*LIGO Laboratory / LIGO Scientific Collaboration*

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TEC Controller Library Documentation

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| **Library** |
| Title | TECController |
| Version | 1 |
| TwinCAT version | 2.11.2230 |
| Name space |  |
| Author | Sheila Dwyer |
| Description | Controls the temperature of an SHG oven, using Beckhoff modules EL3692 to measure the temperature using a 10kOhm thermistor (epcos PN: B57861S0103F040), EL3102 to sense the temperature and a TEC from Laird technologies, HOT20, 31, F2A, 0909 and EL4132 for TEC outputs. The TEC is installed in the SHG with the wider side facing upwards, as shown in the picture. This is because the data sheet indicates that the narrower side should be the cool side. C:\Users\Sheila2\Documents\My Documents\ALS\SHG oven\ALSSHG 001.JPGC:\Users\Sheila2\Documents\My Documents\ALS\SHG oven\ALSSHG 002.JPGWith the unity gain frequency of the servo set to 5Hz, the overshoot is about 20%, so this is a good nominal setting.  |
| Error Codes | TECControllerFB:0x0001 – Thermistor resistance too high (open)0x0002 - Thermistor resistance too low (short)0x0004 - TEC Voltage too high0x0008 – TEC Current is too high0x0010 – TEC power dissipated if too high0x0020 – Integrator limit is exceeded (currently integrator limit is 100V)0x0040 – Thermistor data invalid0x0080 – Thermistor measurement errorThermistorFB:0x0001 – Thermistor resistance too high (open)0x0002 - Thermistor resistance too low (short)0x0004 – Thermistor data invalid0x0008 – Thermistor measurement error |
| Library Dependencies | SaveRestore, Error, ReadADC, WriteADC |

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| **Hardware Input Type**TYPE ThermStatusStruct:STRUCT UnderRange: BOOL; OverRange: BOOL; ExtenRange: BOOL; DataInvalid: BOOL; RangeInvalid: BOOL; AutoRangeDis: BOOL; Error: BOOL; SteadyState: BOOL; END\_STRUCTEND\_TYPE |
| Type name | ThermStatusStruct |
| Description | Status information of the EL3692 |
| Element | Name: UnderRangeType: BOOLDescription: Indicates an under range condition |
| Element | Name: OverRangeType: BOOLDescription: Indicates an over range condition |
| Element | Name: ExtenRangeType: BOOLDescription: Indicates an extended range condition |
| Element | Name: DataInvalidType: BOOLDescription: Indicates the data is invalid |
| Element | Name: RangeInvalidType: BOOLDescription: Indicates the range is invalid |
| Element | Name: AutoRangeDisType: BOOLDescription: Indicates the auto ranging is disabled |
| Element | Name: ErrorType: BOOLDescription: Indicates an error condition |
| Element | Name: SteadyStateType: BOOLDescription: measurement is in steady stateAt last 4 values no more than x/1024 apart |

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| **Hardware Input Type**TYPE ThermistorInStruct :STRUCT ThermStatus: ThermStatusStruct; ThermValue: REAL;END\_STRUCTEND\_TYPE |
| Type name | ThermistorInStruct |
| Description | Hardware inputs for thermistor measurement |
| Definition | STRUCT |
| Element | Name: ThermStatusType:ThermStatusStructDescription: Structure of status indicators for resistance measurement module EL3692 |
| Element | Name: ThemValueType: REALDescription: resistance of thermistor in C |

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| **Hardware Input Type**TYPE TECControllerInStruct :STRUCT ThermStatus: ThermStatusStruct; ThermValue: REAL; TECVoltageReadback: INT; TECCurrentReadback: INT;END\_STRUCTEND\_TYPE |
| Type name | TECControllerInStruct |
| Description | Hardware inputs  |
| Definition | STRUCT |
| Element | Name: ThermStatusType:ThermStatusStructDescription: Structure of status indicators for resistance measurement module EL3692 |
| Element | Name: ThemValueType: REALDescription: resistance of thermistor |
| Element | Name: TECVoltageReadbackType: INTDescription: readback of voltage across the TEC |
| Element | Name: TECCurrentReadbackType: INTDescription: readback of current into the TEC |

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| **Hardware Output Type**TYPE ThermControlStruct :STRUCT DisableAutoRange: BOOL; Mode: BYTE; Range: SINT; StartConv: BOOL;END\_STRUCTEND\_TYPE |
| Type name | ThermControlStruct |
| Description | Control information of the EL3692 |
| Definition | STRUCT |
| Element | Name: DisableAutoRangeType: BOOLDescription: Disable the auto-ranging feature |
| Element | Name: ModeType: BYTEDescription: measurement mode 0: 4-wire measurement 1: 4-wire measurement, single-shot mode 2: 2-wire measurement 3: 4-wire measurement, single-shot mode |
| Element | Name: RangeType: SINTDescription: Measurement range -1: 10 mΩ - 100 mΩ 0: 100 mΩ - 1 Ω 1: 1 Ω - 10 Ω 2: 10 Ω - 100 Ω 3: 100 Ω - 1 kΩ 4: 1 kΩ - 10 kΩ 5: 10 kΩ - 100 kΩ 6: 100 kΩ - 1 MΩ 7: 1 MΩ - 10 MΩ |
| Element | Name: StartConvType: BOOLDescription: Start a measurement in single shot mode |

