*LIGO Laboratory / LIGO Scientific Collaboration*

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TECController 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 | 0x0001 – Thermistor resistance too high (open)0x0002 - Thermistor resistance too low (short)0x0003 - TEC Voltage too high0x0004 – TEC Current is too high0x0005 – TEC power dissipated if too high0x0006 – Integrator limit is exceeded (currently integrator limit is 100V)0x0007 – Thermistor data invalid0x0008 – Thermistor measurement error |
| Library Dependencies | SaveRestore, Error, ReadADC, WriteADC |

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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 |  |
| 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 |

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| **Hardware Input Type**{copy type definition here} |
| Type name |  |
| Description |  |
| Definition |  |
| Element | Name: Type:Description: |
| Element | Name: Type:Description: |
| Element | Name: Type:Description: |

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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;(\*~(OPC : 1 : Make variable visible for OPC-Server) (OPC\_PROP[005] : 3 : OPC\_PROP\_RIGHTS) (OPC\_PROP[0100] :C: Unit) (OPC\_PROP[0101] :Temperature measured by thermistor: Description) (OPC\_PROP[0102] :40: HOPR) (OPC\_PROP[0103] :15: LOPR)\*) TECVoltageBack: LREAL;(\*~(OPC : 1 : Make variable visible for OPC-Server) (OPC\_PROP[005] : 1 : OPC\_PROP\_RIGHTS) (OPC\_PROP[0100] :V: Unit) (OPC\_PROP[0101] :Readback of voltage across TEC: Description)\*) TECCurrentBack: LREAL;(\*~ (OPC : 1 : Make variable visible for OPC-Server) (OPC\_PROP[005] : 1 : OPC\_PROP\_RIGHTS) (OPC\_PROP[0100] :Amps: Unit) (OPC\_PROP[0101] :Readback of current across TEC: Description) \*) TECVoltsOut: LREAL;(\*~ (OPC : 1 : Make variable visible for OPC-Server) (OPC\_PROP[005] : 3 : OPC\_PROP\_RIGHTS) (OPC\_PROP[0100] :V: Unit) (OPC\_PROP[0101] :Voltage across TEC setting: Description)\*) Fault: BOOL;(\*~(OPC :1: Make variable visible for OPC-Server) (OPC\_PROP[005] :1: OPC\_PROP\_RIGHTS) (OPC\_PROP[0101] :Fault: Description) (OPC\_PROP[0106] :Fault: ONAM) (OPC\_PROP[0107] :None: ZNAM)\*) SetTemp: LREAL:=35;(\*~ (OPC : 1 : Make variable visible for OPC-Server) (OPC\_PROP[005] : 3 : OPC\_PROP\_RIGHTS) (OPC\_PROP[0100] :C: Unit) (OPC\_PROP[0101] :Set Temperature: Description)\*) Servo: BOOL;(\*~(OPC :1: Make variable visible for OPC-Server) (OPC\_PROP[005] :3: OPC\_PROP\_RIGHTS) (OPC\_PROP[0101] :PI Servo: Description) (OPC\_PROP[0106] :On: ONAM) (OPC\_PROP[0107] :Off: ZNAM)\*) UnityGain: LREAL:=5;(\*~ (OPC : 1 : Make variable visible for OPC-Server) (OPC\_PROP[005] : 3 : OPC\_PROP\_RIGHTS) (OPC\_PROP[0100] :: Unit) (OPC\_PROP[0101] :Proportional term of PI controller: Description) \*) ClearInt: BOOL;(\*~ (OPC : 1 : Make variable visible for OPC-Server) (OPC\_PROP[005] : 3 : OPC\_PROP\_RIGHTS) (OPC\_PROP[0106] :Clear: ONAM) (OPC\_PROP[0107] :Integrator On: ZNAM) \*) OldControlSig: LREAL;(\*~ (OPC : 1 : Make variable visible for OPC-Server) (OPC\_PROP[005] : 3 : OPC\_PROP\_RIGHTS ) (OPC\_PROP[0100] :: Unit) (OPC\_PROP[0101] :Control Signal from last servo cycle: Description)\*)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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| **Type**TYPE ThermStatusStruct :STRUCT UnderRange: BOOL; OverRange: BOOL; ExtenRange: BOOL; DataInvalid: BOOL; RangeInvalid: BOOL; AutoRangeDis: BOOL; Error: BOOL; SteadyState: BOOL; (\*if last 4 values no more than x/1024 of end value apart, this is true\*)END\_STRUCTEND\_TYPE |
| Type Name | ThermStatusStruct |
| Description | Status inputs from EL3692 |
| Definition |  |
| Element: | Name: UnderRangeType:BOOLDescription: the resistance is under the range |
| Element: | Name: OverRangeType:BOOLDescription: the resistance is over the range |
| Element: | Name: ExtenRangeType:BOOLDescription: the EL3692 is using its extended range |
| Element: | Name: DataInvalidType:BOOLDescription:  |
| Element: | Name: RangeInvalidType: BOOLDescription: the range specificed is invalid |
| Element: | Name: AutoRangeDisType:BOOLDescription: disable autorange |
| Element: | Name: ErrorType:BOOLDescription:  |
| Element: | Name: SteadyStateType: BOOLDescription: The last four measurements are all within x.1% of the end value |

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| **Type**TYPE ThermControlStruct :STRUCT DisableAutoRange: BOOL; Mode: BYTE; Range: SINT;END\_STRUCTEND\_TYPE |
| Type Name | ThermControlStruct |
| Description | Structure that controls EL3692 |
| Definition |  |
| Element: | Name: DisableAutoRangeType:BOOLDescription: disables autorange |
| Element: | Name: ModeType:BYTE (maos to 4BIT)Description: indicates mode, 2 resistor measurement or 1, single shot or continuous measurements |
| Element: | Name: RangeType:SINTDescription: Allows user to set the range |

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| **Function Block**FUNCTION\_BLOCK TECControllerFBVAR\_INPUT Request: SaveRestoreEnum; TECControllerIn: TECControllerINStruct;END\_VARVAR\_OUTPUT TECControllerOut: TECControllerOutStruct;END\_VARVAR\_IN\_OUT TECControllerInit: TECControllerStruct; TECController: TECControllerStruct;END\_VARVAR ErrorHandler: ErrorHandlerFB; ConvertRtoT: RtoTempFB; ErrorCheck: ErrorCheckFB; PIServo: PIServoFB;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: 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 |

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| **Visual**{copy screen snapshot here} |
| Name |  |
| Description |  |
| Placeholder | Name:Type:Description: |
| Placeholder | Name:Type:Description: |
| Placeholder | Name:Type:Description: |