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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.JPG  C:\Users\Sheila2\Documents\My Documents\ALS\SHG oven\ALSSHG 002.JPG  With 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 high  0x0008 – TEC Current is too high  0x0010 – TEC power dissipated if too high  0x0020 – Integrator limit is exceeded (currently integrator limit is 100V)  0x0040 – Thermistor data invalid  0x0080 – Thermistor measurement error  ThermistorFB:  0x0001 – Thermistor resistance too high (open)  0x0002 - Thermistor resistance too low (short)  0x0004 – Thermistor data invalid  0x0008 – 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\_STRUCT  END\_TYPE | |
| Type name | ThermStatusStruct |
| Description | Status information of the EL3692 |
| Element | Name: UnderRange  Type: BOOL  Description: Indicates an under range condition |
| Element | Name: OverRange  Type: BOOL  Description: Indicates an over range condition |
| Element | Name: ExtenRange  Type: BOOL  Description: Indicates an extended range condition |
| Element | Name: DataInvalid  Type: BOOL  Description: Indicates the data is invalid |
| Element | Name: RangeInvalid  Type: BOOL  Description: Indicates the range is invalid |
| Element | Name: AutoRangeDis  Type: BOOL  Description: Indicates the auto ranging is disabled |
| Element | Name: Error  Type: BOOL  Description: Indicates an error condition |
| Element | Name: SteadyState  Type: BOOL  Description: measurement is in steady state  At last 4 values no more than x/1024 apart |

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

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| **Hardware Input Type**  TYPE TECControllerInStruct :  STRUCT  ThermStatus: ThermStatusStruct;  ThermValue: REAL;  TECVoltageReadback: INT;  TECCurrentReadback: INT;  END\_STRUCT  END\_TYPE | |
| Type name | TECControllerInStruct |
| Description | Hardware inputs |
| Definition | STRUCT |
| Element | Name: ThermStatus  Type:ThermStatusStruct  Description: Structure of status indicators for resistance measurement module EL3692 |
| Element | Name: ThemValue  Type: REAL  Description: resistance of thermistor |
| Element | Name: TECVoltageReadback  Type: INT  Description: readback of voltage across the TEC |
| Element | Name: TECCurrentReadback  Type: INT  Description: 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\_STRUCT  END\_TYPE | |
| Type name | ThermControlStruct |
| Description | Control information of the EL3692 |
| Definition | STRUCT |
| Element | Name: DisableAutoRange  Type: BOOL  Description: Disable the auto-ranging feature |
| Element | Name: Mode  Type: BYTE  Description: 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: Range  Type: SINT  Description: 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: StartConv  Type: BOOL  Description: Start a measurement in single shot mode |

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

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| **Hardware Output Type**  TYPE TECControllerOutStruct :  STRUCT  ThermControl: ThermControlStruct;  TECVoltageSet: INT;  END\_STRUCT  END\_TYPE | |
| Type name | TECControllerOutStruct |
| Description | Hardware outputs |
| Definition | STRUCT |
| Element | Name: ThermControl  Type: ThermControlStruct  Description: Structure of control bits for EL3692 |
| Element | Name: TECVoltageSet  Type:INT  Description: 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\_STRUCT  END\_TYPE | |
| Type name | TECControllerStruct |
| Description | User interface inputs and outputs for TECController |
| Definition | STRUCT |
| Input tags | Name: Error  Type: ErrorStruct  Description: for use by error handler |
| Input tags | Name: ThermistorTemperature  Type: LREAL  Description: Temperature (in C) measured by thermistor |
| Input tags | Name: TECVoltageBack  Type:LREAL  Description: Voltage readback, in units of volts over TEC |
| Output tags | Name: TECCurrentBack  Type:LREAL  Description:TEC Current readback |
| Output tags | Name: TECVoltsOut  Type:LREAL  Description:Volts sent to TEC, in units of volts over TEC |
| Output tags | Name: Fault  Type:BOOL  Description: Is there an error condition that required output voltage to go to zero? |
| Output tags | Name:SetTemp  Type:LREAL  Description: Temperature setting for servo |
| Output tags | Name:Servo  Type:BOOL  Description: Is the servo on? |
| Output tags | Name:UnityGain  Type: LREAL  Description: unity gain setting for servo |
| Output tags | Name:ClearInt  Type:BOOL  Description: 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:OldControlSig  Type:LREAL  Description: 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\_STRUCT  END\_TYPE | |
| Type name | ThermistorStruct |
| Description | User interface inputs and outputs for a thermistor readout |
| Definition | STRUCT |
| Input tags | Name: Error  Type: ErrorStruct  Description: for use by error handler |
| Input tags | Name: Temperature  Type: LREAL  Description: Temperature (in C) measured by thermistor |

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

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