

## DESCRIPTION

This family is a 4M bit dynamic RAM organized 1,048,576 x 4-bit configuration with Fast Page mode CMOS DRAMs. Fast Page mode offers high speed of random access memory within the same row. The circuit and process design allow this device to achieve high performance and low power dissipation. Optional features are access time(50, 60 or 70ns) package type(SOJ or TSOP-II) and power consumption (Normal or Low power). Hyundai's advanced circuit design and process technology allow this device to achieve high bandwidth, low power consumption and high reliability.

## FEATURES

- Fast Page Mode operation
- Read-modify-write Capability
- TTL compatible inputs and outputs
- /CAS-before-/RAS, /RAS-only, Hidden and Self refresh capability
- Max. Active power dissipation
- JEDEC standard pinout
- 20/26-pin SOJ (300mil)  
20/26-pin TSOP-II(300mil)
- Single power supply of 5V ± 10%
- Early Write or output enable controlled write
- Fast access time and cycle time

Speed	Power
50	715mW
60	832mW
70	550mW

Speed	tRAC	tCAC	tPC
50	50ns	15ns	35ns
60	60ns	15ns	40ns
70	70ns	20ns	45ns

- Refresh cycle

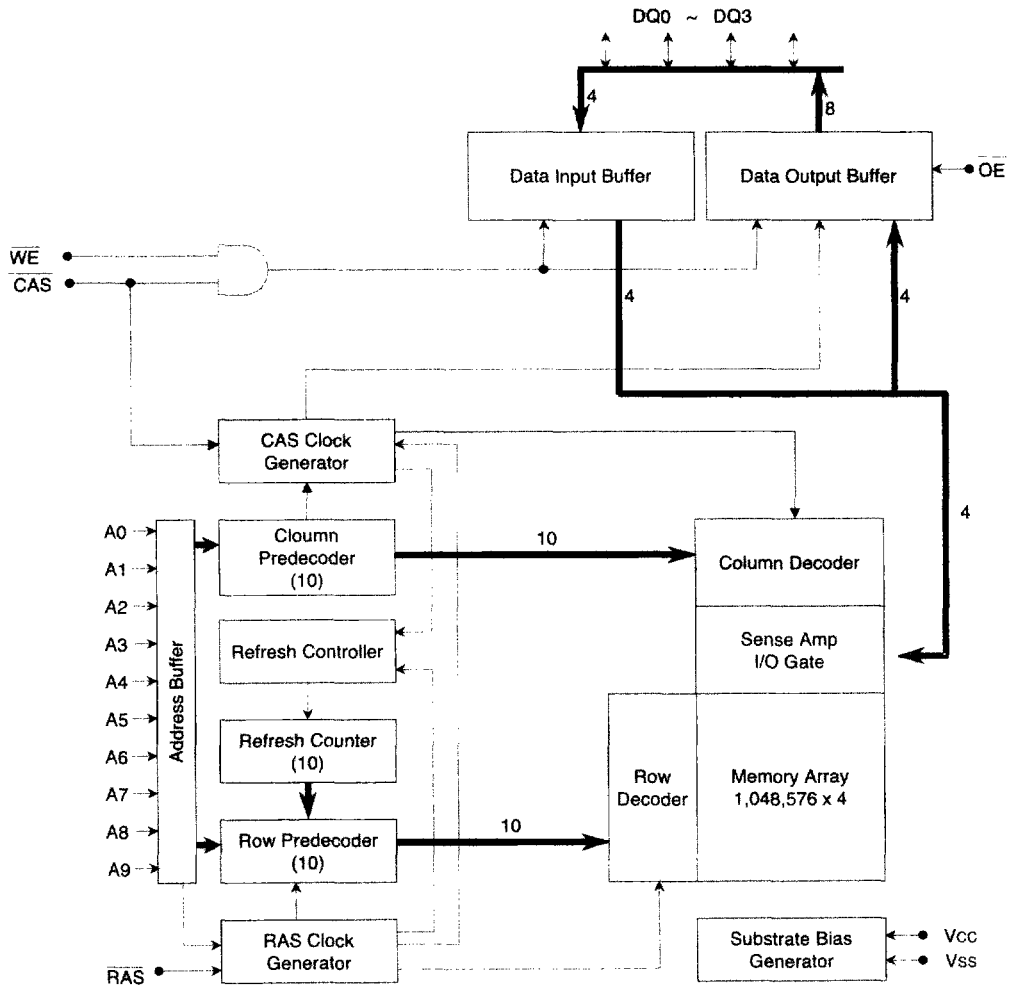
Part number	Refresh	Normal	L-part
HY514400A	1K	16ms	128ms

