*LIGO Laboratory / LIGO Scientific Collaboration*

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TwinCAT Library for
DC Power

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| **Library** |
| Title | DCPower |
| Version | 1 |
| TwinCAT version | 2.11 |
| Name space | – |
| Author | Alexa Staley, Sheila Dwyer |
| Description | Monitors the DC Power of photodiodes and quad photodiodesSupports 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. Each photodetector type supports DC offset adjustment.For DCPowerPhotodiodeAmp there are three transimpedance amplifier subtypes: SlowControls, AlsFiber and Baffle.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. The DCCurrent is then divided by DCPower.Responsivity to give the power in Watts, DCPower.PowerFor 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.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.Each photodetector also support optional low and high limits, the user chooses which ones to enforce. Quad detectors compute sum, pitch and yaw depending on how the detector is mounted. (not sure if this is implemented yet) |
| Error codes | DCPower:0x01 – DC offset too large (greater than 10 or less than -10)0x02 – ABS (Transimpedance) less than 10x04 – Responsivity too small0x08- Power too low (below limit)0x10 – Power too high0x20 – Power limits exceeded (either too low or too high)0x40 – Voltage readback saturatedQuadDCPower:0x0001 – Error in Segment 10x0002 – Error in Segment 20x0004 – Error in Segment 30x0008 – Error in Segment 40x0010 – Transimpedance gain too small0x0020 – Responsivity too small0x0040 – Sum too low0x0080 – Power too low0x0100 – Power too high0x0200 – Power limits exceeded  |
| 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)**

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|  | **Orientation** |
| **Cross** | **Plus** |
| **Rotation** | **Normal** | **Flipped** | **Normal** | **Flipped** |
| **Up** | 1234 | 1432 | 1432 | 4123 |
| **Right** | 4123 | 2143 | 4321 | 1234 |
| **Down** | 3412 | 3214 | 3214 | 2341 |
| **Left** | 2341 | 4321 | 2143 | 3412 |

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| **Hardware Input Type**TYPE DCPowerInStruct :STRUCT DCPower: INT; Status: BOOL; END\_STRUCTEND\_TYPE |
| Type name | DCPowerInStruct |
| Description | Structure of the hardware inputs that are wired up for the DC Power |
| Definition | STRUCT |
| Element | Name: DCPowerType: INTDescription: Monitors the DC power |

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| **Hardware Output Type**TYPE DCPowerOutStruct :STRUCT Gain: BOOL; END\_STRUCTEND\_TYPE |
| Type name | DCPowerOutStruct |
| Description | Structure of the hardware output that are wired up for the DC Power |
| Definition | STRUCT |
| Element | Name: GainType: BOOLDescription: Gain setting for diodes |

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

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

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| **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: GainZeroDescription: No gain |
| Enum Tag | Name: GainTenDescription: 10dB of gain |
| Enum Tag | Name: GainTwentyDescription: 20dB of gain |
| Enum Tag | Name: GainThirtyDescription: 30dB of gain |
| Enum Tag | Name: GainFourtyDescription: 40dB of gain |
| Enum Tag | Name: GainFiftyDescription: 50dB of gain |
| Enum Tag | Name: GainSixtyDescription: 60dB of gain |

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| **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: LimitsNoneDescription: No limit |
| Enum Tag | Name: LimitsLowDescription: Check low limit |
| Enum Tag | Name: LimitsHighDescription: Check high limit |
| Enum Tag | Name: LimitsHiLoDescription: Check low and high limit |

