

New!

## Model 53841

# 1-Ch. 3.6 GHz or 2-Ch. 1.8 GHz, 12-bit A/D, w/ Wideband DDC, Kintex UltraScale FPGA - 3U VPX



Model 53841 COTS (left)  
and rugged version



### Features

- Ideal radar and software radio interface solution
- Supports Xilinx Kintex UltraScale FPGAs
- One-channel mode with 3.6 GHz, 12-bit A/D
- Two-channel mode with 1.8 GHz, 12-bit A/Ds
- Programmable one- or two-channel DDC (Digital Down-converter)
- 5 GB of DDR4 SDRAM
- $\mu$ Sync clock/sync bus for multiboard synchronization
- PCI Express (Gen. 1 & 2) interface up to x8
- Optional LVDS and gigabit serial connections to the FPGA for custom I/O
- Compatible with several VITA standards including: VITA-46, VITA-48 and VITA-65 (OpenVPX™ System Specification)
- Ruggedized and conduction-cooled versions available

### General Information

Model 53841 is a member of the Jade™ family of high-performance 3U VPX boards. The Jade architecture embodies a new streamlined approach to FPGA-based boards, simplifying the design to reduce power and cost, while still providing some of the highest-performance FPGA resources available today. Designed to work with Pentek's new Navigator™ Design Suite of tools, the combination of Jade and Navigator offers users an efficient path to developing and deploying FPGA-based data acquisition and processing.

The 53841 is a high-speed data converter with programmable DDCs (digital down-converters). It is suitable for connection to HF or IF ports of a communications or radar system. Its built-in data capture feature offers an ideal turnkey solution as well as a platform for developing and deploying custom FPGA-processing IP.

It includes a 3.6 GHz, 12-bit A/D converter and a large DDR4 memory. In addition to supporting PCI Express Gen. 3 as a native interface, Model 53841 includes optional high-bandwidth connections to the Kintex UltraScale FPGA for custom digital I/O.

### The Jade Architecture

Evolved from the proven designs of the Pentek Cobalt and Onyx families, Jade raises the processing performance with the new flagship family of Kintex UltraScale FPGAs from Xilinx. As the central feature of the board architecture, the FPGA has access to all data and control paths, enabling factory-installed functions including data multiplexing,

channel selection, data packing, gating, triggering and memory control. The Jade architecture organizes the FPGA as a container for data-processing applications where each function exists as an intellectual property (IP) module.

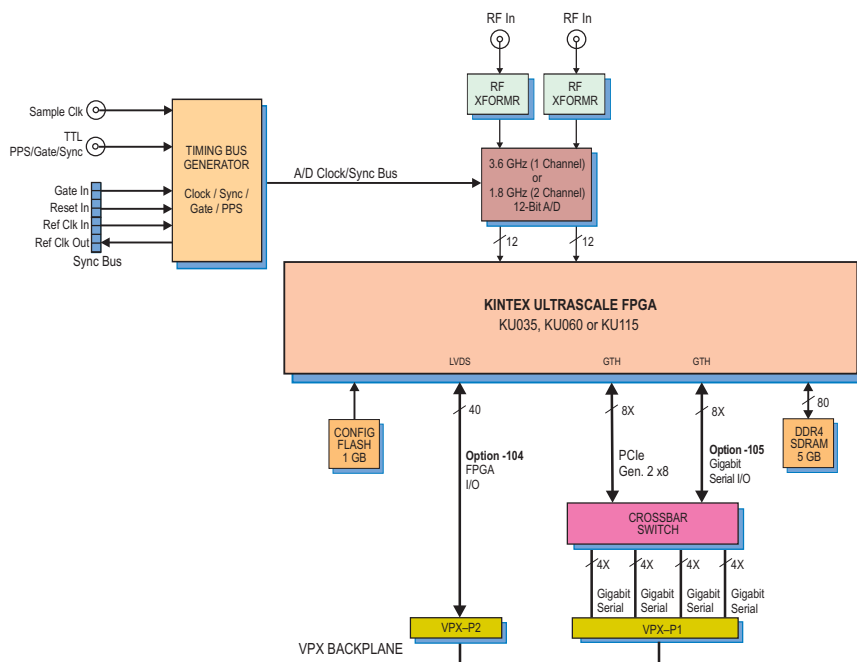
Each member of the Jade family is delivered with factory-installed applications ideally matched to the board's analog interfaces. The 53841 factory-installed functions include an A/D acquisition IP module and a programmable digital downconverter. In addition, IP modules for DDR4 SDRAM memories, a controller for all data clocking and synchronization functions, a test signal generator and a PCIe interface complete the factory-installed functions and enable the 53841 to operate as a complete turnkey solution, without the need to develop any FPGA IP.

