

# MOS INTEGRATED CIRCUIT

## $\mu$ PD4481162, 4481182, 4481322, 4481362

### 8M-BIT ZEROSB™ SRAM PIPELINED OPERATION

#### Description

The  $\mu$ PD4481162 is a 524,288-word by 16-bit, the  $\mu$ PD4481182 is a 524,288-word by 18-bit, the  $\mu$ PD4481322 is a 262,144-word by 32-bit and the  $\mu$ PD4481362 is a 262,144-word by 36-bit ZEROSB static RAM fabricated with advanced CMOS technology using full CMOS six-transistor memory cell.

The  $\mu$ PD4481162,  $\mu$ PD4481182,  $\mu$ PD4481322 and  $\mu$ PD4481362 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  $\mu$ PD4481162,  $\mu$ PD4481182,  $\mu$ PD4481322 and  $\mu$ PD4481362 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  $\mu$ PD4481162,  $\mu$ PD4481182,  $\mu$ PD4481322 and  $\mu$ PD4481362 are packaged in 100-pin PLASTIC LQFP with a 1.4 mm package thickness for high density and low capacitive loading.

#### Features

- Low voltage core supply :  $V_{DD} = 3.3 \pm 0.165 \text{ V}$  (-A44, -A50, -A60, -A75, -A44Y, -A50Y, -A60Y, -A75Y)  
 $V_{DD} = 2.5 \pm 0.125 \text{ V}$  (-C60, -C75, -C60Y, -C75Y)
- Synchronous operation
- Operating temperature :  $T_A = 0 \text{ to } 70 \text{ }^\circ\text{C}$  (-A44, -A50, -A60, -A75, -C60, -C75)  
 $T_A = -40 \text{ to } +85 \text{ }^\circ\text{C}$  (-A44Y, -A50Y, -A60Y, -A75Y, -C60Y, -C75Y)
- 100 percent bus utilization
- Internally self-timed write control
- Burst read / write : Interleaved burst and linear burst sequence
- Fully registered inputs and outputs for pipelined operation
- All registers triggered off positive clock edge
- 3.3V or 2.5V LVTTTL Compatible : All inputs and outputs
- Fast clock access time : 2.8 ns (225 MHz), 3.2 ns (200 MHz), 3.5 ns (167 MHz) , 4.2 ns (133 MHz)
- Asynchronous output enable : /G
- Burst sequence selectable : MODE
- Sleep mode : ZZ (ZZ = Open or Low : Normal operation)
- Separate byte write enable : /BW1 to /BW4 ( $\mu$ PD4481322 and  $\mu$ PD4481362)  
/BW1 and /BW2 ( $\mu$ PD4481162 and  $\mu$ PD4481182)
- Three chip enables for easy depth expansion
- Common I/O using three state outputs

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<R> **Ordering Information**

The ordering information is classified as following.

- Operating Temperature T<sub>A</sub> = 0 to 70°C Conventional Products
- Operating Temperature T<sub>A</sub> = 0 to 70°C Lead-Free Products
- Operating Temperature T<sub>A</sub> = -40 to +85°C Conventional Products
- Operating Temperature T<sub>A</sub> = -40 to +85°C Lead-Free Products

**(1) Operating Temperature T<sub>A</sub> = 0 to 70°C Conventional Products**

Part number	Access Time ns	Clock Frequency MHz	Core Supply Voltage V	I/O Interface	Operating Temperature °C	Package
μPD4481162GF-A44	2.8	225	3.3 ± 0.165	3.3 V LVTTTL <sup>Note</sup>	0 to 70	100-pin PLASTIC LQFP (14 x 20)
μPD4481162GF-A50	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481162GF-A60	3.5	167				
μPD4481162GF-A75	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481182GF-A44	2.8	225				
μPD4481182GF-A50	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481182GF-A60	3.5	167				
μPD4481182GF-A75	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481322GF-A44	2.8	225				
μPD4481322GF-A50	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481322GF-A60	3.5	167				
μPD4481322GF-A75	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481362GF-A44	2.8	225				
μPD4481362GF-A50	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481362GF-A60	3.5	167				
μPD4481362GF-A75	4.2	133		2.5 V LVTTTL		
μPD4481162GF-C60	3.5	167				
μPD4481162GF-C75	4.2	133				
μPD4481182GF-C60	3.5	167				
μPD4481182GF-C75	4.2	133				
μPD4481322GF-C60	3.5	167				
μPD4481322GF-C75	4.2	133				
μPD4481362GF-C60	3.5	167				
μPD4481362GF-C75	4.2	133				

**Note** Although 2.5V LVTTTL interface can also be used, a performance becomes equivalent to -A60 (167 MHz).

(2) Operating Temperature T<sub>A</sub> = 0 to 70°C Lead-Free Products

Part number	Access Time ns	Clock Frequency MHz	Core Supply Voltage V	I/O Interface	Operating Temperature °C	Package
μPD4481162GF-A44-A	2.8	225	3.3 ± 0.165	3.3 V LVTTTL <sup>Note</sup>	0 to 70	100-pin PLASTIC LQFP (14 x 20)
μPD4481162GF-A50-A	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481162GF-A60-A	3.5	167				
μPD4481162GF-A75-A	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481182GF-A44-A	2.8	225				
μPD4481182GF-A50-A	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481182GF-A60-A	3.5	167				
μPD4481182GF-A75-A	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481322GF-A44-A	2.8	225				
μPD4481322GF-A50-A	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481322GF-A60-A	3.5	167				
μPD4481322GF-A75-A	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481362GF-A44-A	2.8	225				
μPD4481362GF-A50-A	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481362GF-A60-A	3.5	167				
μPD4481362GF-A75-A	4.2	133		2.5 ± 0.125		
μPD4481162GF-C60-A	3.5	167				
μPD4481162GF-C75-A	4.2	133				
μPD4481182GF-C60-A	3.5	167				
μPD4481182GF-C75-A	4.2	133				
μPD4481322GF-C60-A	3.5	167				
μPD4481322GF-C75-A	4.2	133				
μPD4481362GF-C60-A	3.5	167				
μPD4481362GF-C75-A	4.2	133				

**Note** Although 2.5V LVTTTL interface can also be used, a performance becomes equivalent to -A60 (167 MHz).

**Remark** Products with -A at the end of the part number are lead-free products.

(3) Operating Temperature T<sub>A</sub> = -40 to +85°C Conventional Products

Part number	Access Time ns	Clock Frequency MHz	Core Supply Voltage V	I/O Interface	Operating Temperature °C	Package
μPD4481162GF-A44Y	2.8	225	3.3 ± 0.165	3.3 V LVTTTL <sup>Note</sup>	-40 to +85	100-pin PLASTIC LQFP (14 x 20)
μPD4481162GF-A50Y	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481162GF-A60Y	3.5	167				
μPD4481162GF-A75Y	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481182GF-A44Y	2.8	225				
μPD4481182GF-A50Y	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481182GF-A60Y	3.5	167				
μPD4481182GF-A75Y	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481322GF-A44Y	2.8	225				
μPD4481322GF-A50Y	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481322GF-A60Y	3.5	167				
μPD4481322GF-A75Y	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481362GF-A44Y	2.8	225				
μPD4481362GF-A50Y	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481362GF-A60Y	3.5	167				
μPD4481362GF-A75Y	4.2	133		2.5 ± 0.125		
μPD4481162GF-C60Y	3.5	167				
μPD4481162GF-C75Y	4.2	133				
μPD4481182GF-C60Y	3.5	167				
μPD4481182GF-C75Y	4.2	133				
μPD4481322GF-C60Y	3.5	167				
μPD4481322GF-C75Y	4.2	133				
μPD4481362GF-C60Y	3.5	167				
μPD4481362GF-C75Y	4.2	133				

