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LIGO-E1200226-v5

Advanced LIGO

9/04/2013

**TwinCAT Library for Low Noise VCO**

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LIGO Scientific Collaboration

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<b>Library</b>	
Title	LowNoiseVco
Version	4
TwinCAT version	2.11
Name space	–
Author	Daniel Sigg
Description	<p>Controls the low noise VCO, <a href="#">D0900605</a></p> <p>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.</p> <p>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.</p> <p>The 3 RF power monitors which have the calibration</p> $P=12 \text{ dBm}-10 \text{ dBm/V} \times (U-4 \text{ V})$ <p>The corresponding temperature readout has the calibration</p> $T=20^{\circ}\text{C}+50^{\circ}\text{C/V} \times (U-6 \text{ V})$ <p>The RF power levels should be alarmed when outside <math>\pm 1\text{dBm}</math> of nominal.</p>
Error codes	<p>0x01 – Power supply voltages out-of-range  0x02 – Reference RF power level out-of-range  0x04 – Divider RF power level out-of-range  0x08 – Output RF power level out-of-range  0x10 – Excitation switch enabled  0x20 – Invalid frequency  0x40 – Controls error</p> <p>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</p>
Library dependencies:	Error, SaveRestore, ReadADC. WriteDAC

<b>Hardware Input Type</b>	
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_STRUCT	
END_TYPE	
Type name	LowNoiseVcoInStruct
Description	Structure of the hardware inputs that are wired up for the low noise VCO
Definition	STRUCT
Element	Name: ReferenceMon Type: INT Description: Monitors the RF power at the reference input
Element	Name: DividerMon Type: INT Description: Monitors the RF power at the divider input
Element	Name: OutputMon Type: INT Description: Monitors the RF power after the output amplifier
Element	Name: ReferenceTemp Type: INT Description: Monitors the temperature of the reference RF detector
Element	Name: DividerTemp Type: INT Description: Monitors the temperature of the divider RF detector
Element	Name: OutputTemp Type: INT Description: Monitors the temperature of the output RF detector
Element	Name: TuneMon Type: INT

	Description: Monitor for the frequency offset
Element	Name: Frequency Type: LREAL Description: Measured frequency
Element	Name: ExcitationSwitch Type: BOOL Description: Monitors the excitation input enable
Element	Name: PowerOk Type: BOOL Description: Voltage monitor readback
Element	Name: FrequencyLive Type: BOOL Description: Keep alive for frequency measurement

<b>Hardware Output Type</b> TYPE LowNoiseVcoOutStruct : STRUCT TuneOfs:                    INT; ExcitationEn:              BOOL; END_STRUCT END_TYPE	
Type name	LowNoiseVcoOutStruct
Description	Structure of the hardware outputs that are wired up for the low noise VCO
Definition	STRUCT
Element	Name: TuneOfs Type: INT Description: Setpoint for the frequency offset
Element	Name: ExcitationEn Type: BOOL Description: Enables the excitation input

<b>User Interface Type</b>	
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_STRUCT	
END_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: Error Type: ErrorStruct Description: For error handler
Output Tag	Name: ReferenceMon Type: LREAL Description: Monitors the RF power at the reference input in dBm
Input Tag	Name: ReferenceNom Type: LREAL Description: Nominal value for the RF power at the reference input in dBm
Output Tag	Name: DividerMon Type: LREAL

	Description: Monitors the RF power at the divider input in dBm
Input Tag	Name: DividerNom Type: LREAL Description: Nominal value for the RF power at the divider input in dBm
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: ReferenceTemp Type: LREAL Description: Monitors the temperature of the reference RF detector in C
Output Tag	Name: DividerTemp Type: LREAL Description: Monitors the temperature of the divider RF detector in C
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: LowNoiseVcoControlsStruct Description: VCO frequency controls parameters



<b>User Interface Type</b>	
TYPE LowNoiseVcoControlsStruct:	
STRUCT	
Error:	ErrorStruct;
Fault:	BOOL;
SetFrequency:	LREAL;
SetFrequencyOffset:	LREAL;
DiffFrequency:	LREAL;
Enable:	BOOL;
UnityGain:	LREAL;
ClearInt:	BOOL;
END_STRUCT	
END_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: 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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<b>Function Block</b> FUNCTION_BLOCK LowNoiseVcoFB VAR_INPUT Request:                 SaveRestoreEnum; LowNoiseVcoIn:         LowNoiseVcoInStruct; Frequency:             LREAL := 0.0; FrequencyError:        BOOL := TRUE; FddStages:             INT := 1; UseSigmaDelta:         BOOL := TRUE; END_VAR VAR_OUTPUT LowNoiseVcoOut:        LowNoiseVcoOutStruct; END_VAR VAR_IN_OUT LowNoiseVcoInit:       LowNoiseVcoStruct; LowNoiseVco:           LowNoiseVcoStruct; END_VAR VAR END_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: Request Type: SaveRestoreEnum Description: Save restore command
Input argument	Name: LowNoiseVcoIn Type: LowNoiseVcoInStruct Description: Input hardware structure
Input argument	Name: Frequency Type: LREAL Description: Externally measured frequency of VCO
Input argument	Name: FrequencyError Type: BOOL Description: Externally measured frequency is invalid
Input argument	Name: FddStages Type: INT Description: Number of frequency difference dividers used
Input argument	Name: UseSigmaDelta Type: BOOL Description: Use a sigma delta modulator for averaging the control

	signal
Output argument	Name: LowNoiseVcoOut Type: LowNoiseVcoOutStruct Description: Output hardware structure
In/out argument	Name: LowNoiseVcoInit Type: LowNoiseVcoStruct Description: Save/restore variables in persistent memory
In/out argument	Name: LowNoiseVco Type: LowNoiseVcoStruct Description: User Interface structure

<b>Visual</b>	
<p>The screenshot shows a graphical user interface for a Low Noise VCO. It features several monitoring displays and control elements:</p> <ul style="list-style-type: none"> <li>Two green status indicators at the top: "Power Ok" and "Excitation Switch".</li> <li>Monitoring displays for power levels: Reference Mon, Divider Mon, Output Mon, Reference Nom, Divider Nom, and Output Nom, each showing a value in dBm (e.g., %3.1f dBm).</li> <li>Monitoring displays for temperatures: Reference Temp, Divider Temp, and Output Temp, each showing a value in Celsius (e.g., %3.1f C).</li> <li>A "Tune Mon" display showing a voltage value in Volts (e.g., %3.4f V).</li> <li>An "Excitation Enable" checkbox.</li> <li>A "Tune Ofs" control consisting of a slider and a display showing a voltage value in Volts (e.g., %3.4f V).</li> <li>An "Error" indicator with a green background, showing a format string "%i %s".</li> <li>Four stacked error message boxes, each with a green indicator and a placeholder "\$ErrorMessage\$".</li> </ul>	
Name	LowNoiseVcoVis
Description	Displays several MON and temperature readings, power and excitation status, and error alarms
Placeholder	Name: LowNoiseVCO Type: LowNoiseVCOStruct Description: Low Noise VCO structure