Application Note -

Simulation of Modern Radar Systems using Pentek 78620 FPGA cards with the Giga-tronics GT-ASGM18A Advanced Signal Generator and GT-ASAM18A Advanced Signal Analyzer

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Published: November 1, 2015
Revision: A

Giga-tronics
Advanced Microwave Signal Generation and Analysis

Summary

Modern radar systems produce signals which are complex in nature using simultaneous multiple operational principles. The testing methods for these radar receiver systems must use advanced operational methods to meet the complex capabilities of the radar transmitter system. These new testing systems are designed to produce signal waveforms which have characteristics which are not only multi-dimensional in operational capability but are adaptable to the platform under test. Testing systems for these advanced requirements require technology that no only anticipates future requirements but also is modular in nature for reconfiguration of the testing methodology. This paper describes a fully modular system which is COTS, reconfigurable and includes capabilities to meet new radar receiver testing requirements.

Introduction

A radar system can be broken down into 4 distinct area of operation.

1. Waveform creation, i.e. the ability to create a specific waveform and schedule its playout in the form of a radar mode with specific RF characteristics (Pulse Width, Modulation) and an applicable PRI (Pulse Repetition Interval).
2. A microwave transmission system, or the ability to up convert the waveform with sufficient frequency and amplitude agility.
3. A microwave down conversion system with sufficient frequency and amplitude agility.
4. An IF processing system providing the appropriate signal processing to determine range, velocity and any other environmental conditions that will affect the radar's next set of waveforms or mode.

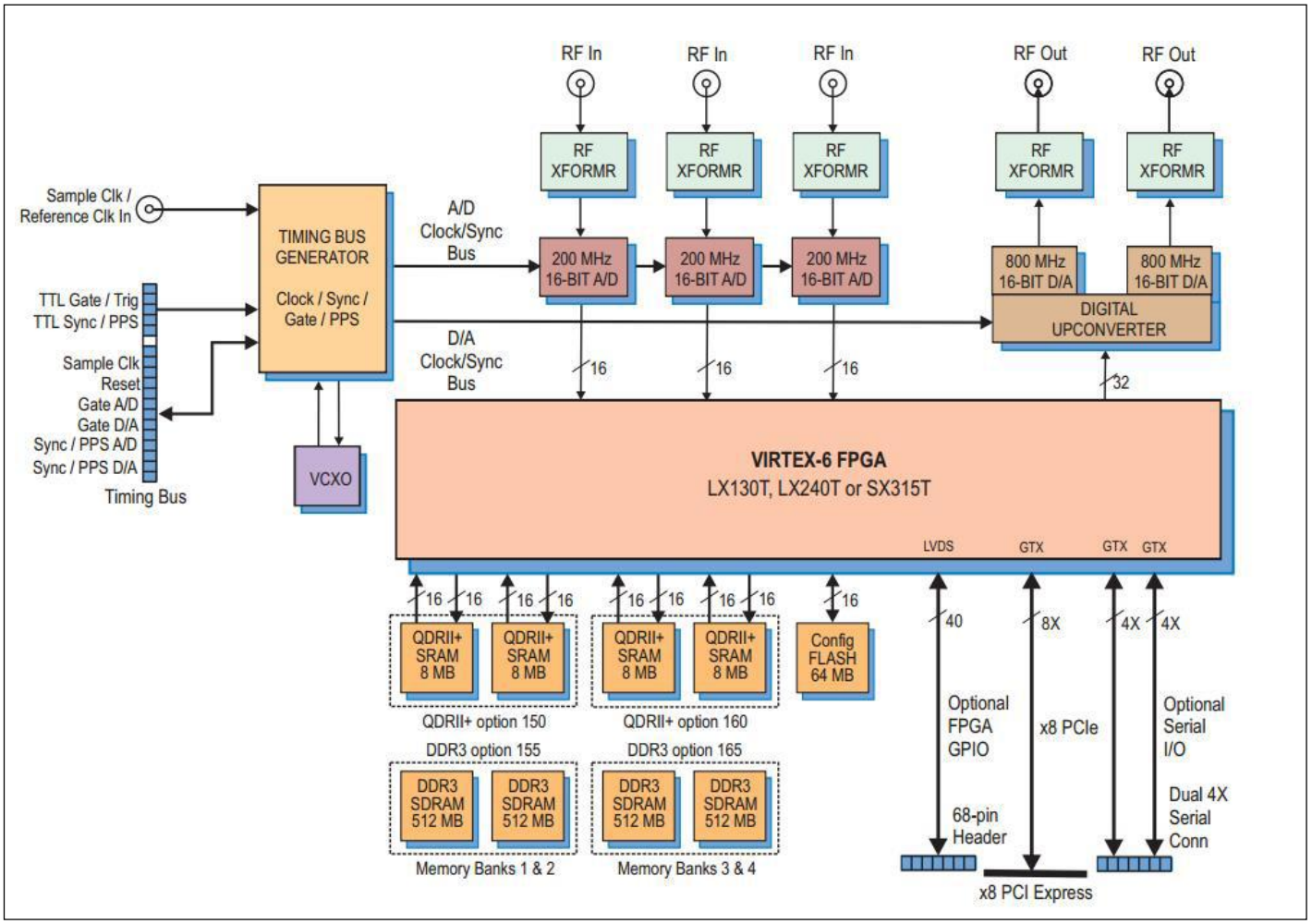
These four areas listed above can be mapped to physical modules, with defined characteristics of operation and interfaces to each of the other areas. As will be discussed in this paper the four areas can be addressed in the following manner.

