

**OKI Semiconductor****MSM5118165A****1,048,576-Word × 16-Bit DYNAMIC RAM : FAST PAGE MODE TYPE WITH EDO****DESCRIPTION**

The MSM5118165A is a 1,048,576-word × 16-bit dynamic RAM fabricated in OKI's CMOS silicon gate technology. The MSM5118165A achieves high integration, high-speed operation, and low-power consumption due to quadruple polysilicon double metal CMOS. The MSM5118165A is available in a 42-pin plastic SOJ or 50/44-pin plastic TSOP.

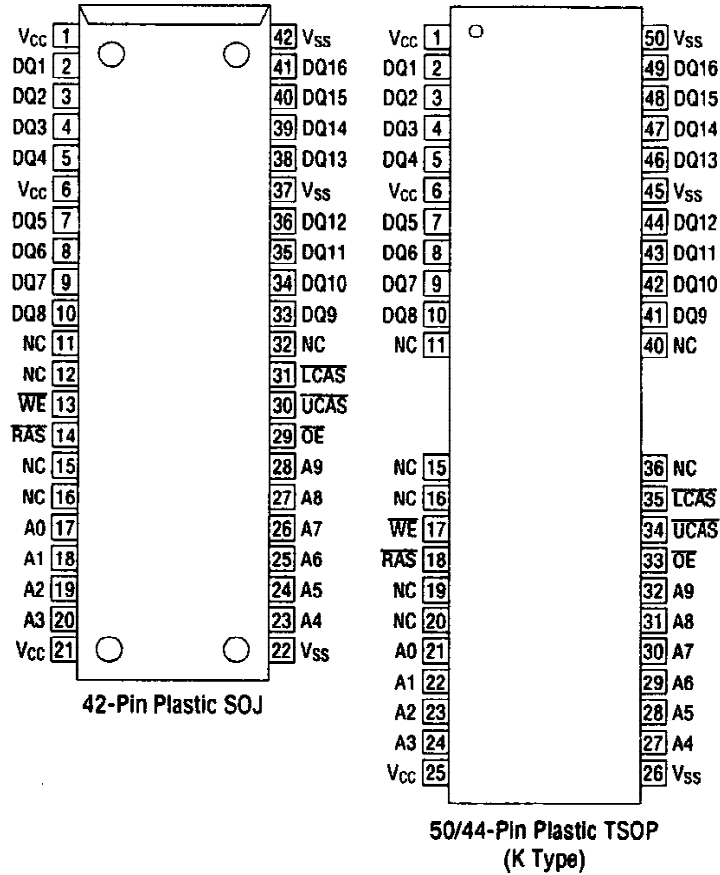
**FEATURES**

- 1,048,576-word × 16-bit configuration
  - Single 5 V power supply, ±10% tolerance
  - Input : TTL compatible, low input capacitance
  - Output : TTL compatible, 3-state
  - Refresh : 1024 cycles/16 ms
  - Fast page mode with EDO, read modify write capability
  - CAS before  $\overline{\text{RAS}}$  refresh, hidden refresh,  $\overline{\text{RAS}}$ -only refresh capability
  - Package options:
    - 42-Pin 400 mil plastic SOJ (SOJ42-P-400) (Product : MSM5118165A-xxJS)
    - 50/44-Pin 400 mil plastic TSOP (TSOP50/44-P-400/0.8-K) (Product : MSM5118165A-xxTS-K)
- xx indicates speed rank.

**PRODUCT FAMILY**

Family	Access Time (Max.)				Cycle Time (Min.)	Power Dissipation	
	t <sub>RAC</sub>	t <sub>AA</sub>	t <sub>CAC</sub>	t <sub>OEA</sub>		Operating (Max.)	Standby (Max.)
MSM5118165A-60	60 ns	30 ns	15 ns	15 ns	110 ns	1210 mW	5.5 mW
MSM5118165A-70	70 ns	35 ns	20 ns	20 ns	130 ns	1100 mW	
MSM5118165A-80	80 ns	40 ns	20 ns	20 ns	150 ns	990 mW	

