512K x 36, 1024K x 18
18Mb SYNCHRONOUS PIPELINED, DOUBLE CYCLE DESELECT STATIC RAM

JULY 2008

FEATURES

- Internal self-timed write cycle
- Individual Byte Write Control and Global Write
- Clock controlled, registered address, data and control
- Burst sequence control using MODE input
- Three chip enable option for simple depth expansion and address pipelining
- Common data inputs and data outputs
- Auto Power-down during deselect
- Double cycle deselect
- Snooze MODE for reduced-power standby
- JTAG Boundary Scan for PBGA package
- Power Supply

  LPD: V_{DD} 3.3V ± 5%, V_{DDQ} 3.3V/2.5V ± 5%

  VPD: V_{DD} 2.5V ± 5%, V_{DDQ} 2.5V ± 5%
- JEDEC 100-Pin TQFP and 165-pin PBGA package
- Lead-free available

DESCRIPTION

The *ISSI* IS61LPD/VPD51236A and IS61LPD/VPD102418A are high-speed, low-power synchronous static RAMs designed to provide burstable, high-performance memory for communication and networking applications. The IS61LPD/VPD51236A is organized as 524,288 words by 36 bits, and the IS61LPD/VPD102418A is organized as 1,048,576 words by 18 bits. Fabricated with *ISSI*'s advanced CMOS technology, the device integrates a 2-bit burst counter, high-speed SRAM core, and high-drive capability outputs into a single monolithic circuit. All synchronous inputs pass through registers controlled by a positive-edge-triggered single clock input.

Write cycles are internally self-timed and are initiated by the rising edge of the clock input. Write cycles can be one to four bytes wide as controlled by the write control inputs.

Separate byte enables allow individual bytes to be written. The byte write operation is performed by using the byte write enable ($\overline{BWE}$) input combined with one or more individual byte write signals ($\overline{BWx}$). In addition, Global Write ($\overline{GW}$) is available for writing all bytes at one time, regardless of the byte write controls.

Bursts can be initiated with either $\overline{ADSP}$ (Address Status Processor) or $\overline{ADSC}$ (Address Status Cache Controller) input pins. Subsequent burst addresses can be generated internally and controlled by the $\overline{ADV}$ (burst address advance) input pin.

The mode pin is used to select the burst sequence order, Linear burst is achieved when this pin is tied LOW. Interleave burst is achieved when this pin is tied HIGH or left floating.

FAST ACCESS TIME

Symbol	Parameter	250	200	Units
t_{KQ}	Clock Access Time	2.6	3.1	ns
t_{KC}	Cycle Time	4	5	ns
	Frequency	250	200	MHz

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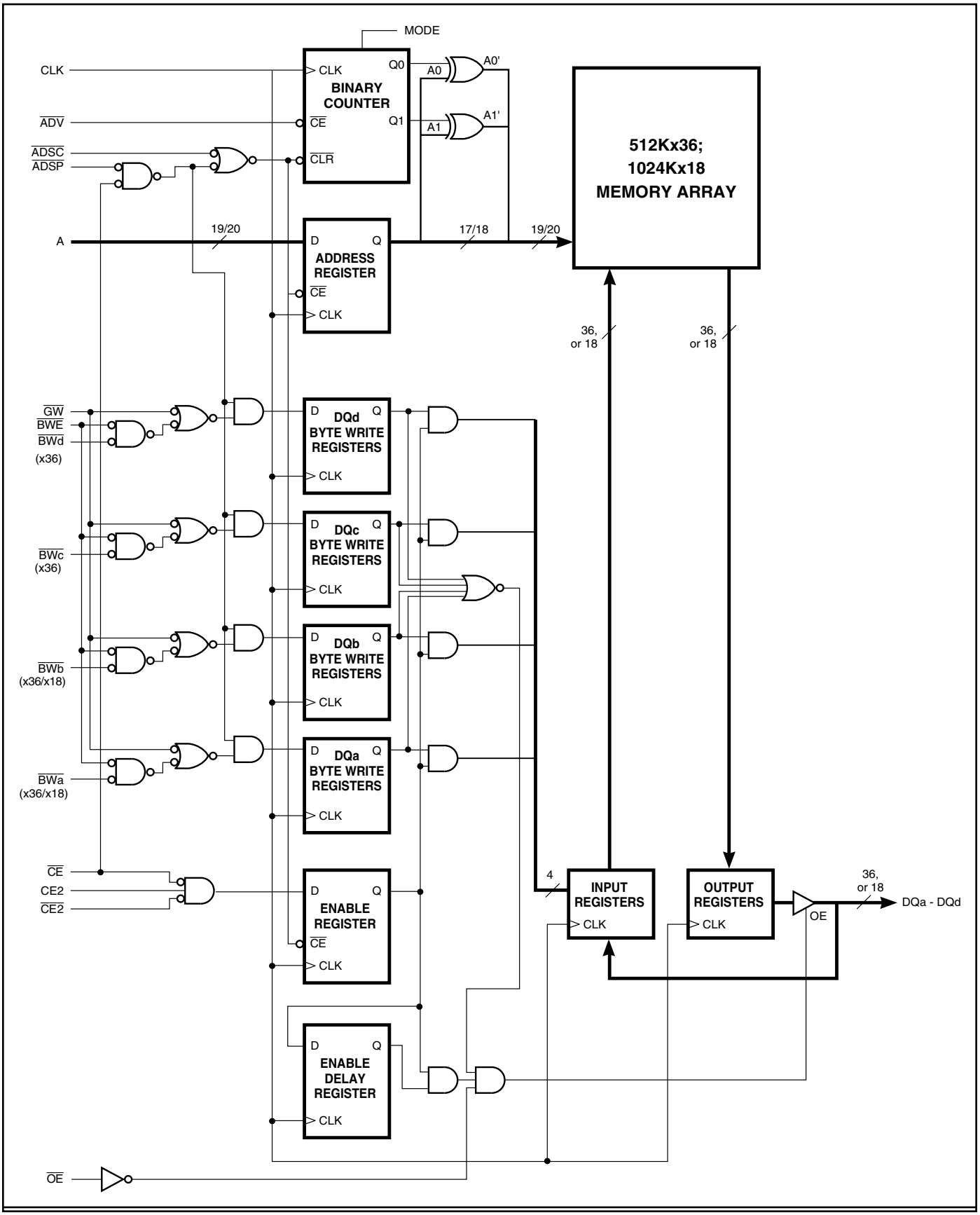
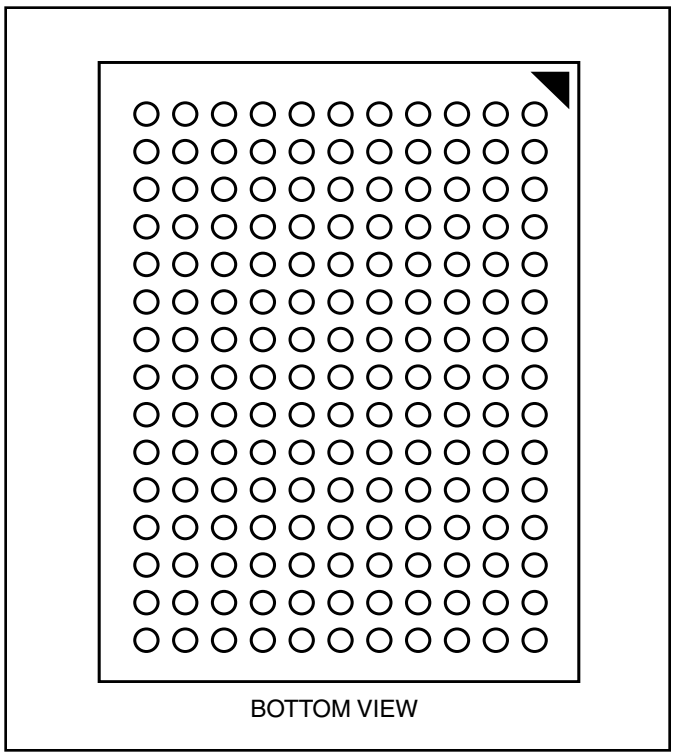
BLOCK DIAGRAM



165-PIN BGA

165-Ball, 13x15 mm BGA
1mm Ball Pitch, 11x15 Ball Array



BOTTOM VIEW

165 PBGA PACKAGE PIN CONFIGURATION

512K x 36 (TOP VIEW)

	1	2	3	4	5	6	7	8	9	10	11
A	NC	A	$\overline{CE}$	$\overline{BWc}$	$\overline{BWb}$	$\overline{CE2}$	$\overline{BWE}$	$\overline{ADSC}$	$\overline{ADV}$	A	NC
B	NC	A	CE2	$\overline{BWd}$	$\overline{BWa}$	CLK	$\overline{GW}$	$\overline{OE}$	$\overline{ADSP}$	A	NC
C	DQPc	NC	V_{DDQ}	Vss	Vss	Vss	Vss	Vss	V_{DDQ}	NC	DQPb
D	DQc	DQc	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQb	DQb
E	DQc	DQc	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQb	DQb
F	DQc	DQc	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQb	DQb
G	DQc	DQc	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQb	DQb
H	NC	Vss	NC	V_{DD}	Vss	Vss	Vss	V_{DD}	NC	NC	ZZ
J	DQd	DQd	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQa	DQa
K	DQd	DQd	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQa	DQa
L	DQd	DQd	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQa	DQa
M	DQd	DQd	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQa	DQa
N	DQPd	NC	V_{DDQ}	Vss	NC	A	Vss	Vss	V_{DDQ}	NC	DQPa
P	NC	NC	A	A	TDI	A1*	TDO	A	A	A	A
R	MODE	NC	A	A	TMS	A0*	TCK	A	A	A	A

Note: * A_0 and A_1 are the two least significant bits (LSB) of the address field and set the internal burst counter if burst is desired.

PIN DESCRIPTIONS

Symbol	Pin Name
A	Address Inputs
A0, A1	Synchronous Burst Address Inputs
$\overline{ADV}$	Synchronous Burst Address Advance
$\overline{ADSP}$	Address Status Processor
$\overline{ADSC}$	Address Status Controller
$\overline{GW}$	Global Write Enable
CLK	Synchronous Clock
$\overline{CE}$	Synchronous Chip Select
$\overline{CE2}$	Synchronous Chip Select
CE2	Synchronous Chip Select
$\overline{BW}$x (x=a,b,c,d)	Synchronous Byte Write Controls

Symbol	Pin Name
$\overline{BWE}$	Byte Write Enable
$\overline{OE}$	Output Enable
ZZ	Power Sleep Mode
MODE	Burst Sequence Selection
TCK, TDO TMS, TDI	JTAG Pins
NC	No Connect
DQa-DQb	Data Inputs/Outputs
DQPa-Pb	Data Inputs/Outputs
V_{DD}	Power Supply
V_{DDQ}	Output Power Supply
Vss	Ground

165 PBGA PACKAGE PIN CONFIGURATION

1M x 18 (TOP VIEW)

	1	2	3	4	5	6	7	8	9	10	11
A	NC	A	$\overline{CE}$	$\overline{BWb}$	NC	$\overline{CE2}$	$\overline{BWE}$	$\overline{ADSC}$	$\overline{ADV}$	A	A
B	NC	A	CE2	NC	$\overline{BWa}$	CLK	$\overline{GW}$	$\overline{OE}$	$\overline{ADSP}$	A	NC
C	NC	NC	V_{DDQ}	Vss	Vss	Vss	Vss	Vss	V_{DDQ}	NC	DQPa
D	NC	DQb	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	NC	DQa
E	NC	DQb	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	NC	DQa
F	NC	DQb	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	NC	DQa
G	NC	DQb	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	NC	DQa
H	NC	Vss	NC	V_{DD}	Vss	Vss	Vss	V_{DD}	NC	NC	ZZ
J	DQb	NC	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQa	NC
K	DQb	NC	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQa	NC
L	DQb	NC	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQa	NC
M	DQb	NC	V_{DDQ}	V_{DD}	Vss	Vss	Vss	V_{DD}	V_{DDQ}	DQa	NC
N	DQPb	NC	V_{DDQ}	Vss	NC	A	Vss	Vss	V_{DDQ}	NC	NC
P	NC	NC	A	A	TDI	A1*	TDO	A	A	A	A
R	MODE	NC	A	A	TMS	A0*	TCK	A	A	A	A

Note: * A_0 and A_1 are the two least significant bits (LSB) of the address field and set the internal burst counter if burst is desired.

