PRELIMINARY

4,194,304 WORD X 16 BIT EDO (HYPER PAGE) DYNAMIC RAM

Description

The TC5165165AJ/AFT is the EDO (hyper page) dynamic RAM organized 4,194,304 words by 16 bits. The TC5165165AJ/AFT utilizes Toshiba's CMOS silicon gate process technology as well as advanced circuit techniques to provide wide operating margins, both internally and to the system user. Multiplexed address inputs permit the TC5165165AJ/AFT to be packaged in a 50 pin plastic SOJ, and a 50 pin plastic TSOP. The package size provides high system bit densities and is compatible with widely available automated testing and insertion equipment. System oriented features include single power supply of 3.3V±0.3V tolerance, direct interfacing capability with high performance logic families such as Schottky LVTTL.

Features

- 4,194,304 word by 16 bit organization
- Fast access time and cycle time
- Single power supply of 3.3V±0.3V with a built-in V_{BB} generator
- Low Power
  - 504mW MAX. Operating
  - (TC5165165AJ/AFT-60)
  - 432mW MAX. Operating
  - (TC5165165AJ/AFT-70)
  - 1.8mW MAX. Standby
- Outputs unlatched at cycle end allows two-dimensional chip selection
- Read-Modify-Write, $\overline{CAS}$ before $\overline{RAS}$ refresh, $\overline{RAS}$-only refresh, Hidden refresh, EDO (Hyper Page Mode) and Test Mode capability
- All inputs and outputs LVTTL compatible
- 1024 refresh cycles/16ms
- Package TC5165165AJ: SOJ50-P-
  TC5165165AFT: TSOP50-P-400D
- For packaging details see Mechanical Dimensions section

Key Parameters

ITEM		TC5165165AJ/AFT	
		-50	-60
t_{RAC}	$\overline{RAS}$ Access Time	50ns	60ns
t_{AA}	Column Address Access Time	25ns	30ns
t_{CAC}	$\overline{CAS}$ Access Time	13ns	15ns
t_{RC}	Cycle Time	84ns	104ns
t_{HPC}	Hyper Page Mode Cycle Time	20ns	25ns

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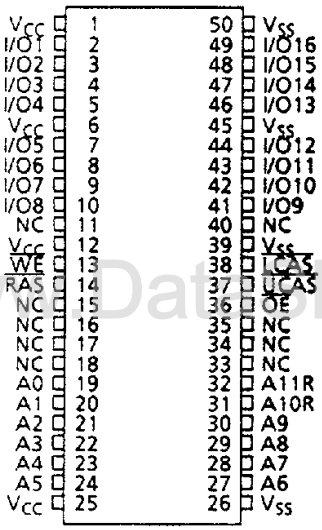
Pin Name

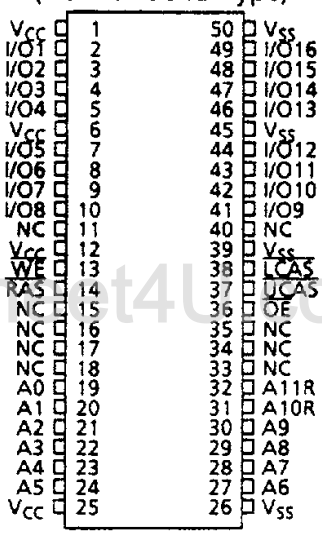
A0 ~ A11	Address Inputs
$\overline{RAS}$	Row Address Strobe
$\overline{UCAS}$	Column Address Strobe/ Upper Byte Control
$\overline{LCAS}$	Column Address Strobe/ Lower Byte Control
$\overline{WE}$	Write Enable
$\overline{OE}$	Output Enable
I/O1 ~ I/O16	Data Input/Output
V_{CC}	Power (+3.3V)
V_{SS}	Ground
NC	No Connection

Pin Connection (Top View)

