Inspur Server Mother Board Design Scheme

Whistler
Rev 0.1

Author:
Inspur Whistler Team
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<tr>
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<td>5/21/2019</td>
<td>Initial Release</td>
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3. **Scope**

This specification describe a kind of 4 sockets server system’s mother board design. It is designed based on Intel Purley Platform. It has 4 pcs CPU sockets, 48 DIMMs, 5 pcs M.2 on board and 9 pcs PCIe slots.

4. **Overview**

4.1 **Overview**

Whistler is based on Intel® Sky Lake-SP CPU architecture. The motherboard supports up to 48 DIMMs. Whistler was designed in the Q1 of 2018.

4.2 **Product Overview**

Whistler is a completely independent research and development of server products. Based on Intel® Sky lake-SP CPU architecture, using Lewisburg chipset. Support four mainstream Intel Xeon Sky Lake-SP 81xx/61xx/51xx series processors. Support 48 DIMMs DDR4 memory, the biggest support to 2666 MHZ. Support Lewisburg-1G PCH and AST2500 is managed chipset. There are 9 pcs PCIe Slots on board and maximum support 12 pcs slots. Supports 5 pcs M.2 SSD on board.

4.3 **Product standard**

<table>
<thead>
<tr>
<th>CPU</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CPU type</strong></td>
<td>Supports four Intel® Sky Lake-SP 81xx/61xx/51xx series processors (TDP 205W)</td>
</tr>
<tr>
<td><strong>Connector</strong></td>
<td>Four Socket-P0 slots</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chipset</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chipset type</strong></td>
<td>PCH LBG-1G</td>
</tr>
</tbody>
</table>
### RAM
- **RAM type**: DDR4 RDIMM/LRDIMM/AEP/NVDIMM
- **RAM slot quantity**: 48
- **RAM total capacity**: Total capacity 6144GB (single 128GB)

### I/O Connecter
- **USB**: Two external USB 3.0 ports (Front), Internal USB 2.0 port
- **VGA**: One external VGA (Front)
- **UID**: One ID pilot lamp inlay

### Manager chipset
- **Manager chipset**: Integrated one independent 1000 Mbps network interface, specifically for remote management of IPMI.
- **PCI Express slot**: The motherboard supports 9 pcs PCI Express 3.0 slots

### HDD
- **HDD type**: Support one 3.5-inch SAS/SATA HDDs and 32 M.2 SSD

### Power supply
- **PSU spec**: The whole system adopts three specifications of PSU, the power is 1600W, and the maximum configuration is 4 power supplies. According to the system configuration, the appropriate PSU and PSU redundancy modes are selected to support 2+2 redundancy under certain configuration conditions.
- **Input power**: The main specifications is 1600W PSU
  - AC: 180-264V, Typical 230V
  - DC: 164-300V, Typical 270V

### 5. Physical Specifications
5.1 Block Diagram

Figure 5-1 illustrates the functional block diagram of the Motherboard.

5.2 Placement and Form Factor

Board form factor is 16.7 inch by 22.7 inch (16.7” x 22.7”). Figure 5-2 is board placement. The placement is meant to show key components’ relative positions, exact dimension and position information would be exchanged by DXF format for layout and 3D model of mechanical.
Figure 5-2 Placement
5.3 CPU and Memory

5.3.1 CPU

The motherboard supports all Intel® Sky Lake-SP processors with TDP up to 205W.

- Support four Sky Lake-SP processors up to 205W TDP.
- Three full-width Intel UPI links up to 10.4 GT/s/direction for Sky Lake-SP processor.
- Up to 28 cores per CPU (up to 56 threads with Hyper-Threading Technology).
- Single Processor mode and Two-CPU mode are both supported

5.3.2 DIMM

The motherboard has DIMM subsystem designed as below:

- DDR4 direct attach memory support on CPU0, CPU1, CPU2 and CPU3.
- 6x channels DDR4 registered memory interface on each CPU
- 2x DDR4 slots on each Chanel (total 48x DIMMs)
- Support DDR4 speeds up to 2666MT/s 1DCP and 2DCP
- Support DDR4 RDIMM/LRDIMM/AEP/NVDIMM
- Support SR, DR, QR and 8R DIMMs
- Up to maximum 6144 GB with 128 GB DRAM DIMM
- Follow updated JEDEC DDR4 specification with 288 pin DIMM socket
- Memory support matrix for DDR4 is as Table 5-1

<table>
<thead>
<tr>
<th>2 Slots Per Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 DIMM Per Channel</td>
</tr>
<tr>
<td>2666 MT/s</td>
</tr>
</tbody>
</table>

Table 5-1

5.4 PCH

The motherboard uses Intel® Lewisburg chipset, which supports following features:

- Two external USB 3.0 port(Front), One internal USB 2.0 port;
- 4x slimline x8 connector use x16 PCIE riser card;
- 1x Oculink connector use FPGA card;
- LPC interface, mux with BMC to enable BMC the capability to perform BIOS upgrade and Recovery
- SPI interface for TPM header
- SMBUS interface (master & slave)
- Intel® Server Platform Services (SPS) 4.0 Firmware with Intel® Node Manager
- PECI access to CPU
- SMLink0 connect to BMC
- Intel® Manageability Engine (ME) obtain HSC PMBus related information directly.
- Intel® ME SMLink1 connects to Hot swap controller PMBus interface by default.
- BMC connected to HSC PMBus, so it masters HSC PMBus related feature flexibly.
- Temperature sensors reading from BMC
- PCH SKUs
- Board design shall support all PCH SKUs in terms of power delivery and thermal design.