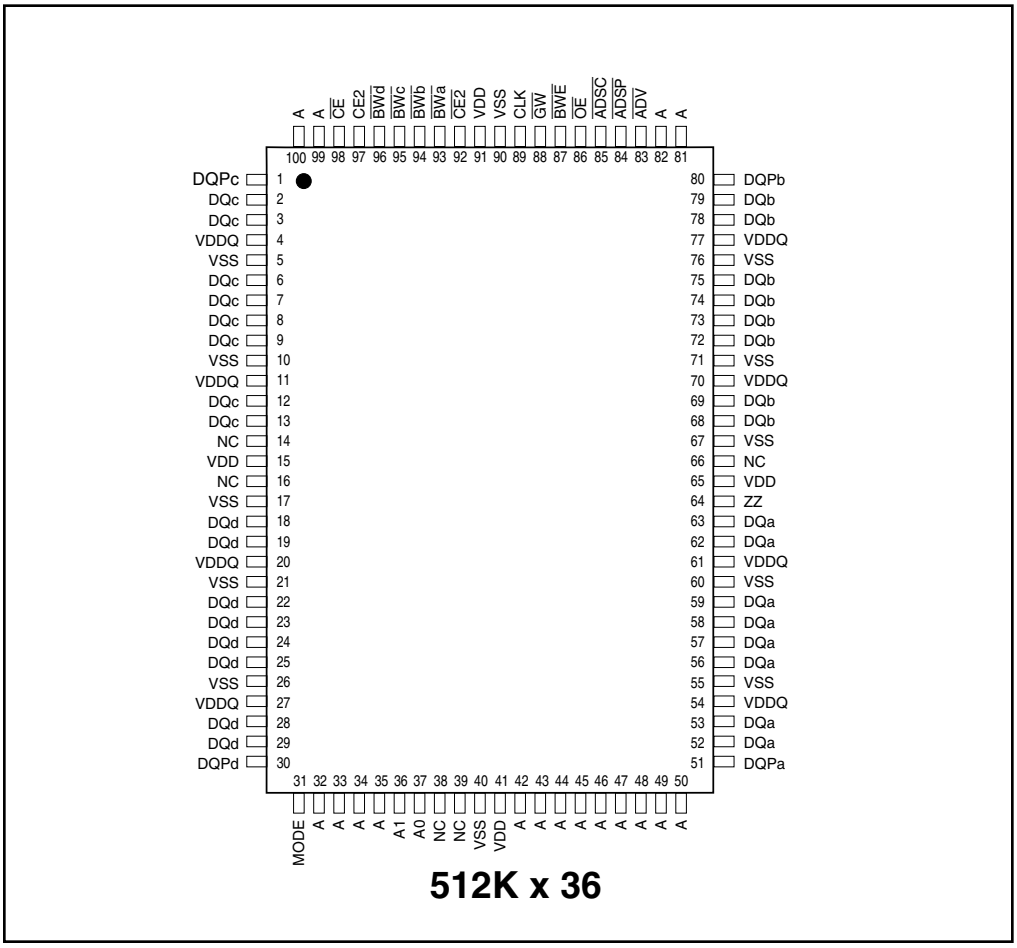
PIN DESCRIPTIONS

Symbol	Pin Name
A	Address Inputs
A0, A1	Synchronous Burst Address Inputs
$\overline{ADV}$	Synchronous Burst Address Advance
$\overline{ADSP}$	Address Status Processor
$\overline{ADSC}$	Address Status Controller
$\overline{GW}$	Global Write Enable
CLK	Synchronous Clock
$\overline{CE}$	Synchronous Chip Select
$\overline{CE2}$	Synchronous Chip Select
CE2	Synchronous Chip Select
$\overline{BW}$x (x=a,b)	Synchronous Byte Write Controls

Symbol	Pin Name
$\overline{BWE}$	Byte Write Enable
$\overline{OE}$	Output Enable
ZZ	Power Sleep Mode
MODE	Burst Sequence Selection
TCK, TDO TMS, TDI	JTAG Pins
NC	No Connect
DQa-DQb	Data Inputs/Outputs
DQPa-Pb	Data Inputs/Outputs
V_{DD}	Power Supply
V_{DDQ}	Output Power Supply
Vss	Ground

PIN CONFIGURATION

100-PIN TQFP



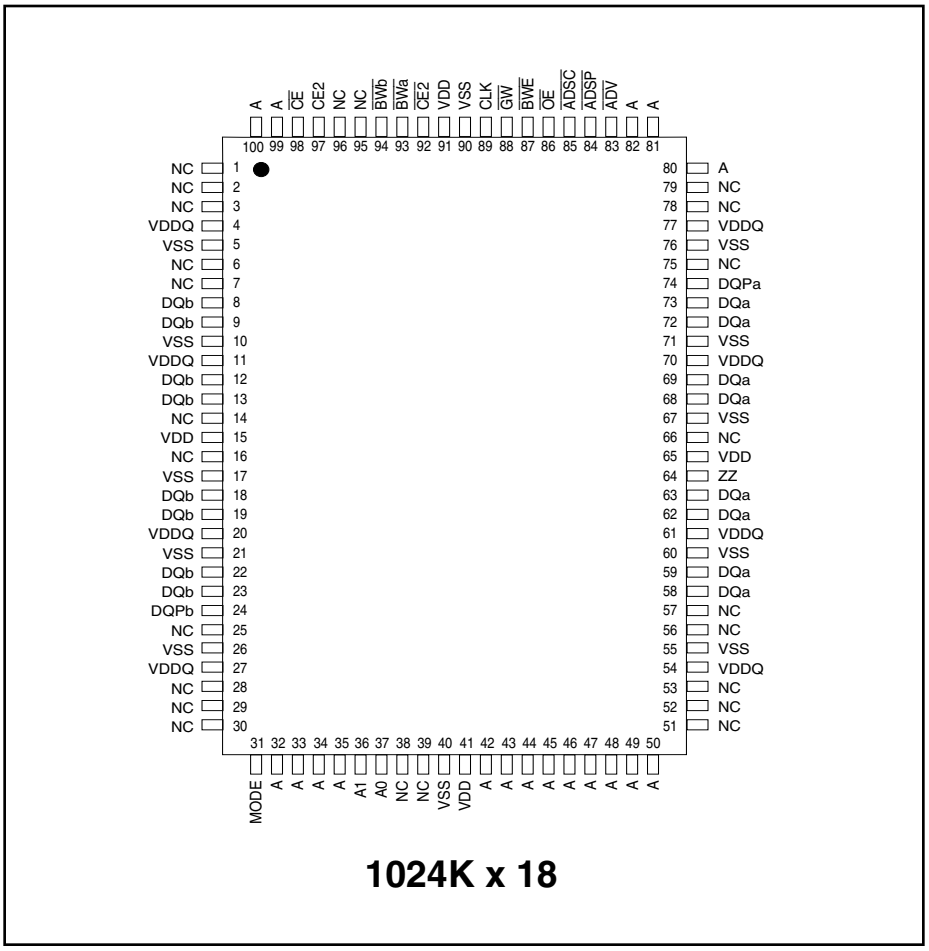
PIN DESCRIPTIONS

A0, A1	Synchronous Address Inputs. These pins must tied to the two LSBs of the address bus.
A	Synchronous Address Inputs
$\overline{ADSC}$	Synchronous Controller Address Status
$\overline{ADSP}$	Synchronous Processor Address Status
$\overline{ADV}$	Synchronous Burst Address Advance
$\overline{BWa}$-$\overline{BWd}$	Synchronous Byte Write Enable
$\overline{BWE}$	Synchronous Byte Write Enable
$\overline{CE}$, CE2	Synchronous Chip Enable
$\overline{CE2}$	Synchronous Chip Enable
CLK	Synchronous Clock

DQa-DQd	Synchronous Data Input/Output
DQPa-DQPd	Parity Data Input/Output
$\overline{GW}$	Synchronous Global Write Enable
MODE	Burst Sequence Mode Selection
$\overline{OE}$	Output Enable
V_{DD}	3.3V/2.5V Power Supply
V_{DDQ}	Isolated Output Buffer Supply: 3.3V/2.5V
Vss	Ground
ZZ	Snooze Enable

PIN CONFIGURATION

100-PIN TQFP



1024K x 18

PIN DESCRIPTIONS

A0, A1	Synchronous Address Inputs. These pins must tied to the two LSBs of the address bus.
A	Synchronous Address Inputs
$\overline{\text{ADSC}}$	Synchronous Controller Address Status
$\overline{\text{ADSP}}$	Synchronous Processor Address Status
$\overline{\text{ADV}}$	Synchronous Burst Address Advance
$\overline{\text{BWa}}$-$\overline{\text{BWb}}$	Synchronous Byte Write Enable
$\overline{\text{BWE}}$	Synchronous Byte Write Enable
$\overline{\text{CE}}$, CE2, $\overline{\text{CE2}}$	Synchronous Chip Enable
CLK	Synchronous Clock
DQa-DQb	Synchronous Data Input/Output

DQPa-DQPb	Parity Data I/O; DQPa is parity for DQa1-8; DQPb is parity for DQb1-8
$\overline{\text{GW}}$	Synchronous Global Write Enable
MODE	Burst Sequence Mode Selection
$\overline{\text{OE}}$	Output Enable
V_{DD}	3.3V/2.5V Power Supply
V_{DDQ}	Isolated Output Buffer Supply: 3.3V/2.5V
Vss	Ground
ZZ	Snooze Enable

TRUTH TABLE[1-8] (3CE option)

OPERATION	ADDRESS	$\overline{CE}$	CE2	$\overline{CE2}$	ZZ	$\overline{ADSP}$	$\overline{ADSC}$	$\overline{ADV}$	WRITE	$\overline{OE}$	CLK	DQ
Deselect Cycle, Power-Down	None	H	X	X	L	X	L	X	X	X	L-H	High-Z
Deselect Cycle, Power-Down	None	L	X	L	L	L	X	X	X	X	L-H	High-Z
Deselect Cycle, Power-Down	None	L	H	X	L	L	X	X	X	X	L-H	High-Z
Deselect Cycle, Power-Down	None	L	X	L	L	H	L	X	X	X	L-H	High-Z
Deselect Cycle, Power-Down	None	L	H	X	L	H	L	X	X	X	L-H	High-Z
Snooze Mode, Power-Down	None	X	X	X	H	X	X	X	X	X	X	High-Z
Read Cycle, Begin Burst	External	L	L	H	L	L	X	X	X	L	L-H	Q
Read Cycle, Begin Burst	External	L	L	H	L	L	X	X	X	H	L-H	High-Z
Write Cycle, Begin Burst	External	L	L	H	L	H	L	X	L	X	L-H	D
Read Cycle, Begin Burst	External	L	L	H	L	H	L	X	H	L	L-H	Q
Read Cycle, Begin Burst	External	L	L	H	L	H	L	X	H	H	L-H	High-Z
Read Cycle, Continue Burst	Next	X	X	X	L	H	H	L	H	L	L-H	Q
Read Cycle, Continue Burst	Next	X	X	X	L	H	H	L	H	H	L-H	High-Z
Read Cycle, Continue Burst	Next	H	X	X	L	X	H	L	H	L	L-H	Q
Read Cycle, Continue Burst	Next	H	X	X	L	X	H	L	H	H	L-H	High-Z
Write Cycle, Continue Burst	Next	X	X	X	L	H	H	L	L	X	L-H	D
Write Cycle, Continue Burst	Next	H	X	X	L	X	H	L	L	X	L-H	D
Read Cycle, Suspend Burst	Current	X	X	X	L	H	H	H	H	L	L-H	Q
Read Cycle, Suspend Burst	Current	X	X	X	L	H	H	H	H	H	L-H	High-Z
Read Cycle, Suspend Burst	Current	H	X	X	L	X	H	H	H	L	L-H	Q
Read Cycle, Suspend Burst	Current	H	X	X	L	X	H	H	H	H	L-H	High-Z
Write Cycle, Suspend Burst	Current	X	X	X	L	H	H	H	L	X	L-H	D
Write Cycle, Suspend Burst	Current	H	X	X	L	X	H	H	L	X	L-H	D