**Note** Although 2.5V LVTTTL interface can also be used, a performance becomes equivalent to -A60Y (167 MHz).

(4) Operating Temperature T<sub>A</sub> = -40 to +85°C Lead-Free Products

Part number	Access Time ns	Clock Frequency MHz	Core Supply Voltage V	I/O Interface	Operating Temperature °C	Package
μPD4481162GF-A44Y-A	2.8	225	3.3 ± 0.165	3.3 V LVTTTL <sup>Note</sup>	-40 to +85	100-pin PLASTIC LQFP (14 x 20)
μPD4481162GF-A50Y-A	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481162GF-A60Y-A	3.5	167				
μPD4481162GF-A75Y-A	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481182GF-A44Y-A	2.8	225				
μPD4481182GF-A50Y-A	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481182GF-A60Y-A	3.5	167				
μPD4481182GF-A75Y-A	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481322GF-A44Y-A	2.8	225				
μPD4481322GF-A50Y-A	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481322GF-A60Y-A	3.5	167				
μPD4481322GF-A75Y-A	4.2	133		3.3 V LVTTTL <sup>Note</sup>		
μPD4481362GF-A44Y-A	2.8	225				
μPD4481362GF-A50Y-A	3.2	200		3.3 V or 2.5 V LVTTTL		
μPD4481362GF-A60Y-A	3.5	167				
μPD4481362GF-A75Y-A	4.2	133		2.5 ± 0.125		
μPD4481162GF-C60Y-A	3.5	167				
μPD4481162GF-C75Y-A	4.2	133				
μPD4481182GF-C60Y-A	3.5	167				
μPD4481182GF-C75Y-A	4.2	133				
μPD4481322GF-C60Y-A	3.5	167				
μPD4481322GF-C75Y-A	4.2	133				
μPD4481362GF-C60Y-A	3.5	167				
μPD4481362GF-C75Y-A	4.2	133				

**Note** Although 2.5V LVTTTL interface can also be used, a performance becomes equivalent to -A60Y (167 MHz).

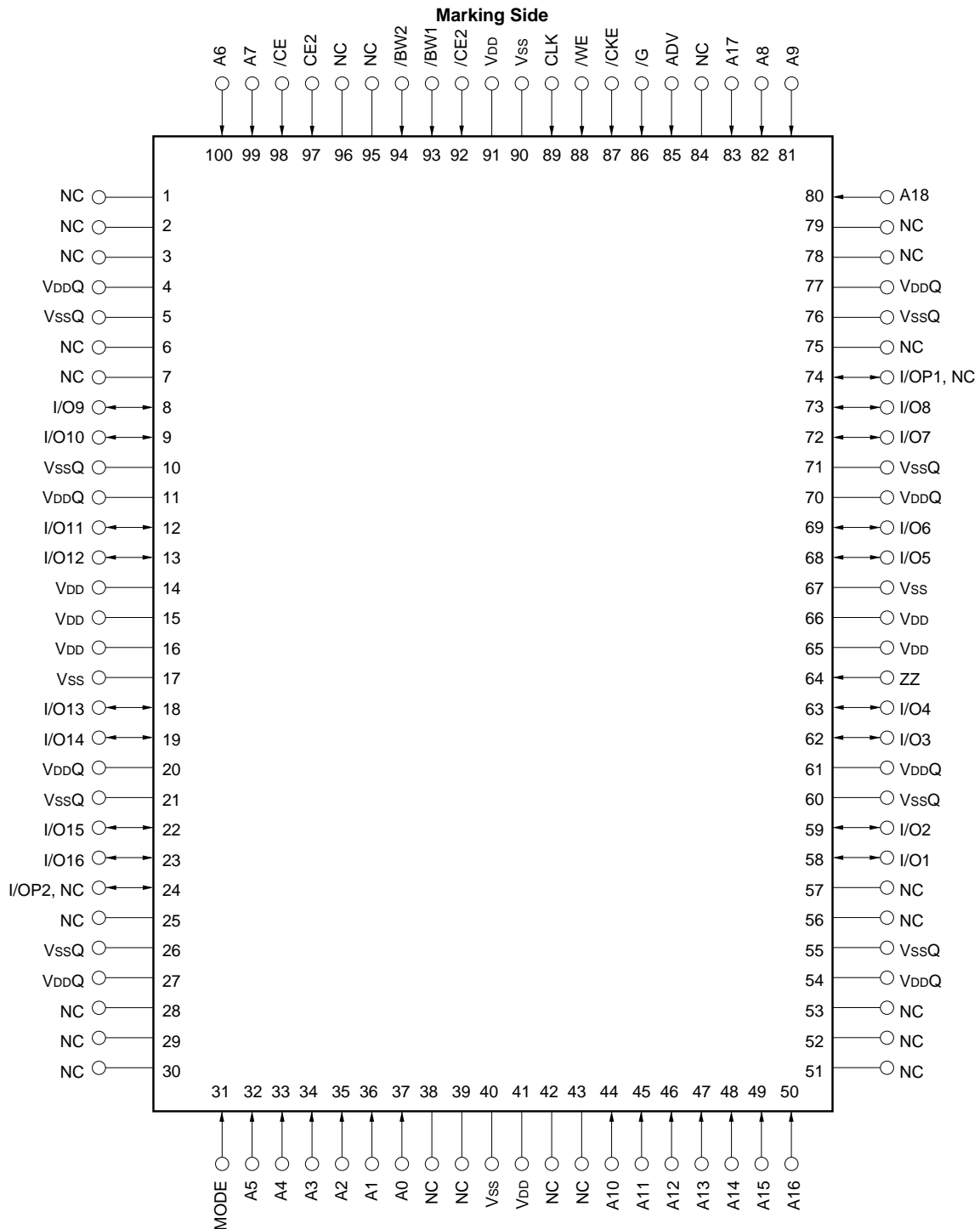
**Remark** Products with -A at the end of the part number are lead-free products.

Pin Configurations

/xxx indicates active low signal.

100-pin PLASTIC LQFP (14 × 20)  
 [μPD4481162GF, μPD4481182GF]  
 [μPD4481162GF-A, μPD4481182GF-A]

