter Library documentation

Sheila Dwyer

Distribution of this document:

LIGO Scientific Collaboration

This is an internal working note  
of the LIGO Laboratory.

|  |  |
| --- | --- |
| **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 | 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 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: |