

# Ensemble® 6000 Series OpenVPX™

## Intel Xeon D server-class family module with I/O mezzanine sites LDS6527

- Intel Xeon D family SoC processor with AVX2
- InfiniBand or Ethernet high-bandwidth switching:  
Ethernet: 10GBASE-KX4, 10GBASE-KR and 40GBASE-KR4  
Or InfiniBand: DDR and FDR10
- BuiltSECURE systems security engineering
- MOTS options for extreme environmental protection
- Integrated Gen3 PCIe switching infrastructure for on-board and off-board co-processing
- One XMC and one XMC/PMC mezzanine sites



The Ensemble 6000® Series LDS6527 6U OpenVPX™ is a single board computer (SBC) with options for Modified Off the Shelf (MOTS) extreme durability configurations and BuiltSECURE™ technology. MOTS configurations leverage enhanced commercial components, board fabrication rules, and subsystem design techniques for extra ruggedness and withstand extreme temperature cycles better than other rugged designs.

For deployment at the tactical edge and export to allies, the Ensemble LDS6527 embeds

**BuiltSECURE™**

BuiltSECURE technology to counter nation-state reverse engineering with System Security Engineering (SSE). BuiltSECURE is built-in SSE that enables turn-key or private and personalized security solutions to be quickly configured. The extensible nature of Mercury's SSE delivers system-wide security that evolves over time, building in future-proofing. As countermeasures are developed to offset emerging threats, Mercury's security framework keeps pace, maintaining system-wide integrity. Please contact Mercury directly for BuiltSECURE and extra rugged MOTS options.

Ensemble LDS6527 SBCs combine a powerful, 12-core server-class Xeon D processor, Mellanox CX-3 bridged Ethernet or InfiniBand high bandwidth switching, and configurable mezzanine I/O. Each SBC has a next-gen architecture that blends the computational power of an

AVX2-enabled Xeon D processor with fast InfiniBand or 40Gb/s Ethernet data paths and the versatility of mezzanine-mounted I/O. This scalable computing architecture is well aligned to EW, next-gen radar, complex IMINT, multi-functional sensor chain and advanced situational awareness applications.

### Intel Xeon D Family Server-Class Processor

The Ensemble LDS6527 features a 64-bit Xeon D family processor which is protected and cooled by Mercury's fifth generation of server-class packaging, which has previously been deployed in the full spectrum of Mercury LDS and HDS 6U OpenVPX processing modules.

The D family of Xeon processors includes a System on Chip (SoC) approach, combining the processor and the Intel Platform Controller Hub (PCH) function within a single device. With two high-speed DDR4-2133 memory controllers, the Xeon processor is supported with 16GB of RAM. Significant PCIe interface capabilities are built in to the chip, which enable data interfaces both on-board and off-board.

The on-device PCH functionality enables the Ensemble LDS6527 to access additional I/O, including USB and SATA on the backplane. The D family of Xeon processors has dual 10 Gigabit Ethernet interfaces, enabling backplane access for sensor data or additional inter-processor communication, as well as support for the AVX 2.0 instruction set, that boosts floating-point algorithm performance and is portable to future Intel architectures.

*Mercury Systems is a leading commercial provider of secure processing subsystems designed and made in the USA. Optimized for customer and mission success, Mercury's solutions power a wide variety of critical defense and intelligence programs.*



ACQUIRE



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PROCESS



STORAGE



EXPLOIT



DISSEMINATE

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## High Speed Fabric Interfaces

The Ensemble LDS6527 complements Mercury's other OpenVPX modules that feature dual Mellanox ConnectX-3 host adaptors for data plane communications. Bridging between the native Gen3 PCIe interfaces on the Intel processor and the OpenVPX data plane, the ConnectX-3 can be configured to support InfiniBand (DDR or FRD10 rates) or 10/40 Gb/s Ethernet as the data protocol.

By utilizing Mellanox ConnectX-3 devices and innovative OpenVPX interconnect technology, the Ensemble LDS6527 is a model for open architecture high-performance computing throughout the embedded industry. Mercury OpenVPX subsystems feature robust signal rates that comfortably exceed the margin of the channel to surpass the rate of modern fabrics, delivering the fastest compute solution in the industry with future proof performance headroom.

