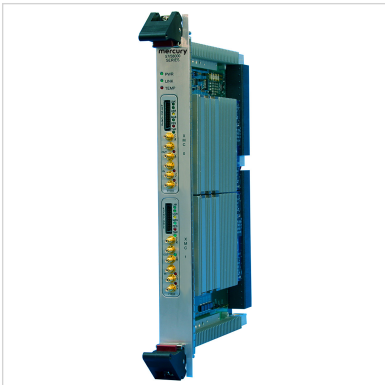


# Cobalt 57650/58650

2- or 4-channel 500 MHz A/D,  
DUC with 2-or 4-channel 800 MHz D/A  
6U VPX boards with Virtex-6 FPGA

## Complete radar and software radio interface solution

- Radar and communication receiver and transmitter
- Electronic Warfare transponder
- Waveform signal generator
- Wideband data acquisition
- Remote monitoring
- Sensor interfaces



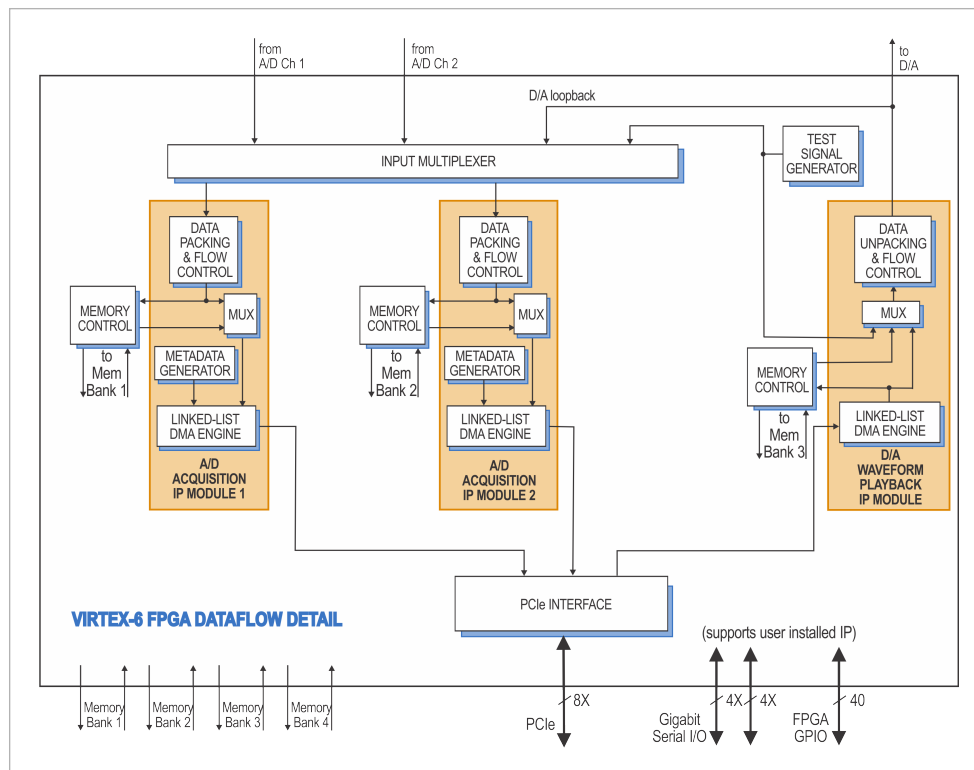
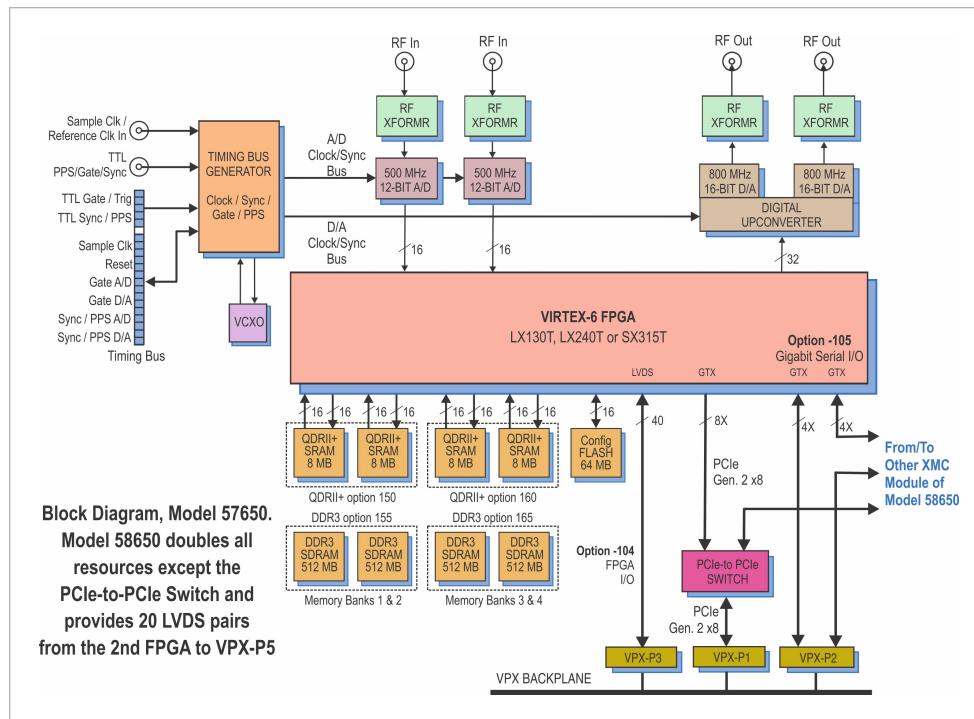
**Models 57650 and 58650 consist of one or two 71650 XMC modules mounted on a VPX carrier board.** The 57650 is a 6U board with one 71650 module while the 58650 is a 6U board with two XMC modules rather than one.

