NEC

MOS INTEGRATED CIRCUIT

μPD4381161, 4381181, 4381321, 4381361

8M-BIT ZEROSB™ SRAM
FLOW THROUGH OPERATION

Description

The μPD4381161 is a 524,288-word by 16-bit, the μPD4381181 is a 524,288-word by 18-bit, the μPD4381321 is a 262,144-word by 32-bit and the μPD4381361 is a 262,144-word by 36-bit ZEROSB static RAM fabricated with advanced CMOS technology using N-channel four-transistor memory cell.

The μPD4381161, μPD4381181, μPD4381321 and μPD4381361 are optimized to eliminate dead cycles for read to write, or write to read transitions. These ZEROSB static RAMs integrate unique synchronous peripheral circuitry, 2-bit burst counter and output buffer as well as SRAM core. All input registers are controlled by a positive edge of the single clock input (CLK).

The μPD4381161, μPD4381181, μPD4381321 and μPD4381361 are suitable for applications which require synchronous operation, high speed, low voltage, high density and wide bit configuration, such as buffer memory.

ZZ has to be set LOW at the normal operation. When ZZ is set HIGH, the SRAM enters Power Down State (“Sleep”). In the “Sleep” state, the SRAM internal state is preserved. When ZZ is set LOW again, the SRAM resumes normal operation.

The μPD4381161, μPD4381181, μPD4381321 and μPD4381361 are packaged in 100-pin PLASTIC LQFP with a 1.4 mm package thickness for high density and low capacitive loading.

Features

- Single 3.3 V power supply
- Synchronous operation
- 100 percent bus utilization
- Internally self-timed write control
- Burst read / write : Interleaved burst and linear burst sequence
- Fully registered inputs for flow through operation
- All registers triggered off positive clock edge
- 3.3 V LVTTL Compatible : All inputs and outputs
- Fast clock access time : 8.5 ns (100 MHz), 9.0 ns (90 MHz), 10 ns (83 MHz)
- Asynchronous output enable : /G
- Burst sequence selectable : MODE
- Sleep mode : ZZ (ZZ = Open or Low : Normal operation)
- Separate byte write enable : /BW1 - /BW4 (μPD4381321, μPD4381361), /BW1 - /BW2 (μPD4381161, μPD4381181)
- Three chip enables for easy depth expansion
- Common I/O using three state outputs

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Ordering Information

Part number	Access Time ns	Clock Frequency MHz	Core Supply Voltage V	I/O Interface	Package	Note
μPD4381161GF-A90	9.0	90	3.3 ± 0.165	3.3 V LVTTL	100-pin PLASTIC LQFP (14 × 20)	1
μPD4381161GF-A10	10.0	83				
μPD4381181GF-A90	9.0	90				
μPD4381181GF-A10	10.0	83				
μPD4381321GF-A85	8.5	100				2
μPD4381321GF-A90	9.0	90				
μPD4381361GF-A85	8.5	100				
μPD4381361GF-A90	9.0	90				

Notes 1. Grade A90 and A10 are available in the μPD4381161GF and μPD4381181GF.

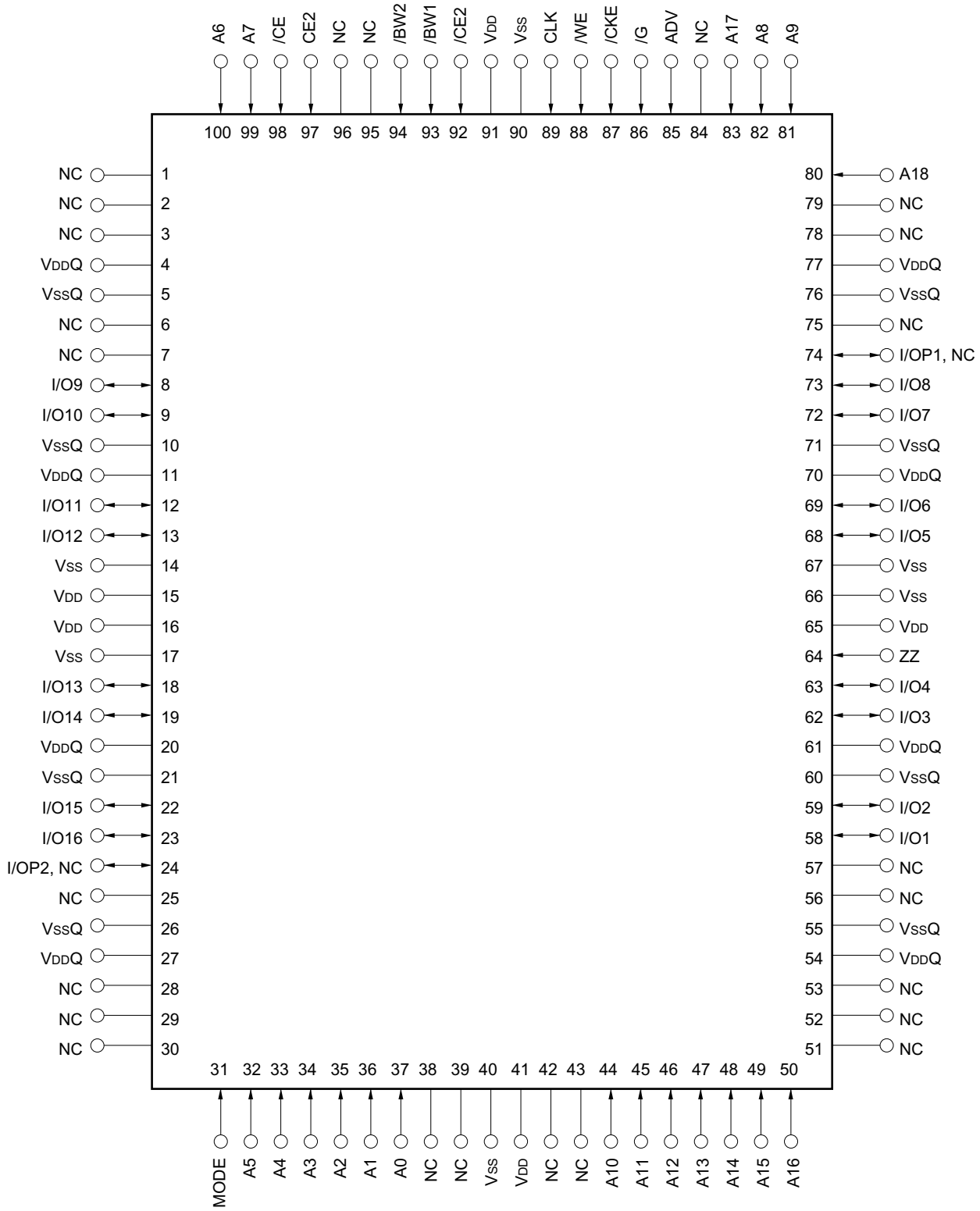
2. Grade A85 and A90 are available in the μPD4381321GF and μPD4381361GF.