NOTE:

1. X means "Don't Care." H means logic HIGH. L means logic LOW.
2. For $\overline{WRITE}$, L means one or more byte write enable signals ($\overline{BWa}$, $\overline{BWb}$, $\overline{BWc}$ or $\overline{BWd}$) and $\overline{BWE}$ are LOW or $\overline{GW}$ is LOW. $\overline{WRITE}$ = H for all $\overline{BWx}$, $\overline{BWE}$, $\overline{GW}$ HIGH.
3. $\overline{BWa}$ enables WRITEs to DQa's and DQPa. $\overline{BWb}$ enables WRITEs to DQb's and DQPb. $\overline{BWc}$ enables WRITEs to DQc's and DQPc. $\overline{BWd}$ enables WRITEs to DQd's and DQPd. DQPa and DQPb are only available on the x18 and x36 versions. DQPc and DQPd are only available on the x36 version.
4. All inputs except $\overline{OE}$ and ZZ must meet setup and hold times around the rising edge (LOW to HIGH) of CLK.
5. Wait states are inserted by suspending burst.
6. For a WRITE operation following a READ operation, $\overline{OE}$ must be HIGH before the input data setup time and held HIGH during the input data hold time.
7. This device contains circuitry that will ensure the outputs will be in High-Z during power-up.
8. $\overline{ADSP}$ LOW always initiates an internal READ at the L-H edge of CLK. A WRITE is performed by setting one or more byte write enable signals and $\overline{BWE}$ LOW or $\overline{GW}$ LOW for the subsequent L-H edge of CLK. See WRITE timing diagram for clarification.

TRUTH TABLE[1-8] (1CE option)

NEXT CYCLE	ADDRESS	$\overline{CE}$	$\overline{ADSP}$	$\overline{ADSC}$	$\overline{ADV}$	$\overline{WRITE}$	$\overline{OE}$	DQ
Deselected	None	H	X	L	X	X	X	High-Z
Read, Begin Burst	External	L	L	X	X	X	L	Q
Read, Begin Burst	External	L	L	X	X	X	H	High-Z
Write, Begin Burst	External	L	H	L	X	L	X	D
Read, Begin Burst	External	L	H	L	X	H	L	Q
Read, Begin Burst	External	L	H	L	X	H	H	High-Z
Read, Continue Burst	Next	X	H	H	L	H	L	Q
Read, Continue Burst	Next	X	H	H	L	H	H	High-Z
Read, Continue Burst	Next	H	X	H	L	H	L	Q
Read, Continue Burst	Next	H	X	H	L	H	H	High-Z
Write, Continue Burst	Next	X	H	H	L	L	X	D
Write, Continue Burst	Next	H	X	H	L	L	X	D
Read, Suspend Burst	Current	X	H	H	H	H	L	Q
Read, Suspend Burst	Current	X	H	H	H	H	H	High-Z
Read, Suspend Burst	Current	H	X	H	H	H	L	Q
Read, Suspend Burst	Current	H	X	H	H	H	H	High-Z
Write, Suspend Burst	Current	X	H	H	H	L	X	D
Write, Suspend Burst	Current	H	X	H	H	L	X	D

NOTE:

1. X means "Don't Care." H means logic HIGH. L means logic LOW.
2. For $\overline{WRITE}$, L means one or more byte write enable signals ($\overline{BWa}$, $\overline{BWb}$, $\overline{BWc}$ or $\overline{BWd}$) and $\overline{BWE}$ are LOW or $\overline{GW}$ is LOW. $\overline{WRITE}$ = H for all $\overline{BWx}$, $\overline{BWE}$, $\overline{GW}$ HIGH.
3. $\overline{BWa}$ enables WRITEs to DQa's and DQPa. $\overline{BWb}$ enables WRITEs to DQb's and DQPb. $\overline{BWc}$ enables WRITEs to DQc's and DQPc. $\overline{BWd}$ enables WRITEs to DQd's and DQPd. DQPa and DQPb are only available on the x18 and x36 versions. DQPc and DQPd are only available on the x36 version.
4. All inputs except $\overline{OE}$ and ZZ must meet setup and hold times around the rising edge (LOW to HIGH) of CLK.
5. Wait states are inserted by suspending burst.
6. For a WRITE operation following a READ operation, $\overline{OE}$ must be HIGH before the input data setup time and held HIGH during the input data hold time.
7. This device contains circuitry that will ensure the outputs will be in High-Z during power-up.
8. $\overline{ADSP}$ LOW always initiates an internal READ at the L-H edge of CLK. A WRITE is performed by setting one or more byte write enable signals and $\overline{BWE}$ LOW or $\overline{GW}$ LOW for the subsequent L-H edge of CLK. See WRITE timing diagram for clarification.

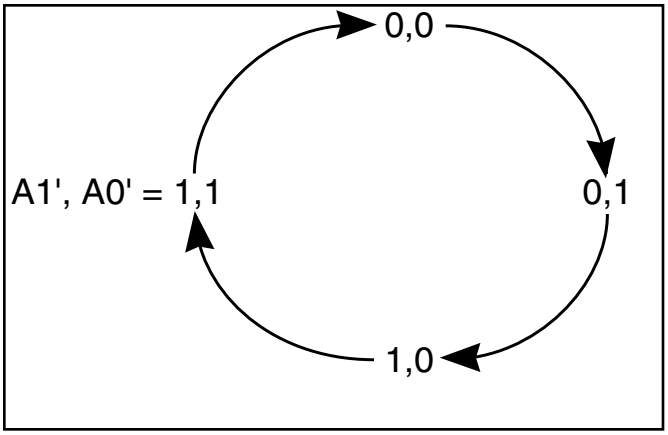
PARTIAL TRUTH TABLE

Function	$\overline{GW}$	$\overline{BWE}$	$\overline{BWa}$	$\overline{BWb}$	$\overline{BWc}$	$\overline{BWd}$
Read	H	H	X	X	X	X
Read	H	L	H	H	H	H
Write Byte 1	H	L	L	H	H	H
Write All Bytes	H	L	L	L	L	L
Write All Bytes	L	X	X	X	X	X

INTERLEAVED BURST ADDRESS TABLE (MODE = V_{DD} or No Connect)

External Address A1 A0	1st Burst Address A1 A0	2nd Burst Address A1 A0	3rd Burst Address A1 A0
00	01	10	11
01	00	11	10
10	11	00	01
11	10	01	00

LINEAR BURST ADDRESS TABLE (MODE = VSS)



ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Parameter	Value	Unit
T_{STG}	Storage Temperature	–55 to +150	°C
P_D	Power Dissipation	1.6	W
I_{OUT}	Output Current (per I/O)	100	mA
V_{IN}, V_{OUT}	Voltage Relative to Vss for I/O Pins	–0.5 to V_{DDQ} + 0.5	V
V_{IN}	Voltage Relative to Vss for for Address and Control Inputs	–0.5 to V_{DD} + 0.5	V
V_{DD}	Voltage on V_{DD} Supply Relative to Vss	–0.5 to 4.6	V

Notes:

1. Stress 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 above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
2. This device contains circuity to protect the inputs against damage due to high static voltages or electric fields; however, precautions may be taken to avoid application of any voltage higher than maximum rated voltages to this high-impedance circuit.
3. This device contains circuitry that will ensure the output devices are in High-Z at power up.

OPERATING RANGE (IS61LPDXXXXX)

Range	Ambient Temperature	V_{DD}	V_{DDQ}
Commercial	0°C to +70°C	3.3V ± 5%	3.3 / 2.5V ± 5%
Industrial	–40°C to +85°C	3.3V ± 5%	3.3 / 2.5V ± 5%

OPERATING RANGE (IS61VPDXXXXX)

Range	Ambient Temperature	V_{DD}	V_{DDQ}
Commercial	0°C to +70°C	2.5V ± 5%	2.5V ± 5%
Industrial	–40°C to +85°C	2.5V ± 5%	2.5V ± 5%

DC ELECTRICAL CHARACTERISTICS (Over Operating Range)

			3.3V		2.5V		
Symbol	Parameter	Test Conditions	Min.	Max.	Min.	Max.	Unit
V_{OH}	Output HIGH Voltage	I_{OH} = –4.0 mA (3.3V) I_{OH} = –1.0 mA (2.5V)	2.4	—	2.0	—	V
V_{OL}	Output LOW Voltage	I_{OL} = 8.0 mA (3.3V) I_{OL} = 1.0 mA (2.5V)	—	0.4	—	0.4	V
V_{IH}	Input HIGH Voltage		2.0	V_{DD} + 0.3	1.7	V_{DD} + 0.3	V
V_{IL}	Input LOW Voltage		-0.3	0.8	-0.3	0.7	V
I_{LI}	Input Leakage Current	$V_{SS} \le V_{IN} \le V_{DD}$(1)	-5	5	-5	5	µA
I_{LO}	Output Leakage Current	$V_{SS} \le V_{OUT} \le V_{DDQ}$, $\overline{OE}$ = V_{IH}	-5	5	-5	5	µA

POWER SUPPLY CHARACTERISTICS(1) (Over Operating Range)

				-250 MAX		-200 MAX		
Symbol	Parameter	Test Conditions	Temp. range	x18	x36	x18	x36	Unit
I_{CC}	AC Operating Supply Current	Device Selected, $\overline{OE}$ = V_{IH}, ZZ ≤ V_{IL}, All Inputs ≤ 0.2V or ≥ V_{DD} – 0.2V, Cycle Time ≥ t_{KC} min.	Com. Ind.	450 500	450 500	425 475	425 475	mA
I_{SB}	Standby Current TTL Input	Device Deselected, V_{DD} = Max., All Inputs ≤ V_{IL} or ≥ V_{IH}, ZZ ≤ V_{IL}, f = Max.	Com. Ind.	150 150	150 150	150 150	150 150	mA
I_{SBI}	Standby Current CMOS Input	Device Deselected, V_{DD} = Max., V_{IN} ≤ V_{SS} + 0.2V or ≥V_{DD} – 0.2V f = 0	Com. Ind.	110 125	110 125	110 125	110 125	mA
I_{SB2}	Sleep Mode	ZZ>V_{IH}	Com. Ind.	60 75	60 75	60 75	60 75	mA

Note:

1. MODE pin has an internal pullup and should be tied to V_{DD} or V_{SS}. It exhibits ±100µA maximum leakage current when tied to ≤ V_{SS} + 0.2V or ≥ V_{DD} – 0.2V.

CAPACITANCE[1,2]

Symbol	Parameter	Conditions	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 0V	6	pF
C_{OUT}	Input/Output Capacitance	V_{OUT} = 0V	8	pF

Notes:
1. Tested initially and after any design or process changes that may affect these parameters.
2. Test conditions: T_A = 25°C, f = 1 MHz, V_{DD} = 3.3V.