5.5 PCIe Usage

PCIe lanes are configured according to Figure 5-3 and Table 5-2:

![Figure 5-3 PCIe Usage](image-url)
## PCIE Resource Configuration

<table>
<thead>
<tr>
<th></th>
<th>PE1(Lane0-7)</th>
<th>PE1(Lane8-15)</th>
<th>PE2(Lane0-15)</th>
<th>PE3(Lane0-15)</th>
<th>PE1(Lane0-15)</th>
<th>PE2(Lane0-15)</th>
<th>PE3(Lane0-15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU0</td>
<td>X8</td>
<td>2 X4</td>
<td>X16</td>
<td>X16</td>
<td>x16</td>
<td>X16</td>
<td>X16</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oculink for FPGA card</td>
<td>M.2</td>
<td>PCIe Slot 3</td>
<td>PCIe Slot 4</td>
<td>PCIe Slot 9</td>
<td>PCIe Slot 5</td>
<td>PCIe Slot 7</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPU1</td>
<td>PE1(Lane0-15)</td>
<td>PE1(Lane0-15)</td>
<td>PE1(Lane0-15)</td>
<td>PE3(Lane0-15)</td>
<td>2 x8</td>
<td>X16</td>
<td>X16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PCIe Slot 9</td>
<td>PCIe Slot 5</td>
<td>PCIe Slot 7</td>
<td>PCIe Slot 6</td>
<td>2 x8 Slimline</td>
<td>PCIe Slot 8</td>
<td>PCIe Slot 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPU2</td>
<td>PE0(Lane0-7)</td>
<td>PE1(Lane0-15)</td>
<td>PE2(Lane0-15)</td>
<td>PE3(Lane0-15)</td>
<td>2 X4</td>
<td>X16</td>
<td>2 x8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>M.2</td>
<td>PCIe Slot 1</td>
<td>PCIe Slot 2</td>
<td>2 x8 Slimline</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPU3</td>
<td>PE1(Lane0-15)</td>
<td>PE1(Lane0-15)</td>
<td>PE2(Lane0-15)</td>
<td>PE3(Lane0-15)</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### 5.6 MB PCB Stack Up
5.7 DIMM Slot

Total 48 DIMMs, DIMM 1 is Black, DIMM0 is White.

5.8 Network

Management network
The motherboard has one management network interface for BMC’s connection. Dedicated RJ45 port for Board management, driven by BMC through RMII/NC-SI.

5.9 USB

The Motherboard has two external USB2.0/3.0 connectors located in Front edge of Motherboard and one internal USB 2.0 header. BIOS should support follow devices on USB ports available on Motherboard:

- USB Keyboard and mouse
- USB flash drive (bootable)
- USB hard drive (bootable)
- USB optical drive (bootable)
5.10 LED

▶ Power status LED, Green/Orange
--When power on, turn on green LED
--When Power off, turn on orange LED
▶ UID status LED, Blue
--When device is selected, turn on LED
--When device is not selected, turn off LED
► Attention status LED: RED

--When system is abnormal, turn on LED
--When system is normal or power off, turn off LED

5.11 TPM

The Motherboard supports one TPM with SPI interface.

5.12 Header

<table>
<thead>
<tr>
<th>Signal</th>
<th>Description</th>
<th>Location</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM_MFG_MODE</td>
<td>1-2:Enable Manufacture Mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-3:Disable Manufacture Mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDA_SDO</td>
<td>1-2:Disable Flash Override</td>
<td>J72</td>
<td>Default 1-2</td>
</tr>
<tr>
<td></td>
<td>2-3:Enable Flash Override</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM_ME_RECOVER_N</td>
<td>1-2:Normal</td>
<td>J88</td>
<td>Default 1-2</td>
</tr>
<tr>
<td></td>
<td>2-3:ME Force Update</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RST_RTCRST_N</td>
<td>1-2:Normal Operation</td>
<td>J89</td>
<td>Default 1-2</td>
</tr>
<tr>
<td></td>
<td>2-3:Clear CMOS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM_PASSWORD_CLEAR_N</td>
<td>1-2:Normal Operation</td>
<td>J103</td>
<td>Default 1-2</td>
</tr>
<tr>
<td></td>
<td>2-3:Clear Password</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-2: Normal</td>
<td>J120</td>
<td>Default 1-2</td>
</tr>
<tr>
<td></td>
<td>2-3: Recover BIOS Also Top Swap Disable</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-3: BMC disable</td>
<td>J90</td>
<td>Default 1-2</td>
</tr>
</tbody>
</table>

6. Power system

6.1 Power Simple Topology
6.2 Input voltage Level

The nominal input voltage delivered by the power supply is 12.2V DC nominal at light loading with a range of 11.8V to 12.6V.

