

LIGO Laboratory / LIGO Scientific Collaboration

LIGO- E1200680-v5

Advanced LIGO

3/15/2018

**TwinCAT Library for
DC Power**

Alexa Staley, 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	DCPower
Version	1
TwinCAT version	2.11
Name space	–
Author	Alexa Staley, Sheila Dwyer
Description	<p>Monitors the DC Power of photodiodes and quad photodiodes</p> <p>Supports 3 types of PDs, DCPowerSimple is for use with the generic PD interface (LIGO-D1002932-v4), DCPowerPhotodiodeAmp is for bare PDs (Thorlabs SM1PD1A) controlled through the amplifier D1200543-v6, DCPowerLegacyLSC is the DC readbacks for LSCPDs.</p> <p>Each photodetector type supports DC offset adjustment.</p> <p>For DCPowerPhotodiodeAmp there are three transimpedance amplifier subtypes: SlowControls, AlsFiber and Baffle.</p> <p>For the SlowControls and the AlsFiber variants the transimpedance is set to 2000 Ω, and an Enum allows the user to select a gain setting of 0 dB, 10 dB, 20 dB or 30 dB, which the code translates into a ratio DCPower.Gain, used along with the transimpedance to calculate the photocurrent, DCPower.DCCurrent.</p> <p>The DCCurrent is then divided by DCPower.Responsivity to give the power in Watts, DCPower.Power</p> <p>For the Baffle variant the transimpedance is set to 20 kΩ and the available gain settings are 0 dB, 20 dB, 40 dB or 60 dB.</p> <p>For the LSC legacy photodiode the transimpedance is set to -100 Ω and the available gain settings are 0 dB, 10 dB, 20 dB, 30 dB or 40 dB.</p> <p>Each photodetector also support optional low and high limits, the user chooses which ones to enforce.</p> <p>Quad detectors compute sum, pitch and yaw depending on how the detector is mounted. (not sure if this is implemented yet)</p>
Error codes	<p>DCPower:</p> <p>0x01 – DC offset too large (greater than 10 or less than -10)</p> <p>0x02 – ABS (Transimpedance) less than 1</p> <p>0x04 – Responsivity too small</p> <p>0x08- Power too low (below limit)</p> <p>0x10 – Power too high</p> <p>0x20 – Power limits exceeded (either too low or too high)</p> <p>0x40 – Voltage readback saturated</p> <p>DCQuadPower:</p> <p>0x01 – Error in Segment 1</p> <p>0x02 – Error in Segment 2</p> <p>0x04 – Error in Segment 3</p> <p>0x08 – Error in Segment 4</p> <p>0x10 – Sum below threshold</p>
Library dependencies	Error, ReadADC, SaveRestore

Usage example:

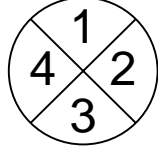

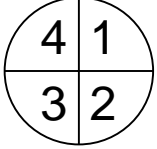
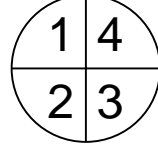
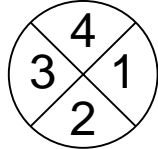
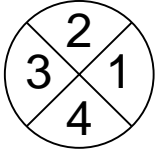
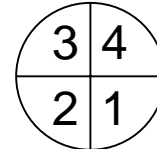
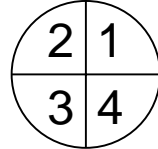
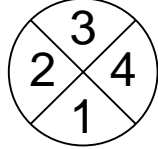
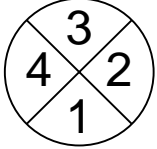
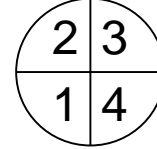
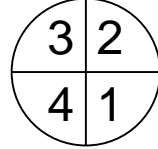
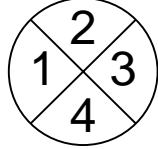
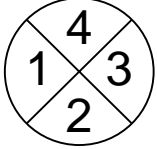
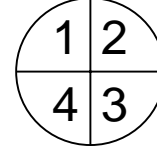
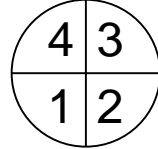
```
ALSDoublingPathIRDCPDFB (  
    Photodiode_Type := DCPowerPhotodiodeAmp,  
    AmplifierType := DCPowerAmplifierSlowControls,  
    DCPowerIn := ALSDoublingPathIRDCPDIn,  
    DCPowerOut => ALSDoublingPathIRDCPDOut,  
    DCPower := Ifo.ALS.C.DoublingPathIRDCPD,  
    Request := Request,  
    DCPowerInit := ALSDoublingPathIRDCPDInit);
```