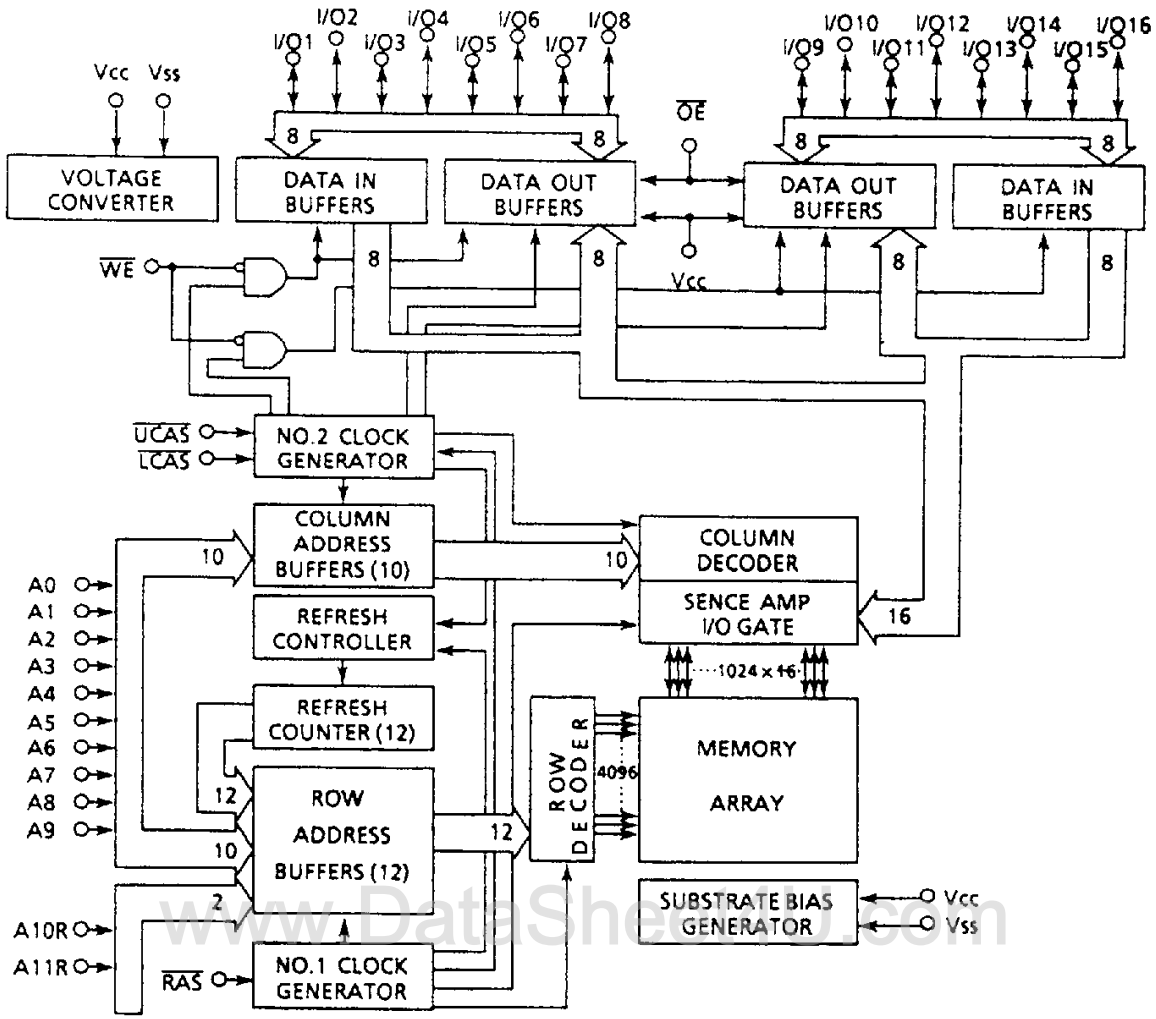
Plastic SOJ



Plastic TSOP (Normal Bend Type)



