



LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Advanced LIGO

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TEC Controller Library Documentation

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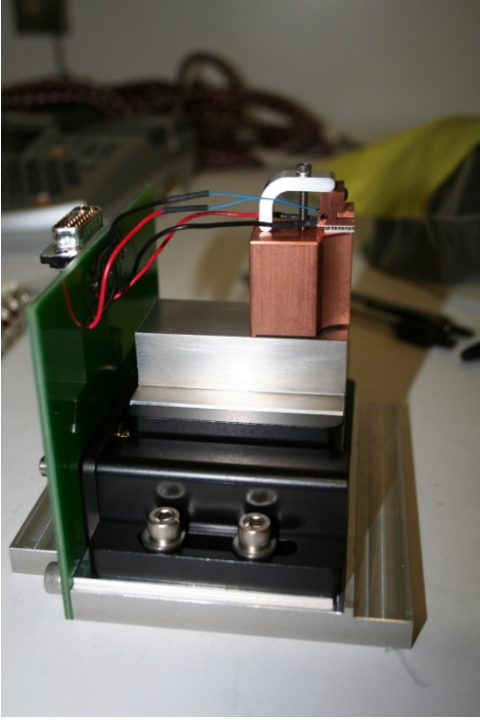
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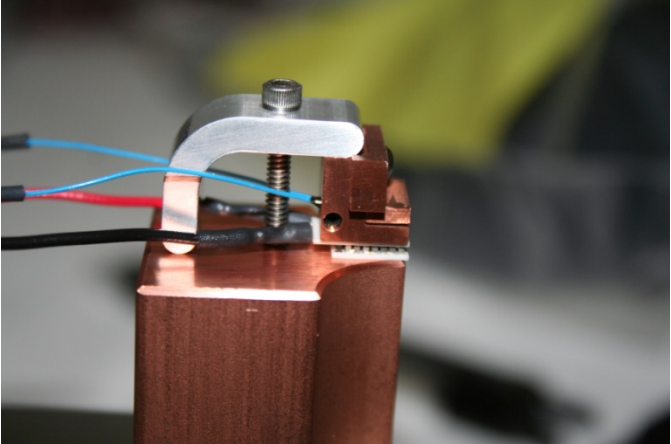
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Library	
Title	TECController
Version	1
TwinCAT version	2.11.2230
Name space	
Author	Sheila Dwyer
Description	<p>Controls the temperature of an SHG oven, using Beckhoff modules EL3692 to measure the temperature using a 10kOhm thermistor (epcos PN: B57861S0103F040), EL3102 to sense the temperature and a TEC from Laird technologies, HOT20, 31, F2A, 0909 and EL4132 for TEC outputs.</p> <p>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.</p>
	

	 <p data-bbox="574 646 1437 701">With the unity gain frequency of the servo set to 5Hz, the overshoot is about 20%, so this is a good nominal setting.</p>
Error Codes	<p data-bbox="574 722 787 747">TECControllerFB:</p> <ul style="list-style-type: none"> <li data-bbox="574 760 1133 789">0x0001 – Thermistor resistance too high (open) <li data-bbox="574 802 1117 831">0x0002 - Thermistor resistance too low (short) <li data-bbox="574 844 938 873">0x0004 - TEC Voltage too high <li data-bbox="574 886 971 915">0x0008 – TEC Current is too high <li data-bbox="574 928 1075 957">0x0010 – TEC power dissipated if too high <li data-bbox="574 970 1409 999">0x0020 – Integrator limit is exceeded (currently integrator limit is 100V) <li data-bbox="574 1012 961 1041">0x0040 – Thermistor data invalid <li data-bbox="574 1054 1052 1083">0x0080 – Thermistor measurement error <p data-bbox="574 1108 747 1138">ThermistorFB:</p> <ul style="list-style-type: none"> <li data-bbox="574 1150 1133 1180">0x0001 – Thermistor resistance too high (open) <li data-bbox="574 1192 1117 1222">0x0002 - Thermistor resistance too low (short) <li data-bbox="574 1234 961 1264">0x0004 – Thermistor data invalid <li data-bbox="574 1276 1052 1306">0x0008 – Thermistor measurement error
Library Dependencies	SaveRestore, Error, ReadADC, WriteADC

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

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

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

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 m Ω - 100 m Ω 0: 100 m Ω - 1 Ω 1: 1 Ω - 10 Ω 2: 10 Ω - 100 Ω 3: 100 Ω - 1 k Ω 4: 1 k Ω - 10 k Ω 5: 10 k Ω - 100 k Ω 6: 100 k Ω - 1 M Ω 7: 1 M Ω - 10 M Ω
Element	Name: StartConv Type: BOOL Description: Start a measurement in single shot mode

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

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;	
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.

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

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 thermistor
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

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