*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 photodiodes  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.  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.Power  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.  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 1  0x04 – Responsivity too small  0x08- Power too low (below limit)  0x10 – Power too high  0x20 – Power limits exceeded (either too low or too high)  0x40 – Voltage readback saturated  QuadDCPower:  0x0001 – Error in Segment 1  0x0002 – Error in Segment 2  0x0004 – Error in Segment 3  0x0008 – Error in Segment 4  0x0010 – Transimpedance gain too small  0x0020 – Responsivity too small  0x0040 – Sum too low  0x0080 – Power too low  0x0100 – Power too high  0x0200 – 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** | 1  2  3  4 | 1  4  3  2 | 1  4  3  2 | 4  1  2  3 |
| **Right** | 4  1  2  3 | 2  1  4  3 | 4  3  2  1 | 1  2  3  4 |
| **Down** | 3  4  1  2 | 3  2  1  4 | 3  2  1  4 | 2  3  4  1 |
| **Left** | 2  3  4  1 | 4  3  2  1 | 2  1  4  3 | 3  4  1  2 |

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| **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 |

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| **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 |

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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: 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 |

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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: 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 |

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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: 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 |

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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: 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 |

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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\_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 |

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| **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 arugment | 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 |

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| **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 |

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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: Cross  Description: Segment 1 on top, then clockwise |
| Enum Tag | Name: Plus  Description: 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: 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 |

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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\_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 |
| In/out Tag | Name: Transimpedance  Type: LREAL  Description: Photodetector transimpedance in Ohms |
| In/out Tag | Name: Responsivity  Type: LREAL  Description: Photodetector response in A/W |
| In/Out Tag | Name: SplitterR  Type: LREAL  Description: Reflectivity of pick off beam splitter in percent |
| Output Tag | Name: DCCurrent  Type: LREAL  Description: Photodetector sum current in mA |
| Output Tag | Name: Power  Type: LREAL  Description: Monitors the DC sum power in mW |
| Output Tag | Name: PowerMon  Type: LREAL  Description: Sum power at the pick off beam splitter |
| Output Tag | Name: Sum  Type: LREAL  Description: Monitors the DC sum current in mA |
| 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 |
| In/Out Tag | Name: Limits  Type: DCPowerLimitsEnum  Description: Specifies optional limits |
| Output Tag | Name: Range  Type: BOOL  Description: True if limits exceeded |
| In/Out Tag | Name: Low  Type: LREAL  Description: Low limit for power in mW |
| In/Out Tag | Name: High  Type: LREAL  Description: High limit for power in mW |
| Output Tag | Name: Nominal  Type: LREAL  Description: Nominal sum DC current in mA |
| Output Tag | Name: Normalized  Type: LREAL  Description: Sum DC current normalized by nominal |

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| **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 |

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| **Visual** | |
| Name | DCPowerVis |
| Description | Displays the DC power |
| Placeholder | Name: DCPower  Type: DCPowerStruct  Description: DC power structure |

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| **Visual** | |
| Name | QuadDCPowerVis |
| Description | Displays the DC power monitors, pitch, yaw, and error |
| Placeholder | Name: DCPower  Type: QuadDCPowerStruct  Description: DC power structure |