ASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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TECController Library Documentation

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LIGO Scientific Collaboration

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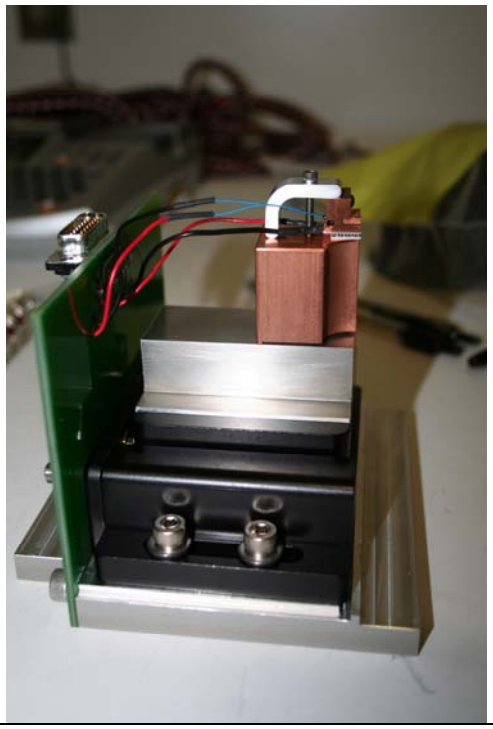
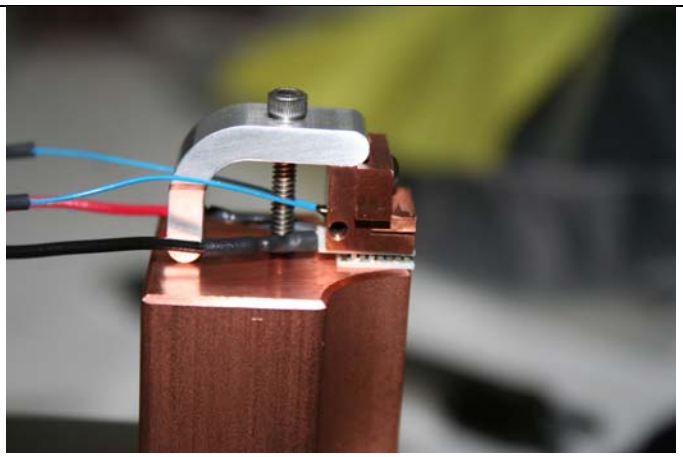
Library	
Title	TECController
Version	1
TwinCAT version	2.11.2230
Name space	
Author	Sheila Dwyer
Description	Controls the temperature of an SHG oven, using Beckhoff modules EL3692 to measure the temperature using a 10kOhm thermistor (epcos PN: B57861S0103F040), EL3102 to sense the temperature and a TEC 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. 

	 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	0x0001 – Thermistor resistance too high (open) 0x0002 - Thermistor resistance too low (short) 0x0003 - TEC Voltage too high 0x0004 – TEC Current is too high 0x0005 – TEC power dissipated if too high 0x0006 – Integrator limit is exceeded (currently integrator limit is 100V) 0x0007 – Thermistor data invalid 0x0008 – Thermistor measurement error
Library Dependencies	SaveRestore, Error, ReadADC, WriteADC

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	
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

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

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)

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_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.

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_STRUCT
END_TYPE

Type Name	ThermStatusStruct
Description	Status inputs from EL3692
Definition	
Element:	Name: UnderRange Type:BOOL Description: the resistance is under the range
Element:	Name: OverRange Type:BOOL Description: the resistance is over the range
Element:	Name: ExtenRange Type:BOOL Description: the EL3692 is using its extended range
Element:	Name: DataInvalid Type:BOOL Description:
Element:	Name: RangeInvalid Type: BOOL Description: the range specificed is invalid
Element:	Name: AutoRangeDis Type:BOOL Description: disable autorange
Element:	Name: Error Type:BOOL Description:
Element:	Name: SteadyState Type: BOOL Description: The last four measurements are all within x.1% of the end value

Type
TYPE ThermControlStruct :
STRUCT
DisableAutoRange: BOOL;
Mode: BYTE;
Range: SINT;

END_STRUCT
END_TYPE

Type Name	ThermControlStruct
Description	Structure that controls EL3692

Definition	
Element:	Name: DisableAutoRange Type:BOOL Description: disables autorange
Element:	Name: Mode Type:BYTE (maos to 4BIT) Description: indicates mode, 2 resistor measurement or 1, single shot or continuous measurements
Element:	Name: Range Type:SINT Description: Allows user to set the range

Function Block

```
FUNCTION_BLOCK TECControllerFB
VAR_INPUT
        Request:                SaveRestoreEnum;
        TECControllerIn:        TECControllerINStruct;
END_VAR
VAR_OUTPUT
        TECControllerOut:       TECControllerOutStruct;
END_VAR
VAR_IN_OUT
        TECControllerInit:      TECControllerStruct;
        TECController:          TECControllerStruct;
END_VAR
VAR
        ErrorHandler:           ErrorHandlerFB;
        ConvertRtoT:            RtoTempFB;
        ErrorCheck:             ErrorCheckFB;
        PIServo:                PIServoFB;
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: 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

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