Xilinx Kintex Ultrascale+ FPGA Pattern Generator

Scope
Provide a custom high-speed FPGA pattern generator with multiple I/O lines for use in a cutting edge quantum computing application.

Solution
Spark Product Innovation created a Printed Circuit Board (PCB) assembly with ultra-high speed differential tracking and carefully designed termination networks, we also created the necessary FPGA firmware to deliver our customer a turnkey solution.

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Spark Product Innovation was approached by a quantum encryption communications company that had heard about our high speed digital and FPGA firmware skills by word of mouth. They needed a bespoke FPGA design to interface and control their proprietary high-speed encryption silicon and photonics.
Spark Product Innovation approached this by sitting down with the client and fully understanding their requirements, discussing various options and exploring what is technically feasible is and what is not. A detailed proposal was made and accepted. The detailed engineering, prototyping, testing and technical demonstrations followed and have now been completed and signed off by the client. Spark Product Innovation is also working with the client on several other electronic and firmware projects.

The design consists of a PCB based around a Xilinx Kintex Ultrascale+ FPGA. This part was selected as it is available on a development kit; taking this approach enabled the FPGA firmware to run in parallel with the electronic development.
In addition to the FPGA the PCB also had an FMC mezzanine connector to facilitate system testing and commissioning.

- High Speed Xilinx Kintex Ultrascale+ FPGA (XCKU5P) with 6.25 GHz I/O lines and FPGA based MicroBlaze microprocessor.
- Analog devices HMC856 wideband 28 Gbps, Digital Time Delay IC with 3pS resolution.
- USB and UART interfaces to allow customization and user programmable patterns.
- High Speed I/O lines available on FMC mezzanine connector to facilitate system testing and commissioning.
- Fully simulated and laboratory tested high speed differential tracking and termination networks.

Note: Spark also has other ongoing projects using the Artix-7 FPGA.
About
Spark Product Innovation is a multi-discipline team specializing in electronic PCB design, software, embedded firmware, DSP, power electronics, inverters, FPGAs. We also offer product packaging to give our customers a complete turnkey solution.

Services
- Electronic and software design services
- Mechanical packaging
- Prototyping
- System, electronic and motor testing
- Low and medium volume Manufacturing
- Automatic Test Equipment
- feasibility studies

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System Architecture

The centre of the system is the Xilinx FPGA with a MicroBlaze uP. Around this part, there's various connectivity to the outside world including JTAG, USB, RS232 and an FMC Mezzanine connector. Electrically there are carefully designed power supplies with power sequencing for the many FPGA voltage rails, clock and timers, memory, digital delays and the customer’s proprietary silicon.

Printed Circuit Board Assembly

FPGA Printed Circuit Board – Front Side
- Major component face.
- Mezzanine connector.
- Xilinx Kintex Ultrascale+ FPGA.
- Analog devices 28 Gbps, Digital Time Delay ICs.

FPGA Printed Circuit Board – Rear Side
- 16 layer design with multiple signal layers and power planes.
- High speed impedance matched differential tracking with a carefully selected termination scheme.

FPGA Printed Circuit Board – With Mezzanine
- FMC Mezzanine with High Speed connectivity to test equipment.
- Off the shelf Mezzanine with custom FPGA PCB to lower total costs.

FPGA Printed Circuit Board – pS Signals
- 160pS signals
- Firmware and Hardware multiple customer specific high speed I/O lines.