Integrated Connections

The FPGA Guide
The FPGA Guide

The field-programmable gate array (FPGA) is an integrated circuit designed to be configured by a customer or a designer after manufacturing – hence “field-programmable”. FPGAs contain an array of programmable logic blocks, and a hierarchy of reconfigurable interconnects that allow the blocks to be “wired together” like many logic gates that can be inter-wired in different configurations. Logic blocks can be configured to perform complex combinational functions, or merely simple logic gates.

The FPGA has come a long way from its roots as a flexible logic-circuit replacement based on programmable-memory technology in the 1980s. They are now used as the primary or sole processor for small and large systems in applications spanning basic appliances to high-end aerospace. Now SoC FPGAs integrate the software programmability of a processor with the hardware programmability of an FPGA, providing an unrivaled level of system performance, flexibility, and scalability.

Jump Start your next FPGA or SoC FPGA Design

At Avnet we have partnered with Microsemi and Xilinx for FPGA/SoC devices along with some of the top suppliers providing complementary data converter, interconnect, memory, thermal, power and timing devices for FPGA/SoC based designs. To support the research phase of your next FPGA based design we have assembled a library of product information, development kits and reference designs/kits to jump start your next project.
Xilinx is a leading provider of All Programmable FPGAs, SoCs, MPSoCs and 3D ICs, enabling the next generation of smarter, connected, and differentiated systems and networks. Driven by the industry-wide shifts towards Cloud Computing, SDN/NFV, Video Everywhere, Embedded Vision, Industrial IoT, and 5G Wireless, Xilinx innovations enable these applications that are both, software defined, yet hardware optimized. Xilinx’s portfolio of software defined and hardware optimized solutions include proven C and IP based design tools that support the development of ‘software defined hardware’, and a new family of software development environments that supports the development of ‘software defined systems’. With this unique combination, Xilinx is addressing the rapidly growing demands for programmability and intelligence with software, while enabling >10X the bandwidth, 1/10th the latency and power, and flexible any-to-any connectivity with optimized hardware.

**Artix® - 7**

Artix®-7 devices deliver the lowest power and cost at 28nm and are optimized to give your designs the highest performance/watt fabric, AMS integration, and transceiver line rates in a low cost FPGA. The family is the best value for a variety of cost- and power-sensitive applications including software-defined radio, machine vision cameras, and low-end wireless backhaul.

**Features:**
- Up to 215K LCs; AXI IP and Analog Mixed Signal integration
- Up to 16 x 6.6G GTs, 930 GMAC/s, 13 Mb BRAM, 1.2 Gb/s LVDS, DDR3-1066
- Small wire bond packaging and up to $5 analog component savings
- 65% lower static and 50% lower power than 45 nm generation devices

**Virtex® - 7**

Virtex®-7 FPGAs are optimized for system performance and integration at 28nm and bring best-in-class performance/watt fabric, DSP performance, and I/O bandwidth to your designs. The family is used in an array of applications such as 10G to 100G networking, portable radar, and ASIC Prototyping.

**Features:**
- Up to 215K LCs; AXI IP and Analog Mixed Signal integration
- Up to 16 x 6.6G GTs, 930 GMAC/s, 13 Mb BRAM, 1.2 Gb/s LVDS, DDR3-1066
- Small wire bond packaging and up to $5 analog component savings
- 65% lower static and 50% lower power than 45 nm generation devices

**Kintex® - 7**

Kintex®-7 FPGAs provide your designs with the best price/performance/watt at 28nm while giving you high DSP ratios, cost-effective packaging, and support for mainstream standards like PCIe® Gen3 and 10 Gigabit Ethernet. The Kintex-7 family is ideal for applications including 3G and 4G wireless, flat panel displays, and video over IP solutions.

**Features:**
- Up to 478K logic cells, VCXO component, AXI IP and AMS integration
- Up to 32 x 12.5G GTs, 2,845 GMACs, 34 Mb BRAM, DDR3-1866
- Half the price of similar density 40nm devices, EasyPath™ cost reduction
- 50% lower power than previous generation 40 nm devices
Kintex® UltraScale™
Kintex® UltraScale™ devices provide the best price/performance/watt at 20nm and include the highest signal processing bandwidth in a mid-range device, next-generation transceivers, and low-cost packaging for an optimum blend of capability and cost-effectiveness. The family is ideal for packet processing in 100G networking and data center applications as well as DSP-intensive processing needed in next-generation medical imaging, video, and heterogeneous wireless infrastructure.

Features:
- Up to 1.5 M System Logic Cells leveraging 2nd generation 3D IC
- 8.2 TeraMACs of DSP compute performance
- 12.5 Gb/s transceivers in slowest speed grade
- 2,400 Mb/s DDR4 in a mid-speed grade

Zynq®-7000 SoC
Zynq®-7000 All Programmable SoC (AP SoC) devices integrate the software programmability of an ARM®-based processor with the hardware programmability of an FPGA, enabling key analytics and hardware acceleration while integrating CPU, DSP, ASSP, and mixed signal functionality on a single device. Zynq-7000 AP SoCs infuse customizable intelligence into today’s embedded systems to suit your unique application requirements.

Features:
- Application processor unit: Dual-core ARM® Cortex™-A9 MPCore™ with CoreSight™ up to 1 GHz
- Dynamic memory interface: DDR3, DDR3L, DDR2, LPDDR2
- Peripherals: USB 2.0, Gigabit Ethernet, SD/SDIO

Zynq® UltraScale™+ MPSoC
Zynq® UltraScale+™ MPSoC devices provide 64-bit processor scalability while combining real-time control with soft and hard engines for graphics, video, waveform, and packet processing. Integrating an ARM®-based system for advanced analytics and on-chip programmable logic for task acceleration creates unlimited possibilities for applications ranging from 5G Wireless, to next generation ADAS, and Industrial Internet-of-Things.