## ORDERING INFORMATION

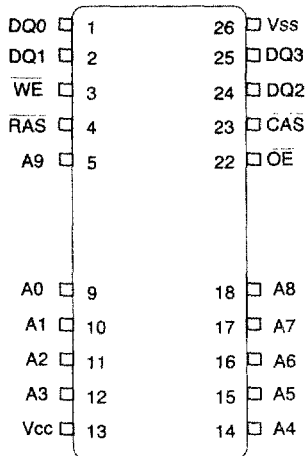
Part Name	Refresh	Power	Package
HY514400AJ	1K		20/26Pin SOJ
HY514400ALJ	1K	L-part	20/26Pin SOJ
HY514400AT	1K		20/26Pin TSOP-II
HY514400ALT	1K	L-part	20/26Pin TSOP-II

\*L : Low power

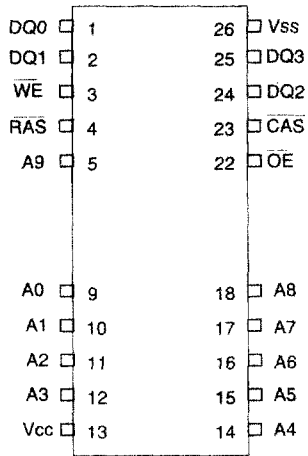
**FUNCTIONAL BLOCK DIAGRAM**



**PIN CONFIGURATION (Marking Side)**



20/26 Pin Plastic SOJ (300mil)



20/26 Pin Plastic TSOP-II (300mil)

**PIN DESCRIPTION**

Pin Name	Parameter
/RAS	Row Address Strobe
/CAS	Column Address Strobe
/WE	Write Enable
/OE	Output Enable
A0~A9	Address Input
DQ0~DQ3	Data In/Out
Vcc	Power (5V)
Vss	Ground

**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Rating	Unit
TA	Ambient Temperature	0 to 70	°C
TSTG	Storage Temperature	-55 to 145	°C
V <sub>IN</sub> , V <sub>OUT</sub>	Voltage on Any Pin relative to V <sub>SS</sub>	-1.0 to 7.0	V
V <sub>CC</sub>	Voltage on V <sub>CC</sub> relative to V <sub>SS</sub>	-1.0 to 7.0	V
I <sub>OS</sub>	Short Circuit Output Current	50	mA
P <sub>D</sub>	Power Dissipation	0.9	W
T <sub>SOLDER</sub>	Soldering Temperature · Time	260 · 10	°C · sec

Note : Operation at or above Absolute Maximum Ratings can adversely affect device reliability

**RECOMMENDED DC OPERATING CONDITIONS**

(TA = 0 °C to 70 °C)

Symbol	Parameter	Min	Typ	Max	UNIT
V <sub>CC</sub>	Power Supply Voltage	4.5	5.0	5.5	V
V <sub>IH</sub>	Input High Voltage	2.4	-	V <sub>CC</sub> +1.0	V
V <sub>IL</sub>	Input Low Voltage	-1.0	-	0.8	V

Note : All voltages are referenced to V<sub>SS</sub>.

**DC OPERATING CHARACTERISTICS**

Symbol	Parameter	Test condition	Min	Max	Unit
I <sub>LI</sub>	Input Leakage Current (Any input)	V <sub>SS</sub> ≤ V <sub>IN</sub> ≤ V <sub>CC</sub> + 1.0 All other pins not under test = V <sub>SS</sub>	-10	10	μA
I <sub>LO</sub>	Output Leakage Current (Any input)	V <sub>SS</sub> ≤ V <sub>OUT</sub> ≤ V <sub>CC</sub> /RAS & /CAS at V <sub>IH</sub>	-10	10	μA
V <sub>OL</sub>	Output Low Voltage	I <sub>OL</sub> = 4.2mA	-	0.4	V
V <sub>OH</sub>	Output High Voltage	I <sub>OH</sub> = -5.0mA	2.4	-	V

## DC CHARACTERISTICS

(TA = 0°C to 70°C, VCC = 5V ± 10%, VSS = 0V, unless otherwise noted.)

Symbol	Parameter	Test condition	Speed	Max.	Unit
Icc1	Operating Current	/RAS, /CAS Cycling tRC = tRC(min)	50	130	mA
			60	115	
			70	100	
Icc2	TTL Standby Current	/RAS, /CAS ≥ VIH(min) Other inputs ≥ VSS		2	mA
Icc3	/RAS-only Refresh Current	/RAS Cycling, /CAS = VIH tRC = tRC(min)	50	130	mA
			60	115	
			70	100	
Icc4	Fast Page mode Current	/CAS Cycling, /RAS = VIL tPC = tPC(min)	50	80	mA
			60	70	
			70	60	
Icc5	CMOS Standby Current	/RAS = /CAS ≥ VCC - 0.2V	L-part	1 200	mA μA
Icc6	/CAS-before-/RAS Refresh Current	/RAS & /CAS = 0.2V tRC = tRC(min.)	50	130	mA
			60	115	
			70	100	
Icc7	Battery Back-up Current (SL-part)	tRC=125μs /CAS = CBR cycling or 0.2V /OE & /WE = VCC - 0.2V Address = VCC-0.2V or 0.2V DQ0~DQ3 = VCC-0.2, 0.2V or Open	tRAS ≤ 300ns	300	μA
			tRAS ≤ 1us	400	