1. Waveform Creation: Pentek Model 78620 PCIe module with signal development software.
2. Microwave Transmitter: Giga-tronics model GT-ASGM18A Ultra-fast frequency switching Advanced Signal Generator.
3. Microwave Receiver: Giga-tronics model GT-ASA18A Ultra-fast frequency switching Advanced Signal Analyzer (down-converter).
4. Signal Processing: Pentek Model 78620 PCIe module with signal processing software/firmware.

Waveform Creation and Signal Processing

The Pentek Model 78620 is a high performance PCIe board used in many EW applications, it is based on the Xilinx Virtex-6 FPGA, that can be mounted in most modern COTS PCs. As a multichannel, high-speed data converter, it is suitable for connecting with the IF input of a microwave up/down converter such as the Giga-tronics' GT-ASGM18A Advanced Signal Generator and GT-ASAM18A Advanced Signal Analyzer. The Pentek Model 78620's built-in data acquisition and waveform generation features offer an ideal turnkey solution for radar and electronic warfare baseband signal simulation.

Each word board includes three A/Ds, two D/As and four banks of memory. In addition to supporting PCI Express Gen. 2 as a native interface, the Model 78620 also includes optional general purpose and gigabit serial card edge connectors for application-specific I/O.



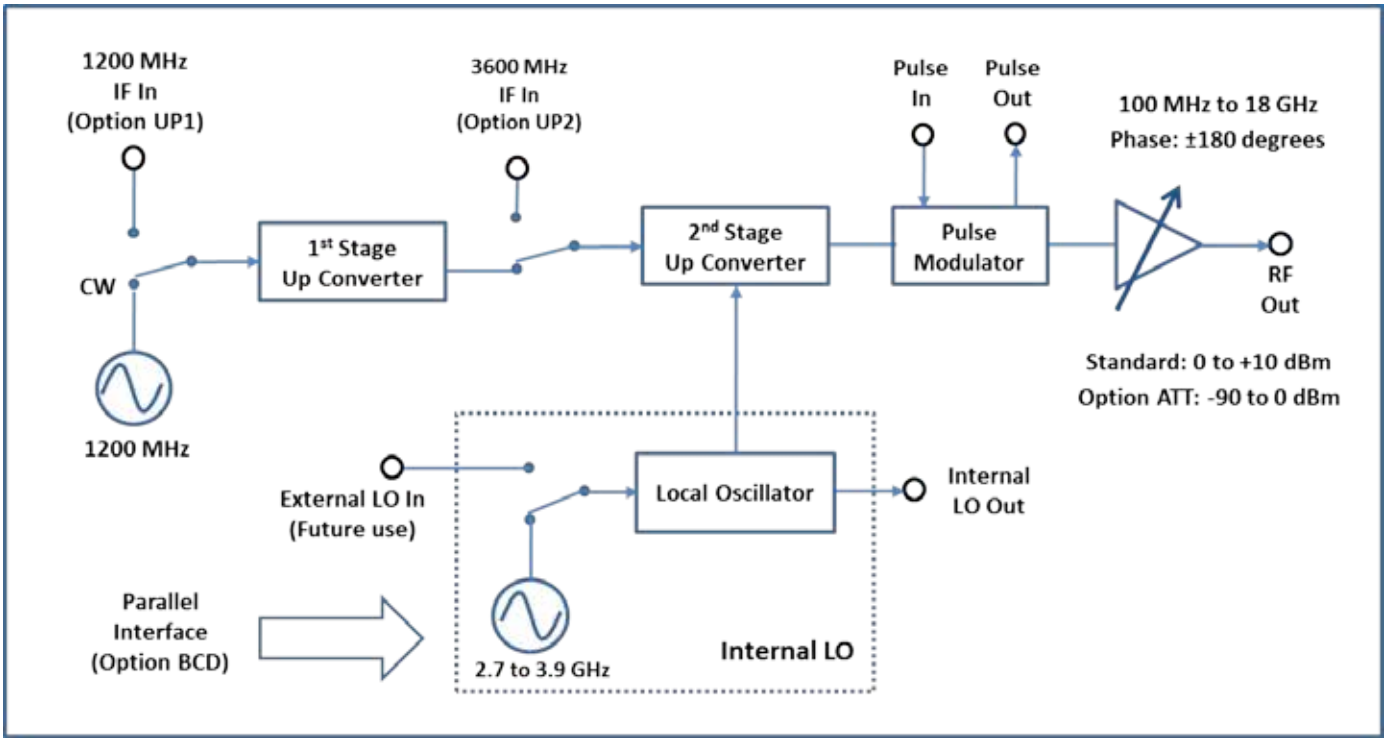
Pentek 78620 Block Diagram

Microwave Up and Down Conversion

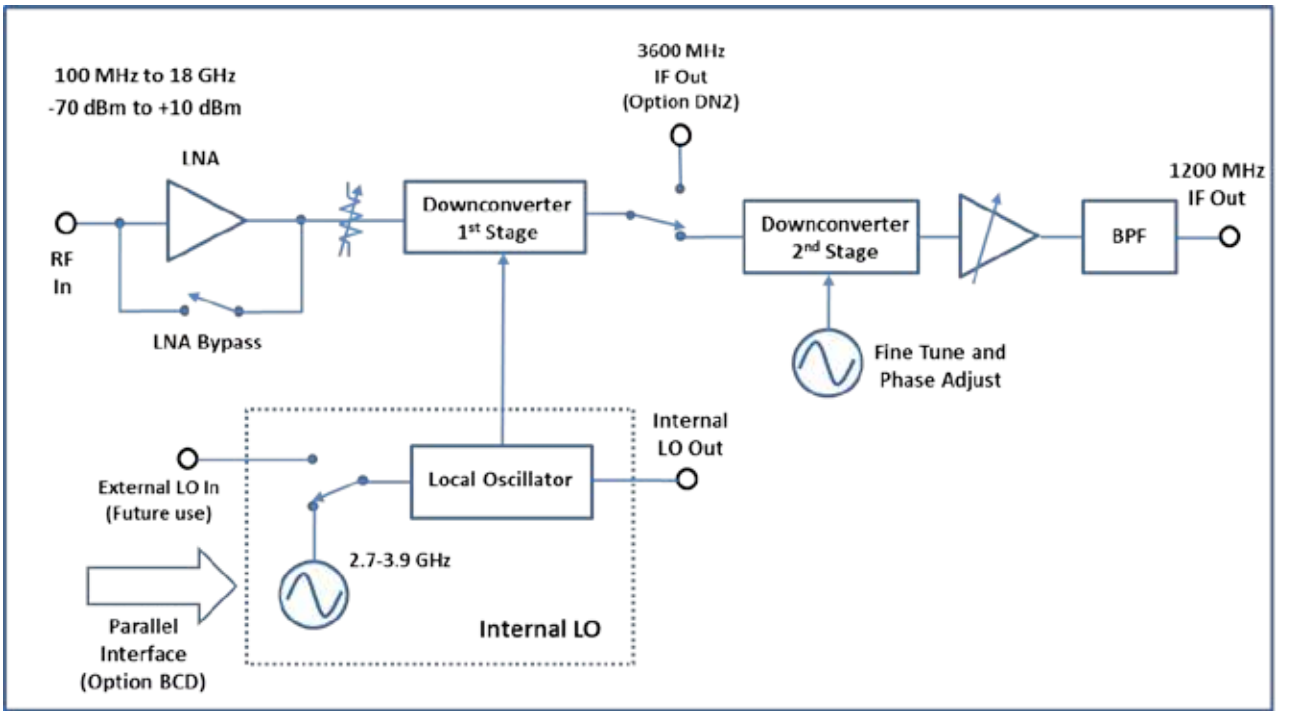
The Giga-tronics GT-ASGM18A Advanced Signal Generator and GT-ASAM18A Advanced Signal Analyzer are high fidelity coherent, fast frequency switching, up and down converters ideal for transmitting and receiving signals at frequencies between 100 MHz and 18 GHz. These units have built-in high speed, high signal fidelity, local oscillators allowing for broadband extremely agile, coherent frequency switching. Based on the industry standard AXIe modular platform, multiple phase coherent channels of up-conversion and down-conversion can be utilized to emulate specific types of radars or create a wave-front and emulate angle of arrival.

