

## Description

The μPD41416 is a 16,384-word by 4-bit dynamic N-channel MOS RAM designed to operate from a single +5 V power supply. The negative voltage substrate bias is internally generated; its operation is both automatic and transparent. The μPD41416 utilizes a double-polylayer, N-channel, silicon gate process which provides high storage cell density, high performance, and high reliability.

The μPD41416 uses a single transistor dynamic storage cell and advanced dynamic circuitry throughout, ensuring minimum power dissipation. Refresh is accomplished by performing RAS-only refresh cycles, hidden refresh cycles, or normal read or write cycles on the 128 address combinations of A<sub>0</sub>-A<sub>6</sub> during the refresh period of 2 milliseconds.

Multiplexed address inputs permit the μPD41416 to be packaged in a standard 18-pin dual-in-line package for high system bit density.

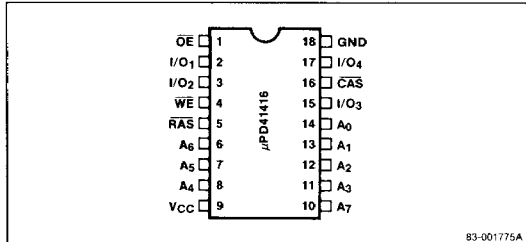
## Features

- 16,384-word × 4-bit organization
- Single +5 V power supply ± 10%
- Standard 18-pin plastic package
- CAS, OE or early write mode to control D<sub>OUT</sub> buffer impedance
- Low power dissipation,
  - Active (t<sub>RC</sub> = min): 303 mW
  - Standby: 28 mW
- Read, write, read-write, read-modify-write. RAS-only refresh, hidden refresh, and page mode capabilities
- 128 refresh cycles during 2 ms period

## Performance Ranges

Device	t <sub>RAC</sub>	t <sub>CAC</sub>	t <sub>OEA</sub>
μPD41416-12	120 ns	60 ns	30 ns
μPD41416-15	150 ns	75 ns	40 ns
μPD41416-20	200 ns	100 ns	50 ns

## Pin Configuration

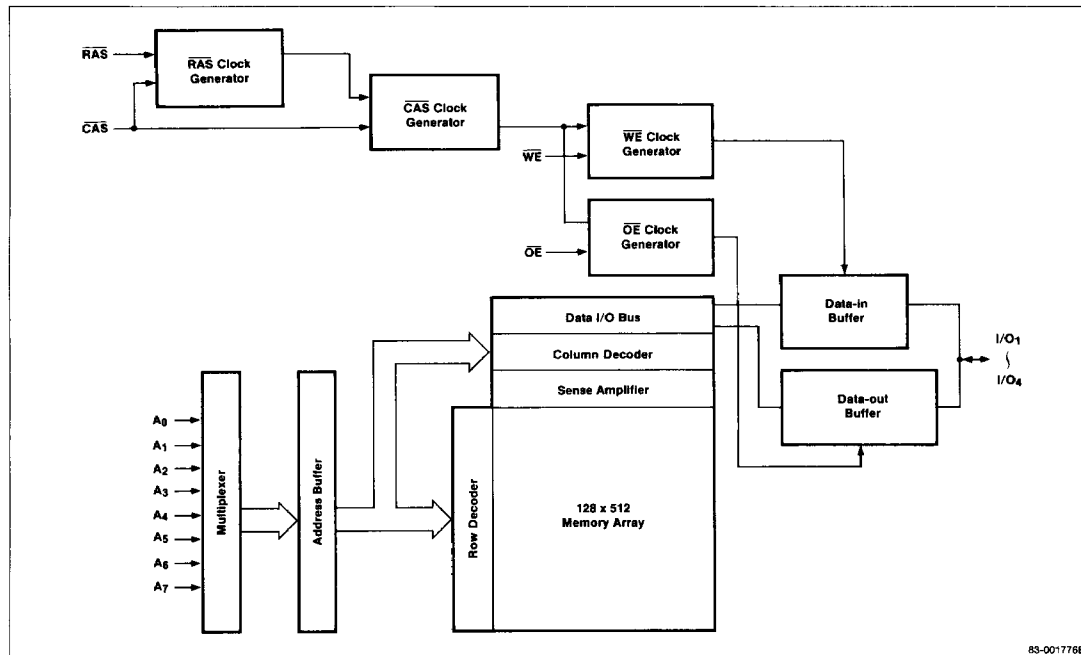


## Pin Identification

No.	Symbol	Function
1	OE	Output enable
2-3, 15, 17	I/O <sub>1</sub> -I/O <sub>4</sub>	Data input / output
4	WE	Write enable
5	RAS	Row address strobe
6-8, 10-14	A <sub>0</sub> -A <sub>7</sub>	Address inputs: A <sub>0</sub> -A <sub>5</sub> = Column address inputs A <sub>0</sub> -A <sub>6</sub> = Refresh address A <sub>0</sub> -A <sub>7</sub> = Row address inputs
9	V <sub>CC</sub>	+5 V power supply
16	CAS	Column address strobe
18	GND	Ground