### Extendable IP Design

For applications that require specialized functions, users can install their own custom IP for data processing. Pentek Navigator FPGA Design Kits include all of the factory-installed modules as documented source code. Developers can integrate their own IP with the Pentek factory-installed functions or use the Navigator kit to completely replace the Pentek IP with their own.

### Xilinx Kintex UltraScale FPGA

The Kintex UltraScale FPGA site can be populated with a range of FPGAs to match the specific requirements of the processing task, spanning the KU035 through KU115. The KU115 features 5520 DSP48E2 slices ➤



### A/D Acquisition IP Module

The 53841 features an A/D Acquisition IP Module for easy capture and data moving. The IP module can receive data from the A/D, or a test signal generator. The IP module has an associated 5 GB memory bank for buffering data in FIFO mode or for storing data in transient capture mode.

In single-channel mode, all of 5 GB are used to store the single-channel of input data. In dual-channel mode, one half of the memory stores data from input channel 1 and the other half stores data from input channel 2. In both modes, continuous, full-rate transient capture of 12-bit data is supported.

The memory bank is supported with a DMA engine for moving A/D data through the PCIe interface. This powerful linked-list DMA engine is capable of a unique Acquisition Gate Driven mode. In this mode, the length of a transfer performed by a link definition need not be known prior to data acquisition; rather, it is governed by the length of the acquisition gate. This is extremely useful in applications where an external gate drives acquisition and the exact length of that gate is not known or is likely to vary.

For each transfer, the DMA engine can automatically construct metadata packets containing a sample-accurate time stamp and data length information. These actions simplify the host processor's job of identifying and executing on the data.

### DDC IP Cores

Within the FPGA is a powerful DDC IP core. The core supports a single-channel mode, accepting data samples from the A/D at the full 3.6 GHz rate. Additionally, a dual-channel mode supports the A/D's 1.8 GHz two-channel operation.

In single-channel mode, decimation can be programmed to 8 or 16 to 512 in steps of 16.

In dual-channel mode, decimation can be programmed to 4 or 8 to 256 in steps of 8. In dual-channel mode, both channels share the same decimation rate.

In either mode, the DDC can be bypassed completely.

The decimating filter for each DDC accepts a unique set of user-supplied 16-bit coefficients. The 80% default filters deliver an output bandwidth of  $0.8 \cdot f_s / N$ , where  $N$  is the decimation setting. The rejection of adjacent-band components within the 80% output bandwidth is better than 100 dB. Each DDC delivers a complex output stream consisting of 16-bit I + 16-bit Q samples at a rate of  $f_s / N$ .

➤ and is ideal for modulation/demodulation, encoding/decoding, encryption/decryption, and channelization of the signals between transmission and reception. For applications not requiring large DSP resources or logic, a lower-cost FPGA can be installed.

Option -104 connects 20 pairs of LVDS connections between the FPGA and the VPX P2 connector for custom I/O.

Option -105 connects one 8X gigabit serial link from the FPGA to the VPX P1 connector to support serial protocols.

