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# HN27C4001G Series

524288-word × 8-bit CMOS UV Erasable and Programmable ROM

# HITACHI

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## Description

The Hitachi HN27C4001G is a 4-Mbit ultraviolet erasable and electrically programmable ROM, featuring high speed and low power dissipation. Fabricated on advanced fine process and high speed circuitry technique, the HN27C4001G makes high speed access time possible. Therefore, it is suitable for high speed microcomputer systems. The HN27C4001G offers high speed programming using page programming mode.

## Features

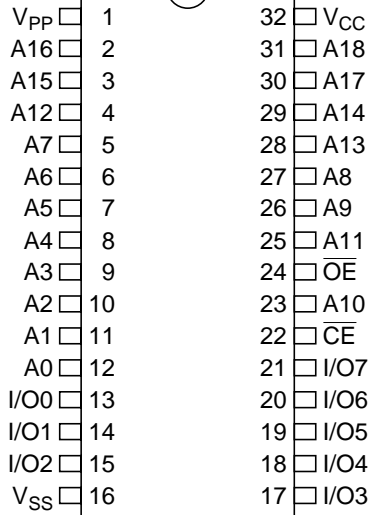
- High speed  
Access time: 100 ns/120 ns/150 ns (max)
- Low power dissipation  
Standby mode: 5  $\mu$ W(typ)  
Active mode: 35 mW/MHz (typ)
- Fast high reliability page programming and fast high-reliability programming  
Programming voltage: +12.5 V D.C.  
Program time: 3.5 sec (min) (Theoretical in page programming)
- Inputs and outputs TTL compatible during both read and program modes
- Pin arrangement  
32-pin JEDEC standard
- Device identifier mode  
Manufacturer code and device code

## Ordering Information

Type No.	Access Time	Package
HN27C4001G-10	100 ns	600 mil 32-pin Cerdip (DG-32A)
HN27C4001G-12	120 ns	
HN27C4001G-15	150 ns	