These models include two or four A/Ds, one or two DUCs, two or four D/As and four or eight banks of memory.

## FEATURES

- Supports Xilinx® Virtex®-6 LXT and SXT FPGA
- Two or four 500 MHz 12-bit A/Ds
- One or two DUCs (digital upconverters)
- Two or four 800 MHz 16-bit D/As
- Up to 2 or 4 GB of DDR3 SDRAM; or: 32 MB or 64 MB of QDRII+ SRAM
- PCI Express (Gen. 1 & 2) interface up to x8
- Sample clock synchronization an external system reference
- LVPECL clock/sync bus for multiboard synchronization
- Optional user-configurable gigabit serial interface
- Optional LVDS connections to the FPGA for custom I/O
- Ruggedized and conduction-cooled versions available

## 57650 BLOCK DIAGRAMS



## THE COBALT ARCHITECTURE

The Cobalt® Architecture features a Xilinx Virtex-6 FPGA. All of the board's data and control paths are accessible by the FPGA, enabling factory-installed functions including data multiplexing, channel selection, data packing, gating, triggering and memory control. The Cobalt 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 Cobalt family is delivered with factory-installed applications ideally matched to the board's analog interfaces. The 57650 factory-installed functions include two A/D acquisition and one D/A waveform playback IP modules. In addition, IP modules for either DDR3 or QDRII+ 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 57650 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. The GateFlow FPGA Design Kits include all of the factory-installed modules as document source code. Developers can integrate their own IP with the factory-installed functions or use the GateFlow kit to completely replace the IP with their own.

## XILINX VIRTEX-6 FPGA

The Virtex-6 FPGA site can be populated with a variety of different FPGAs to match the specific requirements of the processing task. Supported FPGAs include: LX130T, LX240T, or SX315T. The SXT part features 1344 DSP48E slices 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, one of the lower-cost LXT FPGAs can be installed.