Features:
- Application processor unit: Quad-core ARM® Cortex™-A53 MPCore up to 1.5 GHz
- Dynamic memory interface: DDR4, LPDDR4, DDR3, DDR3L, LPDDR3
- Peripherals: PCIe® Gen2, USB3.0, SATA 3.1, DisplayPort, Gigabit Ethernet, SD/SDIO
Interconnect

Today’s designs using FPGA/SoC technology demand high speed, high density interconnects to match the processing, I/O and memory associated with these leading edge applications. Samtec delivers a broad range of innovative connectors and cable assemblies that consistently optimize overall system performance.

High Speed Board-to-Board Connectors

Samtec offers a comprehensive portfolio of high speed board-to-board connectors that complement FPGA/SoC-based systems. Samtec’s board-to-board connector solutions support various high speed, high density, rugged and isolation applications. Samtec’s Mezzanine Strips feature integral ground planes, ruggedized contact systems, slim bodies and a number of low profile stacking heights. Samtec Rugged High Speed Strips offer increased insertion depths and rugged designs for contact protection during mating and unmating.

High density arrays offer a variety of pitches, stack heights and configurations allowing for maximum routing, grounding and design flexibility. Newer backplane solutions enable FPGA/SoC designers to optimize signal density in line card applications while providing a path to 28 Gbps and beyond. Whether conforming to industry standards or providing application specific solutions, a growing number of Samtec board-to-board connector solutions are found in modern FPGA/SoC systems.

Samtec High Speed Board-to-Board Connectors

| FMC Standard Connectors | The VITA 57 Field Programmable Mezzanine Card (FMC) standard specifies Samtec’s SEARAY™ connector set. The VITA 57 SEAM/SEAF Series system provides two options: High Pin Count (HPC) or Low Pin Count (LPC).  
• HPC offers 400 I/Os in a 40 x 10 configuration  
• LPC offers 160 I/Os in a selectively loaded 40 x 10 configuration  
• Both LPC and HPC options cope in 8.5 mm and 10 mm stack heights |
| Q STRIP® High Speed Ground Plane Terminal and Socket Strips (QTE/QSE series) | Samtec Q Strip® connectors are designed for high speed board-to-board applications where signal integrity is essential. They have surface mount signal contacts and ground planes for improved electrical performance. |
| Edge Rate® Rugged High Speed Terminal and Socket Strips (ERM8/ERF8 series) | Rugged Edge Rate® contact systems optimized for signal integrity performance in high speed, high cycle applications. The smooth, milled surface of the Edge Rate® contact reduces wear tracks while increasing durability and cycle count. It also lowers insertion and withdrawal forces allowing the connectors to be zippered when unmating. |
**High Speed Edge Card Connectors**

Samtec's high speed edge card interconnects features rugged Edge Rate™ contacts as well as a variety of orientations. They are designed for high speed, high cycle applications. The surface of the Edge Rate® contact is milled creating a smooth mating surface area instead of a stamped contact that mates on a cut edge. This smooth mating surface reduces the wear tracks on the contact increasing the durability and cycle life of the contact system. It also lowers insertion and withdrawal forces allowing the connectors to be zippered when unmating.

<table>
<thead>
<tr>
<th>Samtec High Speed Edge Card Connectors</th>
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</thead>
<tbody>
<tr>
<td><strong>0.80 mm Edge Rate® High Speed Edge Card Connector; Vertical, Edge Mount and Right Angle (HSEC8 Series)</strong></td>
</tr>
<tr>
<td>Samtec's high speed edge card interconnects features rugged Edge Rate™ contacts as well as a variety of orientations. They are designed for high speed, high cycle applications. It also lowers insertion and withdrawal forces allowing the connectors to be zippered when unmating.</td>
</tr>
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</table>

**High Speed Cable Assemblies**

As a vertically integrated cable assembly manufacturer, Samtec offers FPGA/SoC designers standard or custom copper and optical cable assembles that complement their designs. The combination of Samtec's in-house design capabilities and customer service enables predictable lead times, high quality product, optimized performance and unparalleled pricing and delivery. Samtec now provides several cable assembly solutions used extensively in FPGAs/SoC systems.

<table>
<thead>
<tr>
<th>Samtec High Speed Cable Assemblies</th>
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<tbody>
<tr>
<td><strong>BULLS EYE® HIGH PERFORMANCE TEST SOLUTIONS</strong></td>
</tr>
<tr>
<td>Samtec's BullEye™ test point system is a low cost, high performance test point system that eliminates the need for expensive SMA connectors on production boards. BullEye™ is a high density array that provides up to 4X the high bandwidth signals in the same real estate, allowing for a smaller board and fewer layers. The system is available in single or multi-port designs, or as a high-density ganged connector.</td>
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<tr>
<th>FMC Cable Assemblies</th>
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<tbody>
<tr>
<td>In addition to FMC Standard Connectors, cables assemblies are becoming a popular option for connecting FMC-enabled solutions together. Several options supporting both HPC and LPC versions are available from Samtec.</td>
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</tbody>
</table>
Increased data transfer rates between boards in a system or system to system in a network require advanced high-speed interconnect technologies. The TE Connectivity (TE) portfolio of connectors and packaging products fit the requirements of these applications in support of the FPGA or SoC that drives the overall system performance for the telecommunications, video and data transmission, test and measurement or defense and security markets.