Pin Configurations (Marking Side)

/xxx indicates active low signal.

100-pin PLASTIC LQFP (14 × 20)

[μPD4381161GF, μPD4381181GF]



Remark Refer to **Package Drawing** for 1-pin index mark.

Pin Identifications

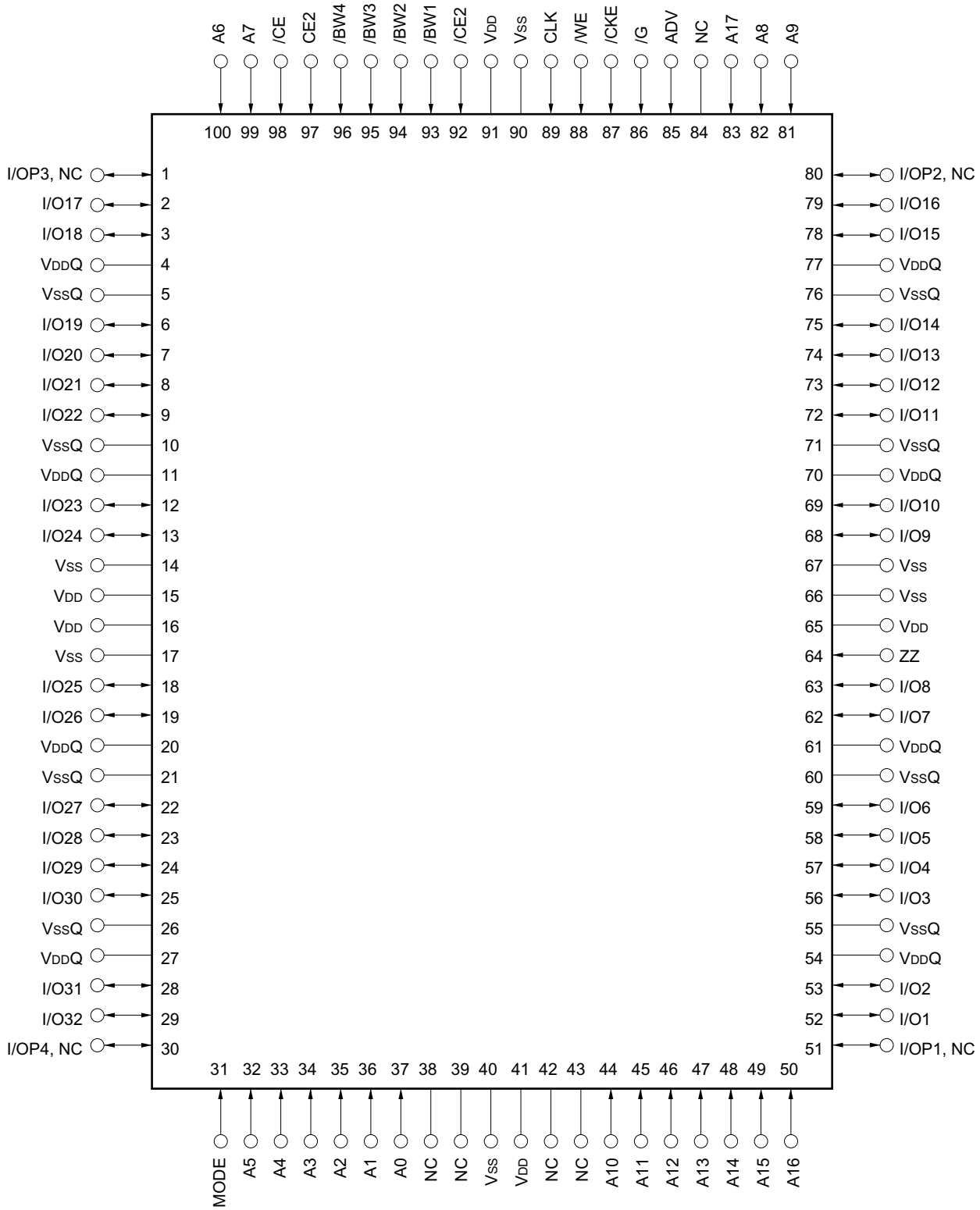
[μPD4381161GF, μPD4381181GF]

Symbol	Pin No.	Description
A0 - A18	37, 36, 35, 34, 33, 32, 100, 99, 82, 81, 44, 45, 46, 47, 48, 49, 50, 83, 80	Synchronous Address Input
I/O1 - I/O16	58, 59, 62, 63, 68, 69, 72, 73, 8, 9, 12, 13, 18, 19, 22, 23	Synchronous Data In, Synchronous / Asynchronous Data Out
I/OP1, NC Note	74	Synchronous Data In (Parity), Synchronous / Asynchronous Data Out (Parity)
I/OP2, NC Note	24	
ADV	85	Synchronous Address Load / Advance Input
/CE, CE2, /CE2	98, 97, 92	Synchronous Chip Enable Input
/WE	88	Synchronous Write Enable Input
/BW1, /BW2	93, 94	Synchronous Byte Write Enable Input
/G	86	Asynchronous Output Enable Input
CLK	89	Clock Input
/CKE	87	Synchronous Clock Enable Input
MODE	31	Asynchronous Burst Sequence Select Input Have to tied to V_{DD} or V_{SS} during normal operation
ZZ	64	Asynchronous Power Down State Input
V_{DD}	15, 16, 41, 65, 91	Power Supply
V_{SS}	14, 17, 40, 66, 67, 90	Ground
$V_{DD}Q$	4, 11, 20, 27, 54, 61, 70, 77	Output Buffer Power Supply
$V_{SS}Q$	5, 10, 21, 26, 55, 60, 71, 76	Output Buffer Ground
NC	1, 2, 3, 6, 7, 25, 28, 29, 30, 38, 39, 42, 43, 51, 52, 53, 56, 57, 75, 78, 79, 84, 95, 96	No Connection

Note NC (No Connection) is used in the μPD4381161GF.
I/OP1 - I/OP2 are used in the μPD4381181GF.

100-pin PLASTIC LQFP (14 × 20)

[μPD4381321GF, μPD4381361GF]



Remark Refer to **Package Drawing** for 1-pin index mark.

