Instructions for Programming TUTOR EPROMs

The TUTOR code will be programmed into two 2764 EPROM chips from files which reside in the EPROM directory of the hard disk on the PC nearest the TA office door. The files are named TUTOR.EVN and TUTOR.ODD, and contain the even and odd bytes respectively of the TUTOR code.

The procedure for preparing the chips is as follows:

1. Obtain two blank 2764 devices from the TA. If you are not certain the devices are blank, have the TA show you how to use the EPROM eraser (if you don't already know), and erase the devices for 15 minutes.

2. Boot up the PC in the lab, which has the EPROM programming system, installed in it (closest one to the door to the TA office). Change directories to the EPROM directory.

3. Enter the command UPP512. This is the program, which you will use to program the EPROM's. A menu will appear on the screen.

4. Select the 12.5 Volt level.

5. Select the Load (L) menu option. You will be prompted for a buffer start address (enter 0000) and a file name (enter TUTOR.EVN or TUTOR.ODD).

6. Select the Blank Check and Copy (4) option. A "Ready?" prompt will appear. Insert a blank 2764 in the EPROM programmer socket and enter Y. The program will then proceed to blank check, program, and verify the device.

7. Repeat steps 5 and 6 for the other file. When you are finished, select menu option Q (quit).

Using the Logic Analyzer to Verify Bootstrap Action

The file "`bootstrap.la`" in the logic analyzer can be used to verify that the circuit functions correctly for the first 8 bus cycles after reset. The following 8 bytes should appear on the data bus after RESET* has been asserted:

```
HEX      00     04     00     81              from ROM0
HEX         00     44     00     46           from ROM1
HEX      00 01 02 03 04 05 06 07              from 68008 address
```

The reset vectors are `SP = $0000 0444`
`PC = $0000 8146`

1. Make sure that both Logic Analyzer and your circuit are turned off.
2. Make the following connections to POD1 and POD2 on your Logic Analyzer:

SIGNAL	LEAD		COLOR	SIGNAL	LEAD		COLOR
D0	0	POD1A	BLACK	AS*	8	POD2A	BLACK
D1	1		BROWN	A0	9		BROWN
D2	2		RED	A1	10		RED
D3	3		ORANGE	A2	11		ORANGE
D4	4		YELLOW	A3	12		YELLOW
D5	5		GREEN	ROMEN0*	13		GREEN
D6	6		BLUE	ROMEN1*	14		BLUE
D7	7		MAGENTA	RESET*[a]	15		MAGENTA

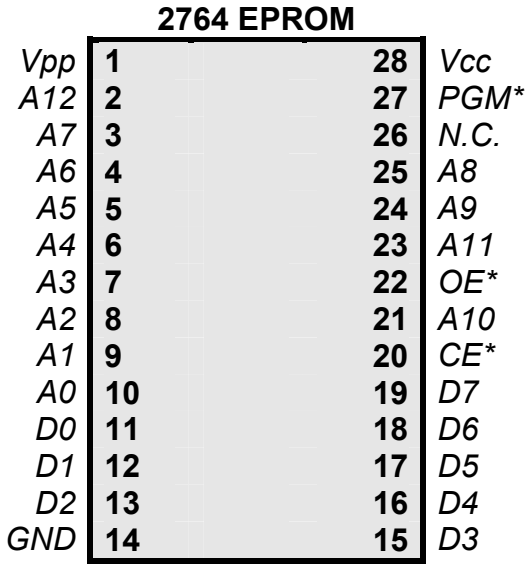
[a]BOOT-CLR*

3. Connect the GND pin of each Logic POD to your circuit's ground (i.e., with a GRAY wire)
4. Open the Logic Analyzer.
5. On the Logic Analyzer, select the "bootstrap" setting and load it.
6. Power up your circuit. Your circuit should be in single step mode
7. Set the trigger condition for the assertion of AS*. The trigger mode is set to single step.
8. Check the valid data at the appropriate addresses. Take few more samples to check your bootstrap action is working fine.

NOTES:

1. There should be 4 distinct signals from the reset module: HALT*, RESET*, SLAVE-CLR* (to PIA & baud-Generator) and BOOT-CLR*(to DDVM).
2. Addresses A01-A13 from the CPU should be connected to A00-A12 on the ROM.

2764 EPROM Pinout



NOTES:

- **Vpp**: Programming Voltage. Connect to Vcc for reading
- **CE***: Chip Enable
- **OE***: Output Enable
- **PGM***: Program/Read Mode: Connect to Vcc for Reading

FAIRCHILD SEMICONDUCTOR™

January 1999

NMC27C64
65,536-Bit (8192 x 8) CMOS EPROM

General Description

The NMC27C64 is a 64K UV erasable, electrically reprogrammable and one-time programmable (OTP) CMOS EPROM ideally suited for applications where fast turnaround, pattern experimentation and low power consumption are important requirements.

The NMC27C64 is designed to operate with a single +5V power supply with ±10% tolerance. The CMOS design allows the part to operate over extended and military temperature ranges.

The NMC27C64Q is packaged in a 28-pin dual-in-line package with a quartz window. The quartz window allows the user to expose the chip to ultraviolet light to erase the bit pattern. A new pattern can then be written electrically into the device by following the programming procedure.

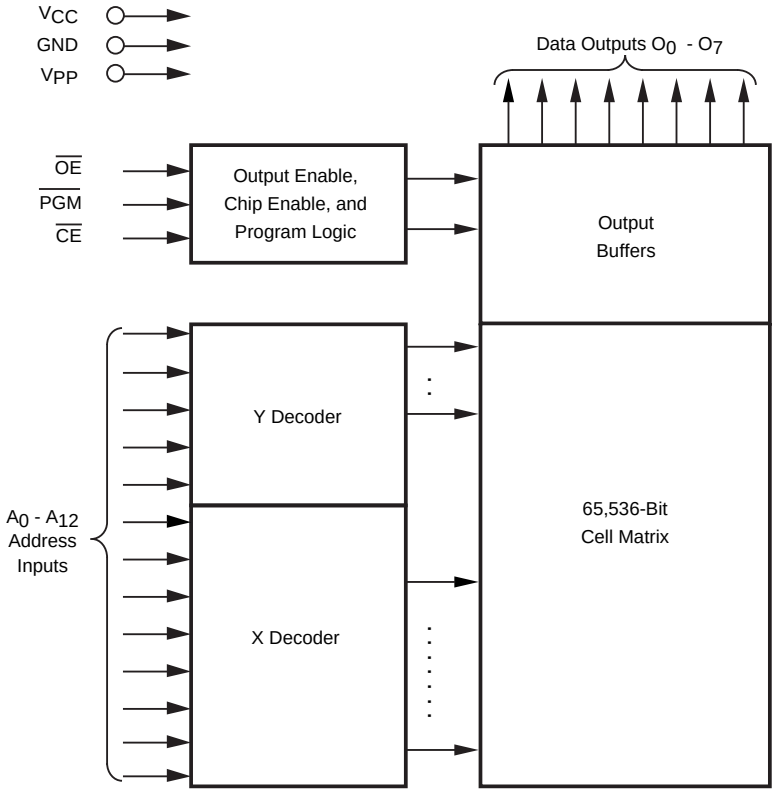
The NMC27C64N is packaged in a 28-pin dual-in-line plastic molded package without a transparent lid. This part is ideally suited for high volume production applications where cost is an important factor and programming only needs to be done once.

This family of EPROMs are fabricated with Fairchild's proprietary, time proven CMOS double-poly silicon gate technology which combines high performance and high density with low power consumption and excellent reliability.

Features

- High performance CMOS
  - —150 ns access time
- JEDEC standard pin configuration
  - —28-pin Plastic DIP package
  - —28-pin CERDIP package
- Drop-in replacement for 27C64 or 2764
- Manufacturers identification code

Block Diagram



DS008634-1

Connection Diagram

27C512 27512	27C256 27256	27C128 27128	27C32 2732	27C16 2716					27C16 2716	27C32 2732	27C128 27128	27C256 27256	27C512 27512
A_{15}	V_{PP}	V_{PP}			V_{PP}	1	28	V_{CC}			V_{CC}	V_{CC}	V_{CC}
A_{12}	A_{12}	A_{12}			A_{12}	2	27	$\overline{PGM}$			$\overline{PGM}$	A_{14}	A_{14}
A_7	A_7	A_7	A_7	A_7	A_7	3	26	NC	V_{CC}	V_{CC}	A_{13}	A_{13}	A_{13}
A_6	A_6	A_6	A_6	A_6	A_6	4	25	A_8	A_8	A_8	A_8	A_8	A_8
A_5	A_5	A_5	A_5	A_5	A_5	5	24	A_9	A_9	A_9	A_9	A_9	A_9
A_4	A_4	A_4	A_4	A_4	A_4	6	23	A_{11}	V_{PP}	A_{11}	A_{11}	A_{11}	A_{11}
A_3	A_3	A_3	A_3	A_3	A_3	7	22	$\overline{OE}$	$\overline{OE}$	$\overline{OE}/V_{PP}$	$\overline{OE}$	$\overline{OE}$	$\overline{OE}/V_{PP}$
A_2	A_2	A_2	A_2	A_2	A_2	8	21	A_{10}	A_{10}	A_{10}	A_{10}	A_{10}	A_{10}
A_1	A_1	A_1	A_1	A_1	A_1	9	20	$\overline{CE}$	$\overline{CE}/\overline{PGM}$	$\overline{CE}$	$\overline{CE}$	$\overline{CE}/\overline{PGM}$	$\overline{CE}$
A_0	A_0	A_0	A_0	A_0	A_0	10	19	O_7	O_7	O_7	O_7	O_7	O_7
O_0	O_0	O_0	O_0	O_0	O_0	11	18	O_6	O_6	O_6	O_6	O_6	O_6
O_1	O_1	O_1	O_1	O_1	O_1	12	17	O_5	O_5	O_5	O_5	O_5	O_5
O_2	O_2	O_2	O_2	O_2	O_2	13	16	O_4	O_4	O_4	O_4	O_4	O_4
GND	GND	GND	GND	GND	GND	14	15	O_3	O_3	O_3	O_3	O_3	O_3

NMC27C64

Note: Socket compatible EPROM pin configurations are shown in the blocks adjacent to the NMC27C64 pins.

