

32Mx16
Mobile SDRAM
54CSP 2C/S
(VDD/VDDQ 2.5V/1.8V or 2.5V/2.5V, PASR & TCSR)

Revision 1.2

December 2002

8M x 16Bit x 4 Banks Mobile SDRAM**FEATURES**

- 2.5V power supply
- LVCMOS compatible with multiplexed address
- Four banks operation
- MRS cycle with address key programs
 - CAS latency (1, 2 & 3)
 - Burst length (1, 2, 4, 8 & Full page)
 - Burst type (Sequential & Interleave)
- EMRS cycle with address key programs.
- All inputs are sampled at the positive going edge of the system clock.
- Burst read single-bit write operation.
- Special Function Support.
 - PASR (Partial Array Self Refresh).
 - TCSR (Temperature Compensated Self Refresh).
- DQM for masking
- Auto & self refresh
- Extended temperature support.
- 64ms refresh period (8K cycle)
- 2 /CS Support.
- Extended Temperature Operation (-25°C ~ 85°C).
- 54balls CSP.

GENERAL DESCRIPTION

The K4S51153LC is 536,870,912 bits synchronous high data rate Dynamic RAM organized as 4 x 8,388,608 words by 16bits, fabricated with SAMSUNG's high performance CMOS technology. Synchronous design allows precise cycle control with the use of system clock I/O transactions are possible on every clock cycle. Range of operating frequencies, programmable burst lengths and programmable latencies allow the same device to be useful for a variety of high bandwidth and high performance memory system applications.

ORDERING INFORMATION

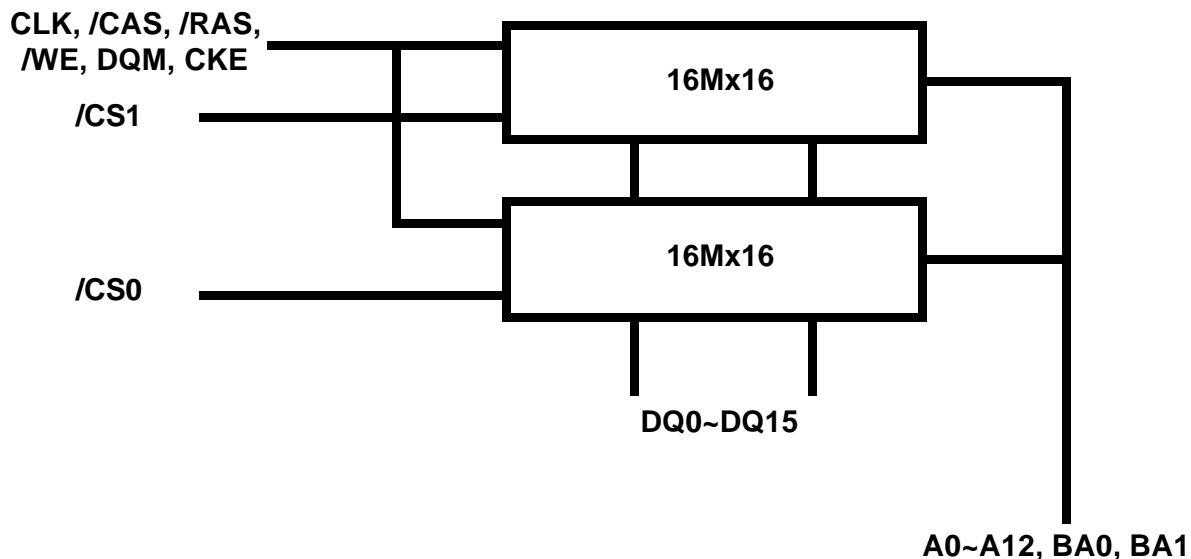
Part No.	Max Freq.	Interface	Package
K4S51153LC-YG/S1H	100MHz(CL=2)	LVCMOS	54 CSP
K4S51153LC-YG/S1L	100MHz(CL=3) ^{*1}		
K4S51153LC-YG/S15	66MHz(CL=2/3) ^{*2}		

-YS ; Super Low Power, Operating Temp : -25°C ~ 85°C.