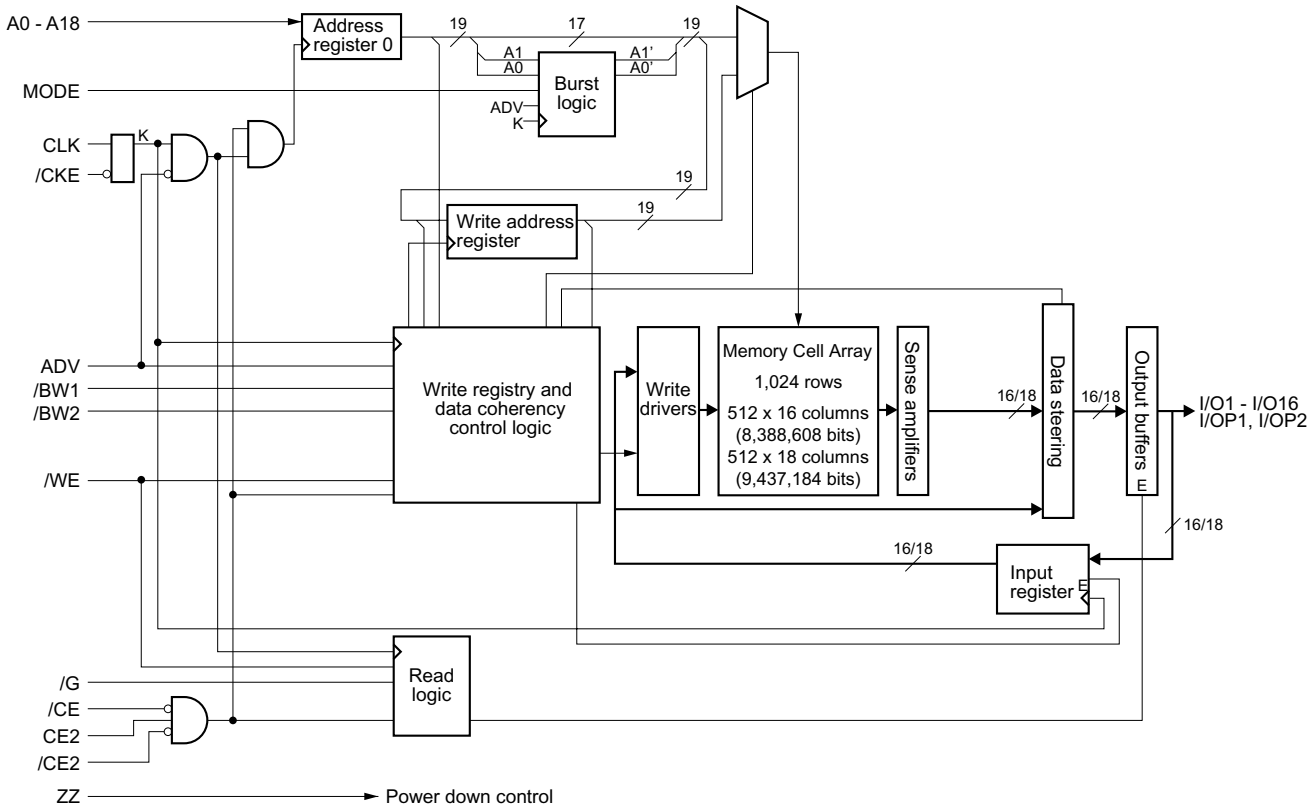
[μPD4381321GF, μPD4381361GF]

Symbol	Pin No.	Description
A0 - A17	37, 36, 35, 34, 33, 32, 100, 99, 82, 81, 44, 45, 46, 47, 48, 49, 50, 83	Synchronous Address Input
I/O1 - I/O32	52, 53, 56, 57, 58, 59, 62, 63, 68, 69, 72, 73, 74, 75, 78, 79, 2, 3, 6, 7, 8, 9, 12, 13, 18, 19, 22, 23, 24, 25, 28, 29	Synchronous Data In, Synchronous / Asynchronous Data Out
I/OP1, NC Note	51	Synchronous Data In (Parity), Synchronous / Asynchronous Data Out (Parity)
I/OP2, NC Note	80	
I/OP3, NC Note	1	
I/OP4, NC Note	30	
ADV	85	Synchronous Address Load / Advance Input
/CE, CE2, /CE2	98, 97, 92	Synchronous Chip Enable Input
/WE	88	Synchronous Write Enable Input
/BW1 - /BW4	93, 94, 95, 96	Synchronous Byte Write Enable Input
/G	86	Asynchronous Output Enable Input
CLK	89	Clock Input
/CKE	87	Synchronous Clock Enable Input
MODE	31	Asynchronous Burst Sequence Select Input Have to tied to V_{DD} or V_{SS} during normal operation
ZZ	64	Asynchronous Power Down State Input
V_{DD}	15, 16, 41, 65, 91	Power Supply
V_{SS}	14, 17, 40, 66, 67, 90	Ground
$V_{DD}Q$	4, 11, 20, 27, 54, 61, 70, 77	Output Buffer Power Supply
$V_{SS}Q$	5, 10, 21, 26, 55, 60, 71, 76	Output Buffer Ground
NC	38, 39, 42, 43, 84	No Connection

Note NC (No Connection) is used in the μPD4381321GF.
I/OP1 - I/OP4 are used in the μPD4381361GF.

Block Diagrams

[μPD4381161, μPD4381181]



Burst Sequence

[μPD4381161, μPD4381181]