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## Pin Arrangement

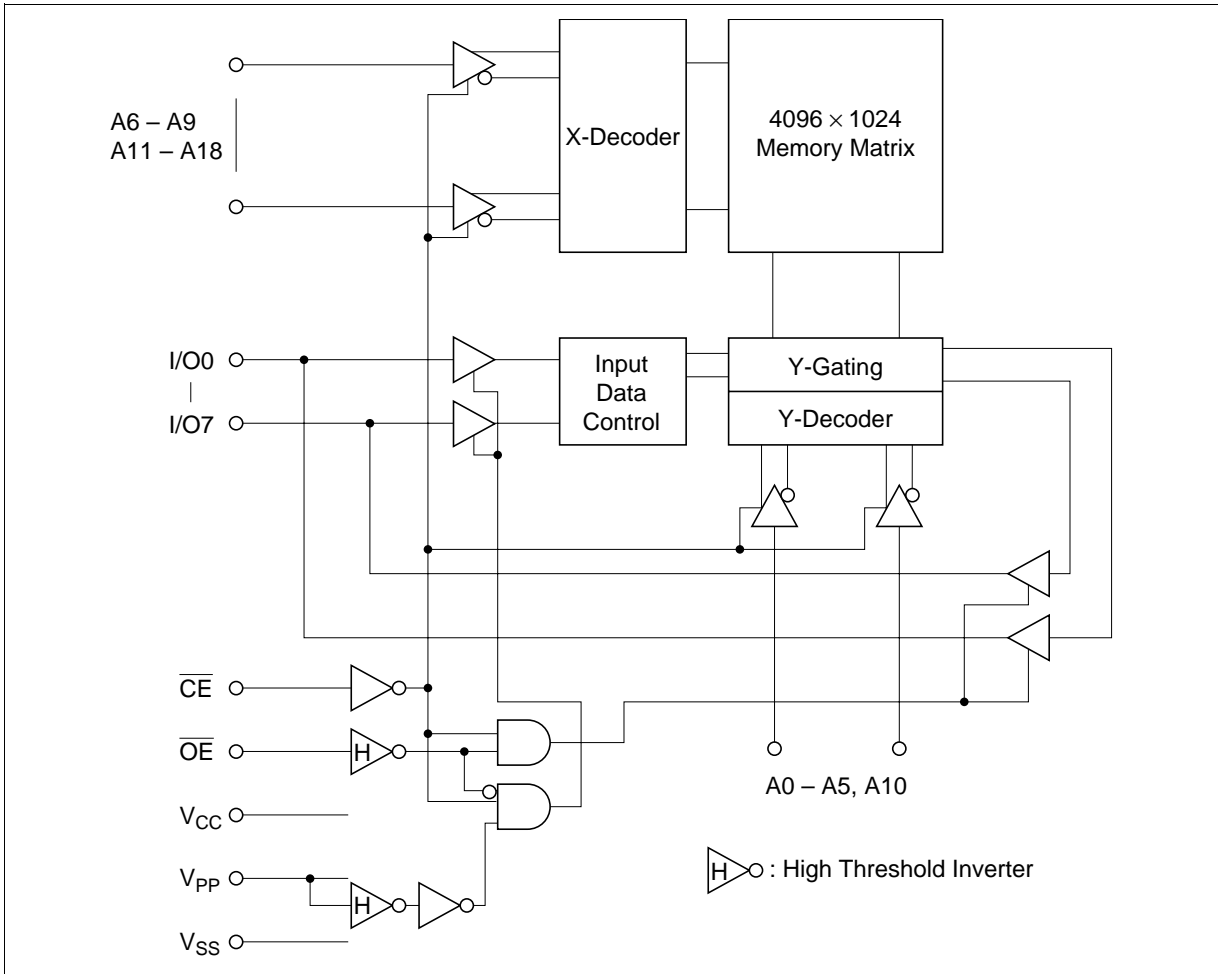


(Top view)

## Pin Description

Pin Name	Function
A0–A18	Address
I/O0 – I/O7	Input / output
$\overline{CE}$	Chip enable
$\overline{OE}$	Output enable
V <sub>CC</sub>	Power supply
V <sub>PP</sub>	Programming power supply
V <sub>SS</sub>	Ground

Block Diagram



## Mode Selection

Mode	Pin	$\overline{CE}$ (22)	$\overline{OE}$ (24)	A9 (26)	$V_{PP}$ (1)	$V_{CC}$ (32)	I/O (13 –15, 17 –21)
Read		$V_{IL}$	$V_{IL}$	X	$V_{SS} - V_{CC}$	$V_{CC}$	Dout
Output disable		$V_{IL}$	$V_{IH}$	X	$V_{SS} - V_{CC}$	$V_{CC}$	High-Z
Standby		$V_{IH}$	X	X	$V_{SS} - V_{CC}$	$V_{CC}$	High-Z
Page program	Page program set	$V_{IH}$	$V_H^{*2}$	X	$V_{PP}$	$V_{CC}$	High-Z
	Page data latch	$V_{IL}$	$V_H^{*2}$	X	$V_{PP}$	$V_{CC}$	Din
	Page program	$V_{IL}$	$V_{IH}$	X	$V_{PP}$	$V_{CC}$	High-Z
	Page program verify	$V_{IH}$	$V_{IL}$	X	$V_{PP}$	$V_{CC}$	Dout
	Page program reset	$V_{IH}$	$V_{IH}$	X	$V_{CC}$	$V_{CC}$	High-Z
Word program	Program	$V_{IL}$	$V_{IH}$	X	$V_{PP}$	$V_{CC}$	Din
	Program verify	$V_{IH}$	$V_{IL}$	X	$V_{PP}$	$V_{CC}$	Dout
	Optional verify	$V_{IL}$	$V_{IL}$	X	$V_{PP}$	$V_{CC}$	Dout
	Program inhibit	$V_{IH}$	$V_{IH}$	X	$V_{PP}$	$V_{CC}$	High-Z
Identifier		$V_{IL}$	$V_{IL}$	$V_H^{*2}$	$V_{SS} - V_{CC}$	$V_{CC}$	Code

- Notes: 1. X: Don't care.  
 2.  $V_H$ : 12.0 V  $\pm$  0.5 V.

## Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
All input and output voltages <sup>1</sup>	$V_{in}, V_{out}$	-0.6 <sup>2</sup> to +7.0	V
Voltage on Pin A9 and $\overline{OE}$	$V_{ID}$	-0.6 <sup>2</sup> to +13.0	V
$V_{pp}$ voltage <sup>1</sup>	$V_{PP}$	-0.6 to +13.5	V
$V_{cc}$ voltage <sup>1</sup>	$V_{CC}$	-0.6 to +7.0	V
Operating temperature range	$T_{opr}$	0 to +70	°C
Storage temperature range <sup>3</sup>	$T_{stg}$	-65 to +125	°C
Storage temperature range under bias	$T_{bias}$	-20 to +80	°C

- Notes: 1. Relative to  $V_{SS}$ .  
 2.  $V_{in}, V_{out}, V_{ID}$  min = -2.0 V for pulse width  $\leq$  20 ns.  
 3. Storage temperature range of device before programming.

**Capacitance** ( $T_a = 25^\circ\text{C}$ ,  $f = 1\text{ MHz}$ )

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Input capacitance	Cin	—	—	12	pF	Vin = 0 V
Output capacitance	Cout	—	—	20	pF	Vout = 0 V

**Read Operation**
**DC Characteristics** ( $V_{CC} = 5\text{ V} \pm 10\%$ ,  $V_{PP} = V_{SS}$  to  $V_{CC}$ ,  $T_a = 0$  to  $+70^\circ\text{C}$ )

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Input leakage current	$I_{LI}$	—	—	2	$\mu\text{A}$	Vin = 5.5 V
Output leakage current	$I_{LO}$	—	—	2	$\mu\text{A}$	Vout = 5.5 V/0.45 V
Vpp current	$I_{PP1}$	—	1	20	$\mu\text{A}$	Vpp = 5.5 V
Standby $V_{CC}$ current	$I_{SB1}$	—	—	1	mA	$\overline{CE} = V_{IH}$
	$I_{SB2}$	—	1	20	$\mu\text{A}$	$\overline{CE} = V_{CC} \pm 0.3\text{ V}$
Operating $V_{CC}$ current	$I_{CC1}$	—	—	30	mA	Iout = 0 mA, f = 1 MHz
	$I_{CC2}$	—	—	100	mA	Iout = 0 mA, f = 10 MHz
Input voltage	$V_{IL}$	$-0.3^{*1}$	—	0.8	V	
	$V_{IH}$	2.2	—	$V_{CC} + 1^{*2}$	V	
Output voltage	$V_{OL}$	—	—	0.45	V	$I_{OL} = 2.1\text{ mA}$
	$V_{OH}$	2.4	—	—	V	$I_{OH} = -400\ \mu\text{A}$

Notes: 1.  $V_{IL}$  min =  $-1.0\text{ V}$  for pulse width  $\leq 50\text{ ns}$ .

$V_{IL}$  min =  $-2.0\text{ V}$  for pulse width  $\leq 20\text{ ns}$ .

2.  $V_{IH}$  max =  $V_{CC} + 1.5\text{ V}$  for pulse width  $\leq 20\text{ ns}$ .

If  $V_{IH}$  is over the specified maximum value, read operation cannot be guaranteed.

