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

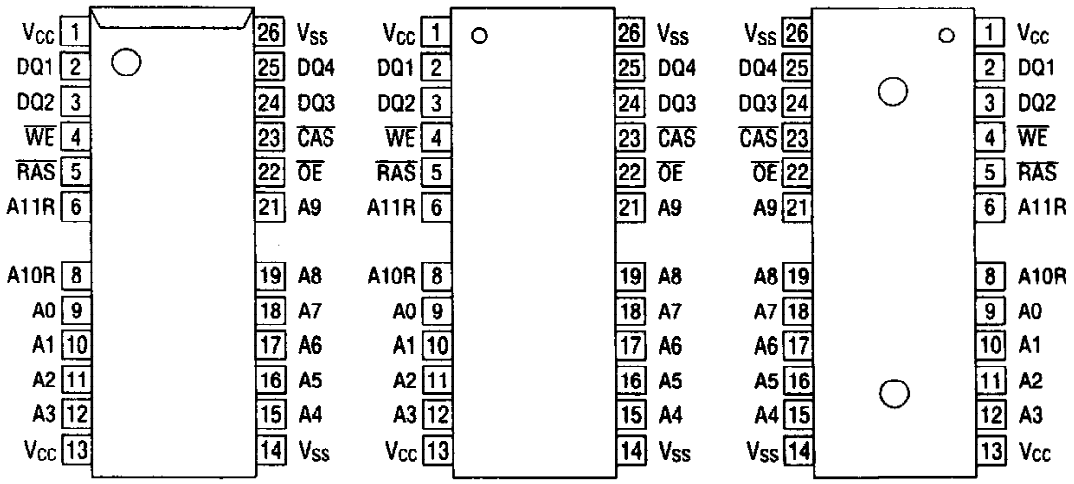
- 4,194,304-word × 4-bit configuration
- Single 5 V power supply, ±10% tolerance
- Input : TTL compatible, low input capacitance
- Output : TTL compatible, 3-state
- Refresh : 4096 cycles/64 ms
- Fast page mode with EDO, read modify write capability
- $\overline{CAS}$ before $\overline{RAS}$ refresh, hidden refresh, $\overline{RAS}$-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)



26/24-Pin Plastic SOJ

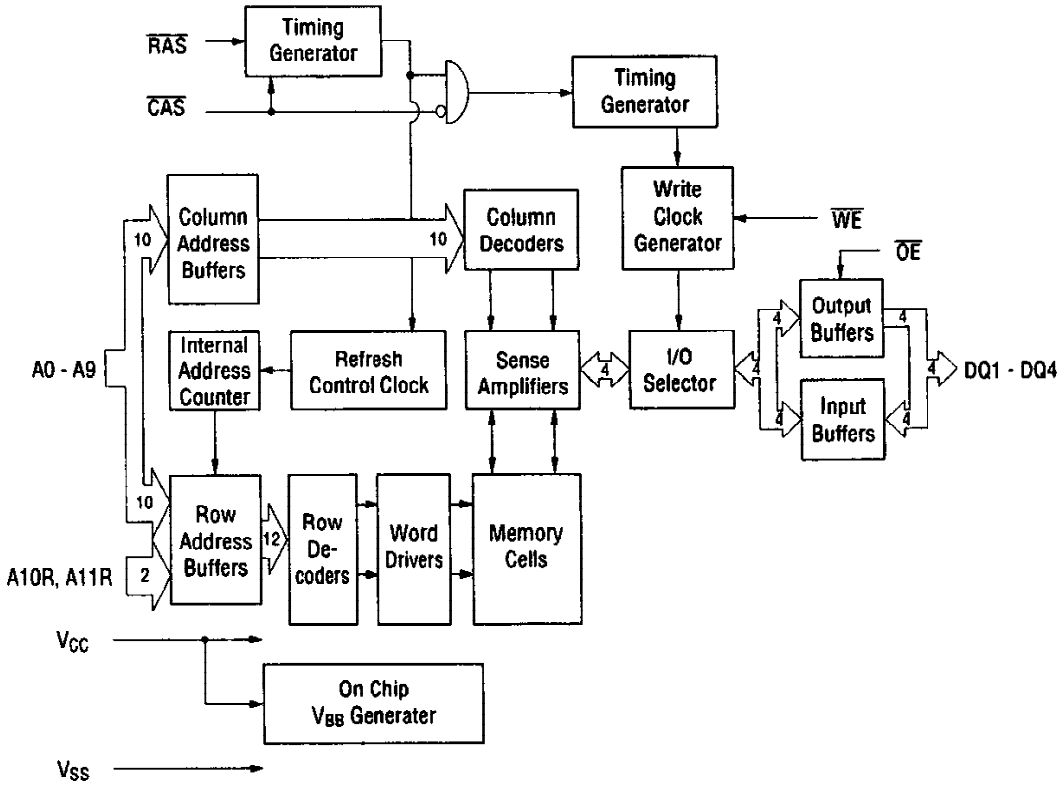
26/24-Pin Plastic TSOP (K Type)