## PCIe Architecture

The Ensemble LDS6527 provides a single Gen3 PCIe switch for both on-board switching and off-board expansion. This switch complex provides an x8 PCIe interface to each of the two VITA-compliant XMC sites, as well as an x4 connection to a PCIe to PCI-X® bridge for the single PMC site. This enables the mezzanine sites to operate at full bandwidth, optimizing the flow of I/O into the processing subsystem. Externally, the Ensemble LDS6527 implements a full Gen3 x16 PCIe connection to the OpenVPX expansion plane on the P2 VPX connector, and a Gen x8 PCIe connection to P5 as well. These expansion plane interfaces enable the Ensemble LDS6527's compatibility with Mercury's GPU or FPGA based co-processing modules. These configuration options let the module effectively act as an upstream/downstream PCIe switch to allow the "chaining" of PCIe devices.

## Mezzanine Card Flexibility

The Ensemble LDS6527 provides two mezzanine sites: one PMC/ XMC and one XMC-only. Each of the standard mezzanine sites may be configured with off-the-shelf mezzanine cards to bring additional I/O into the system for processing or control. PMC cards are supported with a 32-bit or 64-bit PCI/PCI-X interface at up to 133 MHz on the PMC/XMC site, with PMC user-defined I/O mapped to the backplane. XMCs are supported with x8 PCIe on the J15/J25 connector per the VITA 42.3 standard. There are 16 differential pairs and 38 single-ended signals of XMC user I/O mapped to the backplane via the J16/J26 connector. The Ensemble LDS6527 utilizes VITA 61 XMC connectors for Gen3 PCIe signal integrity and greater ruggedness.

## Multiple I/O Options

In addition to the flexibility offered via the on-board mezzanine sites, the Ensemble LDS6527 has a variety of additional built-in I/O options:

- One 10/100/1000BASE-T Gigabit Ethernet connection can be routed to the front-panel on air-cooled configurations or to the backplane.
- One additional 10/100/1000BASE-T Gigabit Ethernet connection is routed to the backplane.
- Two 1000BASE-BX SERDES Ethernet connections are routed to the backplane per the OpenVPX control plane specification.
- One TIA-232 serial port is routed to the front-panel on air-cooled configurations, or to the backplane on conduction-cooled configurations. When routed to the backplane, the serial interface can be configured for either TIA-232 or TIA-422 signaling.
- One front-panel USB 3.0 interface is available on air-cooled configurations.
- Two backplane USB interfaces are available (one 2.0, one 3.0) with both air-cooled and conduction-cooled configurations.
- Two SATA interfaces to the backplane are provided to interface with storage devices.
- Eight GPIO lines act as discrete I/O usable as input, output, or to generate interrupts on the module.
- Several additional bussed signals enhance the functionality of the Ensemble LDS6527 module.

## System Management

The Ensemble LDS6527 module implements full compliance to advanced system management functionality architected in the OpenVPX (VITA 46.11) standard to enable remote monitoring, alarm management, and hardware revision and health status. Using the standard I2C bus and Intelligent Platform Management Controller (IPMC) protocol, the on-board system management block implements the IPMC. This allows the Ensemble LDS6527 module to:

- Read sensor values
- Read and write sensor thresholds, allowing an application to react to thermal, voltage or current variations that exceed those thresholds
- Reset the entire module
- Power up/down the entire module
- Retrieve module Field Replaceable Unit (FRU) information
- Be managed remotely by a Chassis Management Controller at the system level, such as implemented on Mercury's 6U OpenVPX chassis or system management modules