# HN27C4001G Series

**AC Characteristics** ( $V_{CC} = 5\text{ V} \pm 10\%$ ,  $V_{PP} = V_{SS}$  to  $V_{CC}$ ,  $T_a = 0$  to  $+70^\circ\text{C}$ )

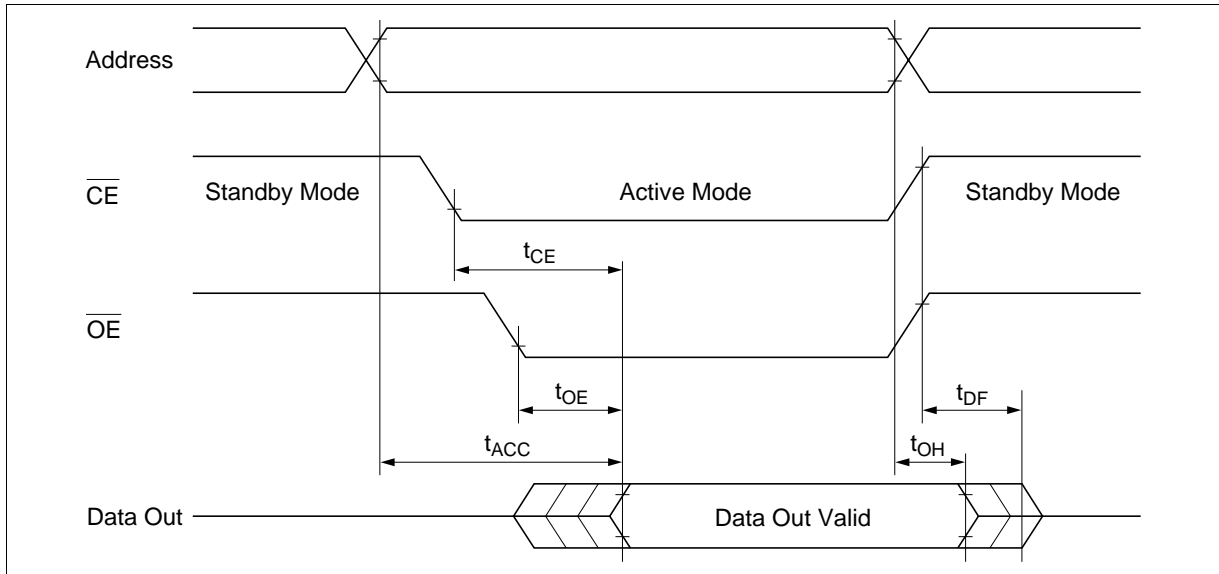
## Test Conditions

- Input pulse levels: 0.45 to 2.4 V
- Input rise and fall time:  $\leq 10$  ns
- Output load: 1TTL Gate + 100 pF
- Reference levels for measuring timing: 0.8 V, 2.0 V

		HN27C4001							
		-10		-12		-15			
Parameter	Symbol	Min	Max	Min	Max	Min	Max	Unit	Test Conditions
Address to output delay	$t_{ACC}$	—	100	—	120	—	150	ns	$\overline{CE} = \overline{OE} = V_{IL}$
$\overline{CE}$ to output delay	$t_{CE}$	—	100	—	120	—	150	ns	$\overline{OE} = V_{IL}$
$\overline{OE}$ to output delay	$t_{OE}$	—	60	—	60	—	70	ns	$\overline{CE} = V_{IL}$
$\overline{OE}$ high to output float <sup>1</sup>	$t_{DF}$	0	35	0	40	0	50	ns	$\overline{CE} = V_{IL}$
Address to output hold	$t_{OH}$	5	—	5	—	5	—	ns	$\overline{CE} = \overline{OE} = V_{IL}$

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

## Read Timing Waveform



## **Fast High-Reliability Page Programming**

This device can be applied the high performance page programming algorithm shown in the following flowchart. This algorithm allows to obtain faster programming time without any voltage stress to the device nor deterioration in reliability of programmed data.