## Note

- Icc1, Icc3, Icc4, Icc6 and Icc7 depend on output loading and cycle rates(tRC and tPC).
- Specified values are obtained with output unloaded.
- Icc is specified as an average current. In Icc1, Icc3, Icc6, address can be changed only once while /RAS=VIL. In Icc4, address can be changed maximum once while /CAS=VIH within one cycle time tPC.
- Only tRAS(max) = 1μs is applied to refresh of battery backup but tRAS(max) = 10μs is to normal functional operation.
- Icc5(max.), Icc7 are applied to L-part only.

## AC CHARACTERISTICS

(TA = 0 °C to 70 °C, VCC = 5V ± 10%, VSS = 0V, unless otherwise noted.)

Symbol	Parameter	50ns		60ns		70ns		Unit	Notes
		Min	Max	Min	Max	Min	Max		
tRC	Random read or write cycle time	90	-	110	-	130	-	ns	
tRWC	Read-modify-write cycle time	130	-	150	-	180	-	ns	
tPC	Fast Page mode cycle time	35	-	40	-	45	-	ns	
tPRWC	Fast Page mode read-modify-write cycle time	75	-	80	-	95	-	ns	
tRAC	Access time from /RAS	-	50	-	60	-	70	ns	4,9,10
tCAC	Access time from /CAS	-	15	-	15	-	20	ns	4,9
tAA	Access time from column address	-	25	-	30	-	35	ns	4,10
tCPA	Access time from /CAS precharge	-	30	-	35	-	40	ns	4,15
tCLZ	/CAS to output low impedance	0	-	0	-	0	-	ns	4
tOFF	Output Buffer Turn-off Dealy Time	0	15	0	15	0	20	ns	5
tT	Transition time(rise and fall)	3	50	3	50	3	50	ns	3
tRP	/RAS precharge time	30	-	40	-	50	-	ns	
tRAS	/RAS pulse width	50	10K	60	10K	70	10K	ns	
tRASP	/RAS pulse width(FP mode)	50	200K	60	200K	70	200K	ns	
tRSH	/RAS hold time	15	-	15	-	20	-	ns	
tCSH	/CAS hold time	50	-	60	-	70	-	ns	
tCAS	/CAS pulse width	15	10K	15	10K	20	10K	ns	
tRCD	/RAS to /CAS delay time	15	35	20	45	20	50	ns	9
tRAD	/RAS to column address delay time	10	25	15	30	15	35	ns	10
tCRP	/CAS to /RAS precharge time	5	-	5	-	5	-	ns	15
tCP	/CAS precharge time	10	-	10	-	10	-	ns	17
tASR	Row address set-up time	0	-	0	-	0	-	ns	
tRAH	Row address hold time	8	-	10	-	10	-	ns	
tASC	Column address set-up time	0	-	0	-	0	-	ns	14
tCAH	Column address hold time	15	-	15	-	15	-	ns	14
tAR	Column address hold time from /CAS	45	-	50	-	55	-	ns	
tRAL	Column address to /RAS lead time	25	-	30	-	35	-	ns	
tRCS	Read command set-up time	0	-	0	-	0	-	ns	14
tRCH	Read command hold time referenced to /CAS	0	-	0	-	0	-	ns	6,14
tRRH	Read command hold time referenced to /RAS	0	-	0	-	0	-	ns	6
tWCH	Write command hold time	10	-	15	-	15	-	ns	14
tWCR	Write command hold time from /RAS	40	-	50	-	55	-	ns	
tWP	Write command pulse width	10	-	15	-	15	-	ns	
tRWL	Write command to /RAS lead time	15	-	15	-	20	-	ns	