DS008634-2

Pin Names

A0–A12	Addresses
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
$O_0 - O_7$	Outputs
$\overline{PGM}$	Program
NC	No Connect
V_{PP}	Programming Voltage
V_{CC}	Power Supply
GND	Ground

Commercial Temperature Range V_{CC} = 5V ±10%

Parameter/Order Number	Access Time (ns)
NMC27C64Q, N 150	150
NMC27C64Q, N 200	200

Extended Temp Range (-40°C to +85°C) V_{CC} = 5V ±10%

Parameter/Order Number	Access Time (ns)
NMC27C64QE, NE200	200

Absolute Maximum Ratings (Note 1)

Temperature Under Bias	-55°C to +125°C
Storage Temperature	-65°C to +150°C
All Input Voltages except A9 with Respect to Ground (Note 10)	+6.5V to -0.6V
All Output Voltages with Respect to Ground (Note 10)	V_{CC} +1.0V to GND -0.6V
V_{PP} Supply Voltage and A_9 with Respect to Ground During Programming	+14.0V to -0.6V
V_{CC} Supply Voltage with Respect to Ground	+7.0V to -0.6V
Power Dissipation	1.0W
Lead Temperature (Soldering, 10 sec.)	300°C
ESD Rating (Mil Spec 883C, Method 3015.2)	2000V

Operating Conditions (Note 7)

Temperature Range	
NMC27C64Q 150, 200 NMC27C64N 150, 200	0°C to +70°C
NMC27C64QE 200 NMC27C64NE 200	-40°C to +85°C
V_{CC} Power Supply	+5V ±10%

READ OPERATION

DC Electrical Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_{LI}	Input Load Current	$V_{IN} = V_{CC}$ or GND			10	µA
I_{LO}	Output Leakage Current	$V_{OUT} = V_{CC}$ or GND, $\overline{CE} = V_{IH}$			10	µA
I_{CC1} (Note 9)	V_{CC} Current (Active) TTL Inputs	$\overline{CE} = V_{IL}$,f=5 MHz Inputs = V_{IH} or V_{IL}, I/O = 0 mA		5	20	mA
I_{CC2} (Note 9)	V_{CC} Current (Active) CMOS Inputs	$\overline{CE}$ = GND, f = 5 MHz Inputs = V_{CC} or GND, I/O = 0 mA		3	10	mA
I_{CCSB1}	V_{CC} Current (Standby) TTL Inputs	$\overline{CE} = V_{IH}$		0.1	1	mA
I_{CCSB2}	V_{CC} Current (Standby) CMOS Inputs	$\overline{CE} = V_{CC}$		0.5	100	µA
I_{PP}	VPP Load Current	$V_{PP} = V_{CC}$		10	µA	
V_{IL}	Input Low Voltage		-0.1		0.8	V
V_{IH}	Input High Voltage		2.0		V_{CC} +1	V
V_{OL1}	Output Low Voltage	I_{OL} = 2.1 mA			0.45	V
V_{OH1}	Output High Voltage	I_{OH} = -400 µA	2.4			V
V_{OL2}	Output Low Voltage	I_{OL} = 0 µA			0.1	V
V_{OH2}	Output High Voltage	I_{OH} = 0 µA	V_{CC} - 0.1			V

AC Electrical Characteristics

Symbol	Parameter	Conditions	NMC27C64				Units
			150		200, E200		
			Min	Max	Min	Max	
t_{ACC}	Address to Output Delay	$\overline{CE} = \overline{OE} = V_{IL}$ $\overline{PGM} = V_{IH}$		150		200	ns
t_{CE}	$\overline{CE}$ to Output Delay	$\overline{OE} = V_{IL}$, $\overline{PGM} = V_{IH}$		150		200	ns
t_{OE}	$\overline{OE}$ to Output Delay	$\overline{CE} = V_{IL}$, $\overline{PGM} = V_{IH}$		60		60	ns
t_{DF}	$\overline{OE}$ High to Output Float	$\overline{CE} = V_{IL}$, $\overline{PGM} = V_{IH}$	0	60	0	60	ns
t_{CF}	$\overline{CE}$ High to Output Float	$\overline{OE} = V_{IL}$, $\overline{PGM} = V_{IH}$	0	60	0	60	ns
t_{OH}	Output Hold from Addresses, $\overline{CE}$ or $\overline{OE}$, Whichever Occurred First	$\overline{CE} = \overline{OE} = V_{IL}$ $\overline{PGM} = V_{IH}$	0		0		ns

Capacitance TA = +25˚C, f = 1 MHz (Note 2) NMC27C64Q

Symbol	Parameter	Conditions	Typ	Max	Units
C_{IN}	Input Capacitance	V_{IN} = 0V	6	8	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V	9	12	pF

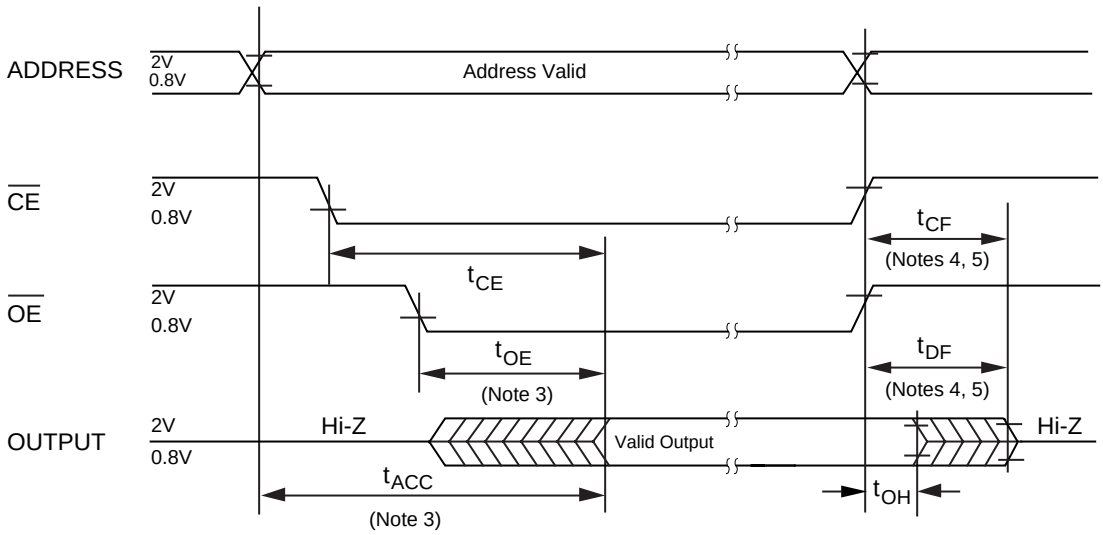
Capacitance TA = +25˚C, f = 1 MHz (Note 2) NMC27C64N

Symbol	Parameter	Conditions	Typ	Max	Units
C_{IN}	Input Capacitance	V_{IN} = 0V	5	10	pF
C_{OUT}	Output Capacitance	V_{OUT} = 0V	8	10	pF

AC Test Conditions

Output Load	1 TTL Gate and C_L = 100 pF (Note 8)
Input Rise and Fall Times	≤5 ns
Input Pulse Levels	0.45V to 2.4V
Timing Measurement Reference Level	
Inputs	0.8V and 2V
Outputs	0.8V and 2V

AC Waveforms (Note 6) (Note 9)



Note 1: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: This parameter is only sampled and is not 100% tested.

Note 3: $\overline{OE}$ may be delayed up to t_{ACC} - t_{OE} after the falling edge of $\overline{CE}$ without impacting t_{ACC}.

Note 4: The t_{DF} and t_{CF} compare level is determined as follows:
High to TRI-STATE ® , the measured V_{OH1} (DC) ، 0.10V;
Low to TRI-STATE, the measured V_{OL1} (DC) + 0.10V.

Note 5: TRI-STATE may be attained using $\overline{OE}$ or $\overline{CE}$.

Note 6: The power switching characteristics of EPROMs require careful device decoupling. It is recommended that at least a 0.1 µF ceramic capacitor be used on every device between V_{CC} and GND.

Note 7: The outputs must be restricted to V_{CC} + 1.0V to avoid latch-up and device damage.

Note 8: 1 TTL Gate: I_{OL} = 1.6 mA, I_{OH} = -400 µA.
C_L: 100 pF includes fixture capacitance.