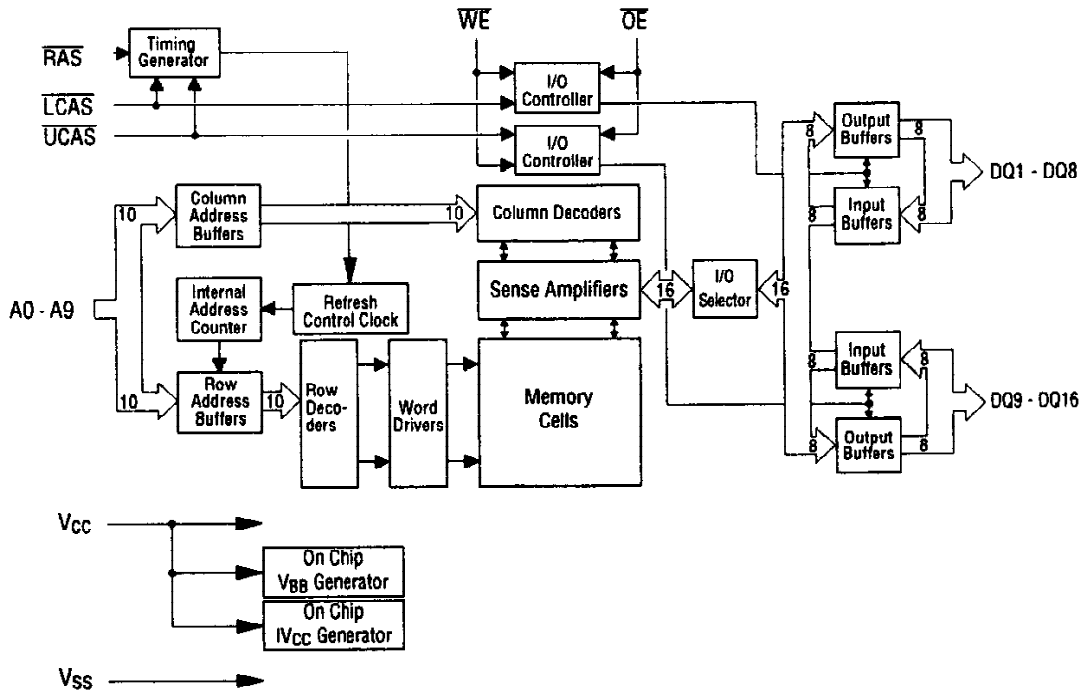
**PIN CONFIGURATION (TOP VIEW)**



Pin Name	Function
A0 - A9	Address Input
RAS	Row Address Strobe
LCAS	Lower Byte Column Address Strobe
UCAS	Upper Byte Column Address Strobe
DQ1 - DQ16	Data Input/Data Output
OE	Output Enable
WE	Write Enable
Vcc	Power Supply (5 V)
Vss	Ground (0 V)
NC	No Connection

Note: The same power supply voltage must be provided to every V<sub>CC</sub> pin, and the same GND voltage level must be provided to every V<sub>SS</sub> pin.

**BLOCK DIAGRAM**



**FUNCTION TABLE**

Input Pin					DQ Pin		Function Mode
RAS	LCAS	UCAS	WE	OE	DQ1 - DQ8	DQ9 - DQ16	
H	*	*	*	*	High-Z	High-Z	Standby
L	H	H	*	*	High-Z	High-Z	Refresh
L	L	H	H	L	D <sub>OUT</sub>	High-Z	Lower Byte Read
L	H	L	H	L	High-Z	D <sub>OUT</sub>	Upper Byte Read
L	L	L	H	L	D <sub>OUT</sub>	D <sub>OUT</sub>	Word Read
L	L	H	L	H	D <sub>IN</sub>	Don't Care	Lower Byte Write
L	H	L	L	H	Don't Care	D <sub>IN</sub>	Upper Byte Write
L	L	L	L	H	D <sub>IN</sub>	D <sub>IN</sub>	Word Write
L	L	L	H	H	High-Z	High-Z	—

\*: "H" or "L"