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

## Pin Identifications

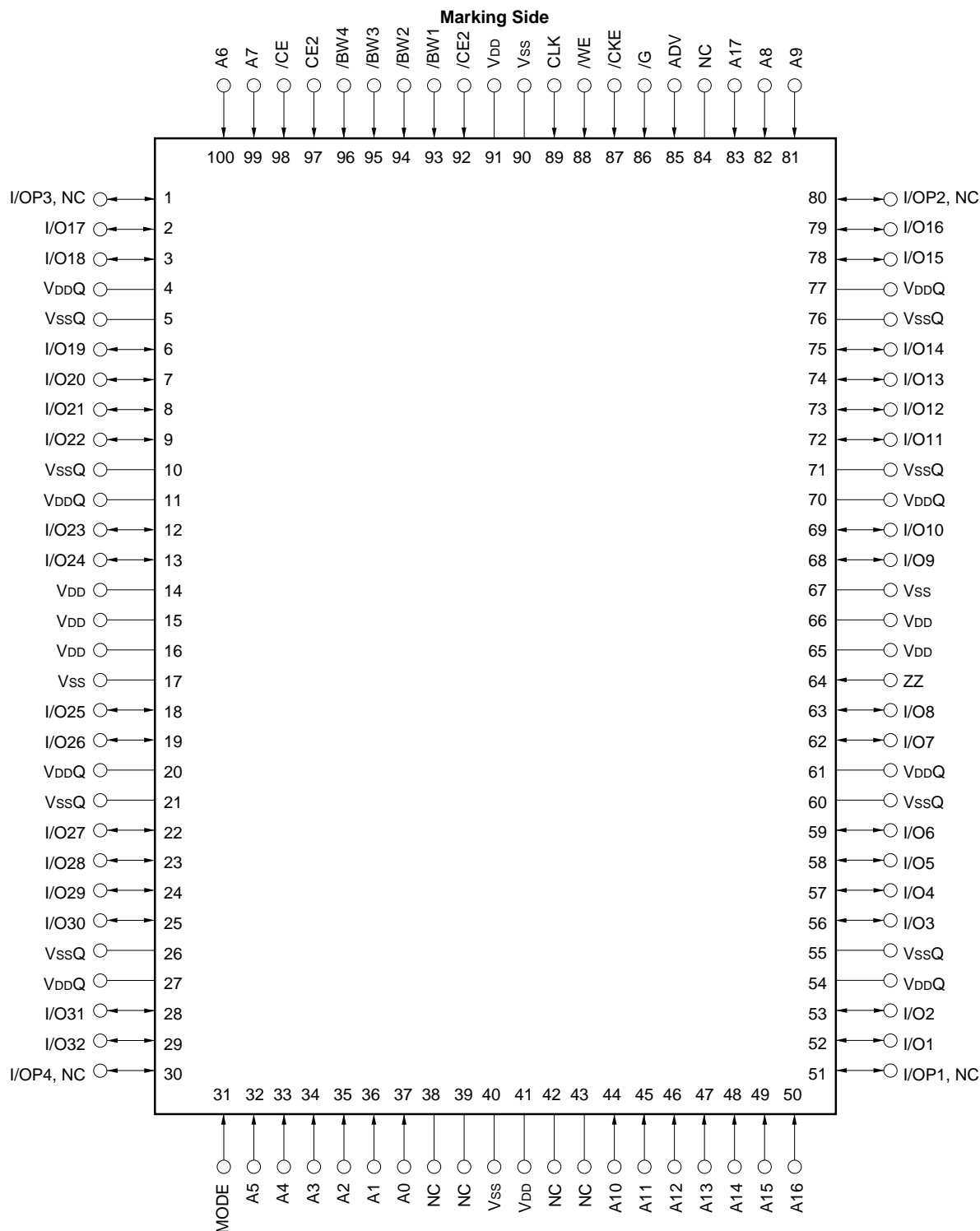
<R> [ $\mu$ PD4481162GF,  $\mu$ PD4481182GF,  $\mu$ PD4481162GF-A,  $\mu$ PD4481182GF-A]

Symbol	Pin No.	Description
A0 to 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 to 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 <sup>Note</sup>	74	Synchronous Data In (Parity), Synchronous / Asynchronous Data Out (Parity)
I/OP2, NC <sup>Note</sup>	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 <sub>DD</sub> or V <sub>SS</sub> during normal operation
ZZ	64	Asynchronous Power Down State Input
V <sub>DD</sub>	14, 15, 16, 41, 65, 66, 91	Power Supply
V <sub>SS</sub>	17, 40, 67, 90	Ground
V <sub>DDQ</sub>	4, 11, 20, 27, 54, 61, 70, 77	Output Buffer Power Supply
V <sub>SSQ</sub>	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  $\mu$ PD4481162GF.I/OP1 and I/OP2 are used in the  $\mu$ PD4481182GF.

100-pin PLASTIC LQFP (14 × 20)  
 [μPD4481322GF, μPD4481362GF]  
 [μPD4481322GF-A, μPD4481362GF-A]

<R>



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



<R> [ $\mu$ PD4481322GF,  $\mu$ PD4481362GF,  $\mu$ PD4481322GF-A,  $\mu$ PD4481362GF-A]

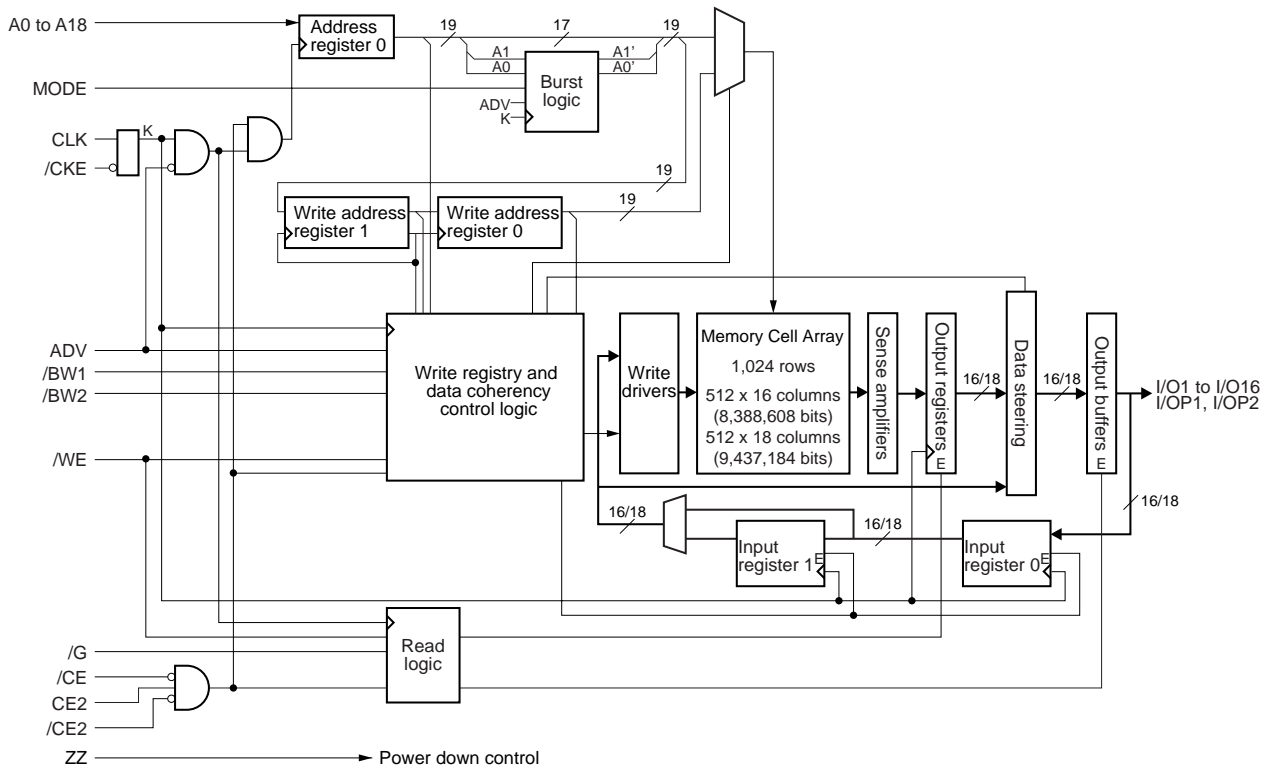
Symbol	Pin No.	Description
A0 to A17	37, 36, 35, 34, 33, 32, 100, 99, 82, 81, 44, 45, 46, 47, 48, 49, 50, 83	Synchronous Address Input
I/O1 to I/O32	52, 53, 56, 57, 58, 59, 62, 63, 68, 69, 72, 73, 74, 75, 78, 79, 2, 3, 6, 7, 8, 9, 12, 13, 18, 19, 22, 23, 24, 25, 28, 29	Synchronous Data In, Synchronous / Asynchronous Data Out
I/OP1, NC <sup>Note</sup>	51	Synchronous Data In (Parity), Synchronous / Asynchronous Data Out (Parity)
I/OP2, NC <sup>Note</sup>	80	
I/OP3, NC <sup>Note</sup>	1	
I/OP4, NC <sup>Note</sup>	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 to /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 <sub>DD</sub> or V <sub>SS</sub> during normal operation
ZZ	64	Asynchronous Power Down State Input
V <sub>DD</sub>	14, 15, 16, 41, 65, 66, 91	Power Supply
V <sub>SS</sub>	17, 40, 67, 90	Ground
V <sub>DDQ</sub>	4, 11, 20, 27, 54, 61, 70, 77	Output Buffer Power Supply
V <sub>SSQ</sub>	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  $\mu$ PD4481322GF.