Ifo.C.DoublingPathIRDCPD.Responsivity:=0.65; (*just a guess*)

Associated MEDM screens:

```
\opt\rtcds\userapps\release\isc\common\medm\CUST_DCPD.adl
```

**Table of quad photodiode orientation
(Front view)**

	Orientation			
	Cross		Plus	
Rotation	Normal	Flipped	Normal	Flipped
Up				
Right				
Down				
Left				

Hardware Input Type TYPE DCPowerInStruct : STRUCT DCPower: INT; Status: BOOL; END_STRUCT END_TYPE	
Type name	DCPowerInStruct
Description	Structure of the hardware inputs that are wired up for the DC Power
Definition	STRUCT
Element	Name: DCPower Type: INT Description: Monitors the DC power

Hardware Output Type TYPE DCPowerOutStruct : STRUCT Gain: BOOL; END_STRUCT END_TYPE	
Type name	DCPowerOutStruct
Description	Structure of the hardware output that are wired up for the DC Power
Definition	STRUCT
Element	Name: Gain Type: BOOL Description: Gain setting for diodes

User Interface Type	
TYPE DCPowerEnum : (DCPowerSimple, DCPowerPhotodiodeAmp, DCPowerLegacyLSC); END_TYPE	
Type name	DCPowerEnum
Description	List of available photodiode types
Definition	ENUM
Enum Tag	Name: DCPowerSimple Description: Simple photodiode with fixed gain setting
Enum Tag	Name: DCPowerPhotodiodeAmp Description: Transimpedance amplifier with adjustable gain
Enum Tag	Name: DCPowerLegacyLSC Description: LSC Legacy photodiode readout with adjustable gain

User Interface Type	
TYPE DCPowerAmplifierEnum : (DCPowerAmplifierSlowControl, DCPowerAmplifierAlsFiber, DCPowerAmplifierBaffle); END_TYPE	
Type name	DCPowerAmplifierEnum
Description	Variant of the transimpedance amplifier
Definition	ENUM
Enum Tag	Name: DCPowerAmplifierSlowControl Description: Standard slow controls variant
Enum Tag	Name: DCPowerAmplifierAlsFiber Description: Variant built into the ALS fiber distribution
Enum Tag	Name: DCPowerAmplifierBaffle Description: Variant used to read the AOS cavity baffle diodes

User Interface Type	
TYPE DCPowerGainEnum : (GainZero, GainTen, GainTwenty, GainThirty, GainFourty, GainFifty, GainSixty); END_TYPE	
Type name	DCPowerGainEnum
Description	List the available gain options
Definition	ENUM
Enum Tag	Name: GainZero Description: No gain
Enum Tag	Name: GainTen Description: 10dB of gain
Enum Tag	Name: GainTwenty Description: 20dB of gain
Enum Tag	Name: GainThirty Description: 30dB of gain
Enum Tag	Name: GainFourty Description: 40dB of gain
Enum Tag	Name: GainFifty Description: 50dB of gain
Enum Tag	Name: GainSixty Description: 60dB of gain

User Interface Type	
TYPE DCPowerLimitsEnum : (LimitsNone, LimitsLow, LimitsHigh, LimitsHiLo); END_TYPE	
Type name	DCPowerLimitsEnum
Description	List of optional limit choices
Definition	ENUM
Enum Tag	Name: LimitsNone Description: No limit
Enum Tag	Name: LimitsLow Description: Check low limit
Enum Tag	Name: LimitsHigh Description: Check high limit
Enum Tag	Name: LimitsHiLo Description: Check low and high limit