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| **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\_STRUCTEND\_TYPE |
| Type name | DCPowerStruct |
| Description | Structure of the user interface tags that are used to control the DC power |
| Definition | STRUCT |
| Output Tag | Name: ErrorType: ErrorStructDescription: Error handling |
| Output Tag | Name: PhotodiodeTypeType: DCPowerEnumDescription: Photodiode type |
| Output Tag | Name: AmplifierTypeType: DCPowerAmplifierEnumDescription: Variant of the transimpedance amplifier |
| Output Tag | Name: VoltsType: LREALDescription: Monitors the photodetector DC power in V |
| In/out Tag | Name: OffsetType: LREALDescription: DC offset in V |
| In/out Tag | Name: TransimpedanceType: LREALDescription: Photodetector transimpedance in Ohms |
| Output Tag | Name: GainSettingType: DCPowerGainEnumDescription: Gain setting in dB |
| Output Tag | Name: GainType: LREALDescription: Gain as a ratio |
| Output Tag | Name: DCCurrentType: LREALDescription: Photodetector current in mA |
| In/out Tag | Name: ResponsivityType: LREALDescription: Photodetector response in A/W |
| Output Tag | Name: PowerType: LREALDescription: Monitors the DC power in mW |
| Output Tag | Name: SplitterRType: LREALDescription: Reflectivity of pick off beam splitter in percent |
| Output Tag | Name: PowerMonType: LREALDescription: Power at the pick off beam splitter |
| Output Tag | Name: LimitsType: DCPowerLimitsEnumDescription: Specifies optional limits |
| Output Tag | Name: RangeType: BOOLDescription: True if limits exceeded |
| Output Tag | Name: LowType: LREALDescription: Low limit for power in mW |
| Output Tag | Name: HighType: LREALDescription: High limit for power in mW |
| Output Tag | Name: NominalType: LREALDescription: Nominal DC current |
| Output Tag | Name: NormalizedType: LREALDescription: Current normalized to nominal |

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| **Function Block**FUNCTION\_BLOCK DCPowerFBVAR\_INPUT Request: SaveRestoreEnum; PhotodiodeType: DCPowerEnum := DCPowerSimple; AmplifierType: DCPowerAmplifierEnum := DCPowerAmplifierSlowControl; InvertedGain: BOOL := FALSE; DCPowerIn: DCPowerInStruct;END\_VARVAR\_OUT DCPowerOut: DCPowerOutStruct;END\_VARVAR\_IN\_OUT DCPowerInit: DCPowerStruct; DCPower: DCPowerStruct;END\_VAR |
| Name | DCPowerFB |
| Description | Controls the DC Power |
| Input argument | Name: RequestType: SaveRestoreEnumDescription: Save/restore command |
| Input argument | Name: PhotodiodeTypeType: DCPowerEnumDefault: DCPowerSimpleDescription: Input of photodiode type |
| Input argument | Name: AmplifierTypeType: DCPowerAmplifierEnumDefault: DCPowerAmplifierSlowControlDescription: Variant of transimpedance amplifier |
| Input argument | Name: InvertedGainType: BOOLDefault: FALSEDescription: Gain bits are inverted (baffle PD variant only) |
| Input argument | Name: DCPowerInType: DCPowerInStructDescription: Input hardware structure |
| Output arugment | Name: DCPowerOutType: DCPowerOutStructDescription: Output hardware structure |
| In/out argument | Name: DCPowerInitType: DCPowerStructDescription: Interface structure for save/restore |
| In/out argument | Name: DCPowerType: DCPowerStructDescription: User Interface structure |

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| **Hardware Input Type**TYPE QuadDCPowerInStruct :STRUCT Seg: ARRAY [1..4] OF DCPowerInStruct;END\_STRUCTEND\_TYPE |
| Type name | QuadDCPowerInStruct |
| Description | Structure of the hardware inputs that are wired up for the DC Power |
| Definition | STRUCT |
| Element | Name: SegType: ARRAYDescription: Creates a four array of DCPowerInStruct |

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| **User Interface Type**TYPE QuadDCPowerOrientationEnum : (Cross, Plus);END\_TYPE |
| Type name | QuadDCPowerOrientationEnum |
| Description | Basic quad photodetector orientation  |
| Definition | ENUM |
| Enum Tag | Name: CrossDescription: Segment 1 on top, then clockwise |
| Enum Tag | Name: PlusDescription: Segment 1 top/right, then clockwise |

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| **User Interface Type**TYPE QuadDCPowerRotationEnum : (Up, Right, Down, Left);END\_TYPE |
| Type name | QuadDCPowerRotationEnum |
| Description | Photodetector rotation  |
| Definition | ENUM |
| Enum Tag | Name: UpDescription: Segment 1 on top or top/right |
| Enum Tag | Name: RightDescription: Segment 1 on the right or bottom/right |
| Enum Tag | Name: DownDescription: Segment 1 on bottom or bottom/left |
| Enum Tag | Name: LeftDescription: Segment 1 on the left or top/left |