### Pluggable Connectors & Cages

Speed, density, flexibility, efficiency, and standardization. These are the five words that best describe TE’s rich portfolio of pluggable I/O interconnects. TE products are continuously improved to move data faster while also keeping system thermal management in mind. TE products are designed to industry standards specifications to ensure compatibility with complimentary FPGA and SoC devices.

<table>
<thead>
<tr>
<th>TE Pluggable Connectors &amp; Cages</th>
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<tbody>
<tr>
<td><strong>zSFP+ (SFP28) Connectors &amp; Cages</strong></td>
</tr>
<tr>
<td>• Next generation 25 Gbps SFP interface, backwards compatible to SFP+</td>
</tr>
<tr>
<td>• Broad portfolio including 1x8 and 2x12 configurations</td>
</tr>
<tr>
<td>• Quick turn for custom Cage/HS/LP configurations</td>
</tr>
<tr>
<td>• Thermally enhanced versions available</td>
</tr>
<tr>
<td><strong>zQSFP+ (QSFP28) Connectors &amp; Cages</strong></td>
</tr>
<tr>
<td>• Next generation 25 Gbps QSFP interface, backwards compatible to QSFP/QSFP+</td>
</tr>
<tr>
<td>• 0.8 mm pitch, 38 position interface</td>
</tr>
<tr>
<td>• 4 channels x 25 Gbps data rates</td>
</tr>
<tr>
<td>• Supports 100G Ethernet, 100G Infiniband, 128G Fibre Channel and 25G/50G Consortium</td>
</tr>
</tbody>
</table>

### High Speed Board-to-Board Power Connectors

TE Connectivity high speed power board-to-board connectors are optimized for any application where signal transfer is required. With a wide range of options, these products are ideal for industrial control and medical devices.

### MULTI-BEAM Power Connectors

<table>
<thead>
<tr>
<th>MULTI-BEAM XLE Power Connectors</th>
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<tr>
<td>MULTI-BEAM XLE connectors feature a 3-beam contact, made from a thicker/higher conductivity material than the original single or 4-beam designs. The new 3-beam design allows for a greater angular mis-alignment between mating connectors and a lower mating force. In addition, MULTI-BEAM XLE connector’s slimmer housing design reduces the overall PCB footprint and has the option of using a low power Universal Power Module (UPM) contact.</td>
</tr>
</tbody>
</table>
High Speed Backplane Connectors

Designers of electronic products are continually challenged to evolve those products, which requires incorporating the newest features while addressing trends toward higher density, greater speed, expanded connectivity, and improved power management. High speed backplane connectors are the backbone of data center architectures. TE’s solutions can provide high speed and scalability for what’s next. Increasing bandwidth demands require better-performing high speed connectors. TE’s assortment of 6.25 – 56 Gbps backplane interconnects provides the connections needed to keep data flowing.

### TE High Speed Backplane Connectors

#### STRADA Whisper Backplane Connector

- 25 to 56 Gb/s speeds
- Design flexibility: mid-plane orthogonal, traditional, cabled-backplane and embedded cap
- Power Sum FEXT lower than -50 dB for system implementation at 12.5 GHz
- Insertion loss < 1 dB and linear up to 20 GHz
- Individual shielded pairs for excellent signal integrity / EMI performance
- Little to no skew through high-speed differential pairs
- Common mode impedance controlled throughout the connector, footprint and mating interface
- Electrical performance maintained in a 1.5 mm unmated condition

#### Z-PACK HM-e Zd+ Connector for ATCA Applications

- Designed for data rates of 20 to 25+ Gbps
- Backwards compatible mating interface, inter-matable with HM-Zd family
- 4 Pair, 10 Column version available
- New footprint for the receptacle and header
- Ideal for 100G ATCA – Next generation standard

#### Z-PACK Slim UHD Backplane Connector

- 10% denser than similar products on the market
- Low-profile design for space savings and design flexibility
- Accompanying 5-position power connector available
- Complement to TE’s 25G STRADA Whisper backplane connector for lower signal speeds

#### IMPACT Connectors

- Data rates up to 25 Gbps
- High differential pair density (up to 80 pairs per linear inch)
- Reduced crosstalk with broad-edge-coupled, differential-pair systems running higher data rates
- Application with compliant, press fit tails
- Excellent mating performance with inline staggered, bifurcated contact beams in a daughter card interface

MULTI-BEAM XLE, STRADA Whisper, Z-PACK, TE Connectivity and TE connectivity (logo) are trademarks.

zSFP+ and zQSFP+ are part of the ZXP® family of connectors and use ZXP technology. ZXP is a trademark of Molex, LLC.

IMPACT is a trademark of Molex, LLC.
Cypress offers the world’s broadest portfolio of SRAMs, including synchronous, asynchronous, QDR, and dual-port SRAMs. Cypress also offers the industry’s fastest, most energy-efficient, and highest-reliability Nonvolatile RAM solutions to capture and protect the world’s most critical data. Cypress compliments these products with an extensive offering of NAND and NOR Flash memory. Cypress continues to invest in innovative memories to address the increasing performance demands of mission-critical systems everywhere. Cypress is the one-stop supplier for high-performance memories today and in the future. Cypress memories are well suited for FPGA and SoC designs based on both proven performance and close collaboration with the leading FPGA providers on product development and reference designs.