-YG ; Low Power, Operating Temp : -25°C ~ 85°C.

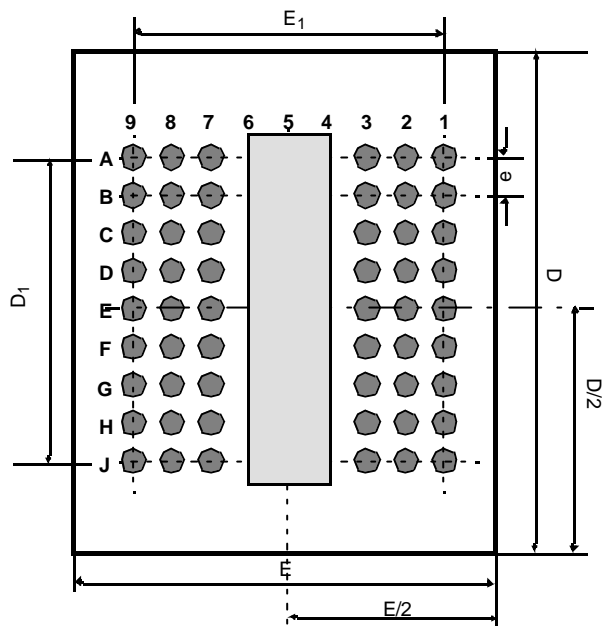
Notes :

1. In case of 40MHz Frequency, CL1 can be supported.
2. In case of 33MHz Frequency, CL1 can be supported.

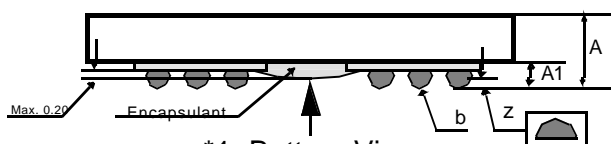
FUNCTIONAL BLOCK DIAGRAM

* Samsung Electronics reserves the right to change products or specification without notice.

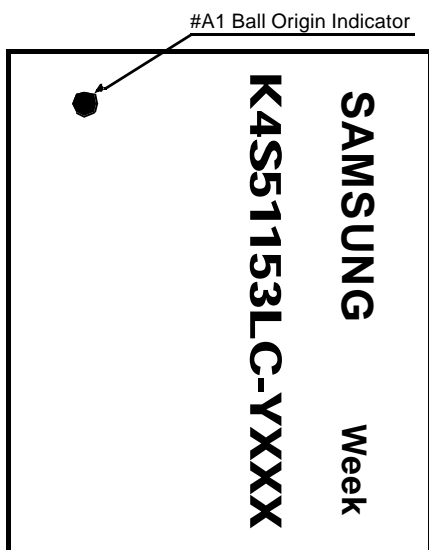
Package Dimension and Pin Configuration

< Bottom View ^{*1} >

*2: Top View



*1: Bottom View

< Top View ^{*2} >< Top View ^{*2} >

54Ball(6x9) CSP						
	1	2	3	7	8	9
A	V _{SS}	DQ15	V _{SSQ}	V _{DDQ}	DQ0	V _{DD}
B	DQ14	DQ13	V _{DDQ}	V _{SSQ}	DQ2	DQ1
C	DQ12	DQ11	V _{SSQ}	V _{DDQ}	DQ4	DQ3
D	DQ10	DQ9	V _{DDQ}	V _{SSQ}	DQ6	DQ5
E	DQ8	CS1	V _{SS}	V _{DD}	LDQM	DQ7
F	UDQM	CLK	CKE	CAS	RAS	WE
G	A12	A11	A9	BA0	BA1	CS0
H	A8	A7	A6	A0	A1	A10
J	V _{SS}	A5	A4	A3	A2	V _{DD}

