HN27C4001 Series

4M (512K x 8-bit) UV and OTP EPROM

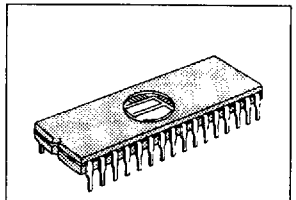
■ DESCRIPTION

The Hitachi HN27C4001 is a 4-Megabit Ultraviolet Erasable and One-Time Programmable Electrically Programmable Read Only Memory organized as 524,288 x 8-bits.

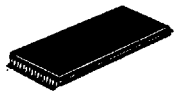
The HN27C4001 features fast address access times of 100, 120 and 150 ns and low power dissipation. This combination makes the HN27C4001 suitable for high speed 16 and 32-bit microcomputer systems. The HN27C4001 offers high speed programming using page programming mode.

Hitachi's HN27C4001 is offered in JEDEC-Standard Byte-Wide EPROM pinouts in 32-pin Ceramic DIP. This allows socket replacement with Mask ROMs and Flash Memory. The HN27C4001 is also available in 32-lead Plastic TSOP packages with both standard and reverse bend leads.

The Ceramic DIP package is erasable by exposure to Ultraviolet light. The TSOP packaged device is One-Time Programmable and once programmed, can not be rewritten.



(DG-32)



(TFP-32D)

(TFP-32DR)

■ FEATURES

- Fast Access Times:
  100 ns/120 ns/150 ns (max)
- Single Power Supply:
  V_{CC} = 5 V ± 10%
- Low Power Dissipation:
  Active Mode: 35 mW/MHz (typ)
  Standby Mode: 5 µW (max)
- High Speed Page and Word Programming:
  Page Programming Time: 3.5 sec (min)
- Programming Power Supply:
  V_{PP} = 12.5 V ± 0.3 V
- Pin Arrangement:
  JEDEC Standard Byte-Wide EPROM
  Mask ROM and Flash Memory Compatible
- Packages:
  32-pin Ceramic DIP
  32-lead Plastic TSOP (Type II)

■ ORDERING INFORMATION

Type No.	Access Time	Package
HN27C4001G-10	100 ns	32-pin Ceramic DIP
HN27C4001G-12	120 ns	(DG-32)
HN27C4001G-15	150 ns	
HN27C4001TT-12	120 ns	32-lead Plastic TSOP
HN27C4001TT-15	150 ns	(TFP-32D)
HN27C4001RR-12	120 ns	32-lead Plastic TSOP
HN27C4001RR-15	150 ns	(TFP-32D)
		Reverse bend

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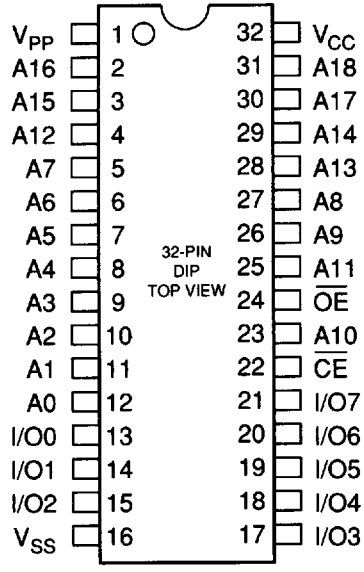
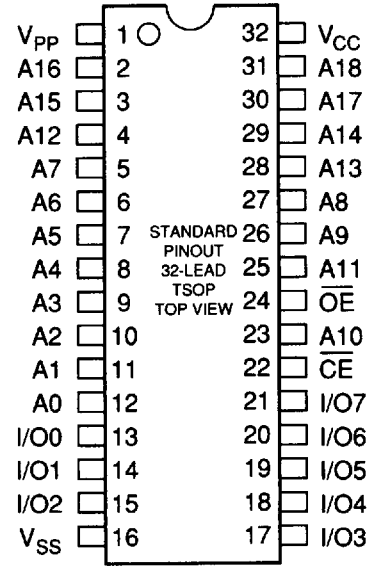
■ PIN ARRANGEMENT

HN27C4001G Series



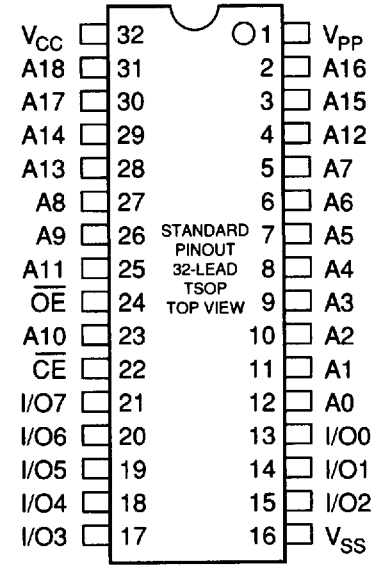
(PinD32.HN27C4001)

HN27C4001TT Series



(PinT232.HN27C4001T)