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| **User Interface Type**TYPE QuadDCPowerStruct :STRUCT Error: ErrorStruct; Seg: ARRAY [1..4] OF DCPowerStruct; Transimpedance: LREAL; Responsivity: LREAL; SplitterR: LREAL; DCCurrent: LREAL;  Power: LREAL; PowerMon: LREAL; Sum: LREAL; Threshold: LREAL; Flip: BOOL; Orientation: QuadDCPowerOrientationEnum; Rotation: QuadDCPowerRotationEnum; Pit: LREAL; Yaw: LREAL; Limits: DCPowerLimitsEnum; Range: BOOL; Low: LREAL;  High: LREAL; Nominal: LREAL;  Normalized: LREAL;END\_STRUCTEND\_TYPE |
| Type name | QuadDCPowerStruct |
| Description | Structure of the user interface tags that are used to control the DC power |
| Definition | STRUCT |
| Output Tag | Name: ErrorType: ErrorStructDescription: Error handling |
| Output Tag | Name: SegType: ARRAYDescription: Creates a four array for the four monitors of the DC power |
| In/out Tag | Name: TransimpedanceType: LREALDescription: Photodetector transimpedance in Ohms |
| In/out Tag | Name: ResponsivityType: LREALDescription: Photodetector response in A/W |
| In/Out Tag | Name: SplitterRType: LREALDescription: Reflectivity of pick off beam splitter in percent |
| Output Tag | Name: DCCurrentType: LREALDescription: Photodetector sum current in mA |
| Output Tag | Name: PowerType: LREALDescription: Monitors the DC sum power in mW |
| Output Tag | Name: PowerMonType: LREALDescription: Sum power at the pick off beam splitter |
| Output Tag | Name: SumType: LREALDescription: Monitors the DC sum current in mA |
| In/Out Tag | Name: ThresholdType: LREALDescription: Threshold for sum in mW |
| In/out Tag | Name: FlipType: BOOLDescription: Counterclockwise numbering of segments |
| In/out Tag | Name: OrientationType: QuadDCPowerOrientationEnumDescription: Plus or cross configuration |
| In/out Tag | Name: RotationType: QuadDCPowerRotationEnumDescription: Rotation of photodetector in steps of 90 degree |
| Output Tag | Name: PitchType: LREALDescription: Pitch, calculated by (Top – Bottom) / Sum |
| Output Tag | Name: YawType: LREALDescription: Yaw, calculated by (Right – Left) / Sum |
| In/Out Tag | Name: LimitsType: DCPowerLimitsEnumDescription: Specifies optional limits |
| Output Tag | Name: RangeType: BOOLDescription: True if limits exceeded |
| In/Out Tag | Name: LowType: LREALDescription: Low limit for power in mW |
| In/Out Tag | Name: HighType: LREALDescription: High limit for power in mW |
| Output Tag | Name: NominalType: LREALDescription: Nominal sum DC current in mA |
| Output Tag | Name: NormalizedType: LREALDescription: Sum DC current normalized by nominal |

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| **Function Block**FUNCTION\_BLOCK QuadDCPowerFBVAR\_INPUT Request: SaveRestoreEnum; QuadDCPowerIn: QuadDCPowerInStruct;END\_VARVAR\_IN\_OUT QuadDCPowerInit: QuadDCPowerStruct; QuadDCPower: QuadDCPowerStruct;END\_VAR |
| Name | DCPowerFB |
| Description | Controls the DC Power |
| Input argument | Name: RequestType: SaveRestoreEnumDescription: Save/restore command |
| Input argument | Name: QuadDCPowerInType: QuadDCPowerInStructDescription: Input hardware structure |
| In/out argument | Name: QuadDCPowerInitType: QuadDCPowerStructDescription: Interface structure for save/restore |
| In/out argument | Name: QuadDCPowerType: QuadDCPowerStructDescription: User Interface structure |

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| **Visual** |
| Name | DCPowerVis |
| Description | Displays the DC power |
| Placeholder | Name: DCPowerType: DCPowerStructDescription: DC power structure |

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| **Visual** |
| Name | QuadDCPowerVis |
| Description | Displays the DC power monitors, pitch, yaw, and error |
| Placeholder | Name: DCPowerType: QuadDCPowerStructDescription: DC power structure |