*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$$P=12 dBm-10 dBm/V×(U-4 V)$$With $U$ the measured voltage.The external RF power monitors have the calibration$$P=-8 dBm+R-10 dBm/V×\left(U-4 V\right)$$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$$T=20°C+50°C/V×(U\*1.10-6 V)$$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-range0x02 – Output RF power level out-of-range0x04 – Excitation switch enabled0x08 – Invalid coupler 1 ratio0x10 – Invalid coupler 2 ratio0x20 – Invalid frequency0x40 – Controls errorControls errors:0x01 – Unity gain frequency too high0x02 – Unity gain frequency too low0x04 – High limit reached0x08 – Low limit reached0x10 – Invalid error signal0x20 – 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\_STRUCTEND\_TYPE |
| Type name | VcxoInStruct |
| Description | Structure of the hardware inputs that are wired up for the VCXO |
| Definition | STRUCT |
| Element | Name: OutputMonType: INTDescription: Monitors the RF power at the output amplifier |
| Element | Name: Extra1MonType: INTDescription: Monitors the RF power at the first extra monitor |
| Element | Name: Extra2MonType: INTDescription: Monitors the RF power after the second extra monitor |
| Element | Name: OutputTempType: INTDescription: Monitors the temperature of the output RF detector |
| Element | Name: Extra1TempType: INTDescription: Monitors the temperature of the first extra RF detector |
| Element | Name: Extra2TempType: INTDescription: Monitors the temperature of the second extra RF detector |
| Element | Name: TuneMonType: INTDescription: Monitor for the frequency offset |
| Element | Name: SpareType: INTDescription: Spare tag |
| Element | Name: ExcitationSwitchType: BOOLDescription: Monitors the excitation input enable |
| Element | Name: PowerOkType: BOOLDescription: Voltage monitor readback |

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| **Hardware Output Type**TYPE VcxoOutStruct :STRUCT TuneOfs: INT; ExcitationEn: BOOL;END\_STRUCTEND\_TYPE |
| Type name | VcxoOutStruct |
| Description | Structure of the hardware outputs that are wired up for the VCXO |
| Definition | STRUCT |
| Element | Name: TuneOfsType: INTDescription: Setpoint for the frequency offset |
| Element | Name: ExcitationEnType: BOOLDescription: 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\_STRUCTEND\_TYPE |
| Type name | VcxoStruct |
| Description | Structure of the user interface tags that are used to control the VCXO |
| Definition | STRUCT |
| Output Tag | Name: ErrorType: ErrorStructDescription: For error handler |
| Output Tag | Name: OutputMonType: LREALDescription: Monitors the RF power after the output amplifier dBm |
| Input Tag | Name: OutputNomType: LREALDescription: Nominal value for the RF power at the output amplifier in dBm |
| Output Tag | Name: OutputTempType: LREALDescription: Monitors the temperature of the output RF detector in C |
| Input Tag | Name: TuneOfsType: LREALDescription: Setpoint for the frequency offset in V |
| Output Tag | Name: TuneMonType: LREALDescription: Monitor for the frequency offset in V |
| Input Tag | Name: TuneLimitType: LREALDescription: Limit for the frequency offset in V |
| Input Tag | Name: ExcitationEnType: BOOLDescription: Enables the excitation input |
| Output Tag | Name: ExcitationSwitchType: BOOLDescription: Monitors the excitation input enable |
| Output Tag | Name: PowerOkType: BOOLDescription: Voltage monitor readback |
| Output Tag | Name: FrequencyType: LREALDescription: Frequency of the VCO output |
| Output Tag | Name: FrequencyFaultType: BOOLDescription: Indicates if the frequency of the VCO is no longer updating correctly |
| Input Tag | Name: ControlsType: VcxoControlsStructDescription: 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\_STRUCTEND\_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: ErrorType: ErrorStructDescription: For error handler |
| Output Tag | Name: FaultType: BOOLDescription: Indicated a servo fault |
| Input Tag | Name: SetFrequencyType: LREALDescription: Set frequency in Hz |
| Input Tag | Name: SetFrequencyOffsetType: LREALDescription: Set frequency offset in Hz |
| Output Tag | Name: DiffFrequencyType: LREALDescription: Difference between measured and set frequency in Hz |
| Input Tag | Name: EnableType: BOOLDescription: Enable the servo |
| Input Tag | Name: UnityGainType: LREALDescription: Unity gain frequency in Hz |
| Input Tag | Name: ClearIntType: BOOLDescription: Clear the history of the integrator |

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| **Function Block**FUNCTION\_BLOCK VcxoFBVAR\_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\_VARVAR\_INPUT CONSTANT R1: LREAL := 20.0; R2: LREAL := 20.0;END\_VARVAR\_OUTPUT VcxoOut: VcxoOutStruct; Extra1Mon: INT; Extra2Mon: INT;END\_VARVAR\_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: RequestType: SaveRestoreEnumDescription: Save restore command |
| Input argument | Name: R1Type: LREALDescription: Ratio of coupler 1 in dB, must be between 0 and 120. |
| Input argument | Name: R2Type: LREALDescription: Ratio of coupler 2 in dB, must be between 0 and 120. |
| Input argument | Name: FrequencyType: LREALDescription: Externally measured frequency of VCODefault: 0 |
| Input argument | Name: FrequencyErrorType: BOOLDescription: Externally measured frequency is invalidDefault: TRUE (invalid) |
| Input argument | Name: ExtUpdateRateType: INTDescription: 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 | UseSigmaDeltaType: BOOLIf true, use a sigma-delta modulator for averaging the control signal.Default: TRUE |
| Input argument | Name: VcxoFrequencyType: LREALCenter frequency of XO in Hz.Default: 203.125000E6 |
| Input argument | Name: VcxoTuningCoefType: LREALTuning coefficient of XO in ppm/V. Use a negative value, if the tuning input has a negative slope.Default: -3E-6 |
| Input argument | Name: VcxoInType: VcxoInStructDescription: Input hardware structure |
| Output argument | Name: VcxoOutType: VcxoOutStructDescription: Output hardware structure |
| Output argument | Name: Extra1MonType: INTDescription: Uncalibrated output of first extra RF monitor corrected for a coupler ratio different from 20dB.  |
| Output argument | Name: Extra2MonType: INTDescription: Uncalibrated output of first extra RF monitor corrected for a coupler ratio different from 20dB. |
| In/out argument | Name: VcxoInitType: VcxoStructDescription: Save/restore variables in persistent memory |
| In/out argument | Name: VcxoType: VcxoStructDescription: User Interface structure |