

A CMOS Ultra-Wideband Pulse Generator with Programmable Pulse Shape



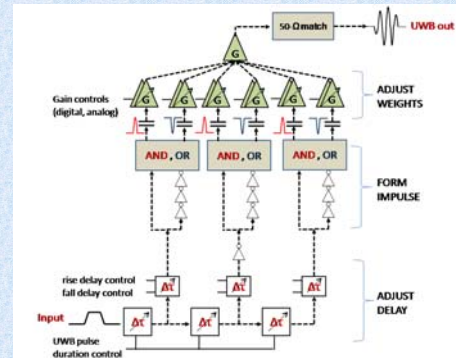
Introduction

- Ultra-Wideband (UWB) technology: a low-power, low-profile way to transmit short range wireless data.
- UWB transmits data in short-time pulses of broad bandwidth in many possible modulation formats
- **Goal:** Generate UWB waveforms that dynamically adapt to changing channel, standards, PVT conditions.
- **Design:** A UWB transmitter in 90nm CMOS with high flexibility in programming the pulse shape
- Approach: Pulse Combinatorial Method (PCM): generate, replicate, scale copies of a single impulse.

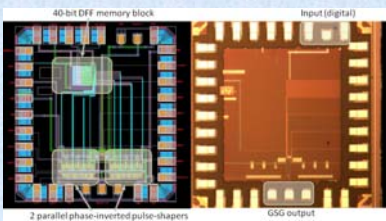
Design

PCM approach: input is a simple “square-like” waveform

- Voltage-controlled delay elements $\Delta\tau$ to position each rise/fall
 - Split the signal down several ‘taps’
 - Combinatorial logic to form an impulse from each rise/fall
 - Bank of selectable amplifiers to scale each impulse
 - Recombine all impulses \rightarrow Output
- \rightarrow CONTROL of GAIN and DELAY of each copy of the impulse!
 \rightarrow ... Can then synthesize any output with up to 6 sub-pulses.



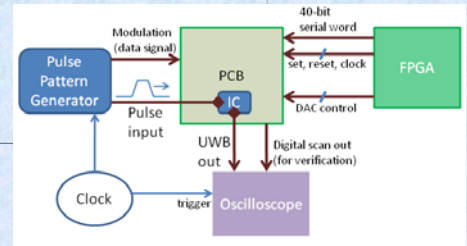
Chip contains 2 PCM modules and a memory block for storing 2 pulse shapes.



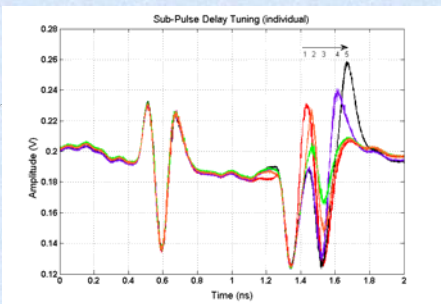
Experiment

Schematic of test setup

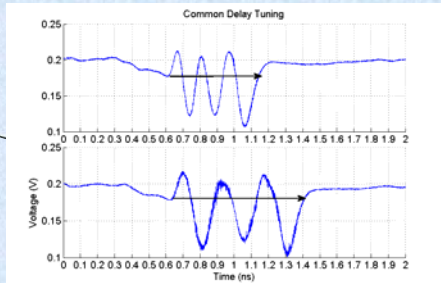
- Pulse generator produced square-like inputs
- FPGA unit generates control signals and programs control chip
- PCB with onboard DAC houses the IC
- Outputs taken directly from chip via probing to scope.



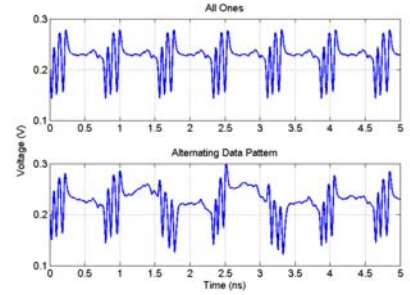
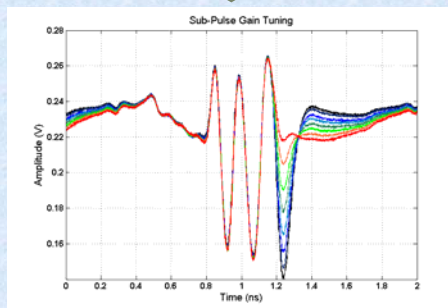
Measurements



Control over individual sub-pulse delay (above) ... or all at once (below) for “accordion” stretch



Scaling a sub-pulse with 8 possible “coarse” settings
Analog controls allow fine adjustments (not shown)



1.3 Gbps BPSK data stream using two parallel PCM implementations with 180° inversion

Summary

- UWB waveform generator with programmable shapes
- 50mW power @ 1.5 Gbps; 1.2 V supply; 1.1mm² chip area
- BPSK, 2-PPM, or pulse-shape modulation possible.