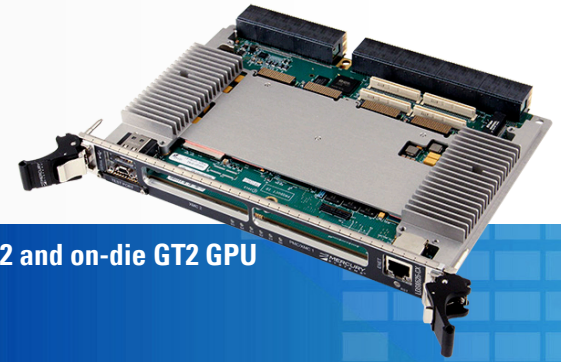# Ensemble® 6000 Series OpenVPX™ Intel 4ᵗʰ Generation Core i7 module LDS6525-CX

4ᵗʰ Gen Intel® Quad-Core™ i7 LDS module with CPU on-die GPU and mezzanine sites

MERCURY SYSTEMS™

- **4ᵗʰ Gen Intel® Quad-Core™ i7 processor (Haswell mobile class) with AVX2 and on-die GT2 GPU**
- **InfiniBand or Ethernet high-bandwidth switching:**
    - **Ethernet: 10GBASE-KX4, 10GBASE-KR and 40GBASE-KR4**
    - **Or InfiniBand: DDR, QDR and FDR10**
- **Integrated Gen3 PCIe switching infrastructure for on-board and off-board co-processing**
- **One XMC and one XMC/PMC mezzanine sites**
- **Rugged 6U OpenVPX™ compliant VITA 65/46/48 (VPX-REDI) module**

The Ensemble® 6000 Series OpenVPX™ with 4ᵗʰ Gen Intel® Quad-Core™ i7 processor (Haswell mobile class) LDS6525-CX module combines a powerful mobile-class Quad-Core Intel processor, Mellanox X-3 powered Ethernet or InfiniBand™ high-bandwidth switching and configurable mezzanine I/O in a single 6U OpenVPX slot. The Ensemble LDS6525-CX provides a next-gen architecture that blends the computational capabilities of the AVX2-enabled Core i7 processor with fast InfiniBand or 40Gb/s Ethernet data paths. The combination provides a powerful and scalable computing architecture that is well aligned with EW, next-gen radar, complex IMINT, multi-functional sensor chain and advanced situational awareness applications.

Intel 4ᵗʰ Gen Core i7 Haswell Mobile-Class Processor

At the heart of the Ensemble LDS6525-CX is the Intel 64-bit 4ᵗʰ Gen Core i7-4700EQ processor, running at up to 2.4 GHz. This processor includes Advanced Vector Extensions-2 (AVX2) instruction set which doubles the width of the processor's SIMD engine from 128 bit to 256 bit, and includes Fused Multiply-Add (FMA), delivering a significant improvement in floating-point processing.

The 4700EQ includes a large 6 MB cache shared between the cores, allowing many high-performance calculations to remain cache resident. This accelerates processing by eliminating the potential latency required to access DRAM to fetch upcoming data. The processor supports dual high-speed DDR3-1600 memory controllers, providing up to 25 GB/s of raw memory bandwidth. 8 GB of DDR3-DRAM with ECC support is populated on the Ensemble LDS6525-CX.

The four processor cores are supported by the latest on-die GT2 GPU for high definition graphical and intensive parallel data processing. Programming options include the device's native OpenCL™ support and the efficiency of Intel's FMA.

High Speed Fabric Interfaces

The Ensemble LDS6525-CX compliments 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 processors and the OpenVPX data plane, the ConnectX-3 can be configured to support InfiniBand (DDR, QDR or FRD10) or 10/40 Gb/s Ethernet as the data protocol.

By utilizing Mellanox ConnectX-3 devices and innovative OpenVPX interconnect technology the Ensemble LDS6525-CX is a model for open architecture high performance computing throughout the embedded

Mercury Systems is a best-of-breed provider of commercially developed, open sensor and Big Data processing systems, software and services for critical commercial, defense and intelligence applications.