I/OP1 to I/OP4 are used in the  $\mu$ PD4481362GF.

Block Diagrams

[μPD4481162, μPD4481182]



Burst Sequence

[μPD4481162, μPD4481182]

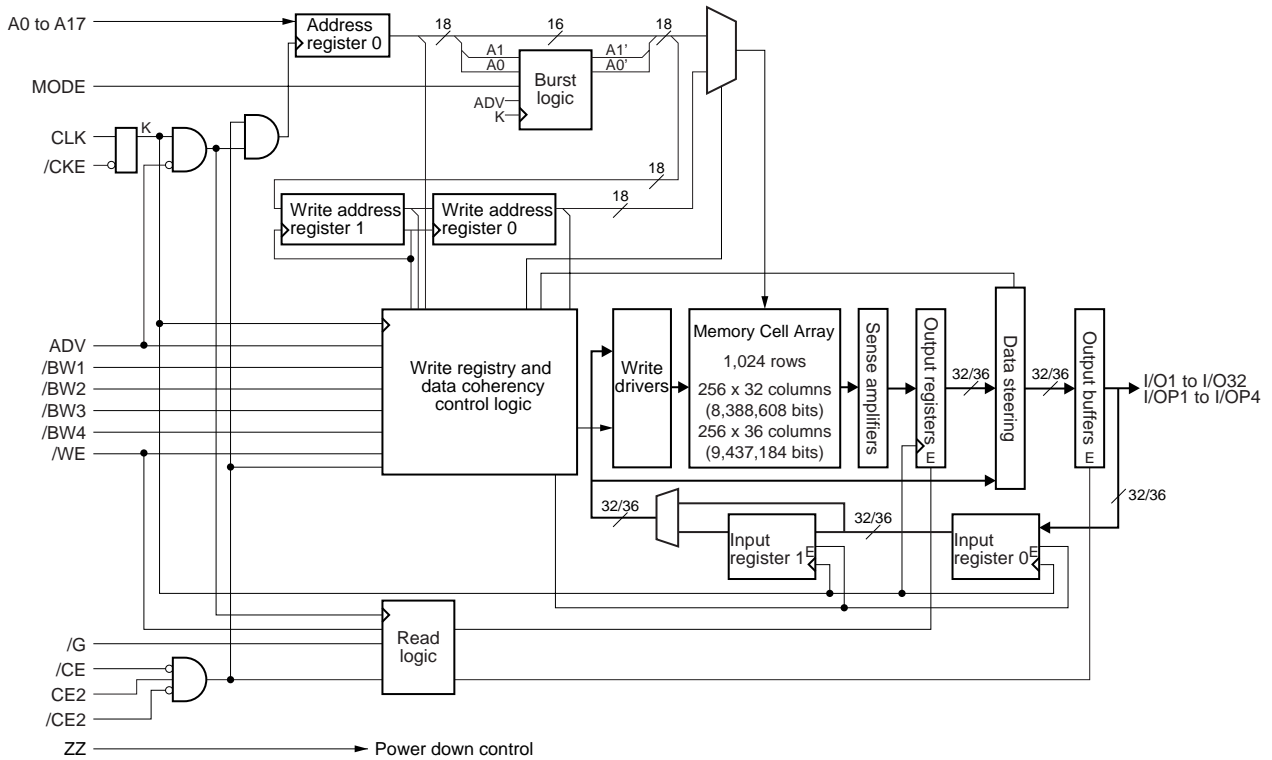
Interleaved Burst Sequence Table (MODE = V<sub>DD</sub>)

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

Linear Burst Sequence Table (MODE = V<sub>SS</sub>)

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

[μPD4481322, μPD4481362]



[μPD4481322, μPD4481362]

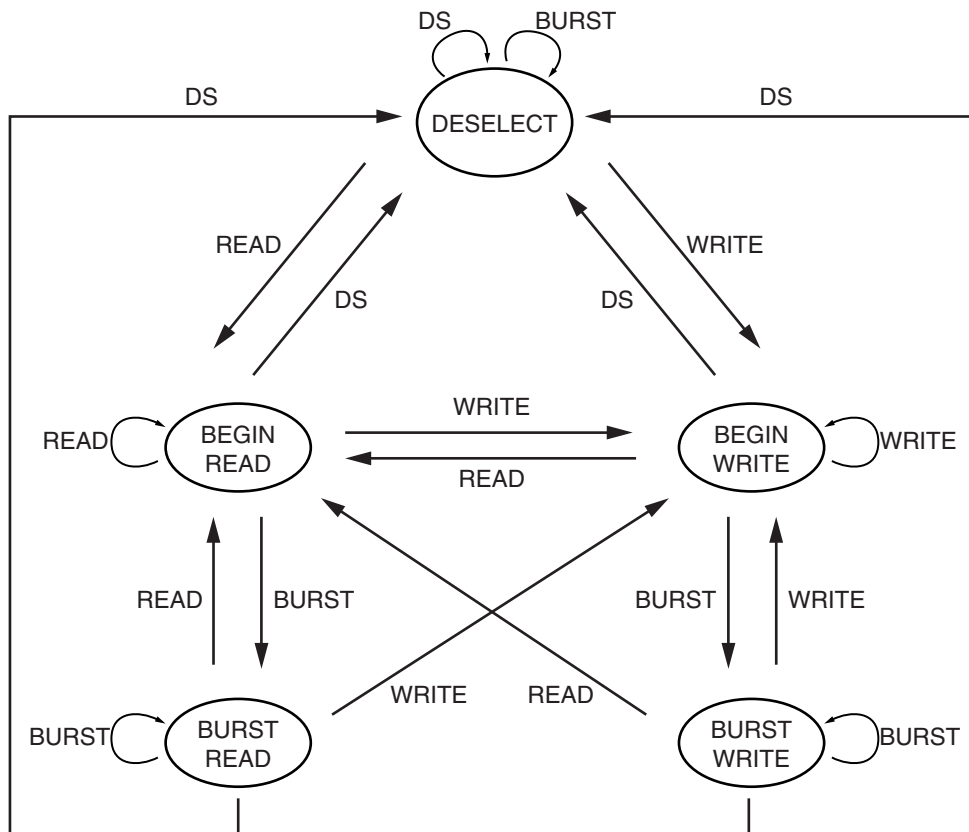
**Interleaved Burst Sequence Table (MODE = V<sub>DD</sub>)**

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

**Linear Burst Sequence Table (MODE = V<sub>SS</sub>)**

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

State Diagram



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

- Remarks**
- States change on the rising edge of the clock.
  - A Stall or 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	Dout
Read Cycle	H	High-Z
Write Cycle	×	High-Z, Din
Deselected	×	High-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	High-Z	None	1
Deselected	×	L	×	L	×	×	L	L → H	High-Z	None	1
Deselected	×	×	H	L	×	×	L	L → H	High-Z	None	1
Continue Deselected	×	×	×	H	×	×	L	L → H	High-Z	None	1
Read Cycle / Begin Burst	L	H	L	L	H	×	L	L → H	Dout	External	
Read Cycle / Continue Burst	×	×	×	H	×	×	L	L → H	Dout	Next	
Write Cycle / Begin Burst	L	H	L	L	L	L	L	L → H	Din	External	
Write Cycle / Continue Burst	×	×	×	H	×	L	L	L → H	Din	Next	
Write Cycle / Write Abort	L	H	L	L	L	H	L	L → H	High-Z	External	
Write Cycle / Write Abort	×	×	×	H	×	H	L	L → H	High-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 impedance). If it occurs during a write cycle, the bus will remain high impedance. 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