<table>
<thead>
<tr>
<th>Cypress Asynchronous SRAM</th>
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<tbody>
<tr>
<td><strong>Async Fast SRAMs</strong></td>
</tr>
<tr>
<td>Cypress offers a broad portfolio of Fast Async SRAM devices, with products ranging from 64-Kbit up-to 32-Mbit and are available in industry-standard voltage, bus-width, and package options. New products feature PowerSnooze™ which combines the access time of Fast SRAMs with the standby current of Micropower SRAMs.</td>
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<tr>
<th>Micropower Async SRAMs</th>
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<tbody>
<tr>
<td>Cypress’s MoBL® (More Battery Life) devices provide for a broad portfolio of Async SRAMs, with active offerings ranging from 64-Kbit up-to 64-Mbit and available in industry-standard voltage, bus-width, and package options.</td>
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<tr>
<th>Async SRAM with ECC</th>
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<tbody>
<tr>
<td>Cypress has added Asynchronous SRAMs with ECC to their portfolio. This product features on-chip Error Correcting Code and bit interleaving, offer reliability with maximum FIT rates of 0.1FIT/Mb and also come with an additional ERR pin to indicate detection and correction of single bit errors.</td>
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<thead>
<tr>
<th>Cypress Synchronous SRAM</th>
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<tbody>
<tr>
<td><strong>QDR-II+ &amp; QDR-II+ Xtreme</strong></td>
</tr>
<tr>
<td>Cypress’s QDR-II+ is a high performance, dual-port SRAM memory. QDR-II+ SRAM offers a maximum speed of 550 MHz, densities up to 144 Mb, read latencies of 2 or 2.5 cycles, burst length of 2 or 4, and is available in an industry-standard 165-ball FBGA package. QDR-II+ Xtreme SRAM operates up to 633 MHz and is available in 36 Mb or 72 Mb densities. QDR-II+ products also offer optional programmable On-Die Termination (ODT).</td>
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<tr>
<th>QDR-IV</th>
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</table>
Cypress Nonvolatile RAM (NVRAM)

Cypress is the worldwide leader in Nonvolatile RAM (NVRAM) products with the broadest portfolio on the market and over 1 billion devices shipped. Cypress has two complimentary families of NVRAM products: F-RAM, the industry’s most energy-efficient serial NVRAM solution, and nvSRAM, the industry’s fastest parallel NVRAM solution. Cypress was the first to produce F-RAM and nvSRAM products and has 25 years of experience in NVRAM technology.

Cypress NOR Flash Memory

High Performance, Parallel Page Mode NOR

The Cypress GL NOR Flash family is optimized for the voltage, density, cost-per-bit, reliability, performance and scalability needs of a wide variety of embedded applications. With densities from 32 Mb to 2 Gb, each device requires only a single 3.0 V power supply for read and write functions and is entirely command set compatible with the JEDEC Flash standards.

Quad SPI NOR

Cypress FL Serial Flash Memory offers a reduced pin count for lower system cost while providing optimal read/write performance for a variety of automotive, networking, consumer electronics and industrial applications.

FL-S

Densities form 128 MB up to 1 Gb. Hybrid Sector Architecture. Read speed in Single, Dual and Quad I/O modes up to 133 MHz SDR, and up to 80 MHz DDR delivering read bandwidth of up to 80 MBps. Industry leading Programming performance (up to 1.08 MBps).

FL1-K

Densities of 16 Mb up to 64 Mb. Uniform 4 KB Sector Size. Read speed in Single, Dual and Quad I/O modes up to 108 MHz SDR delivering read bandwidth of up to 54 MBps. Fast Programming performance of 365 KBps.

Cypress NAND Flash Memory

Cypress’s high performance and high reliability SLC NAND product portfolio is available in 1 Gb - 16 Gb densities. There are two standard product families offering 1bit and 4 bit ECC SLC NAND. High Reliability, SLC NAND

<table>
<thead>
<tr>
<th>Product</th>
<th>Voltage</th>
<th>Interface</th>
<th>Density</th>
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<tbody>
<tr>
<td>S34ML</td>
<td>3V NAND Flash Memory with 1 and 4 bit ECC requirement</td>
<td>x8 or x16 I/O interface</td>
<td>1Gb – 16Gb</td>
</tr>
<tr>
<td>S34MS</td>
<td>1.8V NAND Flash Memory with 1 and 4 bit ECC requirement</td>
<td>x8 or x16 I/O interface</td>
<td>1Gb – 16Gb</td>
</tr>
<tr>
<td>S34SL</td>
<td>3V NAND Flash Memory with enhanced security features and 4 bit ECC requirement</td>
<td>x8 I/O interface</td>
<td>1Gb – 4Gb</td>
</tr>
</tbody>
</table>
ADI GSPS (Giga Sample per Second) converter solutions offer a new, simplified architecture for state-of-the-art aerospace and defense, communications, electronic test and measurement, and other high speed, signal-sensitive applications. By offering best-in-class high dynamic range and wide input bandwidth, ADI GSPS converters capture a wider frequency range of input signals, while also offering integrated signal processing for a flexible, programmable platform.

High-performance FPGA suppliers, have incorporated on-chip JESD204B SerDes (serializer/deserializer) ports into their latest generation products. This end-to-end seamless connectivity for the analog signal chain results in simplified PCB layout, rapid prototyping capability, and faster time-to-market.

A new generation of high-performance GSPS data converters are available to simplify and greatly enhance system capabilities by getting data into and out of FPGAs as fast as the devices can process it. Here’s just a few of the Data Converters from Analog Devices that will work well with your next FPGA based design.

