LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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TwinCAT Library for VCXO

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Library	
Title	Vcxo
Version	1
TwinCAT version	2.11
Name space	–
Author	Daniel Sigg
Description	Controls the VCXO, D1600500 The internal RF power monitors has the calibration $$P = 12\ \mathrm{dBm} - 10\ \mathrm{dBm/V} \times (U - 4\ \mathrm{V})$$ With U the measured voltage. The external RF power monitors have the calibration $$P = -8\ \mathrm{dBm} + R - 10\ \mathrm{dBm/V} \times (U - 4\ \mathrm{V})$$ Where R is the coupler ratio in dB (positive between 0 and 120 dB) that is used by the measurement setup. The corresponding temperature readout has the calibration $$T = 20°\mathrm{C} + 50°\mathrm{C/V} \times (U * 1.10 - 6\ \mathrm{V})$$ The RF power levels should be alarmed when outside ±1dBm of nominal. The only set value is a tune offset into the VXCO which translates into a frequency offset at the output. A binary output is used to enable the excitation input. Additional monitors are available for the tune voltage, the state of the excitation switch, and a power ok bit. If a frequency counter has been setup through the timing system, the measured frequency can be stabilized by feeding back to the bias offset. This then allows the user to select a fixed output frequency.
Error codes	0x01 – Power supply voltages out-of-range 0x02 – Output RF power level out-of-range 0x04 – Excitation switch enabled 0x08 – Invalid coupler 1 ratio 0x10 – Invalid coupler 2 ratio 0x20 – Invalid frequency 0x40 – Controls error Controls errors: 0x01 – Unity gain frequency too high 0x02 – Unity gain frequency too low 0x04 – High limit reached 0x08 – Low limit reached 0x10 – Invalid error signal 0x20 – Invalid set frequency
Library dependencies:	Error, SaveRestore, ReadADC. WriteDAC

Hardware Input Type

```
TYPE VcxoInStruct :
STRUCT
        OutputMon:          INT;
        Extra1Mon:          INT;
        Extra2Mon:          INT;
        OutputTemp:         INT;
        Extra1Temp:         INT;
        Extra2Temp:         INT;
        TuneMon:            INT;
        Spare:              INT;
        ExcitationSwitch:   BOOL;
        PowerOk:            BOOL;
END_STRUCT
END_TYPE
```

Type name	VcxoInStruct
Description	Structure of the hardware inputs that are wired up for the VCXO
Definition	STRUCT
Element	Name: OutputMon Type: INT Description: Monitors the RF power at the output amplifier
Element	Name: Extra1Mon Type: INT Description: Monitors the RF power at the first extra monitor
Element	Name: Extra2Mon Type: INT Description: Monitors the RF power after the second extra monitor
Element	Name: OutputTemp Type: INT Description: Monitors the temperature of the output RF detector
Element	Name: Extra1Temp Type: INT Description: Monitors the temperature of the first extra RF detector
Element	Name: Extra2Temp Type: INT Description: Monitors the temperature of the second extra RF detector
Element	Name: TuneMon Type: INT Description: Monitor for the frequency offset

Element	Name: Spare Type: INT Description: Spare tag
Element	Name: ExcitationSwitch Type: BOOL Description: Monitors the excitation input enable
Element	Name: PowerOk Type: BOOL Description: Voltage monitor readback

Hardware Output Type	
TYPE VcxoOutStruct : STRUCT TuneOfs: INT; ExcitationEn: BOOL; END_STRUCT END_TYPE	
Type name	VcxoOutStruct
Description	Structure of the hardware outputs that are wired up for the VCXO
Definition	STRUCT
Element	Name: TuneOfs Type: INT Description: Setpoint for the frequency offset
Element	Name: ExcitationEn Type: BOOL Description: Enables the excitation input

User Interface Type

```
TYPE VcxoStruct :
STRUCT
        Error:                  ErrorStruct;
        OutputMon:              LREAL;
        OuptutNom:              LREAL;
        OutputTemp:             LREAL;
        TuneOfs:                LREAL;
        TuneMon:                LREAL;
        TuneLimit:              LREAL;
        ExcitationSwitch:       BOOL;
        ExcitationEn:           BOOL;
        PowerOk:                BOOL;
        Frequency:              LREAL;
        FrequencyFault:         BOOL;
        Controls:               VcxoControlsStruct;
END_STRUCT
END_TYPE
```

Type name	VcxoStruct
Description	Structure of the user interface tags that are used to control the VCXO
Definition	STRUCT
Output Tag	Name: Error Type: ErrorStruct Description: For error handler
Output Tag	Name: OutputMon Type: LREAL Description: Monitors the RF power after the output amplifier dBm
Input Tag	Name: OutputNom Type: LREAL Description: Nominal value for the RF power at the output amplifier in dBm
Output Tag	Name: OutputTemp Type: LREAL Description: Monitors the temperature of the output RF detector in C
Input Tag	Name: TuneOfs Type: LREAL Description: Setpoint for the frequency offset in V
Output Tag	Name: TuneMon Type: LREAL Description: Monitor for the frequency offset in V
Input Tag	Name: TuneLimit Type: LREAL Description: Limit for the frequency offset in V