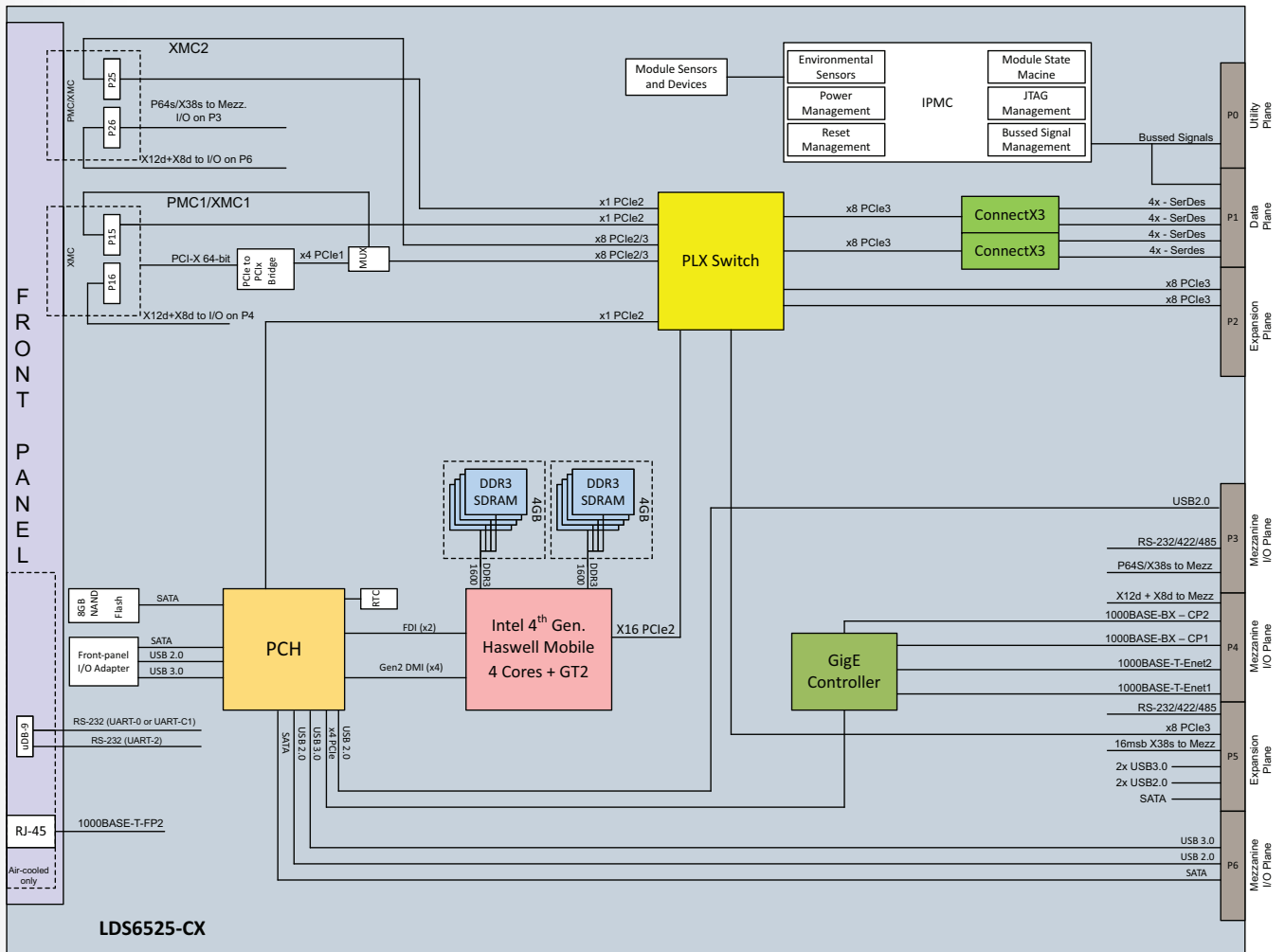ACQUIRE | DIGITIZE | PROCESS | STORAGE | EXPLOIT | DISSEMINATE

Figure 1. *LDS6525-CX functional block diagram*

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 LDS6525-CX provides single 81-lane Gen3 PCIe switches for both on-board switching and off-board expansion. This switch complex provides an x8 PCIe interface to each of the two 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 LDS6525-CX implements a full Gen3 x16 PCIe connection to the OpenVPX expansion plane on the P2 VPX connector. This expansion plane interface enables the Ensemble LDS6525-CX'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 LDS6525-CX 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 LDS6525-CX supports configuration with either VITA 42 or VITA 61 XMC connectors. Air-cooled variants are populated by default with the VITA 42 XMC connector, while rugged conduction-cooled or Air Flow-By™ variants are populated by default with VITA 61 XMC connectors. The VITA 61 connector offers superior signal integrity characteristics and is a more rugged design, appropriate for high-end XMC modules utilizing Gen3 PCIe interfaces in environmentally challenging applications.

Multiple I/O Options

In addition to the flexibility offered via the on-board mezzanine sites, the Ensemble LDS6525-CX offers 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 bused signals enhance the functionality of the Ensemble LDS6525-CX module.

System Management

The Ensemble LDS6525-CX module implements the advanced system management functionality architected in the OpenVPX specification 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 LDS6525-CX 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 switched fabric modules

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 LDS6525-CX 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, reduces operating temperature, extends MTBF by an order of magnitude and enables the most powerful processing solutions.

Additional Features

The Ensemble LDS6525-CX 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 LDS6525-CX module provides users with a toolkit enabling many different application use cases. Features include:

- Real-time clock with granularity to 1 ms 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 8 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 LDS6525-CX module. The same Linux® development and run-time environment is implemented on the Ensemble LDS6525-CX 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.

Specifications

Processor

Single 2.4GHz 4th Gen Intel i7 Quad-Core mobile (Haswell mobile) CPU (i7-4700EQ)

Threads per core: 2 (8 total per CPU)

On-die GT2 GPU

Processor support: AVX2, 256 bit vector engine incorporating

Fused Multiple-Add (FMA)

Peak performance per module:

    Processor: 307 GFLOPS

    GT2 GPU: 208 GFLOPS

PCIe Gen 3 (x8)

OpenCL

PCH (Platform Controller Hub) LynxPoint mobile QM87

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/QDR/FDR10 InfiniBand or 40 Gb/s Ethernet protocols

OpenVPX Multi-Plane Architecture

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

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

Full x16 or dual x8 Gen3 PCIe expansion plane to P2 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

PCIe

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

Additional I/O Capabilities

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

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 3.0 interface (air-cooled configurations only)

One USB 2.0 and one USB 3.0 interface to backplane

One DVI 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

6U OpenVPX and VPX-REDI

1.0" slot pitch

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 46/48.1/48.2 (REDI)

InfiniBand, PCIe, 10 Gigabit Ethernet

Please refer to Mercury publication "Environmental Protections for Operation at the Tactical Edge" for specific ruggedness levels and cooling options.

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