16Mb DDR1 HSTL High Speed Synchronous SRAM (1M x 18) **Preliminary**

Description

The CXK77L18162GB is a high speed CMOS synchronous static RAM with common I/O pins, organized as 1,048,576 words by 18 bits. This synchronous SRAM integrates input registers, high speed RAM, output registers, and a two-deep write buffer onto a single monolithic IC. Single Data Rate (SDR) and Double Data Rate (DDR) Register - Register (R-R) Read operations and Late Write (LW) Write operations are supported, providing a flexible, high-performance user interface. Continue operations are supported, providing burst capability. Positive and negative output clocks are provided for applications requiring source-synchronous operation.

All address and control input signals except the $\overline{G}$ output enable signal are registered on the rising edge of the CK differential input clock. All commands are input via the B(1:3) control signals.

During SDR read operations, output data is driven valid once, from the rising edge of CK, one full clock cycle after the address is registered. During DDR read operations, output data is driven valid twice, first from the rising edge of CK and then from the falling edge of CK, beginning one full clock cycle after the address is registered. In both cases, output data transitions are closely aligned with output clock transitions.

During SDR write operations, input data is registered once, on the rising edge of CK, one full clock cycle after the address is registered. During DDR write operations, input data is registered twice, first on the rising edge of CK and then on the falling edge of CK, beginning one full clock cycle after the address is registered.

Output drivers are series terminated, and output impedance is programmable via the ZQ input pin. By connecting an external control resistor RQ between ZQ and V_{SS}, the impedance of all data and clock output drivers can be precisely controlled.

400 MHz operation (800 Mbps) is obtained from a single 1.8V power supply. JTAG boundary scan interface is provided using a subset of IEEE standard 1149.1 protocol.

Features

3 Speed Bins	Cycle Time / Access Time	Data Rate
-25	2.5ns / 1.8ns	800 Mbps
-27	2.7ns / 1.9ns	740 Mbps
-3	3.0ns / 1.9ns	666 Mbps

- Single 1.8V power supply (V_{DD}): 1.8V ± 0.1V
- Dedicated output supply voltage (V_{DDQ}): 1.5V to 1.8V typical
- HSTL-compatible I/O interface with dedicated input reference voltage (V_{REF}): $V_{DDQ}/2$ typical
- DDR1 functional compatibility
- Register - Register (R-R) read protocol
- Late Write (LW) write protocol
- Single Data Rate (SDR) and Double Data Rate (DDR) data transfers
- Burst capability via Continue commands
- Linear or interleaved burst order, selectable via dedicated mode pin ($\overline{LBO}$)
- Full read/write coherency
- Two cycle deselect
- Differential input clocks (CK/$\overline{CK}$)
- Positive and negative output clocks (CQ/$\overline{CQ}$) - one pair per 18 bits of output data (DQ)
- Asynchronous output enable ($\overline{G}$)
- Programmable output driver impedance
- JTAG boundary scan (subset of IEEE standard 1149.1)
- 153 pin (9x17), 1.27mm pitch, 14mm x 22mm Ball Grid Array (BGA) package

Pin Assignment (Top View)

	1	2	3	4	5	6	7	8	9
A	V_{SS}	V_{DDQ}	SA	SA	ZQ	SA	SA	V_{DDQ}	V_{SS}
B	NC	DQ	SA	V_{SS}	B1	V_{SS}	SA	NC	DQ
C	V_{SS}	V_{DDQ}	SA	SA	$\overline{G}$	SA	SA	V_{DDQ}	V_{SS}
D	DQ	NC	SA	V_{SS}	V_{DD}	V_{SS}	SA	DQ	NC
E	V_{SS}	V_{DDQ}	V_{SS}	V_{DD}	V_{REF}	V_{DD}	V_{SS}	V_{DDQ}	V_{SS}
F	NC	CQ	NC	V_{DD}	V_{DD}	V_{DD}	DQ	NC	DQ
G	V_{SS}	V_{DDQ}	V_{SS}	V_{SS}	CK	V_{SS}	V_{SS}	V_{DDQ}	V_{SS}
H	DQ	NC	DQ	V_{DD}	$\overline{CK}$	V_{DD}	NC	DQ	NC
J	V_{SS}	V_{DDQ}	V_{SS}	V_{DD}	V_{DD}	V_{DD}	V_{SS}	V_{DDQ}	V_{SS}
K	NC	DQ	NC	V_{SS}	B2	V_{SS}	DQ	NC	DQ
L	V_{SS}	V_{DDQ}	V_{SS}	$\overline{LBO}$	B3	NC (1)	V_{SS}	V_{DDQ}	V_{SS}
M	DQ	NC	DQ	V_{DD}	V_{DD}	V_{DD}	NC	$\overline{CQ}$	NC
N	V_{SS}	V_{DDQ}	V_{SS}	V_{DD}	V_{REF}	V_{DD}	V_{SS}	V_{DDQ}	V_{SS}
P	NC	DQ	SA (x18)	V_{SS}	V_{DD}	V_{SS}	SA	NC	DQ
R	V_{SS}	V_{DDQ}	V_{DD}	SA	SA1	SA	V_{DD}	V_{DDQ}	V_{SS}
T	DQ	NC	SA	V_{SS}	SA0	V_{SS}	SA	DQ	NC
U	V_{SS}	V_{DDQ}	TMS	TDI	TCK	TDO	RSVD (2)	V_{DDQ}	V_{SS}

Notes:

1. Pad Location 6L is a true no-connect. However, it may be defined as a mode pin in future versions of DDR SRAMs.
2. Pad Location 7U must be left unconnected. It is used by Sony for internal test purposes.