## A/D CONVERTER STAGES

The board's analog interface accepts two or four full scale analog HF or IF inputs on front panel SSMC connectors at +5 dBm into 50 ohms with transformer coupling into two or four Texas Instruments ADS5463 500 MHz, 12-bit A/D converters.

The digital outputs are delivered into the Virtex-6 FPGA for signal processing, data capture or for routing to other module resources

## A/D ACQUISITION MODULES

These models feature two A/D Acquisition IP Modules for easy capture and data moving. Each IP module can receive data from either of the two A/Ds, a test signal generator or from the D/A Waveform Playback IP Module in loopback mode. Each IP module has an associated memory bank for buffering data in FIFO mode or for storing data in transient capture mode. All memory banks are supported with DMA engines for moving A/D data through the PCIe interface.

These powerful linked-list DMA engines are 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/D channel ID, a sample-accurate time stamp, and data length information. These actions simplify the host processor's job of identifying and executing on the data.

## D/A WAVEFORM PLAYBACK IP MODULES

These models include one or two factory-installed sophisticated D/A Waveform Playback IP modules. Linked-list controllers allow users to easily play back waveforms stored in either on-board memory or off-board host memory to the dual D/As.

Parameters including length of waveform, delay from playback trigger, waveform repetition, etc. can be programmed for each waveform.

Up to 64 or 128 individual link entries can be chained together to create complex waveforms with a minimum of programming.

## DIGITAL UPCONVERTER AND D/A STAGES

One or two Texas Instruments DAC5688 DUCs and D/As accept baseband real or complex data streams from the FPGAs and provide that input to the upconvert, interpolate and dual D/A stages.

When operating as a DUC, it interpolates and translates real or complex baseband input signals to any IF center frequency up to 360 MHz. It delivers real or quadrature (I+Q) analog outputs to the dual 16-bit D/A converter. Analog output is through front panel SSMC connectors.

If translation is disabled, the DAC5688 acts as a dual interpolating 16-bit D/A with output sampling rates up to 800 MHz. In both modes the DAC5688 provides interpolation factors of 2x, 4x and 8x.

### CLOCKING AND SYNCHRONIZATION

Two internal timing buses provide either a single clock or two different clock rates to the A/D and D/A signal paths.

Each timing bus includes a clock, sync and a gate or trigger signal. An on-board clock generator receives an external sample clock from the front panel SSMC connector. This clock can be used directly for either the A/D or D/A sections or can be divided by a built-in clock synthesizer circuit to provide different A/D and D/A clocks. In an alternate mode, the sample clock can be sourced from an on-board programmable voltage-controlled crystal oscillator. In this mode, the front panel SSMC connector can be used to provide a 10 MHz reference clock for synchronizing the internal oscillator

A front panel 26-pin LVPECL Clock/Sync connector allows multiple boards to be synchronized. In the slave mode, it accepts LVPECL inputs that drive the clock, sync and gate signals. In the master mode, the LVPECL bus can drive the timing signals for synchronizing multiple boards.

Multiple boards can be driven from the LVPECL bus master, supporting synchronous sampling and sync functions across all connected boards.

### MEMORY RESOURCES

The Cobalt architecture supports up to four or eight independent memory banks which can be configured with all QDRII+ SRAM, DDR3 SDRAM, or as combination of two banks of each type of memory.

Each QDRII+ SRAM bank can be up to 8 MB deep and is an integral part of the board's DMA capabilities, providing FIFO memory space for creating DMA packets. For applications requiring deep memory resources, DDR3 SDRAM banks can each be up to 512 MB deep. Built-in memory functions include A/D data transient capture mode and D/A waveform playback mode.

In addition to the factory-installed functions, custom user-installed IP within the FPGA can take advantage of the memories for many other purposes.

### PCI EXPRESS INTERFACE

These models include an industry standard interface fully compliant with PCI Express Gen. 1 & 2 bus specifications. Supporting PCIe links up to x8, the interface includes multiple DMA controllers for efficient transfers to and from the board.