26/24-Pin Plastic TSOP (L Type)

Pin Name	Function
A0 - A9, A10R, A11R	Address Input
$\overline{RAS}$	Row Address Strobe
$\overline{CAS}$	Column Address Strobe
DQ1 - DQ4	Data Input/Data Output
$\overline{OE}$	Output Enable
$\overline{WE}$	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

*: Ta = 25°C

Recommended Operating Conditions

(Ta = 0°C to 70°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 V ±10%, Ta = 25°C, f = 1 MHz)

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

DC Characteristics

(V_{CC} = 5 V ±10%, Ta = 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}	$\overline{RAS}$, $\overline{CAS}$ cycling, t_{RC} = Min.	—	100	—	90	—	80	mA	1, 2
Power Supply Current (Standby)	I_{CC2}	$\overline{RAS}$, $\overline{CAS}$ = V_{IH}	—	2	—	2	—	2	mA	1
		$\overline{RAS}$, $\overline{CAS}$ ≥ V_{CC} −0.2 V	—	1	—	1	—	1		
Average Power Supply Current ($\overline{RAS}$-only Refresh)	I_{CC3}	$\overline{RAS}$ cycling, $\overline{CAS}$ = V_{IH}, t_{RC} = Min.	—	100	—	90	—	80	mA	1, 2
Power Supply Current (Standby)	I_{CC5}	$\overline{RAS}$ = V_{IH}, $\overline{CAS}$ = V_{IL}, DQ = enable	—	5	—	5	—	5	mA	1
Average Power Supply Current ($\overline{CAS}$ before $\overline{RAS}$ Refresh)	I_{CC6}	$\overline{RAS}$ cycling, $\overline{CAS}$ before $\overline{RAS}$	—	100	—	90	—	80	mA	1, 2
Average Power Supply Current (Fast Page Mode)	I_{CC7}	$\overline{RAS}$ = V_{IL}, $\overline{CAS}$ 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 $\overline{RAS}$ = V_{IL}.
3. Address can be changed once or less while $\overline{CAS}$ = V_{IH}.

AC Characteristics (1/2)

(V_{CC} = 5 V ±10%, Ta = 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 $\overline{RAS}$	t_{RAC}	—	60	—	70	—	80	ns	4, 5, 6
Access Time from $\overline{CAS}$	t_{CAC}	—	15	—	20	—	20	ns	4, 5
Access Time from Column Address	t_{AA}	—	30	—	35	—	40	ns	4, 6
Access Time from $\overline{CAS}$ Precharge	t_{CPA}	—	35	—	40	—	45	ns	4
Access Time from $\overline{OE}$	t_{OEA}	—	15	—	20	—	20	ns	4
Output Low Impedance Time from $\overline{CAS}$	t_{CLZ}	0	—	0	—	0	—	ns	4
Data Output Hold After $\overline{CAS}$ Low	t_{DOH}	3	15	3	15	3	15	ns	
$\overline{CAS}$ to Data Output Buffer Turn-off Delay Time	t_{CEZ}	3	15	3	20	3	20	ns	7, 8
$\overline{RAS}$ to Data Output Buffer Turn-off Delay Time	t_{REZ}	3	15	3	20	3	20	ns	7, 8
$\overline{OE}$ to Data Output Buffer Turn-off Delay Time	t_{OEZ}	3	15	3	20	3	20	ns	7
$\overline{WE}$ 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	
$\overline{RAS}$ Precharge Time	t_{RP}	40	—	50	—	60	—	ns	
$\overline{RAS}$ Pulse Width	t_{RAS}	60	10,000	70	10,000	80	10,000	ns	
$\overline{RAS}$ Pulse Width (Fast Page Mode with EDO)	t_{RASP}	60	100,000	70	100,000	80	100,000	ns	
$\overline{RAS}$ Hold Time	t_{RSH}	15	—	20	—	20	—	ns	
$\overline{RAS}$ Hold Time referenced to $\overline{OE}$	t_{ROH}	10	—	10	—	10	—	ns	
$\overline{CAS}$ Precharge Time (Fast Page Mode with EDO)	t_{CP}	10	—	10	—	10	—	ns	
$\overline{CAS}$ Pulse Width	t_{CAS}	10	10,000	10	10,000	15	10,000	ns	
$\overline{CAS}$ Hold Time	t_{CSH}	40	—	45	—	50	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{CRP}	10	—	10	—	10	—	ns	
$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	t_{RHCP}	35	—	40	—	45	—	ns	
$\overline{OE}$ Hold Time from $\overline{CAS}$ (DQ Disable)	t_{CHO}	5	—	10	—	10	—	ns	
$\overline{RAS}$ to $\overline{CAS}$ Delay Time	t_{RCD}	20	45	20	50	20	60	ns	5
$\overline{RAS}$ to Column Address Delay Time	t_{RAD}	15	30	15	35	15	40	ns	6
$\overline{RAS}$ to Second $\overline{CAS}$ 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 $\overline{RAS}$	t_{AR}	40	—	45	—	50	—	ns	
Column Address to $\overline{RAS}$ Lead Time	t_{RAL}	30	—	35	—	40	—	ns	