HN27C4001RR Series

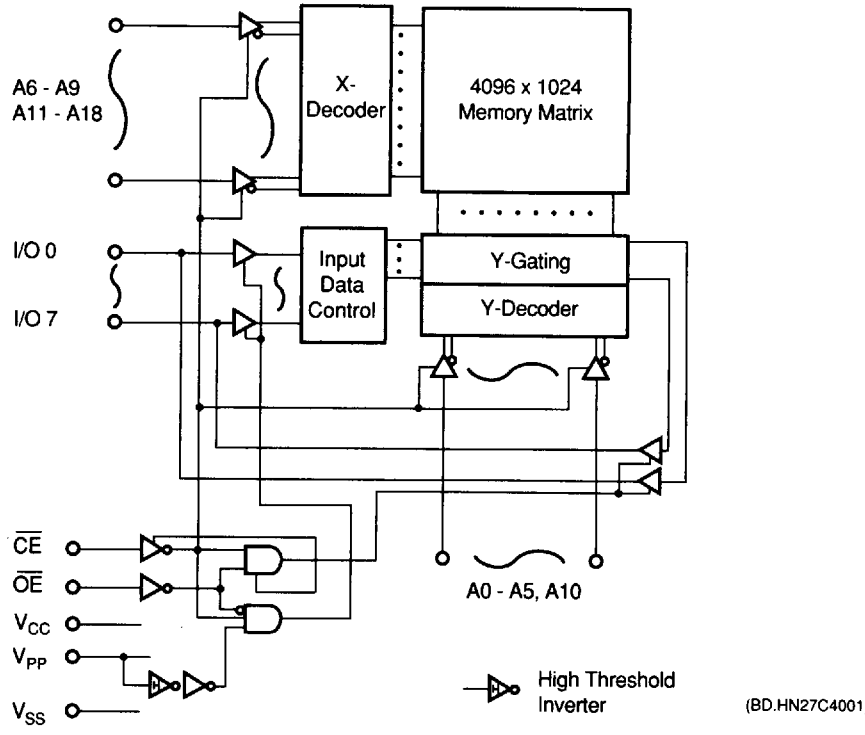


(PinT232.HN27C4001R)

■ PIN DESCRIPTION

Pin Name	Function
A_0 - A_{18}	Address
I/O_0 - I/O_7	Input/Output
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
V_{CC}	Power Supply
V_{PP}	Programming Supply
V_{SS}	Ground

■ BLOCK DIAGRAM



■ MODE SELECTION

Mode		V_{PP}	V_{CC}	$\overline{CE}$	$\overline{OE}$	A_9	I/O
Read		V_{SS}-V_{CC}	V_{CC}	V_{IL}	V_{IL}	X[1]	D_{OUT}
Output Disable		V_{SS}-V_{CC}	V_{CC}	V_{IL}	V_{IH}	X	High-Z
Standby		V_{SS}-V_{CC}	V_{CC}	V_{IH}	X	X	High-Z
Page Prog.	Page Prog. Set	V_{PP}	V_{CC}	V_{IH}	V_H[2]	X	High-Z
	Page Data Latch	V_{PP}	V_{CC}	V_{IL}	V_H	X	D_{IN}
	Page Program	V_{PP}	V_{CC}	V_{IL}	V_{IH}	X	High-Z
	Page Prog. Verify	V_{PP}	V_{CC}	V_{IH}	V_{IL}	X	D_{OUT}
	Page Prog. Reset	V_{CC}	V_{CC}	V_{IH}	V_{IH}	X	High-Z
Word Prog.	Program	V_{PP}	V_{CC}	V_{IL}	V_{IH}	X	D_{IN}
	Program Verify	V_{PP}	V_{CC}	V_{IH}	V_{IL}	X	D_{OUT}
	Optional Verify	V_{PP}	V_{CC}	V_{IL}	V_{IL}	X	D_{OUT}
	Program Inhibit	V_{PP}	V_{CC}	V_{IH}	V_{IH}	X	High-Z
Identifier		V_{SS}-V_{CC}	V_{CC}	V_{IL}	V_{IL}	V_H	ID

Notes: 1. X = Don't Care. V_{PP} = 0 V to V_{CC}.
2. 11.5 V ≤ V_H ≤ 12.5 V

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■ ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Value	Unit
Supply Voltage [1]	V_{CC}	-0.6 to +7.0	V
Programming Voltage [1]	V_{PP}	-0.6 to +13.5	V
All Input and Output Voltage [1,2]	V_{IN}, V_{OUT}	-0.6 to +7.0	V
A_9 and $\overline{OE}$ Voltage [2]	V_{ID}	-0.6 to +13.0	V
Operating Temperature Range	T_{OPR}	0 to +70	°C
Storage Temperature Range [3]	T_{STG}	-65 to +125 [4] -55 to +125 [5]	°C
Storage Temperature Under Bias	T_{BIAS}	-20 to +80 [4] -10 to +80 [5]	°C

Notes: 1. Relative to V_{SS}.
2. V_{IN}, V_{OUT}, and V_{ID} min = -2.0V for pulse width ≤ 20 ns.
3. Device storage temperature range before programming.
4. HN27C4001G.
5. HN27C4001TT and HN27C4001RR.