[μPD4481162, μPD4481182]

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

[μPD4481322, μPD4481362]

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 <sub>DD</sub> - 0.2 V	Sleep

**Electrical Specifications**

**Absolute Maximum Ratings**

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Supply voltage	V <sub>DD</sub>	-A44, -A50, -A60, -A75	-0.5		+4.0	V
		-A44Y, -A50Y, -A60Y, -A75Y				
		-C60, -C75	-0.5		+3.0	
		-C60Y, -C75Y				
Output supply voltage	V <sub>DDQ</sub>		-0.5		V <sub>DD</sub>	V
Input voltage	V <sub>IN</sub>		-0.5 <sup>Note</sup>		V <sub>DD</sub> + 0.5	V
Input / Output voltage	V <sub>I/O</sub>		-0.5 <sup>Note</sup>		V <sub>DDQ</sub> + 0.5	V
Operating ambient temperature	T <sub>A</sub>	-A44, -A50, -A60, -A75, -C60, -C75	0		70	°C
		-A44Y, -A50Y, -A60Y, -A75Y, -C60Y, -C75Y	-40		+85	
Storage temperature	T <sub>stg</sub>		-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**

(1/2)

Parameter	Symbol	Conditions	-A44, -A50, -A60, -A75 -A44Y, -A50Y, -A60Y, -A75Y			Unit
			MIN.	TYP.	MAX.	
			Supply voltage	V <sub>DD</sub>	3.135	
<b>2.5 V LVTTTL Interface</b>						
Output supply voltage	V <sub>DDQ</sub>		2.375	2.5	2.9	V
High level input voltage	V <sub>IH</sub>		1.7		V <sub>DDQ</sub> + 0.3	V
Low level input voltage	V <sub>IL</sub>		-0.3 <sup>Note</sup>		+0.7	V
<b>3.3 V LVTTTL Interface</b>						
Output supply voltage	V <sub>DDQ</sub>		3.135	3.3	3.465	V
High level input voltage	V <sub>IH</sub>		2.0		V <sub>DDQ</sub> + 0.3	V
Low level input voltage	V <sub>IL</sub>		-0.3 <sup>Note</sup>		+0.8	V

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

**Recommended DC Operating Conditions**

(2/2)

Parameter	Symbol	Conditions	-C60, -C75 -C60Y, -C75Y			Unit
			MIN.	TYP.	MAX.	
			Supply voltage	V <sub>DD</sub>	2.375	
Output supply voltage	V <sub>DDQ</sub>	2.375	2.5	2.625	V	
High level input voltage	V <sub>IH</sub>	1.7		V <sub>DDQ</sub> + 0.3	V	
Low level input voltage	V <sub>IL</sub>	-0.3 <sup>Note</sup>		+0.7	V	

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

**DC Characteristics (V<sub>DD</sub> = 3.3 ± 0.165 V or 2.5 ± 0.125 V)**

Parameter	Symbol	Test condition	MIN.	TYP.	MAX.	Unit
Input leakage current	I <sub>LI</sub>	V <sub>IN</sub> (except ZZ, MODE) = 0 V to V <sub>DD</sub>	-2		+2	μA
I/O leakage current	I <sub>LO</sub>	V <sub>I/O</sub> = 0 V to V <sub>DDQ</sub> , Outputs are disabled.	-2		+2	μA
Operating supply current	I <sub>DD</sub>	Device selected, Cycle = MAX. V <sub>IN</sub> ≤ V <sub>IL</sub> or V <sub>IN</sub> ≥ V <sub>IH</sub> , I <sub>I/O</sub> = 0 mA	-A44 -A44Y		440	mA
			-A50 -A50Y		400	
			-A60, -C60 -A60Y, -C60Y		320	
			-A75, -C75 -A75Y, -C75Y		300	
Standby supply current	I <sub>SB</sub>	Device deselected, Cycle = 0 MHz, V <sub>IN</sub> ≤ V <sub>IL</sub> or V <sub>IN</sub> ≥ V <sub>IH</sub> , All inputs are static.			30	mA
	I <sub>SB1</sub>	Device deselected, Cycle = 0 MHz, V <sub>IN</sub> ≤ 0.2 V or V <sub>IN</sub> ≥ V <sub>DD</sub> - 0.2 V, V <sub>I/O</sub> ≤ 0.2 V, All inputs are static.			15	
	I <sub>SB2</sub>	Device deselected, Cycle = MAX. V <sub>IN</sub> ≤ V <sub>IL</sub> or V <sub>IN</sub> ≥ V <sub>IH</sub>			130	
Power down supply current	I <sub>SBZZ</sub>	ZZ ≥ V <sub>DD</sub> - 0.2 V, V <sub>I/O</sub> ≤ V <sub>DDQ</sub> + 0.2 V			15	mA
<b>2.5 V LVTTTL Interface</b>						
High level output voltage	V <sub>OH</sub>	I <sub>OH</sub> = -2.0 mA	1.7			V
		I <sub>OH</sub> = -1.0 mA	2.1			
Low level output voltage	V <sub>OL</sub>	I <sub>OL</sub> = +2.0 mA			0.7	V
		I <sub>OL</sub> = +1.0 mA			0.4	
<b>3.3 V LVTTTL Interface</b>						
High level output voltage	V <sub>OH</sub>	I <sub>OH</sub> = -4.0 mA	2.4			V
Low level output voltage	V <sub>OL</sub>	I <sub>OL</sub> = +8.0 mA			0.4	V

**Capacitance (T<sub>A</sub> = 25 °C, f = 1MHz)**

Parameter	Symbol	Test condition	MIN.	TYP.	MAX.	Unit
Input capacitance	C <sub>IN</sub>	V <sub>IN</sub> = 0 V			6.0	pF
Input / Output capacitance	C <sub>I/O</sub>	V <sub>I/O</sub> = 0 V			8.0	pF
Clock input capacitance	C <sub>clk</sub>	V <sub>clk</sub> = 0 V			6.0	pF

**Remark** These parameters are periodically sampled and not 100% tested.

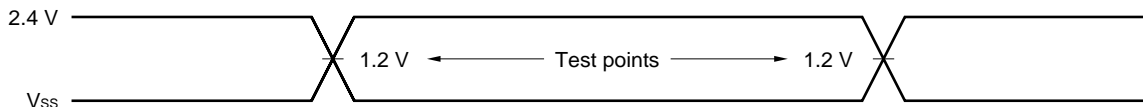


AC Characteristics ( $V_{DD} = 3.3 \pm 0.165 \text{ V}$  or  $2.5 \pm 0.125 \text{ V}$ )

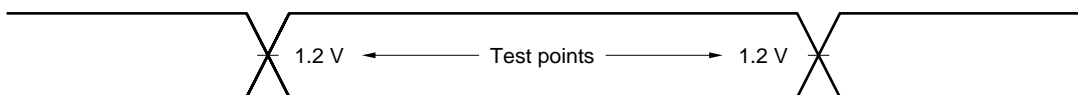
AC Test Conditions

2.5 V LVTTTL Interface

Input waveform (Rise / Fall time  $\leq 2.4 \text{ ns}$ )

