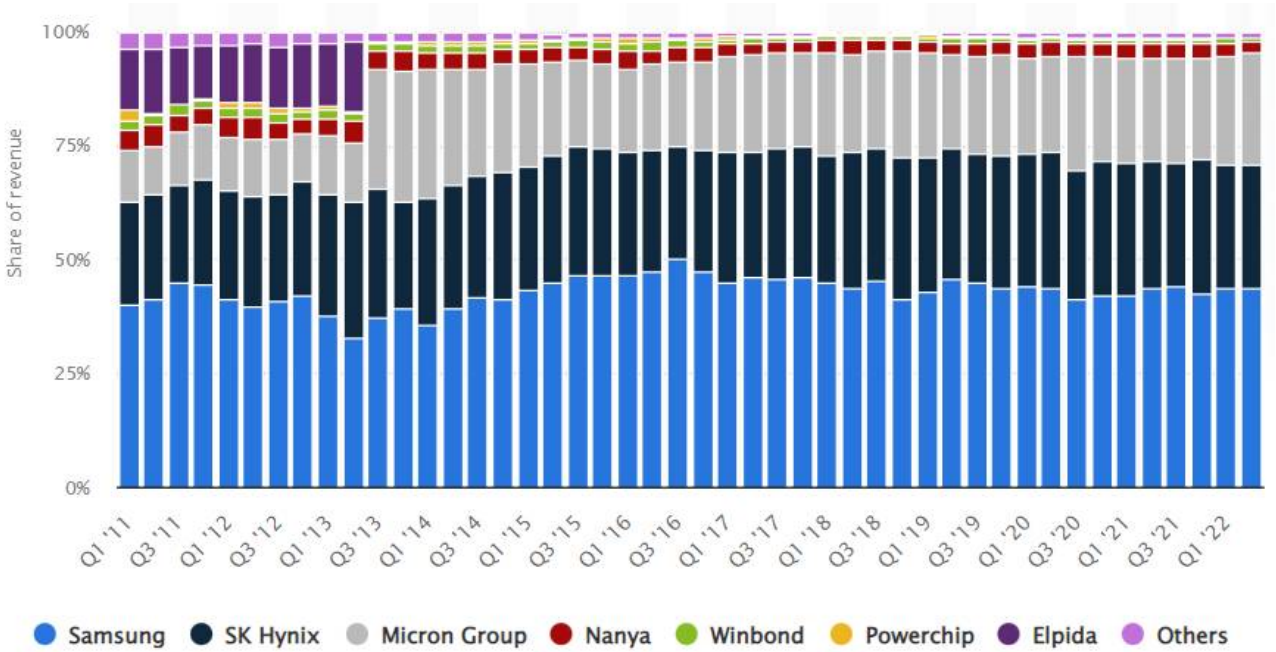
Содержание

LPDDR4(4x) 3
Manufacturers 3
Table 3
Configurations 4
SKHynix 8
low power 12
ECC 12
Termination 12
VREF 12
VTT 13
Routing 13
Docs 13

LPDDR4(4x)

Manufacturers

https://semiconductor.samsung.com/dram/lpddr/lpddr4x/	Samsung	BGA200 up to 32Gb and more
https://product.skhynix.com/products/dram/lpddr/lpddr4x_4.go	SKHynix	BGA200 up to 32Gb and more
https://www.micron.com/products/dram/lpdram/part-catalog	Micron	BGA200 up to 24Gb (купил Elpida)
https://www.nanya.com/en/Product/List/547/2356	Nanya	BGA200 up to 32Gb
	Quimonda	Обанкротилась
https://www.issi.com/US/product-dram-lpddr4.shtml	ISSI	BGA200 up to 8Gb
https://www.alliancememory.com/products/lpddr4-mobile-ddr4/	Alliancememory	BGA200 up to 8Gb
https://www.intelligentmemory.com/dram-components/LPDDR4/	Intelligentmemory	BGA200 up to 8Gb
https://www.winbond.com/hq/product/mobile-dram/low-power-ddr4-ddr4x-sdram/?__locale=en	Winbond	BGA200 up to 4Gb
https://www.apmemory.com/products/low-power-dram/	Apmemory	512Mb(x16) under development (Дочка Powerchip)
https://www.cxmt.com/en/products/lpddr4x-dram/	ChangXin Memory Technologies	No info
https://en.biwin.com.cn/	BIWIN	packaging only?