■ CAPACITANCE (T_a = 25°C, f = 1MHz)

Item	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Input Capacitance	C_{IN}	-	-	12	pF	V_{IN} = 0V
Output Capacitance	C_{OUT}	-	-	20	pF	V_{OUT} = 0V

■ DC ELECTRICAL CHARACTERISTICS FOR READ OPERATION

(V_{CC} = 5V ± 10%, V_{PP} = V_{SS} to V_{CC}, T_a = 0 to 70°C)

Item	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Input Leakage Current	I_{LI}	-	-	2	µA	V_{IN} = 5.5 V
Output Leakage Current	I_{LO}	-	-	2	µA	V_{OUT} = 5.5 V/0.45 V
Operating V_{CC} Current	I_{CC1}	-	-	30	mA	I_{OUT} = 0 mA, f = 1 MHz
	I_{CC2}	-	-	100 [3] 90 [4]	mA mA	I_{OUT} = 0 mA, f = 10 MHz I_{OUT} = 0 mA, f = 8.4 MHz
Standby V_{CC} Current	I_{SB1}	-	-	1	mA	$\overline{CE}$ = V_{IH}
	I_{SB2}	-	1	20	µA	$\overline{CE}$ = V_{CC} ± 0.3 V
V_{PP} Current	I_{PP1}	-	1	20	µA	V_{PP} = 5.5 V
Input Voltage	V_{IH}	2.2	-	V_{CC} + 1 [2]	V	
	V_{IL}	-0.3 [1]	-	0.8	V	
Output Voltage	V_{OH}	2.4	-	-	V	I_{OH} = -400 µA
	V_{OL}	-	-	0.45	V	I_{OL} = 2.1 mA

Notes: 1. V_{IL} min = -1.0 V for pulse width ≤ 50 ns.
V_{IL} min = -2.0 V for pulse width ≤ 20 ns.
2. V_{IH} max = V_{CC} + 1.5 V for pulse width ≤ 20 ns.
If V_{IH} is over the specified maximum value, Read operation can not be guaranteed.
3. HN27C4001G.
4. HN27C4001TT and HN27C4001RR.

■ AC ELECTRICAL CHARACTERISTICS FOR READ OPERATION

(V_{CC} = 5V ± 10%, V_{PP} = V_{SS} to V_{CC}, T_a = 0 to 70°C)

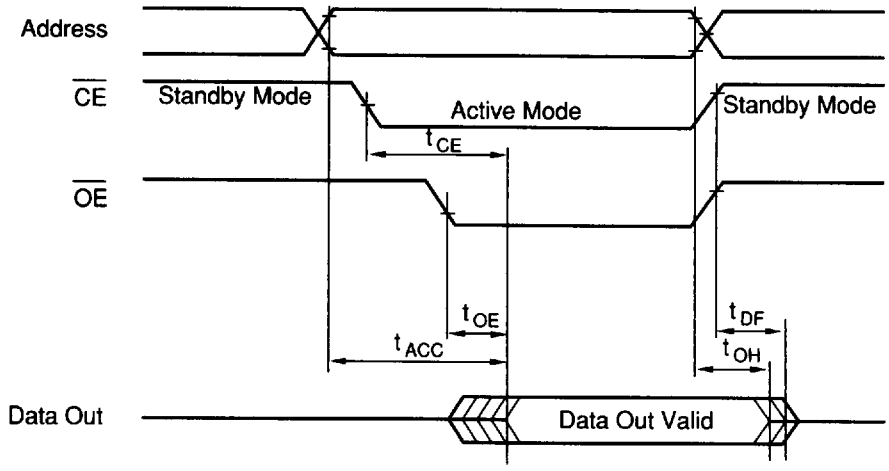
Test Conditions

- Input pulse levels: 0.45 V / 2.4 V
- Input rise and fall times: ≤ 10 ns
- Output load: 1 TTL Gate + 100 pF (Including scope and jig)
- Reference levels for measuring timing: 0.8 V/2.0 V

Item	Symbol	HN27C4001-10		HN27C4001-12		HN27C4001-15		Unit	Test Condition
		Min.	Max.	Min.	Max.	Min.	Max.		
Address Access Time	t_{ACC}	-	100	-	120	-	150	ns	$\overline{CE}$ = $\overline{OE}$ = V_{IL}
Chip Enable Access Time	t_{CE}	-	100	-	120	-	150	ns	$\overline{OE}$ = V_{IL}
Output Enable Access Time	t_{OE}	-	60	-	60	-	70	ns	$\overline{CE}$ = V_{IL}
Output Disable to High-Z [1]	t_{DF}	0	35	0	40	0	50	ns	$\overline{CE}$ = V_{IL}
Output Hold to Address Change	t_{OH}	5	-	5	-	5	-	ns	$\overline{CE}$ = $\overline{OE}$ = V_{IL}

Note: 1. t_{DF} is defined as the time at which the output becomes an open circuit and data is no longer driven.

