NEC

NEC Electronics Inc.

μPD446
2,048 x 8-BIT STATIC CMOS RAM

Revision 3

Description

The μPD446 is a high-speed, low-power, 2048-word by 8-bit static CMOS RAM fabricated with advanced silicon-gate CMOS technology. A unique circuitry technique makes the μPD446 a very low operating power device which requires no clock or refreshing to operate. Minimum standby power current is drawn by this device when $\overline{CS}$ equals V_{CC} independently of the other input levels. Data retention is guaranteed at a power supply voltage as low as 2 V.

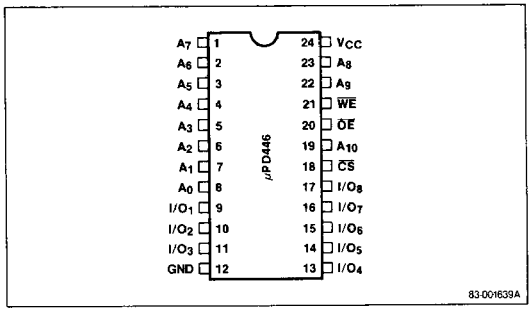
The μPD446 has a standard 24-pin dual-in-line package and is plug-in compatible with 16K EPROMs.

The μPD446 is also packaged in a miniflat package providing high density application.

Features

- ☐ Single +5 V supply
- ☐ Fully static operation — no clock or refreshing required
- ☐ TTL compatible — all inputs and outputs
- ☐ Common I/O using three-state output
- ☐ $\overline{OE}$ eliminates need for external bus buffers
- ☐ Max access/min cycle times down to 150 ns
- ☐ Low power dissipation
  - — Active: 38 mA max
  - — Standby: 10 μA max
- ☐ Data retention voltage: 2 V min
- ☐ Operating temperature range: −40°C to +85°C
- ☐ Standard 24-pin plastic package (μPD446C)
- ☐ Plug-in compatible with 16K EPROMs (μPD446C)
- ☐ Miniflat package for high density application (μPD446G)
- ☐ L version
  - — Standby current 1.0 μA max at 60°C for battery backup operation

Pin Configuration



Pin Identification

No.	Symbol	Function
1–8, 19, 22, 23	A_0–A_{10}	Address input
9–11, 13–17	I/O_1–I/O_8	Data input / output
18	$\overline{CS}$	Chip select
20	$\overline{OE}$	Output enable
21	$\overline{WE}$	Write enable
24	V_{CC}	Power (+5 V)
12	GND	GND

Performance Ranges

Device	Access Time (Max)	Cycle Time (Min)	Power Supply (Max)	
			Active	Standby
μPD446C-3, 446G-15	150 ns	150 ns	38 mA	(Note 1)
μPD446C-2, 446G-20	200 ns	200 ns	30 mA	(Note 1)
μPD446C-1, 446G-25	250 ns	250 ns	26 mA	(Note 1)
μPD446C, 446G-45	450 ns	450 ns	18 mA	(Note 1)

Note:

(1) μPD446C-L/-1L/-2L/-3L, μPD446G-45L/25L/20L/15L

$T_A = 25°C$, 0.2 μA

$T_A = 60°C$, 1.0 μA

$T_A = 85°C$, 10 μA

μPD446C/-1/-2/-3, μPD446G-45/25/20/15

$T_A = 25°C$, 1.0 μA

$T_A = 60°C$, 5.0 μA

$T_A = 85°C$, 10 μA

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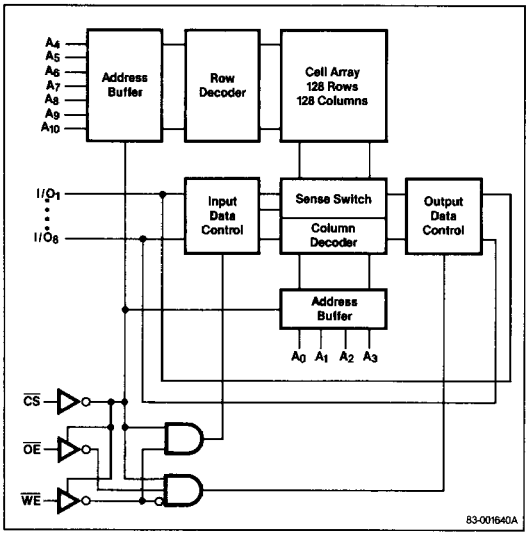
Block Diagram



Absolute Maximum Ratings

Power supply voltage, V_{CC}	7.0 V
Input voltage, V_{IN}	−0.3 to V_{CC} + 0.3 V
Output voltage, V_{OUT}	−0.3 to V_{CC} + 0.3 V
Operating temperature, T_{OPR}	−40 to 85°C
Storage temperature, T_{STG}	−55 to 125°C

Comment: Exposing the device to stresses 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 sections of the specification. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Capacitance