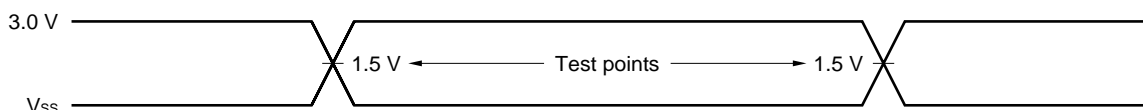


Output waveform

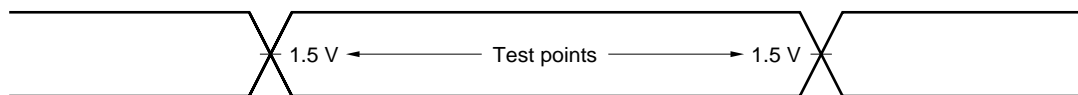


3.3 V LVTTTL Interface

Input waveform (Rise / Fall time  $\leq 3.0 \text{ ns}$ )



Output waveform

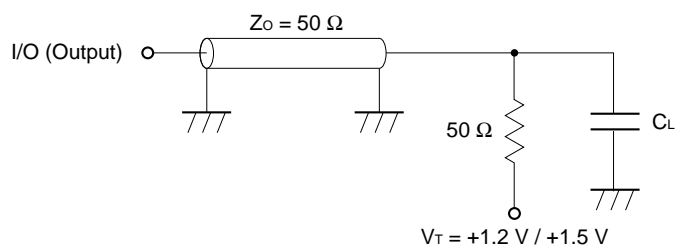


Output load condition

$C_L$ : 30 pF

5 pF (TKHQX1, TKHQX2, TGLQX, TGHQZ, TKHQZ)

Figure External load at test



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

Read and Write Cycle (2.5 V LVTTTL Interface)

Parameter	Symbol		-A44, -A50, -A60, -C60 -A44Y, -A50Y, -A60Y, -C60Y (167 MHz)		-A75, -C75 -A75Y, -C75Y (133 MHz)		Unit	Notes
	Standard	Alias	MIN.	MAX.	MIN.	MAX.		
Cycle time	TKHKH	TCYC	6	–	7.5	–	ns	
Clock access time	TKHQV	TCD	–	3.5	–	4.2	ns	
Output enable access time	TGLQV	TOE	–	3.5	–	4.2	ns	
Clock high to output active	TKHQX1	TDC1	1.5	–	1.5	–	ns	1, 2
Clock high to output change	TKHQX2	TDC2	1.5	–	1.5	–	ns	
Output enable to output active	TGLQX	TOLZ	0	–	0	–	ns	1
Output disable to output High-Z	TGHQZ	TOHZ	0	3.5	0	4.2	ns	1
Clock high to output High-Z	TKHQZ	TCZ	1.5	3.5	1.5	3.5	ns	1, 2
Clock high pulse width	TKHKL	TCH	1.8	–	2.2	–	ns	
Clock low pulse width	TKLKH	TCL	1.8	–	2.2	–	ns	
Setup times	Address	TAVKH	TAS	1.5	–	1.5	–	ns
	Address advance	TADVVKH	TADVS					
	Clock enable	TEVKH	TCES					
	Chip enable	TCVKH	TCSS					
	Data in	TDVKH	TDS					
	Write enable	TWVKH	TWS					
Hold times	Address	TKHAX	TAH	0.5	–	0.5	–	ns
	Address advance	TKHADVX	TADVH					
	Clock enable	TKHEX	TCEH					
	Chip enable	TKHCX	TCSH					
	Data in	TKHDX	TDH					
	Write enable	TKHWX	TWH					
Power down entry time	TZZE	TZZE	–	12	–	15	ns	
Power down recovery time	TZZR	TZZR	–	12	–	15	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 (T<sub>A</sub> min., V<sub>DD</sub> max.) than TKHQZ, which is a max. parameter (worse case at T<sub>A</sub> max., V<sub>DD</sub> min.).

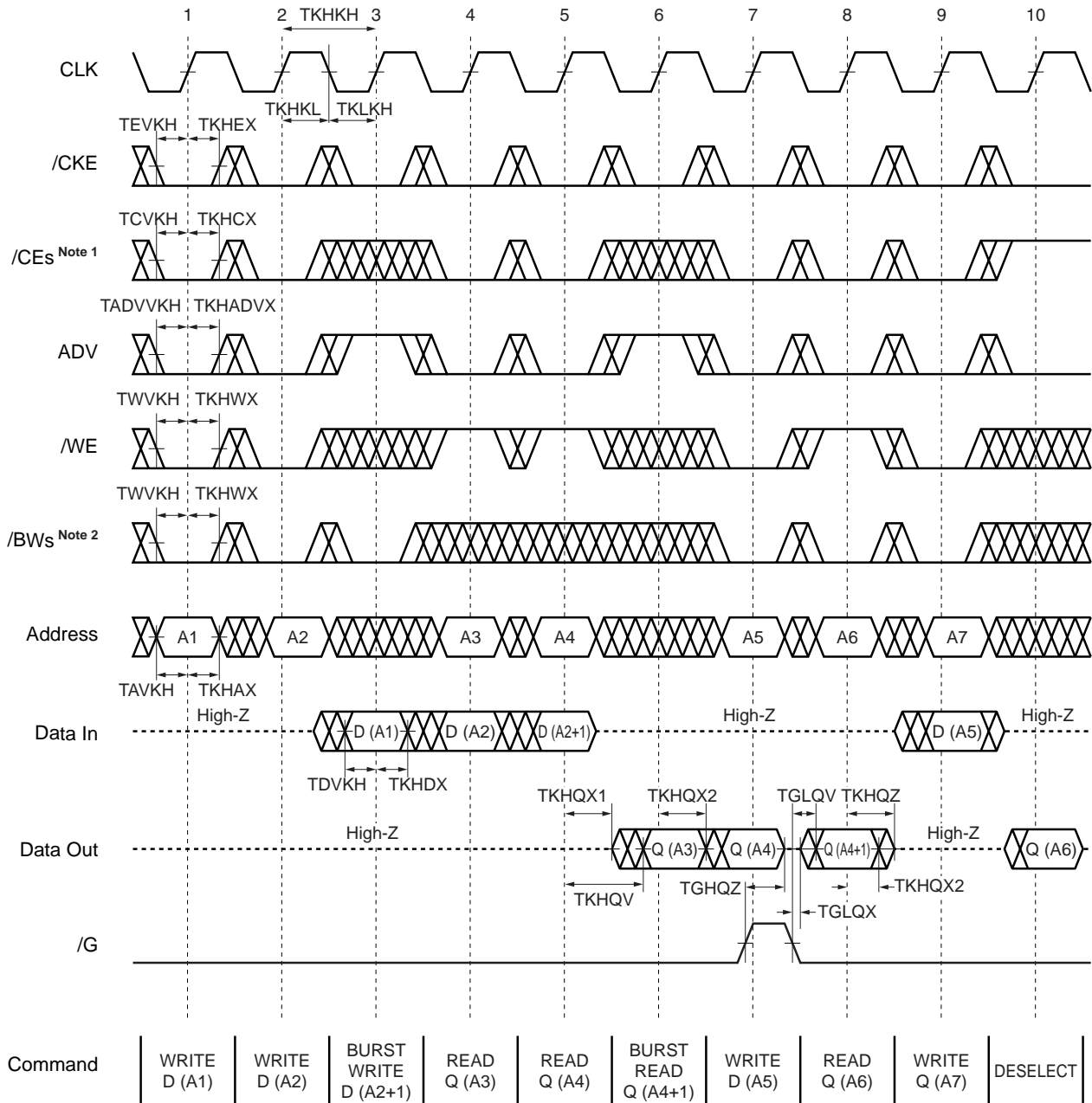
Read and Write Cycle (3.3 V LVTTTL Interface)