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**Block Diagram**



83-001776B

**Absolute Maximum Ratings**

Voltage on any pin relative to GND	-1.0 V to +7.0 V
Storage temperature, T <sub>STG</sub>	-55°C to 125°C
Short-circuit output current, I <sub>OS</sub>	50 mA
Power dissipation, P <sub>D</sub>	1.0 W

**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<sub>A</sub> = 0°C to +70°C, V<sub>CC</sub> = 5.0 V ±10%; f = 1.0 MHz

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Input capacitance, address inputs	C <sub>I1</sub>			5	pF	
Input capacitance, strobe inputs	C <sub>I2</sub>			8	pF	
input/output capacitance, data ports	C <sub>I/O</sub>			7	pF	

**DC Characteristics**

T<sub>A</sub> = 0°C to +70°C

Parameter	Symbol	Limits			Unit	Test Conditions
		Min	Typ	Max		
Supply voltage, high	V <sub>CC</sub>	4.5	5.0	5.5	V	
Supply voltage, low	GND	0	0	0	V	
Standby supply current	I <sub>CC2</sub>			5.0	mA	RAS = V <sub>IH</sub> , D <sub>OUT</sub> = High impedance
Input leakage current	I <sub>I(L)</sub>	-10		10	μA	0 V ≤ V <sub>IN</sub> ≤ V <sub>CC</sub> , all other pins not under test = 0 V
Output leakage current	I <sub>O(L)</sub>	-10		10	μA	D <sub>OUT</sub> is disabled, 0 V ≤ V <sub>OUT</sub> ≤ +5.5 V
Output voltage, low	V <sub>OL</sub>	0		0.4	V	I <sub>OUT</sub> = 4.2 mA
Output voltage, high	V <sub>OH</sub>	2.4			V	I <sub>OUT</sub> = -2 mA
Input voltage, low	V <sub>IL</sub>	-1.0		0.8	V	
Input voltage, high	V <sub>IH</sub>	2.4		5.5	V	

## AC Characteristics (Notes 2, 3, 4)

$T_A = 0^\circ\text{C to } +70^\circ\text{C}$ ,  $V_{CC} = 5.0\text{ V} \pm 10\%$  (Note 1)

Parameter	Symbol	Limits						Unit	Test Conditions
		μPD41416-12		μPD41416-15		μPD41416-20			
		Min	Max	Min	Max	Min	Max		
Operating supply current, average	$I_{CC1}$		55		50		45	mA	$\overline{\text{RAS}}$ , CAS cycling, $t_{RC} = t_{RC \text{ min}}$ , (Note 5)
Operating supply current, refresh mode, average	$I_{CC3}$		45		40		35	mA	$\overline{\text{RAS}}$ cycling, CAS = $V_{IH}$ , $t_{RC} = t_{RC \text{ min}}$ , (Note 5)
Operating supply current, page mode operation, average	$I_{CC4}$		45		40		35	mA	$\overline{\text{RAS}} = V_{IL}$ , CAS cycling, $t_{PC} = t_{PC \text{ min}}$ , (Note 5)
Random read or write cycle time	$t_{RC}$		220		260		330	ns	(Note 6)
Read-write cycle time	$t_{RWC}$		300		355		445	ns	(Note 6)
Page mode cycle time	$t_{PC}$		120		145		180	ns	(Note 6)
Access time from $\overline{\text{RAS}}$	$t_{RAC}$		120		150		200	ns	(Notes 7, 8)
Access time from $\overline{\text{CAS}}$	$t_{CAC}$		60		75		100	ns	(Notes 7, 9)
Output turn-off delay from $\overline{\text{CAS}}$	$t_{OFF}$	0	30	0	40	0	50	ns	(Note 10)
Transition time, rise and fall	$t_T$	3	50	3	50	3	50	ns	(Note 4)
$\overline{\text{RAS}}$ precharge time	$t_{RP}$		90		100		120	ns	
$\overline{\text{RAS}}$ pulse width	$t_{RAS}$	120	10,000	150	10,000	200	10,000	ns	
$\overline{\text{RAS}}$ hold time	$t_{RSH}$	60		75		100		ns	
CAS pulse width	$t_{CAS}$	60	10,000	75	10,000	100	10,000	ns	
CAS hold time	$t_{CSH}$	120		150		200		ns	
$\overline{\text{RAS}}$ to CAS delay time	$t_{RCD}$	25	60	25	75	30	100	ns	(Note 11)
CAS to $\overline{\text{RAS}}$ precharge time	$t_{CRP}$	0		0		0		ns	(Note 12)
CAS precharge time, non-page cycle	$t_{CPN}$	25		25		30		ns	
CAS precharge time, page cycle	$t_{CP}$	50		60		70		ns	
$\overline{\text{RAS}}$ precharge, CAS hold time	$t_{RPC}$	0		0		0		ns	
Row address setup time	$t_{ASR}$	0		0		0		ns	
Row address hold time	$t_{RAH}$	15		15		20		ns	
Column address setup time	$t_{ASC}$	0		0		0		ns	
Column address hold time	$t_{CAH}$	20		25		30		ns	
Column address hold time referenced to $\overline{\text{RAS}}$	$t_{AR}$	80		100		130		ns	
Read command setup time	$t_{RCS}$	0		0		0		ns	
Read command hold time referenced to $\overline{\text{RAS}}$	$t_{RRH}$	20		20		20		ns	(Note 13)
Read command hold time referenced to CAS	$t_{RCH}$	0		0		0		ns	(Note 13)
Write command hold time	$t_{WCH}$	35		45		55		ns	
Write command hold time referenced to $\overline{\text{RAS}}$	$t_{WCR}$	95		120		155		ns	
Write command pulse width	$t_{WP}$	35		45		55		ns	
Write command to $\overline{\text{RAS}}$ lead time	$t_{RWL}$	40		45		55		ns	
Write command to CAS lead time	$t_{CWL}$	40		45		55		ns	
Data-in setup time	$t_{DS}$	0		0		0		ns	(Note 14)