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| **Hardware Output Type**TYPE ThermistorOutStruct:STRUCT ThermControl: ThermControlStruct;END\_STRUCTEND\_TYPE |
| Type name | ThermistorOutStruct |
| Description | Hardware outputs |
| Definition | STRUCT |
| Element | Name: ThermControlType: ThermControlStructDescription: Structure of control bits for EL3692 |

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| **Hardware Output Type**TYPE TECControllerOutStruct :STRUCT ThermControl: ThermControlStruct; TECVoltageSet: INT;END\_STRUCTEND\_TYPE |
| Type name | TECControllerOutStruct |
| Description | Hardware outputs |
| Definition | STRUCT |
| Element | Name: ThermControlType: ThermControlStructDescription: Structure of control bits for EL3692 |
| Element | Name: TECVoltageSetType:INTDescription: voltage sent to the TEC (in units of volts over the TEC, the gain of the controller board is taken out in the code) |

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| **User Interface Type**TYPE TECControllerStruct :STRUCT Error: ErrorStruct; ThermistorTemperature: LREAL; TECVoltageBack: LREAL; TECCurrentBack: LREAL; TECVoltsOut: LREAL; Fault: BOOL; SetTemp: LREAL:=35; Servo: BOOL; UnityGain: LREAL:=5; ClearInt: BOOL; OldControlSig: LREAL;END\_STRUCTEND\_TYPE |
| Type name | TECControllerStruct |
| Description | User interface inputs and outputs for TECController |
| Definition | STRUCT |
| Input tags | Name: ErrorType: ErrorStructDescription: for use by error handler |
| Input tags | Name: ThermistorTemperatureType: LREALDescription: Temperature (in C) measured by thermistor |
| Input tags | Name: TECVoltageBackType:LREALDescription: Voltage readback, in units of volts over TEC |
| Output tags | Name: TECCurrentBackType:LREALDescription:TEC Current readback |
| Output tags | Name: TECVoltsOutType:LREALDescription:Volts sent to TEC, in units of volts over TEC |
| Output tags | Name: FaultType:BOOLDescription: Is there an error condition that required output voltage to go to zero? |
| Output tags | Name:SetTempType:LREALDescription: Temperature setting for servo |
| Output tags | Name:ServoType:BOOLDescription: Is the servo on? |
| Output tags | Name:UnityGainType: LREALDescription: unity gain setting for servo |
| Output tags | Name:ClearIntType:BOOLDescription: Allows the user to clear the integrator, in case the servo gets into a bad state where the integrator value is too high. |
| Output tags | Name:OldControlSigType:LREALDescription: TECVoltsOut from last cycle in which the servo was on. This is saved so that when the servo is turned on again, it will initialize with the old value.  |

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| **User Interface Type**TYPE ThermistorStruct:STRUCT Error: ErrorStruct; Temperature: LREAL;END\_STRUCTEND\_TYPE |
| Type name | ThermistorStruct |
| Description | User interface inputs and outputs for a thermistor readout |
| Definition | STRUCT |
| Input tags | Name: ErrorType: ErrorStructDescription: for use by error handler |
| Input tags | Name: TemperatureType: LREALDescription: Temperature (in C) measured by thermistor |

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| **Function Block**FUNCTION\_BLOCK ThermistorFBVAR\_INPUT Request: SaveRestoreEnum; ThermistorIn: ThermistorINStruct;END\_VARVAR\_OUTPUT ThermistorOut: ThermistorOutStruct;END\_VARVAR\_IN\_OUT ThermistorInit: ThermistorStruct; Thermistor: ThermistorStruct;END\_VAR |
| Name | ThermistorFB |
| Description | Function block to read a thermsitor |
| Input argument | Name: RequestType:SaveRestoreEnumDescription: Request for save/restore/safemode or noop.  |
| Input argument | Name: ThermistorInType: ThermistorInStructDescription: Hardware inputs |
| Output argument | Name: ThermistorOutType: ThermistorOutStructDescription: Hardware outputs |
| In/Out argument | Name: ThermistorType: ThermistorStructDescription: User interface |
| In/Out argument | Name: ThermistorInitType: ThermistorStructDescription: User interface variables to initialize to, if power is lost |

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| **Function Block**FUNCTION\_BLOCK TECControllerFBVAR\_INPUT Request: SaveRestoreEnum; VoltageLimit: LREAL := 2.9; TECControllerIn: TECControllerINStruct;END\_VARVAR\_OUTPUT TECControllerOut: TECControllerOutStruct;END\_VARVAR\_IN\_OUT TECControllerInit: TECControllerStruct; TECController: TECControllerStruct;END\_VAR |
| Name | TECControllerFB |
| Description | Main temperature controller function block |
| Input argument | Name: RequestType:SaveRestoreEnumDescription: Request for save/restore/safemode or noop.  |
| Input argument | Name: VoltageLimitType: LREALDescription: Maximum voltage applied to controller output |
| Input argument | Name: TECControllerInType: TECControllerInStructDescription: Hardware inputs |
| Output argument | Name: TECControllerOutType: TECControllerOutStructDescription: Hardware outputs for TECController |
| In/Out argument | Name: TECControllerType: TECControllerStructDescription: User interface |
| In/Out argument | Name: TECControllerInitType: TECControllerStructDescription: User interface variables to initialize to if power is lost |