T_A = 25°C, f = 1MHz

Parameter	Symbol	Limits Min	Typ	Max	Unit	Test Conditions
Input capacitance	C_{IN}			6	pF	V_{IN} = 0 V
Input/output capacitance	$C_{I/O}$			8	pF	$V_{I/O}$ = 0 V

Recommended DC Operating Conditions

T_A = −40 to +85°C

Parameter	Symbol	Limits Min	Typ	Max	Unit
Supply voltage	V_{CC}	4.5	5.0	5.5	V
Input voltage low	V_{IL}	−0.3		0.8	V
Input voltage high	V_{IH}	2.2		V_{CC} + 0.3	V

DC Characteristics

T_A = −40 to 85°C, V_{CC} = 5 V ± 10%

Parameter	Symbol	Limits Min	Typ	Max	Unit	Test Conditions
Input leakage current	I_{LI}			1	μA	V_{IN} = 0 V to V_{CC}
I/O leakage current	I_{LO}			1	μA	$V_{I/O}$ = 0 V to V_{CC}, $\overline{CS}$ = V_{IH} or $\overline{OE}$ = V_{IH} or $\overline{WE}$ = V_{IL}
Operating supply current	I_{CCA1}		(1)	(1)	mA	$\overline{CS}$ = V_{IL}, $I_{I/O}$ = 0 V min cycle
Operating supply current	I_{CCA2}		5	10	mA	$\overline{CS}$ = V_{IL}, $I_{I/O}$ = 0 V DC current
Standby supply current	I_{CCS}		0.02	(2)	μA	$\overline{CS}$ = V_{CC} − 0.2 V, V_{IN} = 0 V to V_{CC}
Output voltage low	V_{OL}			0.4	V	I_{OL} = 2.0 mA
Output voltage high	V_{OH}	2.4			V	I_{OH} = −1.0 mA

Notes:

(1) μPD446C-3/3L, μPD446G-15/15L: 25 mA typ, 38 mA max
μPD446C-2/2L, μPD446G-20/20L: 20 mA typ, 30 mA max
μPD446C-1/1L, μPD446G-25/25L: 18 mA typ, 26 mA max
μPD446C/-L, μPD446G-45/45L: 12 mA typ, 18 mA max

(2) μPD446C-L/-1L/-2L/-3L, μPD446G-45L/25L/20L/15L
T_A = 25°C, 0.2 μA
T_A = 60°C, 1.0 μA
T_A = 85°C, 10 μA
μPD446C/-1/-2/-3, μPD446G-45/25/20/15
T_A = 25°C, 1.0 μA
T_A = 60°C, 5.0 μA
T_A = 85°C, 10 μA

AC Characteristics

$T_A = -40$ to 85°C, $V_{CC} = 5\ V \pm 10\%$

Parameter	Symbol	μPD446C-3 μPD446G-15 Min	μPD446C-3 μPD446G-15 Max	μPD446C-2 μPD446G-20 Min	μPD446C-2 μPD446G-20 Max	μPD446C-1 μPD446G-25 Min	μPD446C-1 μPD446G-25 Max	μPD446C μPD446G-45 Min	μPD446C μPD446G-45 Max	Unit
Read Cycle										
Read cycle time	t_{RC}	150		200		250		450		ns
Address access time	t_{AA}		150		200		250		450	ns
Chip select access time	t_{ACS}		150		200		250		450	ns
Output enable to output valid	t_{OE}		75		100		120		150	ns
Output hold from address change	t_{OH}	15		15		15		15		ns
Chip select to output in Lo-Z	t_{CLZ}	10		10		10		10		ns
Output enable to output in Lo-Z	t_{OLZ}	5		5		5		5		ns
Chip deselect to output in Hi-Z	t_{CHZ}		50		60		80		100	ns
Output disable to output in Hi-Z	t_{OHZ}		50		60		80		100	ns
Write Cycle										
Write cycle time	t_{WC}	150		200		250		450		ns
Chip select to end of write	t_{CW}	120		150		180		210		ns
Address valid to end of write	t_{AW}	120		150		180		210		ns
Address setup time	t_{AS}	0		0		0		0		ns
Write pulse width	t_{WP}	90		120		150		180		ns
Write recovery time	t_{WR}	0		0		0		0		ns
Data valid to end of write	t_{DW}	50		60		80		100		ns
Data hold time	t_{DH}	0		0		0		0		ns
Write enable to output in Hi-Z	t_{WHZ}		50		60		80		100	ns
Output active from end of write	t_{OW}	10		10		10		10		ns

AC Test Conditions

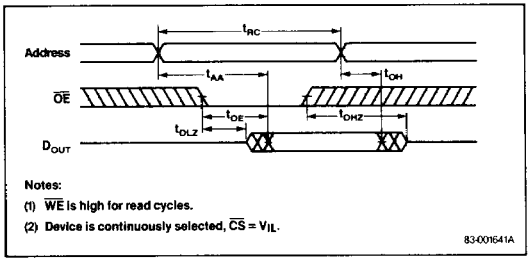
Input pulse levels	0.8 to 2.2 V
Input pulse rise and fall time	10 ns
Timing reference levels	1.5 V
Output load	1 TTL + 100 pF