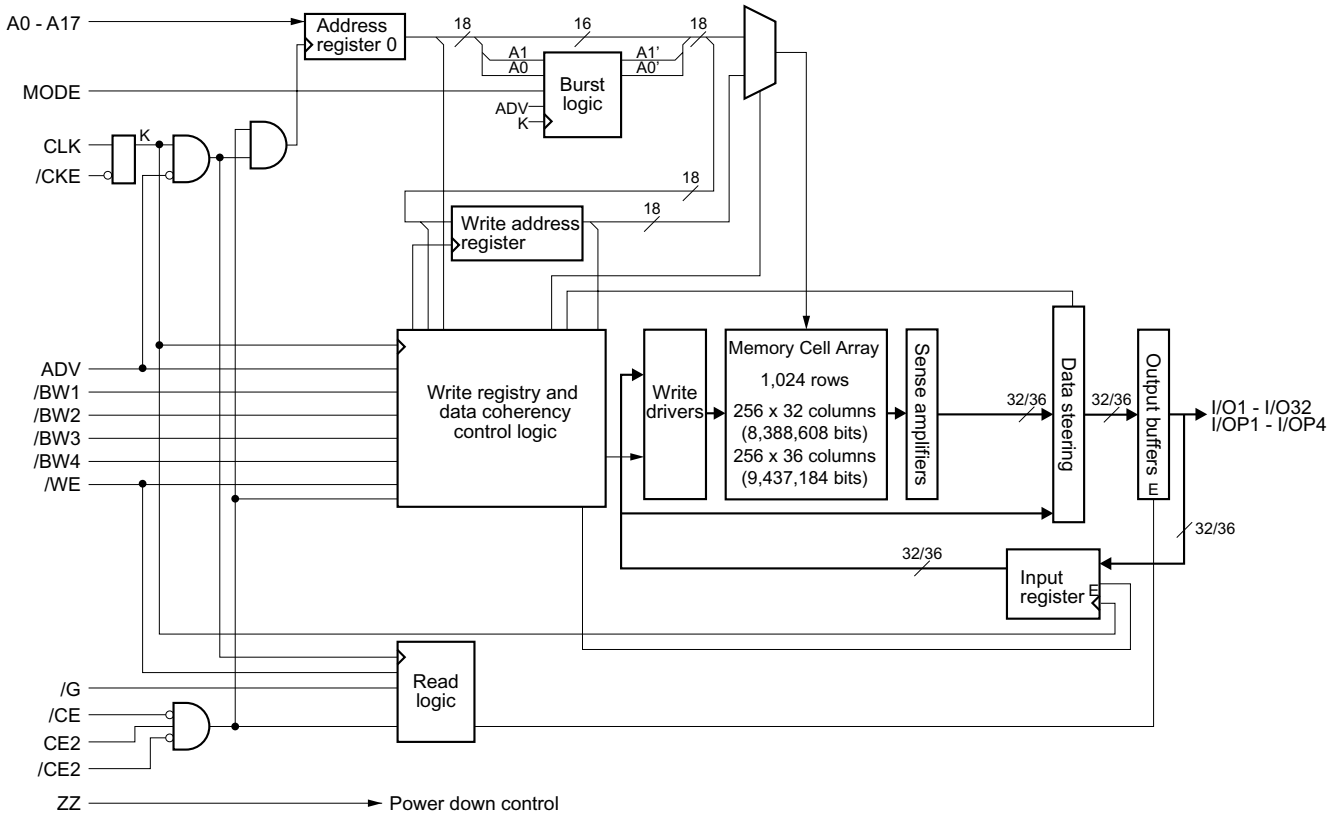
Interleaved Burst Sequence Table (MODE = Open or V_{DD})

External Address	A18 - A2, A1, A0
1st Burst Address	A18 - A2, A1, /A0
2nd Burst Address	A18 - A2, /A1, A0
3rd Burst Address	A18 - A2, /A1, /A0

Linear Burst Sequence Table (MODE = V_{SS})

External Address	A18 - A2, 0, 0	A18 - A2, 0, 1	A18 - A2, 1, 0	A18 - A2, 1, 1
1st Burst Address	A18 - A2, 0, 1	A18 - A2, 1, 0	A18 - A2, 1, 1	A18 - A2, 0, 0
2nd Burst Address	A18 - A2, 1, 0	A18 - A2, 1, 1	A18 - A2, 0, 0	A18 - A2, 0, 1
3rd Burst Address	A18 - A2, 1, 1	A18 - A2, 0, 0	A18 - A2, 0, 1	A18 - A2, 1, 0

[μPD4381321, μPD4381361]



[μPD4381321, μPD4381361]

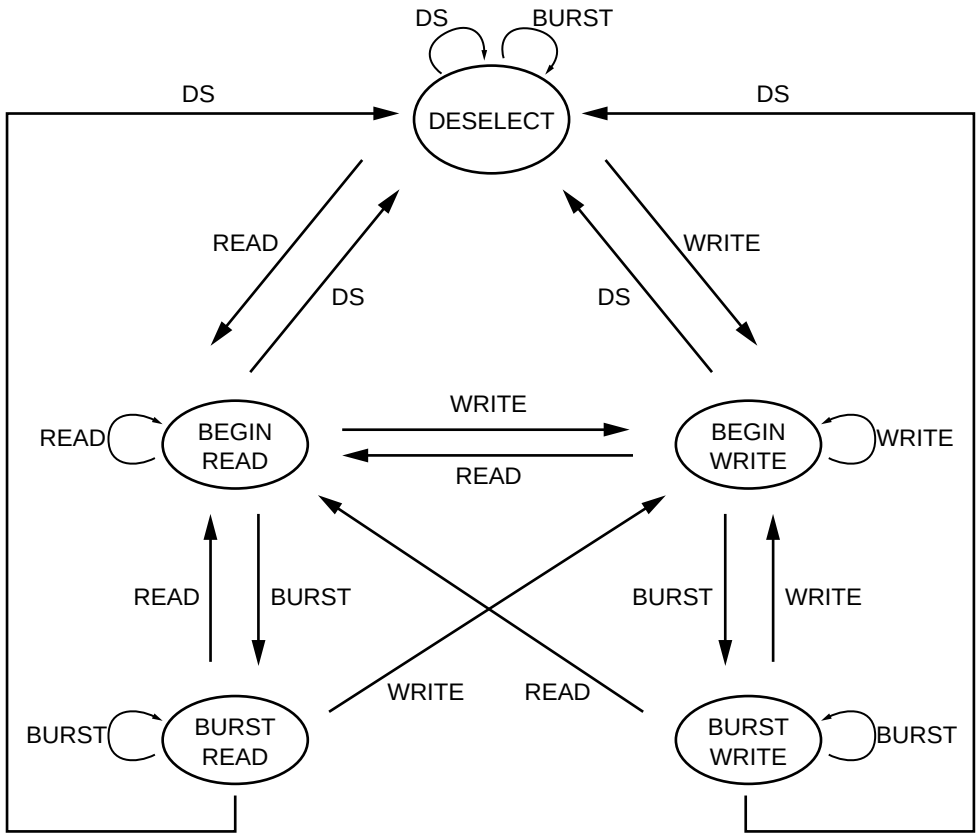
Interleaved Burst Sequence Table (MODE = Open or V_{DD})

External Address	A17 - A2, A1, A0
1st Burst Address	A17 - A2, A1, /A0
2nd Burst Address	A17 - A2, /A1, A0
3rd Burst Address	A17 - A2, /A1, /A0

Linear Burst Sequence Table (MODE = V_{SS})

External Address	A17 - A2, 0, 0	A17 - A2, 0, 1	A17 - A2, 1, 0	A17 - A2, 1, 1
1st Burst Address	A17 - A2, 0, 1	A17 - A2, 1, 0	A17 - A2, 1, 1	A17 - A2, 0, 0
2nd Burst Address	A17 - A2, 1, 0	A17 - A2, 1, 1	A17 - A2, 0, 0	A17 - A2, 0, 1
3rd Burst Address	A17 - A2, 1, 1	A17 - A2, 0, 0	A17 - A2, 0, 1	A17 - A2, 1, 0

State Diagram



Command	Operation
DS	Deselect
Read	New Read
Write	New Write
Burst	Burst Read, Burst Write or Continue Deselect

Remarks 1. States change on the rising edge of the clock.