3.3V I/O AC TEST CONDITIONS

Parameter	Unit
Input Pulse Level	0V to 3.0V
Input Rise and Fall Times	1.5 ns
Input and Output Timing and Reference Level	1.5V
Output Load	See Figures 1 and 2

AC TEST LOADS

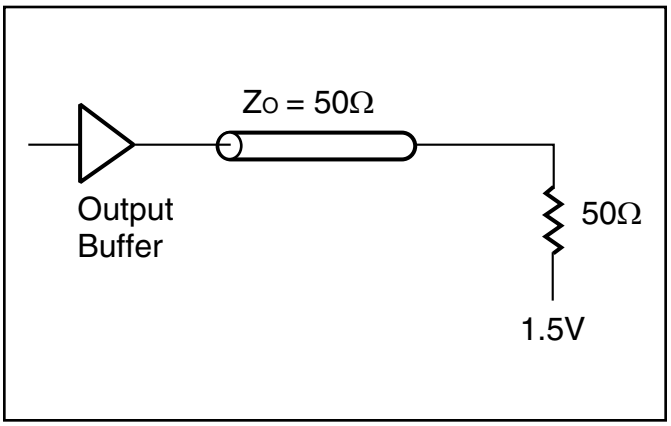


Figure 1

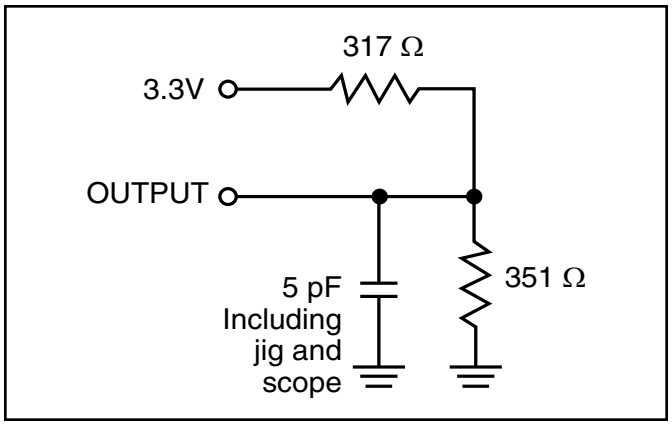


Figure 2

2.5V I/O AC TEST CONDITIONS

Parameter	Unit
Input Pulse Level	0V to 2.5V
Input Rise and Fall Times	1.5 ns
Input and Output Timing and Reference Level	1.25V
Output Load	See Figures 3 and 4

2.5 I/O OUTPUT LOAD EQUIVALENT

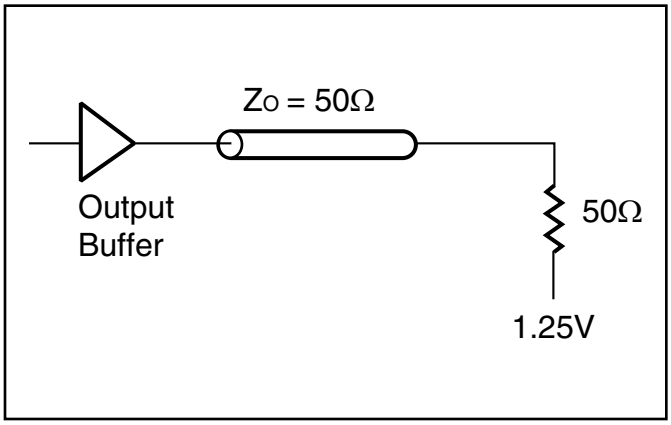


Figure 3

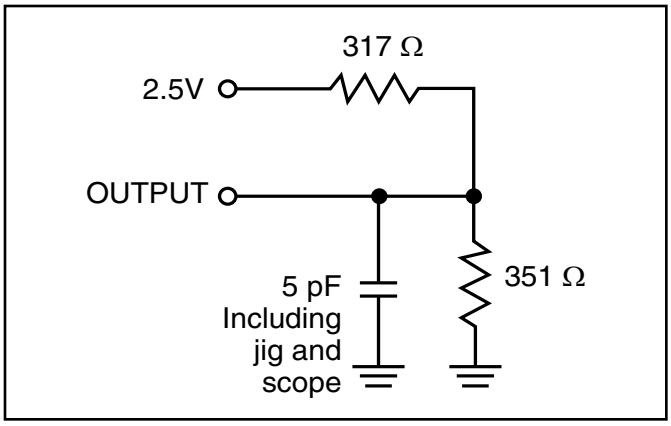


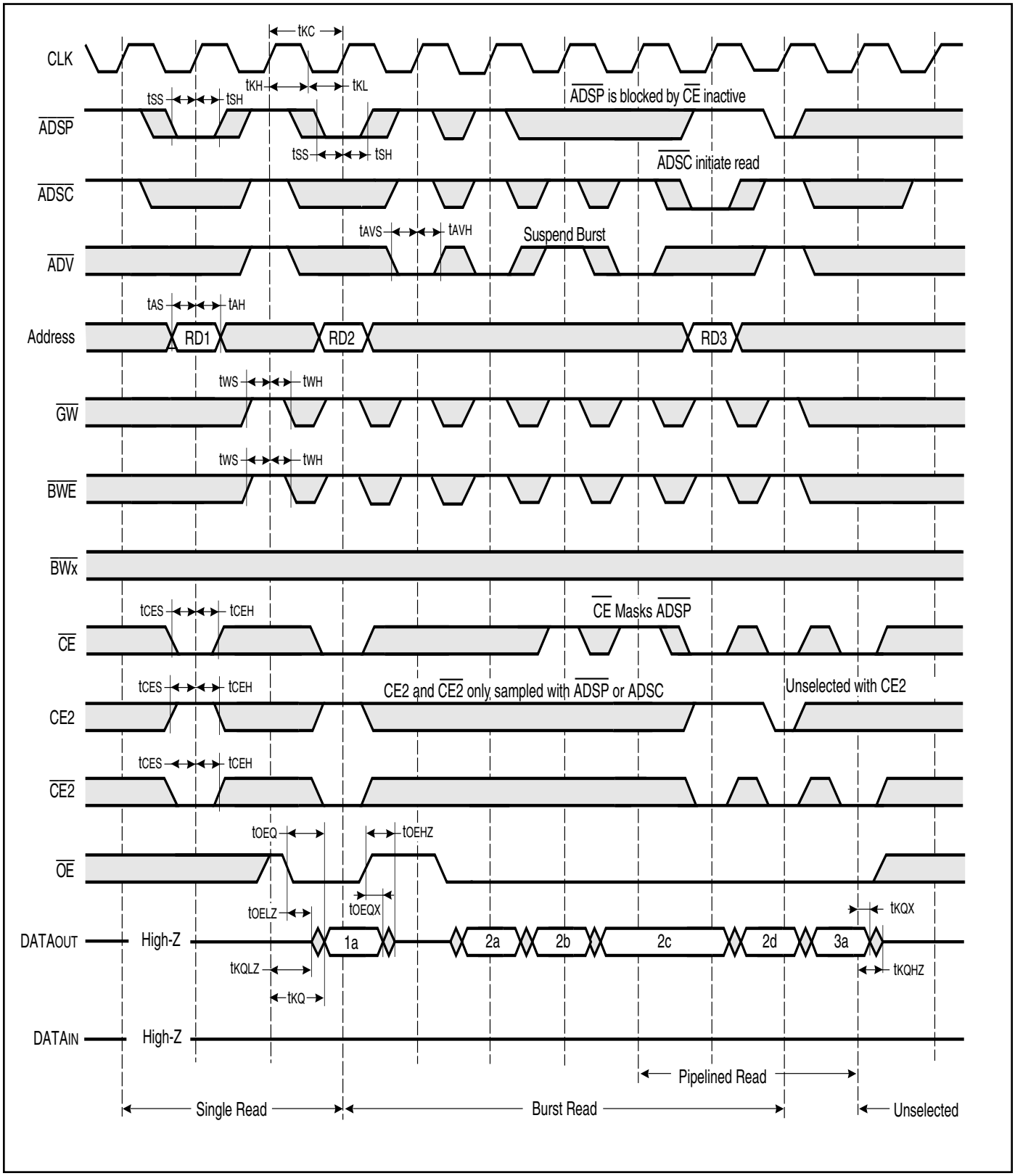
Figure 4

READ/WRITE CYCLE SWITCHING CHARACTERISTICS (Over Operating Range)

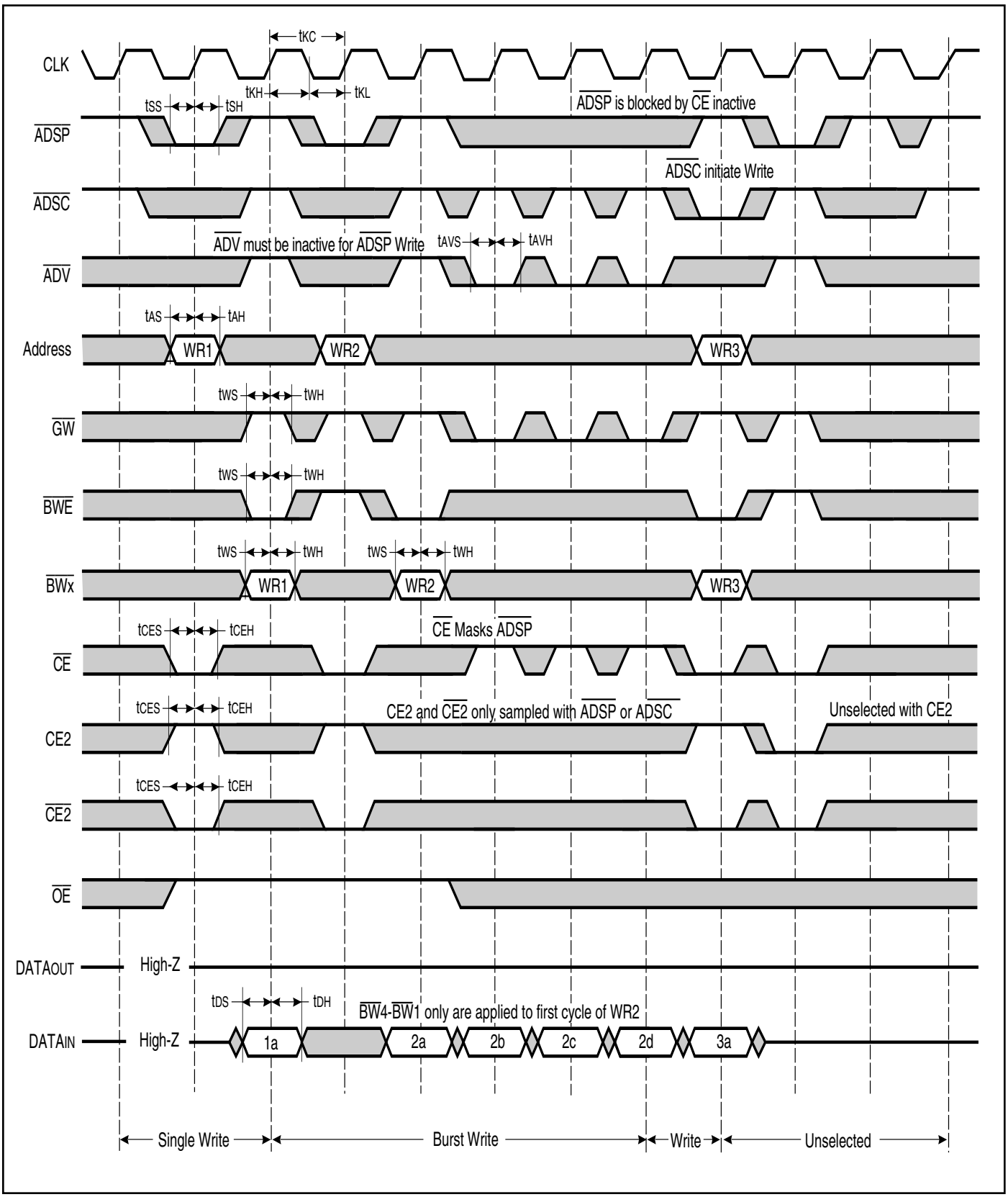
		-250		-200		
Symbol	**Parameter**	**Min.**	**Max.**	**Min.**	**Max.**	**Unit**
f_{MAX}	Clock Frequency	—	250	—	200	MHz
t_{KC}	Cycle Time	4.0	—	5	—	ns
t_{KH}	Clock High Time	1.7	—	2	—	ns
t_{KL}	Clock Low Time	1.7	—	2	—	ns
t_{KQ}	Clock Access Time	—	2.6	—	3.1	ns
t_{KQX}[2]	Clock High to Output Invalid	0.8	—	1.5	—	ns
t_{KQLZ}[2,3]	Clock High to Output Low-Z	0.8	—	1	—	ns
t_{KQHZ}[2,3]	Clock High to Output High-Z	—	2.6	—	3.0	ns
t_{OEQ}	Output Enable to Output Valid	—	2.6	—	3.1	ns
t_{OELZ}[2,3]	Output Enable to Output Low-Z	0	—	0	—	ns
t_{OEHZ}[2,3]	Output Disable to Output High-Z	—	2.6	—	3.0	ns
t_{AS}	Address Setup Time	1.2	—	1.4	—	ns
t_{WS}	Read/Write Setup Time	1.2	—	1.4	—	ns
t_{CES}	Chip Enable Setup Time	1.2	—	1.4	—	ns
t_{AVS}	Address Advance Setup Time	1.2	—	1.4	—	ns
t_{DS}	Data Setup Time	1.2	—	1.4	—	ns
t_{AH}	Address Hold Time	0.3	—	0.4	—	ns
t_{WH}	Write Hold Time	0.3	—	0.4	—	ns
t_{CEH}	Chip Enable Hold Time	0.3	—	0.4	—	ns
t_{AVH}	Address Advance Hold Time	0.3	—	0.4	—	ns
t_{DH}	Data Hold Time	0.3	—	0.4	—	ns
t_{PDS}	ZZ High to Power Down	—	2	—	2	cyc
t_{PUS}	ZZ Low to Power Down	—	2	—	2	cyc