Pin Name	Pin Function
CLK	System Clock
CS _{0 ~ 1}	Chip Select
CKE	Clock Enable
A _{0 ~ 12}	Address
BA _{0 ~ 1}	Bank Select Address
RAS	Row Address Strobe
CAS	Column Address Strobe
WE	Write Enable
L(U)DQM	Data Input/Output Mask
DQ _{0 ~ 15}	Data Input/Output
V _{DD} /V _{SS}	Power Supply/Ground
V _{DDQ} /V _{SSQ}	Data Output Power/Ground

[Unit:mm]

Symbol	Min	Typ	Max
A	1.00	1.10	1.30
A ₁	0.27	0.32	0.37
E	-	9.50	-
E ₁	-	6.40	-
D	-	15.50	-
D ₁	-	6.40	-
e	-	0.80	-
b	0.40	0.45	0.50
z	-	-	0.10

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Voltage on any pin relative to Vss	V _{IN} , V _{OUT}	-1.0 ~ 3.6	V
Voltage on V _{DD} supply relative to Vss	V _{DD} , V _{DDQ}	-1.0 ~ 3.6	V
Storage temperature	T _{STG}	-55 ~ +150	°C
Power dissipation	P _D	1	W
Short circuit current	I _{OS}	50	mA

Notes :

Permanent device damage may occur if ABSOLUTE MAXIMUM RATINGS are exceeded.

Functional operation should be restricted to recommended operating condition.

Exposure to higher than recommended voltage for extended periods of time could affect device reliability.

DC OPERATING CONDITIONS

Recommended operating conditions (Voltage referenced to Vss = 0V, T_A = -25°C to 85°C)

Parameter	Symbol	Min	Typ	Max	Unit	Note
Supply voltage	V _{DD}	2.3	2.5	2.7	V	
	V _{DDQ}	1.65	-	2.7	V	
Input logic high voltage	V _{IH}	0.8 x V _{DDQ}	-	V _{DDQ} + 0.3	V	1
Input logic low voltage	V _{IL}	-0.3	0	0.3	V	2
Output logic high voltage	V _{OH}	V _{DDQ} - 0.2V	-	-	V	I _{OH} = -0.1mA
Output logic low voltage	V _{OL}	-	-	0.2	V	I _{OL} = 0.1mA
Input leakage current	I _{LI}	-10	-	10	uA	3

Notes :

1. V_{IH} (max) = 3.0V AC. The overshoot voltage duration is ≤ 3ns.

2. V_{IL} (min) = -1.0V AC. The undershoot voltage duration is ≤ 3ns.

3. Any input 0V ≤ V_{IN} ≤ V_{DDQ}.

Input leakage currents include Hi-Z output leakage for all bi-directional buffers with tri-state outputs.

4. Dout is disabled, 0V ≤ V_{OUT} ≤ V_{DDQ}.

CAPACITANCE (V_{DD} = 2.5V, T_A = 23°C, f = 1MHz, V_{REF} = 0.9V ± 50 mV)

Pin	Symbol	Min	Max	Unit	Note
Clock	C _{CLK}	3.0	9.0	pF	
$\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WE}}$, CKE, DQM	C _{IN}	3.0	9.0	pF	
$\overline{\text{CS}}$	C _{IN}	1.5	4.5	pF	
Address	C _{ADD}	3.0	9.0	pF	
DQ ₀ ~ DQ ₁₅	C _{OUT}	6.0	13.0	pF	

DC CHARACTERISTICS

Recommended operating conditions (Voltage referenced to V_{SS} = 0V, T_A = -25°C to 85°C)