2. A Stall of Ignore Clock Edge cycle is not shown in the above diagram. This is because /CKE HIGH only blocks the clock (CLK) input and does not change the state of the device.

Asynchronous Truth Table

Operation	/G	I/O
Read Cycle	L	Data-Out
Read Cycle	H	Hi-Z
Write Cycle	×	Hi-Z, Data-In
Deselected	×	Hi-Z

Remark × : don't care

Synchronous Truth Table

Operation	/CE	CE2	/CE2	ADV	/WE	/BWs	/CKE	CLK	I/O	Address	Note
Deselected	H	×	×	L	×	×	L	L → H	Hi-Z	None	1
Deselected	×	L	×	L	×	×	L	L → H	Hi-Z	None	1
Deselected	×	×	H	L	×	×	L	L → H	Hi-Z	None	1
Continue Deselected	×	×	×	H	×	×	L	L → H	Hi-Z	None	1
Read Cycle / Begin Burst	L	H	L	L	H	×	L	L → H	Data-Out	External	
Read Cycle / Continue Burst	×	×	×	H	×	×	L	L → H	Data-Out	Next	
Write Cycle / Begin Burst	L	H	L	L	L	L	L	L → H	Data-In	External	
Write Cycle / Continue Burst	×	×	×	H	×	L	L	L → H	Data-In	Next	
Write Cycle / Write Abort	L	H	L	L	L	H	L	L → H	Hi-Z	External	
Write Cycle / Write Abort	×	×	×	H	×	H	L	L → H	Hi-Z	Next	
Stall / Ignore Clock Edge	×	×	×	×	×	×	H	L → H	–	Current	2

Notes 1. Deselect status is held until new "Begin Burst" entry.

2. If an Ignore Clock Edge command occurs during a read operation, the I/O bus will remain active (Low-Z). If it occurs during a write cycle, the bus will remain Hi-Z. No write operation will be performed during the Ignore Clock Edge cycle.

Remarks 1. × : don't care

2. /BWs = L means any one or more byte write enables (/BW1, /BW2, /BW3 or /BW4) are LOW.
/BWs = H means all byte write enables (/BW1, /BW2, /BW3 or /BW4) are HIGH.

Partial Truth Table for Write Enables

[μPD4381161, μPD4381181]

Operation	/WE	/BW1	/BW2
Read Cycle	H	×	×
Write Cycle / Byte 1 (I/O [1:8], I/OP1)	L	L	H
Write Cycle / Byte 2 (I/O [9:16], I/OP2)	L	H	L
Write Cycle / All Bytes	L	L	L
Write Abort / NOP	L	H	H

Remark × : don't care

[μPD4381321, μPD4381361]

Operation	/WE	/BW1	/BW2	/BW3	/BW4
Read Cycle	H	×	×	×	×
Write Cycle / Byte 1 (I/O [1:8], I/OP1)	L	L	H	H	H
Write Cycle / Byte 2 (I/O [9:16], I/OP2)	L	H	L	H	H
Write Cycle / Byte 3 (I/O [17:24], I/OP3)	L	H	H	L	H
Write Cycle / Byte 4 (I/O [25:32], I/OP4)	L	H	H	H	L
Write Cycle / All Bytes	L	L	L	L	L
Write Abort / NOP	L	H	H	H	H

Remark × : don't care

ZZ (Sleep) Truth Table

ZZ	Chip Status
≤ 0.2 V	Active
Open	Active
≥ V_{DD} – 0.2 V	Sleep

Electrical Specifications

Absolute Maximum Ratings

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply voltage	V_{DD}		–0.5		+4.0	V
Output supply voltage	$V_{DD}Q$		–0.5		V_{DD}	V
Input voltage	V_{IN}		–0.5 Note		V_{DD} + 0.5	V
Input / Output voltage	$V_{I/O}$		–0.5 Note		$V_{DD}Q$ + 0.5	V
Operating ambient temperature	T_A		0		70	°C
Storage temperature	T_{stg}		–55		+125	°C

Note –2.0 V (MIN.) (Pulse width : 2 ns)

Caution Exposing the device to stress above those listed in Absolute Maximum Ratings could cause permanent damage. The device is not meant to be operated under conditions outside the limits described in the operational section of this specification. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

Recommended DC Operating Conditions (T_A = 0 to 70 °C)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply voltage	V_{DD}		3.135	3.3	3.465	V
Output supply voltage	$V_{DD}Q$		3.135	3.3	3.465	V
High level input voltage	V_{IH}		2.0		$V_{DD}Q$ + 0.3	V
Low level input voltage	V_{IL}		–0.3 Note		+0.8	V

Note –0.8 V (MIN.) (Pulse width : 2 ns)

DC Characteristics (T_A = 0 to 70 °C, V_{DD} = 3.3 ± 0.165 V)

Parameter	Symbol	Test condition		MIN.	TYP.	MAX.	Unit
Input leakage current	I_{LI}	V_{IN} (except ZZ, MODE) = 0 V to V_{DD}		–2		+2	μA
I/O leakage current	I_{LO}	$V_{I/O}$ = 0 V to V_{DD}Q, Outputs are disabled.		–2		+2	μA
Operating supply current	I_{DD}	Device selected, Cycle = MAX.	-A85			320	mA
		$V_{IN} \leq V_{IL}$ or $V_{IN} \geq V_{IH}$,	-A90			300	
		$I_{I/O}$ = 0 mA	-A10			270	
Standby supply current	I_{SB}	Device deselected, Cycle = 0 MHz, $V_{IN} \leq V_{IL}$ or $V_{IN} \geq V_{IH}$, All inputs are static.				30	mA
	I_{SB1}	Device deselected, Cycle = 0 MHz, $V_{IN} \leq$ 0.2 V or $V_{IN} \geq V_{DD}$ – 0.2 V, $V_{I/O} \leq$ 0.2 V, All inputs are static.				10	
	I_{SB2}	Device deselected, Cycle = MAX. $V_{IN} \leq V_{IL}$ or $V_{IN} \geq V_{IH}$				140	
Power down supply current	I_{SBZZ}	ZZ ≥ V_{DD} – 0.2 V, $V_{I/O} \leq V_{DD}$Q + 0.2 V				10	mA
High level output voltage	V_{OH}	I_{OH} = –4.0 mA		2.4			V
Low level output voltage	V_{OL}	I_{OL} = +8.0 mA				0.4	V

Capacitance (T_A = 25 °C, f = 1MHz)

Parameter	Symbol	Test condition	MIN.	TYP.	MAX.	Unit
Input capacitance	C_{IN}	V_{IN} = 0 V			5.0	pF
Input / Output capacitance	$C_{I/O}$	$V_{I/O}$ = 0 V			7.0	pF
Clock input capacitance	C_{clk}	V_{clk} = 0 V			6.0	pF

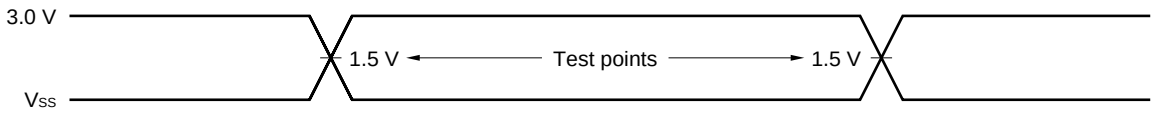
Remark These parameters are not 100% tested.