Truth Table

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	MODE	I/O	I_{CC}
H	X	X	Not selected	Hi-Z	Standby
L	H	H	Not selected	Hi-Z	Active
L	L	H	Read	D_{OUT}	Active
L	X	L	Write	D_{IN}	Active

Timing Waveforms

Read Cycle No. 1



Notes:
(1) $\overline{WE}$ is high for read cycles.
(2) Device is continuously selected, $\overline{CS} = V_{IL}$.

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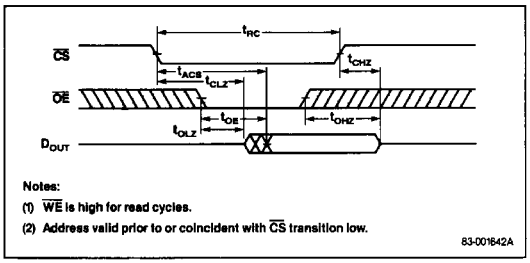
Timing Waveforms (cont)

Read Cycle No. 2



Notes:
(1) $\overline{WE}$ is high for read cycles.
(2) Address valid prior to or coincident with $\overline{CS}$ transition low.

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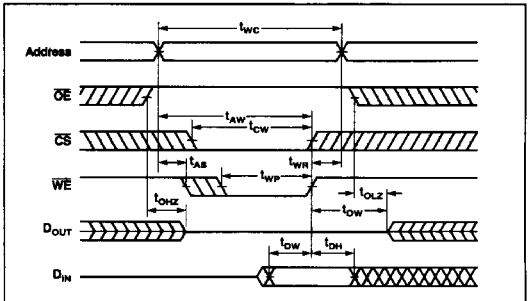
Write Cycle No. 1



Notes:
(1) $\overline{WE}$ must be high during all address transitions.
(2) A write occurs during the overlap of a low $\overline{CS}$ and a low $\overline{WE}$.
(3) t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
(4) If the $\overline{CS}$ low transition occurs simultaneously with or after the $\overline{WE}$ low transition, output buffers remain in a high impedance state.

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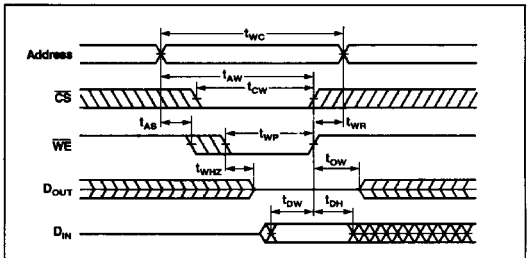
Write Cycle No. 2



Notes:
(1) $\overline{WE}$ must be high during all address transitions.
(2) A write occurs during the overlap of a low $\overline{CS}$ and a low $\overline{WE}$.
(3) t_{WR} is measured from the earlier of $\overline{CS}$ or $\overline{WE}$ going high to the end of write cycle.
(4) If the $\overline{CS}$ low transition occurs simultaneously with or after the $\overline{WE}$ low transition, output buffers remain in a high impedance state.
(5) $\overline{OE}$ is continuously low.

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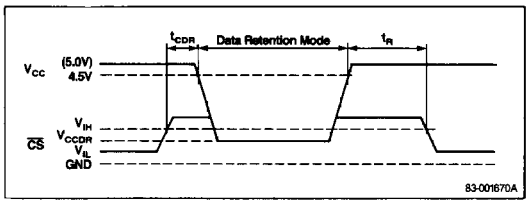
Low V_{CC} Data Retention Characteristics

$T_A = -40$ to 85°C

Parameter	Symbol	Limits Min	Typ	Max	Unit	Test Conditions
Data retention supply voltage	V_{CCDR}	2.0			V	$V_{IN} = 0$ V to V_{CC}, $\overline{CS} = V_{CC}$
Data retention supply current	I_{CCDR}		0.01	(1)	μA	$V_{IN} = 0$ V to V_{CC}, $\overline{CS} = V_{CC}$, $V_{CC} = 3.0$ V
Chip deselection to data retention mode	t_{CDR}	0			ns	
Operation recovery time	t_R	t_{RC}			ns	

Note:
(1) μPD446C-L/-1L/-2L/-3L, μPD446G-45L/25L/20L/15L
$T_A = 25$°C, 0.2 μA
$T_A = 60$°C, 1.0 μA
$T_A = 85$°C, 10 μA
μPD446C/-1/-2/-3, μPD446G-45/25/20/15
$T_A = 25$°C, 1.0 μA
$T_A = 60$°C, 5.0 μA
$T_A = 85$°C, 10 μA

Low V_{CC} Data Retention



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