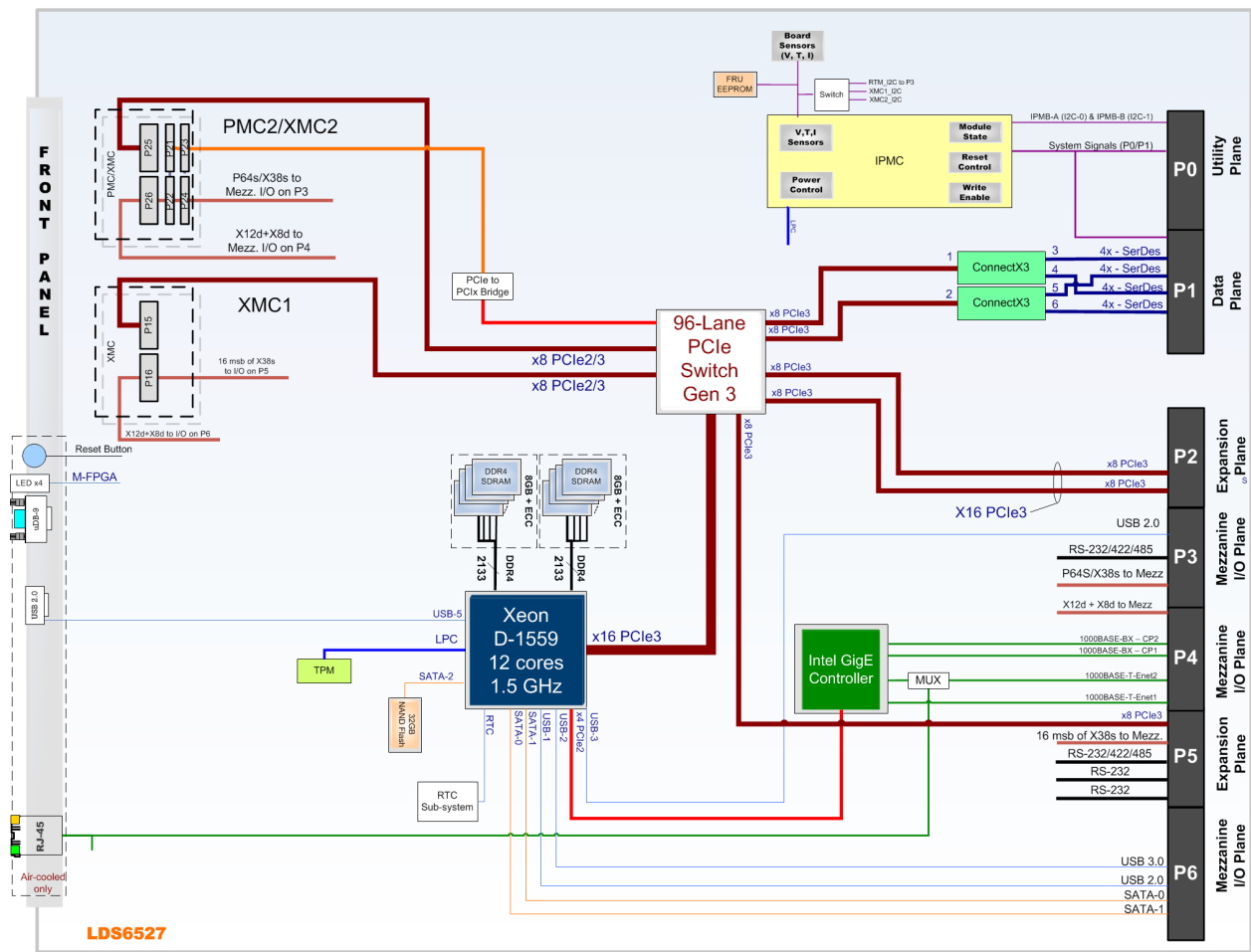


Figure 1. LDS6527 functional block diagram

## VPX-REDI

The VPX (VITA 46) standard defines 6U and 3U board formats with a modern high-performance connector set capable of supporting today's high-speed fabric interfaces. VPX is most attractive when paired with the Ruggedized Enhanced Design Implementation standard — REDI (VITA 48). The Ensemble LDS6527 module is a 6U conduction-cooled/Air Flow-By implementation of VPX-REDI, with air-cooled variants in the same VPX form factor available for less rugged environments.

Targeted primarily for harsh-environment embedded applications, VPX-REDI offers extended mechanical configurations supporting higher functional density, such as two-level maintenance (2LM). 2LM allows maintenance personnel to replace a failed module and restore the system to an operational state in a limited time period.

## Air Flow-By

Air-cooled chassis require filters to remove contaminants from their cooling air streams. Mercury's Air Flow-By™ technology eliminates filtration with the most elegant cooling solution available within a sealed and rugged package. Air Flow-By technology is resilient, boosts SWaP performance, reduces operating temperature, extends MTBF by an order of magnitude and enables the most powerful processing solutions.

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## Additional Features

The Ensemble LDS6527 module provides all the features typically found on a single-board computer. In addition to the sophisticated management subsystem and switched fabric interconnect, the Ensemble LDS6527 module provides users with a toolkit enabling many different application use cases. Features include:

- Real-time clock with granularity to 1ms and time measurement of up to 30 years
- General-purpose timers for synchronization
- Watchdog timer to support processor interrupt or reset
- Multiple boot paths, including netboot, USB boot and boot from SATA or the on-board 32 GB flash device.

## Open Software Environment

Mercury leverages over 35 years of multicomputer software expertise, including recent multicore processor expertise, across its many platforms. This strategy is fully applied to the Ensemble LDS6527 module. The same Linux® development and run-time environment is implemented on the Ensemble LDS6527 module as on other Intel-based Mercury platforms across the Ensemble 3000, 5000 and 6000 Series. Off-the-shelf open software such as OFED, OpenMPI and MultiCore Plus™ are fully supported.