**AC Characteristics (Notes 2, 3, 4) (cont)**

T<sub>A</sub> = 0°C to +70°C, V<sub>CC</sub> = 5.0 V ± 10% (Note 1)

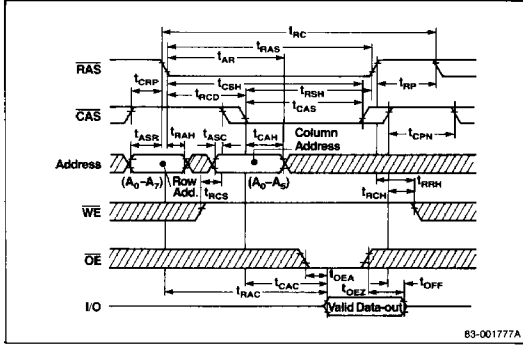
Parameter	Symbol	Limits						Unit	Test Conditions
		μPD41416-12		μPD41416-15		μPD41416-20			
		Min	Max	Min	Max	Min	Max		
Data-in hold time	t <sub>DH</sub>	35		45		55		ns	(Note 14)
Data-in hold time referenced to RAS	t <sub>DHR</sub>	95		120		155		ns	
Refresh period	t <sub>REF</sub>		2		2		2	ms	
WE command setup time	t <sub>WCS</sub>	0		0		0		ns	
CAS to WE delay	t <sub>CWD</sub>	95		120		155		ns	
RAS to WE delay	t <sub>RWD</sub>	155		195		255		ns	
Access time from OE	t <sub>DEA</sub>	30		40		50		ns	
Data delay time	t <sub>DED</sub>	30		40		50		ns	
OE command hold time	t <sub>DEH</sub>	0		0		0		ns	
Output turn-off delay from OE	t <sub>DEZ</sub>	0	30	0	40	0	50	ns	(Note 10)

