Super Micro Computer, Inc.

Memory Configuration Guide

X9 Series DP Motherboards – Revised Ivy Bridge Update (Socket R & B2)

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1/8/2014

Introduction

This document is designed to provide the reader with an easy-to-use guide for proper memory configuration in an X9 Sandy Bridge or Ivy Bridge based system.

Memory Insertion Order

X9 DIMM's are populated using the "Fill First" method. The DIMM slot within a channel which is located the *farthest* from the processor is populated *first.* This is DIMM slot 0 and it is always denoted by its blue connector color. Additionally, when populating a quad-rank DIMM with a single or dual-rank DIMM in the same channel, the quad-rank DIMM must be populated farthest from the processor. Always be sure to populate the DIMM channels in a balanced configuration (all channels populated evenly) otherwise system memory performance will suffer.

Table 1 DIMM insertion order (12 DIMM per CPU example)
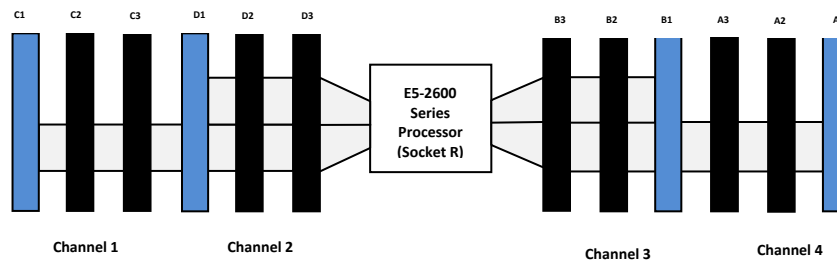
# DIMMs per Channel	Population Order		
	DIMM2	DIMM1	DIMM0
3	3rd	2nd	1st
2	-	2nd	1st
1	-	-	1st

A Few Rules to Keep Closely in Mind:

- All DIMMs *must* be DDR3.
- Unbuffered DIMMs can be ECC or non-ECC.
- A maximum of 8 logical ranks per channel is allowed.
- Mixing of Physical Rank DIMM's within a channel is allowed *except* in a 4R + 2R + 2R configuration.
- Mixing of Registered and Unbuffered DIMMs is **not** allowed.
- Mixing of ECC and non-ECC is **not** allowed.
- Registered DIMMs must be ECC only; Unbuffered DIMMs can be ECC or non-ECC.
- Mixing of LRDIMM with any other DIMM type is **not** allowed.
- Mixing of DDR3 voltages in **not advised**. If regular and low voltage DIMM's are mixed, the DIMMs will run as regular DIMMs.
- Mixing of different DDR3 operating frequencies is **not advised**. If DIMM's with different frequencies are mixed, *all DIMMs will run at the lowest common frequency.*
- Unbalanced memory configurations will result in a performance loss so <u>*always*</u> *populate memory channels evenly for best performance!*

What is DIMM ranking?

The Intel® Xeon® E5-2600/2400 architecture has a maximum number of "logic" ranks per memory channel which limits how many physical DIMMs may be used for any given configuration. The processor can only "see" up to eight logical ranks per channel, therefore whatever combination‡ of DIMMs that are physically added they can never exceed this limit. RDIMMs and UDIMMs typically come in single, dual, or quad rank configurations. The examples below demonstrate this effect.

Table 2 Quad Rank RDIMM Example (Sandy Bridge)

Processor Memory Channel (Socket R)	Logical Rank Limit	DIMM Rank Total	RDIMM/RDIMM-LV Quad Rank		
			DIMM1	DIMM2	DIMM3
Channel 1	8	8	800/1066	800/1066	-
Channel 2	8	8	800/1066	800/1066	-
Channel 3	8	8	800/1066	800/1066	-
Channel 4	8	8	800/1066	800/1066	-

As illustrated in the table above, only two of the quad ranked RDIMMs could be populated per channel without violating the Processors logical rank limit. Because of this DIMM3 is intentionally left unpopulated. Had it been populated, the rank total would have exceeded the logical rank limit of the processor and would not have been recognized by the Processor.