## READYFLOW

Mercury provides ReadyFlow<sup>®</sup> BSPs (Board Support Packages) for all Cobalt, Onyx, and Flexor products. Available for both Linux and Windows, these packages:

- Provide a path for quick start-up through application completion
- Allow programming at high, intermediate and low levels to meet various needs
- Are illustrated with numerous examples
- Include complete documentation and definitions of all functions
- Include library and example source code.

ReadyFlow BSPs contain C-language examples that can be used to demonstrate the capabilities of Cobalt, Onyx, and Flexor products. These programming examples will help you get an immediate start on writing your own application. They provide sample code that is known to work, giving you a means of verifying that your board set is operational.

## COMMAND LINE INTERFACE

The Command Line Interface provides access to pre-compiled executable examples that operate the hardware right out of the box, without the need to write any code. Board-specific hardware

operating arguments can be entered in the command line to control parameters: number of channels to enable, sample clock frequency, data transfer size, reference clock frequency, reference clock source, etc.

The Command Line Interface can be used to call an example application from within a larger user application to control the hardware, and parameter arguments are passed to the application for execution. Functions that control data acquisition automatically save captured data to a pre-named host file or are routed to the Signal Analyzer example function for display.

## SIGNAL ANALYZER

When used with the Command Line Interface, the Signal Analyzer allows users to immediately start acquiring and displaying A/D data. A full-featured analysis tool, the Signal Analyzer displays data in time and frequency domains. Built-in measurement functions display 2nd and 3rd harmonics, THD, and SINAD. Interactive cursors allow users to mark data points and instantly calculate amplitude and frequency of displayed signals.



## GATEFLOW

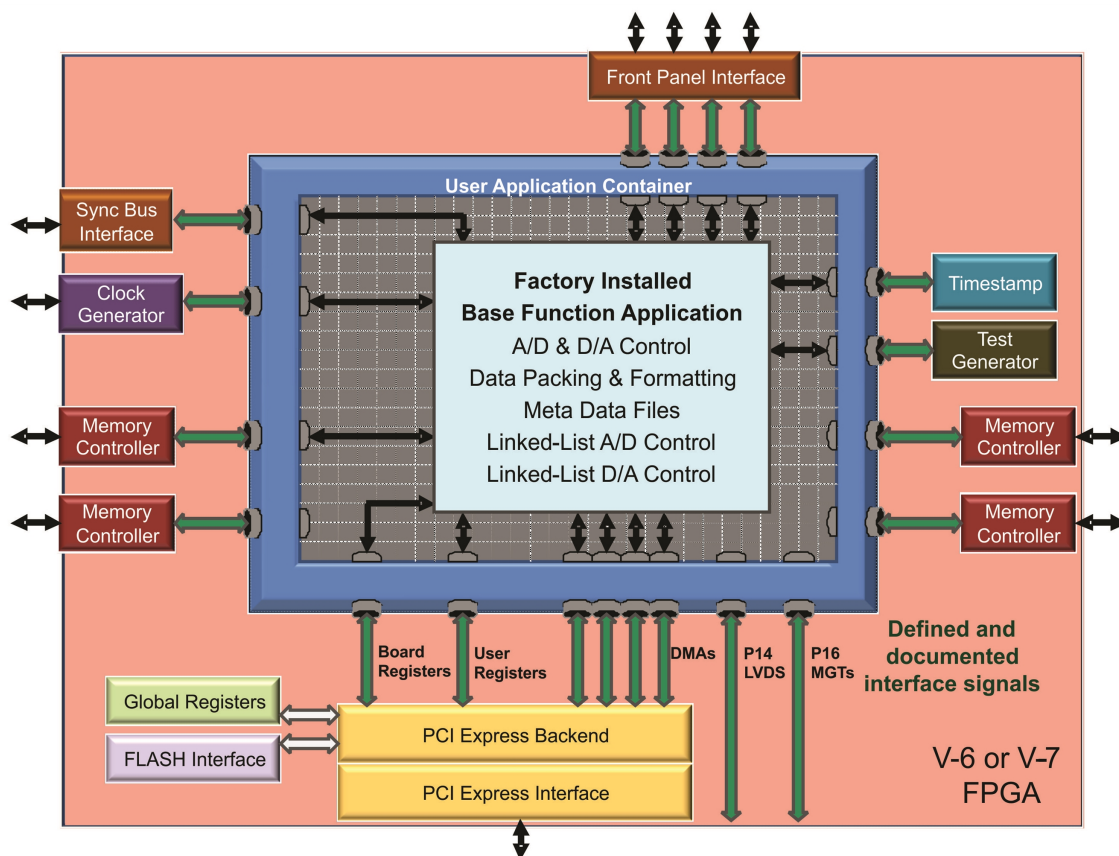
The GateFlow<sup>®</sup> FPGA Design Kit (FDK) allows the user to modify, replace and extend the standard installed functions in the FPGA to incorporate special modes of operation, new control structures, and specialized signal-processing algorithms.