**ELECTRICAL CHARACTERISTICS****Absolute Maximum Ratings**

Parameter	Symbol	Rating	Unit
Voltage on Any Pin Relative to V <sub>SS</sub>	V <sub>T</sub>	-1.0 to 7.0	V
Short Circuit Output Current	I <sub>OS</sub>	50	mA
Power Dissipation	P <sub>D</sub> *	1.1	W
Operating Temperature	T <sub>opr</sub>	0 to 70	°C
Storage Temperature	T <sub>stg</sub>	-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 <sub>CC</sub>	4.5	5.0	5.5	V
	V <sub>SS</sub>	0	0	0	V
Input High Voltage	V <sub>IH</sub>	2.4	—	6.5	V
Input Low Voltage	V <sub>IL</sub>	-1.0	—	0.8	V

**Capacitance**(V<sub>CC</sub> = 5 V ±10%, Ta = 25°C, f = 1 MHz)

Parameter	Symbol	Typ.	Max.	Unit
Input Capacitance (A0 - A9)	C <sub>IN1</sub>	—	5	pF
Input Capacitance (RAS, LCAS, UCAS, WE, OE)	C <sub>IN2</sub>	—	7	pF
Output Capacitance (DQ1 - DQ16)	C <sub>VO</sub>	—	7	pF

DC Characteristics

( $V_{CC} = 5 V \pm 10\%$ ,  $T_a = 0^\circ C$  to  $70^\circ C$ )

Parameter	Symbol	Condition	MSM5118165 A-60		MSM5118165 A-70		MSM5118165 A-80		Unit	Note
			Min.	Max.	Min.	Max.	Min.	Max.		
			Output High Voltage	$V_{OH}$	$I_{OH} = -5.0 \text{ mA}$	2.4	$V_{CC}$	2.4		
Output Low Voltage	$V_{OL}$	$I_{OL} = 4.2 \text{ mA}$	0	0.4	0	0.4	0	0.4	V	
Input Leakage Current	$I_{LI}$	$0 V \leq V_I \leq 6.5 V$ ; All other pins not under test = $0 V$	-10	10	-10	10	-10	10	$\mu A$	
Output Leakage Current	$I_{LO}$	DQ disable $0 V \leq V_O \leq 5.5 V$	-10	10	-10	10	-10	10	$\mu A$	
Average Power Supply Current (Operating)	$I_{CC1}$	$\overline{RAS}$ , $\overline{CAS}$ cycling, $t_{RC} = \text{Min.}$	—	220	—	200	—	180	mA	1, 2
Power Supply Current (Standby)	$I_{CC2}$	$\overline{RAS}$ , $\overline{CAS} = V_{IH}$	—	2	—	2	—	2	mA	1
		$\overline{RAS}$ , $\overline{CAS}$ $\geq V_{CC} - 0.2 V$	—	1	—	1	—	1		
Average Power Supply Current ( $\overline{RAS}$ -only Refresh)	$I_{CC3}$	$\overline{RAS}$ cycling, $\overline{CAS} = V_{IH}$ , $t_{RC} = \text{Min.}$	—	220	—	200	—	180	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 $\overline{RAS}$	—	220	—	200	—	180	mA	1, 2
Average Power Supply Current (Fast Page Mode)	$I_{CC7}$	$\overline{RAS} = V_{IL}$ , $\overline{CAS}$ cycling, $t_{PC} = \text{Min.}$	—	170	—	160	—	150	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<sub>CC</sub> = 5 V ±10%, T<sub>a</sub> = 0°C to 70°C) Note 1, 2, 3