<table>
<thead>
<tr>
<th>Family</th>
<th>Description</th>
<th>Features and Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD9144</td>
<td>TxDAC® Digital-to-Analog Converter (DAC)</td>
<td>Quad, 16-bit, high dynamic range DAC provides a maximum sample rate of 2.8 GSPS, permitting a multicarrier generation up to the Nyquist frequency. JESD204B Subclass 1 support simplifies multichip synchronization in software and hardware design.</td>
</tr>
<tr>
<td>AD9625</td>
<td>2.6 GSPS, 1.3 V/2.5 V Analog-to-Digital Converter (ADC)</td>
<td>12-bit monolithic sampling ADC operates at conversion rates of up to 2.6 GSPS. This product is designed for sampling wide bandwidth analog signals up to the second Nyquist zone. The JESD204B-based high speed serialized output is configurable in a variety of one-, two-, four-, six-, or eight-lane configurations.</td>
</tr>
<tr>
<td>AD9680</td>
<td>JESD204B, Dual Analog-to-Digital Converter (ADC)</td>
<td>Dual, 14-bit, 1.25 GSPS/1 GSPS/820 MSPS/500 MSPS ADC with an on-chip buffer and sample-and-hold circuit designed for low power, small size, and ease of use. Designed for sampling wide bandwidth analog signals of up to 2 GHz. Users can configure the Subclass 1 JESD204B-based high speed serialized output in a variety of one-, two-, or four-lane configurations.</td>
</tr>
<tr>
<td>AD9361</td>
<td>2 x 2 RF Agile Transceiver</td>
<td>High performance, integrated RF Agile Transceiver™. Its programmability and wideband capability make it ideal for a broad range of transceiver applications. The device combines an RF front end with a flexible mixed-signal baseband section and integrated frequency synthesizers, simplifying design-in by providing a configurable digital interface to a processor. The AD9361 operates in the 70 MHz to 6.0 GHz range.</td>
</tr>
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</table>
FPGA Compatible Reference Designs
Analog Devices’ makes it easier for customers to connect Analog Devices’ high-speed and precision data converters, sensors, RF ICs and other components to FPGAs and microprocessors. Through collaboration with industry-leading suppliers, ADI aims to simplify FPGA system design with the ongoing development of complete reference design solutions and tools, such as HDL code, device drivers and reference project examples for rapid prototyping and reduced development time.

<table>
<thead>
<tr>
<th>Design</th>
<th>Description</th>
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<tbody>
<tr>
<td>FMCADC2</td>
<td>High speed Data Acquisition Board featuring AD9625 single channel ADC at 2500MSPS, in an FMC form factor, supporting the JESD204B high speed serial interface.</td>
</tr>
<tr>
<td>FMCADC3</td>
<td>High speed data acquisition board featuring AD9625 single channel ADC at 2500 MSPS and the ADA4961 Low Distortion, 3.2 GHz, RF DGA driving the converter. The FMC form factor supports the JESD204B high speed serial interface.</td>
</tr>
<tr>
<td>FMCADC4</td>
<td>High speed 4-channel data acquisition board featuring two AD9680 dual channel ADC at 1000 MSPS and four ADA4961 low distortion, 3.2 GHz, RF DGA driving each converter. Supports the JESD204B high speed serial interface. All clocking and channel synchronization is supported on-board using the AD9528 clock generator.</td>
</tr>
<tr>
<td>FMCDAQ2</td>
<td>Comprised of the AD9680 dual, 14-bit, 1.0 GSPS, JESD204B ADC, the AD9144 quad, 16-bit, 2.8 GSPS, JESD204B DAC, the AD9523-1 14-output, 1GHz clock, and power management components. It is clocked by an internally generated carrier platform via the FMC connector, comprising a completely self-contained data acquisition and signal synthesis prototyping platform.</td>
</tr>
<tr>
<td>FMCOMMS3</td>
<td>High speed analog module designed to showcase the AD9361, a high performance, highly integrated RF transceiver intended for use in RF applications, such as 3G and 4G base station and test equipment applications, and software defined radios.</td>
</tr>
</tbody>
</table>
Analog Devices multi output regulators enable smaller, more reliable power solutions for RF, high speed, and precision analog products, along with FPGAs/processors. ADI regulators offer complete power solutions and highly integrated power ICs to combine functions like highly efficient buck, boost, and buck-boost switching regulators, battery chargers, autonomous backlight control, low noise LDOs, and real-time clocks. With I2C control features to enable dynamics voltage scaling, sequencing, and monitoring, along with combined application specific functions, our multi output regulators help reduce system cost and improve conversion efficiency.

### Power Management: Analog Devices

<table>
<thead>
<tr>
<th>Product</th>
<th>Specifications</th>
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</table>
| ADP5054: Quad Buck Regulator Integrated Power Solution | • Wide input voltage range: 4.5V to 15.5V  
• ±1.5% output accuracy over full temperature range  
• 250 kHz to 2 MHz adjustable switching frequency with individual 1/2× frequency option  
• Power regulation:  
  • Channel 1 and Channel 2: programmable 2A/4A/6A sync buck regulators with low-side FET driver  
  • Channel 3 and Channel 4: 2.5A sync buck regulators |
| ADP5050: 5-Channel Integrated Power Solution with Quad Buck Regulators, 200 mA LDO Regulator and I2C interface | • Wide input voltage range: 4.5V to 15V  
• ±1.5% output accuracy over full temperature range  
• 250 kHz to 1.4 MHz adjustable switching frequency  
• Adjustable/fixed output options via factory fuse or I2C interface  
• I2C interface with interrupt on fault conditions  
• Power regulation:  
  • Channel 1 and Channel 2: programmable 1.2A/2.5A/4A sync buck regulators with low-side FET driver  
  • Channel 3 and Channel 4: 1.2A sync buck regulators  
  • Channel 5: 200 mA low dropout (LDO) regulator |
| ADP5052: 5-Channel Integrated Power Solution with Quad Buck Regulators and 200 mA LDO Regulator | • Wide input voltage range: 4.5V to 15V  
• ±1.5% output accuracy over full temperature range  
• 250 kHz to 1.4 MHz adjustable switching frequency  
• Adjustable/fixed output options via factory fuse (ADP5051)  
• I2C interface with interrupt on fault conditions (ADP5051)  
• Power regulation:  
  • Channel 1 and Channel 2: programmable 1.2A/2.5A/4A sync buck regulators with low-side FET driver  
  • Channel 3 and Channel 4: 1.2A sync buck regulators  
  • Channel 5: 200 mA low dropout (LDO) regulator |
| ADP5135: 3-Channel Integrated Power Solution with Triple 1.8A Buck Regulators | • Vin 3.0V to 5.5V  
• ±/− 1.8% output accuracy  
• 3MHz fixed switching frequency enables small inductors for compact solution size  
• Individual precision enable pins and power good pin for power up and down sequencing  
• Power regulation  
  • Triple 1.8A synchronous buck regulators |
Timing