The Cobalt (Virtex-6), Onyx (Virtex-7), and Flexor (Virtex-7) architectures configure the FPGA with standard factory-supplied interfaces including memory controllers, DMA engines, A/D and D/A interfaces, timing and synchronization structures, triggering and gating logic, time stamping and header tagging, data formatting engines, and the PCIe interface. These resources are connected to the User Application Container using well-defined ports that present easy-to-use data and control signals, effectively abstracting the lower-level details of the hardware.

## The User Application Container

Shown below is the FPGA block diagram of a typical Cobalt, Onyx or Flexor module. The User Application Container holds a collection of different installed IP modules connected to the various interfaces through the standard ports surrounding the container. The specific IP modules for each product are described in further detail in the datasheet of that product.

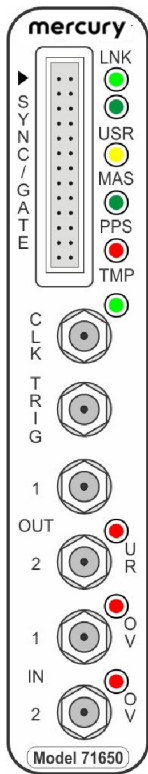
The GateFlow FDK provides a complete Xilinx's ISE or Vivado project folder containing all the files necessary for the FPGA developer to recompile the entire project with or without any required changes. VHDL source code for each IP module provides excellent examples of how the IP modules work, how they might be modified, and how they might be replaced with custom IP to implement a specific function.





## FRONT PANEL CONNECTIONS

The XMC front panel includes a 26-pin  $\mu$ Sync connector, and six SSMC coaxial connectors for input/output of timing and analog signals. The front panel also includes nine LEDs.



- **Sync Bus Connectors:** The 26-pin Sync Bus front panel connector, labeled SYNC/GATE, provides clock, sync and gate input/output pins for the Low-Voltage Positive Emitter-Coupled Logic (LVPECL) Sync Bus.
- **Link LED:** The green **LNK** LED blinks when a valid link has been established over the PCIe interface.
- **User LED:** The green **USR** LED is for user applications.
- **MAS LED:** The yellow **MAS** LED illuminates when this model is the Sync Bus Master.
- **PPS LED:** The green **PPS** LED illuminates when a valid PPS signal is detected. The LED will blink at the rate of the PPS signal.
- **Over Temperature LED:** The red **TMP** LED illuminates when an over-temperature or over-voltage condition is indicated by any of the temperature/voltage sensors on the PCB.
- **Clock Input Connector:** One SSMC coaxial connector, labeled **CLK** for the input of an external sample or reference clock.