**Notes:**

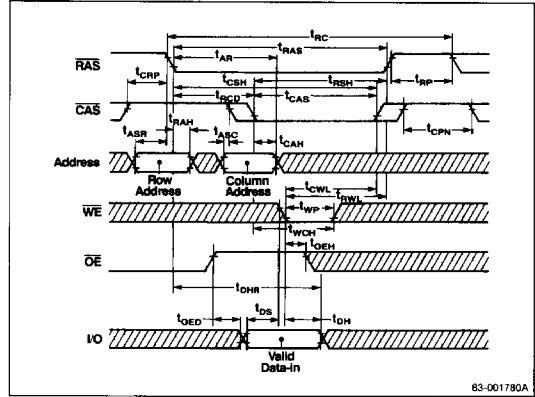
- (1) All voltages referenced to GND.
- (2) An initial pause of 100 μs is required after power-up followed by any 8 RAS cycles before proper device operation is achieved.
- (3) AC measurements assume t<sub>T</sub> = 5 ns.
- (4) V<sub>IH</sub> (min) and V<sub>IL</sub> (max) are reference levels for measuring timing of input signals. Transition times are measured between V<sub>IH</sub> and V<sub>IL</sub>.
- (5) I<sub>CC1</sub>, I<sub>CC3</sub> and I<sub>CC4</sub> depend on output loading and cycle rates. Specified values are obtained with the outputs open.
- (6) The minimum specifications are used only to indicate cycle time at which proper operation over the full temperature range (T<sub>A</sub> = 0°C to 70°C) is assured.
- (7) Load = 2 TTL loads and 100 pF.
- (8) Assumes that t<sub>RCD</sub> ≤ t<sub>RCD</sub> (max). If t<sub>RCD</sub> is greater than the maximum recommended value shown in this table, t<sub>RAC</sub> will increase by the amount that t<sub>RCD</sub> exceeds the value shown.
- (9) Assumes that t<sub>RCD</sub> ≥ t<sub>RCD</sub> (max).
- (10) t<sub>OFF</sub> (max) and t<sub>OEZ</sub> (max) define the time at which the output achieves the open circuit condition and are not referenced to V<sub>OH</sub> or V<sub>OL</sub>.
- (11) Operation within the t<sub>RCD</sub> (max) limit insures that t<sub>RAC</sub> (max) can be met. t<sub>RCD</sub> (max) is specified as a reference point only. If t<sub>RCD</sub> is greater than the specified t<sub>RCD</sub> (max) limit, then access time is controlled exclusively by t<sub>CAC</sub>.
- (12) t<sub>CRP</sub> requirement should be applicable for RAS, CAS cycles preceded by any cycle.
- (13) Either t<sub>RRH</sub> or t<sub>RCH</sub> must be satisfied for a read cycle.
- (14) These parameters are referenced to CAS leading edge in early write cycles and to WE leading edge in delayed write or read-modify-write cycles.

## Timing Waveforms

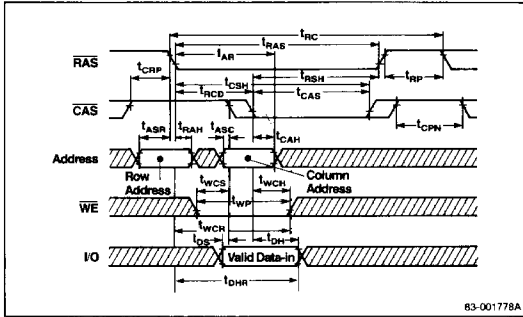
### Read Cycle



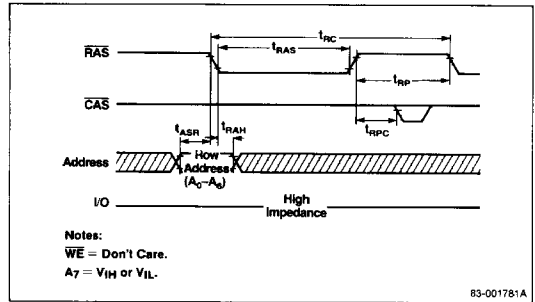
### OE-Controlled Write Cycle



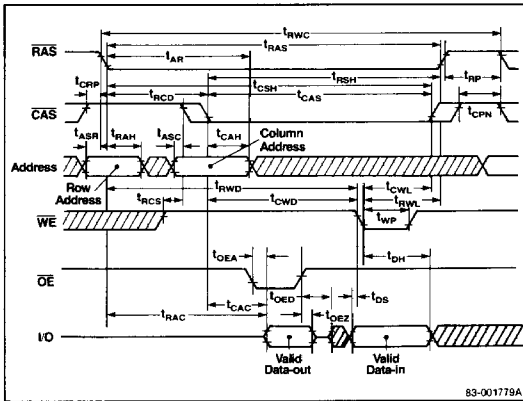
### Write Cycle (Early Write)



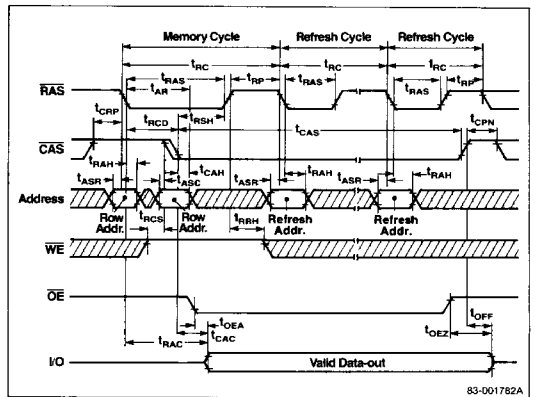
### "RAS-Only" Refresh Cycle



### Read-Write / Read-Modify-Write Cycle



### Hidden Refresh Cycle



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