

Name of the technology: An FPGA based General-purpose Lock-in Amplifier and PID Controller

Introduction: Active stabilization of any electronic signal requires accurate detection of the set-point. For this, the required electronic hardware are frequency generator for modulating the input signal, phase-sensitive *lock-in* for detection of the set point and a Proportional-Integral-Differential (PID) servo loop for dynamic correction of the input to keep it stabilized. Using the advanced digital electronics, all these three modules have been software implemented and that are embedded in a single Field Programmable Gate Array (FPGA) IC.

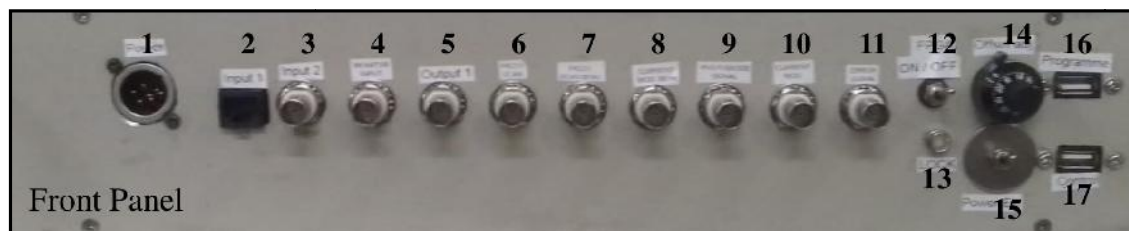


Figure 1: Front panel of the instrument that contains all the input/output (I/O) ports as indicated by 1-17.

Readiness level of the Technology:

Idea	Concept Definition	Proof of Concept	Prototype	Lab Validation	Technology Development	Technology Demonstration	Technology Integrated	Market Launch

Summary of the technology: We have designed, fabricated and tested a new compact all-in-one instrument that comprises of a frequency generator, *lock-in* detector and PID controller, as shown in Fig. 1, and its specifications are given in Table I. Salient features of the developed instrument are: (a) **Compact** – size is reduced compared to total size of frequency generator, lock-in and PID since all of them are implemented in a single FPGA, (b) **Computer control** – the instrument can be fully operated from a remote PC via a user-friendly graphical user interface, (c) **Low noise** – no noise pick up due to digital signal processing, (d) Architectural freedom – easily configurable and re-configurable without any hassle of soldering, and (e) **Cost effective** – off-the-shelf components hence the bill of material cost is very low.

Notable users:

Industries (communication, aviation, driver less transportation, signalling system, power distribution, anti-theft management etc.), maintenance system (stabilization of temperature, humidity, pressure, pH level,



vibration, laser parameter*etc.*), medical instruments (ECG, EEG, USG*etc.*), strategic sectors (secure communication, synchronization*etc.*), universities and research labs (material characterization, controlling experimental parameters and environment*etc.*) have wide applications of the developed instrument.

Table I: Specifications of the Instrument

Parameters	Frequency Generator	Lock-in Amplifier	PID
Damage Threshold	± 6 V	± 6 V	± 6 V
Resolution (I/O)	12 bit (I/O), 16 bit (O)	12 bit (I/O), 16 bit (O)	12 bit (I/O), 16 bit (O)
Max Output Amplitude	3.3 V and ± 5 V	3.3 V and ± 5 V	3.3 V and ± 5 V
Roll Off(4 th order filter)	NA	6 dB/Octave, 12 dB/Octave	NA
Phase Resolution	NA	0.02 deg	NA
Noise @ 10 kHz	26 nV Hz ^{-1/2}	26 nV Hz ^{-1/2}	26 nV Hz ^{-1/2}
Modulation Frequency	DC to 100 kHz	DC to 100 kHz	NA
Modulation Type	Square, Sinusoidal, Triangle, Sawtooth	Square and Sinusoidal	NA
Bandwidth	100 kHz	100 kHz	100 kHz
Signal Latency	NA	5.7(1) μ s	5.7(1) μ s
PI corner Frequency	NA	NA	10 kHz
K _P , K _I and K _D Gain	NA	NA	up to 60 dB

Related Patents: Patent No: **Know-how**, Country: **Not applicable**, Publication Date: **Not applicable**;
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Broad Area/Category: Electronics & Instrumentation

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