User Interface Type	
TYPE DCPowerStruct :	
STRUCT	
Error:	ErrorStruct;
PhotodiodeType:	DCPowerEnum;
AmplifierType:	DCPowerAmplifierEnum;
Volts:	LREAL;
Offset:	LREAL;
Transimpedance:	LREAL;
GainSetting:	DCPowerGainEnum;
Gain:	LREAL;
DCCurrent:	LREAL;
Responsivity:	LREAL;
Power:	LREAL;
SplitterR:	LREAL;
PowerMon:	LREAL;
Limits:	DCPowerLimitsEnum;
Range:	BOOL;
Low:	LREAL;
High:	LREAL;
Nominal:	LREAL;
Normalized:	LREAL;
END_STRUCT	
END_TYPE	
Type name	DCPowerStruct
Description	Structure of the user interface tags that are used to control the DC power
Definition	STRUCT
Output Tag	Name: Error Type: ErrorStruct Description: Error handling
Output Tag	Name: PhotodiodeType Type: DCPowerEnum Description: Photodiode type
Output Tag	Name: AmplifierType Type: DCPowerAmplifierEnum Description: Variant of the transimpedance amplifier
Output Tag	Name: Volts Type: LREAL Description: Monitors the photodetector DC power in V
In/out Tag	Name: Offset Type: LREAL Description: DC offset in V

In/out Tag	Name: Transimpedance Type: LREAL Description: Photodetector transimpedance in Ohms
Output Tag	Name: GainSetting Type: DCPowerGainEnum Description: Gain setting in dB
Output Tag	Name: Gain Type: LREAL Description: Gain as a ratio
Output Tag	Name: DCCurrent Type: LREAL Description: Photodetector current in mA
In/out Tag	Name: Responsivity Type: LREAL Description: Photodetector response in A/W
Output Tag	Name: Power Type: LREAL Description: Monitors the DC power in mW
Output Tag	Name: SplitterR Type: LREAL Description: Reflectivity of pick off beam splitter in percent
Output Tag	Name: PowerMon Type: LREAL Description: Power at the pick off beam splitter
Output Tag	Name: Limits Type: DCPowerLimitsEnum 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 power in mW
Output Tag	Name: High Type: LREAL Description: High limit for power in mW
Output Tag	Name: Nominal Type: LREAL Description: Nominal DC current

Output Tag	Name: Normalized Type: LREAL Description: Current normalized to nominal
------------	---

Function Block FUNCTION_BLOCK DCPowerFB VAR_INPUT Request: SaveRestoreEnum; PhotodiodeType: DCPowerEnum := DCPowerSimple; AmplifierType: DCPowerAmplifierEnum := DCPowerAmplifierSlowControl; InvertedGain: BOOL := FALSE; DCPowerIn: DCPowerInStruct; END_VAR VAR_OUT DCPowerOut: DCPowerOutStruct; END_VAR VAR_IN_OUT DCPowerInit: DCPowerStruct; DCPower: DCPowerStruct; END_VAR	
Name	DCPowerFB
Description	Controls the DC Power
Input argument	Name: Request Type: SaveRestoreEnum Description: Save/restore command
Input argument	Name: PhotodiodeType Type: DCPowerEnum Default: DCPowerSimple Description: Input of photodiode type
Input argument	Name: AmplifierType Type: DCPowerAmplifierEnum Default: DCPowerAmplifierSlowControl Description: Variant of transimpedance amplifier
Input argument	Name: InvertedGain Type: BOOL Default: FALSE Description: Gain bits are inverted (baffle PD variant only)
Input argument	Name: DCPowerIn Type: DCPowerInStruct Description: Input hardware structure
Output argument	Name: DCPowerOut Type: DCPowerOutStruct Description: Output hardware structure
In/out argument	Name: DCPowerInit Type: DCPowerStruct Description: Interface structure for save/restore

In/out argument	Name: DCPower Type: DCPowerStruct Description: User Interface structure
-----------------	---

Hardware Input Type TYPE QuadDCPowerInStruct : STRUCT Seg: ARRAY [1..4] OF DCPowerInStruct; END_STRUCT END_TYPE	
Type name	QuadDCPowerInStruct
Description	Structure of the hardware inputs that are wired up for the DC Power
Definition	STRUCT
Element	Name: Seg Type: ARRAY Description: Creates a four array of DCPowerInStruct

User Interface Type	
TYPE QuadDCPowerOrientationEnum : (Cross, Plus); END_TYPE	
Type name	QuadDCPowerOrientationEnum
Description	Basic quad photodetector orientation
Definition	ENUM
Enum Tag	Name: Cross Description: Segment 1 on top, then clockwise
Enum Tag	Name: Plus Description: Segment 1 top/right, then clockwise