AC Characteristics (T_A = 0 to 70 °C, V_{DD} = 3.3 ± 0.165 V)

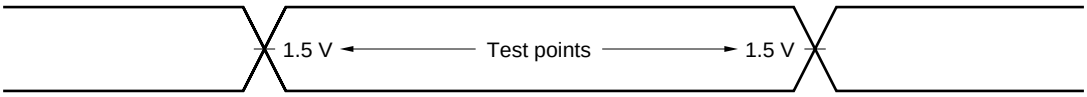
AC Test Conditions

3.3 V LVTTL Interface

Input waveform (Rise / Fall time ≤ 3.0 ns)



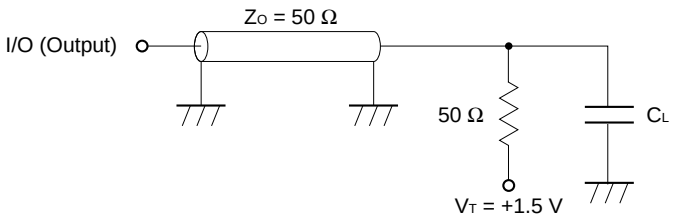
Output waveform



Output load condition

C_L : 30 pF
5 pF (TKHQX1, TKHQX2, TGLQX, TGHQZ, TKHQZ)

Figure1 External load at test



Remark C_L includes capacitances of the probe and jig, and stray capacitances.

