

OKI Semiconductor

MSM5116405A

4,194,304-Word × 4-Bit DYNAMIC RAM : FAST PAGE MODE TYPE WITH EDO

DESCRIPTION

The MSM5116405A is a 4,194,304-word × 4-bit dynamic RAM fabricated in OKI's CMOS silicon gate technology. The MSM5116405A achieves high integration, high-speed operation, and low-power consumption due to quadruple polysilicon double metal CMOS. The MSM5116405A is available in a 26/24-pin plastic SOJ or 26/24-pin plastic TSOP.

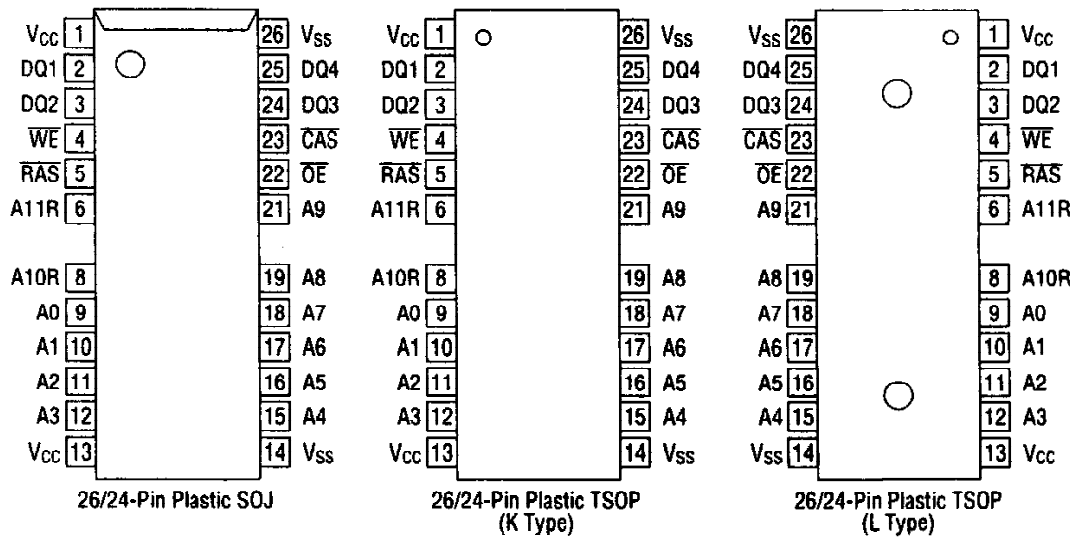
FEATURES

- 4,194,304-word × 4-bit configuration
- Single 5 V power supply, ±10% tolerance
- Input : TTL compatible, low input capacitance
- Output : TTL compatible, 3-state
- Refresh : 4096 cycles/64 ms
- Fast page mode with EDO, read modify write capability
- $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh, hidden refresh, $\overline{\text{RAS}}$ -only refresh capability
- Multi-bit test mode capability
- Package options:
 - 26/24-Pin 300 mil plastic SOJ (SOJ26/24-P-300) (Product : MSM5116405A-xxSJ)
 - 26/24-Pin 300 mil plastic TSOP (TSOP26/24-P-300-K) (Product : MSM5116405A-xxTS-K)
 - (TSOP26/24-P-300-L) (Product : MSM5116405A-xxTS-L)xx indicates speed rank.

PRODUCT FAMILY

Family	Access Time (Max.)				Cycle Time (Min.)	Power Dissipation	
	t _{RAC}	t _{AA}	t _{CAC}	t _{OEA}		Operating (Max.)	Standby (Max.)
MSM5116405A-60	60 ns	30 ns	15 ns	15 ns	110 ns	550 mW	5.5 mW
MSM5116405A-70	70 ns	35 ns	20 ns	20 ns	130 ns	495 mW	
MSM5116405A-80	80 ns	40 ns	20 ns	20 ns	150 ns	440 mW	