Cypress is a leader in programmable timing solutions for consumer electronics, communication, networking and industrial applications. Cypress’s portfolio of silicon based clock generators and buffers offers the best in class performance in terms of jitter, power, speed, integration and package.

Supplying timing products since 1994, Cypress has shipped over 2 billion clock devices and has a broad portfolio of devices including single and multiple-PLL programmable clock synthesizes, program-mable crystal oscillators, VCXO, EMI reduction clocks, programmable-skew and zero/non zero delay buffers.

Clock Generators
Cypress has a broad portfolio of standard performance clock generators with frequency support of 200 MHz and Cycle to Cycle jitter of 100 ps. They support a host of value-added features such as VCXO, Spread Spectrum and Output Phase Alignment

High Performance Clock Generators
Cypress High Performance Clock Generators supports frequencies up to 700MHz with RMS Phase Jitter of < 1ps. These devices support reference clocks for popular interface standards such as PCIe 1/2/3, 10 GbE, SATA 1.0/2.0 and USB 1.0/2.0/3.0.

PLL/SSCG ICs
These are built in dual modulus pre-scaler, adaptable from 50MHz to 3GHz and it can make up low noise small serial input Phase Locked Loop (PLL) frequency enabling pulse swallowing operation.

Standard Performance Buffers

High Performance Buffers
The High Performance Buffer (HPB) is a family includes ultra low-jitter non-PLL clock fanout buffers that delivers up to 10 high-frequency (up to 1.5GHz) differential outputs (LVPECL, LVDS, or CML). HPB delivers the industry’s lowest additive jitter (0.06ps typical RMS phase jitter) and can provide complete high-frequency, low-jitter clock tree solutions in conjunction with FleXO clock generators.
Silicon Labs offers the industry’s broadest portfolio of crystal oscillator, clock generator and clock buffer products and PCI Express (PCIe) clock generators and PCIe Express buffers. Silicon Labs’ patented technology reduces system jitter and the number of expensive discrete components, while improving flexibility, customization and performance.

Comprehensive Portfolio
Silicon Labs offers a portfolio of frequency flexible jitter attenuating clocks, clock generators, clock buffers and oscillators that enable hardware designers to simplify clock synthesis and distribution. Silicon Labs clocks use proprietary DSPLL and MultiSynth technologies to generate any combination of frequencies/formats with low jitter. Clock buffers provide integrated format/voltage level translation and are PCIe compliant.

Data Center
Silicon Labs’ PCIe zero delay buffers meet PCIe Gen 1/2/3 specifications and feature low-power push-pull output driver technology that minimizes power consumption while simplifying PCB design. Silicon Labs’ clock generators are highly frequency flexible, generating any combination of frequencies from any input frequency with unparalleled performance and enabling “clock-tree-on-a-chip” BOM consolidation. Silicon Labs also offers ultra-low jitter programmable oscillators customizable to any frequency, with samples available in less than two weeks.

Networking
Silicon Labs offers industry leading jitter performance for 10/40/100 G OTN and Ethernet Applications (100 fs RMS). Silicon Labs’ clock products are highly frequency flexible, generating any combination of frequencies from any input frequency with unparalleled performance and enabling “clock-tree-on-a-chip” BOM consolidation. Silicon Labs also offers ultra-low jitter programmable oscillators customizable to any frequency, with samples available in less than two weeks. Silicon Labs’ PCI Express timing products provide fully compliant PCIe Gen 1/2/3 clock generation and distribution.
**Wireless**

Silicon Labs presents a comprehensive clock and oscillator portfolio for wireless infrastructure applications. These devices eliminate the need for discrete VCXO and loop filter components, simplifying design, and minimizing overall solution costs. Silicon Labs’ clock products are highly frequency flexible, generating any combination of frequencies from any input frequency with unparalleled performance and enabling “clock-tree-on-a-chip” BOM consolidation.

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**Select Timing Solution found on Every Xilinx Evaluation Board:**

<table>
<thead>
<tr>
<th>Chipset</th>
<th>Target Market</th>
<th>Application</th>
<th>Oscillator</th>
<th>Buffer</th>
<th>Clock</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Virtex® - 7</strong></td>
<td>Highest Performance and Density</td>
<td>Wired Communications and Data Center</td>
<td>Si570</td>
<td>Si533xx</td>
<td>Si532X</td>
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<td>Si534x</td>
</tr>
<tr>
<td><strong>Kintex® - 7</strong></td>
<td>Highest signal processing and low power</td>
<td>Wireless Communications and Industrial</td>
<td>Si570</td>
<td>Si533xx</td>
<td>Si532X</td>
</tr>
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<td>Si534x</td>
</tr>
<tr>
<td><strong>Artix® - 7</strong></td>
<td>Lowest cost, High volume applications</td>
<td>General Purpose, Industrial (Ultrasound, Camera), Backhaul, Multi-Protocol machine</td>
<td>Si570</td>
<td>Si533xx</td>
<td>Si532X</td>
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<td>Si534x</td>
</tr>
<tr>
<td><strong>ZynQ®</strong></td>
<td>Programmable SOCs</td>
<td>General Purpose, Automotive, Consumer, Industrial</td>
<td>Si570</td>
<td>Si533xx</td>
<td>Si532X</td>
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<td>Si534x</td>
</tr>
<tr>
<td><strong>Virtex® UltraScale™</strong></td>
<td>ASIC - All programmable architecture</td>
<td>Wired communications, High Performance Computing, ASIC Prototyping &amp; Emulation</td>
<td>Si570</td>
<td>Si533xx</td>
<td>Si532X</td>
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<td>Si534x</td>
</tr>
</tbody>
</table>