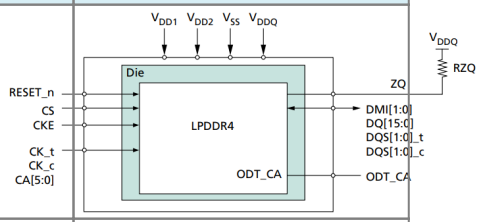
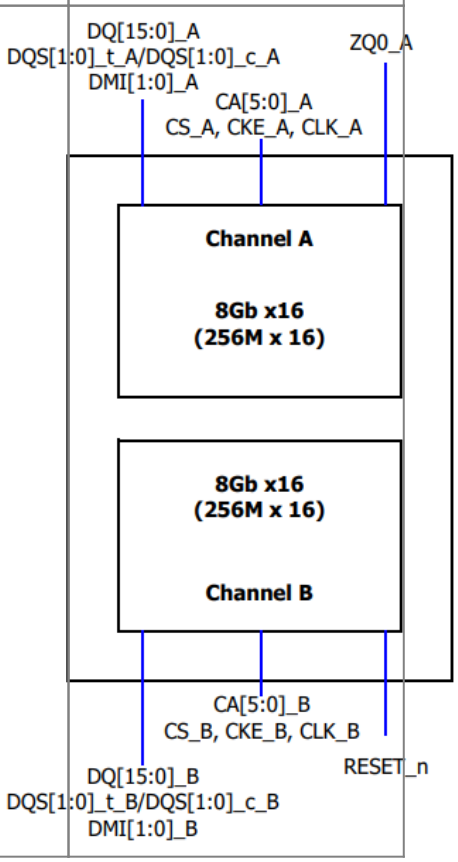


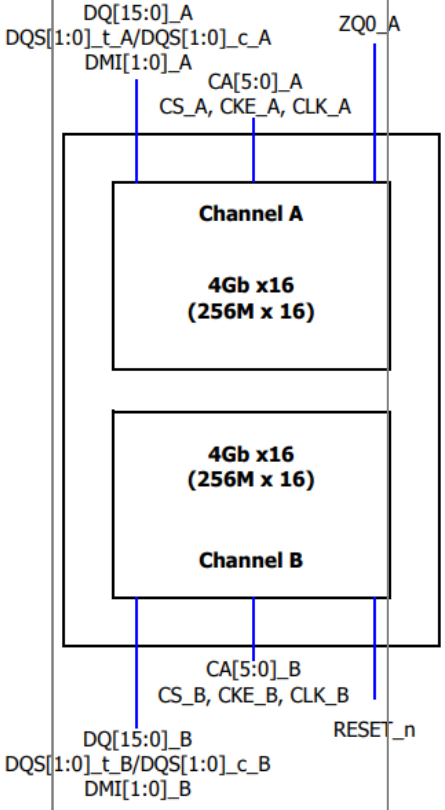
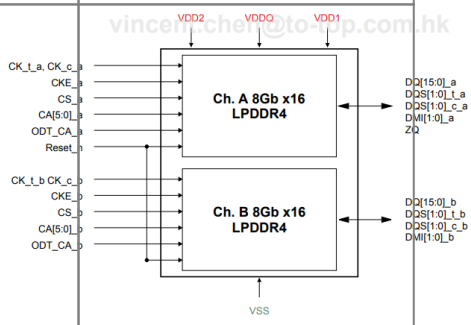
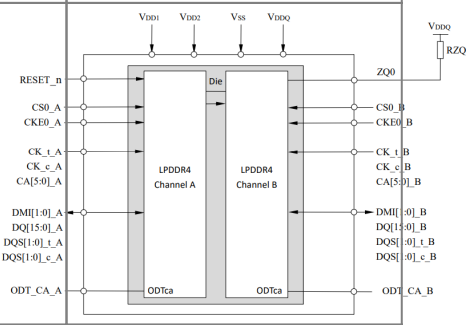
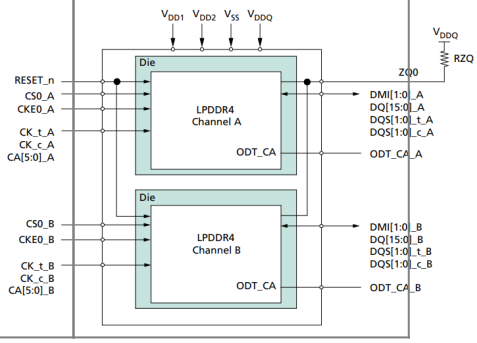
Table