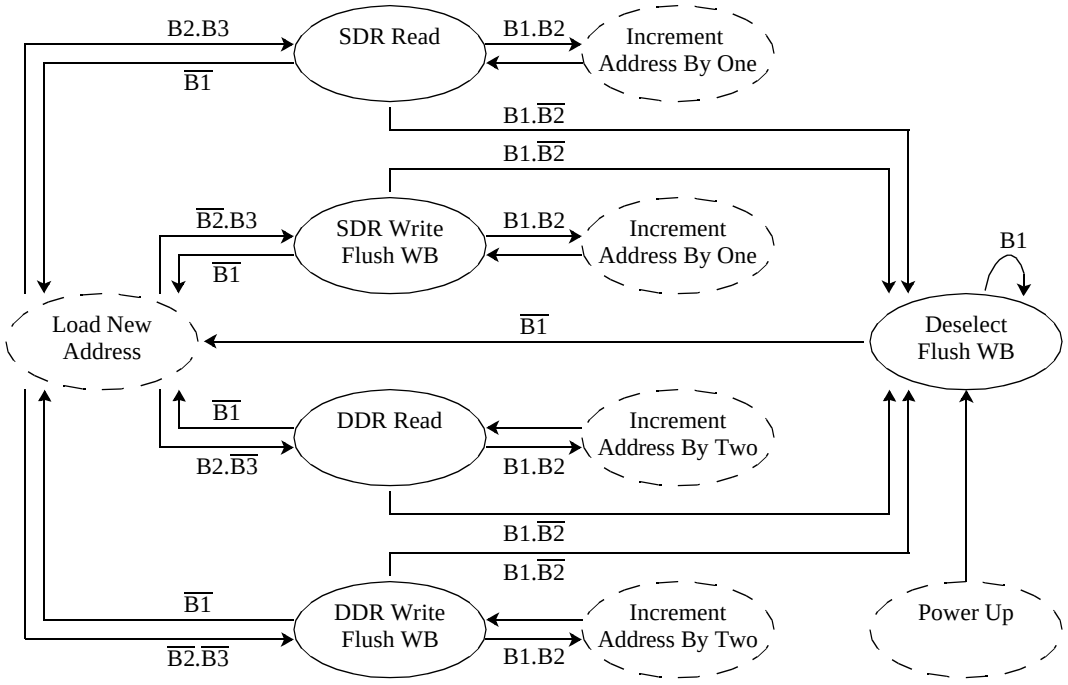
Pin Description

Symbol	Type	Description
SA	Input	Synchronous Address Inputs - Registered on the rising edge of CK.
SA1, SA0	Input	Synchronous Address Inputs (1:0) - Registered on the rising edge of CK. Initialize burst counter.
DQ	I/O	Synchronous Data Inputs / Outputs - Registered on the rising edge of CK during SDR Write operations. Registered on the rising and falling edges of CK during DDR Write operations. Driven from the rising edge of CK during SDR Read operations. Driven from the rising and falling edges of CK during DDR Read operations.
CK, $\overline{CK}$	Input	Differential Input Clocks
CQ, $\overline{CQ}$	I/O	Output Clocks
B1, B2, B3	Input	Synchronous Control Inputs (1:3) - Registered on the rising edge of CK. Specify the type of operation (SDR Read, SDR Write, DDR Read, DDR Write, Continue, or Deselect) to be executed by the SRAM. See the Clock Truth Table and State Diagram sections for further information.
$\overline{G}$	Input	Asynchronous Output Enable Input - Deasserted (high) disables the data output drivers.
$\overline{LBO}$	Input	Burst Order Select Input - This mode pin must be tied “high” or “low” at power-up. $\overline{LBO}$ = 0 selects Linear burst order $\overline{LBO}$ = 1 selects Interleaved burst order
ZQ	Input	Output Impedance Control Resistor Input - This pin must be connected to V_{SS} through an external control resistor RQ to program data and clock output driver impedance. See the Programmable Output Driver Impedance section for further information.
V_{DD}		1.8V Core Power Supply - Core supply voltage.
V_{DDQ}		Output Power Supply - Output buffer supply voltage.
V_{REF}		Input Reference Voltage - Input buffer threshold voltage.
V_{SS}		Ground
TCK	Input	JTAG Clock
TMS	Input	JTAG Mode Select - Weakly pulled “high” internally.
TDI	Input	JTAG Data In - Weakly pulled “high” internally.
TDO	Output	JTAG Data Out
RSVD		Reserved - This pin is used for Sony test purposes only. It must be left unconnected.
NC		No Connect - These pins are true no-connects, i.e. there is no internal chip connection to these pins. They can be left unconnected or tied directly to V_{DD}, V_{DDQ}, or V_{SS}.

Clock Truth Table

CK	B1 (t_n)	B2 (t_n)	B3 (t_n)	Previous Operation	Current Operation	DQ (t_n)	DQ ($t_{n+½}$)	DQ (t_{n+1})	DQ ($t_{n+1½}$)
0→1	0	1	1	---	Single Data Rate Read Load New Address	X		Q1(t_n)	
0→1	0	1	0	---	Double Data Rate Read Load New Address	X	X	Q1(t_n)	Q2(t_n)
0→1	0	0	1	---	Single Data Rate Write Load New Address Flush Write Buffer	X		D1(t_n)	
0→1	0	0	0	---	Double Data Rate Write Load New Address Flush Write Buffer	X	X	D1(t_n)	D2(t_n)
0→1	1	1	X	SDR Read	Single Data Rate Read Continue Increment Address by One	Q1(t_{n-1})		Q2(t_n)	
0→1	1	1	X	DDR Read	Double Data Rate Read Continue Increment Address by Two	Q1(t_{n-1})	Q2(t_{n-1})	Q3(t_n)	Q4(t_n)
0→1	1	1	X	SDR Write	Single Data Rate Write Continue Increment Address by One Flush Write Buffer	D1(t_{n-1})		D2(t_n)	
0→1	1	1	X	DDR Write	Double Data Rate Write Continue Increment Address by Two Flush Write Buffer	D1(t_{n-1})	D2(t_{n-1})	D3(t_n)	D4(t_n)
0→1	1	0	X	not Deselect	Deselect	X		Hi - Z	
0→1	1	X	X	Deselect	Deselect (Continue)	Hi - Z		Hi - Z	

State Diagram



•Continue Operations

These devices support Continue (Burst) operations via the synchronous B(1:3) control input signals. They have the ability to burst transfer a maximum of four (4) distinct pieces of data per single external address input, regardless whether the data transfers are SDR or DDR.

SDR Read and Write operations transfer one (1) piece of data. Consequently, one (1), two (2), or three (3) Continue operations may be initiated immediately after an SDR Read or Write operation to burst transfer two (2), three (3), or four (4) distinct pieces of data per single external address input. If a fourth (4th) Continue operation is initiated, the internal address wraps back to the initial external (base) address.

DDR Read and Write operations transfer two (2) pieces of data. Consequently, one (1) Continue operation may be initiated immediately after a DDR Read or Write operation to burst transfer four (4) distinct pieces of data per single external address input. If a second (2nd) Continue operation is initiated, the internal address wraps back to the initial external (base) address.

The order (i.e. address sequence) in which multiple pieces of data are transferred during DDR and/or Continue operations is determined by the state of $\overline{LBO}$ mode pin.

When $\overline{LBO}$ = 1, data transfers follow the **Interleaved Burst** address sequence depicted in the table below:

Interleaved Burst Address Sequence

Address Sequence	SA(1:0)				Sequence Key
1st (Base) Address	00	01	10	11	SA1, SA0
2nd Address	01	00	11	10	SA1, $\overline{SA0}$
3rd Address	10	11	00	01	$\overline{SA1}$, SA0
4th Address	11	10	01	00	$\overline{SA1}$, $\overline{SA0}$

When $\overline{LBO}$ = 0, data transfers follow the **Linear Burst** address sequence depicted in the table below:.

Linear Burst Address Sequence

Address Sequence	SA(1:0)				Sequence Key
1st (Base) Address	00	01	10	11	SA1, SA0
2nd Address	01	10	11	00	(SA1 xor SA0), $\overline{SA0}$
3rd Address	10	11	00	01	$\overline{SA1}$, SA0
4th Address	11	00	01	10	$\overline{(SA1 \text{ xor } SA0)}$, $\overline{SA0}$

•Programmable Impedance Output Drivers

These devices have programmable impedance output drivers. The output impedance is controlled by an external resistor RQ connected between the SRAM's ZQ pin and V_{SS}, and is equal to one-fifth the value of this resistor, nominally. See the DC Electrical Characteristics section for further information.

Output Driver Impedance Power-Up Requirements

Output driver impedance will reach the programmed value within 8192 cycles after power-up. Consequently, it is recommended that Read operations not be initiated until after the initial 8192 cycles have elapsed.

Output Driver Impedance Updates

Data output impedance is updated during Write and Deselect operations when the output driver is disabled.

Clock pull-up output impedance is updated during Write and Deselect operations when the output driver is driving "low".

Clock pull-down output impedance is updated during Write and Deselect operations when the output driver is driving "high".

•Power-Up Sequence

For reliability purposes, Sony recommends that power supplies power up in the following sequence: V_{SS}, V_{DD}, V_{DDQ}, V_{REF}, and Inputs. V_{DDQ} should never exceed V_{DD}. If this power supply sequence cannot be met, a large bypass diode may be required between V_{DD} and V_{DDQ}. Please contact Sony Memory Application Department for further information.

•Absolute Maximum Ratings

Parameter	Symbol	Rating	Units
Supply Voltage	V_{DD}	-0.5 to +2.5	V
Output Supply Voltage	V_{DDQ}	-0.5 to +2.3	V
Input Voltage (Address, Control, Data, Clock)	V_{IN}	-0.5 to V_{DDQ}+0.5 (2.3V max)	V
Input Voltage ($\overline{LBO}$)	V_{MIN}	-0.5 to V_{DDQ}+0.5 (2.3V max)	V
Input Voltage (TCK, TMS, TDI)	V_{TIN}	-0.5 to V_{DD}+0.5 (2.5V max)	V
Operating Temperature	T_A	0 to 85	°C
Junction Temperature	T_J	0 to 110	°C
Storage Temperature	T_{STG}	-55 to 150	°C

Note: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at these or any other conditions other than those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

•BGA Package Thermal Characteristics

Parameter	Symbol	Rating	Units
Junction to Case Temperature	Θ_{JC}	1.0	°C/W

•I/O Capacitance

(T_A = 25°C, f = 1 MHz)

Parameter		Symbol	Test conditions	Min	Max	Units
Input Capacitance	Address	C_{IN}	V_{IN} = 0V	---	4.2	pF
	Control	C_{IN}	V_{IN} = 0V	---	4.2	pF
	CK Clock	C_{KIN}	V_{KIN} = 0V	---	3.5	pF
Output Capacitance	Data	C_{OUT}	V_{OUT} = 0V	---	4.8	pF
	CQ Clock	C_{OUT}	V_{OUT} = 0V	---	4.8	pF

Note: These parameters are sampled and are not 100% tested.