### A/D Converter Stage

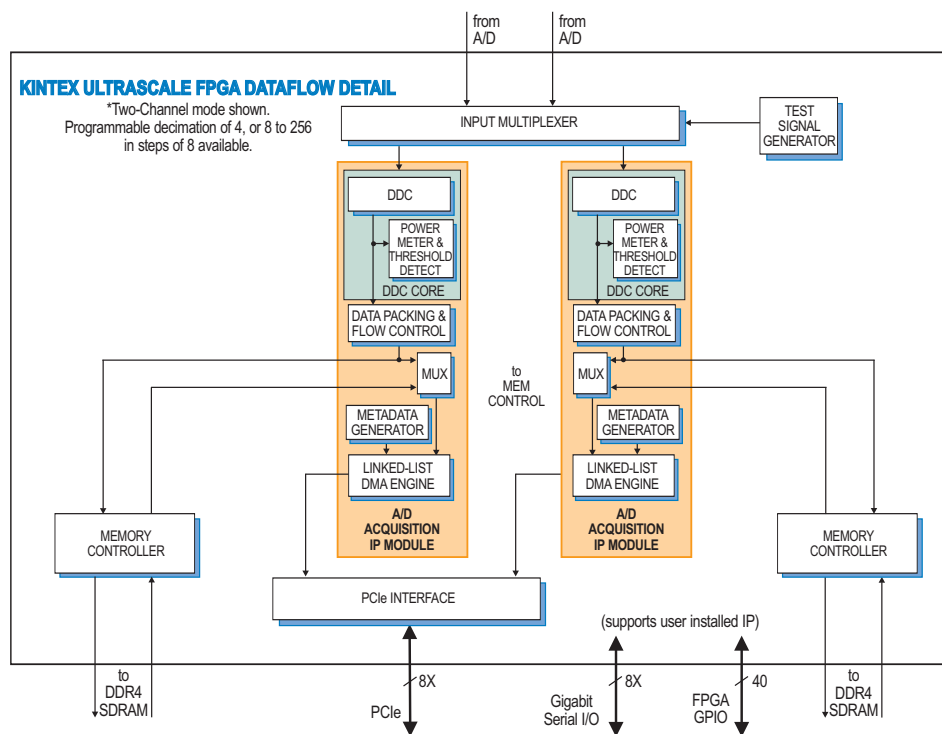
The front end accepts analog HF or IF inputs on a pair of front panel SSMC connectors with transformer coupling into a Texas Instruments ADC12D1800 12-bit A/D. The converter operates in single-channel interleaved mode with a sampling rate of 3.6 GHz and an input bandwidth of 1.75 GHz; or, in dual-channel mode with a sampling rate of 1.8 GHz and input bandwidth of 2.8 GHz.

The full-scale input level of the ADC12D1800 can be digitally trimmed from +2 dBm to +4 dBm to simplify system calibration. A built-in AutoSync feature supports A/D synchronization across multiple boards.

The A/D digital outputs are delivered into the Kintex UltraScale FPGA for signal processing, data capture or for routing to other board resources.

### PCI Express Interface

The Model 53841 includes an industry-standard interface fully compliant with PCI Express Gen. 1 and 2 bus specifications. Supporting PCIe links up to x8, the interface includes multiple DMA controllers for efficient transfers to and from the board ➤



### Model 8267

The Model 8267 is a fully-integrated development system for Pentek Cobalt, Onyx and Flexor 3U VPX boards. It was created to save engineers and system integrators the time and expense associated with building and testing a development system that ensures optimum performance of Pentek boards.



### Memory Resources

The 53841 architecture supports an optional 5 GB bank of DDR4 SDRAM memory. User-installed IP along with the Pentek-supplied DDR4 controller core within the FPGA can take advantage of the memory for custom applications.

### Crossbar Switch

The 53841 features a unique high-speed switching configuration. A fabric-transparent crossbar switch bridges numerous interfaces and components on the board using gigabit serial data paths with no latency. Programmable signal input equalization and output pre-emphasis settings enable optimization.

### Ordering Information

Model	Description
53841	1-Ch. 3.6 GHz or 2-Ch. 1.8 GHz, 12-bit A/D with Wideband DDC, Kintex UltraScale FPGA - 3U VPX

#### Options:

- 084	XCKU060-2 FPGA
- 087	XCKU115-2 FPGA
- 104	LVDS FPGA I/O
- 105	Gigabit serial FPGA I/O
- 702	Air cooled, Level L2
- 713	Conduction cooled, Level L3

Contact Pentek for complete specifications of rugged and conduction-cooled versions

### Clocking and Synchronization

The 53841 accepts a 1.8 GHz dual-edge sample clock via a front panel SSMC connector. A second front panel SSMC accepts a TTL signal that can function as Gate, PPS or Sync.