Table 3 Quad Rank LRDIMM Example (Sandy Bridge)

Processor Memory Channel (Socket R)	Logical Rank Limit	DIMM Rank Total	LRDIMM/LRDIMM-LV Quad Rank		
			DIMM1	DIMM2	DIMM3
Channel 1	8	6	1066/1333 1066/1333	1066/1333 1066/1333	1066/1066
Channel 2	8	6	1066/1333 1066/1333	1066/1333 1066/1333	1066/1066
Channel 3	8	6	1066/1333 1066/1333	1066/1333 1066/1333	1066/1066
Channel 4	8	6	1066/1333 1066/1333	1066/1333 1066/1333	1066/1066

Because LRDIMM are buffered, a quad ranked LRDIMM appears to the Processor as a dual rank DIMM. Because of this it's possible to populate all three DIMM slots without violating the logical limit. However by doing so, the memory speed drops to 1066MHz as a result of the added memory.

‡ **NOTE:** Mixing of DIMM Rank types is allowed except in a three DIMM per slot 4R+2R+2R configuration which is **not supported** by the CPU memory controller.

E5-2600 v2 (Ivy Bridge)
Socket R Memory Configuration

Four Channels per Socket, up to 3 DIMMS per Channel, and speeds up to DDR3 1866MHz
Maximum Number of DIMM's support per CPU

Ranks per DIMM	Maximum UDIMMs per CPU	Maximum RDIMMs per CPU	Maximum LRDIMMs per CPU
Octal	Not Supported	Not Supported	12
Quad	Not Supported	8	12
Dual	8	12	Not Supported
Single	8	12	Not Supported

Maximum memory speed

When populating DIMM modules it's important to *evenly distribute the modules across the channels*. For example, if each CPU has four DIMMs populated, put one DIMM in Channel 1, Channel 2, Channel 3, and Channel 4 respectively. If each CPU has six DIMMs populated. Put the fifth DIMM in Channel 1 and the sixth in Channel 2.

Socket R:

DIMM slots present per CPU	DIMM Type ‡	DIMM modules populated per CPU	Ranks per DIMM	Memory speeds supported
12	UDIMM	1 to 4	Single or dual	1066, 1333, 1600, 1866
		5 to 8	Single or dual	1066, 1333, 1600
		9 to 12	Not supported	Not supported
	Low-voltage UDIMM	1 to 4	Single or dual	1066, 1333
		5 to 8	Single or dual	1066, 1333
		9 to 12	Not supported	Not supported
	RDIMM	1 to 4	Single or dual	1066, 1333, 1600, 1866
			Quad	1066
		5 to 8	Single or dual	1066, 1333, 1600
			Quad	800
		9 to 12	Single or dual	800, 1066
	Low-voltage RDIMM	1 to 4	Single or dual	1066, 1333
			Quad	800
		5 to 8	Single or dual	1066, 1333
			Quad	800
		9 to 12	Single or Dual	800
	LRDIMM	1 to 4	Quad or Octal	1066, 1333, 1600, 1866
		5 to 8	Quad or Octal	1066, 1333, 1600
		9 to 12	Quad or Octal	1066

	Low-voltage LRDIMM	1 to 4	Quad or Octal	1066, 1333, 1600
		5 to 8	Quad or Octal	1066, 1333, 1600
		9 to 12	Quad	1066
8	UDIMM	1 to 4	Single or dual	1066, 1333, 1600, 1866
		5 to 8	Single or dual	1066, 1333, 1600
	Low-voltage UDIMM	1 to 4	Single or dual	1066, 1333
		5 to 8	Single or dual	1066, 1333
	RDIMM	1 to 4	Single or dual	1066, 1333, 1600, 1866
			Quad	800, 1066
		5 to 8	Single or dual	1066, 1333, 1600
			Quad	800
	Low-voltage RDIMM	1 to 4	Single or dual	1066, 1333
			Quad	800
		5 to 8	Single or dual	1066, 1333
			Quad	800
	LRDIMM	1 to 4	Quad or Octal	1066, 1333, 1600, 1866
		5 to 8	Quad or Octal	1066, 1333, 1600
	Low-voltage LRDIMM	1 to 4	Quad or Octal	1066, 1333, 1600
		5 to 8	Quad or Octal	1066, 1333, 1600
4	UDIMM	1 to 4	Single or dual	1066, 1333, 1600, 1866
	Low-voltage UDIMM	1 to 4	Quad	1066, 1333
	RDIMM	1 to 4	Single or dual	1066, 1333, 1600, 1866
			Quad or Octal	800, 1066
	Low-voltage RDIMM	1 to 4	Single or dual	1066, 1333, 1600
			Quad	800
	LRDIMM	1 to 4	Quad or Octal	1066, 1333,1600, 1866
	Low-Voltage LRDIMM	1 to 4	Quad or Octal	1066, 1333, 1600

‡ **All speed configurations qualified using reduced length DIMMs**

E5-2400 v2 (Ivy Bridge)
Socket B2 Memory Configuration

Three Channels per Socket, up to 2 DIMMs per Channel, and speeds up to DDR3 1600MHz

Maximum Number of DIMM's support per CPU (Socket B2)

Ranks per DIMM	Maximum UDIMMs per CPU†	Maximum RDIMMs per CPU	Maximum LRDIMMs per CPU
Octal	Not Supported	Not Supported	6
Quad	Not Supported	6	6
Dual	6	6	Not Supported
Single	6	6	Not Supported

† Non-ECC LV-UDIMM isn't supported for this configuration.