- **Trigger Input Connector:** One SSMC coaxial connector, labeled **TRIG** for input of an external gate or trigger signal.
- **Analog Output Connectors:** Two SSMC coaxial connectors, labeled **1 OUT** and **2 OUT** for the DAC5688 output.
- **DAC Underrun LED:** There is one red **UR** (underrun) LED for the D/A output. This LED illuminates when the DAC5688 FIFO is out of data.
- **ADC Overload LED:** There are two red **OV** (overload) LEDs, one for each A/D input. Use the application ADC Data Control Register to select the signal source for the associated LED.
- **Analog Input Connectors:** Two SSMC coaxial connectors, labeled **1 IN** and **2 IN** for the ADC input channels.

## SPECIFICATIONS

57650: 2 A/Ds, 1 DUC, 2 D/As; 58650: 4 A/Ds, 2 DUCs, 4 D/As

## Front Panel Analog Signal Inputs (2 or 4)

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

Transformer Type: Coil Craft WBC4-6TLB

Full Scale Input: +5 dBm into 50 ohms

3 dB Passband: 300 kHz to 700 MHz

## A/D Converters (standard) (2 or 4)

Type: Texas Instruments ADS5463

Sampling Rate: 20 MHz to 500 MHz

Resolution: 12 bits

## A/D Converters (option -014) (2 or 4)

Type: Texas Instruments ADS5474

Sampling Rate: 20 MHz to 400 MHz

Resolution: 14 bits

## D/A Converters (2 or 4)

Type: Texas Instruments DAC5688

Input Data Rate: 250 MHz max.

Output IF: DC to 400 MHz max.

Output Signal: 2-channel real or 1-channel with frequency translation

Output Sampling Rate: 800 MHz max. with interpolation

Resolution: 16 bits

## Front Panel Analog Signal Outputs (2 or 4)

Output Type: Transformer-coupled, front panel female SSMC connectors

Transformer Type: Coil Craft WBC4-6TLB

Full Scale Output: +4 dBm into 50 ohms

3 dB Passband: 300 kHz to 700 MHz

## Sample Clock Sources (2 or 4)

On-board clock synthesizer generates two clocks: one A/D clock and one D/A clock

## Clock Synthesizers (1 or 2)

Clock Source: Selectable from on-board programmable VCXO (10 to 810 MHz), front panel external clock or LVPECL timing bus

Synchronization: VCXO can be locked to an external 4 to 180 MHz PLL system reference, typically 10 MHz

Clock Dividers: External clock or VCXO can be divided by 1, 2, 4, 8, or 16, independently for the A/D clock and D/A clock

**External Clocks (1 or 2)**

Front panel female SSMC connector, sine wave, 0 to +10 dBm, AC-coupled, 50 ohms, accepts 10 to 800 MHz sample clock or PLL system reference

**Timing Bus (1 or 2)**

26-pin front panel connector LVPECL bus includes, clock/sync/ gate/PPS inputs and outputs; TTL signal for gate/trigger and sync/PPS inputs

**External Trigger Inputs (1 or 2)**

Type: Front panel female SSMC connector, LVTTTL

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

**Field Programmable Gate Arrays (1 or 2)**

- Standard: Xilinx Virtex-6 XC6VLX130T-2
- Optional: Xilinx Virtex-6 XC6VLX240T-2 or XC6VSX315T-2

**Custom I/O**

- Option -104: Provides 20 LVDS pairs between the FPGA and the VPX P3 connector, 57650; P3 and P5, 58650
- Option -105: Supports serial protocols by providing a 4X gigabit link between the FPGA and VPX P2, 57650; or one 4X link from each FPGA to P2 and an additional 4X link between the FPGAs, 58650

**Memory Banks (1 or 2)**

- Option 150 or 160: Two 8 MB QDRII+ SRAM memory banks, 400 MHz DDR
- Option 155 or 165: Two 512 MB DDR3 SDRAM memory banks, 400 MHz DDR

**PCI Express Interface**

PCI Express Bus: Gen. 1 or 2: 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 -763: L3 (conduction-cooled)

- Operating Temp: -20° to 65° C
- Storage Temp: -40° to 100° C
- Relative Humidity: 0 to 95%, non-condensing

**Physical**

Dimensions:

- Depth: 171 mm (6.717 in.)
- Height: 100 mm (3.937 in.)