Note:
1. Configuration signal MODE is static and must not change during normal operation.
2. Guaranteed but not 100% tested. This parameter is periodically sampled.
3. Tested with load in Figure 2.

READ/WRITE CYCLE TIMING



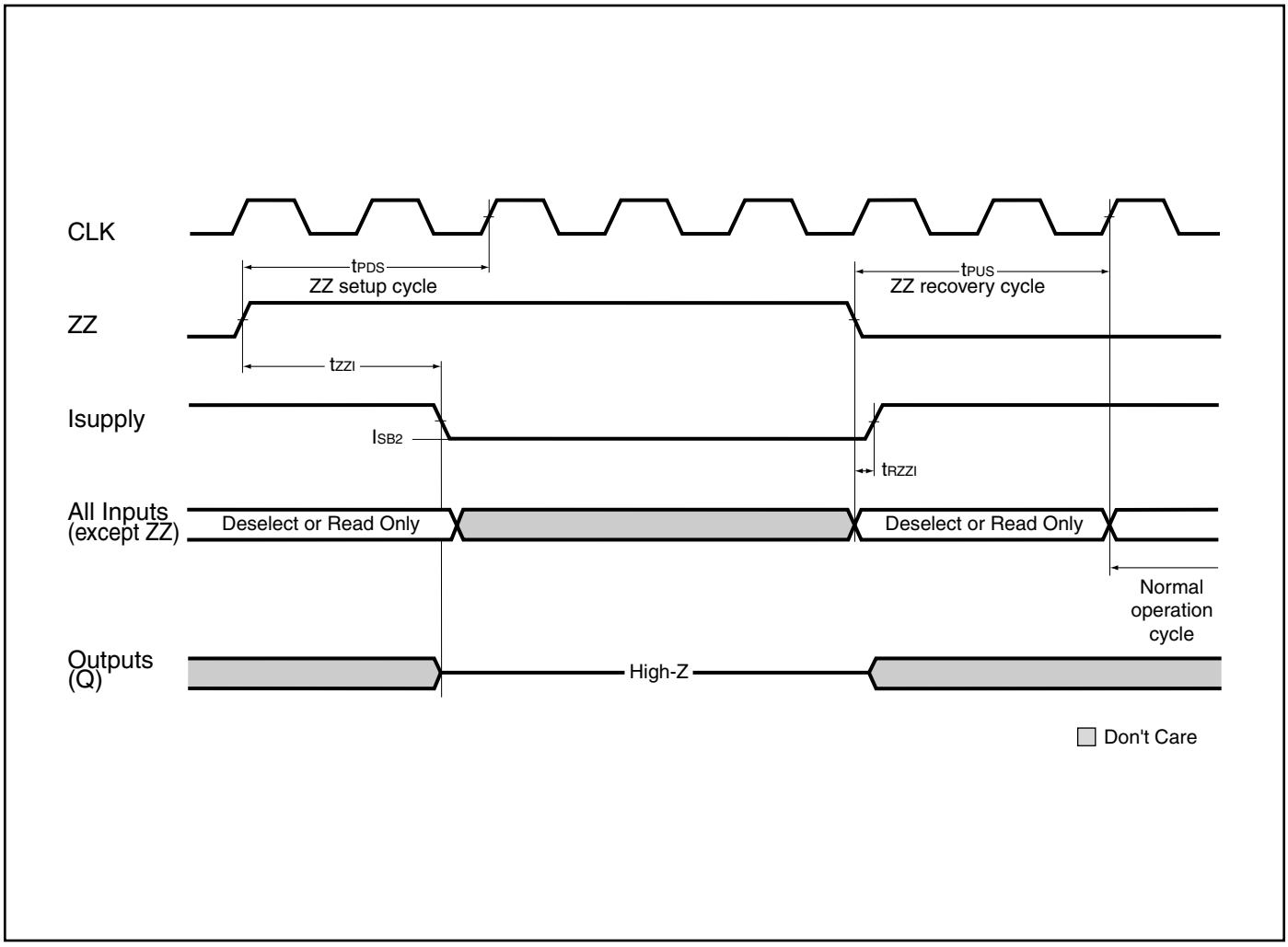
WRITE CYCLE TIMING



SNOOZE MODE ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Conditions	Min.	Max.	Unit
I_{SB2}	Current during SNOOZE MODE	ZZ ≥ Vih	—	60	mA
t_{PDS}	ZZ active to input ignored		—	2	cycle
t_{PUS}	ZZ inactive to input sampled		2	—	cycle
t_{ZZI}	ZZ active to SNOOZE current		—	2	cycle
t_{RZZI}	ZZ inactive to exit SNOOZE current		0	—	ns

SNOOZE MODE TIMING



IEEE 1149.1 SERIAL BOUNDARY SCAN (JTAG)

The IS61LPD/VPD51236A and IS61LPD/VPD102418A have a serial boundary scan Test Access Port (TAP) in the PBGA package only. (The TQFP package not available.) This port operates in accordance with IEEE Standard 1149.1-1900, but does not include all functions required for full 1149.1 compliance. These functions from the IEEE specification are excluded because they place added delay in the critical speed path of the SRAM. The TAP controller operates in a manner that does not conflict with the performance of other devices using 1149.1 fully compliant TAPs. The TAP operates using JEDEC standard 2.5V I/O logic levels.

DISABLING THE JTAG FEATURE

The SRAM can operate without using the JTAG feature. To disable the TAP controller, TCK must be tied LOW (Vss) to prevent clocking of the device. TDI and TMS are internally pulled up and may be disconnected. They may alternately be connected to V_{DD} through a pull-up resistor. TDO should be left disconnected. On power-up, the device will start in a reset state which will not interfere with the device operation.

TEST ACCESS PORT (TAP) - TEST CLOCK

The test clock is only used with the TAP controller. All inputs are captured on the rising edge of TCK and outputs are driven from the falling edge of TCK.

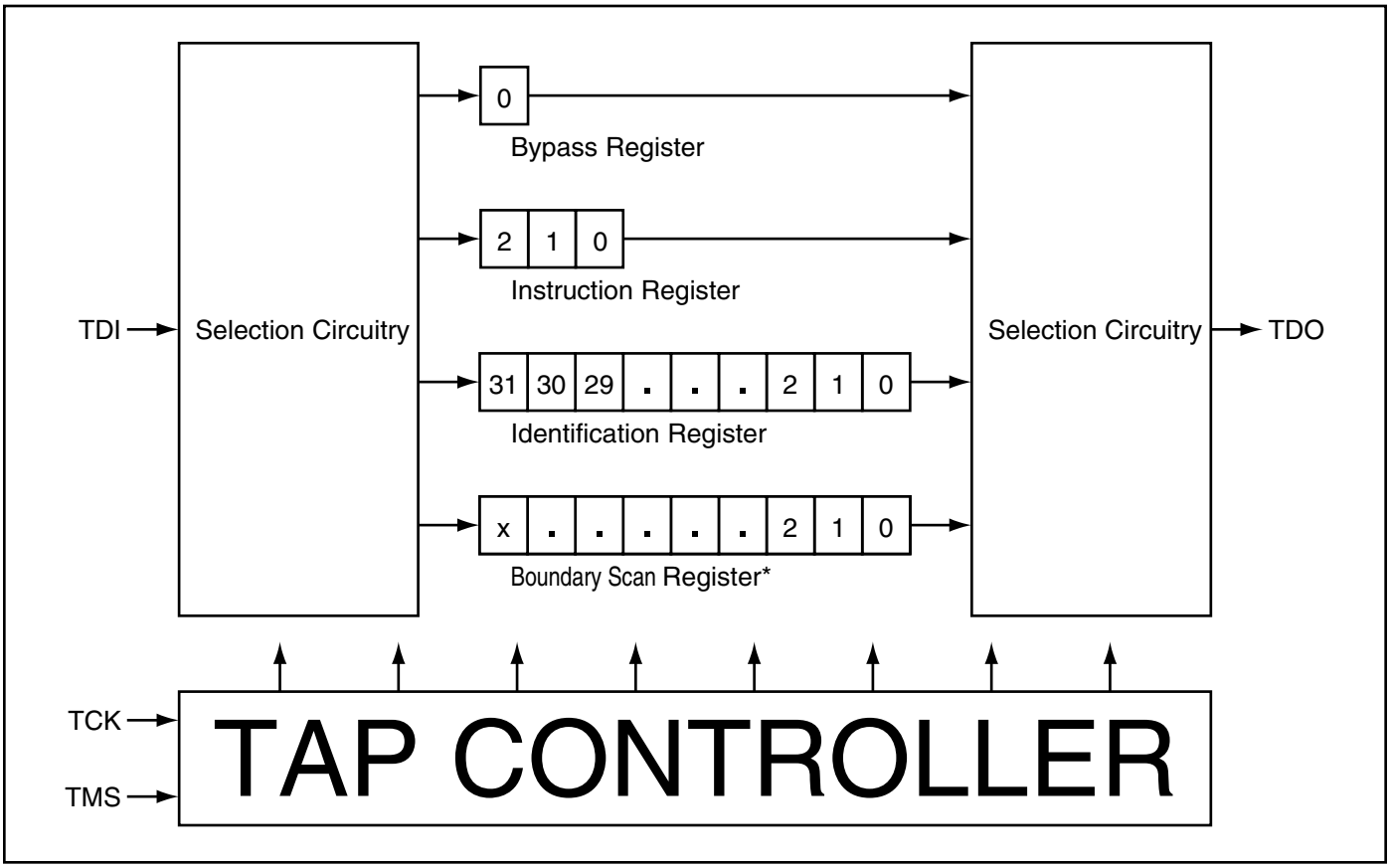
TEST MODE SELECT (TMS)

The TMS input is used to send commands to the TAP controller and is sampled on the rising edge of TCK. This pin may be left disconnected if the TAP is not used. The pin is internally pulled up, resulting in a logic HIGH level.