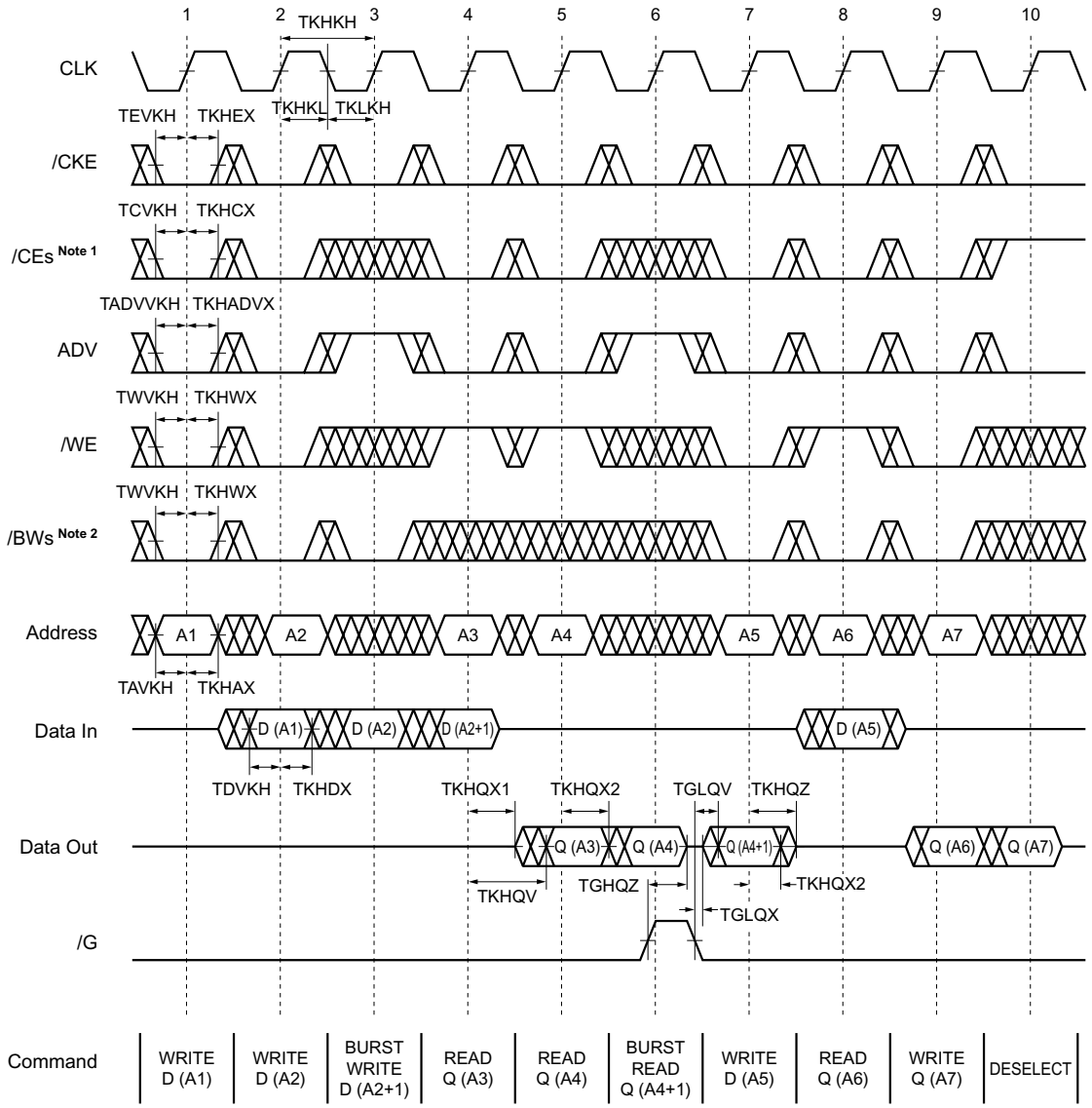
Read and Write Cycle

Parameter		Symbol		-A85 (100 MHz)		-A90 (90 MHz)		-A10 (83 MHz)		Unit	Note
		Standard	Alias	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
Cycle time		TKHKH	TCYC	10	–	11	–	12	–	ns	
Clock access time		TKHQV	TCD	–	8.5	–	9	–	10	ns	
Output enable access time		TGLQV	TOE	–	5	–	5	–	5	ns	
Clock high to output active		TKHQX1	TDC1	2	–	2	–	2	–	ns	1, 2
Clock high to output change		TKHQX2	TDC2	3	–	3	–	3	–	ns	
Output enable to output active		TGLQX	TOLZ	0	–	0	–	0	–	ns	1
Output disable to output Hi-Z		TGHQZ	TOHZ	0	5	0	5	0	5	ns	1
Clock high to output Hi-Z		TKHQZ	TCZ	2	5	2	5	2	5	ns	1, 2
Clock high pulse width		TKHKL	TCH	2.5	–	2.5	–	2.5	–	ns	
Clock low pulse width		TKLKH	TCL	2.5	–	2.5	–	2.5	–	ns	
Setup times	Address	TAVKH	TAS	2	–	2	–	2	–	ns	
	Data in	TDVKH	TDS								
	Write enable	TWVKH	TWS								
	Address advance	TADVVKH	–								
	Chip enable	TEVKH	–								
Hold times	Address	TKHAX	TAH	0.5	–	0.5	–	0.5	–	ns	
	Data in	TKHDX	TDH								
	Write enable	TKHWX	TWH								
	Address advance	TKHADVX	–								
	Chip enable	TKHEX	–								
Power down entry setup		TZZES	TZZES	5	–	5	–	5	–	ns	
Power down entry hold		TZZEH	TZZEH	1	–	1	–	1	–	ns	
Power down recovery setup		TZZRS	TZZRS	6	–	6	–	6	–	ns	
Power down recovery hold		TZZRH	TZZRH	0	–	0	–	0	–	ns	

Notes 1. Transition is measured ±200 mV from steady state.

2. To avoid bus contention, the output buffers are designed such that TKHQZ (device turn-off) is faster than TKHQX1 (device turn-on) at a given temperature and voltage. The specs as shown do not imply bus contention because TKHQX1 is a min. parameter that is worse case at totally different conditions (0 °C, V_{DD} max.) than TKHQZ, which is a max. parameter (worse case at 70 °C, V_{DD} min.).