## Mercury's OpenVPX Ecosystem

Sensor chain awareness is having the technical expertise and resources to design and build capable, interoperable solutions along the whole sensor processor chain. From RF/microwave, digital/analog signal manipulation to dense, SWaP optimized processing resources to actionable intelligence dissemination; Mercury's rugged processing subassemblies leverage the best commercial-item technology, enabling prime contractors to win more business. Modern sensor processing subassemblies are customized assemblies of interoperable building blocks built to open standard architectures. Mercury's hardware and software portfolio of building blocks are physically and electrically interoperable as defined by international industrial standards, including OpenVPX.

## Specifications

### Processor

Single Intel 12-core, 64 bit, Xeon D-1559

Threads per core: 2 (24 total per CPU)

Processor support:

- AVX2, 256 bit vector engine incorporating

- Fused Multiple-Add (FMA)

Memory:

- 16GB DDR4-2133

PCIe Gen 3 (x8)

### Built-in options

For extra MOTS ruggedness and/or build-in security SSE, please Consult factory

### Intelligent Platform Management Interface (IPMI)

- On-board IPMI controller

- Voltage and temperature monitor

- Geographical address monitor

- Power/reset control

- On-board FRU EEPROM interface

- FPGA, CPU and CPLD interfaces

### Data Plane PCIe to Switched Fabric Bridge

- Dual Mellanox ConnectX-3 VPI host adapters

- Support DDR/FDR10 InfiniBand or 10/40 Gb/s Ethernet protocols

## OpenVPX Multi-Plane Architecture

- System management via IPMB-A and IPMB-B links on P0 management plane

- Support DDR/FDR10 InfiniBand or 10/40 Gb/s Ethernet protocols on P1 data plane

- Full x16 or dual x8 Gen3 PCIe expansion plane to P2 connector; x8 Gen3 PCIe to P5 connector

- Dual 1000BASE-BX Ethernet control plane

### PMC/XMC Sites

- Mezzanine sites 1 PMC/XMC and 1 XMC

- PCI-X to PCIe bridge Connects PMC site to on-board

- PMC PCI support 33 and 66 MHz

- PMC PCI-X support 66, 100, and 133 MHz

- PMC user-defined I/O from J14 to backplane

- PCIe XMC sites per VITA 42.3 with XMC user-defined I/O from Jn6 to backplane

- VITA 61 XMC connectors

### Additional I/O Capabilities

- One RS-232 serial interface to front-panel (air-cooled) or backplane (conduction cooled)

- Configurable for RS-232 or RS-422 signaling when routed to backplane

- One additional RS-232/RS-422 serial interface to backplane

- One front-panel USB 2.0 interface (air-cooled configurations only)

- One USB 2.0 interface to backplane

- One USB 3.0 interface to backplane

- Two SATA interfaces to backplane

- Eight single-ended GPIO interfaces to backplane

- System signals to backplane NVMRO, Chassis Test,

- Environmental Bypass, Memory Clear

### Mechanical

- Extended MOTS ruggedness – Consult factory

- Packages – Commercial and rugged air-cooled, rugged Air Flow-By and conduction cooled

- 6U OpenVPX - 1.0" slot pitch

- OpenVPX and VPX-REDI

- VITA 65 module profile MOD6-PAY-4F1Q2U2T-12.2.1-n, where n can vary based on ConnectX-3 configuration

- VITA 65 slot profile SLT6-PAY-4F1Q2U2T-10.2.1

### Compliance

- OpenVPX system standard encompasses VITA 46.0, 46.3, 46.4, 46.6, 46.11

- Compatible with VITA 65

- VITA 61 (High-speed XMC connectors)

- VITA 46.11 (System management)

- VITA 46/48.1/48.2 (REDI)