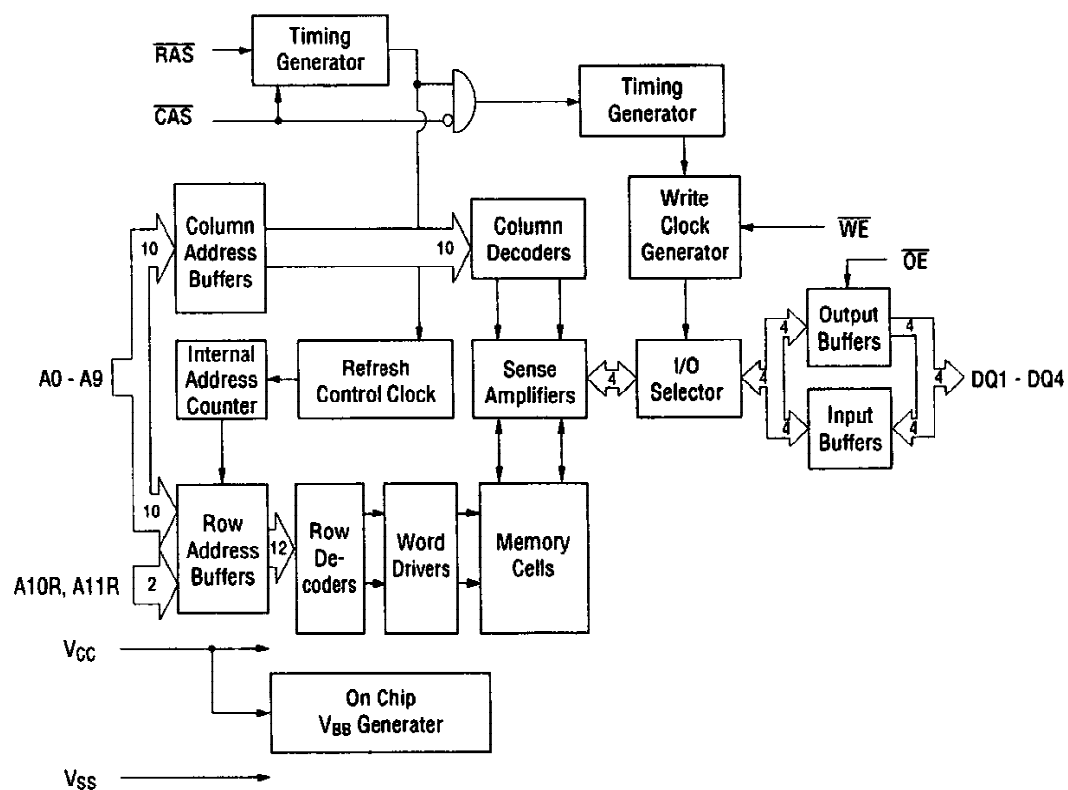
PIN CONFIGURATION (TOP VIEW)



Pin Name	Function
A0 - A9, A10R, A11R	Address Input
RAS	Row Address Strobe
CAS	Column Address Strobe
DQ1 - DQ4	Data Input/Data Output
OE	Output Enable
WE	Write Enable
V _{CC}	Power Supply (5 V)
V _{SS}	Ground (0 V)

Note : The same power supply voltage must be provided to every V_{CC} pin, and the same GND voltage level must be provided to every V_{SS} pin.

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS**Absolute Maximum Ratings**

Parameter	Symbol	Rating	Unit
Voltage on Any Pin Relative to V_{SS}	V_T	-1.0 to 7.0	V
Short Circuit Output Current	I_{OS}	50	mA
Power Dissipation	P_D^*	1	W
Operating Temperature	T_{opr}	0 to 70	°C
Storage Temperature	T_{stg}	-55 to 150	°C

*: $T_a = 25^\circ\text{C}$ **Recommended Operating Conditions** $(T_a = 0^\circ\text{C to } 70^\circ\text{C})$

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{CC}	4.5	5.0	5.5	V
	V_{SS}	0	0	0	V
Input High Voltage	V_{IH}	2.4	—	6.5	V
Input Low Voltage	V_{IL}	-1.0	—	0.8	V

Capacitance $(V_{CC} = 5\text{ V} \pm 10\%, T_a = 25^\circ\text{C}, f = 1\text{ MHz})$

Parameter	Symbol	Typ.	Max.	Unit
Input Capacitance (A0 - A9, A10R, A11R)	C_{IN1}	—	6	pF
Input Capacitance ($\overline{\text{RAS}}$, $\overline{\text{CAS}}$, $\overline{\text{WE}}$, $\overline{\text{OE}}$)	C_{IN2}	—	7	pF
Output Capacitance (DQ1 - DQ4)	$C_{I/O}$	—	10	pF

DC Characteristics

(V_{CC} = 5 V ±10%, T_a = 0°C to 70°C)