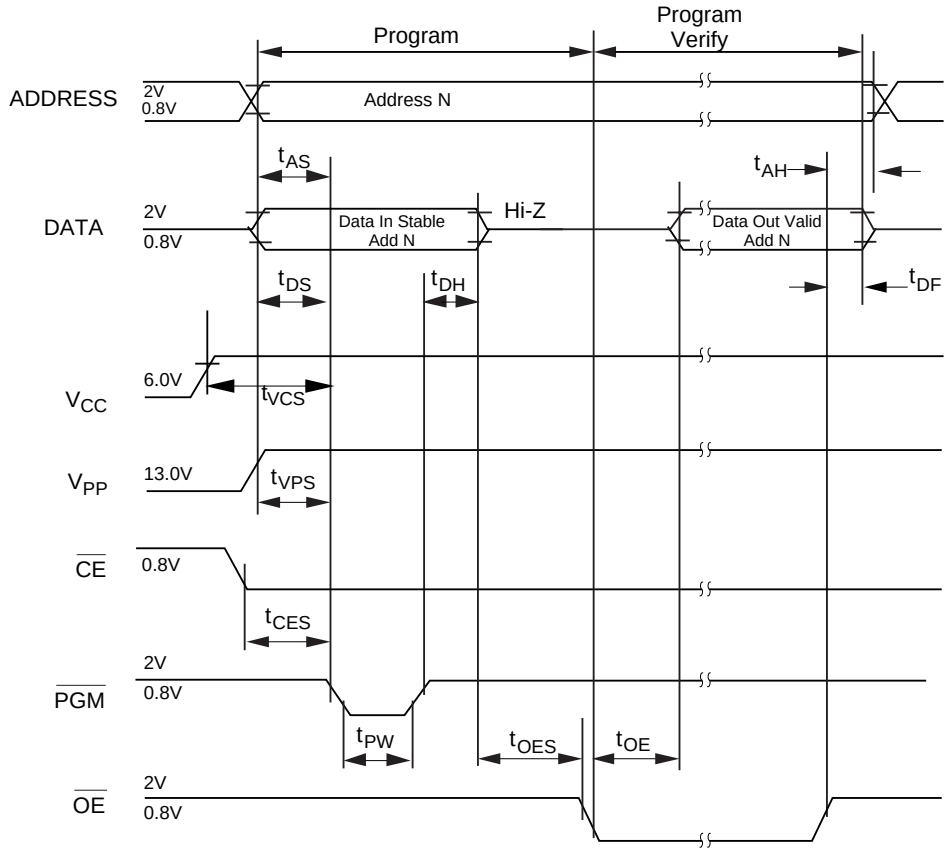
Note 9: V_{PP} may be connected to V_{CC} except during programming.

Note 10: Inputs and outputs can undershoot to -2.0V for 20 ns Max.

Programming Characteristics (Note 11) (Note 12) (Note 13) (Note 14)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{AS}	Address Setup Time		2			µs
t_{OES}	$\overline{OE}$ Setup Time		2			µs
t_{CES}	$\overline{CE}$ Setup Time		2			µs
t_{DS}	Data Setup Time		2			µs
t_{VPS}	V_{PP} Setup Time		2			µs
t_{VCS}	V_{CC} Setup Time		2			µs
t_{AH}	Address Hold Time		0			µs
t_{DH}	Data Hold Time		2			µs
t_{DF}	Output Enable to Output Float Delay	$\overline{CE} = V_{IL}$	0		130	ns
t_{PW}	Program Pulse Width		0.45	0.5	0.55	ms
t_{OE}	Data Valid from $\overline{OE}$	$\overline{CE} = V_{IL}$			150	ns
I_{PP}	V_{PP} Supply Current During Programming Pulse	$\overline{CE} = V_{IL}$ $\overline{PGM} = V_{IL}$			30	mA
I_{CC}	V_{CC} Supply Current				10	mA
T_A	Temperature Ambient		20	25	30	˚C
V_{CC}	Power Supply Voltage		5.75	6.0	6.25	V
V_{PP}	Programming Supply Voltage		12.2	13.0	13.3	V
t_{FR}	Input Rise, Fall Time		5			ns
V_{IL}	Input Low Voltage			0.0	0.45	V
V_{IH}	Input High Voltage		2.4	4.0		V
t_{IN}	Input Timing Reference Voltage		0.8	1.5	2.0	V
t_{OUT}	Output Timing Reference Voltage		0.8	1.5	2.0	V

Programming Waveforms (Note 13)



Note 11: Fairchild's standard product warranty applies to devices programmed to specifications described herein.

Note 12: V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}. The EPROM must not be inserted into or removed from a board with voltage applied to V_{PP} or V_{CC}.

Note 13: The maximum absolute allowable voltage which may be applied to the V_{PP} pin during programming is 14V. Care must be taken when switching the V_{PP} supply to prevent any overshoot from exceeding this 14V maximum specification. At least a 0.1 µF capacitor is required across V_{PP}, V_{CC} to GND to suppress spurious voltage transients which may damage the device.

Note 14: Programming and program verify are tested with the interactive Program Algorithm, at typical power supply voltages and timings.

Fast Programming Algorithm Flow Chart

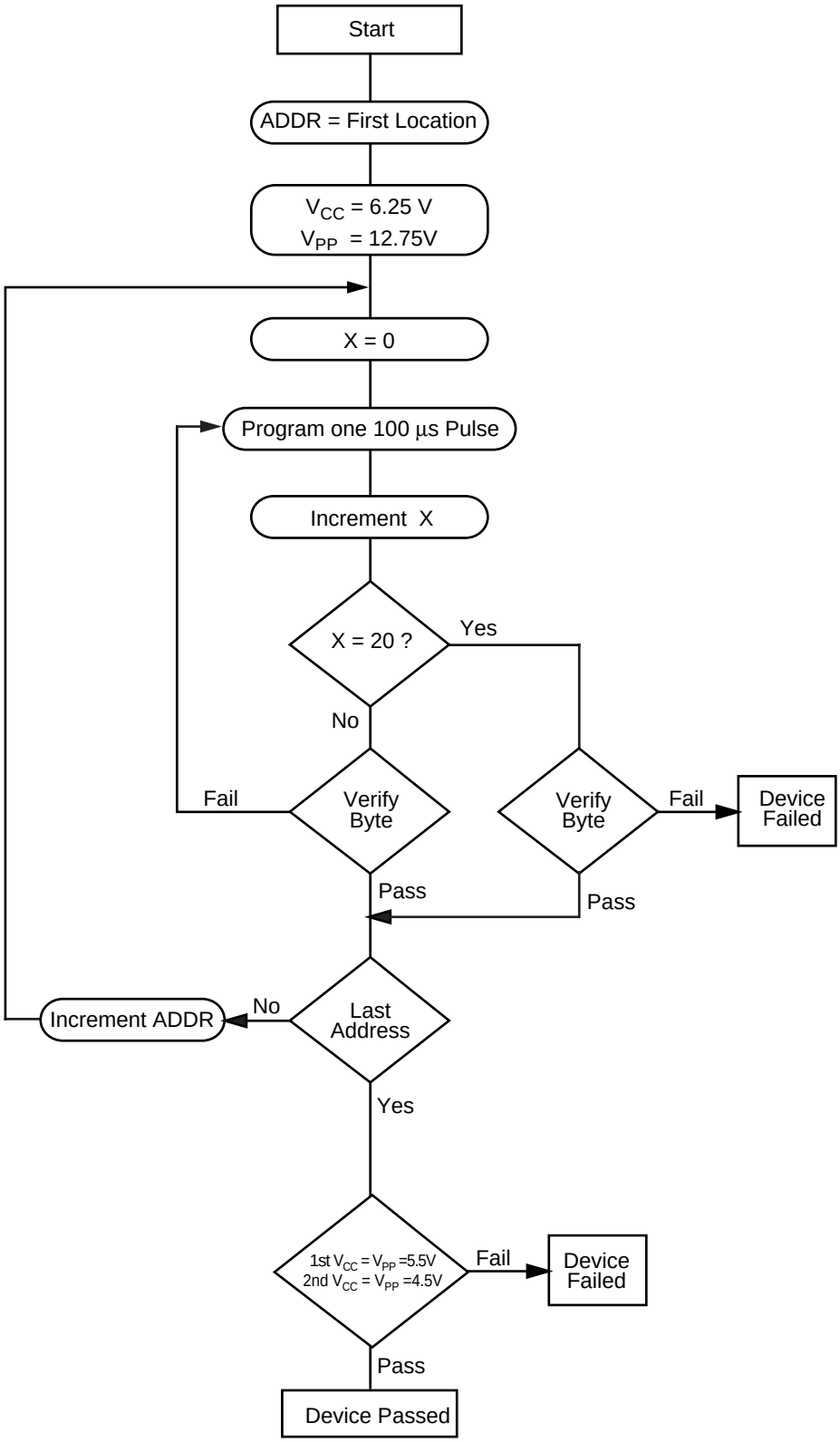


FIGURE 1.

Functional Description

DEVICE OPERATION

The six modes of operation of the NMC27C64 are listed in Table 1. It should be noted that all inputs for the six modes are at TTL levels. The power supplies required are V_{CC} and V_{PP}. The V_{PP} power supply must be at 12.75V during the three programming modes, and must be at 5V in the other three modes. The V_{CC} power supply must be at 6V during the three programming modes, and at 5V in the other three modes.

Read Mode

The NMC27C64 has two control functions, both of which must be logically active in order to obtain data at the outputs. Chip Enable ($\overline{CE}$) is the power control and should be used for device selection. Output Enable ($\overline{OE}$) is the output control and should be used to gate data to the output pins, independent of device selection. The programming pin ($\overline{PGM}$) should be at V_{IH} except during programming. Assuming that addresses are stable, address access time (t_{ACC}) is equal to the delay from $\overline{CE}$ to output (t_{CE}). Data is available at the outputs t_{OE} after the falling edge of OE , assuming that $\overline{CE}$ has been low and addresses have been stable for at least $t_{ACC} - t_{OE}$.