•DC Recommended Operating Conditions

(V_{SS} = 0V, T_A = 0 to 85°C)

Parameter	Symbol	Min	Typ	Max	Units	Notes
Supply Voltage	V_{DD}	1.7	1.8	1.9	V	
Output Supply Voltage	V_{DDQ}	1.4	---	V_{DD}	V	
Input Reference Voltage	V_{REF}	0.65	---	1.0	V	1
Input High Voltage (Address, Control, Data)	V_{IH}	V_{REF} + 0.2	---	V_{DDQ} + 0.3	V	2
Input Low Voltage (Address, Control, Data)	V_{IL}	-0.3	---	V_{REF} - 0.2	V	3
Input High Voltage ($\overline{LBO}$)	V_{MIH}	V_{REF} + 0.3	---	V_{DDQ} + 0.3	V	
Input Low Voltage ($\overline{LBO}$)	V_{MIL}	-0.3	---	V_{REF} - 0.3	V	
Clock Input Signal Voltage	V_{KIN}	-0.3	---	V_{DDQ} + 0.3	V	
Clock Input Differential Voltage	V_{DIF}	0.2	---	V_{DDQ} + 0.6	V	
Clock Input Common Mode Voltage	V_{CM}	0.6	---	1.0	V	

1. The peak-to-peak AC component superimposed on V_{REF} may not exceed 5% of the DC component.
2. V_{IH} (max) AC = V_{DDQ} + 0.9V for pulse widths less than one-quarter of the cycle time (t_{CYC}/4).
3. V_{IL} (min) AC = -0.9V for pulse widths less than one-quarter of the cycle time (t_{CYC}/4).

•DC Electrical Characteristics

(V_{DD} = 1.8V ± 0.1V, V_{SS} = 0V, T_A = 0 to 85°C)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units	Notes
Input Leakage Current (Address, Control, Clock)	I_{LI}	V_{IN} = V_{SS} to V_{DDQ}	-5	---	5	uA	
Input Leakage Current ($\overline{LBO}$)	I_{MLI}	V_{MIN} = V_{SS} to V_{DDQ}	-10	---	10	uA	
Output Leakage Current	I_{LO}	V_{OUT} = V_{SS} to V_{DDQ} $\overline{G}$ = V_{IH}	-10	---	10	uA	
Average Power Supply DDR Operating Current	$I_{DD-D-25}$ $I_{DD-D-27}$ I_{DD-D-3}	I_{OUT} = 0 mA V_{IN} = V_{IH} or V_{IL}	--- --- ---	--- --- ---	980 940 880	mA	
Average Power Supply SDR Operating Current	$I_{DD-S-25}$ $I_{DD-S-27}$ I_{DD-S-3}	I_{OUT} = 0 mA V_{IN} = V_{IH} or V_{IL}	--- --- ---	--- --- ---	870 830 780	mA	
Power Supply Deselect Operating Current (NOP Current)	I_{DD2}	I_{OUT} = 0 mA V_{IN} = V_{IH} or V_{IL}	---	---	520	mA	
Output High Voltage	V_{OH}	I_{OH} = -6.0 mA RQ = 250Ω	V_{DDQ} - 0.4	---	---	V	
Output Low Voltage	V_{OL}	I_{OL} = 6.0 mA RQ = 250Ω	---	---	0.4	V	
Output Driver Impedance	R_{OUT}	V_{OH}, V_{OL} = V_{DDQ}/2 RQ < 150Ω	---	---	35 (30*1.15)	Ω	1
		V_{OH}, V_{OL} = V_{DDQ}/2 150Ω ≤ RQ ≤ 300Ω	(RQ/5)* 0.85	RQ/5	(RQ/5)* 1.15	Ω	
		V_{OH}, V_{OL} = V_{DDQ}/2 RQ > 300Ω	51 (60*0.85)	---	---	Ω	2

1. For maximum output drive (i.e. minimum impedance), the ZQ pin can be tied directly to V_{SS}.
2. For minimum output drive (i.e. maximum impedance), the ZQ pin can be left unconnected or tied to V_{DDQ}.

•AC Electrical Characteristics

(V_{DD} = 1.8V ± 0.1V, V_{SS} = 0V, T_A = 0 to 85°C)

Parameter	Symbol	-25		-27		-3		Units	Notes
		Min	Max	Min	Max	Min	Max		
Input Clock Cycle Time	t_{KHKH}	2.5	---	2.7	---	3.0	---	ns	
Input Clock High Pulse Width Input Clock Low Pulse Width	t_{KHKL} t_{KLKH}	1.0	---	1.1	---	1.2	---	ns	
Address Input Setup Time	t_{AVKH}	0.3	---	0.35	---	0.35	---	ns	1
Address Input Hold Time	t_{KHAX}	0.3	---	0.35	---	0.35	---	ns	1
Control Input Setup Time	t_{BVKH}	0.3	---	0.35	---	0.35	---	ns	1
Control Input Hold Time	t_{KHBX}	0.3	---	0.35	---	0.35	---	ns	1
Data Input Setup Time	t_{DVKH} t_{DVKL}	0.25	---	0.25	---	0.3	---	ns	1
Data Input Hold Time	t_{KHDX} t_{KLDX}	0.25	---	0.25	---	0.3	---	ns	1
Input Clock High to Output Data Valid Input Clock Low to Output Data Valid	t_{KHQV} t_{KLQV}	---	1.8	----	1.9	---	1.9	ns	
Input Clock High to Output Data Hold Input Clock Low to Output Data Hold	t_{KHQX} t_{KLQX}	0.5	---	0.5	---	0.5	---	ns	1
Input Clock High to Output Data Low-Z	t_{KHQX1}	0.5	---	0.5	---	0.5	---	ns	1,2
Input Clock High to Output Data High-Z	t_{KHQZ}	---	1.8	----	1.9	---	1.9	ns	1,2
Input Clock Cross to Output Clock High Input Clock Cross to Output Clock Low	t_{KXCH} t_{KXCL}	0.5	1.8	0.5	1.9	0.5	1.9	ns	
Output Clock High to Output Data Valid Output Clock Low to Output Data Valid	t_{CHQV} t_{CLQV}	---	0.2	---	0.2	---	0.2	ns	1
Output Clock High to Output Data Hold Output Clock Low to Output Data Hold	t_{CHQX} t_{CLQX}	-0.2	---	-0.2	---	-0.2	---	ns	1
Output Clock High Pulse Width	t_{CHCL}	t_{KHKL} ± 0.1		t_{KHKL} ± 0.1		t_{KHKL} ± 0.1		ns	1
Output Clock Low Pulse Width	t_{CLCH}	t_{KLKH} ± 0.1		t_{KLKH} ± 0.1		t_{KLKH} ± 0.1		ns	1
Output Enable Low to Output Valid	t_{GLQV}	---	1.8	----	1.9	---	2.0	ns	
Output Enable Low to Output Low-Z	t_{GLQX}	0.3	---	0.3	---	0.3	---	ns	1,2
Output Enable High to Output High-Z	t_{GHQZ}	---	1.8	----	1.9	---	2.0	ns	1,2

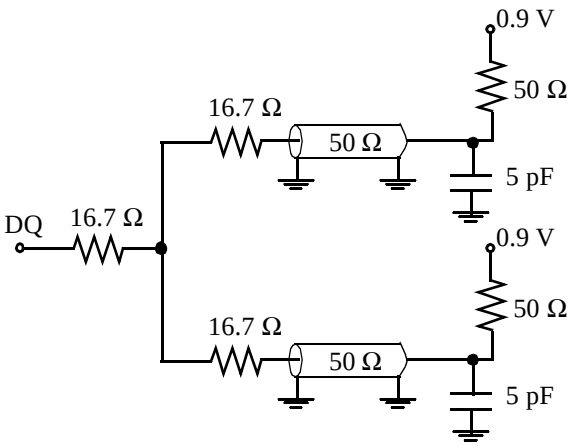
1. These parameters are guaranteed by design through extensive corner lot characterization.
2. These parameters are measured at ± 50mV from steady state voltage.