Parameter	Symbol	MSM5118165 A-60		MSM5118165 A-70		MSM5118165 A-80		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
Random Read or Write Cycle Time	t <sub>RC</sub>	110	—	130	—	150	—	ns	
Read Modify Write Cycle Time	t <sub>RWC</sub>	150	—	180	—	200	—	ns	
Fast Page Mode Cycle Time	t <sub>HPC</sub>	25	—	30	—	35	—	ns	
Fast Page Mode Read Modify Write Cycle Time	t <sub>PRWC</sub>	80	—	95	—	100	—	ns	
Access Time from $\overline{\text{RAS}}$	t <sub>RAC</sub>	—	60	—	70	—	80	ns	4, 5, 6
Access Time from $\overline{\text{CAS}}$	t <sub>CAC</sub>	—	15	—	20	—	20	ns	4, 5
Access Time from Column Address	t <sub>AA</sub>	—	30	—	35	—	40	ns	4, 6
Access Time from $\overline{\text{CAS}}$ Precharge	t <sub>CPA</sub>	—	35	—	40	—	45	ns	4, 13
Access Time from $\overline{\text{OE}}$	t <sub>OEA</sub>	—	15	—	20	—	20	ns	4
Output Low Impedance Time from $\overline{\text{CAS}}$	t <sub>CLZ</sub>	0	—	0	—	0	—	ns	4
Data Output Hold After $\overline{\text{CAS}}$ Low	t <sub>DOH</sub>	3	15	3	15	3	15	ns	
$\overline{\text{CAS}}$ to Data Output Buffer Turn-off Delay Time	t <sub>CEZ</sub>	3	15	3	15	3	15	ns	7, 8
$\overline{\text{RAS}}$ to Data Output Buffer Turn-off Delay Time	t <sub>REZ</sub>	3	15	3	15	3	15	ns	7, 8
$\overline{\text{OE}}$ to Data Output Buffer Turn-off Delay Time	t <sub>OEZ</sub>	3	15	3	15	3	15	ns	7
$\overline{\text{WE}}$ to Data Output Buffer Turn-off Delay Time	t <sub>WEZ</sub>	3	15	3	15	3	15	ns	7
Transition Time	t <sub>T</sub>	3	50	3	50	3	50	ns	3
Refresh Period	t <sub>REF</sub>	—	16	—	16	—	16	ms	
$\overline{\text{RAS}}$ Precharge Time	t <sub>RP</sub>	40	—	50	—	60	—	ns	
$\overline{\text{RAS}}$ Pulse Width	t <sub>RAS</sub>	60	10,000	70	10,000	80	10,000	ns	
$\overline{\text{RAS}}$ Pulse Width (Fast Page Mode with EDO)	t <sub>RASP</sub>	60	100,000	70	100,000	80	100,000	ns	
$\overline{\text{RAS}}$ Hold Time	t <sub>RSH</sub>	15	—	20	—	20	—	ns	
$\overline{\text{RAS}}$ Hold Time referenced to $\overline{\text{OE}}$	t <sub>ROH</sub>	15	—	20	—	20	—	ns	
$\overline{\text{CAS}}$ Precharge Time (Fast Page Mode with EDO)	t <sub>CP</sub>	10	—	10	—	10	—	ns	15
$\overline{\text{CAS}}$ Pulse Width	t <sub>CAS</sub>	10	10,000	10	10,000	15	10,000	ns	
$\overline{\text{CAS}}$ Hold Time	t <sub>CSH</sub>	40	—	45	—	50	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time	t <sub>CRP</sub>	5	—	5	—	5	—	ns	13
$\overline{\text{CAS}}$ to $\overline{\text{RAS}}$ Precharge Time	t <sub>RHCP</sub>	35	—	40	—	45	—	ns	13
$\overline{\text{OE}}$ Hold Time from $\overline{\text{CAS}}$ (DQ Disable)	t <sub>CHO</sub>	5	—	10	—	10	—	ns	
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Delay Time	t <sub>RCD</sub>	20	45	20	50	20	60	ns	5
$\overline{\text{RAS}}$ to Column Address Delay Time	t <sub>RAD</sub>	15	30	15	35	15	40	ns	6
$\overline{\text{RAS}}$ to Second $\overline{\text{CAS}}$ Delay Time	t <sub>RSCD</sub>	60	—	70	—	80	—	ns	
Row Address Set-up Time	t <sub>ASR</sub>	0	—	0	—	0	—	ns	
Row Address Hold Time	t <sub>RAH</sub>	10	—	10	—	10	—	ns	
Column Address Set-up Time	t <sub>ASC</sub>	0	—	0	—	0	—	ns	12
Column Address Hold Time	t <sub>CAH</sub>	15	—	15	—	15	—	ns	12
Column Address Hold Time from $\overline{\text{RAS}}$	t <sub>AR</sub>	40	—	45	—	50	—	ns	
Column Address to $\overline{\text{RAS}}$ Lead Time	t <sub>RAL</sub>	30	—	35	—	40	—	ns	