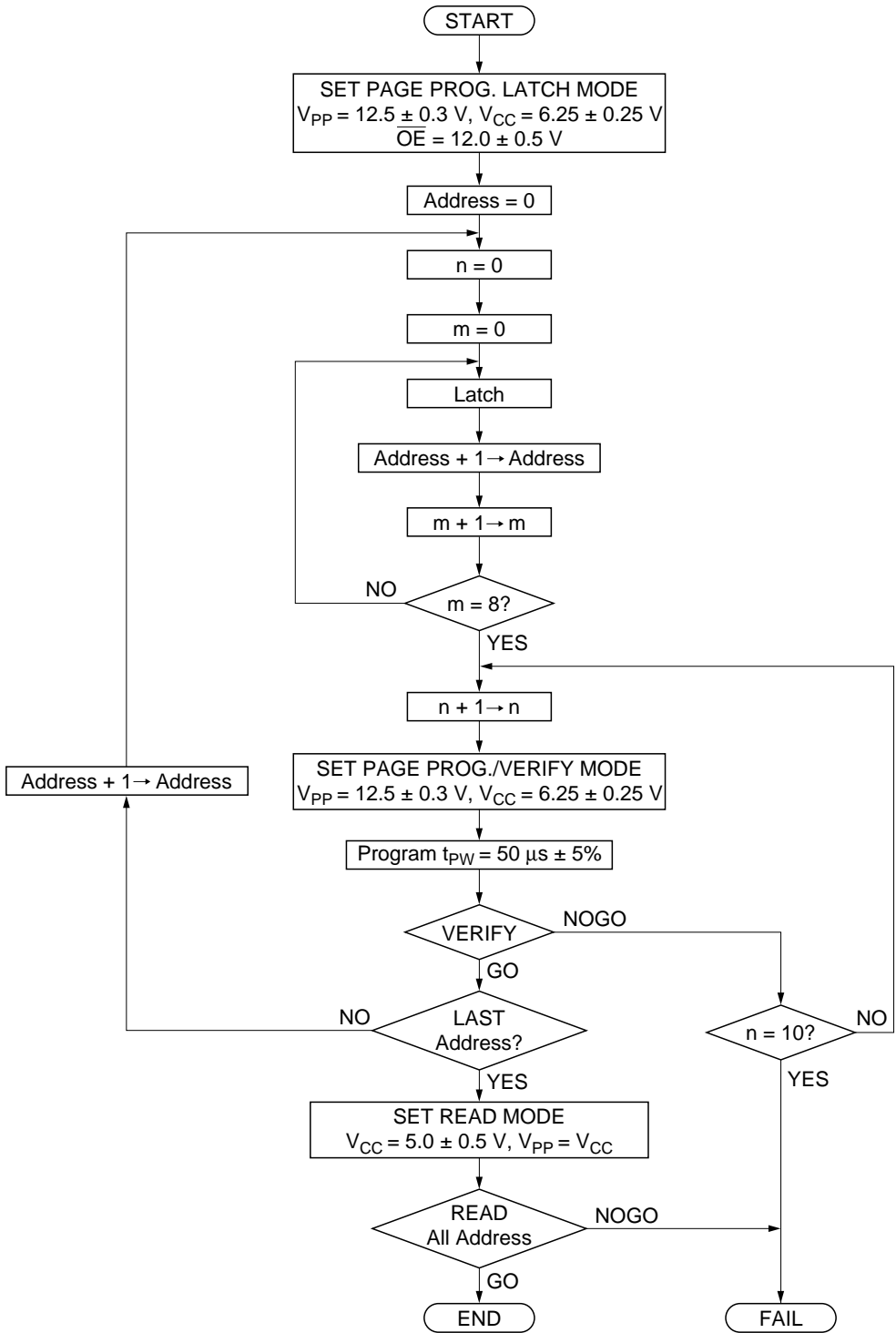
### **Page Program Set**

Apply 12 V to  $\overline{\text{OE}}$  pin after applying 12.5 V to  $V_{\text{pp}}$  to set a page program mode.

The device operates in a page program mode until reset.

### **Page Program Reset**

Set  $V_{\text{pp}}$  to  $V_{\text{CC}}$  level or less to reset a page program mode.