AC Characteristics (2/2)

(V_{CC} = 5 V ±10%, Ta = 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 $\overline{RAS}$	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 $\overline{RAS}$	t_{WCR}	—	—	45	—	50	40	ns	
Write Command Pulse Width	t_{WP}	—	—	10	—	10	10	ns	
$\overline{WE}$ Pulse Width (DQ Disable)	t_{WPE}	—	—	10	—	10	5	ns	
$\overline{OE}$ Command Hold Time	t_{OEH}	—	—	20	—	20	15	ns	
$\overline{OE}$ Precharge Time	t_{OEP}	—	—	10	—	10	10	ns	
$\overline{OE}$ Command Hold Time	t_{OCH}	—	—	10	—	10	10	ns	
Write Command to $\overline{RAS}$ Lead Time	t_{RWL}	—	—	20	—	20	15	ns	
Write Command to $\overline{CAS}$ 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 $\overline{RAS}$	t_{DHR}	—	—	45	—	50	40	ns	
$\overline{OE}$ to Data-in Delay Time	t_{OED}	—	—	20	—	20	15	ns	
$\overline{CAS}$ to $\overline{WE}$ Delay Time	t_{CWD}	—	—	50	—	50	40	ns	10
Column Address to $\overline{WE}$ Delay Time	t_{AWD}	—	—	65	—	70	55	ns	10
$\overline{RAS}$ to $\overline{WE}$ Delay Time	t_{RWD}	—	—	100	—	110	85	ns	10
$\overline{CAS}$ Precharge $\overline{WE}$ Delay Time	t_{CPWD}	—	—	70	—	75	60	ns	10
$\overline{CAS}$ Active Delay Time from $\overline{RAS}$ Precharge	t_{RPC}	—	—	10	—	10	10	ns	
$\overline{RAS}$ to $\overline{CAS}$ Set-up Time ($\overline{CAS}$ before $\overline{RAS}$)	t_{CSR}	—	—	10	—	10	10	ns	
$\overline{RAS}$ to $\overline{CAS}$ Hold Time ($\overline{CAS}$ before $\overline{RAS}$)	t_{CHR}	—	—	20	—	20	20	ns	
$\overline{CAS}$ Precharge Time (Refresh Counter Test)	t_{CPT}	—	—	40	—	40	40	ns	
$\overline{WE}$ to $\overline{RAS}$ Precharge Time ($\overline{CAS}$ before $\overline{RAS}$)	t_{WRP}	—	—	10	—	10	10	ns	
$\overline{WE}$ Hold Time from $\overline{RAS}$ ($\overline{CAS}$ before $\overline{RAS}$)	t_{WRH}	—	—	10	—	10	10	ns	
$\overline{RAS}$ to $\overline{WE}$ Set-up Time (Test Mode)	t_{WTS}	—	—	10	—	10	10	ns	
$\overline{RAS}$ to $\overline{WE}$ Hold Time (Test Mode)	t_{WTH}	—	—	20	—	20	20	ns	

Notes:

1. A start-up delay of 200 μs is required after power-up, followed by a minimum of eight initialization cycles ($\overline{RAS}$-only refresh or $\overline{CAS}$ before $\overline{RAS}$ 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 $\overline{CAS}$ leading edge in an early write cycle, and to $\overline{WE}$ leading edge in an $\overline{OE}$ control write cycle or a read modify write cycle.

12. The test mode is initiated by performing a $\overline{WE}$ and $\overline{CAS}$ before $\overline{RAS}$ 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 $\overline{RAS}$-only refresh cycle or a $\overline{CAS}$ before $\overline{RAS}$ 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