TEST DATA-IN (TDI)

The TDI pin is used to serially input information to the registers and can be connected to the input of any register. The register between TDI and TDO is chosen by the instruction loaded into the TAP instruction register. For information on instruction register loading, see the TAP Controller State Diagram. TDI is internally pulled up and can be disconnected if the TAP is unused in an application. TDI is connected to the Most Significant Bit (MSB) on any register.

TAP CONTROLLER BLOCK DIAGRAM



TEST DATA OUT (TDO)

The TDO output pin is used to serially clock data-out from the registers. The output is active depending on the current state of the TAP state machine (see TAP Controller State Diagram). The output changes on the falling edge of TCK and TDO is connected to the Least Significant Bit (LSB) of any register.

PERFORMING A TAP RESET

A Reset is performed by forcing TMS HIGH (V_{DD}) for five rising edges of TCK. RESET may be performed while the SRAM is operating and does not affect its operation. At power-up, the TAP is internally reset to ensure that TDO comes up in a high-Z state.

TAP REGISTERS

Registers are connected between the TDI and TDO pins and allow data to be scanned into and out of the SRAM test circuitry. Only one register can be selected at a time through the instruction registers. Data is serially loaded into the TDI pin on the rising edge of TCK and output on the TDO pin on the falling edge of TCK.

Instruction Register

Three-bit instructions can be serially loaded into the instruction register. This register is loaded when it is placed between the TDI and TDO pins. (See TAP Controller Block Diagram) At power-up, the instruction register is loaded with the IDCODE instruction. It is also loaded with the IDCODE instruction if the controller is placed in a reset state as previously described.

When the TAP controller is in the CaptureIR state, the two least significant bits are loaded with a binary "01" pattern to allow for fault isolation of the board level serial test path.

Bypass Register

To save time when serially shifting data through registers, it is sometimes advantageous to skip certain states. The bypass register is a single-bit register that can be placed between TDI and TDO pins. This allows data to be shifted through the SRAM with minimal delay. The bypass register is set LOW (Vss) when the BYPASS instruction is executed.

Boundary Scan Register

The boundary scan register is connected to all input and output pins on the SRAM. Several no connect (NC) pins are also included in the scan register to reserve pins for higher density devices. The x36 configuration has a 75-bit-long register and the x18 configuration also has a 75-bit-long register. The boundary scan register is loaded with the contents of the RAM Input and Output ring when the TAP controller is in the Capture-DR state and then placed between the TDI and TDO pins when the controller is moved to the Shift-DR state. The EXTEST, SAMPLE/PRELOAD and SAMPLE-Z instructions can be used to capture the contents of the Input and Output ring.

The Boundary Scan Order tables show the order in which the bits are connected. Each bit corresponds to one of the bumps on the SRAM package. The MSB of the register is connected to TDI, and the LSB is connected to TDO.

Scan Register Sizes

Register Name	Bit Size (x18)	Bit Size (x36)
Instruction	3	3
Bypass	1	1
ID	32	32
Boundary Scan	75	75

Identification (ID) Register

The ID register is loaded with a vendor-specific, 32-bit code during the Capture-DR state when the IDCODE command is loaded to the instruction register. The IDCODE is hardwired into the SRAM and can be shifted out when the TAP controller is in the Shift-DR state. The ID register has vendor code and other information described in the Identification Register Definitions table.

IDENTIFICATION REGISTER DEFINITIONS

Instruction Field	Description	512K x 36	1M x 18
Revision Number (31:28)	Reserved for version number.	xxxx	xxxx
Device Depth (27:23)	Defines depth of SRAM. 512K or 1M	00111	01000
Device Width (22:18)	Defines with of the SRAM. x36 or x18	00100	00011
ISSI Device ID (17:12)	Reserved for future use.	xxxxx	xxxxx
ISSI JEDEC ID (11:1)	Allows unique identification of SRAM vendor.	00011010101	00011010101
ID Register Presence (0)	Indicate the presence of an ID register.	1	1

TAP INSTRUCTION SET

Eight instructions are possible with the three-bit instruction register and all combinations are listed in the Instruction Code table. Three instructions are listed as RESERVED and should not be used and the other five instructions are described below. The TAP controller used in this SRAM is not fully compliant with the 1149.1 convention because some mandatory instructions are not fully implemented. The TAP controller cannot be used to load address, data or control signals and cannot preload the Input or Output buffers. The SRAM does not implement the 1149.1 commands EXTEST or INTEST or the PRELOAD portion of SAMPLE/PRELOAD; instead it performs a capture of the Inputs and Output ring when these instructions are executed. Instructions are loaded into the TAP controller during the Shift-IR state when the instruction register is placed between TDI and TDO. During this state, instructions are shifted from the instruction register through the TDI and TDO pins. To execute an instruction once it is shifted in, the TAP controller must be moved into the Update-IR state.

EXTEST

EXTEST is a mandatory 1149.1 instruction which is to be executed whenever the instruction register is loaded with all 0s. Because EXTEST is not implemented in the TAP controller, this device is not 1149.1 standard compliant. The TAP controller recognizes an all-0 instruction. When an EXTEST instruction is loaded into the instruction register, the SRAM responds as if a SAMPLE/PRELOAD instruction has been loaded. There is a difference between the instructions, unlike the SAMPLE/PRELOAD instruction, EXTEST places the SRAM outputs in a High-Z state.

IDCODE

The IDCODE instruction causes a vendor-specific, 32-bit code to be loaded into the instruction register. It also places the instruction register between the TDI and TDO pins and allows the IDCODE to be shifted out of the device when the TAP controller enters the Shift-DR state. The IDCODE instruction is loaded into the instruction register upon power-up or whenever the TAP controller is given a test logic reset state.

SAMPLE-Z

The SAMPLE-Z instruction causes the boundary scan register to be connected between the TDI and TDO pins when the TAP controller is in a Shift-DR state. It also places all SRAM outputs into a High-Z state.

SAMPLE/PRELOAD

SAMPLE/PRELOAD is a 1149.1 mandatory instruction. The PRELOAD portion of this instruction is not implemented, so the TAP controller is not fully 1149.1 compliant. When the SAMPLE/PRELOAD instruction is loaded to the instruction register and the TAP controller is in the Capture-DR state, a snapshot of data on the inputs and output pins is captured in the boundary scan register.

It is important to realize that the TAP controller clock operates at a frequency up to 10 MHz, while the SRAM clock runs more than an order of magnitude faster. Because of the clock frequency differences, it is possible that during the Capture-DR state, an input or output will under-go a transition. The TAP may attempt a signal capture while in transition (metastable state). The device will not be harmed, but there is no guarantee of the value that will be captured or repeatable results.

To guarantee that the boundary scan register will capture the correct signal value, the SRAM signal must be stabilized long enough to meet the TAP controller's capture set-up plus hold times (t_{CS} and t_{CH}). To insure that the SRAM clock input is captured correctly, designs need a way to stop (or slow) the clock during a SAMPLE/PRELOAD instruction. If this is not an issue, it is possible to capture all other signals and simply ignore the value of the CLK and $\overline{CLK}$ captured in the boundary scan register.

Once the data is captured, it is possible to shift out the data by putting the TAP into the Shift-DR state. This places the boundary scan register between the TDI and TDO pins.

Note that since the PRELOAD part of the command is not implemented, putting the TAP into the Update to the Update-DR state while performing a SAMPLE/PRELOAD instruction will have the same effect as the Pause-DR command.

BYPASS

When the BYPASS instruction is loaded in the instruction register and the TAP is placed in a Shift-DR state, the bypass register is placed between the TDI and TDO pins. The advantage of the BYPASS instruction is that it shortens the boundary scan path when multiple devices are connected together on a board.

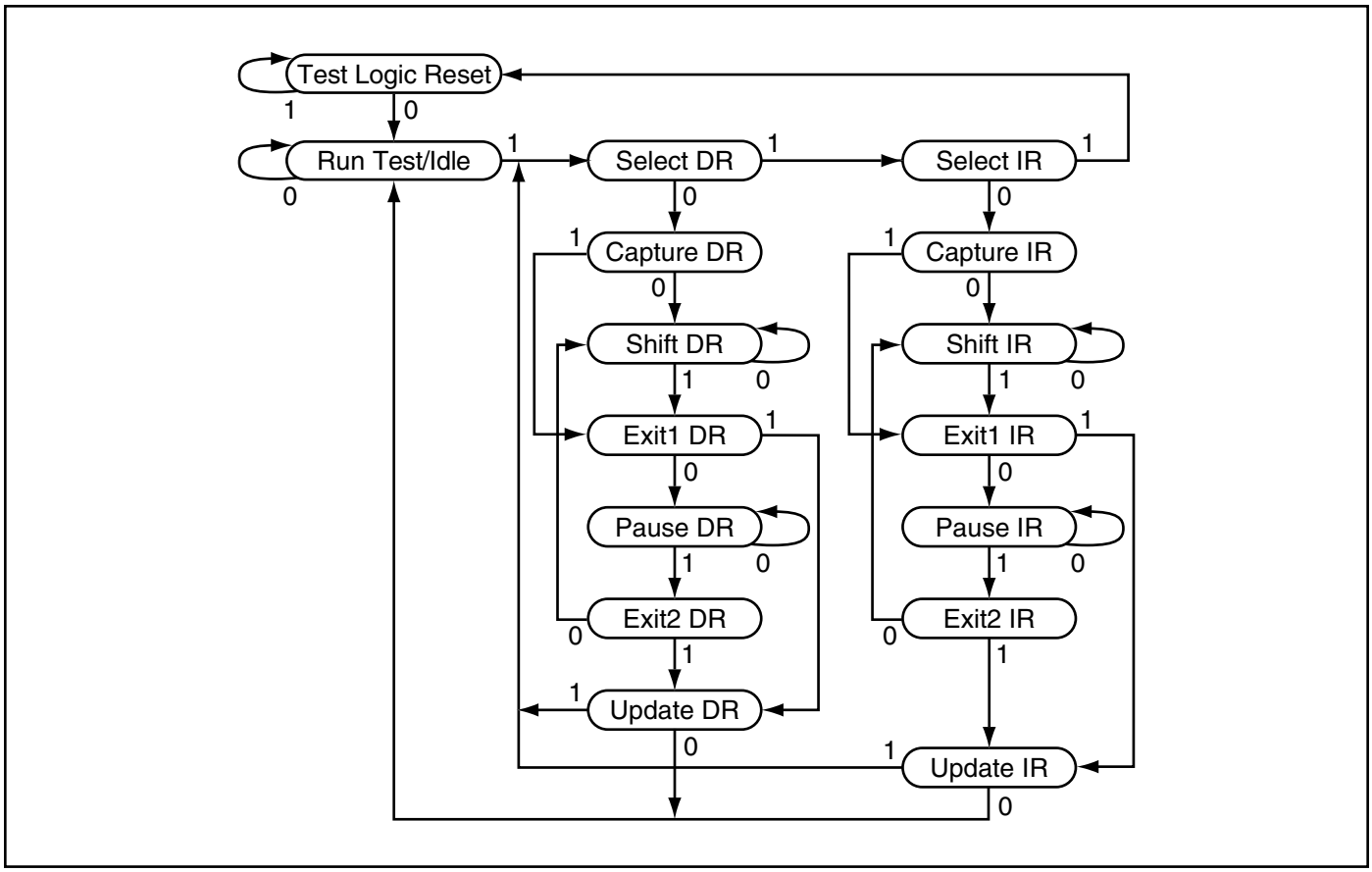
RESERVED

These instructions are not implemented but are reserved for future use. Do not use these instructions.