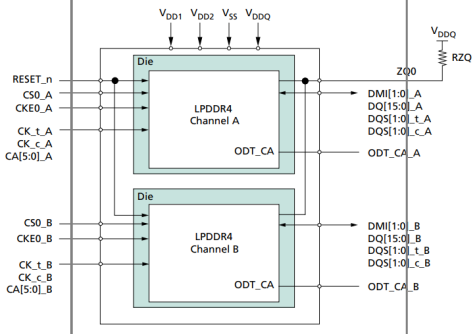
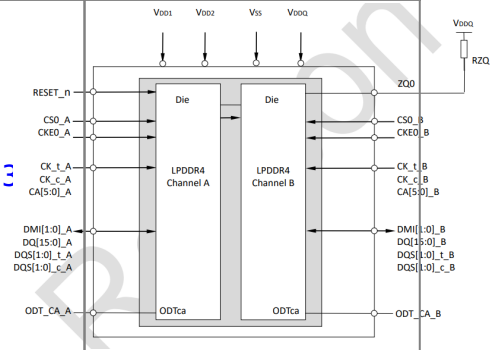
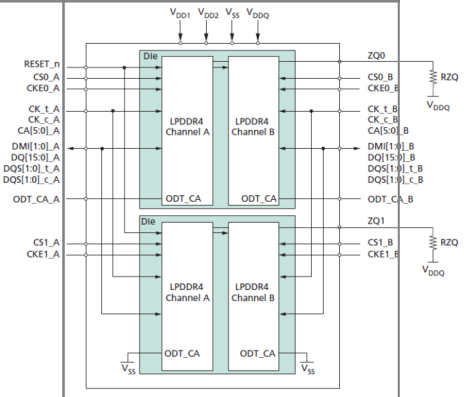
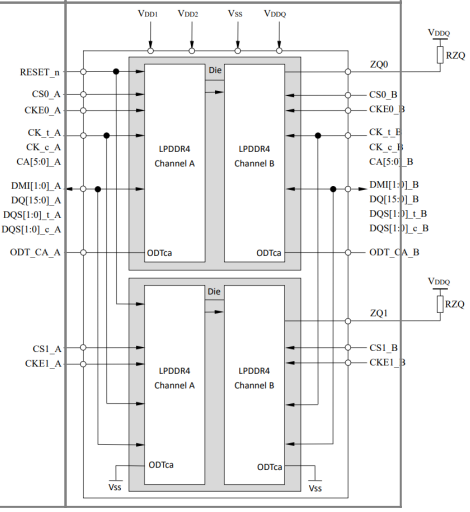
MT53D512M32D2DS-053WT:D	Micron	LPDDR4\4x		32b	16gb	-20...85	EOL	D9WHZ
H2AB32G32D6CPAAI	HWA LING (axeme)	LPDDR4	3733	32b	32gb	-40...95		
W66BQ6NB	Winbond	LPDDR4X			2Gb			
W66CQ2NQ	Winbond	LPDDR4X			4Gb			