Parameter	Symbol	Condition	MSM5116405 A-60		MSM5116405 A-70		MSM5116405 A-80		Unit	Note
			Min.	Max.	Min.	Max.	Min.	Max.		
Output High Voltage	V _{OH}	I _{OH} = -5.0 mA	2.4	V _{CC}	2.4	V _{CC}	2.4	V _{CC}	V	
Output Low Voltage	V _{OL}	I _{OL} = 4.2 mA	0	0.4	0	0.4	0	0.4	V	
Input Leakage Current	I _{LI}	0 V ≤ V _I ≤ 6.5 V; All other pins not under test = 0 V	-10	10	-10	10	-10	10	μA	
Output Leakage Current	I _{LO}	DQ disable 0 V ≤ V _O ≤ 5.5 V	-10	10	-10	10	-10	10	μA	
Average Power Supply Current (Operating)	I _{CC1}	$\overline{\text{RAS}}$, $\overline{\text{CAS}}$ cycling, t _{RC} = Min.	—	100	—	90	—	80	mA	1, 2
Power Supply Current (Standby)	I _{CC2}	$\overline{\text{RAS}}$, $\overline{\text{CAS}}$ = V _{IH}	—	2	—	2	—	2	mA	1
		$\overline{\text{RAS}}$, $\overline{\text{CAS}}$ ≥ V _{CC} - 0.2 V	—	1	—	1	—	1		
Average Power Supply Current ($\overline{\text{RAS}}$ -only Refresh)	I _{CC3}	$\overline{\text{RAS}}$ cycling, $\overline{\text{CAS}}$ = V _{IH} , t _{RC} = Min.	—	100	—	90	—	80	mA	1, 2
Power Supply Current (Standby)	I _{CC5}	$\overline{\text{RAS}}$ = V _{IH} , $\overline{\text{CAS}}$ = V _{IL} , DQ = enable	—	5	—	5	—	5	mA	1
Average Power Supply Current ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ Refresh)	I _{CC6}	$\overline{\text{RAS}}$ cycling, $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$	—	100	—	90	—	80	mA	1, 2
Average Power Supply Current (Fast Page Mode)	I _{CC7}	$\overline{\text{RAS}}$ = V _{IL} , $\overline{\text{CAS}}$ cycling, t _{PC} = Min.	—	120	—	110	—	100	mA	1, 3

- Notes :
1. I_{CC} Max. is specified as I_{CC} for output open condition.
 2. Address can be changed once or less while $\overline{\text{RAS}}$ = V_{IL}.
 3. Address can be changed once or less while $\overline{\text{CAS}}$ = V_{IH}.

AC Characteristics (1/2)