<table>
<thead>
<tr>
<th></th>
<th>Typical</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
<td>AC Input</td>
<td>230V</td>
<td>180V</td>
<td>264V</td>
</tr>
<tr>
<td>DC Input</td>
<td>270V</td>
<td>164V</td>
<td>300V</td>
</tr>
<tr>
<td>Output Main</td>
<td>12.2V</td>
<td>11.8V</td>
<td>12.6V</td>
</tr>
<tr>
<td>Output STBY</td>
<td>12.0V</td>
<td>11.4V</td>
<td>12.6V</td>
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</table>

Table 6-2 PSU Output Characteristics

6.3 DC-DC Power Design

6.3.1 CPU VR

CPU VR follow latest VR13 SPEC. Using the minimum number of total phases to support the maximum CPU power. CPU VR have auto phase dropping feature, and
run at optimized phase count among 1, 2, 3,..., and maximum phase count. CPU VR support all Power States to allow the VRM to operate at its peak efficiency at light loading.

### 6.3.2 DIMM VR

DIMM VR support auto phase dropping for high efficiency across loading. DIMM VR compliant to latest VR13 specification.

### 6.3.3 Detail design

<table>
<thead>
<tr>
<th>Power Rail</th>
<th>VOUT</th>
<th>VIN</th>
<th>VR Type</th>
<th>VR QTY/BRD</th>
<th>VR Controller IC and FET</th>
<th>SMBus Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVCCIN_CPU0</td>
<td>SVID</td>
<td>P12V_A</td>
<td>Switcher</td>
<td>2</td>
<td>MPS MP2965+7Phase MP86956</td>
<td>CPU0:0X40</td>
</tr>
<tr>
<td>PVCCIN_CPU3</td>
<td></td>
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<td></td>
<td></td>
<td>CPU1:0X40</td>
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<td>PVCCIN_CPU1</td>
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</table>

7. **BMC**

BMC is an independent system of host server system. This independent system has its own processor and memory; The host system can be managed by BMC system even if host hardware or OS hang or went down.
7.1 Main Feature

- Support IPMI 2.0, IPMI Interface include KCS, LAN, IPMB
- Management Protocol, IPMI2.0, HTTPS, SNMP, Smash CLI
- Web GUI
- Redfish
- Management Network Interface, Dedicated/NCSI
- Console Redirection(KVM) and Virtual Media
- Serial Over Lan(SOL)
- Diagnostic Logs, System Event Log (SEL), Blackbox Log, Audit Log
- Hardware watchdog timer, Fans will full speed when BMC no response in 4 mins
- Intel® Intelligent Power Node Manager 4.0 support
- Event Alert, SNMP Trap(v1/v2c/v3), Email Alert and Syslog
- Dual BMC firmware image support
- Storage, Monitor RAID Controller/HDD/Virtual HDD
- Firmware update, BMC/BIOS/CPLD
- Device State Monitor and Diagnostic

7.2 Integrated BMC Hardware

ASPEED AST2500 Baseboard Management Controller, at the center of the server management subsystem is the ASPEED AST2500 integrated Baseboard Management Controller. This device provides support for many platform functions including system video capabilities, legacy Super I/O functions, hardware monitoring functions, and incorporates an ARM1176JZF-S 32-bit RISC CPU microcontroller to host an IPMI 2.0 compliant server management firmware stack.

The following functionality is integrated into the component:
- Baseboard Management Controller (BMC) with peripherals
- Server class Super I/O (SIO)
- Graphics controller
- Remote KVM redirection, USB media redirection, and HW Encryption

The eSPI/LPC interface to the host is used for SIO and BMC communication. The eSPI/LPC Bus interface provides IPMI Compliant KCS and BT interfaces.

The PCI Express interface is mainly used for the graphics controller interface to communicate with the host. The graphics controller is a VGA-compliant controller with 2D hardware acceleration and full bus master support. The graphics controller can support up to 1920x1200 resolution at high refresh rates. The PCI Express interface is also used for BMC messaging to other system devices using MCTP protocol.
The USB 2.0 Hub interface is used for remote keyboard and mouse, and remote storage support. BMC supports various storage devices such as CDROM, DVDROM, CDROM (ISO image), floppy and USB flash disk. Any of the storage devices can be used as a boot device and the host can boot from this remote media via redirection over the USB interface.

For the main capabilities of the BMC AST2500.BMC provide the 10/100/1000M local RJ45 management connector through BCM54612 and enable the communication between BMC and OCP A/PCH with NCSI BUS.

8. **Labels and Markings**

8.1 **Labels**

The motherboard shall include the labels such as adhesive and silk screen labels on the component side of the motherboard.

8.2 **Markings**

The motherboard shall include the markings such as adhesive and silk screen markings in accordance with required international certification.

Mother board shall include the following labels on the component side of the motherboard. The labels shall not be placed in a way that may cause them to disrupt the functionality or the air flow path of system.

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