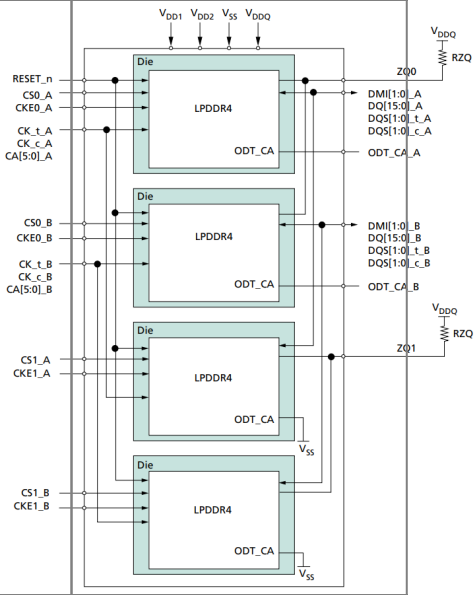
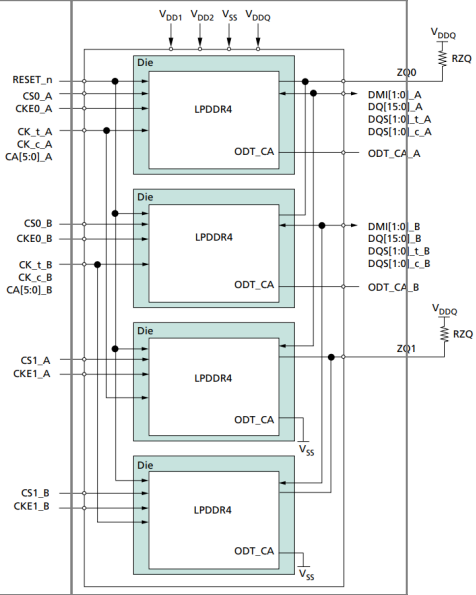
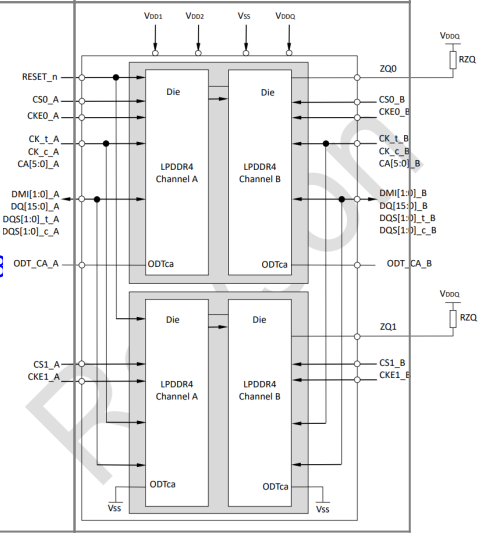
NCLD4C1MA256M32	FORESEE	LPDDR4			8Gb			
NCLD4C2MA512M32	FORESEE	LPDDR4			16Gb			
NCLD4C2MA768M32	FORESEE	LPDDR4			24Gb			
NCLD4C2MA001G32	FORESEE	LPDDR4			32Gb			

Configurations

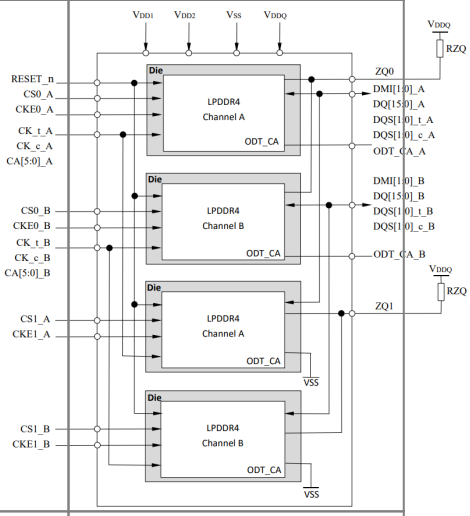
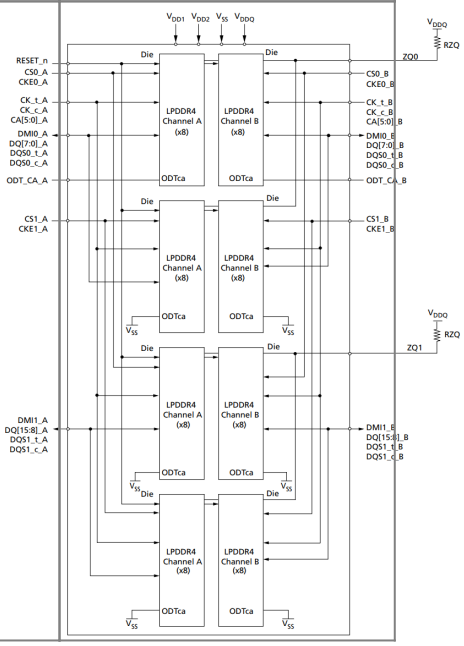
Capacity	Width	CS (Rank)	Channels	Dies	Link	Diagram
16 Gb	x16	1 CS	1 Channel	1 Die	MT53E1G16D1	
16 Gb	x16+x16	1 CS	2 Channel	1 Die	A8XAGH50ABA	