•AC Test Conditions

(V_{DD} = V_{DDQ} = 1.8V ± 0.1V, T_A = 0 to 85°C)

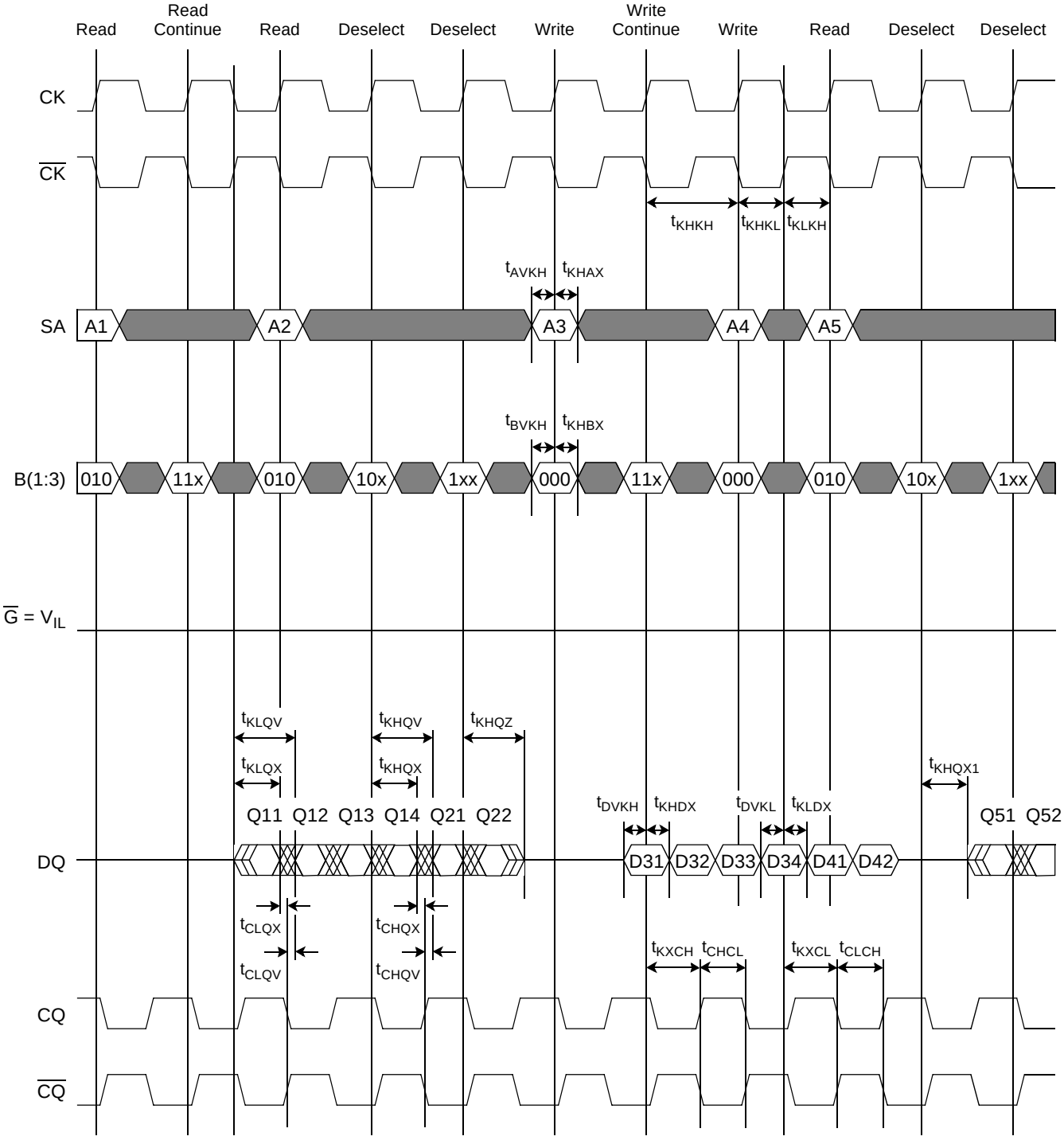
Item	Symbol	Conditions	Units	Notes
Input Reference Voltage	V_{REF}	0.9	V	
Input High Level	V_{IH}	1.4	V	
Input Low Level	V_{IL}	0.4	V	
Input Rise & Fall Time		2.0	V/ns	
Input Reference Level		0.9	V	
Clock Input High Voltage	V_{KIH}	1.4	V	V_{DIF} = 1.0V
Clock Input Low Voltage	V_{KIL}	0.4	V	V_{DIF} = 1.0V
Clock Input Common Mode Voltage	V_{CM}	0.9	V	
Clock Input Rise & Fall Time		2.0	V/ns	
Clock Input Reference Level		CK/$\overline{CK}$ cross	V	
Output Reference Level		0.9	V	
Output Load Conditions		RQ = 250Ω		See Figure 1 below

Figure 1: AC Test Output Load (V_{DDQ} = 1.8V)



Timing Diagram of Double Data Rate (DDR) Read-Write-Read Operations Synchronously Controlled via Deselect Operations ($\overline{G}$ = Low)

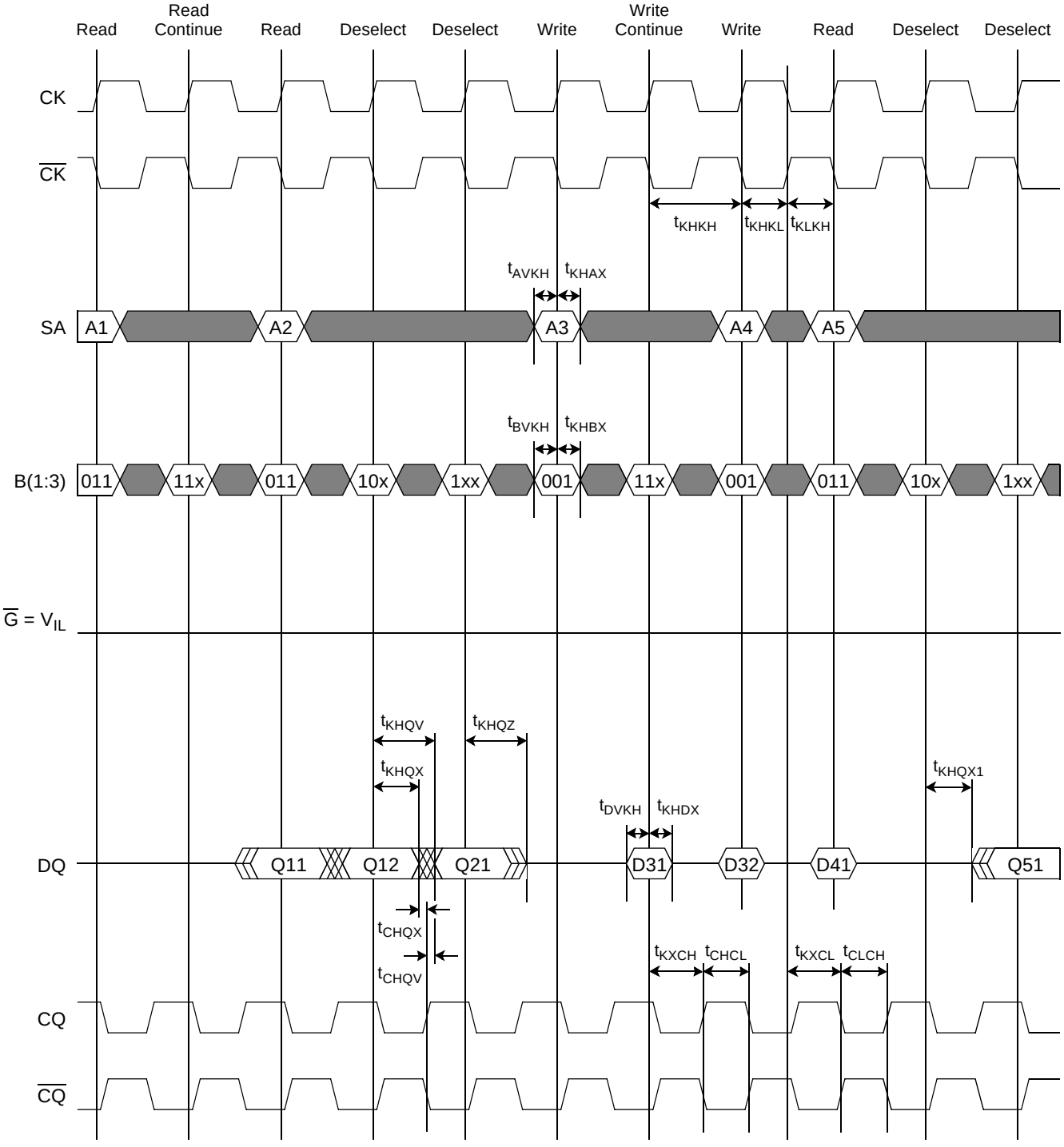
Figure 2



Note: In the diagram above, two Deselect operations are inserted between Read and Write operations to control the data bus transition from output to input. This depiction is for clarity purposes only. It is NOT a requirement. Depending on the application, one Deselect operation may be sufficient.