INSTRUCTION CODES

Code	Instruction	Description
000	EXTEST	Captures the Input/Output ring contents. Places the boundary scan register between the TDI and TDO. Forces all SRAM outputs to High-Z state. This instruction is not 1149.1 compliant.
001	IDCODE	Loads the ID register with the vendor ID code and places the register between TDI and TDO. This operation does not affect SRAM operation.
010	SAMPLE-Z	Captures the Input/Output contents. Places the boundary scan register between TDI and TDO. Forces all SRAM output drivers to a High-Z state.
011	RESERVED	Do Not Use: This instruction is reserved for future use.
100	SAMPLE/PRELOAD	Captures the Input/Output ring contents. Places the boundary scan register between TDI and TDO. Does not affect the SRAM operation. This instruction does not implement 1149.1 preload function and is therefore not 1149.1 compliant.
101	RESERVED	Do Not Use: This instruction is reserved for future use.
110	RESERVED	Do Not Use: This instruction is reserved for future use.
111	BYPASS	Places the bypass register between TDI and TDO. This operation does not affect SRAM operation.

TAP CONTROLLER STATE DIAGRAM



TAP Electrical Characteristics Over the Operating Range[1,2]

Symbol	Parameter	Test Conditions	Min.	Max.	Units
V_{OH1}	Output HIGH Voltage	I_{OH} = –2.0 mA	1.7	—	V
V_{OH2}	Output HIGH Voltage	I_{OH} = –100 µA	2.1	—	V
V_{OL1}	Output LOW Voltage	I_{OL} = 2.0 mA	—	0.7	V
V_{OL2}	Output LOW Voltage	I_{OL} = 100 µA	—	0.2	V
V_{IH}	Input HIGH Voltage		1.7	V_{DD} +0.3	V
V_{IL}	Input LOW Voltage		–0.3	0.7	V
I_X	Input Load Current	$V_{SS} \le V_I \le V_{DDQ}$	–5	5	mA

Notes:
1. All Voltage referenced to Ground.
2. Overshoot: V_{IH} (AC) $\le V_{DD}$ +1.5V for t $\le t_{TCYC}/2$,
   Undershoot: V_{IL} (AC) $\le$ 0.5V for t $\le t_{TCYC}/2$,
   Power-up: V_{IH} < 2.6V and V_{DD} < 2.4V and V_{DDQ} < 1.4V for t < 200 ms.

TAP AC ELECTRICAL CHARACTERISTICS[1,2] (OVER OPERATING RANGE)

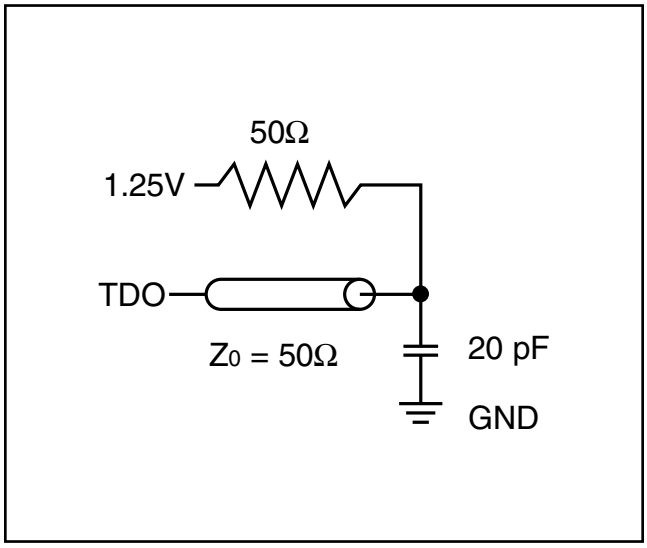
Symbol	Parameter	Min.	Max.	Unit
t_{TCYC}	TCK Clock cycle time	100	—	ns
f_{TF}	TCK Clock frequency	—	10	MHz
t_{TH}	TCK Clock HIGH	40	—	ns
t_{TL}	TCK Clock LOW	40	—	ns
t_{TMSS}	TMS setup to TCK Clock Rise	10	—	ns
t_{TDIS}	TDI setup to TCK Clock Rise	10	—	ns
t_{CS}	Capture setup to TCK Rise	10	—	ns
t_{TMSH}	TMS hold after TCK Clock Rise	10	—	ns
t_{TDIH}	TDI Hold after Clock Rise	10	—	ns
t_{CH}	Capture hold after Clock Rise	10	—	ns
t_{TDOV}	TCK LOW to TDO valid	—	20	ns
t_{TDOX}	TCK LOW to TDO invalid	0	—	ns

Notes:
1. Both t_{CS} and t_{CH} refer to the set-up and hold time latching data requirements from the boundary scan register.
2. Test conditions are specified using the load in TAP AC test conditions. t_R/t_F = 1 ns.

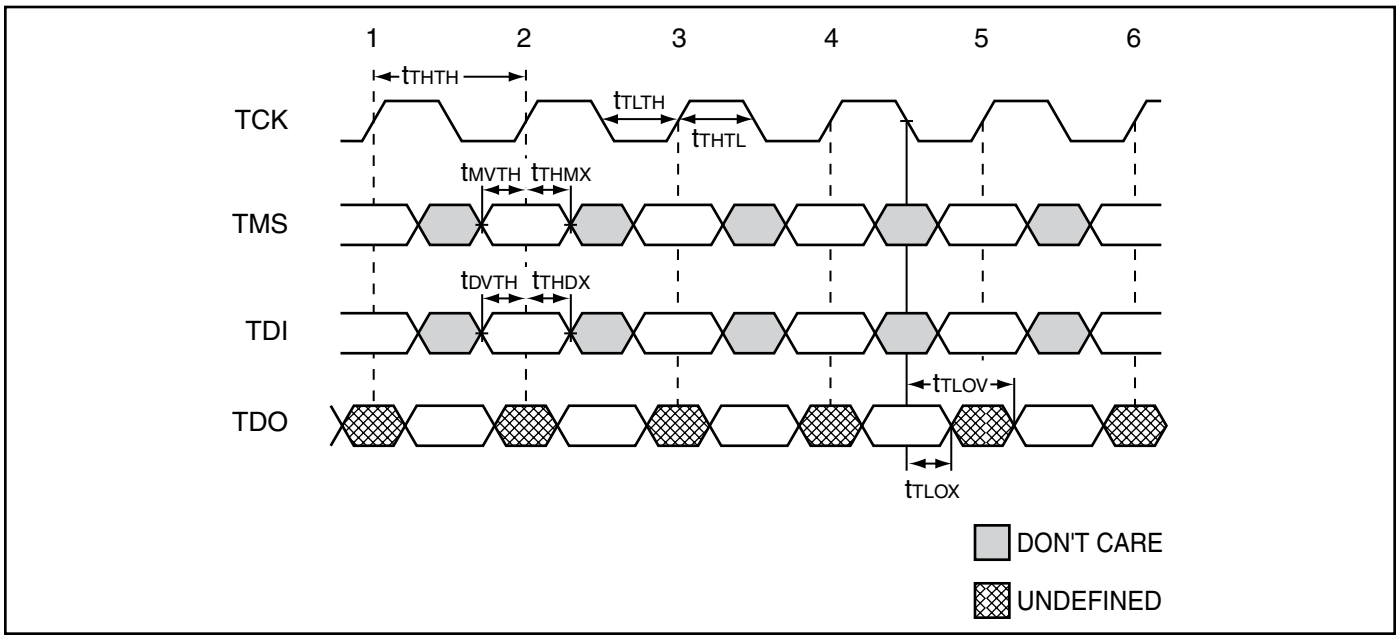
TAP AC TEST CONDITIONS (2.5/3.3V)

Input pulse levels	0 to 2.5V/0 to 3.0V
Input rise and fall times	1ns
Input timing reference levels	1.25V/1.5V
Output reference levels	1.25V/1.5V
Test load termination supply voltage	1.25V/1.5V

TAP Output Load Equivalent



TAP TIMING



165 PBGA BOUNDARY SCAN ORDER (x 36)

Bit #	Signal Name	Bump ID	Bit #	Signal Name	Bump ID	Bit #	Signal Name	Bump ID	Bit #	Signal Name	Bump ID
1	MODE	1R	21	DQb	11G	41	NC	1A	61	DQd	1J
2	A	6N	22	DQb	11F	42	$\overline{CE}$2	6A	62	DQd	1K
3	A	11P	23	DQb	11E	43	$\overline{BW}$a	5B	63	DQd	1L
4	A	8P	24	DQb	11D	44	$\overline{BW}$b	5A	64	DQd	1M
5	A	8R	25	DQb	10G	45	$\overline{BW}$c	4A	65	DQd	2J
6	A	9R	26	DQb	10F	46	$\overline{BW}$d	4B	66	DQd	2K
7	A	9P	27	DQb	10E	47	CE2	3B	67	DQd	2L
8	A	10P	28	DQb	10D	48	$\overline{CE}$	3A	68	DQd	2M
9	A	10R	29	DQb	11C	49	A	2A	69	DQd	1N
10	A	11R	30	NC	11A	50	A	2B	70	A	3P
11	ZZ	11H	31	A	10A	51	NC	1B	71	A	3R
12	DQa	11N	32	A	10B	52	DQc	1C	72	A	4R
13	DQa	11M	33	$\overline{ADV}$	9A	53	DQc	1D	73	A	4P
14	DQa	11L	34	$\overline{ADSP}$	9B	54	DQc	1E	74	A1	6P
15	DQa	11K	35	$\overline{ADSC}$	8A	55	DQc	1F	75	A0	6R
16	DQa	11J	36	$\overline{OE}$	8B	56	DQc	1G			
17	DQa	10M	37	$\overline{BWE}$	7A	57	DQc	2D			
18	DQa	10L	38	$\overline{GW}$	7B	58	DQc	2E			
19	DQa	10K	39	CLK	6B	59	DQc	2F			
20	DQa	10J	40	NC	11B	60	DQc	2G			

165 PBGA BOUNDARY SCAN ORDER (x 18)

Bit #	Signal Name	Bump ID	Bit #	Signal Name	Bump ID	Bit #	Signal Name	Bump ID	Bit #	Signal Name	Bump ID
1	MODE	1R	21	DQa	11G	41	NC	1A	61	DQb	1J
2	A	6N	22	DQa	11F	42	$\overline{CE2}$	6A	62	DQb	1K
3	A	11P	23	DQa	11E	43	$\overline{BWa}$	5B	63	DQb	1L
4	A	8P	24	DQa	11D	44	NC	5A	64	DQb	1M
5	A	8R	25	DQa	11C	45	$\overline{BWb}$	4A	65	DQb	1N
6	A	9R	26	NC	10F	46	NC	4B	66	NC	2K
7	A	9P	27	NC	10E	47	CE2	3B	67	NC	2L
8	A	10P	28	NC	10D	48	$\overline{CE}$	3A	68	NC	2M
9	A	10R	29	NC	10G	49	A	2A	69	NC	2J
10	A	11R	30	A	11A	50	A	2B	70	A	3P
11	ZZ	11H	31	A	10A	51	NC	1B	71	A	3R
12	NC	11N	32	A	10B	52	NC	1C	72	A	4R
13	NC	11M	33	$\overline{ADV}$	9A	53	NC	1D	73	A	4P
14	NC	11L	34	$\overline{ADSP}$	9B	54	NC	1E	74	A1	6P
15	NC	11K	35	$\overline{ADSC}$	8A	55	NC	1F	75	A0	6R
16	NC	11J	36	$\overline{OE}$	8B	56	NC	1G			
17	DQa	10M	37	$\overline{BWE}$	7A	57	DQb	2D			
18	DQa	10L	38	$\overline{GW}$	7B	58	DQb	2E			
19	DQa	10K	39	CLK	6B	59	DQb	2F			
20	DQa	10J	40	NC	11B	60	DQb	2G			