Parameter	Symbol		-A44 -A44Y (225 MHz)		-A50 -A50Y (200 MHz)		-A60 -A60Y (167 MHz)		-A75 -A75Y (133 MHz)		Unit	Notes
	Standard	Alias	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.		
Cycle time	TKHKH	TCYC	4.4	–	5	–	6	–	7.5	–	ns	
Clock access time	TKHQV	TCD	–	2.8	–	3.2	–	3.5	–	4.2	ns	
Output enable access time	TGLQV	TOE	–	2.8	–	3.2	–	3.5	–	4.2	ns	
Clock high to output active	TKHQX1	TDC1	1.5	–	1.5	–	1.5	–	1.5	–	ns	1, 2
Clock high to output change	TKHQX2	TDC2	1.5	–	1.5	–	1.5	–	1.5	–	ns	
Output enable to output active	TGLQX	TOLZ	0	–	0	–	0	–	0	–	ns	1
Output disable to output High-Z	TGHQZ	TOHZ	0	2.8	0	3.2	0	3.5	0	4.2	ns	1
Clock high to output High-Z	TKHQZ	TCZ	1.5	2.8	1.5	3.2	1.5	3.5	1.5	3.5	ns	1, 2
Clock high pulse width	TKHKL	TCH	1.8	–	1.8	–	1.8	–	2.2	–	ns	
Clock low pulse width	TKLKH	TCL	1.8	–	1.8	–	1.8	–	2.2	–	ns	
Setup times	Address	TAVKH	TAS	1.4	–	1.5	–	1.5	–	1.5	–	ns
	Address advance	TADVVKH	TADVS									
	Clock enable	TEVKH	TCES									
	Chip enable	TCVKH	TCSS									
	Data in	TDVKH	TDS									
	Write enable	TWVKH	TWS									
Hold times	Address	TKHAX	TAH	0.4	–	0.5	–	0.5	–	0.5	–	ns
	Address advance	TKHADVX	TADVH									
	Clock enable	TKHEX	TCEH									
	Chip enable	TKHCX	TCSH									
	Data in	TKHDX	TDH									
	Write enable	TKHWX	TWH									
Power down entry time	TZZE	TZZE	–	8.8	–	10	–	12	–	15	ns	
Power down recovery time	TZZR	TZZR	–	8.8	–	10	–	12	–	15	ns	

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

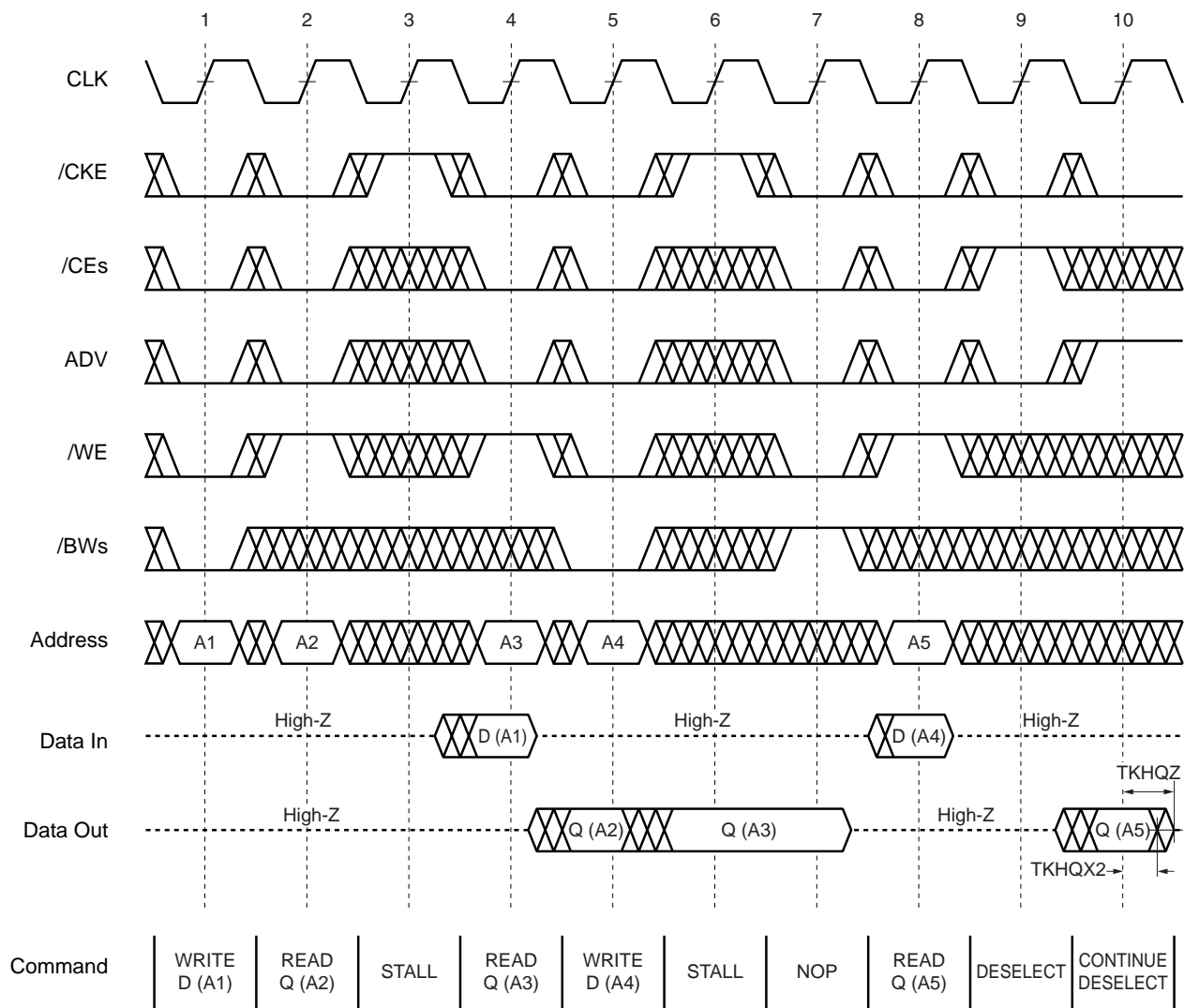
2. To avoid bus contention, the output buffers are designed such that TKHQZ (device turn-off) is faster than TKHQX1 (device turn-on) at a given temperature and voltage. The specs as shown do not imply bus contention because TKHQX1 is a min. parameter that is worse case at totally different conditions (T<sub>A</sub> min., V<sub>DD</sub> max.) than TKHQZ, which is a max. parameter (worse case at T<sub>A</sub> max., V<sub>DD</sub> min.).