■ READ TIMING WAVEFORM



(TD.R.HN27C4001)

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■ DC ELECTRICAL CHARACTERISTICS FOR PROGRAMMING OPERATIONS

(V_{CC} = 6.25 V ± 0.25 V, V_{PP} = 12.5 V ± 0.3 V, T_a = 25 °C ± 5 °C)

Item	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Input Leakage Current	I_{LI}	-	-	2	µA	V_{IN} = 6.5 V/ 0.45 V
Operating V_{CC} Current	I_{CC}	-	-	50	mA	
Operating V_{PP} Current	I_{PP}	-	-	70	mA	$\overline{CE}$ = V_{IL}
Input Voltage [3]	V_{IH}	2.2	-	V_{CC} +.5 [6]	V	
	V_{IL}	- 0.1[5]	-	0.8	V	
	V_H	11.5	12.0	12.5	V	
Output Voltage	V_{OH}	2.4	-	-	V	I_{OH} = -400 µA
	V_{OL}	-	-	0.45	V	I_{OH} = 2.1 mA

Notes:
1. V_{CC} must be applied before V_{PP} and removed after V_{PP}.
2. V_{PP} must not exceed 13 V, including overshoot.
3. Device reliability may be adversely affected if the device is installed or removed while V_{PP} = 12.5 V.
4. Do not change V_{PP} from V_{IL} to 12.5 V or 12.5 V to V_{IL} when $\overline{CE}$ = low.
5. V_{IL} min = -0.6 V for pulse width ≤ 20 ns.
6. If V_{IH} is over the specified maximum value, programming operation can not be guaranteed.

■ AC ELECTRICAL CHARACTERISTICS FOR PROGRAMMING OPERATIONS

(V_{CC} = 6.25 V ± 0.25 V, V_{PP} = 12.5 v ± 0.3 V, T_a = 25°C ± 5°C)

Test Conditions

- Input pulse levels: 0.45 V / 2.4 V
- Input rise and fall times: ≤ 20 ns
- Reference levels for measuring timing: 0.8 V / 2.0V

Item	Symbol	Min.	Typ.	Max.	Unit	Test Condition
Address Setup Time	t_{AS}	2	-	-	µs	
Address Hold Time	t_{AH}	0	-	-	µs	
Data Setup Time	t_{DS}	2	-	-	µs	
Data Hold Time	t_{DH}	2	-	-	µs	
Chip Enable Setup Time	t_{CES}	2	-	-	µs	
V_{PP} Setup Time	t_{VPS}	2	-	-	µs	
V_{CC} Setup Time	t_{VCS}	2	-	-	µs	
Output Enable Setup Time	t_{OES}	2	-	-	µs	
Output Disable Time	t_{DF}	0	-	130	ns	
Programming Pulse Width	t_{PW}	47.5	50.0	52.5	µs	
Data Valid from Output Enable Time	t_{OE}	0	-	150	ns	
Chip Enable Pulse Width During Data Latch	t_{LW}	1	-	-	µs	
Output Enable = V_H Setup Time	t_{OHS}	2	-	-	µs	
Output Enable = V_H Hold Time	t_{OHH}	2	-	-	µs	
Output Enable Hold Time	t_{OEH}	2	-	-	µs	
V_{PP} Hold Time	t_{VRS}	1	-	-	µs	
Page Programming Reset Time	t_{VLW}	1	-	-	µs	

Note: 1. t_{DF} is defined as the time at which the output becomes an open circuit and data is no longer driven.