[pages.silabs.com/clockbuilder-pro-software]
Thermal Management

Thermal management is crucial to the life and performance of your FPGA and the end product. As the world leader in cooling solutions, Aavid has decades of thermal engineering expertise that enable multiple cost effective, high performing solutions and options to meet your unique thermal challenges.

Aavid is a one-stop-shop for all thermal needs from interface materials and attachments to custom integrated solutions. Aavid Engineers consistently collaborate with manufacturers and customer engineering teams to develop a full understanding of the product and industry requirements.

**Aavid thermal management solutions for FPGAs and SoCs include:**

- **FPGA/BGA Heat Sinks:** High Fin Density Heat Sinks provide increased efficiency for high power applications under forced convection by creating greater volumetric surface area and are classified into two types: High Aspect Ratio Extrusions and Fabricated Fin Assemblies. Although both types offer considerable performance gains over standard extrusions.
- **FPGA/BGA Heat Sink & Fan Combinations:** Fan Heat Sinks provide significant component cooling benefits over system level fans. They incorporate a dedicated fan with a heat sink base to increase localized airflow while improving thermal efficiency. These active fan heat sinks allow for greater thermal performance than can be achieved with an equivalent size passive solution.
- **Heat Pipe Assemblies:** Small Diameter Heat Pipe Assemblies provide greater thermal efficiency by embedding heat pipes into an assembly to transport heat away from a concentrated source. Heat pipes passively facilitate this transfer by employing an evaporator and condenser in a closed loop mechanism, spreading heat evenly within a base or transporting it to peripheral fins.
- **Liquid Cooling:** Liquid Cold Plate Heat Sinks provide the best thermal performance per unit volume and counter nearly every drawback associated with air cooling by dissipating more heat with considerably less flow volume, better temperature consistency, and less local acoustic noise. Cold plates take advantage of the increased thermal conduction properties of liquid by actively circulating fluids past a heat source through a closed loop system.

**Clip Attach E-Series for Ball Grid Arrays:**

- Heat sink for BGA with easy to mount plastic frame along with flexible wire springs. The wire springs are resistant to breakage and allow for easy installation. They provide pressure to improve thermal contact. Customization is possible with different interface materials, finishes, and expanded heat sink size for smaller Rca. The standard finish is black anodize.

Aavid cooling offerings will work with any type or brand of FPGA as long as you match the correct system requirements with the thermal technology. Due to the number of options and combinations, Aavid recommends that you fill out the FPGA Solution Questionnaire as thoroughly as possible to be able to match solutions to your needs.

**Key factors to choosing or creating the proper solution:**

- Power Levels/Watts
- Available Space/Solution Size Requirements
- Attachment Type
- Forced or Natural Convection
FINDING YOUR FPGA THERMAL SOLUTION - Requirements Questionnaire

1. Provide a data sheet, if possible. At a minimum, provide the footprint.

2. What are the size (L x W x H) constraints for the heat sink (Maximum in mm)?

3. Where will the device be located on the heat sink base? Please provide a sketch.

4. How much power (Watts) will be dissipated from the device?

5. Describe the ambient conditions:
   a. Are you open to use a fan for cooling? If so, what is the air velocity (CFM)?
   b. Will the heat sink be fully ducted (no extra space between the heat sink edges and the duct)? If not, please describe.
   c. If you do not plan on using a fan, what will the orientation of the heat sink be with respect to gravity?
   d. What is the temperature of the surrounding environment (ambient temp)?

6. What is the maximum allowable case temperature of the device?
   Note: If you do not specify a max case temp, then the heat sink will be designed around the max junction temp listed on the data sheet.

7. Does the device need to be electrically isolated from the heat sink? If so, what dielectric strength is required?

8. What will be used as the interface material between the device and heat sink?
   Note: Aavid can recommend and include an interface material as part of the completed assembly.

9. What is the preferred method of mounting the device to the heat sink?
   Examples: double sided tape, PCB attach, attach to device etc.

10. What finish do you need on the heat sink?

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**Thermal Interface Materials, High Pressure Die Casting and High Density Die Casting**

* vary in thermal efficiency and power based upon application
Avnet development and evaluation products help engineers accelerate the design cycle and get to market faster. Avnet specializes in creating products for industry leading FPGAs.

### Development Kits

#### Xilinx Artix™-7 35T “Arty” FPGA Evaluation Kit

The Artix-7 35T FPGA evaluation board is the perfect solution for designers interested in exploring the MicroBlaze soft processor or Artix-7 FPGAs in general. Experienced FPGA users will find the Artix-7 35T FPGA evaluation board a valuable tool for general purpose prototyping and testing. Utilizes the Xilinx XC7A35T-L1CSG324I device.

#### Xilinx Kintex® UltraScale™ Development Kit

Available with the Kintex UltraScale XCKU040-1FBVA676 device, the Kintex UltraScale kit provides expandability and customization through the FMC HPC expansion slot and PMOD headers.