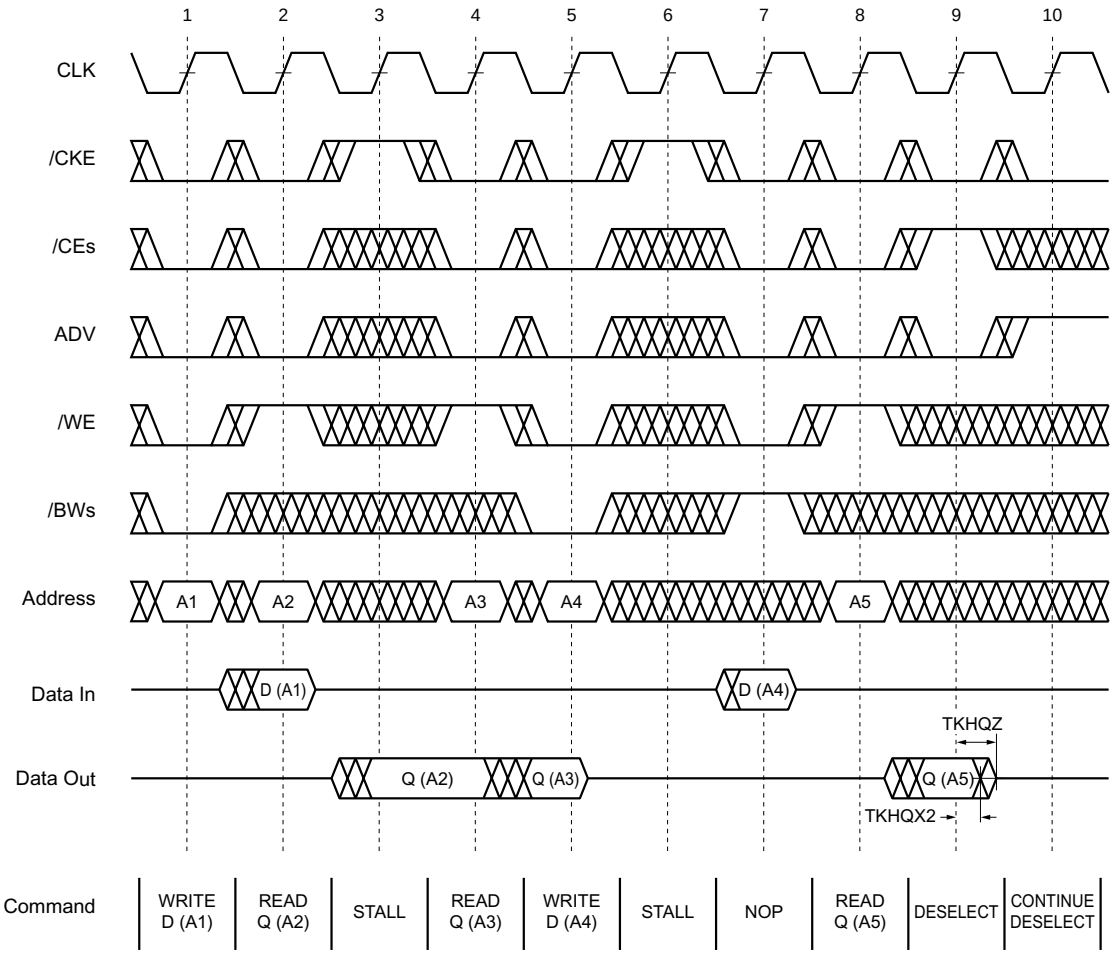
READ / WRITE CYCLE



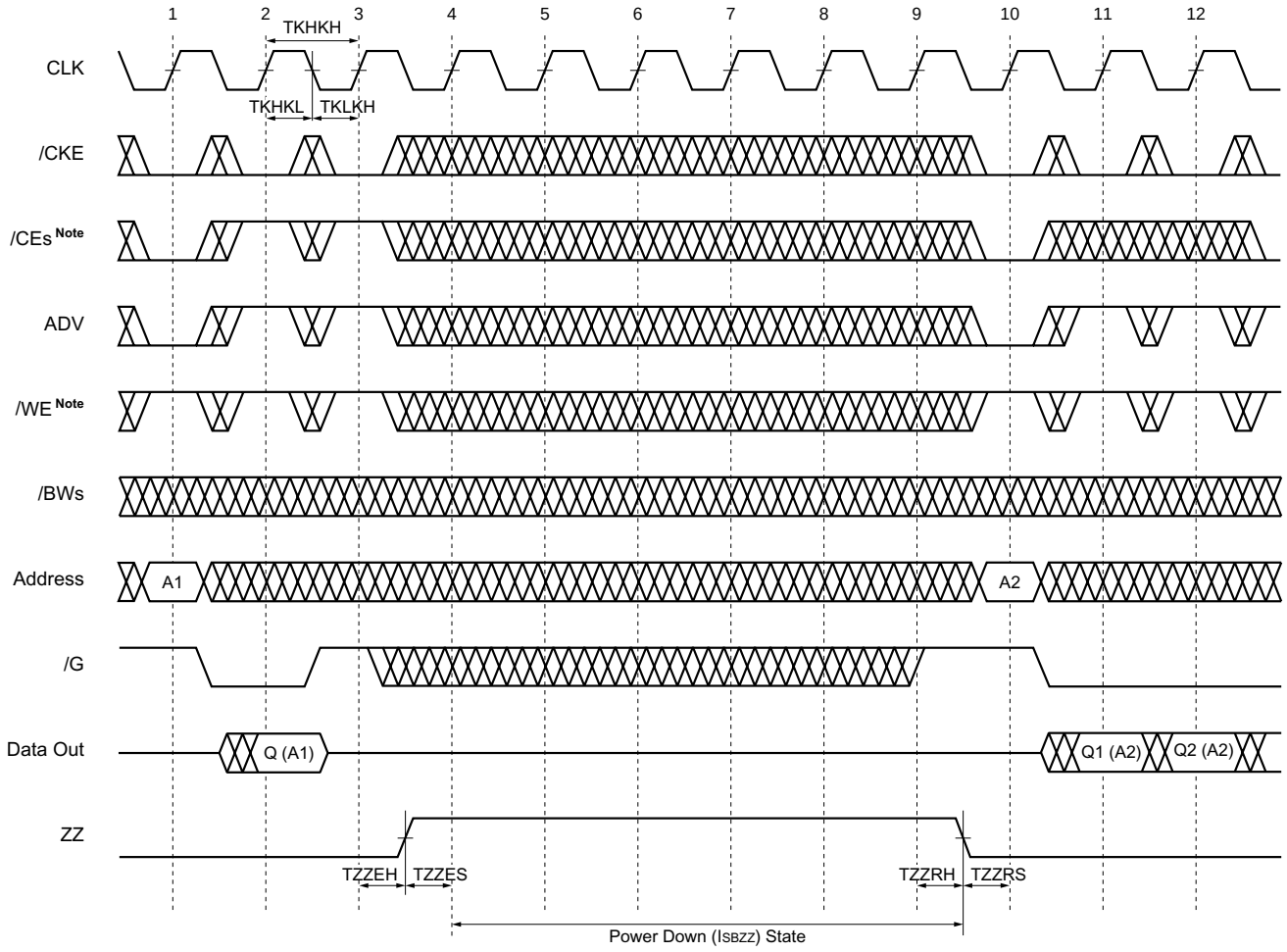
Notes 1. /CEs refers to /CE, CE2 and /CE2. When /CEs is LOW, /CE and /CE2 are LOW and CE2 is HIGH. When /CEs is HIGH, /CE and /CE2 are HIGH and CE2 is LOW.

2. /BWs refers to /BW1, /BW2, /BW3 and /BW4. When /BWs is LOW, any one or more byte write enables (/BW1, /BW2, /BW3 or /BW4) are LOW.

NOP, STALL AND DESELECT CYCLE



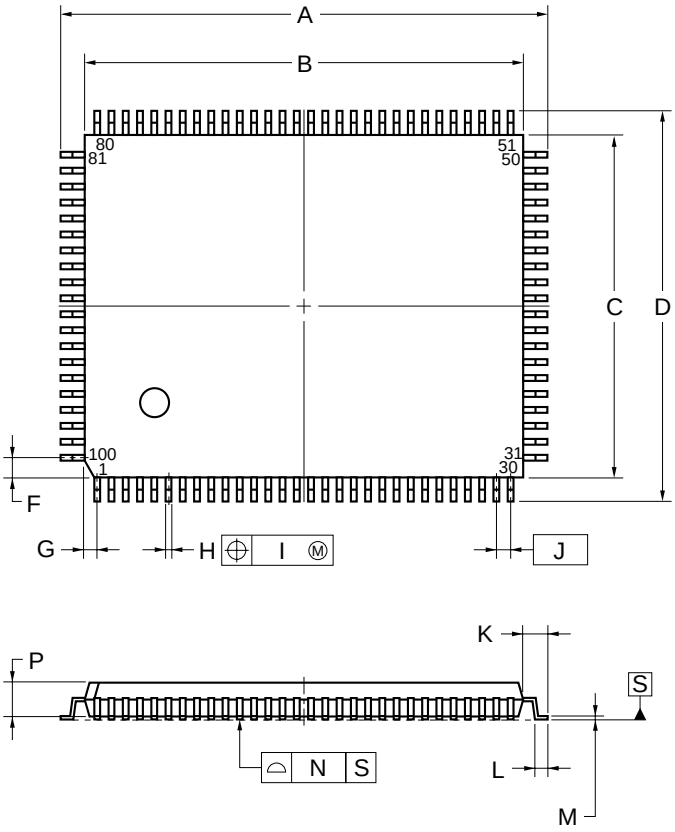
POWER DOWN (ZZ) CYCLE

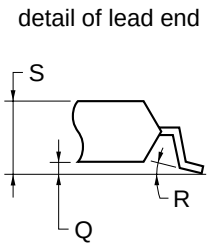


Note /WE or /CEs must be held HIGH at CLK rising edge (clock edge No.3 in this figure) prior to power down state entry.

Package Drawing

100-PIN PLASTIC LQFP (14x20)





NOTE

Each lead centerline is located within 0.13 mm of its true position (T.P.) at maximum material condition.

ITEM	MILLIMETERS
A	22.0±0.2
B	20.0±0.2
C	14.0±0.2
D	16.0±0.2
F	0.825
G	0.575
H	$0.32^{+0.08}_{-0.07}$
I	0.13
J	0.65 (T.P.)
K	1.0±0.2
L	0.5±0.2
M	$0.17^{+0.06}_{-0.05}$
N	0.10
P	1.4
Q	0.125±0.075
R	$3^{\circ}{}^{+7^{\circ}}_{-3^{\circ}}$
S	1.7 MAX.

S100GF-65-8ET-1

Recommended Soldering Condition

Please consult with our sales offices for soldering conditions of the μPD4381161, 4381181, 4381321 and 4381361.

Types of Surface Mount Devices

μPD4381161GF: 100-pin PLASTIC LQFP (14 × 20)
μPD4381181GF: 100-pin PLASTIC LQFP (14 × 20)
μPD4381321GF: 100-pin PLASTIC LQFP (14 × 20)
μPD4381361GF: 100-pin PLASTIC LQFP (14 × 20)

[MEMO]

[MEMO]

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note:

Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note:

Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

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