The sense amps are clocked for fast access time. V_{CC} should therefore be maintained at operating voltage during read and verify. If V_{CC} temporarily drops below the spec. voltage (but not to ground) an address transition must be performed after the drop to insure proper output data.

Standby Mode

The NMC27C64 has a standby mode which reduces the active power dissipation by 99%, from 55 mW to 0.55 mW. The NMC27C64 is placed in the standby mode by applying a CMOS high signal to the $\overline{CE}$ input. When in standby mode, the outputs are in a high impedance state, independent of the $\overline{OE}$ input.

Output OR-Tying

Because NMC27C64s are usually used in larger memory arrays, Fairchild has provided a 2-line control function that accommodates this use of multiple memory connections. The 2-line control function allows for:

1. the lowest possible memory power dissipation, and
2. complete assurance that output bus contention will not occur.

To most efficiently use these two control lines, it is recomended that $\overline{CE}$ (pin 20) be decoded and used as the primary device selecting function, while $\overline{OE}$ (pin 22) be made a common connection to all devices in the array and connected to the READ line from the system control bus. This assures that all deselected memory devices are in their low power standby modes and that the output pins are active only when data is desired from a particular memory device.

Programming

CAUTION: Exceeding 14V on pin 1 (V_{PP}) will damage the NMC27C64.

Initially, all bits of the NMC27C64 are in the "1" state. Data is introduced by selectively programming "0s" into the desired bit locations. Although only "0s" will be programmed, both "1s" and "0s" can be presented in the data word. A "0" cannot be changed to a "1" once the bit has been programmed.

The NMC27C64 is in the programming mode when the V_{PP} power supply is at 12.75V and $\overline{OE}$ is at V_{IH}. It is required that at least a 0.1 µF capacitor be placed across V_{PP}, V_{CC} to ground to suppress spurious voltage transients which may damage the device. The data to be programmed is applied 8 bits in parallel to the data output pins. The levels required for the address and data inputs are TTL.

For programming, $\overline{CE}$ should be kept TTL low at all times while V_{PP} is kept at 12.75V.

When the address and data are stable, an active low, TTL program pulse is applied to the $\overline{PGM}$ input. A program pulse must be applied at each address location to be programmed. The NMC27C64 is programmed with the Fast Programming Algorithm shown in Figure 1. Each address is programmed with a series of 100 µs pulses until it verfies good, up to a maximum of 25 pulses. Most memory cells will program with a single 100 µs pulse. The NMC27C64 must not be programmed with a DC signal applied to the PGM input.

Programming multiple NMC27C64s in parallel with the same data can be easily accomplished due to the simplicity of the programming requirements. Like inputs of the paralleled NMC27C64s may be connected together when they are programmed with the same data. A low level TTL pulse applied to the $\overline{PGM}$ input programs the paralleled NMC27C64s. If an application requires erasing and reprogramming, the NMC27C64Q UV erasable PROM in a windowed package should be used.

TABLE 1. Mode Selection

Mode \ Pins	$\overline{CE}$ (20)	$\overline{OE}$ (22)	$\overline{PGM}$ (27)	V_{PP} (1)	V_{CC} (28)	Outputs (11–13, 15–19)
Read	V_{IL}	V_{IL}	V_{IH}	5V	5V	D_{OUT}
Standby	V_{IH}	Don't Care	Don't Care	5V	5V	Hi-Z
Output Disable	Don't Care	V_{IH}	V_{IH}	5V	5V	Hi-Z
Program	V_{IL}	V_{IH}		13V	6V	D_{IN}
Program Verify	V_{IL}	V_{IL}	V_{IH}	13V	6V	D_{OUT}
Program Inhibit	V_{IH}	Don't Care	Don't Care	13V	6V	Hi-Z

Functional Description (Continued)

Program Inhibit

Programming multiple NMC27C64s in parallel with different data is also easily accomplished. Except for $\overline{CE}$ all like inputs (including $\overline{OE}$ and $\overline{PGM}$) of the parallel NMC27C64 may be common. A TTL low level program pulse applied to an NMC27C64's $\overline{PGM}$ input with $\overline{CE}$ at V_{IL} and V_{PP} at 13.0V will program that NMC27C64. A TTL high level $\overline{CE}$ input inhibits the other NMC27C64s from being programmed.

Program Verify

A verify should be performed on the programmed bits to determine whether they were correctly programmed. The verify may be performed with V_{PP} at 13.0V. V_{PP} must be at V_{CC}, except during programming and program verify.

MANUFACTURER'S IDENTIFICATION CODE

The NMC27C64 has a manufacturer's identification code to aid in programming. The code, shown in Table 2, is two bytes wide and is stored in a ROM configuration on the chip. It identifies the manufacturer and the device type. The code for the NMC27C64 is "8FC2", where "8F" designates that it is made by Fairchild Semiconductor, and "C2" designates a 64k part.

The code is accessed by applying 12V ± 0.5V to address pin A9. Addresses A1–A8, A10–A12, $\overline{CE}$, and $\overline{OE}$ are held at V_{IL}. Address A0 is held at V_{IL} for the manufacturer's code, and at V_{IH} for the device code. The code is read out on the 8 data pins. Proper code access is only guaranteed at 25°C ± 5°C.

The primary purpose of the manufacturer's identification code is automatic programming control. When the device is inserted in a EPROM programmer socket, the programmer reads the code and then automatically calls up the specific programming algorithm for the part. This automatic programming control is only possible with programmers which have the capability of reading the code.

ERASURE CHARACTERISTICS

The erasure characteristics of the NMC27C64 are such that erasure begins to occur when exposed to light with wavelengths shorter than approximately 4000 Angstroms (Å). It should be noted that sunlight and certain types of fluorescent lamps have wavelengths in the 3000Å – 4000Å range.

After programming, opaque labels should be placed over the NMC27C64's window to prevent unintentional erasure. Covering the window will also prevent temporary functional failure due to the generation of photo currents.

The recommended erasure procedure for the NMC27C64 is exposure to short wave ultraviolet light which has a wavelength of 2537 Angstroms (Å). The integrated dose (i.e., UV intensity x exposure time) for erasure should be a minimum of 15W-sec/cm^2.

The NMC27C64 should be placed within 1 inch of the lamp tubes during erasure. Some lamps have a filter on their tubes which should be removed before erasure.

An erasure system should be calibrated periodically. The distance from lamp to unit should be maintained at one inch. The erasure time increases as the square of the distance. (If distance is doubled the erasure time increases by a factor of 4.) Lamps lose intensity as they age. When a lamp is changed, the distance has changed or the lamp has aged, the system should be checked to make certain full erasure is occurring. Incomplete erasure will cause symptoms that can be misleading. Programmers, components, and even system designs have been erroneously suspected when incomplete erasure was the problem.

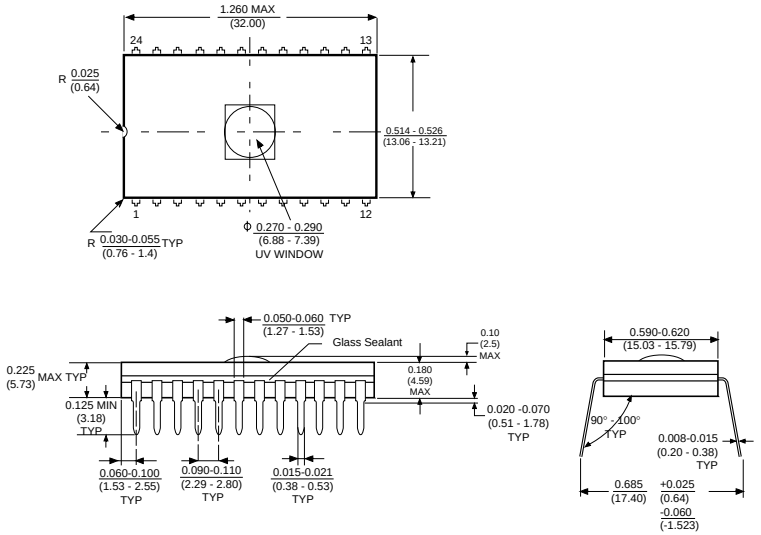
SYSTEM CONSIDERATION

The power switching characteristics of EPROMs require careful decoupling of the devices. The supply current, I_{CC}, has three segments that are of interest to the system designer—the standby current level, the active current level, and the transient current peaks that are produced by voltage transitions on input pins. The magnitude of these transient current peaks is dependent on the output capacitance loading of the device. The associated V_{CC} transient voltage peaks can be suppressed by properly selected decoupling capacitors. It is recommended that at least a 0.1 µF ceramic capacitor be used on every device between V_{CC} and GND. This should be a high frequency capacitor of low inherent inductance. In addition, at least a 4.7 µF bulk electrolytic capacitor should be used between V_{CC} and GND for each eight devices. The bulk capacitor should be located near where the power supply is connected to the array. The purpose of the bulk capacitor is to overcome the voltage drop caused by the inductive effects of the PC board traces.