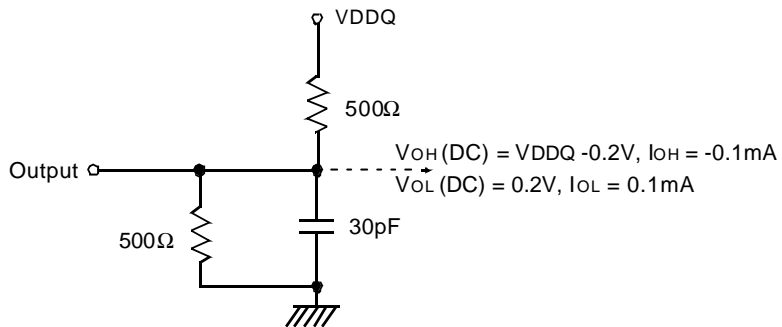
Parameter	Symbol	Test Condition		Version			Unit	Note		
				-1H	-1L	-15				
Operating Current (One Bank Active)	I _{CC1} *	Burst length = 1 t _{RC} ≥ t _{RC} (min) I _O = 0 mA		90	85	80	mA	1		
Precharge Standby Current in power-down mode	I _{CC2P}	CKE ≤ V _{IL} (max), t _{CC} = 10ns		1.5			mA			
	I _{CC2PS}	CKE & CLK ≤ V _{IL} (max), t _{CC} = ∞		1.5						
Precharge Standby Current in non power-down mode	I _{CC2N}	CKE ≥ V _{IH} (min), \overline{CS} ≥ V _{IH} (min), t _{CC} = 10ns Input signals are changed one time during 20ns		30			mA			
	I _{CC2NS}	CKE ≥ V _{IH} (min), CLK ≤ V _{IL} (max), t _{CC} = ∞ Input signals are stable		20						
Active Standby Current in power-down mode	I _{CC3P} *	CKE ≤ V _{IL} (max), t _{CC} = 10ns		7.5			mA			
	I _{CC3PS} *	CKE & CLK ≤ V _{IL} (max), t _{CC} = ∞		7.5						
Active Standby Current in non power-down mode (One Bank Active)	I _{CC3N} *	CKE ≥ V _{IH} (min), \overline{CS} ≥ V _{IH} (min), t _{CC} = 10ns Input signals are changed one time during 20ns		38			mA			
	I _{CC3NS} *	CKE ≥ V _{IH} (min), CLK ≤ V _{IL} (max), t _{CC} = ∞ Input signals are stable		30			mA			
Operating Current (Burst Mode)	I _{CC4} *	I _O = 0 mA Page burst 4Banks Activated t _{CCD} = 2CLKs		130	115	110	mA	1		
Refresh Current	I _{CC5} *	t _{RC} ≥ t _{RC} (min)		175	155	140	mA	2		
Self Refresh Current	I _{CC6}	CKE ≤ 0.2V	TCSR Range		Max 45°C		Max 85°C		°C	
			-YG	4 Banks	1100		1600		uA	3
				2 Banks	900		1200			
				1 Bank	800		950			
			-YS	4 Banks	850		1300			4
				2 Banks	600		900			
				1 Bank	500		700			

Notes :

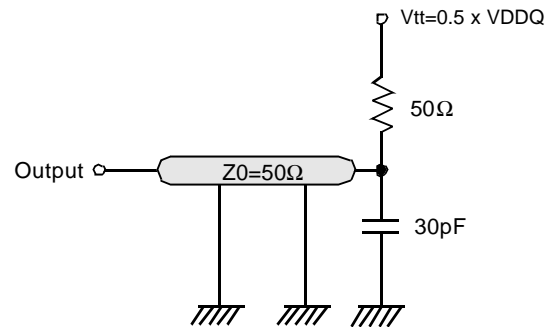
- Measured with outputs open
- Measured with operating(I_{CC1}) condition for 1chip and precharge stanby condition in non power down mode for 1chip(I_{CC2N}).
(I_{CC1}* = I_{CC1} + I_{CC2N})
- Measured with operating(I_{CC4}) condition for 1chip and active stanby condition in non power down mode for 1chip(I_{CC3N}).
(I_{CC4}* = I_{CC4} + I_{CC3N})
- Measured with active stanby condition in power down mode for 1chip (I_{CC3P/PS}) and precharge stanby condition in power down mode for 1chip (I_{CC2P/PS}). (I_{CC3P/PS}* = I_{CC3P/PS} + I_{CC2P/PS})
- Measured with active stanby condition in non power down mode for 1chip (I_{CC3N/NS}) and precharge stanby condition in non power down mode for 1chip (I_{CC2N/NS}). (I_{CC3N/NS}* = I_{CC3N/NS} + I_{CC2N/NS})
- Refresh period is 64ms.
Measured with refresh condition for 1chip (I_{CC5}) and precharge stanby condition in non power down mode for 1chip (I_{CC2N}).
(I_{CC5}* = I_{CC5} + I_{CC2N})
- K4S51153LC-YG**
- K4S51153LC-YS**
- Unless otherwise noted, input swing level is CMOS(V_{IH} / V_{IL} = V_{DDQ} / V_{SSQ})