Weight: VPX Carrier: 110 grams (3.9 oz)

**ORDERING INFORMATION**

Model	Description
57650	Two 500 MHz A/Ds, one DUC, Two 800 MHz D/As with Virtex-6 FPGA - XMC
58650	Four 500 MHz A/Ds, Two DUCs, Four 800 MHz D/As with two Virtex-6 FPGAs 6U VPX

Options	Description
-002*	-2 FPGA speed grade
-014	400 MHz, 14-bit A/Ds
-062	XC6VLX240T FPGA
-064	XC6VSX315T FPGA
-104	LVDS I/O between the FPGA and P3 connector, 57650; P3 and P5 connectors, 58650
-105	Gigabit link between the FPGA and P2 connector, 57650; gigabit links from each FPGA to P2 connector, 78650
-150	Two 8 MB QDRII+ SRAM Memory Banks (Banks 1 and 2)
-155	Two 512 MB DDR3 SDRAM Memory Banks (Banks 1 and 2)
-160	Two 8 MB QDRII+ SRAM Memory Banks (Banks 3 and 4)
-165	Two 512 MB DDR3 SDRAM Memory Banks (Banks 3 and 4)
-702	Air-cooled, Level 2
-763	Conduction-cooled, Level 3
*This option is always required. Contact Mercury for compatible option combinations.	

**ACCESSORY PRODUCTS**

Model	Description
2171	Cable Kit: SSMC to SMA



## DEVELOPMENT SYSTEMS

Mercury offers development systems for Cobalt products. They come with all pre-tested software and hardware ready for immediate operation. These systems are intended to save engineers and system integrators the time and expense associated with building and testing a development system that ensures optimum performance of Cobalt boards. Please [contact Mercury](#) to configure a system that matches your requirements.

## FORM FACTORS

Cobalt products are available in standard form factors including 3U VPX, 6U VPX, PCIe, and XMC. The Cobalt Model 71650 XMC (2-Channel 500 MHz A/D and 2-Channel 800 MHz D/A with Virtex-6 FPGA) has the following variants:

Model	
52650	3U VPX board (single XMC)
57650	6U VPX board (single XMC)
58650	6U VPX board (dual XMC)
71650	XMC module
78650	PCIe board (single XMC)

## LIFETIME SUPPORT FOR COBALT PRODUCTS

Mercury offers worldwide customers shorter development time, reliable, rugged solutions for a variety of environments, reduced costs, and mature software development tools. We offer free lifetime support from our engineering staff, which customers can depend on through phone and email, as well as software updates. Take advantage of our 40 years of experience in delivering high-performance radar, communications, SIGINT, EW, and data acquisition MIL-Aero solutions worldwide.



### Corporate Headquarters

50 Minuteman Road  
Andover, MA 01810 USA  
**+1 978.967.1401** tel  
**+1 866.627.6951** tel  
**+1 978.256.3599** fax

### International Headquarters

**Mercury International**  
Avenue Eugène-Lance, 38  
PO Box 584  
CH-1212 Grand-Lancy 1  
Geneva, Switzerland  
**+41 22 884 5100** tel

### Learn more

**Visit:** [mrcy.com/go/MP57650](https://mrcy.com/go/MP57650)

**For technical details, contact:**  
[mrcy.com/go/CF57650](https://mrcy.com/go/CF57650)



The Mercury Systems logo and the following are trademarks or registered trademarks of Mercury Systems, Inc.: Mercury Systems, Innovation That Matters, Cobalt, GateFlow, and ReadyFlow. Other marks used herein may be trademarks or registered trademarks of their respective holders. Mercury believes this information is accurate as of its publication date and is not responsible for any inadvertent errors. The information contained herein is subject to change without notice.