Socket B2:

DIMM slots present per CPU	DIMM Type	DIMM modules populated per CPU	Ranks per DIMM	Memory speeds supported
6	UDIMM (ECC)	1 to 3	Single or dual	1066, 1333
		4 to 6	Single or dual	1066
	Low-voltage UDIMM (ECC)	1 to 3	Single or dual	1066, 1333
		4 to 6	Single or dual	1066
	RDIMM	1 to 3	Single or dual	1066, 1333, 1600
			Quad	800
		4 to 6	Single or dual	1066, 1333, 1600
			Quad	800
	Low-voltage RDIMM	1 to 3	Single or dual	1066, 1333
			Quad	800
		4 to 6	Single or dual	1066, 1333
			Quad	800
	LRDIMM	1 to 3	Quad or Octal	1066, 1333
		4 to 6	Quad or Octal	1066
	Low-voltage LRDIMM	1 to 3	Quad or Octal	1066, 1333
		4 to 6	Quad or Octal	1066
3	UDIMM (ECC)	1 to 3	Single or dual	1066, 1333
	Low-voltage UDIMM (ECC)	1 to 3	Single or dual	1066, 1333
	RDIMM	1 to 3	Single or dual	1066, 1333, 1600
			Quad	800
	Low-voltage RDIMM	1 to 3	Single or dual	1066, 1333, 1600
			Quad	800
	LRDIMM	1 to 3	Quad or Octal	1066, 1333
	Low-voltage LRDRIMM	1 to 3	Quad or Octal	1066

E5-2600 v1 (Sandy Bridge)
Socket R Memory Configuration

Four channels per socket, up to 3 DIMMS per Channel, and speeds up to DDR3 1600MHz
Maximum Number of DIMM's support per CPU

Ranks per DIMM	Maximum UDIMMs per CPU	Maximum RDIMMs per CPU	Maximum LRDIMMs per CPU
Octal	Not Supported	Not Supported	12
Quad	Not Supported	8	12
Dual	8	12	Not Supported
Single	8	12	Not Supported

Maximum memory speed

When populating DIMM modules it's important to *evenly distribute the modules across the channels*. For example, if each CPU has four DIMMs populated, put one DIMM in Channel 1, Channel 2, Channel 3, and Channel 4 respectively. If each CPU has six DIMMs populated. Put the fifth DIMM in Channel 1 and the sixth in Channel 2.

Socket R:

DIMM slots present per CPU	DIMM Type	DIMM modules populated per CPU	Ranks per DIMM	Memory speeds supported
12	UDIMM	1 to 4	Single or dual	1066, 1333, 1600
		5 to 8	Single or dual	1066, 1333
		9 to 12	Not supported	Not supported
	Low-voltage UDIMM	1 to 4	Single or dual	1066, 1333, 1600
		5 to 8	Single or dual	1066
		9 to 12	Not supported	Not supported
	RDIMM	1 to 4	Single or dual	1066, 1333, 1600
			Quad	1066
		5 to 8	Single or dual	1066, 1333, 1600
			Quad	800
		9 to 12	Single or dual	800, 1066
	Low-voltage RDIMM	1 to 4	Single or dual	1066, 1333
			Quad	800
		5 to 8	Single or dual	1066, 1333
			Quad	800
		9 to 12	Not supported	Not supported
	LRDIMM*	1 to 4	Quad or Octal	1066, 1333
		5 to 8	Quad or Octal	1066, 1333
		9 to 12	Quad	1066