Timing Diagram of Single Data Rate (SDR) Read-Write-Read Operations Synchronously Controlled via Deselect Operations ($\overline{G}$ = Low)

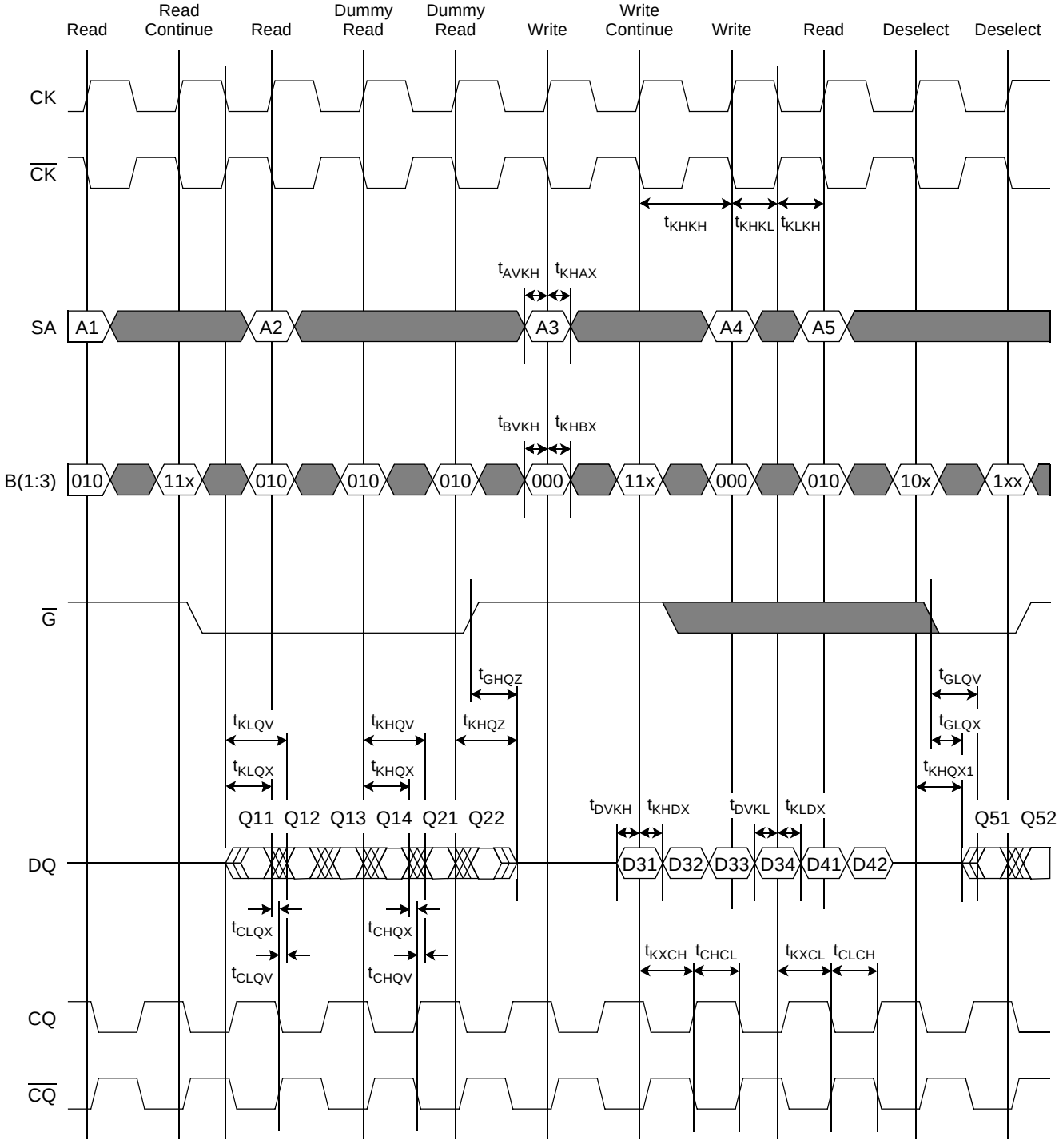
Figure 3



Note: In the diagram above, two Deselect operations are inserted between Read and Write operations to control the data bus transition from output to input. This depiction is for clarity purposes only. It is NOT a requirement. Depending on the application, one Deselect operation may be sufficient.

Timing Diagram of Double Data Rate (DDR) Read-Write-Read Operations Asynchronously Controlled via $\overline{G}$ and Dummy Read Operations

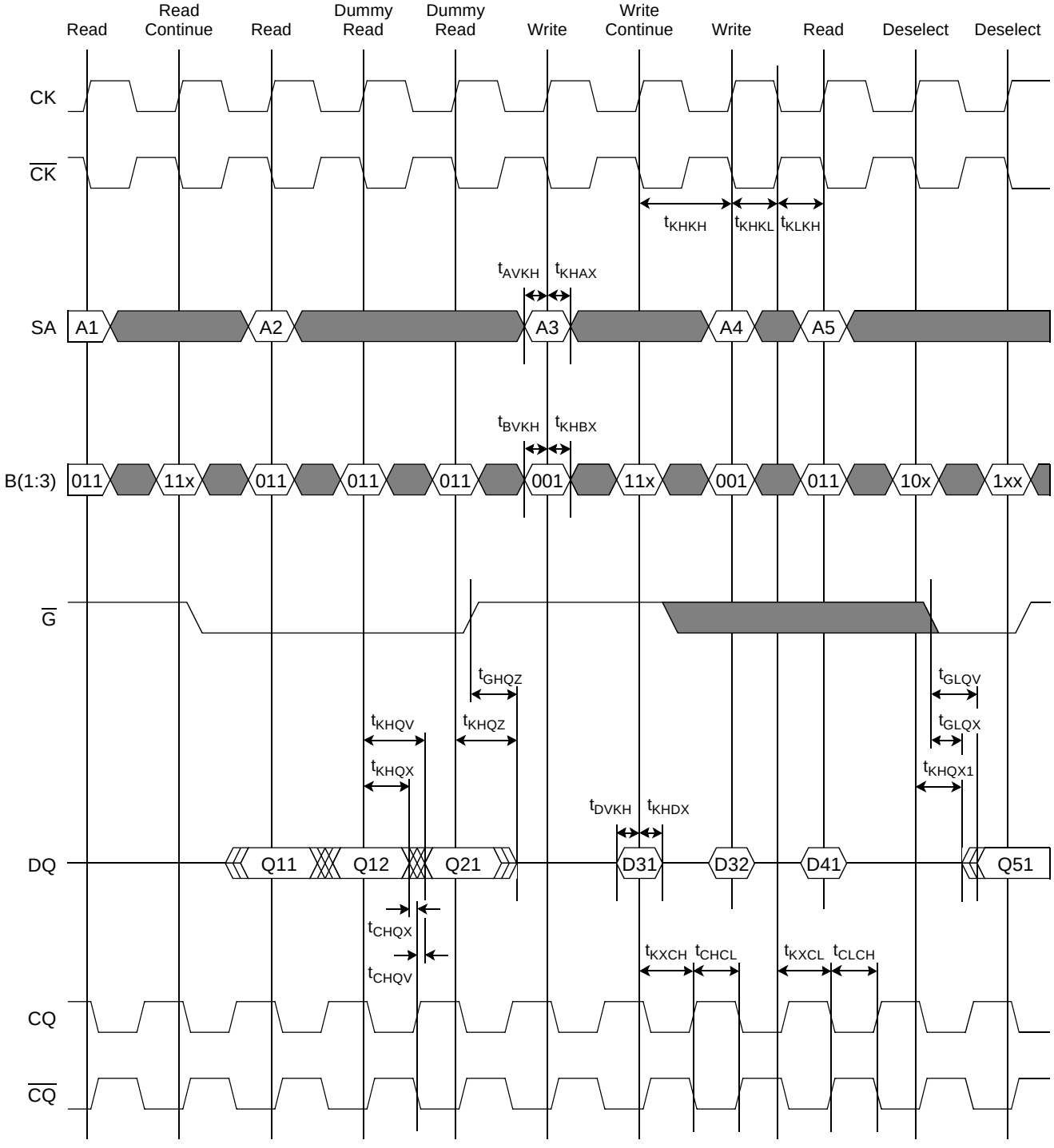
Figure 4



Note: In the diagram above, two Dummy Read operations are inserted between Read and Write operations to control the data bus transition from output to input. This depiction is for clarity purposes only. It is NOT a requirement. Depending on the application, one Dummy Read operation may be sufficient.