Capacity	Width	CS (Rank)	Channels	Dies	Link	Diagram
8 Gb	x16+x16	1 CS	2 Channel	1 Die	H9HCNNN8KUMLHR	
16 Gb	x16+x16	1 CS	2 Channel	1 Die	K4F6E3S4HM	
16 Gb	x16+x16	1 CS	2 Channel	1 Die	RS512M32LO4D1BDS	
16 Gb	x16+x16	1 CS	2 Channel	2 Die	MT53D512M32D2	

Capacity	Width	CS (Rank)	Channels	Dies	Link	Diagram
32 Gb	x16+x16	1 CS	2 Channel	2 Die	MT53E1G32D2	
32 Gb	x16+x16	1 CS	2 Channel	2 Die	RS1G32LV4D2BDS-53	
16 Gb	x16+x16	2 CS	2 Channel	2 Die	H2AB16G32D6C	
32 Gb	x16+x16	2 CS	2 Channel	2 Die	RS1G32LO4D2BDS-46	

Capacity	Width	CS (Rank)	Channels	Dies	Link	Diagram
32 Gb	x16+x16	2 CS	2 Channel	4 Die	MT53D1024M32D4	
64 Gb	X16+x16	2 CS	2 Channel	4 Die	MT53E2G32D4	
64 Gb	x16+x16	2 CS	2 Channel	4 Die	RS2G32LV4D4BDT-53	

Revision

Capacity	Width	CS (Rank)	Channels	Dies	Link	Diagram
64 Gb	x16+x16	2 CS	2 Channel	4 Die	RS2G32LV4D4BDT-46	
128 Gb	x16+x16	2 CS	2 Channel	8 Die	RS4G32LV4D8BDT-53	

SKHynix

H9HCNNNCPUMLXR-NEE	PC	LPDDR4	4GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP -25
H9HCNNNBKUMLXR-NEE	PC	LPDDR4	2GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP -25
H9HCNNNBPUMLHR-NME	PC	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP -25
H9HCNNNBPUMLHR-NLE	PC	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3200Mbps	200Ball	MP -25
H9HCNNN8KUMLHR-NME	PC	LPDDR4	1GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP -25
H9HCNNN8KUMLHR-NLE	PC	LPDDR4	1GB	1.8V / 1.1V / 1.1V	3200Mbps	200Ball	MP -25
H9HCNNNCPUMLXR-NEE	Consumer	LPDDR4	4GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP -25

H9HCNNNCPUMLXR-NEI	Consumer	LPDDR4	4GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP	-40
H9HCNNNCPUMLHR-NME	Consumer	LPDDR4	4GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-25
H9HCNNNBKUMLXR-NEI	Consumer	LPDDR4	2GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP	-40
H9HCNNNBKUMLXR-NEE	Consumer	LPDDR4	2GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP	-25
H9HCNNNBKUMLHR-NME	Consumer	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-25
H9HCNNNBKUMLHR-NMI	Consumer	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNNBPUMLHR-NME	Consumer	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-25
H9HCNNNBPUMLHR-NMI	Consumer	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNNBPUMLHR-NLE	Consumer	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3200Mbps	200Ball	MP	-25
H54G36AYRBX257	Consumer	LPDDR4	1GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	CS	-25
H54G36AYRJX246	Consumer	LPDDR4	1GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	CS	-40
H54G38AYRBX259	Consumer	LPDDR4	1GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	CS	-25
H9HCNNN8KUMLHR-NME	Consumer	LPDDR4	1GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-25
H9HCNNN8KUMLHR-NMI	Consumer	LPDDR4	1GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H54G26AYRBX256	Consumer	LPDDR4	0.5GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	CS	-25
H9HCNNN4KUMLHR-NMI	Consumer	LPDDR4	0.5GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNN4KUMLHR-NME	Consumer	LPDDR4	0.5GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-25
H54G56BYYQX046	Automotive	LPDDR4	4GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP	-40
H54G56BYYVX046	Automotive	LPDDR4	4GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP	-40
H54G56BYYPX046	Automotive	LPDDR4	4GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP	-40
H9HCNNNCPUMLHR-NMN	Automotive	LPDDR4	4GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNNCPUMLHR-NMO	Automotive	LPDDR4	4GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H54G46BYYVX053	Automotive	LPDDR4	2GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP	-40
H54G46BYYPX053	Automotive	LPDDR4	2GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP	-40

