System Description of PLL-Evalboard-Synthesizer

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# Introduction

This document describes our Phase-Locked Loop (PLL) frequency synthesizer for generating medium-precision RF carrier wave (CW) signals. The Quantum Ion Trap group at the Institute for Quantum Computing (IQC) uses a series of evaluation boards from Analog Devices and Peregrine Semiconductor to provide a low-cost series of RF drive signals. Custom boards may be designed later if desired. These signals are calibrated to industry standards, not atomic standards, and so are medium-precision. Analog Devices documentation refers to *both* products as ‘microwave’ synthesizer, but in keeping with AMO community convention we delineate Microwave as >10 GHz, while RF is considered all lower frequency carriers.

# System Design

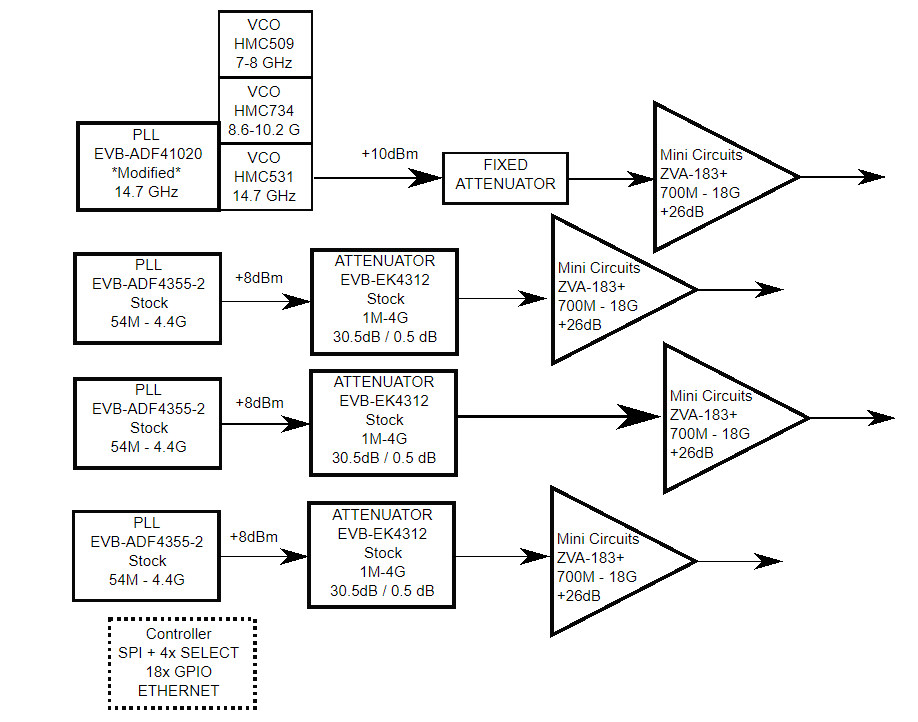


Figure - System Block Diagram

## Oscillator Configuration

The system is designed around a series of Phase-Locked Loop evaluation boards. The ADF-41020 phase locked loop provides microwave carrier, and ADF-4355-2 phase locked loop provides RF carriers. The 4355-2 is wider band, with on-chip voltage-controlled oscillator (VCO). The microwave synthesizer 41020 is narrower band and uses an external VCO.

## Modification of the Microwave Evaluation Board

The microwave synthesizer utilizes an external VCO (off-chip, but built into the evaluation board). The VCO is chosen often more limited than the PLL chip itself, and may be replaced should the eval board is used for certain frequencies. The ADF41020 evaluation board was designed around a specific VCO chip (Analog Devices/Hittite Microwave HMC515), so replacement VCOs must follow compatible pinouts. The following table shows several suitable replacements.

|  |  |
| --- | --- |
| **Frequency** | **Part** |
| 7-8 GHz | HMC509 |
| 8.6-10.2 GHz | HMC734 |
| 14.7 GHz | HMC531 |

This VCO replacement is the only substantial modification that requires delicate soldering operations.

## Amplitude Control

The RF system is designed with programmable amplitude control. The Peregrine Semiconductor EVB-EK4312 programmable attenuator is used to drive the input amplitude prior to final gain. The microwave synthesizer is not programmable due to lack of suitable evaluation board.

## Control Processor

The PLL oscillators and attenuators are controlled via a Raspberry Pi 3 control board. The PLL boards are controlled via serial peripheral interface (SPI) bus, while the attenuators are controlled as individual general-purpose I/O (GPIO) pins.

## Final Amplifier

The final drive to the appropriate laser modulator (AOM or EOM) is provided by a Mini-Circuits ZVA-183+ series power amplifier.

# Control Software

The Raspberry Pi 3 provides a Python control program to interface with GPIO lines and SPI. Details are given in a separate document.