(V_{CC} = 5 V ±10%, T_a = 0°C to 70°C) Note 1, 2, 3, 12, 13

Parameter	Symbol	MSM5116405 A-60		MSM5116405 A-70		MSM5116405 A-80		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
Random Read or Write Cycle Time	t _{RC}	110	—	130	—	150	—	ns	
Read Modify Write Cycle Time	t _{RWC}	155	—	185	—	205	—	ns	
Fast Page Mode Cycle Time	t _{HPC}	25	—	30	—	35	—	ns	
Fast Page Mode Read Modify Write Cycle Time	t _{PRWC}	85	—	100	—	105	—	ns	
Access Time from $\overline{\text{RAS}}$	t _{RAC}	—	60	—	70	—	80	ns	4, 5, 6
Access Time from $\overline{\text{CAS}}$	t _{CAC}	—	15	—	20	—	20	ns	4, 5
Access Time from Column Address	t _{AA}	—	30	—	35	—	40	ns	4, 6
Access Time from $\overline{\text{CAS}}$ Precharge	t _{CPA}	—	35	—	40	—	45	ns	4
Access Time from $\overline{\text{OE}}$	t _{OEA}	—	15	—	20	—	20	ns	4
Output Low Impedance Time from $\overline{\text{CAS}}$	t _{CLZ}	0	—	0	—	0	—	ns	4
Data Output Hold After $\overline{\text{CAS}}$ Low	t _{DOH}	3	15	3	15	3	15	ns	
$\overline{\text{CAS}}$ to Data Output Buffer Turn-off Delay Time	t _{CEZ}	3	15	3	20	3	20	ns	7, 8
$\overline{\text{RAS}}$ to Data Output Buffer Turn-off Delay Time	t _{REZ}	3	15	3	20	3	20	ns	7, 8
$\overline{\text{OE}}$ to Data Output Buffer Turn-off Delay Time	t _{OEZ}	3	15	3	20	3	20	ns	7
$\overline{\text{WE}}$ to Data Output Buffer Turn-off Delay Time	t _{WEZ}	3	15	3	20	3	20	ns	7
Transition Time	t _T	2	50	2	50	2	50	ns	3
Refresh Period	t _{REF}	—	64	—	64	—	64	ms	
$\overline{\text{RAS}}$ Precharge Time	t _{RP}	40	—	50	—	60	—	ns	
$\overline{\text{RAS}}$ Pulse Width	t _{RAS}	60	10,000	70	10,000	80	10,000	ns	
$\overline{\text{RAS}}$ Pulse Width (Fast Page Mode with EDO)	t _{RASP}	60	100,000	70	100,000	80	100,000	ns	
$\overline{\text{RAS}}$ Hold Time	t _{RSH}	15	—	20	—	20	—	ns	
$\overline{\text{RAS}}$ Hold Time referenced to $\overline{\text{OE}}$	t _{ROH}	10	—	10	—	10	—	ns	
$\overline{\text{CAS}}$ Precharge Time (Fast Page Mode with EDO)	t _{CP}	10	—	10	—	10	—	ns	
$\overline{\text{CAS}}$ Pulse Width	t _{CAS}	10	10,000	10	10,000	15	10,000	ns	
$\overline{\text{CAS}}$ Hold Time	t _{CSH}	40	—	45	—	50	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time	t _{CRP}	10	—	10	—	10	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time	t _{RHCP}	35	—	40	—	45	—	ns	
$\overline{\text{OE}}$ Hold Time from $\overline{\text{CAS}}$ (DQ Disable)	t _{CHO}	5	—	10	—	10	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Delay Time	t _{RCD}	20	45	20	50	20	60	ns	5
$\overline{\text{RAS}}$ to Column Address Delay Time	t _{RAD}	15	30	15	35	15	40	ns	6
$\overline{\text{RAS}}$ to Second $\overline{\text{CAS}}$ Delay Time	t _{RSCD}	60	—	70	—	80	—	ns	
Row Address Set-up Time	t _{ASR}	0	—	0	—	0	—	ns	
Row Address Hold Time	t _{RAH}	10	—	10	—	10	—	ns	
Column Address Set-up Time	t _{ASC}	0	—	0	—	0	—	ns	
Column Address Hold Time	t _{CAH}	10	—	15	—	15	—	ns	
Column Address Hold Time from $\overline{\text{RAS}}$	t _{AR}	40	—	45	—	50	—	ns	
Column Address to $\overline{\text{RAS}}$ Lead Time	t _{RAL}	30	—	35	—	40	—	ns	

AC Characteristics (2/2)

(V_{CC} = 5 V ±10%, T_a = 0°C to 70°C) Note 1, 2, 3, 12, 13

Parameter	Symbol	MSM5116405 A-60		MSM5116405 A-70		MSM5116405 A-80		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
Read Command Set-up Time	t _{RCS}	—	—	0	—	0	0	ns	
Read Command Hold Time	t _{RCH}	—	—	0	—	0	0	ns	9
Read Command Hold Time referenced to $\overline{\text{RAS}}$	t _{RRH}	—	—	0	—	0	0	ns	9
Write Command Set-up Time	t _{WCS}	—	—	0	—	0	0	ns	10
Write Command Hold Time	t _{WCH}	—	—	15	—	15	10	ns	
Write Command Hold Time from $\overline{\text{RAS}}$	t _{WCR}	—	—	45	—	50	40	ns	
Write Command Pulse Width	t _{WP}	—	—	10	—	10	10	ns	
$\overline{\text{WE}}$ Pulse Width (DQ Disable)	t _{WPE}	—	—	10	—	10	5	ns	
$\overline{\text{OE}}$ Command Hold Time	t _{OEH}	—	—	20	—	20	15	ns	
$\overline{\text{OE}}$ Precharge Time	t _{OEP}	—	—	10	—	10	10	ns	
$\overline{\text{OE}}$ Command Hold Time	t _{OCH}	—	—	10	—	10	10	ns	
Write Command to $\overline{\text{RAS}}$ Lead Time	t _{RWL}	—	—	20	—	20	15	ns	
Write Command to $\overline{\text{CAS}}$ Lead Time	t _{CWL}	—	—	20	—	20	15	ns	
Data-in Set-up Time	t _{DS}	—	—	0	—	0	0	ns	11
Data-in Hold Time	t _{DH}	—	—	15	—	15	15	ns	11
Data-in Hold Time from $\overline{\text{RAS}}$	t _{DHR}	—	—	45	—	50	40	ns	
$\overline{\text{OE}}$ to Data-in Delay Time	t _{OED}	—	—	20	—	20	15	ns	
$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ Delay Time	t _{CWD}	—	—	50	—	50	40	ns	10
Column Address to $\overline{\text{WE}}$ Delay Time	t _{AWD}	—	—	65	—	70	55	ns	10
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Delay Time	t _{RWD}	—	—	100	—	110	85	ns	10
$\overline{\text{CAS}}$ Precharge $\overline{\text{WE}}$ Delay Time	t _{CPWD}	—	—	70	—	75	60	ns	10
$\overline{\text{CAS}}$ Active Delay Time from $\overline{\text{RAS}}$ Precharge	t _{RPC}	—	—	10	—	10	10	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Set-up Time ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$)	t _{CSR}	—	—	10	—	10	10	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Hold Time ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$)	t _{CHR}	—	—	20	—	20	20	ns	
$\overline{\text{CAS}}$ Precharge Time (Refresh Counter Test)	t _{CPT}	—	—	40	—	40	40	ns	
$\overline{\text{WE}}$ to $\overline{\text{RAS}}$ Precharge Time ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$)	t _{WRP}	—	—	10	—	10	10	ns	
$\overline{\text{WE}}$ Hold Time from $\overline{\text{RAS}}$ ($\overline{\text{CAS}}$ before $\overline{\text{RAS}}$)	t _{WRH}	—	—	10	—	10	10	ns	
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Set-up Time (Test Mode)	t _{WTS}	—	—	10	—	10	10	ns	
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Hold Time (Test Mode)	t _{WTH}	—	—	20	—	20	20	ns	