**Fast High-Reliability Page Programming Flowchart**



**DC Characteristics** ( $V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$ ,  $V_{PP} = 12.5 \text{ V} \pm 0.3 \text{ V}$ ,  $T_a = 25^\circ\text{C} \pm 5^\circ\text{C}$ )

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Input leakage current	$I_{LI}$	—	—	2	$\mu\text{A}$	$V_{in} = 6.5 \text{ V} / 0.45 \text{ V}$
Output voltage during verify	$V_{OL}$	—	—	0.45	V	$I_{OL} = 2.1 \text{ mA}$
	$V_{OH}$	2.4	—	—	V	$I_{OH} = -400 \mu\text{A}$
Operating $V_{CC}$ current	$I_{CC}$	—	—	50	mA	
Input voltage	$V_{IL}$	$-0.1^{15}$	—	0.8	V	
	$V_{IH}$	2.2	—	$V_{CC} + 0.5^{16}$	V	
	$V_H$	11.5	12.0	12.5	V	
$V_{PP}$ supply current	$I_{PP}$	—	—	70	mA	$\overline{CE} = V_{IL}$

- Notes:
- $V_{CC}$  must be applied simultaneously or before  $V_{PP}$  and removed simultaneously or after  $V_{PP}$ .
  - $V_{PP}$  must not exceed 13.5 V including overshoot.
  - An influence may be had upon device reliability if the device is installed or removed while  $V_{PP} = 12.5 \text{ V}$ .
  - Do not alter  $V_{PP}$  either  $V_{IL}$  to 12.5 V or 12.5 V to  $V_{IL}$  when  $\overline{CE} = \text{low}$ .
  - $V_{IL} \text{ min} = -0.6 \text{ V}$  for pulse width  $\leq 20 \text{ ns}$ .
  - If  $V_{IH}$  is over the specified maximum value, programming operation cannot be guaranteed.

## HN27C4001G Series

**AC Characteristics** ( $V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$ ,  $V_{PP} = 12.5 \text{ V} \pm 0.3 \text{ V}$ ,  $T_a = 25^\circ\text{C} \pm 5^\circ\text{C}$ )