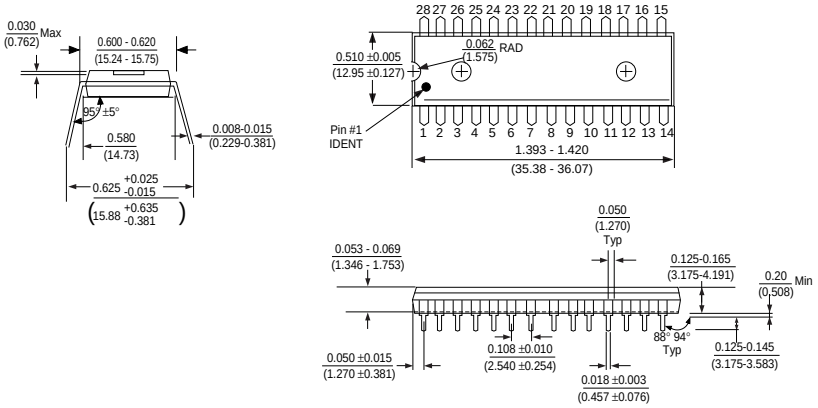
TABLE 2. Manufacturer's Identification Code

Pins	A0 (10)	O7 (19)	O6 (18)	O5 (17)	O4 (16)	O3 (15)	O2 (13)	O1 (12)	O0 (11)	Hex Data
Manufacturer Code	V_{IL}	1	0	0	0	1	1	1	1	8F
Device Code	V_{IH}	1	1	0	0	0	0	1	0	C2

Physical Dimensions inches (millimeters) unless otherwise noted



Dual-In-Line Package (Q)
Order Number NMC27C64Q
Package Number J28AQ



Dual-In-Line Package (N)
Order Number NMC27C64N
Package Number N28B

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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HM6264B Series

64 k SRAM (8-kword × 8-bit)

HITACHI

ADE-203-454B (Z)
Rev. 2.0
Nov. 1997

Description

The Hitachi HM6264B is 64k-bit static RAM organized 8-kword × 8-bit. It realizes higher performance and low power consumption by 1.5 μm CMOS process technology. The device, packaged in 450 mil SOP (foot print pitch width), 600 mil plastic DIP, 300 mil plastic DIP, is available for high density mounting.

Features

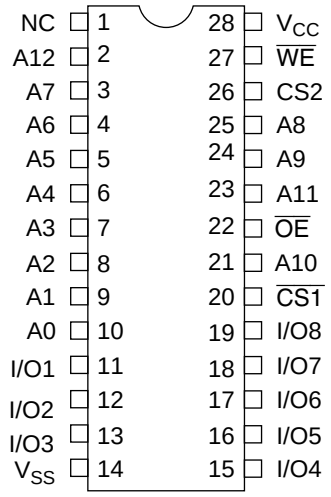
- High speed
  Fast access time: 85/100 ns (max)
- Low power
  Standby: 10 μW (typ)
  Operation: 15 mW (typ) (f = 1 MHz)
- Single 5 V supply
- Completely static memory
  No clock or timing strobe required
- Equal access and cycle times
- Common data input and output
  Three state output
- Directly TTL compatible
  All inputs and outputs
- Battery backup operation capability

Ordering Information

Type No.	Access time	Package
HM6264BLP-8L HM6264BLP-10L	85 ns 100 ns	600-mil, 28-pin plastic DIP (DP-28)
HM6264BLSP-8L HM6264BLSP-10L	85 ns 100 ns	300-mil, 28-pin plastic DIP(DP-28N)
HM6264BLFP-8LT HM6264BLFP-10LT	85 ns 100 ns	450-mil, 28-pin plastic SOP(FP-28DA)

Pin Arrangement

HM6264BLP/BLSP/BLFP Series

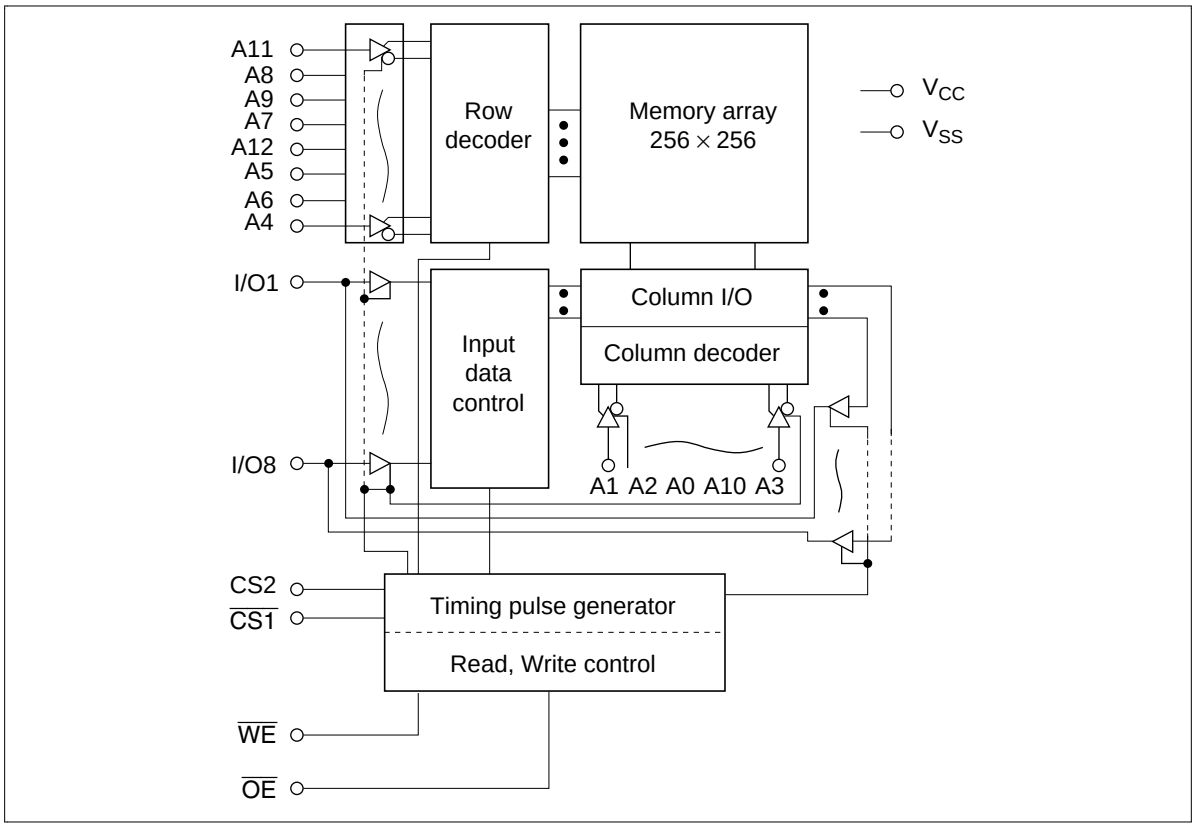


(Top view)

Pin Description

Pin name	Function	Pin name	Function
A0 to A12	Address input	$\overline{WE}$	Write enable
I/O1 to I/O8	Data input/output	$\overline{OE}$	Output enable
$\overline{CS1}$	Chip select 1	NC	No connection
CS2	Chip select 2	V_{CC}	Power supply
		V_{SS}	Ground

Block Diagram



Function Table

$\overline{WE}$	$\overline{CS1}$	CS2	$\overline{OE}$	Mode	V_{CC} current	I/O pin	Ref. cycle
×	H	×	×	Not selected (power down)	I_{SB}, I_{SB1}	High-Z	—
×	×	L	×	Not selected (power down)	I_{SB}, I_{SB1}	High-Z	—
H	L	H	H	Output disable	I_{CC}	High-Z	—
H	L	H	L	Read	I_{CC}	Dout	Read cycle (1)–(3)
L	L	H	H	Write	I_{CC}	Din	Write cycle (1)
L	L	H	L	Write	I_{CC}	Din	Write cycle (2)

Note: ×: H or L

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Power supply voltage[*1]	V_{CC}	–0.5 to +7.0	V
Terminal voltage[*1]	V_T	–0.5[*2] to V_{CC} + 0.3[*3]	V
Power dissipation	P_T	1.0	W
Operating temperature	Topr	0 to + 70	°C
Storage temperature	Tstg	–55 to +125	°C
Storage temperature under bias	Tbias	–10 to +85	°C

Notes: 1. Relative to V_{SS}
2. V_T min: –3.0 V for pulse half-width ≤ 50 ns
3. Maximum voltage is 7.0 V

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

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	V_{CC}	4.5	5.0	5.5	V
	V_{SS}	0	0	0	V
Input high voltage	V_{IH}	2.2	—	V_{CC} + 0.3	V
Input low voltage	V_{IL}	–0.3[*1]	—	0.8	V

Note: 1. V_{IL} min: –3.0 V for pulse half-width ≤ 50 ns

DC Characteristics (Ta = 0 to +70°C, V_{CC} = 5 V ±10%, V_{SS} = 0 V)

Parameter	Symbol	Min	Typ[*1]	Max	Unit	Test conditions
Input leakage current	$\|I_{LI}\|$	—	—	2	µA	Vin = V_{SS} to V_{CC}
Output leakage current	$\|I_{LO}\|$	—	—	2	µA	$\overline{CS1}$ = V_{IH} or CS2 = V_{IL} or $\overline{OE}$ = V_{IH} or $\overline{WE}$ = V_{IL}, $V_{I/O}$ = V_{SS} to V_{CC}
Operating power supply current	I_{CCDC}	—	7	15	mA	$\overline{CS1}$ = V_{IL}, CS2 = V_{IH}, $I_{I/O}$ = 0 mA others = V_{IH}/V_{IL}
Average operating power supply current	I_{CC1}	—	30	45	mA	Min cycle, duty = 100%, $\overline{CS1}$ = V_{IL}, CS2 = V_{IH}, $I_{I/O}$ = 0 mA others = V_{IH}/V_{IL}
	I_{CC2}	—	3	5	mA	Cycle time = 1 µs, duty = 100%, $I_{I/O}$ = 0 mA $\overline{CS1}$ ≤ 0.2 V, CS2 ≥ V_{CC} – 0.2 V, V_{IH} ≥ V_{CC} – 0.2 V, V_{IL} ≤ 0.2 V
Standby power supply current	I_{SB}	—	1	3	mA	$\overline{CS1}$ = V_{IH}, CS2 = V_{IL}
	I_{SB1}	—	2	50	µA	$\overline{CS1}$ ≥ V_{CC} – 0.2 V, CS2 ≥ V_{CC} – 0.2 V or 0 V ≤ CS2 ≤ 0.2 V, 0 V ≤ Vin
Output low voltage	V_{OL}	—	—	0.4	V	I_{OL} = 2.1 mA
Output high voltage	V_{OH}	2.4	—	—	V	I_{OH} = –1.0 mA

Notes: 1. Typical values are at V_{CC} = 5.0 V, Ta = +25°C and not guaranteed.