User Interface Type	
TYPE QuadDCPowerRotationEnum : (Up, Right, Down, Left); END_TYPE	
Type name	QuadDCPowerRotationEnum
Description	Photodetector rotation
Definition	ENUM
Enum Tag	Name: Up Description: Segment 1 on top or top/right
Enum Tag	Name: Right Description: Segment 1 on the right or bottom/right
Enum Tag	Name: Down Description: Segment 1 on bottom or bottom/left
Enum Tag	Name: Left Description: Segment 1 on the left or top/left

User Interface Type	
TYPE QuadDCPowerStruct :	
STRUCT	
Error:	ErrorStruct;
Seg:	ARRAY [1..4] OF DCPowerStruct;
Sum:	LREAL;
Threshold:	LREAL;
Flip:	BOOL;
Orientation:	QuadDCPowerOrientationEnum;
Rotation:	QuadDCPowerRotationEnum;
Pitch:	LREAL;
Yaw:	LREAL;
END_STRUCT	
END_TYPE	
Type name	QuadDCPowerStruct
Description	Structure of the user interface tags that are used to control the DC power
Definition	STRUCT
Output Tag	Name: Error Type: ErrorStruct Description: Error handling
Output Tag	Name: Seg Type: ARRAY Description: Creates a four array for the four monitors of the DC power
Output Tag	Name: Sum Type: LREAL Description: Sum of the four DC power monitors in mW
In/Out Tag	Name: Threshold Type: LREAL Description: Threshold for sum in mW
In/out Tag	Name: Flip Type: BOOL Description: Counterclockwise numbering of segments
In/out Tag	Name: Orientation Type: QuadDCPowerOrientationEnum Description: Plus or cross configuration
In/out Tag	Name: Rotation Type: QuadDCPowerRotationEnum Description: Rotation of photodetector in steps of 90 degree
Output Tag	Name: Pitch Type: LREAL Description: Pitch, calculated by (Top – Bottom) / Sum

Output Tag	Name: Yaw Type: LREAL Description: Yaw, calculated by (Right – Left) / Sum
------------	--

Function Block FUNCTION_BLOCK QuadDCPowerFB VAR_INPUT Request: SaveRestoreEnum; QuadDCPowerIn: QuadDCPowerInStruct; END_VAR VAR_IN_OUT QuadDCPowerInit: QuadDCPowerStruct; QuadDCPower: QuadDCPowerStruct; END_VAR	
Name	DCPowerFB
Description	Controls the DC Power
Input argument	Name: Request Type: SaveRestoreEnum Description: Save/restore command
Input argument	Name: QuadDCPowerIn Type: QuadDCPowerInStruct Description: Input hardware structure
In/out argument	Name: QuadDCPowerInit Type: QuadDCPowerStruct Description: Interface structure for save/restore
In/out argument	Name: QuadDCPower Type: QuadDCPowerStruct Description: User Interface structure

Visual			
DC Mon	%3.4f V	DC Offset	%3.4f V
DC Current	%3.4f mA	Transimpedance	%3.0f Ohm
DC Power	%3.4f mW	Response	%3.3f A/W
Limits	%s		
Low	%3.3f mW	High	%3.3f mW
Error	%i	%s	
	\$ErrorMessage\$		
	\$ErrorMessage\$		
	\$ErrorMessage\$		
	\$ErrorMessage\$		
Name	DCPowerVis		
Description	Displays the DC power		
Placeholder	Name: DCPower Type: DCPowerStruct Description: DC power structure		

Visual			
DC Power 1	%3.3 mW	Segment 1	
DC Power 2	%3.3f mW	Segment 2	
DC Power 3	%3.3f mW	Segment 3	
DC Power 4	%3.3f mW	Segment 4	
Sum	%3.3f mW	Threshold	%3.3f mW
Pitch	%3.4f	Flip	Orientation %s
Yaw	%3.4f		Rotation %s
Error	%i	%s	
	\$ErrorMessage\$		
	\$ErrorMessage\$		
	\$ErrorMessage\$		
	\$ErrorMessage\$		
	\$ErrorMessage\$		
Name	QuadDCPowerVis		
Description	Displays the DC power monitors, pitch, yaw, and error		
Placeholder	Name: DCPower Type: QuadDCPowerStruct Description: DC power structure		