	Low-voltage LRDIMM	1 to 4	Quad or Octal	1066, 1333
		5 to 8	Quad or Octal	1066
		9 to 12	Quad	1066
8	UDIMM	1 to 4	Single or dual	1066, 1333
		5 to 8	Single or dual	1066, 1333
	Low-voltage UDIMM	1 to 4	Single or dual	1066, 1333
		5 to 8	Single or dual	1066, 1333
	RDIMM	1 to 4	Single or dual	1066, 1333, 1600
			Quad	1066
		5 to 8	Single or dual	1066, 1333, 1600
			Quad	800
	Low-voltage RDIMM	1 to 4	Single or dual	1066, 1333
			Quad	800
		5 to 8	Single or dual	1066, 1333
			Quad	800
	LRDIMM	1 to 4	Quad or Octal	1066, 1333
		5 to 8	Quad or Octal	1066, 1333
	Low-voltage LRDIMM	1 to 4	Quad or Octal	1066
		5 to 8	Quad or Octal	1066
4	UDIMM	1 to 4	Single or dual	1066, 1333, 1600
	Low-voltage UDIMM	1 to 4	Single or dual	1066, 1333
	RDIMM	1 to 4	Single or dual	1066, 1333, 1600
			Quad	1066
	Low-voltage RDIMM	1 to 4	Single or dual	1066, 1333
			Quad	800
	LRDIMM	1 to 4	Quad or Octal	1066, 1333
	Low-Voltage LRDIMM	1 to 4	Quad or Octal	1066, 1333

E5-2400 v1 (Sandy Bridge)
Socket B2 Memory Configuration

Three Channels per socket, up to 2 DIMMs per Channel, and speeds up to DDR3 1600MHz

Maximum Number of DIMM's support per CPU (Socket B2)

Ranks per DIMM	Maximum UDIMMs per CPU†	Maximum RDIMMs per CPU	Maximum LRDIMMs per CPU
Octal	Not Supported	Not Supported	6
Quad	Not Supported	6	6
Dual	6	6	Not Supported
Single	6	6	Not Supported

† Non-ECC LV-UDIMM isn't supported for this configuration.

Socket B2:

DIMM slots present per CPU	DIMM Type	DIMM modules populated per CPU	Ranks per DIMM	Memory speeds supported
6	UDIMM	1 to 3	Single or dual	1066, 1333
		4 to 6	Single or dual	1066, 1333
	Low-voltage UDIMM	1 to 3	Single or dual	1066, 1333
		4 to 6	Single or dual	1066
	RDIMM	1 to 3	Single or dual	1066, 1333, 1600
			Quad	800
		4 to 6	Single or dual	1066, 1333, 1600
			Quad	800
	Low-voltage RDIMM	1 to 3	Single or dual	1066, 1333
			Quad	800
		4 to 6	Single or dual	1066, 1333
			Quad	800
	LRDIMM	1 to 3	Quad or Octal	1066, 1333
		4 to 6	Quad or Octal	1066
	Low-voltage LRDIMM	1 to 3	Quad or Octal	1066
		4 to 6	Quad or Octal	800
3	UDIMM	1 to 3	Single or dual	800, 1066, 1333
	Low-voltage UDIMM	1 to 3	Single or dual	800, 1066, 1333
	RDIMM	1 to 3	Single or dual	800, 1066, 1333
			Quad	800, 1066
	Low-voltage RDIMM	1 to 3	Single or dual	800, 1066, 1333
			Quad	800
	LRDIMM	1 to 3	Quad or Octal	1066, 1333
	Low-voltage LRDRIMM	1 to 3	Quad or Octal	1066

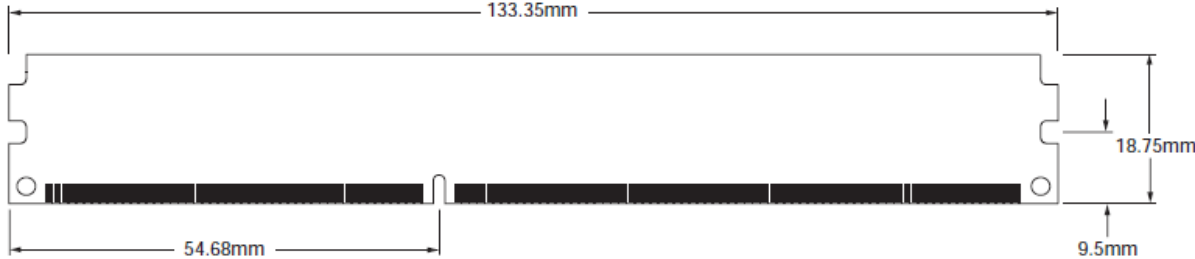## DDR3 DIMM Modules Mechanical Specification