H54G46BYYQX053	Automotive	LPDDR4	2GB	1.8V / 1.1V / 1.1V	4266Mbps	200Ball	MP	-40
H9HCNNNBPUMLHR-NMO	Automotive	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNNBPUMLHR-NMN	Automotive	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNNBKUMLHR-NMO	Automotive	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNNBKUMLHR-NMN	Automotive	LPDDR4	2GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNN8KUMLHR-NMN	Automotive	LPDDR4	1GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNN8KUMLHR-NMO	Automotive	LPDDR4	1GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNN4KUMLHR-NMO	Automotive	LPDDR4	0.5GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNN4KUMLHR-NMP	Automotive	LPDDR4	0.5GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40
H9HCNNN4KUMLHR-NMN	Automotive	LPDDR4	0.5GB	1.8V / 1.1V / 1.1V	3733Mbps	200Ball	MP	-40

H9HCNNNFAMMLXR-NEE	PC	LPDDR4X	8GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-25
H9HCNNNFAMALTR-NME	PC	LPDDR4X	8GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-25
H9HCNNNCPMMLXR-NEE	PC	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-25
H9HCNNNCPMALHR-NEE	PC	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-25
H9HCNNNBKMALHR-NEE	PC	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-25
H9HCNNNBKMMLXR-NEE	PC	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-25
H54G66BYYJX104	Consumer	LPDDR4X	8GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H9HCNNNFAMMLXR-NEI	Consumer	LPDDR4X	8GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H9HCNNNFAMMLXR-NEE	Consumer	LPDDR4X	8GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-25
H9HCNNNCPMMLXR-NEE	Consumer	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-25
H54G56BYYJX089	Consumer	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H9HCNNNCPMMLXR-NEI	Consumer	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H9HCNNNCPMMLHR-NMI	Consumer	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-40
H9HCNNNCPMMLHR-NME	Consumer	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-25

H54G46BYYJX085	Consumer	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H9HCNNNBKMMLXR-NEI	Consumer	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H9HCNNNBKMMLXR-NEE	Consumer	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-25
H9HCNNNBKMMLHR-NME	Consumer	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-25
H9HCNNNBKMMLHR-NMI	Consumer	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-40
H9HCNNN4KMMLHR-NME	Consumer	LPDDR4X	0.5GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-25
H54G66BYYVX104	Automotive	LPDDR4X	8GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G66BYYPX104	Automotive	LPDDR4X	8GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G66BYYQX104	Automotive	LPDDR4X	8GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G56BYYPX089	Automotive	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G56BYYVX089	Automotive	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H9HCNNNCPMMLHR-NMO	Automotive	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-40
H9HCNNNCPMMLHR-NMN	Automotive	LPDDR4X	4GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-40
H54G46BYYQX085	Automotive	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G46BYYVX085	Automotive	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G46BYYPX085	Automotive	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H9HCNNNBKMMLHR-NMO	Automotive	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-40
H9HCNNNBKMMLHR-NMN	Automotive	LPDDR4X	2GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-40
H54G38AYRPX264	Automotive	LPDDR4X	1GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G36AYRPX246	Automotive	LPDDR4X	1GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G36AYRQX246	Automotive	LPDDR4X	1GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G38AYRVX264	Automotive	LPDDR4X	1GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G36AYRVX246	Automotive	LPDDR4X	1GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G38AYRQX264	Automotive	LPDDR4X	1GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40

H54G26AYRPX066	Automotive	LPDDR4X	0.5GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G26AYRVX066	Automotive	LPDDR4X	0.5GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H54G26AYRQX066	Automotive	LPDDR4X	0.5GB	1.8V / 1.1V / 0.6V	4266Mbps	200Ball	MP	-40
H9HCNNN4KMMLHR-NMP	Automotive	LPDDR4X	0.5GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-40
H9HCNNN4KMMLHR-NMO	Automotive	LPDDR4X	0.5GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-40
H9HCNNN4KMMLHR-NMN	Automotive	LPDDR4X	0.5GB	1.8V / 1.1V / 0.6V	3733Mbps	200Ball	MP	-40

low power

LPDDR4X is a variant of LPDDR4, with the difference of additional power savings by reducing the I/O voltage from 1.1 V to 0.6 V.