Timing Diagram of Single Data Rate (SDR) Read-Write-Read Operations Asynchronously Controlled via $\overline{G}$ and Dummy Read Operations

Figure 5



Note: In the diagram above, two Dummy Read operations are inserted between Read and Write operations to control the data bus transition from output to input. This depiction is for clarity purposes only. It is NOT a requirement. Depending on the application, one Dummy Read operation may be sufficient.

•Test Mode Description

These devices provide a JTAG Test Access Port (TAP) and Boundary Scan interface using a limited set of IEEE std. 1149.1 functions. This test mode is intended to provide a mechanism for testing the interconnect between master (processor, controller, etc.), SRAMs, other components, and the printed circuit board.

In conformance with a subset of IEEE std. 1149.1, this device contains a TAP Controller and four TAP Registers. The TAP Registers consist of one Instruction Register and three Data Registers (ID, Bypass, and Boundary Scan Registers).

The TAP consists of the following four signals:

TCK:	Test Clock	Induces (clocks) TAP Controller state transitions.
TMS:	Test Mode Select	Inputs commands to the TAP Controller. Sampled on the rising edge of TCK.
TDI:	Test Data In	Inputs data serially to the TAP Registers. Sampled on the rising edge of TCK.
TDO:	Test Data Out	Outputs data serially from the TAP Registers. Driven from the falling edge of TCK.

Disabling the TAP

When JTAG is not used, TCK should be tied “low” to prevent clocking the SRAM. TMS and TDI should either be tied “high” through a pull-up resistor or left unconnected. TDO should be left unconnected.

Note: Operation of the TAP does not interfere with normal SRAM operation except when the SAMPLE-Z instruction is selected. Consequently, TCK, TMS, and TDI can be controlled any number of ways without adversely affecting the functionality of the device.

JTAG DC Recommended Operating Conditions

(V_{DD} = 1.8V ± 0.1V, T_A = 0 to 85°C)

Parameter	Symbol	Test Conditions	Min	Max	Units
JTAG Input High Voltage	V_{TIH}	---	1.4	V_{DD} + 0.3	V
JTAG Input Low Voltage	V_{TIL}	---	-0.3	0.8	V
JTAG Output High Voltage (CMOS)	V_{TOH}	I_{TOH} = -100uA	V_{DD} - 0.1	---	V
JTAG Output Low Voltage (CMOS)	V_{TOL}	I_{TOL} = 100uA	---	0.1	V
JTAG Output High Voltage (TTL)	V_{TOH}	I_{TOH} = -4.0mA	V_{DD} - 0.4	---	V
JTAG Output Low Voltage (TTL)	V_{TOL}	I_{TOL} = 4.0mA	---	0.4	V
JTAG Input Leakage Current	I_{TLI}	V_{TIN} = V_{SS} to V_{DD}	-10	10	uA

JTAG AC Test Conditions

(V_{DD} = 1.8V ± 0.1V, T_A = 0 to 85°C)

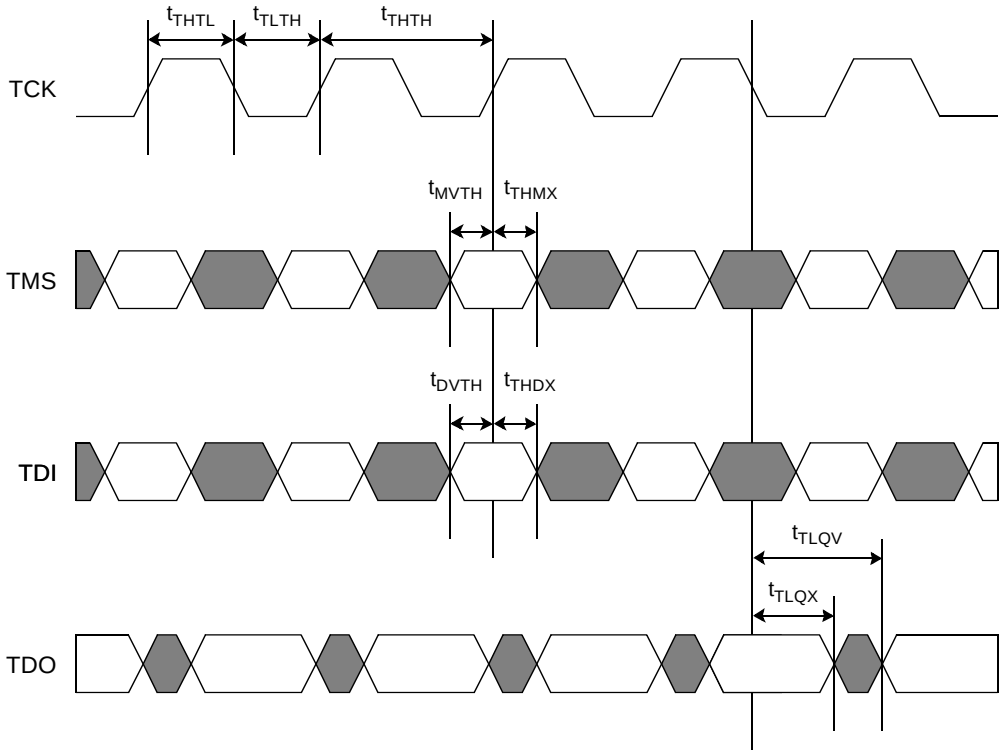
Parameter	Symbol	Conditions	Units	Notes
JTAG Input High Level	V_{TIH}	1.8	V	
JTAG Input Low Level	V_{TIL}	0.0	V	
JTAG Input Rise & Fall Time		1.0	V/ns	
JTAG Input Reference Level		0.9	V	
JTAG Output Reference Level		0.9	V	
JTAG Output Load Condition				See Fig.1 (page 10)

JTAG AC Electrical Characteristics

Parameter	Symbol	Min	Max	Unit
TCK Cycle Time	t_{THTH}	100		ns
TCK High Pulse Width	t_{THTL}	40		ns
TCK Low Pulse Width	t_{TLTH}	40		ns
TMS Setup Time	t_{MVTH}	10		ns
TMS Hold TIme	t_{THMX}	10		ns
TDI Setup Time	t_{DVTH}	10		ns
TDI Hold TIme	t_{THDX}	10		ns
TCK Low to TDO Valid	t_{TLQV}		20	ns
TCK Low to TDO Hold	t_{TLQX}	0		ns

JTAG Timing Diagram

Figure 6



TAP Controller

The TAP Controller is a 16-state state machine that controls access to the various TAP Registers and executes the operations associated with each TAP Instruction. State transitions are controlled by TMS and occur on the rising edge of TCK.

The TAP Controller enters the “Test-Logic Reset” state in one of two ways:

