*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](https://dcc.ligo.org/LIGO-D1600500)  The internal RF power monitors has the calibration  With the measured voltage.  The external RF power monitors have the calibration  Where 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  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 |

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| **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 |

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| **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 |

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| **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 |

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| **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 |

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| **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 |