AC OPERATING TEST CONDITIONS ($V_{DD} = 2.5V \pm 0.2V$, $T_A = -25^\circ C$ to $85^\circ C$)

Parameter	Value	Unit
AC input levels (V_{ih}/V_{il})	$0.9 \times V_{DDQ} / 0.2$	V
Input timing measurement reference level	$0.5 \times V_{DDQ}$	V
Input rise and fall time	$t_r/t_f = 1/1$	ns
Output timing measurement reference level	$0.5 \times V_{DDQ}$	V
Output load condition	See Fig. 2	



(Fig. 1) DC Output Load Circuit



(Fig. 2) AC Output Load Circuit

OPERATING AC PARAMETER

(AC operating conditions unless otherwise noted)

Parameter		Symbol	Version			Unit	Note
			- 1H	-1L	-15		
Row active to row active delay		tRRD (min)	20	20	30	ns	1
RAS to CAS delay		tRCD (min)	20	24	30	ns	1
Row precharge time		tRP(min)	20	24	30	ns	1
Row active time		tRAS(min)	50	60	60	ns	1
		tRAS(max)	100			us	
Row cycle time		tRC(min)	70	84	90	ns	1
Last data in to row precharge		tRDL(min)	2			CLK	2,3
Last data in to Active delay		tDAL (min)	tRDL + tRP			-	3
Last data in to new col. address delay		tCDL(min)	1			CLK	2
Last data in to burst stop		tBDL (min)	1			CLK	2
Col. address to col. address delay		tCCD (min)	1			CLK	4
Number of valid output data	CAS latency=3		2			ea	5
	CAS latency=2		1				
	CAS latency=1		-	0			

Notes :

1. The minimum number of clock cycles is determined by dividing the minimum time required with clock cycle time and then rounding off to the next higher integer.
2. Minimum delay is required to complete write.
3. Minimum $t_{RDL}=2CLK$ and $t_{DAL}(=t_{RDL} + t_{RP})$ is required to complete both of last data write command(t_{RDL}) and precharge command(t_{RP}). $t_{RDL}=1CLK$ can be supported only in the case under 100MHz with manual precharge mode.
4. All parts allow every cycle column address change.
5. In case of row precharge interrupt, auto precharge and read burst stop.

AC CHARACTERISTICS (AC operating conditions unless otherwise noted)

Parameter		Symbol	-1H		-1L		-15		Unit	Note
			Min	Max	Min	Max	Min	Max		
CLK cycle time	CAS latency=3	tcc	10	1000	10	1000	15	1000	ns	1
	CAS latency=2		10		12		15			
	CAS latency=1		-		25		30			
CLK to valid output delay	CAS latency=3	tsac		7		7		9	ns	1,2
	CAS latency=2			7		8		9		
	CAS latency=1			-		20		24		
Output data hold time	CAS latency=3	toH	2.5		2.5		2.5		ns	2
	CAS latency=2		2.5		2.5		2.5			
	CAS latency=1		-		2.5		2.5			
CLK high pulse width		tCH	3		3		3.5		ns	3
CLK low pulse width		tCL	3		3		3.5		ns	3
Input setup time		tss	2.5		2.5		3.5		ns	3
Input hold time		tSH	1.5		1.5		2.0		ns	3
CLK to output in Low-Z		tsLZ	1		1		1		ns	2
CLK to output in Hi-Z	CAS latency=3	tSHZ		7		7		9	ns	
	CAS latency=2			7		8		9		
	CAS latency=1			-		20		24		