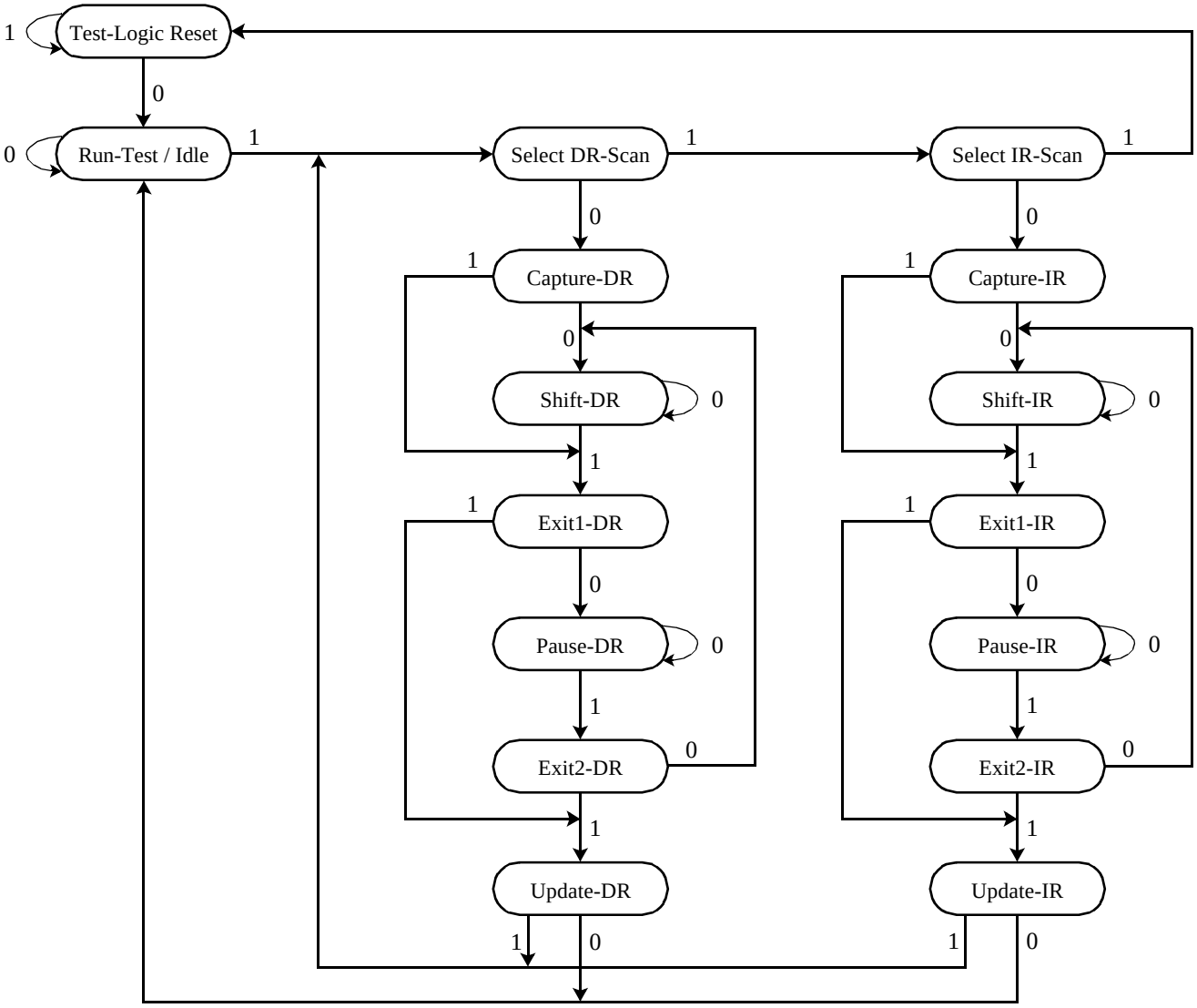
1. At power up.
2. When a logic “1” is applied to TMS for at least 5 consecutive rising edges of TCK.

The TDI input receiver is sampled only when the TAP Controller is in either the “Shift-IR” state or the “Shift-DR” state.

The TDO output driver is active only when the TAP Controller is in either the “Shift-IR” state or the “Shift-DR” state.

TAP Controller State Diagram

Figure 7



TAP Registers

TAP Registers are serial shift registers that capture serial input data (from TDI) on the rising edge of TCK, and drive serial output data (to TDO) on the subsequent falling edge of TCK. They are divided into two groups: “Instruction Registers” (IR), which are manipulated via the “IR” states in the TAP Controller, and “Data Registers” (DR), which are manipulated via the “DR” states in the TAP Controller.

Instruction Register (IR - 3 bits)

The Instruction Register stores the various TAP Instructions supported by these devices. It is loaded with the IDCODE instruction at power-up, and when the TAP Controller is in the “Test-Logic Reset” and “Capture-IR” states. It is inserted between TDI and TDO when the TAP Controller is in the “Shift-IR” state, at which time it can be loaded with a new instruction. However, newly loaded instructions are not executed until the TAP Controller has reached the “Update-IR” state.

The Instruction Register is 3 bits wide, and is encoded as follows:

Code (2:0)	Instruction	Description
000	BYPASS	See code “111”.
001	IDCODE	Loads a predefined device- and manufacturer-specific identification code into the ID Register when the TAP Controller is in the “Capture-DR” state, and inserts the ID Register between TDI and TDO when the TAP Controller is in the “Shift-DR” state. See the ID Register description for more information.
010	SAMPLE-Z	Captures the individual logic states of all address, control, data, and clock signals in the Boundary Scan Register when the TAP Controller is in the “Capture-DR” state, and inserts the Boundary Scan Register between TDI and TDO when the TAP Controller is in the “Shift-DR” state. Also disables the data and clock output drivers. See the Boundary Scan Register description for more information.
011	BYPASS	See code “111”.
100	SAMPLE	Captures the individual logic states of all address, control, data, and clock signals in the Boundary Scan Register when the TAP Controller is in the “Capture-DR” state, and inserts the Boundary Scan Register between TDI and TDO when the TAP Controller is in the “Shift-DR” state. See the Boundary Scan Register description for more information.
101	PRIVATE	Do not use. Reserved for manufacturer use only.
110	BYPASS	See code “111”.
111	BYPASS	Loads a logic “0” into the Bypass Register when the TAP Controller is in the “Capture-DR” state, and inserts the Bypass Register between TDI and TDO when the TAP Controller is in the “Shift-DR” state. See the Bypass Register description for more information.

Bit 0 is the LSB of the Instruction Register, and Bit 2 is the MSB. When the Instruction Register is selected, TDI serially shifts data into the MSB, and the LSB serially shifts data out through TDO.

Bypass Register (DR - 1 bit)

The Bypass Register is one bit wide, and provides the minimum length serial path between TDI and TDO. It is loaded with a logic “0” when the BYPASS instruction has been loaded in the Instruction Register and the TAP Controller is in the “Capture-DR” state. It is inserted between TDI and TDO when the BYPASS instruction has been loaded into the Instruction Register and the TAP Controller is in the “Shift-DR” state.

ID Register (DR - 32 bits)

The ID Register is loaded with a predetermined device- and manufacturer-specific identification code when the IDCODE instruction has been loaded into the Instruction Register and the TAP Controller is in the "Capture-DR" state. It is inserted between TDI and TDO when the IDCODE instruction has been loaded into the Instruction Register and the TAP Controller is in the "Shift-DR" state.

The ID Register is 32 bits wide, and is encoded as follows:

Revision Number (31:28)	Part Number (27:12)	Sony ID (11:1)	Start Bit (0)
xxxx	0000 0000 0100 1101	0000 1110 001	1

Bit 0 is the LSB of the ID Register, and Bit 31 is the MSB. When the ID Register is selected, TDI serially shifts data into the MSB, and the LSB serially shifts data out through TDO.

Boundary Scan Register (DR - 49 bits)

The Boundary Scan Register is equal in length to the number of active signal connections to the SRAM (excluding the TAP pins) plus a number of place holder locations reserved for density and/or functional upgrades. The Boundary Scan Register is loaded with the contents of the SRAM's I/O ring when the SAMPLE or SAMPLE-Z instruction has been loaded into the Instruction Register and the TAP Controller is in the "Capture-DR" state. It is inserted between TDI and TDO when the SAMPLE or SAMPLE-Z instruction has been loaded into the Instruction Register and the TAP Controller is in the "Shift-DR" state.

The Boundary Scan Register contains the following bits:

DQ	18
SA, SA1, SA0	20
CK, $\overline{CK}$	2
CQ, $\overline{CQ}$	2
B1, B2, B3	3
$\overline{G}$	1
$\overline{LBO}$, ZQ	2
Place Holder	1

Note: For deterministic results, all signals composing the SRAM's I/O ring must meet setup and hold times with respect to TCK (same as TDI and TMS) when sampled.

Note: CK and $\overline{CK}$ are connected to a differential input receiver that generates a single-ended input clock signal to the device. Therefore, in order to capture specific values for these signals in the Boundary Scan Register, these signals must be at opposite logic levels when sampled.

Note: When an external resistor RQ is connected between the ZQ pin and V_{SS}, the value of the ZQ signal captured in the Boundary Scan Register is non-deterministic.

Note: Place Holders are required for some NC pins to allow for future density and/or functional upgrades. They are connected to V_{DD} internally, regardless of pin connection externally.

Boundary Scan Register Bit Order Assignments

The table below depicts the order in which bits are arranged in the Boundary Scan Register. Bit 1 is the LSB and bit 49 is the MSB. When the Boundary Scan Register is selected, TDI serially shifts data into the MSB, and the LSB serially shifts data out through TDO.