## AC CHARACTERISTICS

Continued

Symbol	Parameter	50ns		60ns		70ns		Unit	Note
		Min	Max	Min	Max	Min	Max		
tCWL	Write command to /CAS lead time	15	-	15	-	20	-	ns	16
tDS	Data-in set-up time	0	-	0	-	0	-	ns	7
tDH	Data-in hold time	15	-	15	-	15	-	ns	7
tDHR	Data-in hold time Referenced to /RAS	40	-	50	-	55	-	ns	
tREF	Refresh period(1024 cycles)	16	-	16	-	16	-	ms	12
	Refresh period(L-part)	128	-	128	-	128	-	ms	11
tWCS	Write command set-up time	0	-	0	-	0	-	ns	8
tCWD	/CAS to /WE delay time	35	-	35	-	40	-	ns	8
tRWD	/RAS to /WE delay time	70	-	80	-	95	-	ns	8
tAWD	Column address to /WE delay time	45	-	50	-	60	-	ns	8
tCSR	/CAS set-up time(CBR cycle)	5	-	5	-	5	-	ns	14
tCHR	/CAS hold time(CBR cycle)	10	-	10	-	10	-	ns	15
tRPC	/RAS to /CAS precharge time	5	-	5	-	5	-	ns	14
tCPT	/CAS precharge time(CBR counter test)	25	-	30	-	35	-	ns	17
tROH	/RAS hold time referenced to /OE	10	-	10	-	10	-	ns	
tOEA	/OE access time	-	15	-	15	-	20	ns	
tOED	/OE to data delay	15	-	15	-	20	-	ns	
tOEZ	Output buffer turn-off delay time from /OE	0	15	0	15	0	20	ns	5
tOEH	/OE command hold time	15	-	15	-	20	-	ns	
tCPWD	/WE delay time from /CAS precharge	50	-	55	-	65	-	ns	8
tRHCP	/RAS hold time from /CAS precharge	30	-	35	-	40	-	ns	
tWRP	/WE to /RAS Precharge time (CBR cycle)	10	-	10	-	10	-	ns	
tWRH	/WE to /RAS Hold time (CBR cycle)	10	-	10	-	10	-	ns	
tWTS	Write Command Set-up time (Test Mode In)	10	-	10	-	10	-	ns	
tWTH	Write Command Hole time (test Mode In)	10	-	10	-	10	-	ns	

## NOTE

1. An initial pause of 200 $\mu$ s is required after power-up followed by 8 /RAS only refresh cycles before proper device operation is achieved. In case of using internal refresh counter, a minimum of 8 CBR refresh cycles instead of 8 /RAS-only refresh cycles are required.
2. If /RAS=Vss during power-up, the HY514400A could begin an active cycle. This condition results in higher current than necessary current which is demanded from the power supply during power-up. It is recommended that /RAS and /CAS track with Vcc during power-up or be held at a valid VIH in other to minimize the power-up current.
3. VIH(min.) and VIL(max.) are reference levels for measuring timing of input signals. Transition times are measured between VIH(min.) and VIL(max.), and are assumed to be 5ns for all inputs.
4. Measured at VOH=2.0V and VOL=0.8V with a load equivalent to 2TTL loads and 100pF.
5. tOFF(max.) and tOEZ define the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
6. Either tRCH or tRRH must be satisfied for a read cycle.
7. tCEZ and tOEZ define the time at which the output achieves the open circuit condition and is not referenced to output voltage levels.
8. twcs, trwd, tcwd, tawd and tcpwd are not restrictive operating parameters. They are included in the data sheet as electrical characteristics only. If twcs  $\geq$  twcs(min.), the cycle is an early write cycle and data out pin will remain open circuit (high impedance) through the entire cycle. If trwd  $\geq$  trwd(min.), tcwd  $\geq$  tcwd(min.), tawd  $\geq$  tawd(min.), and tcpwd  $\geq$  tcpwd(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.
9. Operation within the trcd(max.) limit ensures that trac(max.) can be met. trcd(max.) is specified as a reference point only. If trcd is greater than the specified trcd(max.) limit, then access time is controlled by tcac.
10. Operation within the trad(max.) limit ensures that trac(max.) can be met. trad(max.) is specified as a reference point only. If trad is greater than the specified trad(max.) limit, then access time is controlled by taa.
11. tREF(max.)=128ms is applied to L-parts only.
12. A burst of 1024 CBR refresh cycles must be executed within 16ms (128ms for L-part) after exiting self refresh.
13. When CAS goes low at the same time, 4bits data are written into the device.
14. These parameters are determined by the earlier falling edge of /CAS.
15. These parameters are determined by the later rising edge of /CAS.
16. tcWL must be satisfied by /CAS for 4bits access cycle.
17. tcp and tcPT are measured when /CAS and is high state.

## CAPACITANCE

(TA = 25 °C, VCC = 5V  $\pm$  10%, VSS = 0V and f=1MHz, unless otherwise noted.)

Symbol	Parameter	Typ.	Max	Unit
CIN1	Input Capacitance (A0-A9)	-	5	pF
CIN2	Input Capacitance (/RAS, /CAS, /WE, /OE)	-	7	pF
CdQ	Data Input / Output Capacitance (DQ0-DQ3)	-	7	pF