- InfiniBand, PCIe, 10 Gigabit Ethernet

## Environmental

		Environmental Qualification Levels				
		Air-cooled		Air Flow-By	Conduction-cooled	
		Commercial L0	Rugged L1	Rugged L2	Rugged L4	Rugged L3
Ruggedness		•	••	••	•••	•••
Moisture/dust protection		•	••	••	•••	•••
Typical cooling performance		~140W*	~140W*	~150W*	~200W*	~150W**
Temperature	Operating*	0°C to +40°C	-25°C to +55°C	-45°C to +70°C	-40°C to +60°C	-40°C to +71°C
Operating temperature maximum rate of change		N/A	5°C/min	10°C/min	10°C/min	10°C/min
Temperature	Storage	-40°C to +85°C	-55°C to +85°C	-55°C to +125°C	-55°C to +125°C	-55°C to +125°C
Humidity	Operating*	10-90%, non-condensing	5-95%, non-condensing	5-95%, non-condensing	5-95%, non-condensing 100% condensing	5-95%, non-condensing 100% condensing
	Storage	10-90%, non-condensing	5-95%, non-condensing	5-95%, non-condensing	5-95%, non-condensing 100% condensing	5-95%, non-condensing 100% condensing
Altitude	Operating*	0-10,000ft	0-30,000ft	0-30,000ft	0-30,000ft	0-70,000ft
	Storage	0-30,000ft	0-50,000ft	0-70,000ft	0-70,000ft	0-70,000ft
Vibration	Random	0.003 g <sup>2</sup> /Hz; 20-2000 Hz, 1 hr/axis	0.04 g <sup>2</sup> /Hz; 20-2000 Hz, 1 hr/axis	0.04 g <sup>2</sup> /Hz; 20-2000 Hz, 1 hr/axis	0.1 g <sup>2</sup> /Hz; 5-2000 Hz, 1 hr/axis	0.1 g <sup>2</sup> /Hz; 5-2000 Hz, 1 hr/axis
	Sine	N/A	N/A	N/A	10G peak; 5-2000 Hz, 1 hr/axis	10G peak; 5-2000 Hz, 1 hr/axis
	Shock	z-axis: 20g; x and y-axes: 32g; (11ms 1/2-sine pulse, 3 positive, 3 negative)	z-axis: 50g; x and y-axes: 80g; (11ms 1/2-sine pulse, 3 positive, 3 negative)	z-axis: 50g; x and y-axes: 80g; (11ms 1/2-sine pulse, 3 positive, 3 negative)	z-axis: 50g; x and y-axes: 80g; (11ms 1/2-sine pulse, 3 positive, 3 negative)	z-axis: 50g; x and y-axes: 80g; (11ms 1/2-sine pulse, 3 positive, 3 negative)
Salt/Fog		N/A	Contact Factory	Contact Factory	10% NaCl	10% NaCl
VITA 47		Contact Factory				

\* Customer must maintain required cfm level. Consult factory for the required flow rates.

\*\* Card edge should be maintained below 71°C

Storage Temperature is defined per MIL-STD-810F, Method 502.4, para 4.5.2, where the product under non-operational test is brought to an initial high temperature cycle to remove moisture. Then the unit under non-operational test will be brought to the low storage temperature. The low temperature test is maintained for 2 hours. The product is then brought to the high storage temperature and is maintained for 2 hours. The product is then brought back to ambient temperature. All temperature transitions are at a maximum rate of 10°C/min. One cold/hot cycle constitutes the complete non-operational storage temperature test. This assumes that the board level products are individually packaged in accordance with ASTM-D-3951 approved storage containers. These tests are not performed in Mercury shipping containers, but in an unrestrained condition. Please consult the factory if you would like additional test details.

All products manufactured by Mercury meet elements of the following specifications: MIL-STD-454, MIL-STD-883, MIL-HDBK-217F, and MIL-I-46058 or IPC-CC-830, and various IPC standards. Mercury's inspection system has been certified in accordance with MIL-I-45208A.

Additional Services			
Optional Environmental Screening and Analysis Services		Standard Module, Optional Services	
<ul style="list-style-type: none"> <li>• Cold Start Testing</li> <li>• Cold Soak Testing</li> <li>• Custom Vibration</li> <li>• CFD Thermal Analysis</li> <li>• Finite Element Analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Safety Margin Analysis</li> <li>• Temperature Cycling</li> <li>• Power Cycling</li> <li>• Environmental Stress Screening</li> </ul>	<ul style="list-style-type: none"> <li>• Engineering Change Order (ECO) Notification</li> <li>• ECO Control</li> <li>• Custom Certificate of Conformity (CofC)</li> <li>• Custom UID Labeling</li> </ul>	<ul style="list-style-type: none"> <li>• Alternate Mean Time Between Failure (MTBF) Calculations</li> <li>• Hazmat Analysis</li> <li>• Diminished Manufacturing Sources (DMS) Management</li> <li>• Longevity of Supply (LOS)</li> <li>• Longevity of Repair (LOR)</li> </ul>
Contact factory for additional information			

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INNOVATION THAT MATTERS™

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