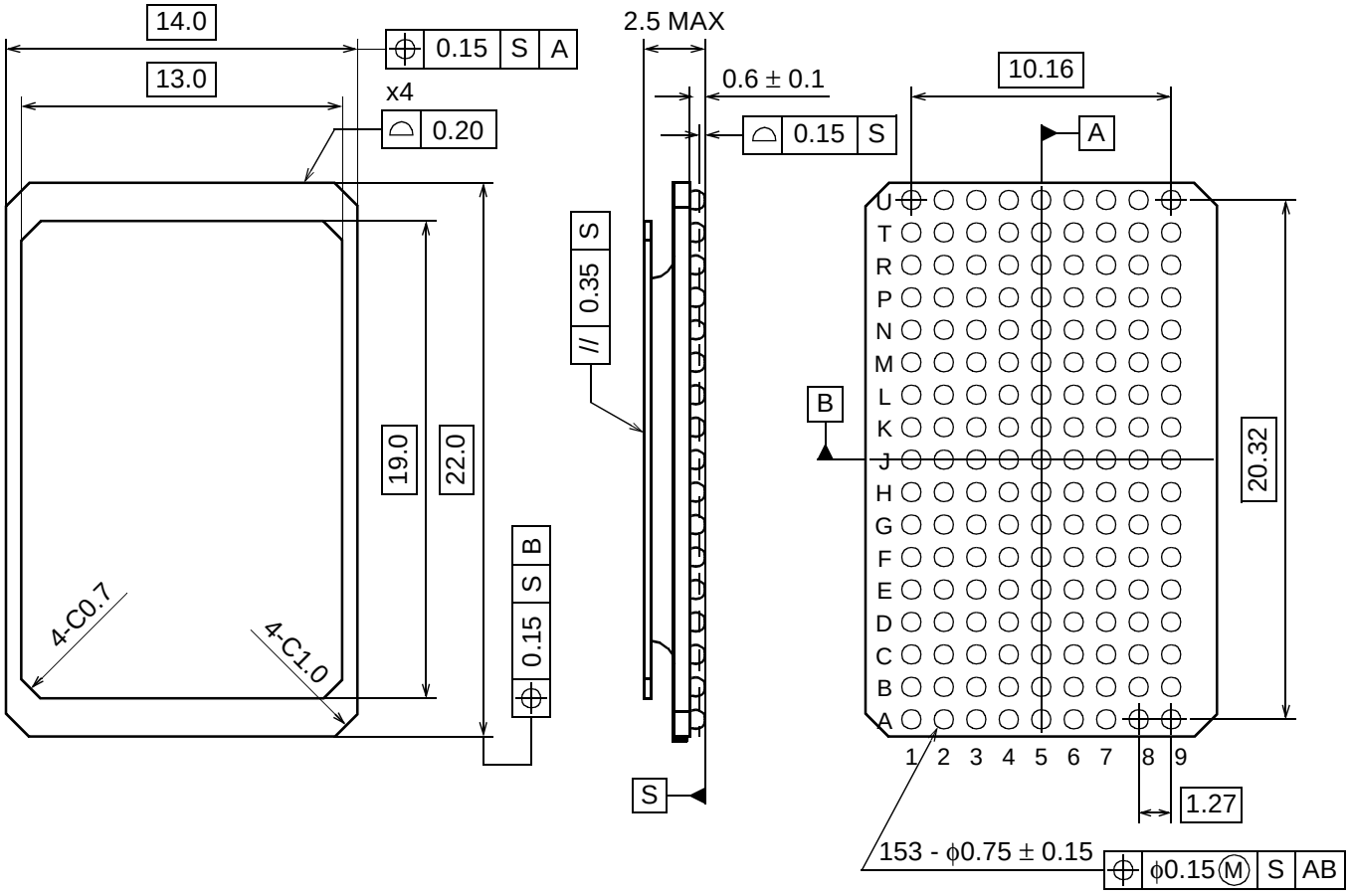
Bit	Signal	Pad	Bit	Signal	Pad
1	SA1	5R	26	SA	4A
2	SA0	5T	27	SA	4C
3	SA	6R	28	SA	3A
4	SA	7T	29	SA	3B
5	SA	7P	30	SA	3C
6	DQ	8T	31	SA	3D
7	DQ	9P	32	DQ	2B
8	$\overline{CQ}$	8M	33	DQ	1D
9	DQ	7K	34	CQ	2F
10	DQ	9K	35	DQ	3H
11	NC (1)	6L	36	DQ	1H
12	$\overline{CK}$	5H	37	ZQ	5A
13	CK	5G	38	B1	5B
14	$\overline{G}$	5C	39	B2	5K
15	DQ	8H	40	B3	5L
16	DQ	9F	41	$\overline{LBO}$	4L
17	DQ	7F	42	DQ	2K
18	DQ	8D	43	DQ	1M
19	DQ	9B	44	DQ	3M
20	SA	7D	45	DQ	2P
21	SA	7C	46	DQ	1T
22	SA	7B	47	SA	3P
22	SA	7A	48	SA	3T
24	SA	6C	49	SA	4R
25	SA	6A			

Note 1: NC pin at pad location 6L is connected to V_{DD} internally, regardless of pin connection externally.

•Ordering Information

Part Number	V_{DD}	I/O Type	Size	Speed (Cycle Time / Access Time)
CXK77L18162GB-25	1.8V	HSTL	1M x 18	2.5ns / 1.8ns
CXK77L18162GB-27	1.8V	HSTL	1M x 18	2.7ns / 1.9ns
CXK77L18162GB-3	1.8V	HSTL	1M x 18	3.0ns / 1.9ns

153 Pin BGA Package Dimensions



PRELIMINARY

PACKAGE STRUCTURE

SONY CODE	BGA-153P-021
EIAJ CODE	BGA153-P-1422
JEDEC CODE	————————

PACKAGE MATERIAL	EPOXY RESIN
BORAD TREATMENT	COPPER-CLAD LAMINATE
LEAD MATERIAL	SOLDER
PACKAGE MASS	1.5g

•Revision History

Rev. #	Rev. Date	Description of Modifications
rev 0.0	09/29/00	Initial Version.
rev 1.0	06/29/01	1. Modified DC Recommended Operating Conditions (p. 7). V_{IH} (min) V_{REF} + 0.1V to V_{REF} + 0.2V V_{IL} (max) V_{REF} - 0.1V to V_{REF} - 0.2V 2. Modified AC Electrical Characteristics (p. 9). -25, -27 t_{AVKH}, t_{KHAX}, t_{BVKH}, t_{KHBX} 0.3ns to 0.35ns t_{DVKH}, t_{DVKL}, t_{KHDX}, t_{KLDX} 0.2ns to 0.25ns t_{CHQV}, t_{CLQV} 0.15ns to 0.2ns t_{CHQX}, t_{CLQX} -0.15ns to -0.2ns 3. Added 1.8V V_{DDQ} AC Test Conditions (p. 11). 4. Modified JTAG DC Recommended Operating Conditions (p. 16). I_{TOH} Test Condition for V_{TOH} (min) = V_{DD} - 0.4V -8mA to -4mA I_{TOL} Test Condition for V_{TOL} (max) = 0.4V 8mA to 4mA
rev 1.1	10/05/01	1. Modified DC Electrical Characteristics (p. 8). Updated DDR Operating Current I_{DD-D-3} (max) 860mA to 880mA $I_{DD-D-27}$ (max) 940mA to 940mA $I_{DD-D-25}$ (max) 1000mA to 980mA Added SDR Operating Current I_{DD-S-3} (max) 780mA $I_{DD-S-27}$ (max) 830mA $I_{DD-S-25}$ (max) 870mA Updated Deselect Operating Current I_{DD2} (max) 520mA 2. Modified AC Electrical Characteristics (p. 9). -25 t_{AVKH}, t_{KHAX}, t_{BVKH}, t_{KHBX} 0.35ns to 0.3ns t_{KHQV}, t_{KLQV}, t_{KHQZ}, t_{GLQV}, t_{GHQZ} 1.75ns to 1.8ns -27 t_{KHQV}, t_{KLQV}, t_{KHQZ}, t_{GLQV}, t_{GHQZ} 1.85ns to 1.9ns 3. Updated 153p BGA Package Dimensions (p. 24).
rev 1.2	03/06/02	1. Modified AC Electrical Characteristics (p. 9). -3 t_{DVKH}, t_{DVKL}, t_{KHDX}, t_{KLDX} 0.25ns to 0.3ns
rev 1.3	07/19/02	1. Modified DC Electrical Characteristics (p. 8). R_{OUT} RQ/5 ± 10% to RQ/5 ± 15% 2. Modified AC Electrical Characteristics (p. 9). Removed Output Enable Setup and Hold Times. -25 t_{KXCH}, t_{KXCL} 1.6ns to 1.8ns -27 t_{KXCH}, t_{KXCL} 1.7ns to 1.9ns -3 t_{KHQV}, t_{KLQV}, t_{KHQZ} 2.0ns to 1.9ns t_{KXCH}, t_{KXCL} 1.8ns to 1.9ns 2. Removed 1.5V V_{DDQ} AC Test Conditions.