Capacitance (Ta = 25°C, f = 1.0 MHz)

Parameter	Symbol	Min	Typ	Max	Unit	Test conditions
Input capacitance[*1]	Cin	—	—	5	pF	Vin = 0 V
Input/output capacitance[*1]	$C_{I/O}$	—	—	7	pF	$V_{I/O}$ = 0 V

Note: 1. This parameter is sampled and not 100% tested.

AC Characteristics (Ta = 0 to +70°C, V_{CC} = 5 V ± 10%, unless otherwise noted.)

Test Conditions

- Input pulse levels: 0.8 V to 2.4 V
- Input and output timing reference level: 1.5 V
- Input rise and fall time: 10 ns
- Output load: 1 TTL Gate + C_L (100 pF) (Including scope & jig)

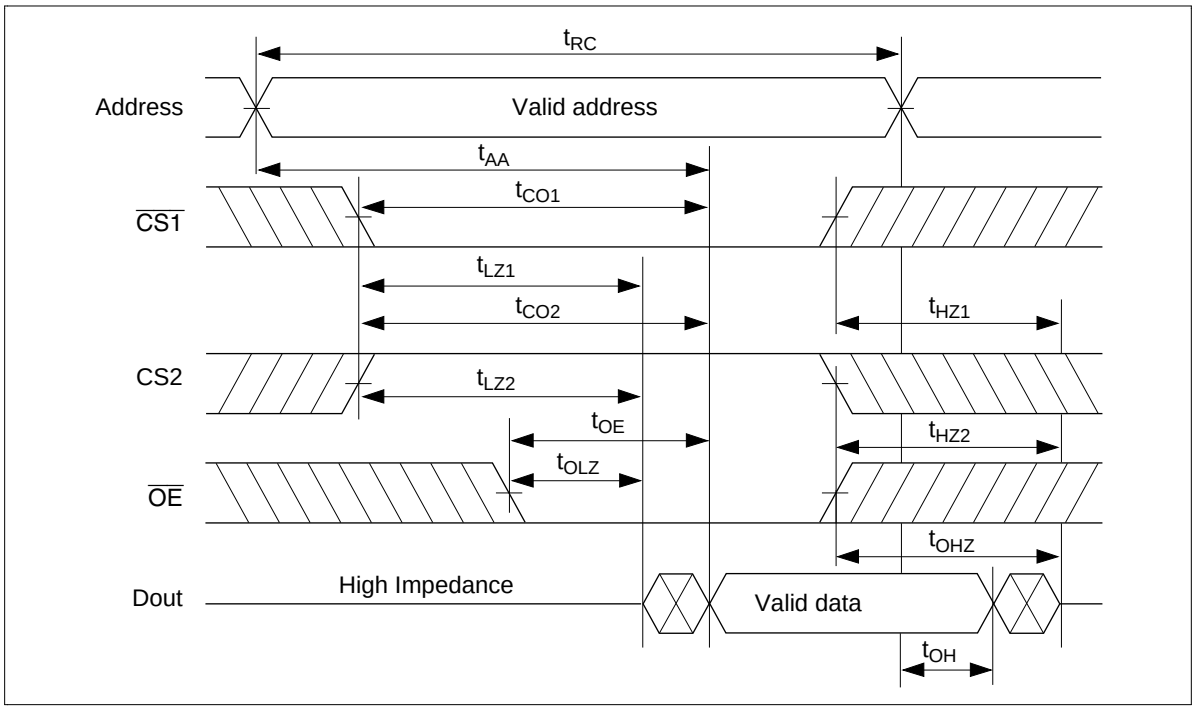
Read Cycle

			HM6264B-8L		HM6264B-10L			
Parameter		**Symbol**	**Min**	**Max**	**Min**	**Max**	**Unit**	**Notes**
Read cycle time		t_{RC}	85	—	100	—	ns	
Address access time		t_{AA}	—	85	—	100	ns	
Chip select access time	$\overline{CS1}$	t_{CO1}	—	85	—	100	ns	
	CS2	t_{CO2}	—	85	—	100	ns	
Output enable to output valid		t_{OE}	—	45	—	50	ns	
Chip selection to output in low-Z	$\overline{CS1}$	t_{LZ1}	10	—	10	—	ns	2
	CS2	t_{LZ2}	10	—	10	—	ns	2
Output enable to output in low-Z		t_{OLZ}	5	—	5	—	ns	2
Chip deselection in to output in high-Z	$\overline{CS1}$	t_{HZ1}	0	30	0	35	ns	1, 2
	CS2	t_{HZ2}	0	30	0	35	ns	1, 2
Output disable to output in high-Z		t_{OHZ}	0	30	0	35	ns	1, 2
Output hold from address change		t_{OH}	10	—	10	—	ns	

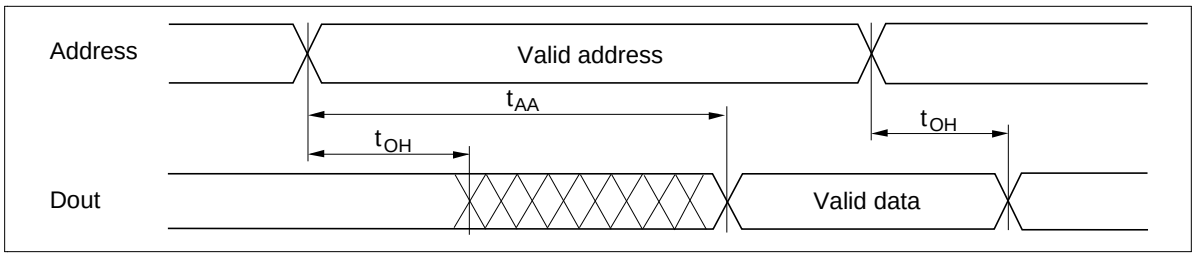
Notes: 1. t_{HZ} is defined as the time at which the outputs achieve the open circuit conditions and are not referred to output voltage levels.

2. At any given temperature and voltage condition, t_{HZ} maximum is less than t_{LZ} minimum both for a given device and from device to device.

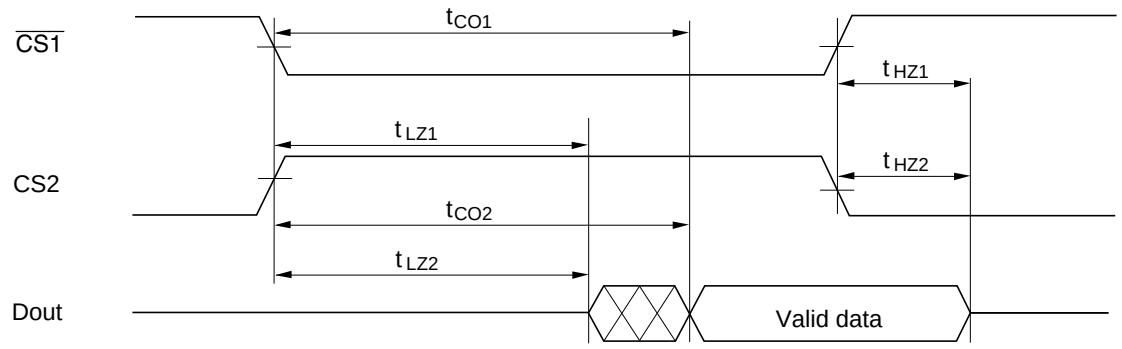
Read Timing Waveform (1) ($\overline{WE}$ = V_{IH})



Read Timing Waveform (2) ($\overline{WE}$ = V_{IH}, $\overline{OE}$ = V_{IL})



Read Timing Waveform (3) ($\overline{WE}$ = V_{IH}, $\overline{OE}$ = V_{IL})[*1]



Note: 1. Address must be valid prior to or simultaneously with $\overline{CS1}$ going low or CS2 going high.