A front panel  $\mu$ Sync bus connector allows multiple boards to be synchronized, ideal for multichannel systems. The  $\mu$ Sync bus includes gate, reset, and in and out reference clock signals. Two 53841's can be synchronized with a simple cable. For larger systems, multiple 53841's can be synchronized using the Model 7192 high-speed sync module to drive the sync bus.

### Specifications

#### Front Panel Analog Signal Inputs

**Input Type:** Transformer-coupled, front panel female SSMC connectors

#### A/D Converter

**Type:** Texas Instruments ADC12D1800

**Sampling Rate:** Single-channel mode: 500 MHz to 3.6 GHz; dual-channel mode: 150 MHz to 1.8 GHz

**Resolution:** 12 bits

**Input Bandwidth:** single-channel mode: 1.75 GHz; dual-channel mode: 2.8 GHz

**Full Scale Input Level:** may be trimmed from +2 dBm to +4 dBm with a 15-bit integer

#### Digital Downconverters

**Modes:** One or two channels, programmable

**Supported Sample Rate:** One-channel mode: 3.6 GHz, two-channel mode: 1.8 GHz

**Single-channel mode:** decimation can be programmed to 8 or 16 to 512 in steps of 16

**Dual-channel mode:** decimation can be programmed to 4 or 8 to 256 in steps of 8; both channels

share the same decimation value

**Either mode:** the DDC can be bypassed completely

**LO Tuning Freq. Resolution:** 32 bits, 0 to  $f_s$   
**LO SFDR:** >120 dB

**Phase Offset Resolution:** 32 bits, 0 to 360 degrees

**FIR Filter:** User-programmable 18-bit coefficients

**Default Filter Set:** 80% bandwidth, <0.3 dB passband ripple, >100 dB stopband attenuation

**Sample Clock Source:** Front panel SSMC connector

**Timing Bus:** 19-pin  $\mu$ Sync bus connector includes sync and gate/trigger inputs, CML

#### External Trigger Input

**Type:** Front panel female SSMC connector, LVTTTL

**Function:** Programmable functions include: trigger, gate, sync and PPS

#### Field Programmable Gate Array

**Standard:** Xilinx Kintex UltraScale XCKU035-2

**Option -084:** Xilinx Kintex UltraScale XCKU060-2

**Option -087:** Xilinx Kintex UltraScale XCKU115-2

#### Custom I/O

**Option -104:** Connects 20 LVDS pairs between the FPGA and VPX P2

**Option -105:** Connects 8X gigabit serial links between the FPGA and VPX P1 or P2

#### Memory

**Type:** DDR4 SDRAM

**Size:** 5 GB

**Speed:** 1200 MHz (2400 MHz DDR)

#### PCI-Express Interface

**PCI Express Bus:** Gen. 1, 2 or 3: x4 or x8

#### Environmental

**Standard: L0 (air cooled)**

**Operating Temp:** 0° to 50° C

**Storage Temp:** -20° to 90° C

**Relative Humidity:** 0 to 95%, non-condensing

**Option -702: L2 (air cooled)**

**Operating Temp:** -20° to 65° C

**Storage Temp:** -40° to 100° C

**Relative Humidity:** 0 to 95%, non-condensing

**Option -713: L3 (conduction cooled)**

**Operating Temp:** -40° to 70° C

**Storage Temp:** -50° to 100° C

**Relative Humidity:** 0 to 95%, non-condensing

**Size:** 3.937 in. x 6.717 in. (100 mm x 170.6 mm)

### VPX Families

Pentek offers two families of 3U VPX products: the 53xxx and the 52xxx. For more information on a 52xxx product, please refer to the product datasheet. The table below provides a comparison of their main features.

VPX Family Comparison

	52xxx	53xxx
Form Factor	3U VPX	
# of XMCs	One XMC	
Crossbar Switch	No	Yes
PCIe path	VPX P1	VPX P1 or P2
PCIe width	x4	x8
Option -104 path	20 pairs on VPX P2	
Option -105 path	Two x4 or one x8 on VPX P1	Two x4 or one x8 on VPX P1 or P2
Lowest Power	Yes	No
Lowest Price	Yes	No