Input Tag	Name: ExcitationEn Type: BOOL Description: Enables the excitation input
Output Tag	Name: ExcitationSwitch Type: BOOL Description: Monitors the excitation input enable
Output Tag	Name: PowerOk Type: BOOL Description: Voltage monitor readback
Output Tag	Name: Frequency Type: LREAL Description: Frequency of the VCO output
Output Tag	Name: FrequencyFault Type: BOOL Description: Indicates if the frequency of the VCO is no longer updating correctly
Input Tag	Name: Controls Type: VcxoControlsStruct Description: VCO frequency controls parameters

User Interface Type

```
TYPE VcxoControlsStruct:
STRUCT
        Error:                  ErrorStruct;
        Fault:                  BOOL;
        SetFrequency:           LREAL;
        SetFrequencyOffset:     LREAL;
        DiffFrequency:          LREAL;
        Enable:                 BOOL;
        UnityGain:              LREAL;
        ClearInt:               BOOL;
END_STRUCT
END_TYPE
```

Type name	VcxoControlsStruct
Description	Structure of the user interface that is used to control the frequency of the low noise VCO
Definition	STRUCT
Output Tag	Name: Error Type: ErrorStruct Description: For error handler
Output Tag	Name: Fault Type: BOOL Description: Indicated a servo fault
Input Tag	Name: SetFrequency Type: LREAL Description: Set frequency in Hz
Input Tag	Name: SetFrequencyOffset Type: LREAL Description: Set frequency offset in Hz
Output Tag	Name: DiffFrequency Type: LREAL Description: Difference between measured and set frequency in Hz
Input Tag	Name: Enable Type: BOOL Description: Enable the servo
Input Tag	Name: UnityGain Type: LREAL Description: Unity gain frequency in Hz
Input Tag	Name: ClearInt Type: BOOL Description: Clear the history of the integrator

Function Block

```
FUNCTION_BLOCK VcxoFB
VAR_INPUT
        Request:            SaveRestoreEnum;
        VcxoIn:             VcxoInStruct;
        Frequency:          LREAL := 0.0;
        FrequencyError:     BOOL := TRUE;
        ExtUpdateRate:      INT := 1;
        UseSigmaDelta:      BOOL := TRUE;
        VcxoFrequency:      LREAL := 203.125000E6;
        VcxoTuningCoef:     LREAL := -3E-6;
END_VAR
VAR_INPUT CONSTANT
        R1:                 LREAL := 20.0;
        R2:                 LREAL := 20.0;
END_VAR
VAR_OUTPUT
        VcxoOut:            VcxoOutStruct;
        Extra1Mon:          INT;
        Extra2Mon:          INT;
END_VAR
VAR_IN_OUT
        VcxoInit:           VcxoStruct;
        Vcxo:               VcxoStruct;
END_VAR
```

Name	VcxoFB
Description	Controls the VCXO. One function block for each VCXO chassis needs to be instantiated.
Input argument	Name: Request Type: SaveRestoreEnum Description: Save restore command
Input argument	Name: R1 Type: LREAL Description: Ratio of coupler 1 in dB, must be between 0 and 120.
Input argument	Name: R2 Type: LREAL Description: Ratio of coupler 2 in dB, must be between 0 and 120.

Input argument	Name: Frequency Type: LREAL Description: Externally measured frequency of VCO Default: 0
Input argument	Name: FrequencyError Type: BOOL Description: Externally measured frequency is invalid Default: TRUE (invalid)
Input argument	Name: ExtUpdateRate Type: INT Description: How much is the update rate of external frequency readback slower than the processing clock. For 10 ms processing clock, a value of 100 corresponds to 1s updates, such as through the timing system. Default: 1 (10ms)
Input argument	UseSigmaDelta Type: BOOL If true, use a sigma-delta modulator for averaging the control signal. Default: TRUE
Input argument	Name: VcxoFrequency Type: LREAL Center frequency of XO in Hz. Default: 203.125000E6
Input argument	Name: VcxoTuningCoef Type: LREAL Tuning coefficient of XO in ppm/V. Use a negative value, if the tuning input has a negative slope. Default: -3E-6
Input argument	Name: VcxoIn Type: VcxoInStruct Description: Input hardware structure
Output argument	Name: VcxoOut Type: VcxoOutStruct Description: Output hardware structure
Output argument	Name: Extra1Mon Type: INT Description: Uncalibrated output of first extra RF monitor corrected for a coupler ratio different from 20dB.
Output argument	Name: Extra2Mon Type: INT Description: Uncalibrated output of first extra RF monitor corrected for a coupler ratio different from 20dB.

In/out argument	Name: VcxoInit Type: VcxoStruct Description: Save/restore variables in persistent memory
In/out argument	Name: Vcxo Type: VcxoStruct Description: User Interface structure