#### MicroZed™ Zynq®-7000 All Programmable SoC System-on-Modules

MicroZed™ is a low-cost development board based on the Xilinx Zynq®-7000 All Programmable SoC. Its unique design allows it to be used as both a stand-alone evaluation board for basic SoC experimentation, or combined with a carrier card as an embeddable system-on-module (SOM). Utilizes the Xilinx XC7Z010-1CLG400C or XC7Z020-1CLG400C.

#### PicoZed™ Zynq®-7000 All Programmable SoC System-on-Modules

PicoZed™ is a highly flexible, rugged, SOM that is based on the Xilinx Zynq®-7000 All Programmable SoC. It offers designers the flexibility to migrate between the 7010/15/20/30 Zynq-7000 AP SoC devices in a pin-compatible footprint. The PicoZed module contains the common functions required to support the core of most SoC designs, including memory, configuration, Ethernet, USB, and clocks.

#### MATLAB and Simulink for FPGA and Zynq SoC Development

Use Model-Based Design with MATLAB® and Simulink® to significantly reduce hardware-software codesign development time for systems based on the Xilinx® Zynq®-7000 All Programmable SoC. Move from concept, to code, to production using MathWorks hardware support, which offers a complete solution for system modeling and simulation, HDL IP core generation using HDL Coder™, Linux executable generation using Embedded Coder® and Support options that span development, evaluation, or application-focused Zynq development kits.
Reference Designs and Tools

To accelerate your FPGA and SoC based designs, the following are some of the reference designs and tools available from our partners for determining the right set of complimentary products.

Aavid Thermalloy

**Heat Pipe Exploration Kit**
Aavid’s Heat Pipe Exploration Kit is for you to get your hands onto heat pipes and get a feel for how they work, what they do, and try them out in your own application.

**Heat Pipe Discovery Kit**
Aavid’s Heat Pipe Discovery Kit is for you to get your hands onto heat pipes and get a feel for how they work, what they do, and try them out in your own application.

**Gap Filling Thermal Interface Material Demonstration Kit**
Aavid’s Gap Filler Demonstration Kit allows you to feel and test our new high thermal conductivity gap filling interface materials. Kit includes all three product lines.

Analog Devices

**EVAL-ADP5054: ADP5054 Evaluation Board**
The ADP5054 evaluation board connects to high input voltages, up to 15V directly without any pre-regulators.

**EVAL-ADP5052: ADP5052 Evaluation Board**
The ADP5050/ADP5052 evaluation board combines four high performance buck regulators and one 200 mA LDO in a 48-lead LFCSP package.
Final Inch® - Pre-optimized Break Out Region Reference Designs

In an effort to simplify high speed connector selection for FPGAs/SoCs, Samtec has extended the concept of manufacturer supplied PCB layouts and connector electrical models to include one of the most difficult design issues on the PCB: the break out region (BOR) around a high speed connector.

Samtec’s Final Inch® reference designs:

- Save design, development and validation time and resources
- Balance performance with manufacturability and cost
- Predict real-world performance expectations
  - Physical Models
  - Electrical Models
  - Empirical Data
  - Test and Evaluation Boards
- Are based on standard PCB material and manufacturing processes
- Minimize signal degradation

The following products have Final Inch® data available.

- ERM8/ERF8
- HSEC8
- QTE/QSE
- SEAM/SEAF (FMC Standard Connectors series)

Silicon Labs

Silicon Labs programmable oscillators, clocks generators, jitter attenuators and clock fan-out buffers are featured on evaluation boards and reference designs showcasing the latest FPGA and SoC technologies from Xilinx.

- Virtex®- 7: VC707 Evaluation Board
- Kintex®- 7: KC705 Evaluation Board
- Artix®- 7: AC701 Evaluation Board
- Zynq®-7000: ZC702 and ZC706 Reference Designs
- Kintex®-Ultrascale™: KCU105 Evaluation Board

ClockBuilder Pro Software

This software solution is provided in executable format to support Silicon Labs’ Si534x and Si538x clock generators and jitter attenuators.

Quick-Turn XOs

Need an XO on your next design? Enter your requirements using Silicon Labs’ web utility and request samples from Avnet. Silicon Labs ships samples of any Si5xx XO/VCXO with short 2 week lead times. To access the utility, click here.
FPGA Services and Support

**Design Chain Solution**
Customers large and small can all benefit from working with Avnet engineers through design and production. Technologies are always changing and our engineering teams stay aligned with the trends that customers are integrating into their products. Our broad supplier base and expertise allow customers to have all the options necessary to get the best products to market.

**Field Application Engineers (FAEs)**
- Component and technology selections
- Developing complex solutions with multiple technologies
- Guide you from design to production

**Device Programming & Modifications**
- Device Programming
- Customized Power Supply
- Customized Thermal Management

**FPGA Design Services**
- Code Development and Validation
- Vendor and 3rd Party Tools Training
- Design Workshops with Hands On Labs

**Supply Chain Solutions**
Our comprehensive supply chain portfolio and global scale provide you with options to maximize your supply chain and keep your products in the market longer, without disrupting production or supplies. In addition, our industry-recognized supply chain experts can help you assess your supply chain health and manage future expansion.

**Inventory Management & Warehousing**
- In Plant & Out Plant Stores
- Vendor Managed Inventory / Consignment
- Inventory & Order Visibility
- Inventory Replenishment

**Risk & Time to Market**
- Risk Mitigation
- Assurance of Supply
- Obsolescence Services

**Supply Chain Assessment & Planning**
- Logistical Analysis – Rapid Benefits Estimation Tool
- Global Solutions