Block Diagram



Absolute Maximum Ratings

ITEM	SYMBOL	RATING	UNIT	NOTE
Input Voltage	V_{IN}	-0.5 ~ V_{CC} + 0.3	V	1
Output Voltage	V_{OUT}	-0.5 ~ V_{CC} + 0.3	V	1
Power Supply Voltage	V_{CC}	-0.3 ~ 4.6	V	1
Operating Temperature	T_{OPR}	0 ~ 70	°C	1
Storage Temperature	T_{STG}	-55 ~ 150	°C	1
Soldering Temperature (10s)	T_{SOLDER}	260	°C	1
Power Dissipation	P_D	1.0	W	1
Short Circuit Output Current	I_{OUT}	50	mA	1

Recommended DC Operating Conditions (Ta = 0 ~ 70°C)

SYMBOL	PARAMETER	MIN.	TYP	MAX	UNIT	NOTE
V_{CC}	Supply Voltage	3.0	3.3	3.6	V	2
V_{IH}	Input High Voltage	2.0	-	V_{CC} + 0.3*	V	2
V_{IL}	Input Low Voltage	-0.3**	-	0.8	V	2

*V_{CC} + 1.2V at pulse width ≤ 20ns (pulse width is measured at V_{CC}).
**-1.2V at pulse width ≤ 20ns (pulse width is measured at V_{SS}).

DC Electrical Characteristics (V_{CC} = 3.3V±0.3V, Ta = 0 ~ 70°C)

SYMBOL	PARAMETER		MIN.	MAX	UNIT	NOTES
I_{CC1}	OPERATING CURRENT Average Power Supply Operating Current ($\overline{RAS}$, $\overline{CAS}$, Address Cycling: t_{RC}=t_{RC} MIN.)	TC5165165AJ/AFT-50	-	140	mA	3, 4, 5
		TC5165165AJ/AFT-50	-	120		
I_{CC2}	STANDBY CURRENT Power Supply Standby Current ($\overline{RAS}$=$\overline{CAS}$=V_{IH})		-	1	mA	
I_{CC3}	$\overline{RAS}$ ONLY REFRESH CURRENT Average Power Supply Current, $\overline{RAS}$ Only Mode ($\overline{RAS}$ Cycling, $\overline{CAS}$=V_{IH}: t_{RC}=t_{RC} MIN.)	TC5165165AJ/AFT-60	-	140	mA	3, 5
		TC5165165AJ/AFT-50	-	120		
I_{CC4}	HYPER PAGE MODE CURRENT Average Power Supply Current, Hyper Page Mode ($\overline{RAS}$=V_{IL}, $\overline{CAS}$, Address Cycling: t_{HPC}=t_{HPC} MIN.)	TC5165165AJ/AFT-50	-	105	mA	3, 5
		TC5165165AJ/AFT-50	-	85		
I_{CC5}	STANDBY CURRENT Power Supply Standby Current ($\overline{RAS}$=$\overline{CAS}$=V_{CC}-0.2V)		-	500	µA	
I_{CC6}	$\overline{CAS}$ BEFORE $\overline{RAS}$ REFRESH CURRENT Average Power Supply Current, $\overline{CAS}$ Before $\overline{RAS}$ Mode ($\overline{RAS}$, $\overline{CAS}$, Cycling: t_{RC}=t_{RC} MIN.)	TC5165165AJ/AFT-50	-	140	mA	3, 5
		TC5165165AJ/AFT-50	-	120		
$I_{I(L)}$	INPUT LEAKAGE CURRENT Input Leakage Current, any input (0V≤V_{IN}≤V_{CC}, All Other Pins Not Under Test=0V)		-10	10	µA	
$I_{O(L)}$	OUTPUT LEAKAGE CURRENT (D_{OUT} is disabled, (0V≤V_{OUT}≤V_{CC})		-10	10	µA	
V_{OH}	OUTPUT LEVEL Output "H" Level Voltage (I_{OUT}= -2mA)		2.4	-	V	
V_{OL}	OUTPUT LEVEL Output "L" Level Voltage (I_{OUT}=2mA)		-	0.4	V	