ECC

ECC is supported on the LPDDR4 interface. Unlike traditional ECC interfaces which require dedicated memory pins and devices, ECC is supported inline. The ECC system impact is in interface bandwidth and overall memory density, as ECC data is stored alongside non-ECC data.

- sideband - это когда отдельный чип под ECC (для LPDDR - не бывает)
- inline - когда из разных мест читает контроллер
- on-die - когда всё в пямяти и дополнительно для ECC место выделено
- есть p\n с ECC (https://www.issi.com/WW/pdf/43-46LQ16256-32128EA-AL.pdf), есть - без ECC (https://www.issi.com/WW/pdf/43-46LQ32256A-AL.pdf)

Termination

LPDDR4 memories have software configurable on-die termination for both the data group nets. The DDR subsystem also contains software configurable on-die termination for the address/control group nets. Thus, termination is not required on any DDR signals for an LPDDR4 configuration.

VREF

LPDDR4 memories generate their own VREFCA and VREFDQ internally for the address / command bus and data bus, respectively. Similarly, the DDR PHY also provides its own reference voltage for the data group nets during reads. Thus unlike DDR3 and DDR4, VREF does not need to be generated on the board, and there is no required VREF routing for an LPDDR4 configuration.

VTT

Unlike DDR3 and DDR4, there is no required termination on the PCB of the address/control bus of an LPDDR4 configuration. All termination is handled internally (on-die). Thus, VTT does not apply for LPDDR4.

Routing

	TI	RockChip ref design
SE impedance	40 Ohm	4mil\0.035u\0.082 prepreg Dk4.5 - ??? Ohm
DIFF impedance	80 Ohm	3.8mil\6mil\0.035u\0.082 prepreg Dk4.5 - ??? Ohm

Balanced T traces (also referred to as T-branch traces) are split traces from source to multiple end points. The target impedance of the split trace should be 2 times the non-branched impedance.

The length/delay matching process should include a mechanism for compensating for the velocity delta between these two types of PCB interconnects. A compensation factor of 1.1 has been specified for this purpose by JEDEC. All microstrip segment lengths are to be divided by 1.1 before summation into the length matching equation. The resulting compensated length is termed the 'stripline equivalent length'.

CK and ADDR_CTRL	TI
CK+ to CK- skew	0.25 ps TYP
inside ADDR_CTRL skew	3 ps TYP
CK to ADDR_CTRL skew	3 ps TYP
CK\ADDR_CTRL propagation delay	250 ps MAX
DATA	**TI**
DQS+ to DQS- skew	0.1 ps TYP
inside DQSx + BYTEx skew	0.5 ps TYP
BYTEx\DQSx propagation delay	250 ps MAX
Propagation delay of each DQS pair must be less than propagation delay DQ/DM	
Propagation delay of each DQS pair must be less than propagation delay of CK pair.	

Docs

Application Notes						
link	**ext**	**description**	**manufacturer**	**version**	**date**	**lang**
8MN HDG LPDDR4 related excerpts.pdf	pdf	i.MX 8M Nano LPDDR4-3200 design recommendations NXP	NXP			EN
spracn9b.pdf	pdf	SPRACN9B Application Report Jacinto 7 LPDDR4 Board Design and Layout Guidelines	Texas Instruments	Rev. B	2021	EN

Application Notes						
link	**ext**	**description**	**manufacturer**	**version**	**date**	**lang**
spraar7h.pdf	pdf	Application Report SPRAAR7H–August 2014–Revised Ocrtober 2018 High-Speed Interface Layout Guidelines	Texas Instruments	Rev. H	2018	EN
Datasheets						
link	**ext**	**description**	**manufacturer**	**version**	**date**	**lang**
200b_z11m_non_auto_lpddr4_lpddr4x.pdf	pdf	MT53D512M16D1, MT53D512M32D2, MT53D1024M32D4 200b: x16/x32 LPDDR4/LPDDR4X SDRAM 1GB, 2GB, 4GB	Micron	Rev. D 3/20	2017	EN