The Giga-tronics GT-ASGM18A and GT-ASAM18A can take an IF signal from the Pentek FPGA cards and up or down convert to any frequency within an 18 GHz range. They can coherently retune to any frequency in less than a microsecond and can maintan an amplitude flatness typically within +/- 1dB over that frequency range. The optional high speed microwave output attenuator entends the range of the output by 90 dB, allowing for signal creation range in excess of 100 dBc.

GT-ASGM18A Simplified Block Diagram

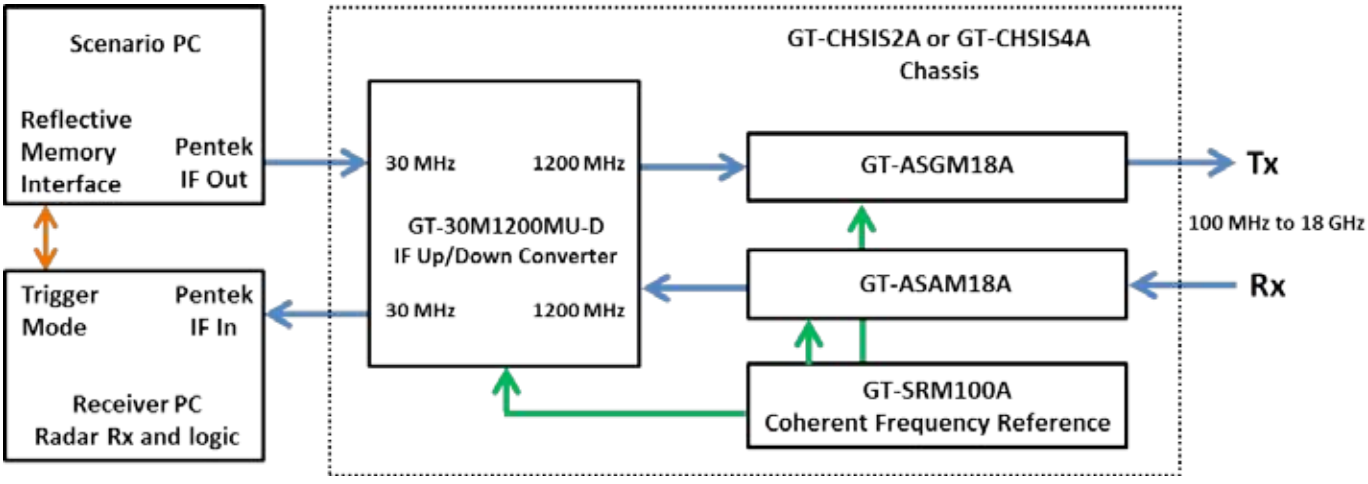


GT-ASAM18A Simplified Block Diagram



IF Conversion

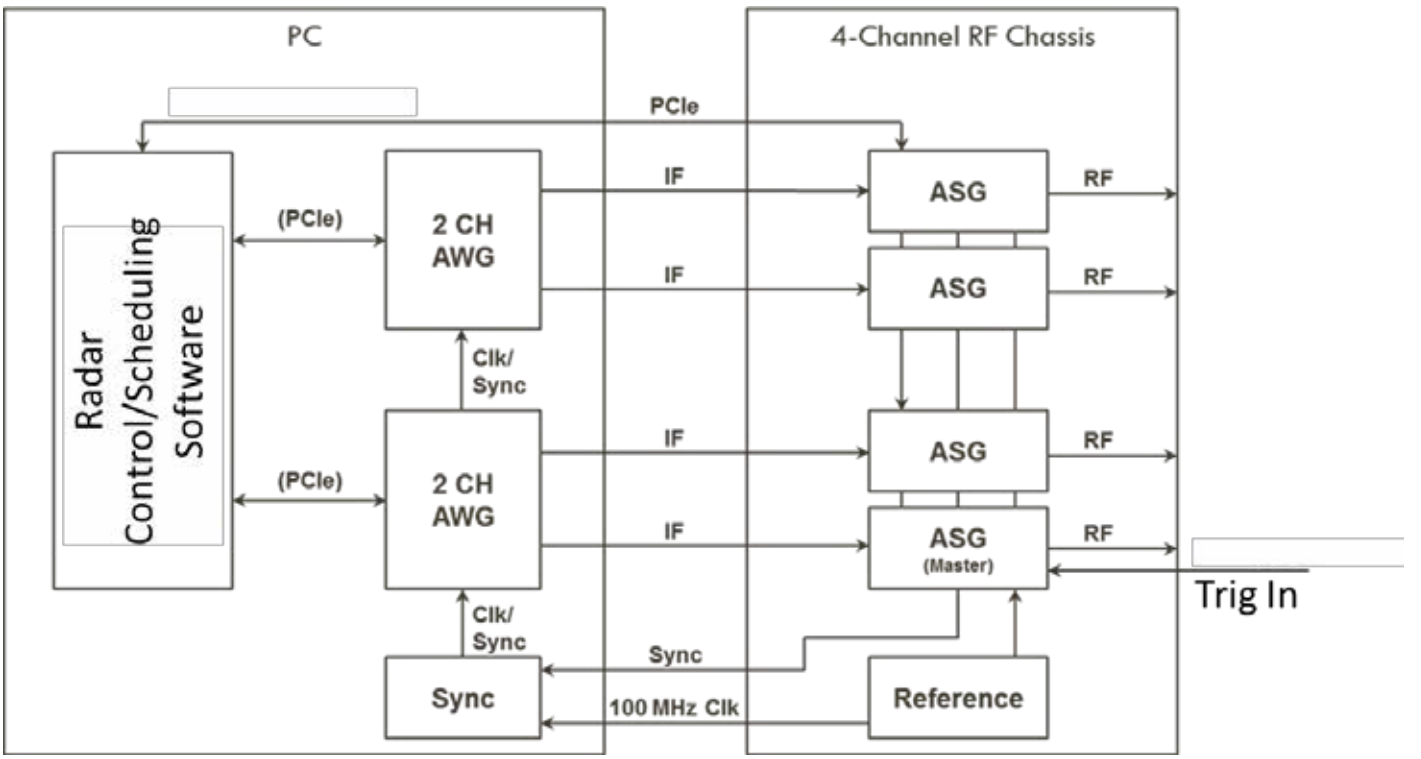
Matching the IF signals from the Pentek cards requires IF conversion to take a 30 MHz IF signal chosen to utilize the best performance from the Pentek card and match that to the 1200 MHz IF of the microwave up and down converters. The Giga-tronics GT-SRM100A System Reference Module provides 10 MHz, 100 MHz and 1200 MHz outputs that can be used as LOs (Local Oscillators) to drive an IF up and down converters as shown in the following figure.



System Block Diagram showing an IF Up and Down converter

Putting it all together

The following block diagram is an example system utilizing four independent RF channels. A similar block diagram could be used for the receiver. The Radar control and scheduling software would schedule the waveform playout times, a LAN connection from the receiver PC and RF subsystem can determine the next mode, PRI or waveform based on the nature of the received signal. The Waveforms are scheduled within the Pentek FPGA Cards (AWG) and the frequency and amplitude of the waveform is controlled in real time across PCIe. Optionally, fine timing resolution can be maintained by taking a trigger line from the Pentek cards and using that to deterministically control frequency and amplitude changes in the RF chassis.



Radar Simulation System Block Diagram

A four channel system consisting of two GT-ASGM18A up-converters and two GT-ASAM18A down-converters.

Conclusions

A range of radars and radar emulators, from simple single channel radars to complex multi-channel frequency-agile radars, can be created utilizing state-of-the-art waveform creation and processing technologies. All the hardware components are commercially available off-the-shelf and no custom hardware is required. Testing complex devices such as Radar Warning Receivers, or Electronic Counter Measure systems is simplified with this platform approach, and the creation of new types of radar prototypes can be rapidly achieved and shared between various programs.

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