*LIGO Laboratory / LIGO Scientific Collaboration*

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TwinCAT Library for Low Noise VCO

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| **Library** |
| Title | LowNoiseVco |
| Version | 4 |
| TwinCAT version | 2.11 |
| Name space | – |
| Author | Daniel Sigg |
| Description | Controls the low noise VCO, [D0900605](https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?.submit=Number&docid=D0900605&version=)The low noise VCO is based on a frequency difference divider. It requires a 71MHz/10dBm reference source and a VCO source at either 125MHz or 79MHz. Both RF levels as well as the RF level at the output of the frequency difference divider are monitored. The only set value is an offset into the VCO 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.The 3 RF power monitors which have the calibration$$P=12 dBm-10 dBm/V×(U-4 V)$$The corresponding temperature readout has the calibration$$T=20°C+50°C/V×(U-6 V)$$The RF power levels should be alarmed when outside ±1dBm of nominal. |
| Error codes | 0x01 – Power supply voltages out-of-range0x02 – Reference RF power level out-of-range0x04 – Divider RF power level out-of-range0x08 – Output RF power level out-of-range0x10 – Excitation switch enabled0x20 – 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 LowNoiseVcoInStruct :STRUCT ReferenceMon: INT; DividerMon: INT; OutputMon: INT; ReferenceTemp: INT; DividerTemp: INT; OutputTemp: INT; TuneMon: INT; Frequency: LREAL; (\* not used \*) ExcitationSwitch: BOOL; PowerOk: BOOL; FrequencyLive: BOOL; (\* not used \*)END\_STRUCTEND\_TYPE |
| Type name | LowNoiseVcoInStruct |
| Description | Structure of the hardware inputs that are wired up for the low noise VCO |
| Definition | STRUCT |
| Element | Name: ReferenceMonType: INTDescription: Monitors the RF power at the reference input |
| Element | Name: DividerMonType: INTDescription: Monitors the RF power at the divider input |
| Element | Name: OutputMonType: INTDescription: Monitors the RF power after the output amplifier |
| Element | Name: ReferenceTempType: INTDescription: Monitors the temperature of the reference RF detector |
| Element | Name: DividerTempType: INTDescription: Monitors the temperature of the divider RF detector |
| Element | Name: OutputTempType: INTDescription: Monitors the temperature of the output RF detector |
| Element | Name: TuneMonType: INTDescription: Monitor for the frequency offset |
| Element | Name: FrequencyType: LREALDescription: Measured frequency |
| Element | Name: ExcitationSwitchType: BOOLDescription: Monitors the excitation input enable |
| Element | Name: PowerOkType: BOOLDescription: Voltage monitor readback |
| Element | Name: FrequencyLiveType: BOOLDescription: Keep alive for frequency measurement |

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| **Hardware Output Type**TYPE LowNoiseVcoOutStruct :STRUCT TuneOfs: INT; ExcitationEn: BOOL;END\_STRUCTEND\_TYPE |
| Type name | LowNoiseVcoOutStruct |
| Description | Structure of the hardware outputs that are wired up for the low noise VCO |
| 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 LowNoiseVcoStruct :STRUCT Error: ErrorStruct; ReferenceMon: LREAL;  ReferenceNom: LREAL; DividerMon: LREAL;  DividerNom: LREAL; OutputMon: LREAL;  OuptutNom: LREAL; ReferenceTemp: LREAL;  DividerTemp: LREAL; OutputTemp: LREAL; TuneOfs: LREAL; TuneMon: LREAL; TuneLimit: LREAL; ExcitationSwitch: BOOL; ExcitationEn: BOOL; PowerOk: BOOL; Frequency: LREAL; FrequencyFault: BOOL; Controls: LowNoiseVcoControlsStruct;END\_STRUCTEND\_TYPE |
| Type name | LowNoiseVcoStruct |
| Description | Structure of the user interface tags that are used to control the low noise VCO |
| Definition | STRUCT |
| Output Tag | Name: ErrorType: ErrorStructDescription: For error handler |
| Output Tag | Name: ReferenceMonType: LREALDescription: Monitors the RF power at the reference input in dBm |
| Input Tag | Name: ReferenceNomType: LREALDescription: Nominal value for the RF power at the reference input in dBm |
| Output Tag | Name: DividerMonType: LREALDescription: Monitors the RF power at the divider input in dBm |
| Input Tag | Name: DividerNomType: LREALDescription: Nominal value for the RF power at the divider input in dBm |
| 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: ReferenceTempType: LREALDescription: Monitors the temperature of the reference RF detector in C |
| Output Tag | Name: DividerTempType: LREALDescription: Monitors the temperature of the divider RF detector in C |
| 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: LowNoiseVcoControlsStructDescription: VCO frequency controls parameters |

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| **User Interface Type**TYPE LowNoiseVcoControlsStruct:STRUCT Error: ErrorStruct; Fault: BOOL; SetFrequency: LREAL; SetFrequencyOffset: LREAL; DiffFrequency: LREAL; Enable: BOOL; UnityGain: LREAL; ClearInt: BOOL;END\_STRUCTEND\_TYPE |
| Type name | LowNoiseVcoControlsStruct |
| 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 LowNoiseVcoFBVAR\_INPUT Request: SaveRestoreEnum; LowNoiseVcoIn: LowNoiseVcoInStruct; Frequency: LREAL := 0.0; FrequencyError: BOOL := TRUE; FddStages: INT := 1; UseSigmaDelta: BOOL := TRUE;END\_VARVAR\_OUTPUT LowNoiseVcoOut: LowNoiseVcoOutStruct;END\_VARVAR\_IN\_OUT LowNoiseVcoInit: LowNoiseVcoStruct; LowNoiseVco: LowNoiseVcoStruct;END\_VARVAREND\_VAR |
| Name | LowNoiseVcoFB |
| Description | Controls the low noise VCO. One function block for each low noise VCO chassis needs to be instantiated. |
| Input argument | Name: RequestType: SaveRestoreEnumDescription: Save restore command |
| Input argument | Name: LowNoiseVcoInType: LowNoiseVcoInStructDescription: Input hardware structure |
| Input argument | Name: FrequencyType: LREALDescription: Externally measured frequency of VCO |
| Input argument | Name: FrequencyErrorType: BOOLDescription: Externally measured frequency is invalid |
| Input argument | Name: FddStagesType: INTDescription: Number of frequency difference dividers used |
| Input argument | Name: UseSigmaDeltaType: BOOLDescription: Use a sigma delta modulator for averaging the control signal |
| Output argument | Name: LowNoiseVcoOutType: LowNoiseVcoOutStructDescription: Output hardware structure |
| In/out argument | Name: LowNoiseVcoInitType: LowNoiseVcoStructDescription: Save/restore variables in persistent memory |
| In/out argument | Name: LowNoiseVcoType: LowNoiseVcoStructDescription: User Interface structure |

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| **Visual** |
| Name | LowNoiseVcoVis |
| Description | Displays several MON and temperature readings, power and excitation status, and error alarms |
| Placeholder | Name: LowNoiseVCOType: LowNoiseVCOStructDescription: Low Noise VCO structure |