## AC Characteristics (2/2)

(V<sub>CC</sub> = 5 V ±10%, T<sub>a</sub> = 0°C to 70°C) Note 1, 2, 3

Parameter	Symbol	MSM5118165 A-60		MSM5118165 A-70		MSM5118165 A-80		Unit	Note
		Min.	Max.	Min.	Max.	Min.	Max.		
Read Command Set-up Time	t <sub>RCS</sub>	0	—	0	—	0	—	ns	12
Read Command Hold Time	t <sub>RCH</sub>	0	—	0	—	0	—	ns	9, 12
Read Command Hold Time referenced to $\overline{\text{RAS}}$	t <sub>RRH</sub>	0	—	0	—	0	—	ns	9
Write Command Set-up Time	t <sub>WCS</sub>	0	—	0	—	0	—	ns	10, 12
Write Command Hold Time	t <sub>WCH</sub>	10	—	15	—	15	—	ns	12
Write Command Hold Time from $\overline{\text{RAS}}$	t <sub>WCR</sub>	40	—	45	—	50	—	ns	
Write Command Pulse Width	t <sub>WP</sub>	10	—	15	—	15	—	ns	
$\overline{\text{WE}}$ Pulse Width (DQ Disable)	t <sub>WPE</sub>	5	—	10	—	10	—	ns	
$\overline{\text{OE}}$ Command Hold Time	t <sub>OEH</sub>	15	—	20	—	20	—	ns	
$\overline{\text{OE}}$ Precharge Time	t <sub>OEP</sub>	10	—	10	—	10	—	ns	
$\overline{\text{OE}}$ Command Hold Time	t <sub>OCH</sub>	10	—	10	—	10	—	ns	
Write Command to $\overline{\text{RAS}}$ Lead Time	t <sub>RWL</sub>	15	—	20	—	20	—	ns	
Write Command to $\overline{\text{CAS}}$ Lead Time	t <sub>CWL</sub>	15	—	20	—	20	—	ns	14
Data-in Set-up Time	t <sub>DS</sub>	0	—	0	—	0	—	ns	11, 12
Data-in Hold Time	t <sub>DH</sub>	15	—	15	—	15	—	ns	11, 12
Data-in Hold Time from $\overline{\text{RAS}}$	t <sub>DHR</sub>	40	—	45	—	50	—	ns	
$\overline{\text{OE}}$ to Data-in Delay Time	t <sub>OED</sub>	15	—	15	—	15	—	ns	
$\overline{\text{CAS}}$ to $\overline{\text{WE}}$ Delay Time	t <sub>CWD</sub>	35	—	45	—	45	—	ns	10
Column Address to $\overline{\text{WE}}$ Delay Time	t <sub>AWD</sub>	50	—	60	—	65	—	ns	10
$\overline{\text{RAS}}$ to $\overline{\text{WE}}$ Delay Time	t <sub>RWD</sub>	80	—	95	—	105	—	ns	10
$\overline{\text{CAS}}$ Precharge $\overline{\text{WE}}$ Delay Time	t <sub>CPWD</sub>	55	—	65	—	70	—	ns	10
$\overline{\text{CAS}}$ Active Delay Time from $\overline{\text{RAS}}$ Precharge	t <sub>RPC</sub>	5	—	5	—	5	—	ns	12
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Set-up Time ( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ )	t <sub>CSR</sub>	5	—	5	—	5	—	ns	12
$\overline{\text{RAS}}$ to $\overline{\text{CAS}}$ Hold Time ( $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ )	t <sub>CHR</sub>	10	—	15	—	15	—	ns	13
$\overline{\text{CAS}}$ Precharge Time (Refresh Counter Test)	t <sub>CPT</sub>	20	—	30	—	40	—	ns	15

- Notes:
1. A start-up delay of 200  $\mu$ 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  $\overline{\text{UCAS}}$ ,  $\overline{\text{LCAS}}$ , 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. These parameters are determined by the falling edge of  $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$ , whichever is earlier.
  13. These parameters are determined by the rising edge of  $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$ , whichever is later.
  14.  $t_{CWL}$  should be satisfied by both  $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$ .
  15.  $t_{CP}$  and  $t_{CPT}$  are determined by the time both  $\overline{\text{UCAS}}$  or  $\overline{\text{LCAS}}$  are high.

**See ADDENDUM H for AC Timing Waveforms**