ORDERING INFORMATION (3.3V core/2.5V-3.3V I/O)

Commercial Range: 0°C to +70°C

Configuration	Frequency	Order Part Number	Package
512Kx36			
	250	IS61LPD51236A-250TQ	100 TQFP
		IS61LPD51236A-250B3	165 PBGA
	200	IS61LPD51236A-200TQ	100 TQFP
		IS61LPD51236A-200B3	165 PBGA
1Mx18			
	250	IS61LPD102418A-250TQ	100 TQFP
		IS61LPD102418A-250B3	165 PBGA
	200	IS61LPD102418A-200TQ	100 TQFP
		IS61LPD102418A-200B3	165 PBGA

Industrial Range: -40°C to +85°C

Configuration	Frequency	Order Part Number	Package
512Kx36			
	250	IS61LPD51236A-250TQI	100 TQFP
		IS61LPD51236A-250B3I	165 PBGA
		IS61LPD51236A-250B3LI	165 PBGA, Lead-free
	200	IS61LPD51236A-200TQI	100 TQFP
		IS61LPD51236A-200TQLI	100 TQFP, Lead-free
		IS61LPD51236A-200B3I	165 PBGA
1Mx18			
	250	IS61LPD102418A-250TQI	100 TQFP
		IS61LPD102418A-250B3I	165 PBGA
	200	IS61LPD102418A-200TQI	100 TQFP
		IS61LPD102418A-200B3I	165 PBGA

ORDERING INFORMATION (2.5V core/2.5V I/O)

Commercial Range: 0°C to +70°C

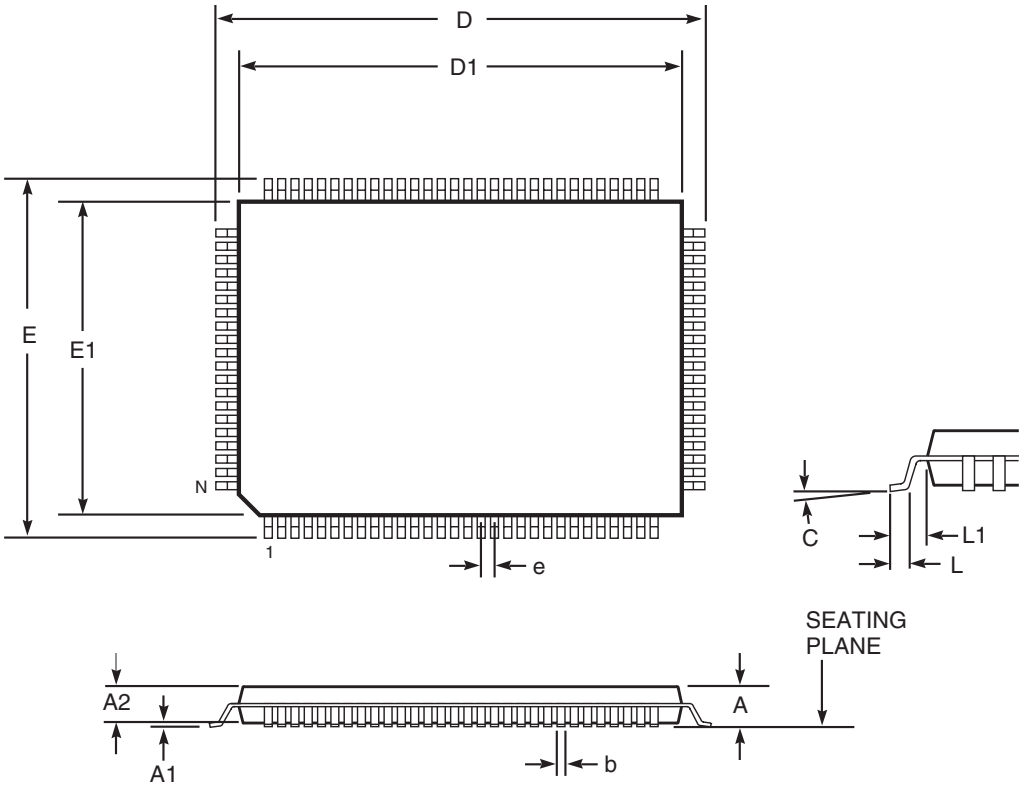
Configuration	Frequency	Order Part Number	Package
512Kx36			
	250	IS61VPD51236A-250TQ	100 TQFP
		IS61VPD51236A-250B3	165 PBGA
	200	IS61VPD51236A-200TQ	100 TQFP
		IS61VPD51236A-200B3	165 PBGA
1Mx18			
	250	IS61VPD102418A-250TQ	100 TQFP
		IS61VPD102418A-250B3	165 PBGA
	200	IS61VPD102418A-200TQ	100 TQFP
		IS61VPD102418A-200B3	165 PBGA

Industrial Range: -40°C to +85°C

Configuration	Frequency	Order Part Number	Package
512Kx36			
	250	IS61VPD51236A-250TQI	100 TQFP
		IS61VPD51236A-250B3I	165 PBGA
	200	IS61VPD51236A-200TQI	100 TQFP
		IS61VPD51236A-200B3I	165 PBGA
1Mx18			
	250	IS61VPD102418A-250TQI	100 TQFP
		IS61VPD102418A-250B3I	165 PBGA
	200	IS61VPD102418A-200TQI	100 TQFP
		IS61VPD102418A-200B3I	165 PBGA

PACKAGING INFORMATION

TQFP (Thin Quad Flat Pack Package)
Package Code: TQ

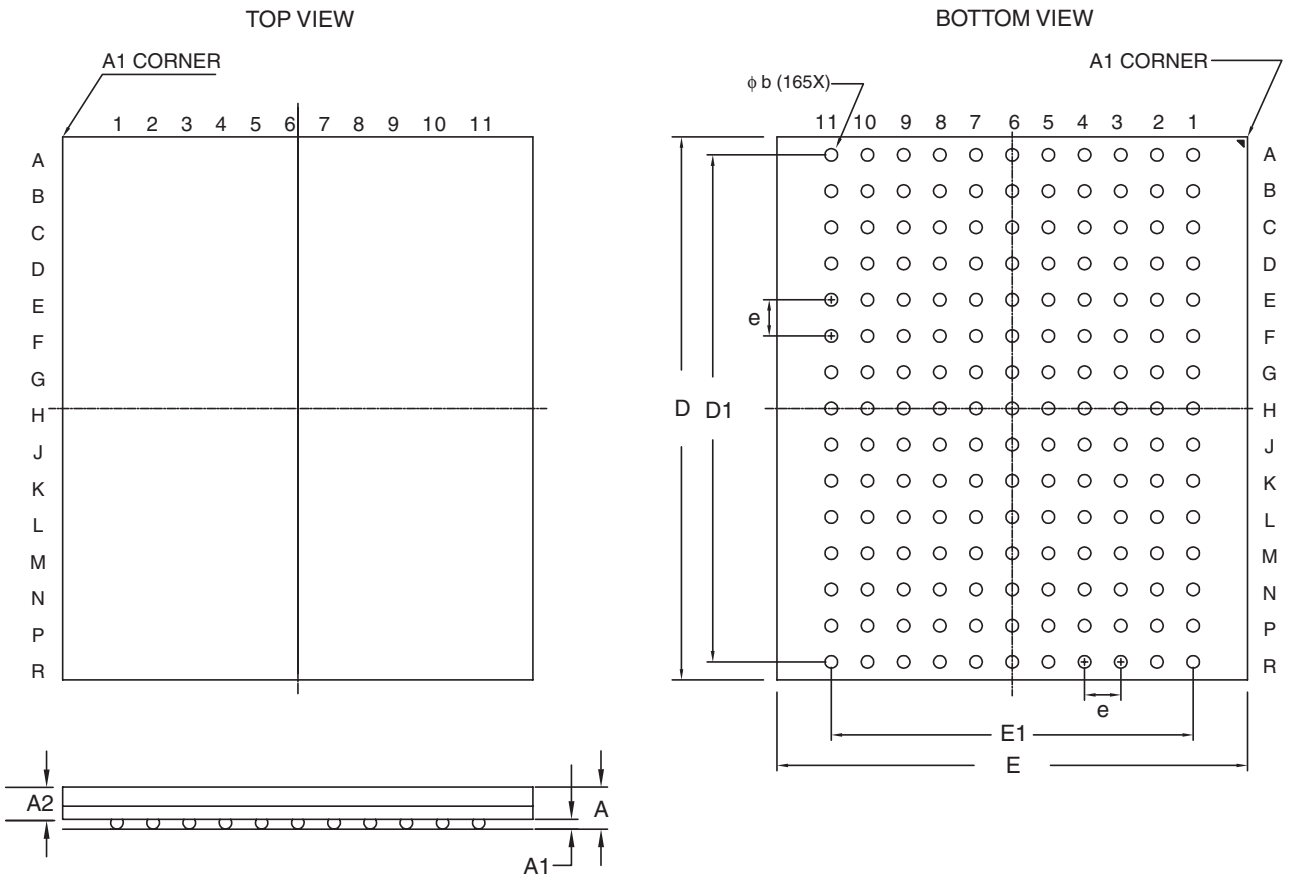


Thin Quad Flat Pack (TQ)								
	Millimeters		Inches		Millimeters		Inches	
Symbol	Min	Max	Min	Max	Min	Max	Min	Max
Ref. Std.								
No. Leads (N)	100				128			
A	—	1.60	—	0.063	—	1.60	—	0.063
A1	0.05	0.15	0.002	0.006	0.05	0.15	0.002	0.006
A2	1.35	1.45	0.053	0.057	1.35	1.45	0.053	0.057
b	0.22	0.38	0.009	0.015	0.17	0.27	0.007	0.011
D	21.90	22.10	0.862	0.870	21.80	22.20	0.858	0.874
D1	19.90	20.10	0.783	0.791	19.90	20.10	0.783	0.791
E	15.90	16.10	0.626	0.634	15.80	16.20	0.622	0.638
E1	13.90	14.10	0.547	0.555	13.90	14.10	0.547	0.555
e	0.65 BSC		0.026 BSC		0.50 BSC		0.020 BSC	
L	0.45	0.75	0.018	0.030	0.45	0.75	0.018	0.030
L1	1.00 REF.		0.039 REF.		1.00 REF.		0.039 REF.	
C	0°	7°	0°	7°	0°	7°	0°	7°

Notes:
1. All dimensioning and tolerancing conforms to ANSI Y14.5M-1982.
2. Dimensions D1 and E1 do not include mold protrusions. Allowable protrusion is 0.25 mm per side. D1 and E1 do include mold mismatch and are determined at datum plane -H-.
3. Controlling dimension: millimeters.

PACKAGING INFORMATION

Ball Grid Array
Package Code: B (165-pin)



BGA - 13mm x 15mm

	MILLIMETERS			INCHES		
Sym.	**Min.**	**Nom.**	**Max.**	**Min.**	**Nom.**	**Max.**
N0. Leads		**165**			**165**	
A	—	—	1.20	—	—	0.047
A1	0.25	0.33	0.40	0.010	0.013	0.016
A2	—	0.79	—	—	0.031	—
D	14.90	15.00	15.10	0.587	0.591	0.594
D1	13.90	14.00	14.10	0.547	0.551	0.555
E	12.90	13.00	13.10	0.508	0.512	0.516
E1	9.90	10.00	10.10	0.390	0.394	0.398
e	—	1.00	—	—	0.039	—
b	0.40	0.45	0.50	0.016	0.018	0.020

Notes:
1. Controlling dimensions are in millimeters.

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- *Специальные условия для постоянных клиентов.*
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