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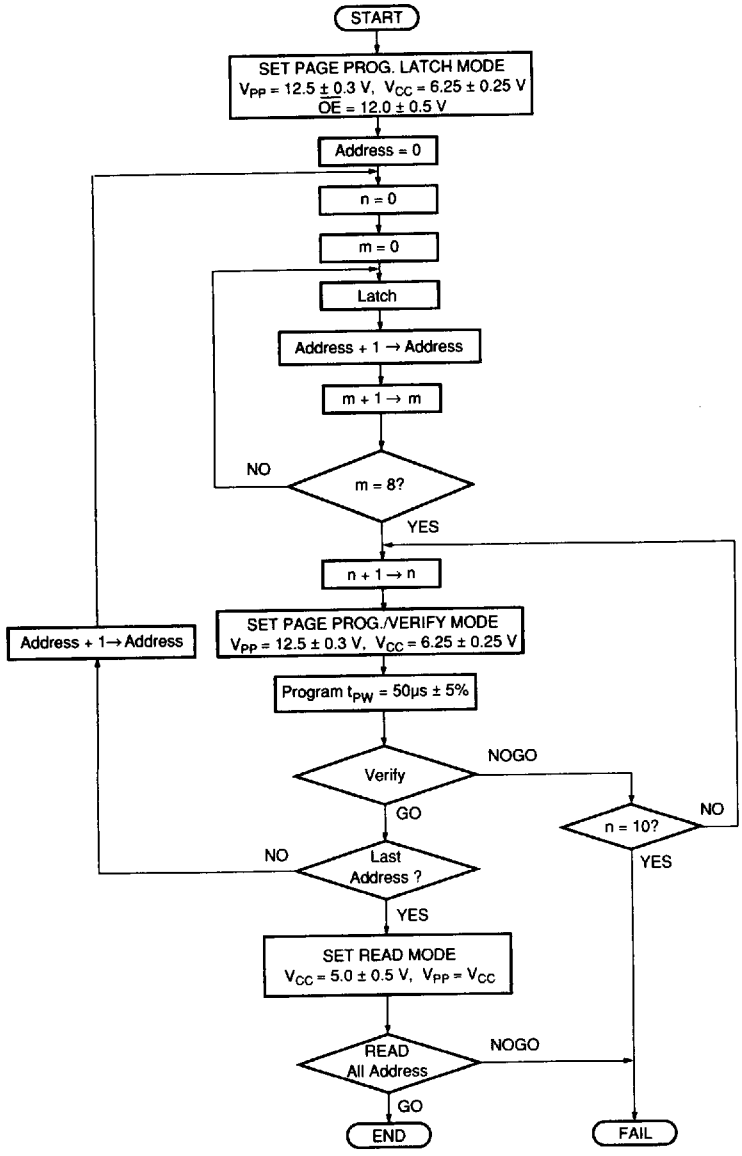
■ PAGE PROGRAMMING FLOWCHART

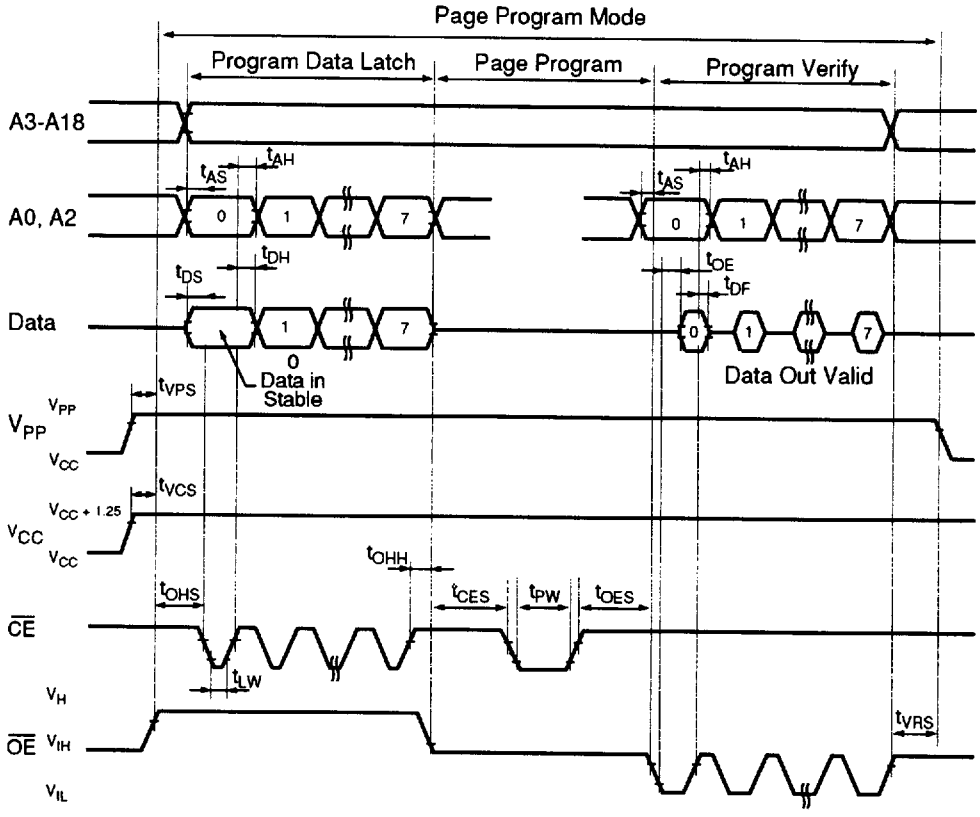
The Hitachi HN27C4001 can be programmed with the high performance Page Programming algorithm shown in the following flowchart. This algorithm provides a fast programming time without voltage stress to the device or deterioration in reliability of programmed data.

Note: 1. To set the device into Page Programming, apply 12.5 V to V_{PP} then followed by applying 12 V to $\overline{OE}$. The device operates in Page Program Mode until reset.
2. To reset the Page Program Mode, set $V_{PP} = V_{CC}$ or less.