Notes :

- Parameters depend on programmed CAS latency.
- If clock rising time is longer than 1ns, $(tr/2-0.5)ns$ should be added to the parameter.
- Assumed input rise and fall time (tr & tf) = 1ns.
If tr & tf is longer than 1ns, transient time compensation should be considered,
i.e., $[(tr + tf)/2-1]ns$ should be added to the parameter.

Notes :

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SIMPLIFIED TRUTH TABLE

COMMAND			CKEn-1	CKEn	\overline{CS}	\overline{RAS}	\overline{CAS}	\overline{WE}	DQM	BA _{0,1}	A ₁₀ /AP	A ₁₁ , A ₁₂ , A ₉ ~ A ₀	Note
Register	Mode Register Set		H	X	L	L	L	L	X	OP CODE			1, 2
Refresh	Auto Refresh		H	H	L	L	L	H	X	X			3
	Self Refresh	Entry		L									3
		Exit	L	H	L	H	H	H	X	X			3
													3
Bank Active & Row Addr.			H	X	L	L	H	H	X	V	Row Address		
Read & Column Address	Auto Precharge Disable		H	X	L	H	L	H	X	V	L	Column Address (A ₀ ~ A ₈)	4
	Auto Precharge Enable										H		4, 5
Write & Column Address	Auto Precharge Disable		H	X	L	H	L	L	X	V	L	Column Address (A ₀ ~ A ₈)	4
	Auto Precharge Enable										H		4, 5
Burst Stop			H	X	L	H	H	L	X	X			6
Precharge	Bank Selection		H	X	L	L	H	L	X	V	L	X	
	All Banks									X	H		
Clock Suspend or Active Power Down		Entry	H	L	H	X	X	X	X	X			
					L	V	V	V					
		Exit	L	H	X	X	X	X	X				
Precharge Power Down Mode		Entry	H	L	H	X	X	X	X	X			
					L	H	H	H					
		Exit	L	H	H	X	X	X	X				
					L	V	V	V					
DQM			H	X					V	X			7
No Operation Command			H	X	H	X	X	X	X	X			
					L	H	H	H					

(V=Valid, X=Don't Care, H=Logic High, L=Logic Low)

Notes :

1. OP Code : Operand Code

A₀ ~ A₁₂ & BA₀ ~ BA₁ : Program keys. (@MRS)

2. MRS can be issued only at all banks precharge state.

A new command can be issued after 2 CLK cycles of MRS.

3. Auto refresh functions are the same as CBR refresh of DRAM.

The automatical precharge without row precharge command is meant by "Auto".

Auto/self refresh can be issued only at all banks precharge state.

PASR & TCSR can be issued only after setting partial self refresh mode.

4. BA₀ ~ BA₁ : Bank select addresses.If both BA₀ and BA₁ are "Low" at read, write, row active and precharge, bank A is selected.If BA₀ is "Low" and BA₁ is "High" at read, write, row active and precharge, bank B is selected.If BA₀ is "High" and BA₁ is "Low" at read, write, row active and precharge, bank C is selected.If both BA₀ and BA₁ are "High" at read, write, row active and precharge, bank D is selected.If A₁₀/AP is "High" at row precharge, BA₀ and BA₁ is ignored and all banks are selected.

5. During burst read or write with auto precharge, new read/write command can not be issued.

Another bank read/write command can be issued after the end of burst.

New row active of the associated bank can be issued at t_{RP} after the end of burst.

6. Burst stop command is valid at every burst length.

7. DQM sampled at the positive going edge of CLK masks the data-in at that same CLK in write operation (Write DQM latency is 0), but in read operation makes the data-out Hi-Z state after 2 CLK cycles. (Read DQM latency is 2).