Electrical Characteristics and Recommended AC Operating Conditions (V_{CC} = 3.3V±0.3V, Ta = 0 ~ 70°C) (Notes 6,7,8)

SYMBOL	PARAMETER	TC5165165AJ/AFT				UNIT	NOTES
		-50		-60			
		MIN	MAX	MIN	MAX		
t_{RC}	Random Read or Write Cycle Time	84	-	104	-	ns	
t_{RMW}	Read-Modify-Write Cycle	111	-	135	-	ns	
t_{RAC}	Access Time from $\overline{RAS}$	-	50	-	60	ns	9, 14, 15
t_{CAC}	Access Time from $\overline{CAS}$	-	13	-	15	ns	9, 14
t_{AA}	Access Time from Column Address	-	25	-	30	ns	9, 15
t_{CPA}	Access Time from $\overline{CAS}$ Precharge	-	28	-	35	ns	9
t_{CLZ}	$\overline{CAS}$ to Output in Low-Z	0	-	0	-	ns	9
t_{OFF}	Output Buffer Turn-off Delay	0	13	0	15	ns	10, 16
t_T	Transition Time (Rise and Fall)	1	50	1	50	ns	8
t_{RP}	$\overline{RAS}$ Precharge Time	30	-	40	-	ns	
t_{RAS}	$\overline{RAS}$ Pulse Width	50	10,000	60	10,000	ns	
t_{RASP}	$\overline{RAS}$ Pulse Width (Hyper Page Mode)	50	100,000	60	100,000	ns	
t_{RSH}	$\overline{RAS}$ Hold Time	8	-	10	-	ns	
t_{RHCP}	$\overline{RAS}$ Hold Time from $\overline{CAS}$ Precharge (Hyper Page Mode)	28	-	35	-	ns	
t_{CSH}	$\overline{CAS}$ Hold Time	35	-	40	-	ns	
t_{CAS}	$\overline{CAS}$ Pulse Width	8	10,000	10	10,000	ns	
t_{RCD}	$\overline{RAS}$ to $\overline{CAS}$ Delay Time	11	37	14	45	ns	14
t_{RAD}	$\overline{RAS}$ to Column Address Delay Time	9	25	12	30	ns	15
t_{CRP}	$\overline{CAS}$ to $\overline{RAS}$ Precharge Time	5	-	5	-	ns	
t_{CP}	$\overline{CAS}$ Precharge Time	8	-	10	-	ns	
t_{ASR}	Row Address Set-Up Time	0	-	0	-	ns	
t_{RAH}	Row Address Hold Time	7	-	10	-	ns	
t_{ASC}	Column Address Set-Up Time	0	0	0	0	ns	
t_{CAH}	Column Address Hold Time	7	-	10	-	ns	
t_{RAL}	Column Address to $\overline{RAS}$ Lead Time	25		30		ns	
t_{RCS}	Read Command Set-Up Time	0	-	0	-	ns	
t_{RCH}	Read Command Hold Time	0	-	0	-	ns	11
t_{RRH}	Read Command Hold Time referenced to $\overline{RAS}$	0	-	0	-	ns	11
t_{WCH}	Write Command Hold Time	7	-	10	-	ns	
t_{WP}	Write Command Pulse Width	7	-	10	-	ns	
t_{RWL}	Write Command to $\overline{RAS}$ Lead Time	8	-	10	-	ns	

Electrical Characteristics and Recommended AC Operating Conditions (Cont)