- Notes:
1. A start-up delay of 200 μ s is required after power-up, followed by a minimum of eight initialization cycles ($\overline{\text{RAS}}$ -only refresh or $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh) before proper device operation is achieved.
 2. The AC characteristics assume $t_T = 5$ ns.
 3. V_{IH} (Min.) and V_{IL} (Max.) are reference levels for measuring input timing signals. Transition times (t_T) are measured between V_{IH} and V_{IL} .
 4. This parameter is measured with a load circuit equivalent to 2 TTL loads and 100 pF.
 5. Operation within the t_{RCD} (Max.) limit ensures that t_{RAC} (Max.) can be met. t_{RCD} (Max.) is specified as a reference point only. If t_{RCD} is greater than the specified t_{RCD} (Max.) limit, access time is controlled by t_{CAC} .
 6. Operation within the t_{RAD} (Max.) limit ensures that t_{RAC} (Max.) can be met. t_{RAD} (Max.) is specified as a reference point only. If t_{RAD} is greater than the specified t_{RAD} (Max.) limit, access time is controlled by t_{AA} .
 7. t_{CEZ} (Max.), t_{REZ} (Max.), t_{WEZ} (Max.) and t_{OEZ} (Max.) define the time at which the output achieves the open circuit condition and are not referenced to output voltage levels.
 8. t_{CEZ} and t_{REZ} must be satisfied for open circuit condition.
 9. t_{RCH} or t_{RRH} must be satisfied for a read cycle.
 10. t_{WCS} , t_{CWD} , t_{RWD} , t_{AWD} and t_{CPWD} are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If $t_{WCS} \geq t_{WCS}$ (Min.), the cycle is an early write cycle and the data out will remain open circuit (high impedance) throughout the entire cycle. If $t_{CWD} \geq t_{CWD}$ (Min.), $t_{RWD} \geq t_{RWD}$ (Min.), $t_{AWD} \geq t_{AWD}$ (Min.) and $t_{CPWD} \geq t_{CPWD}$ (Min.), the cycle is a read modify write cycle and data out will contain data read from the selected cell; if neither of the above sets of conditions is satisfied, the condition of the data out (at access time) is indeterminate.
 11. These parameters are referenced to $\overline{\text{CAS}}$ leading edge in an early write cycle, and to $\overline{\text{WE}}$ leading edge in an $\overline{\text{OE}}$ control write cycle or a read modify write cycle.
 12. The test mode is initiated by performing a $\overline{\text{WE}}$ and $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh cycle. This mode is latched and remains in effect until the exit cycle is generated. In a test mode CA0 and CA1 are not used and each DQ pin now accesses 4-bit locations. Since all 4 DQ pins are used, a total of 16 data bits can be written in parallel into the memory array. In a read cycle, if 4 data bits are equal, the DQ pin will indicate a high level. If the 4 data bits are not equal, the DQ pin will indicate a low level. The test mode is cleared and the memory device returned to its normal operating state by performing a $\overline{\text{RAS}}$ -only refresh cycle or a $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ refresh cycle.
 13. In a test mode read cycle, the value of access time parameters is delayed for 5 ns for the specified value. These parameters should be specified in test mode cycle by adding the above value to the specified value in this data sheet.

See ADDENDUM L for AC Timing Waveforms