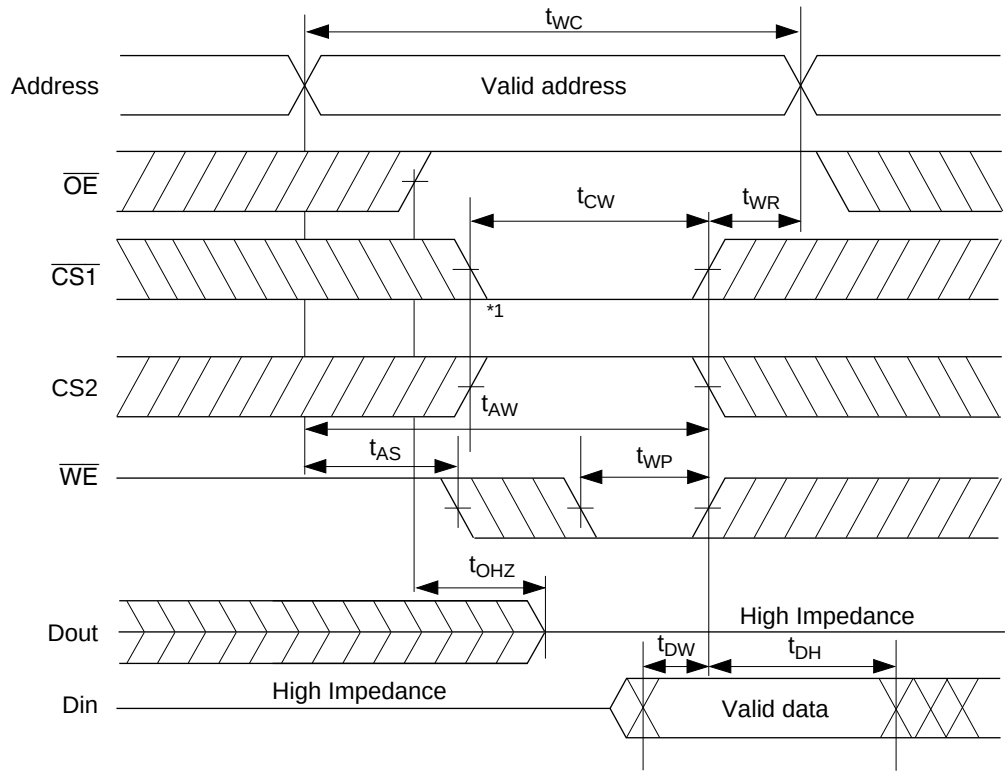
Write Cycle

		HM6264B-8L		HM6264B-10L			
Parameter	**Symbol**	**Min**	**Max**	**Min**	**Max**	**Unit**	**Notes**
Write cycle time	t_{WC}	85	—	100	—	ns	
Chip selection to end of write	t_{CW}	75	—	80	—	ns	2
Address setup time	t_{AS}	0	—	0	—	ns	3
Address valid to end of write	t_{AW}	75	—	80	—	ns	
Write pulse width	t_{WP}	55	—	60	—	ns	1, 6
Write recovery time	t_{WR}	0	—	0	—	ns	4
$\overline{WE}$ to output in high-Z	t_{WHZ}	0	30	0	35	ns	5
Data to write time overlap	t_{DW}	40	—	40	—	ns	
Data hold from write time	t_{DH}	0	—	0	—	ns	
Output active from end of write	t_{OW}	5	—	5	—	ns	
Output disable to output in high-Z	t_{OHZ}	0	30	0	35	ns	5

Notes:
1. A write occurs during the overlap of a low $\overline{CS1}$, and high CS2, and a high $\overline{WE}$. A write begins at the latest transition among $\overline{CS1}$ going low,CS2 going high and $\overline{WE}$ going low. A write ends at the earliest transition among $\overline{CS1}$ going high CS2 going low and $\overline{WE}$ going high. Time t_{WP} is measured from the beginning of write to the end of write.
2. t_{CW} is measured from the later of $\overline{CS1}$ going low or CS2 going high to the end of write.
3. t_{AS} is measured from the address valid to the beginning of write.
4. t_{WR} is measured from the earliest of $\overline{CS1}$ or $\overline{WE}$ going high or CS2 going low to the end of write cycle.
5. During this period, I/O pins are in the output state, therefore the input signals of the opposite phase to the outputs must not be applied.
6. In the write cycle with $\overline{OE}$ low fixed, t_{WP} must satisfy the following equation to avoid a problem of data bus contention

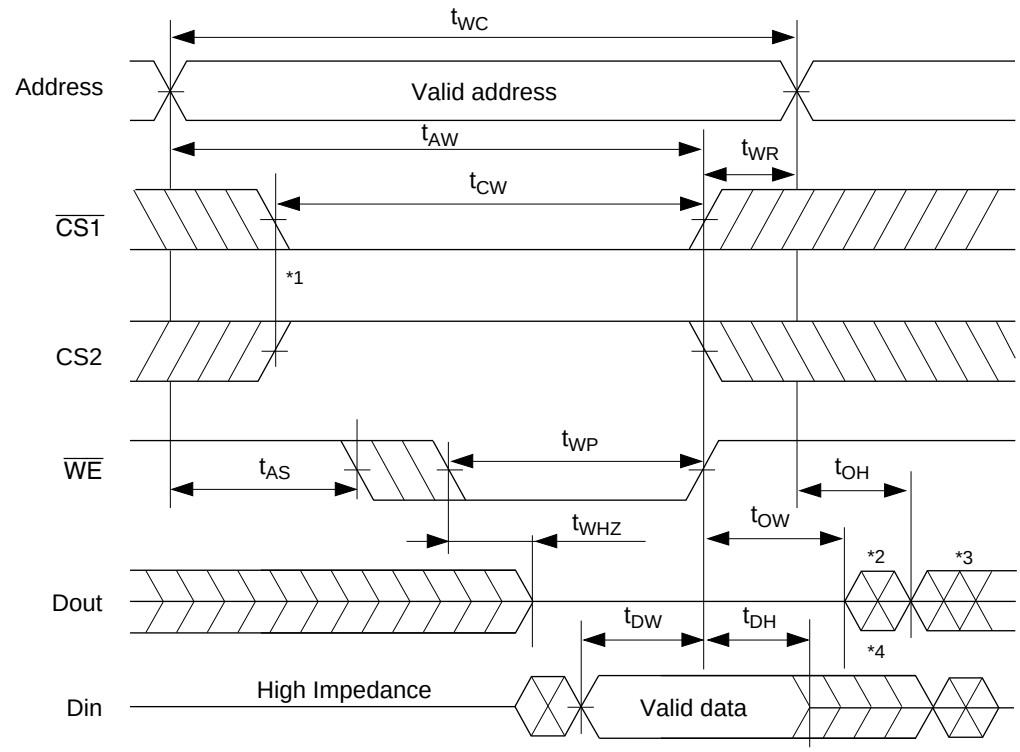
   $t_{WP} \geq t_{WHZ}$ max + t_{DW} min.

Write Timing Waveform (1) ($\overline{OE}$ Clock)



Note: 1. If $\overline{CS1}$ goes low or CS2 goes high simultaneously with $\overline{WE}$ going low or after $\overline{WE}$ going low, the outputs remain in the high impedance.state.

Write Timing Waveform (2) ($\overline{OE}$ Low Fixed) ($\overline{OE}$ = V_{IL})



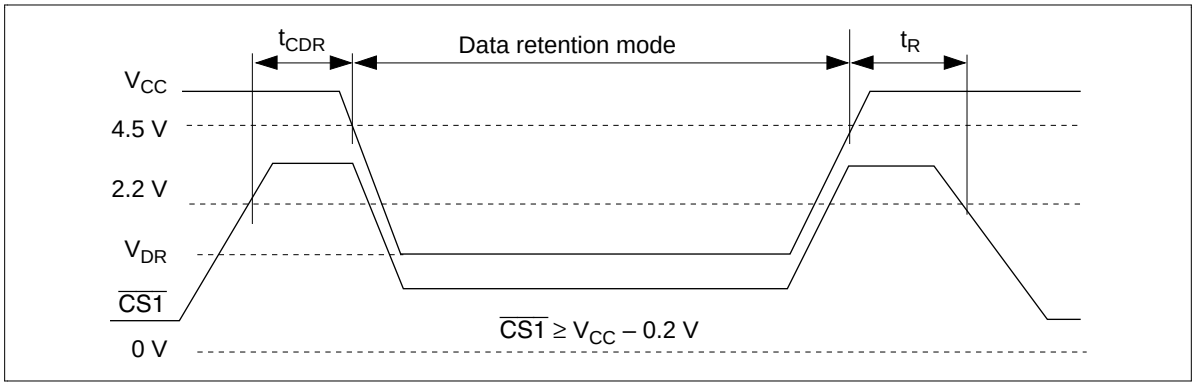
Notes:
1. If $\overline{CS1}$ goes low simultaneously with $\overline{WE}$ going low or after $\overline{WE}$ goes low, the outputs remain in high impedance state.
2. Dout is the same phase of the written data in this write cycle.
3. Dout is the read data of the next address.
4. If $\overline{CS1}$ is low and CS2 is high during this period, I/O pins are in the output state. Input signals of opposite phase to the outputs must not be applied to I/O pins.