(FC.PP.HN27C4001)

■ PAGE PROGRAMMING TIMING WAVEFORM



(TD.PP.HN27C4001)

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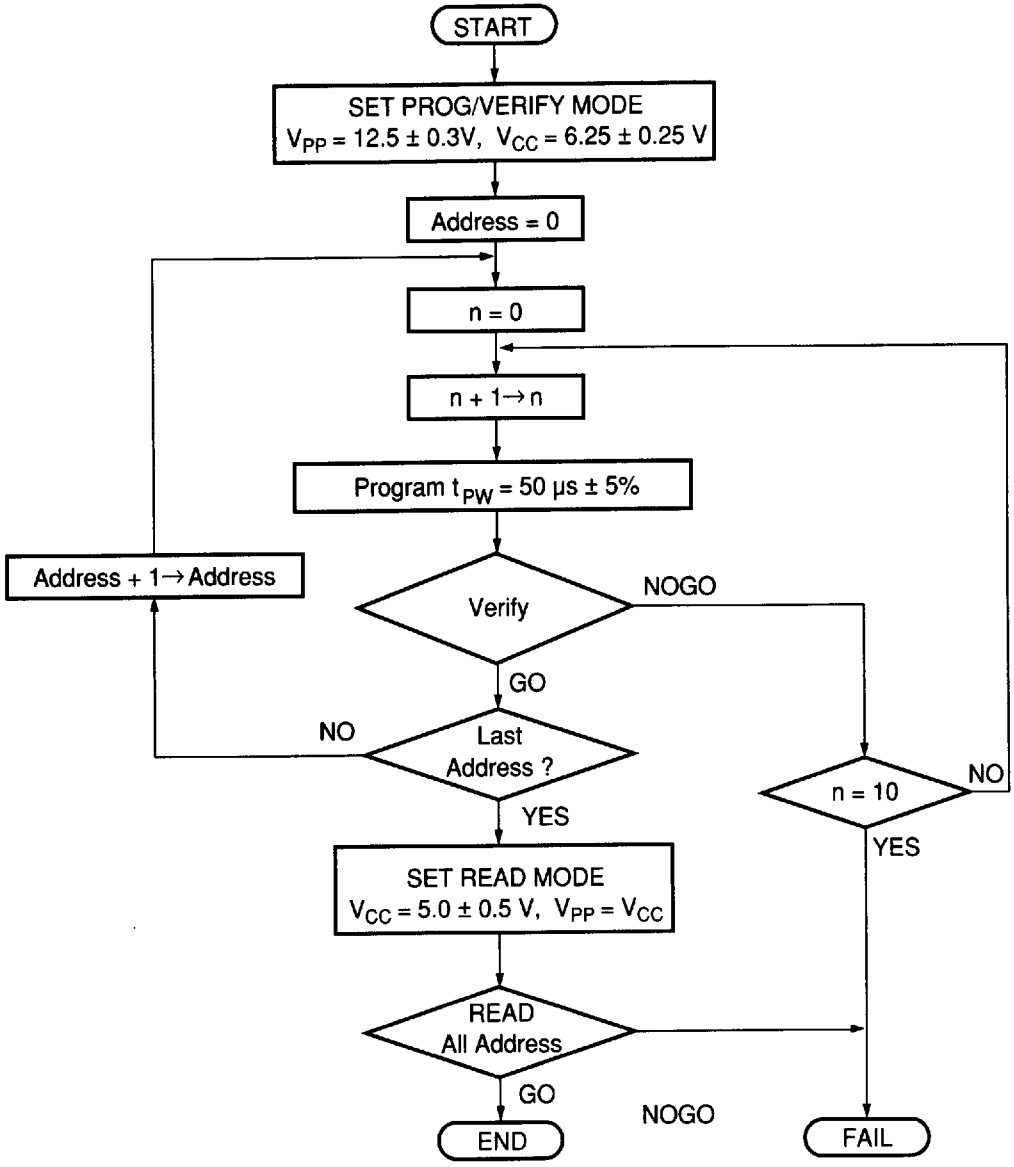
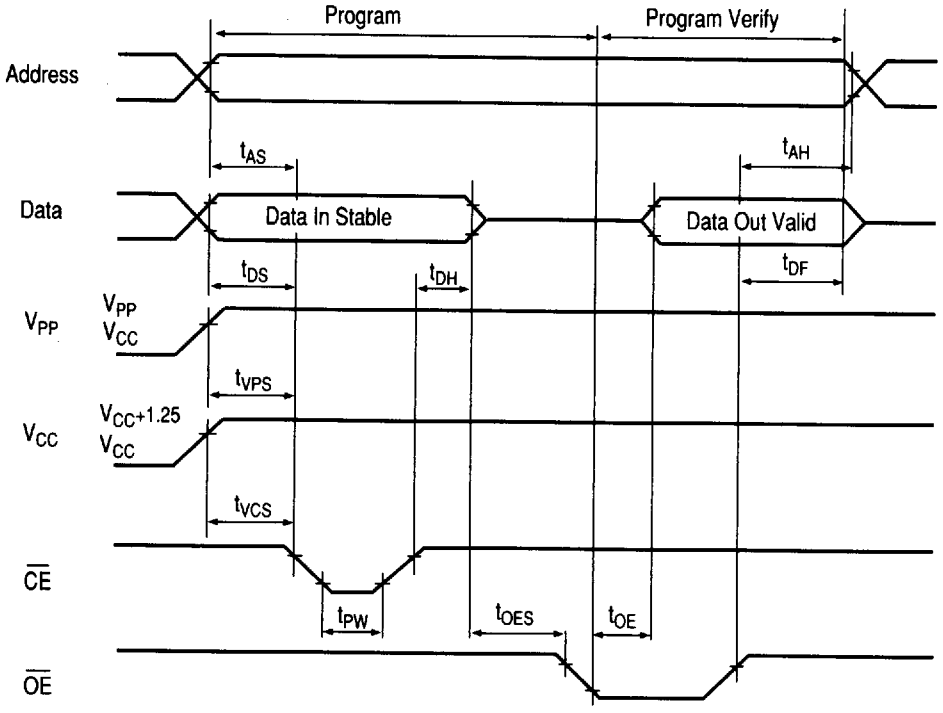
■ BYTE PROGRAMMING FLOWCHART