SYMBOL	PARAMETER	TC5165165AJ/AFT				UNIT	NOTES
		-50		-60			
		MIN	MAX	MIN	MAX		
t_{CWL}	Write Command to $\overline{CAS}$ Lead Time	7	-	10	-	ns	
t_{DS}	Data Set-Up Time	0	-	0	-	ns	12
t_{DH}	Data Hold Time	7	-	10	-	ns	12
t_{REF}	Refresh Period	-	64	-	64	ms	
t_{WCS}	Write Command Set-Up Time	0	-	0	-	ns	13
t_{CWD}	$\overline{CAS}$ to $\overline{WE}$ Delay Time	30	-	34	-	ns	13
t_{RWD}	$\overline{RAS}$ to $\overline{WE}$ Delay Time	67	-	79	-	ns	13
t_{AWD}	Column Address to $\overline{WE}$ Delay Time	42	-	49	-	ns	13
t_{CPWD}	$\overline{CAS}$ Precharge to $\overline{WE}$ Delay Time	45	-	54	-	ns	13
t_{CSR}	$\overline{CAS}$ Set-Up Time ($\overline{CAS}$ before $\overline{RAS}$ Cycle)	5	-	5	-	ns	
t_{CHR}	$\overline{CAS}$ Hold Time ($\overline{CAS}$ before $\overline{RAS}$ Cycle)	7	-	10	-	ns	
t_{RPC}	$\overline{RAS}$ to $\overline{CAS}$ Precharge Time	5	-	5	-	ns	
t_{ROH}	$\overline{RAS}$ Hold Time referenced to $\overline{OE}$	7	-	10	-	ns	
t_{OEA}	$\overline{OE}$ Access Time	-	13	-	15	ns	9
t_{OED}	$\overline{OE}$ to Data Delay	13	-	15	-	ns	
t_{OLZ}	$\overline{OE}$ to Output in Low-Z	0	-	0	-	ns	
t_{OEZ}	Output buffer turn off Delay Time from $\overline{OE}$	0	13	0	15	ns	10
t_{OEH}	$\overline{OE}$ Command Hold Time	7	-	10	-	ns	
t_{ODS}	Output Disable Set-Up Time	0	-	0	-	ns	
t_{WTS}	Write Command Set-Up Time (Test Mode In)	5	-	5	-	ns	
t_{WTH}	Write Command Hold Time (Test Mode In)	7	-	10	-	ns	
t_{WRP}	$\overline{WE}$ to $\overline{RAS}$ Precharge Time ($\overline{CAS}$ before $\overline{RAS}$ Cycle)	5	-	5	-	ns	
t_{WRH}	$\overline{WE}$ to $\overline{RAS}$ Hold Time ($\overline{CAS}$ before $\overline{RAS}$ Cycle)	7	-	10	-	ns	
t_{RNCD}	$\overline{RAS}$ to next $\overline{CAS}$ Delay Time (Hyper Page Mode)	50	-	60	-	ns	
t_{HPC}	Hyper Page Mode Cycle Time	20	-	25	-	ns	
t_{HPRWC}	Hyper Page Mode Read-Modify-Write Cycle Time	56	-	68	-	ns	
t_{COH}	Output Data Hold Time	5	-	5	-	ns	
t_{REZ}	Output Buffer Turn-off Delay from $\overline{RAS}$	0	13	0	15	ns	10, 16
t_{WEZ}	Output Buffer Turn-off Delay from $\overline{WE}$	0	13	0	15	ns	10
t_{WED}	$\overline{WE}$ to Data Delay	13	-	15	-	ns	
t_{OE}	$\overline{OE}$ Pulse Width	13	-	15	-	ns	
t_{OEP}	$\overline{OE}$ Precharge Time	8	-	10	-	ns	
t_{CPO}	$\overline{CAS}$ to $\overline{OE}$ Precharge Time	5	-	5	-	ns	
t_{OCH}	$\overline{CAS}$ Hold Time referenced to $\overline{OE}$	7	-	10	-	ns	

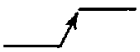
Capacitance (V_{CC} = 3.3V±0.3V, f = 1MHz, Ta = 0 ~ 70°C)