Low V_{CC} Data Retention Characteristics (Ta = 0 to +70°C)

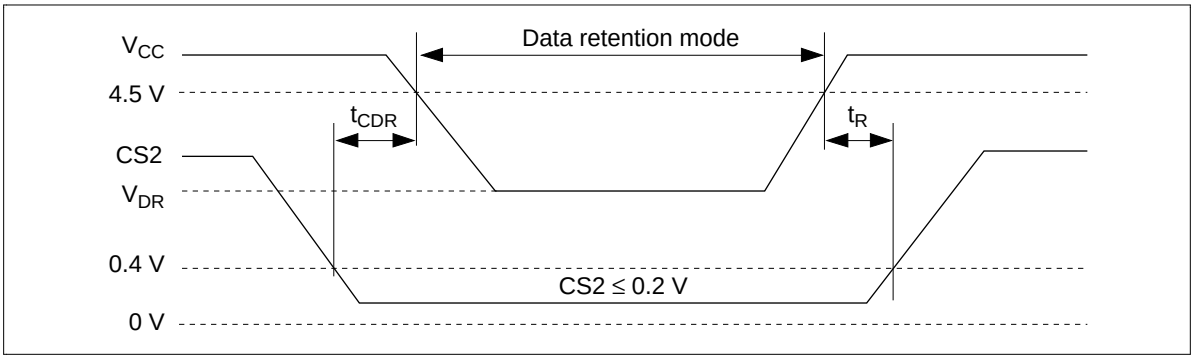
Parameter	Symbol	Min	Typ[*1]	Max	Unit	Test conditions[*4]
V_{CC} for data retention	V_{DR}	2.0	—	—	V	$\overline{CS1} \geq V_{CC} - 0.2$ V, CS2 ≥ V_{CC} –0.2 V or CS2 ≤ 0.2 V
Data retention current	I_{CCDR}	—	1[*1]	25[*2]	µA	V_{CC} = 3.0 V, 0 V ≤ Vin ≤ V_{CC} $\overline{CS1} \geq V_{CC}$ –0.2 V, CS2 ≥ V_{CC} –0.2 V or 0 V ≤ CS2 ≤ 0.2 V
Chip deselect to data retention time	t_{CDR}	0	—	—	ns	See retention waveform
Operation recovery time	t_R	t_{RC}[*3]	—	—	ns	

Notes: 1. Reference data at Ta = 25°C.
2. 10 µA max at Ta = 0 to + 40°C.
3. t_{RC} = read cycle time.
4. CS2 controls address buffer, $\overline{WE}$ buffer, $\overline{CS1}$ buffer, $\overline{OE}$ buffer, and Din buffer. If CS2 controls data retention mode, Vin levels (address, $\overline{WE}$, $\overline{OE}$, $\overline{CS1}$, I/O) can be in the high impedance state. If $\overline{CS1}$ controls data retention mode, CS2 must be CS2 ≥ V_{CC} – 0.2 V or 0 V ≤ CS2 ≤ 0.2 V. The other input levels (address, $\overline{WE}$, $\overline{OE}$, I/O) can be in the high impedance state.

Low V_{CC} Data Retention Timing Waveform (1) ($\overline{CS1}$ Controlled)



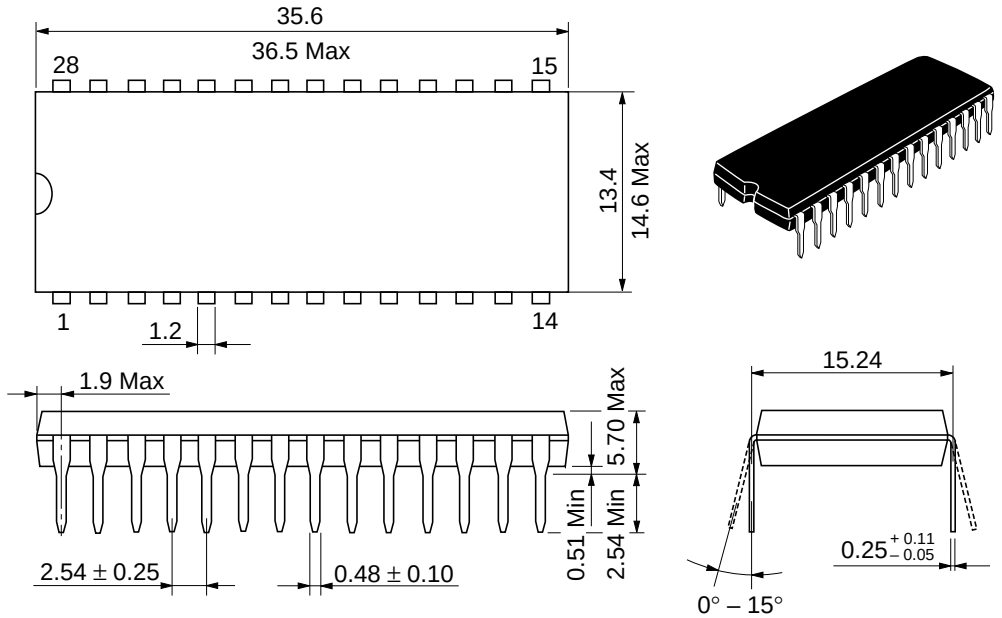
Low V_{CC} Data Retention Timing Waveform (2) (CS2 Controlled)



Package Dimensions

HM6264BLP Series (DP-28)

Unit: mm

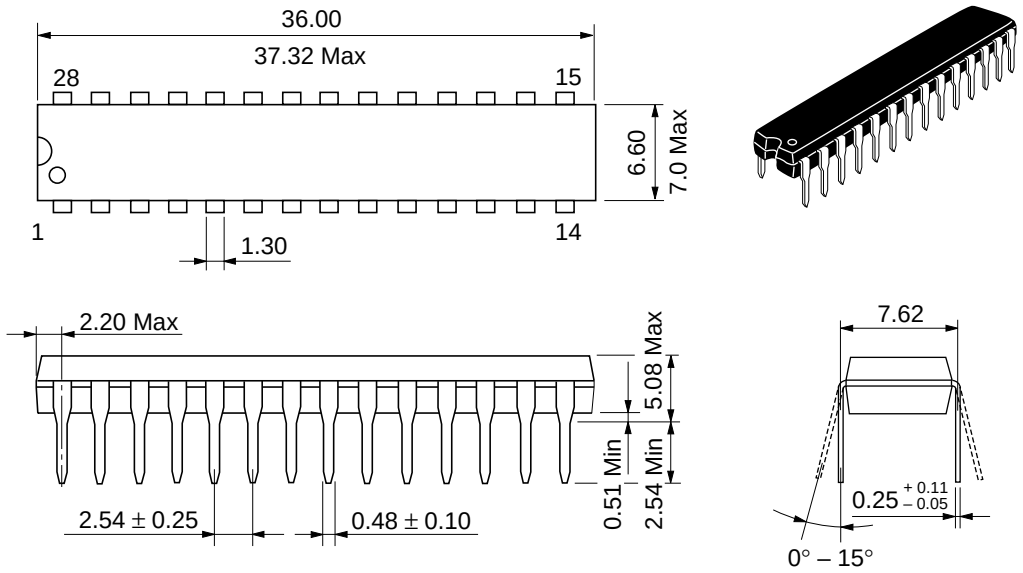


Hitachi Code	DP-28
JEDEC	—
EIAJ	Conforms
Weight (reference value)	4.6 g

Package Dimensions (cont)

HM6264BLSP Series (DP-28N)

Unit: mm

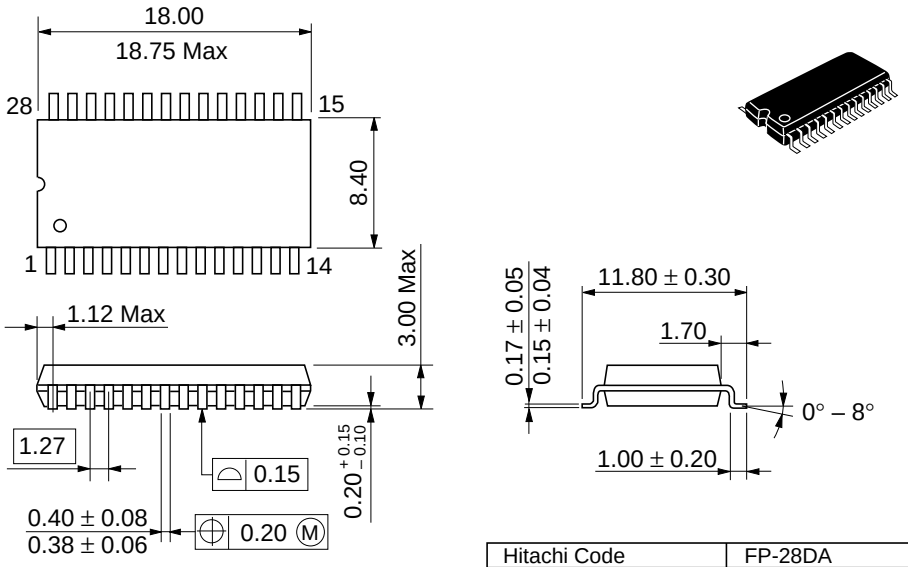


Hitachi Code	DP-28N
JEDEC	—
EIAJ	Conforms
Weight (reference value)	2.04 g

Package Dimensions (cont)

HM6264BLFP Series (FP-28DA)

Unit: mm



Dimension including the plating thickness
Base material dimension

Hitachi Code	FP-28DA
JEDEC	Conforms
EIAJ	Conforms
Weight (reference value)	0.82 g

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Revision Record

Rev.	Date	Contents of Modification	Drawn by	Approved by
0.0	Sep. 5, 1995	Initial issue	I. Ogiwara	K. Yoshizaki
1.0	Dec. 6, 1995	Deletion of Preliminary	I. Ogiwara	K. Yoshizaki
2.0	Nov. 1997	Change of Subtitle Change of FP-28DA		