The Hitachi HN27C4096H can be programmed with the high performance Byte Programming algorithm shown in the following flowchart. This algorithm provides a fast programming time without voltage stress to the device or deterioration in reliability of programmed data.



(FC.P.HN27C4001)

■ BYTE PROGRAMMING TIMING WAVEFORM



(TD.P.HN27C4001)

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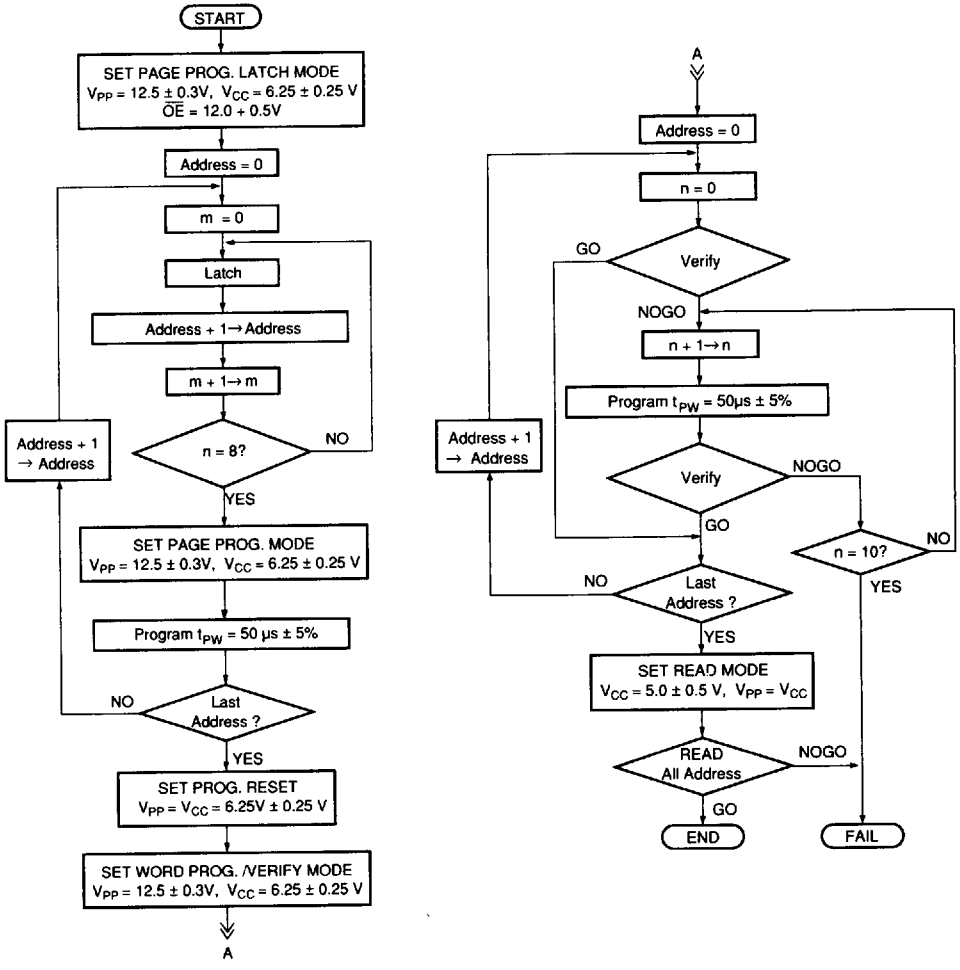
■ OPTIONAL PAGE PROGRAMMING FLOWCHART

The Hitachi HN27C4001 can be programmed with the high performance Optional Page Programming algorithm shown in the following flowchart. This algorithm provides a fast programming time without voltage stress to the device or deterioration in reliability of programmed data.