SYMBOL	PARAMETER	MIN	MAX	UNIT
C_{I1}	Input Capacitance (A0 ~ A11)	-	5	pF
C_{I2}	Input Capacitance ($\overline{RAS}$, $\overline{CAS}$, $\overline{WE}$, $\overline{OE}$)	-	7	
C_O	Input Capacitance (I/O1 ~ I/O16)	-	7	

Notes:

1. Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.
2. All voltages are referenced to V_{SS}.
3. I_{CC1}, I_{CC3}, I_{CC4}, I_{CC6} depend on cycle rate.
4. I_{CC1}, I_{CC4} depend on output loading. Specified values are obtained with the output open.
5. Address can be changed one or less while $\overline{RAS}=V_{IL}$. In case of I_{CC4}, it can be changed once or less during a hyper page mode cycle (t_{HPC}).
6. An initial pause of 200μs is required after power-up followed by 8 $\overline{RAS}$ only refresh cycles before proper device operation is achieved. When the internal refresh counter is used, a minimum of 8 $\overline{CAS}$ before $\overline{RAS}$ refresh cycles instead of 8 $\overline{RAS}$ only refresh cycles are required.
7. AC measurements assume t_T=2ns.
8. V_{IH} (min.) and V_{IL} (max.) are reference levels for measuring timing of input signals. Also, transition times are measured between V_{IH} and V_{IL}.
9. Measured with a load equivalent to 100pF at V_{OH}=2.0V (I_{OUT}=-2mA), V_{OL}=0.8V (I_{OUT}=2mA).
10. t_{OFF} (max.), t_{OEZ} (max.), t_{REZ} (max.) and t_{WEZ} (max.) define the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
11. Either t_{RCH} or t_{RRH} must be satisfied for a read cycle.
12. These parameters are referenced to $\overline{CAS}$ leading edge in early write cycles and to $\overline{WE}$ leading edge in Read-Modify-Write cycles.
13. t_{WCS}, t_{RWD}, t_{CWD}, 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 pin will remain open circuit (high impedance) through the entire cycle; If $t_{RWD} \geq t_{RWD}$ (min.), $t_{CWD} \geq t_{CWD}$ (min.), $t_{AWD} \geq t_{AWD}$ (min.) and $t_{CPWD} \geq t_{CPWD}$ (min.) (Hyper Page Mode), the cycle is a Read-Modify-Write cycle and the data out will contain data read from the selected cell: If neither of the above sets of conditions are satisfied, the condition of the data out (at access time) is indeterminate.
14. Operation within the t_{RCD} (max.) limit insures that t_{RAC} 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, then access time is controlled by t_{CAC}.
15. Operation within the t_{RAD} (max.) limit insures 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, then access time is controlled by t_{AA}.
16. If $\overline{RAS}$ goes to high before $\overline{CAS}$ high going, the open circuit condition of the output is achieved by $\overline{CAS}$ high going (t_{OFF}). If $\overline{CAS}$ goes to high before $\overline{CAS}$ high going, the open circuit condition of the output is achieved by $\overline{RAS}$ high going (t_{REZ}).

Data Out Hi-Z Control Logic

$\overline{RAS}$	$\overline{UCAS}$, $\overline{LCAS}$	$\overline{OE}$	$\overline{WE}$	Timing Specification
"H"		"L"	"H"	t_{OFF}
	"H"	"L"	"H"	t_{REZ}
"L"	"L"		"H"	t_{OEZ}
"L"	"H"	"L"		t_{WEZ}

Data Out Lo-Z Control Logic

$\overline{RAS}$	$\overline{UCAS}$, $\overline{LCAS}$	$\overline{OE}$	$\overline{WE}$	Timing Specification
"L"		"L"	"H"	t_{CLZ}
"L"	"L"		"H"	t_{OLZ}
"L"	"L"		"H"	t_{OLZ}