READ / WRITE CYCLE

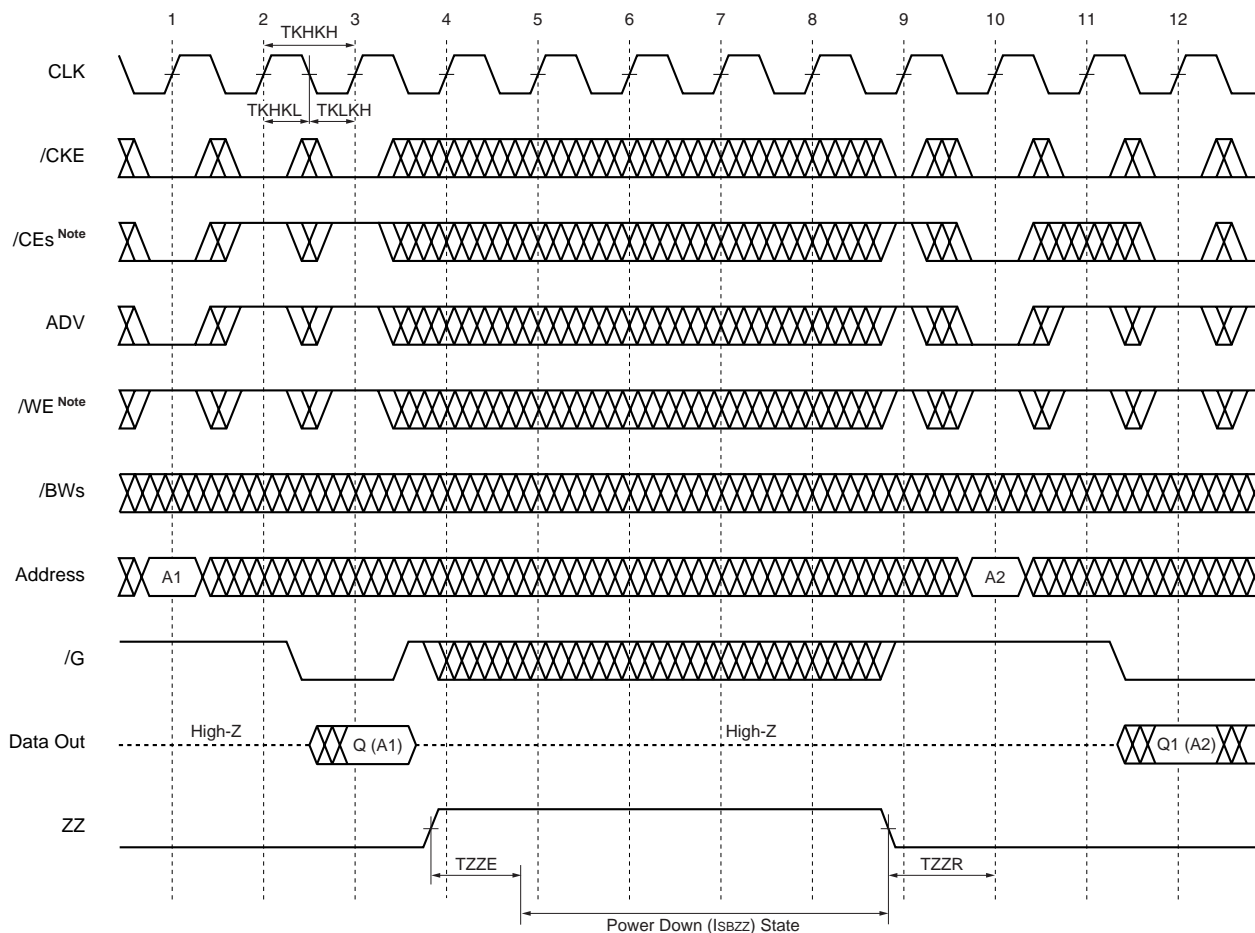


- Notes**
1. /CEs refers to /CE, CE2 and /CE2. When /CEs is LOW, /CE and /CE2 are LOW and CE2 is HIGH. When /CEs is HIGH, /CE and /CE2 are HIGH and CE2 is LOW.
  2. /BWs refers to /BW1, /BW2, /BW3 and /BW4. When /BWs is LOW, any one or more byte write enables (/BW1, /BW2, /BW3 or /BW4) are LOW.

NOP, STALL AND DESELECT CYCLE



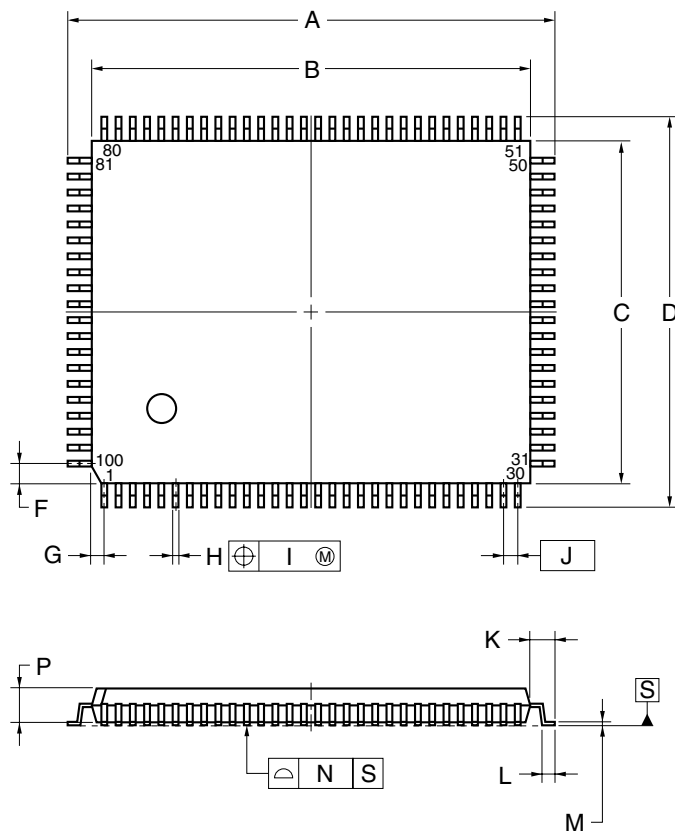
POWER DOWN (ZZ) CYCLE



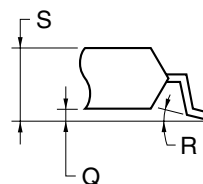
**Note** /WE or /CEs must be held HIGH at CLK rising edge (clock edge No.2 and No.3 in this figure) prior to power down state entry.

Package Drawing

100-PIN PLASTIC LQFP (14x20)



detail of lead end



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 <sup>+0.08</sup> <sub>-0.07</sub>
I	0.13
J	0.65 (T.P.)
K	1.0±0.2
L	0.5±0.2
M	0.17 <sup>+0.06</sup> <sub>-0.05</sub>
N	0.10
P	1.4
Q	0.125±0.075
R	3° <sup>+7°</sup> <sub>-3°</sub>
S	1.7 MAX.

S100GF-65-8ET-1

**Recommended Soldering Condition**

Please consult with our sales offices for soldering conditions of the  $\mu$ PD4481162, 4481182, 4481322 and 4481362.

**Types of Surface Mount Devices**

$\mu$ PD4481162GF : 100-pin PLASTIC LQFP (14 x 20)

$\mu$ PD4481182GF : 100-pin PLASTIC LQFP (14 x 20)

$\mu$ PD4481322GF : 100-pin PLASTIC LQFP (14 x 20)

$\mu$ PD4481362GF : 100-pin PLASTIC LQFP (14 x 20)

<R>  $\mu$ PD4481162GF-A : 100-pin PLASTIC LQFP (14 x 20)

<R>  $\mu$ PD4481182GF-A : 100-pin PLASTIC LQFP (14 x 20)

<R>  $\mu$ PD4481322GF-A : 100-pin PLASTIC LQFP (14 x 20)

<R>  $\mu$ PD4481362GF-A : 100-pin PLASTIC LQFP (14 x 20)



**Revision History**

Edition/ Date	Page		Type of revision	Location	Description  (Previous edition → This edition)
	This edition	Previous edition			
4th edition/ Feb. 2006	pp.2-5	pp.2,3	Addition	Ordering Information	Lead-free products have been added
	pp.6-9	pp.4-7	Addition	Pin Configuration	Lead-free products have been added
	p.24	p.22	Addition	Recommended Soldering Conditions	Lead-free products have been added

[MEMO]

## NOTES FOR CMOS DEVICES

**① VOLTAGE APPLICATION WAVEFORM AT INPUT PIN**

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between  $V_{IL}$  (MAX) and  $V_{IH}$  (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between  $V_{IL}$  (MAX) and  $V_{IH}$  (MIN).

**② HANDLING OF UNUSED INPUT PINS**

Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to  $V_{DD}$  or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

**③ PRECAUTION AGAINST ESD**

A 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 when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up 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 benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

**④ STATUS BEFORE INITIALIZATION**

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

**⑤ POWER ON/OFF SEQUENCE**

In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current.

The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

**⑥ INPUT OF SIGNAL DURING POWER OFF STATE**

Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

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