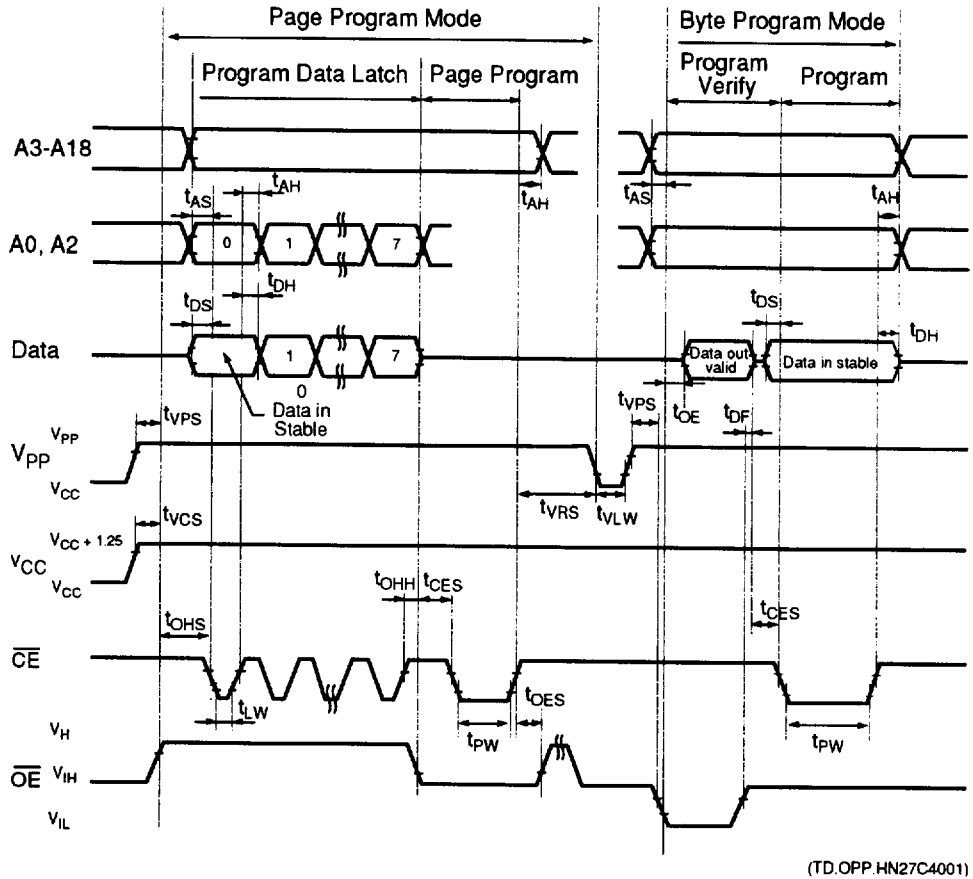
This programming algorithm is a combination of Page Programming and Byte Verify. It can be used to avoid the increased programming verify time when a programmer with a slower machine cycle is used and shorten the total programming time.

Please refer to the timing specifications for page programming and byte programming.



(FC.OPP.HN27C4001)

■ OPTIONAL PAGE PROGRAMMING TIMING WAVEFORM



(TD.OPP.HN27C4001)

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■ ERASING THE HN27C4001

The Hitachi HN27C4001 Ceramic DIP package allows the device to be erased by exposure to ultraviolet light of 2537Å. All of the data is changed to "1" after this erasure procedure. The minimum integrated dose (UV intensity x exposure time) for erasure is 15 W-sec/cm^2.

■ DEVICE IDENTIFIER MODE DESCRIPTION

The Device Identifier Mode allows binary codes to be read from the outputs that identify the manufacturer and the type of device. Using this mode with programming equipment, the device will automatically match its own erase and programming algorithm.

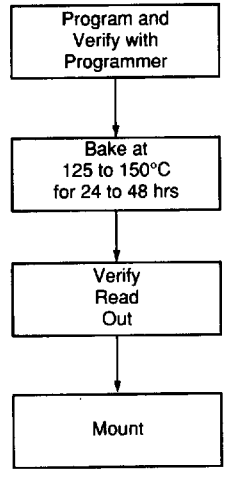
■ HN27C4001 SERIES IDENTIFIER CODE

Identifier	A_0	I/O_7	I/O_6	I/O_5	I/O_4	I/O_3	I/O_2	I/O_1	I/O_0	Hex Data
Manufacturer Code	V_{IL}	0	0	0	0	0	1	1	1	07
Device Code	V_{IH}	0	0	1	0	0	0	0	0	20

Notes: 1. $V_{CC} = 5.0\ V \pm 10\%$
2. $A_9 = 12.0\ V \pm 0.5V$
3. A_1-A_8, A_{10}-A_{18}, $\overline{CE}$, $\overline{OE} = V_{IL}$
4. X = Don't Care

■ HN27C4001TT/RR RECOMMENDED SCREENING CONDITIONS

Before mounting the HN27C4001TT/RR packages, please make the following screening (baking without bias) shown below:



(RSC.EPROM)