Standard:
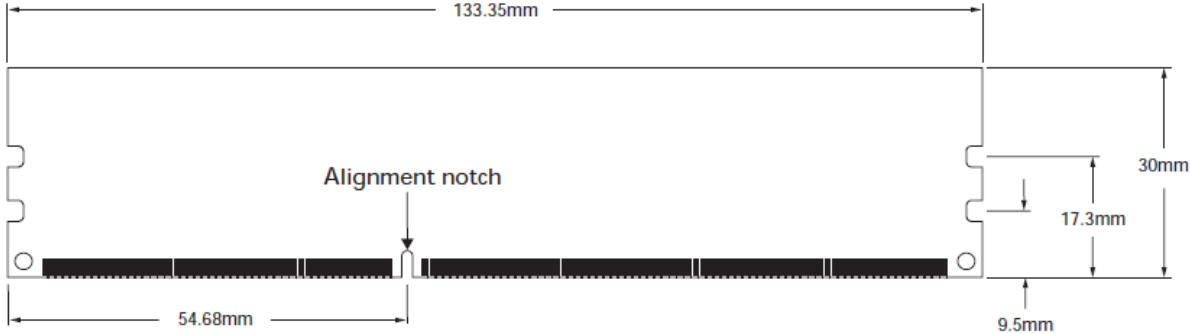
Features
• 30mm x 133.35mm
• 240 pins
• 1.5V/1.35V (Low-Voltage)
• Unbuffered or registered
• x64/x72
• JEDEC MO-269

Low Profile:

Features
• 18.75mm x 133.35mm
• 240 pins
• 1.5V/1.35V (Low-Voltage)
• Unbuffered or registered
• x64/x72
• JEDEC MO-269

Memory FAQ

Question/Answer
Question: **I am using one of your 16DIMM Dual Processor motherboard with E5-2600 v2 processors and I'd like to use LVRDIMM (1.35V) memory running at 1600MHz, but the system BIOS keeps setting the speed to 1333MHz. Why won't it let me run the DIMMs at full speed?** Answer: **LV-RDIMM is running to Intel specifications at 1333MHz (see Socket R memory table) for a 1.35v device. It is possible to run the LVDIMMs at 1600MHz by going into the BIOS and choosing FORCE DDR3 1600. This is still technically within the memory vendor's spec, but it needs to be done manually because of the 1.35V characteristics of the LVDIMM.**
Question: **Can I mix different types of RDIMM, say 4GB & 2GB on the same CPU? What if I use only 4GB on CPU0 and use 2GB on CPU2?** Answer: **Supermicro does not recommend any mixing of different DIMM sizes within or across CPUs.**
Question: **Can I mix RDIMM with LRDIMM?** Answer: **No, mixing of the two types is not allowed.**
Question: **Can I mix low voltage RDIMM together with normal RDIMM in the same memory channel?** Answer: **Although it's not recommend, you can safely mix 1.35V and 1.5V as the system will default to the higher voltage. Supermicro qualified low voltage memory meets the JEDEC requirement to operate in either 1.35V or 1.5V environments.**
Question: **I am planning to use NVDIMM in my configuration. Can I mix it with other DIMM types and voltages?** Answer: **NVDIMM is a special type of memory that "looks" like RDIMM to the system and can be safely mixed with it if it's the same density and voltage. NVDIMM typically comes in 4GB and 8GB sizes and operates at 1.5v. Be sure to check with the NVDIMM memory supplier to ensure proper configuration and operation.**

Question/Answer

Question:

Do I have to populate all CPU memory channels? What if I only put one or two DIMMs per processor?

Answer:

It's ok to run with as little as one RDIMM/UDIMM/LRDIMM per system or per CPU (unbalanced configurations) but it will directly impact CPU performance. Socket R CPU's have four memory channels (three in Socket B2) and for best performance it is always recommended to have a minimum of one DIMM in per channel. A channel left unpopulated will reduce the memory bandwidth by 25%, so with only one RDIMM per CPU memory bandwidth performance is reduced by 75%.

Question:

Will reducing the memory speed affect PCI-E performance?

Answer:

No, the memory and PCI-E subsystems operate independently and have no impact on each other.

Question:

I am thinking of using NVDIMM in my server deployment, what do I need to make it work?

Answer:

NVDIMM is an exciting new technology for preserving your mission critical data in the event of a power failure without the need for expensive battery UPS back-up. NVDIMM, though versatile is not plug n' play technology and may require additional O/S, 3rd party, or customer provided software to use it. Supermicro recommends customers work directly with NVDIMM module vendor(s) directly to find out more about how to best implement this technology for their needs. To find out which NVDIMM modules are supported, please contact your Supermicro sales representative.