### Test Conditions

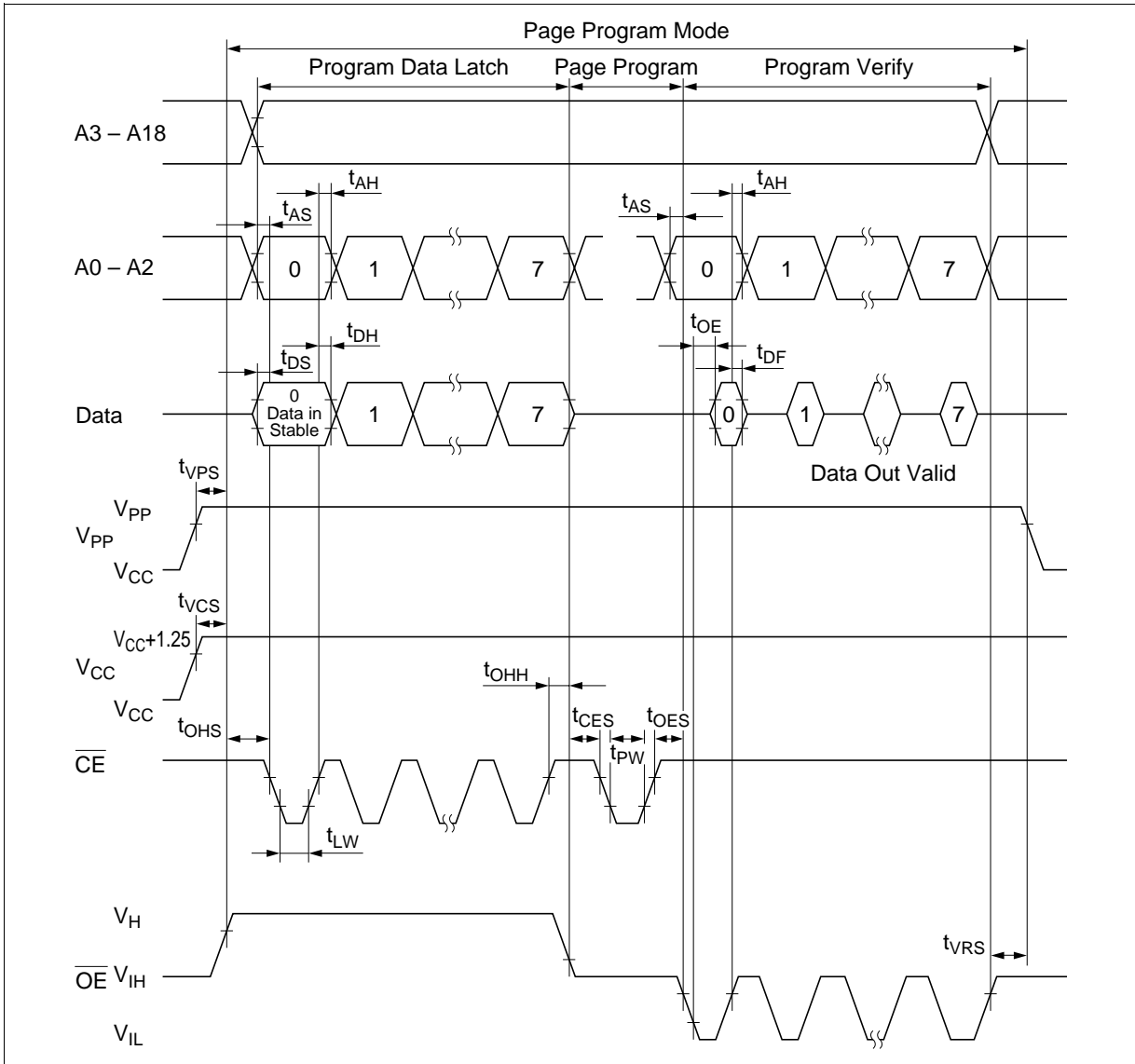
- Input pulse levels: 0.45 to 2.4 V
- Input rise and fall time:  $\leq 20 \text{ ns}$
- Reference levels for measuring timing: Inputs: 0.8 V, 2.0 V  
Outputs: 0.8 V, 2.0 V

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Address setup time	$t_{AS}$	2	—	—	$\mu\text{s}$	
$\overline{OE}$ setup time	$t_{OES}$	2	—	—	$\mu\text{s}$	
Data setup time	$t_{DS}$	2	—	—	$\mu\text{s}$	
Address hold time	$t_{AH}$	0	—	—	$\mu\text{s}$	
Data hold time	$t_{DH}$	2	—	—	$\mu\text{s}$	
$\overline{OE}$ high to output float delay	$t_{DF}^{*1}$	0	—	130	ns	
$V_{PP}$ setup time	$t_{VPS}$	2	—	—	$\mu\text{s}$	
$V_{CC}$ setup time	$t_{VCS}$	2	—	—	$\mu\text{s}$	
$\overline{CE}$ programming pulse width	$t_{PW}$	47.5	50.0	52.5	$\mu\text{s}$	
$\overline{CE}$ setup time	$t_{CES}$	2	—	—	$\mu\text{s}$	
Data valid from $\overline{OE}$	$t_{OE}$	0	—	150	ns	
$\overline{CE}$ pulse width during data latch	$t_{LW}$	1	—	—	$\mu\text{s}$	
$\overline{OE} = V_H$ setup time	$t_{OHS}$	2	—	—	$\mu\text{s}$	
$\overline{OE} = V_H$ hold time	$t_{OHH}$	2	—	—	$\mu\text{s}$	
$V_{PP}$ hold time <sup>*2</sup>	$t_{VRS}$	1	—	—	$\mu\text{s}$	

Notes: 1.  $t_{DF}$  is defined as the time at which the output achieves the open circuit conditions and data is no longer driven.

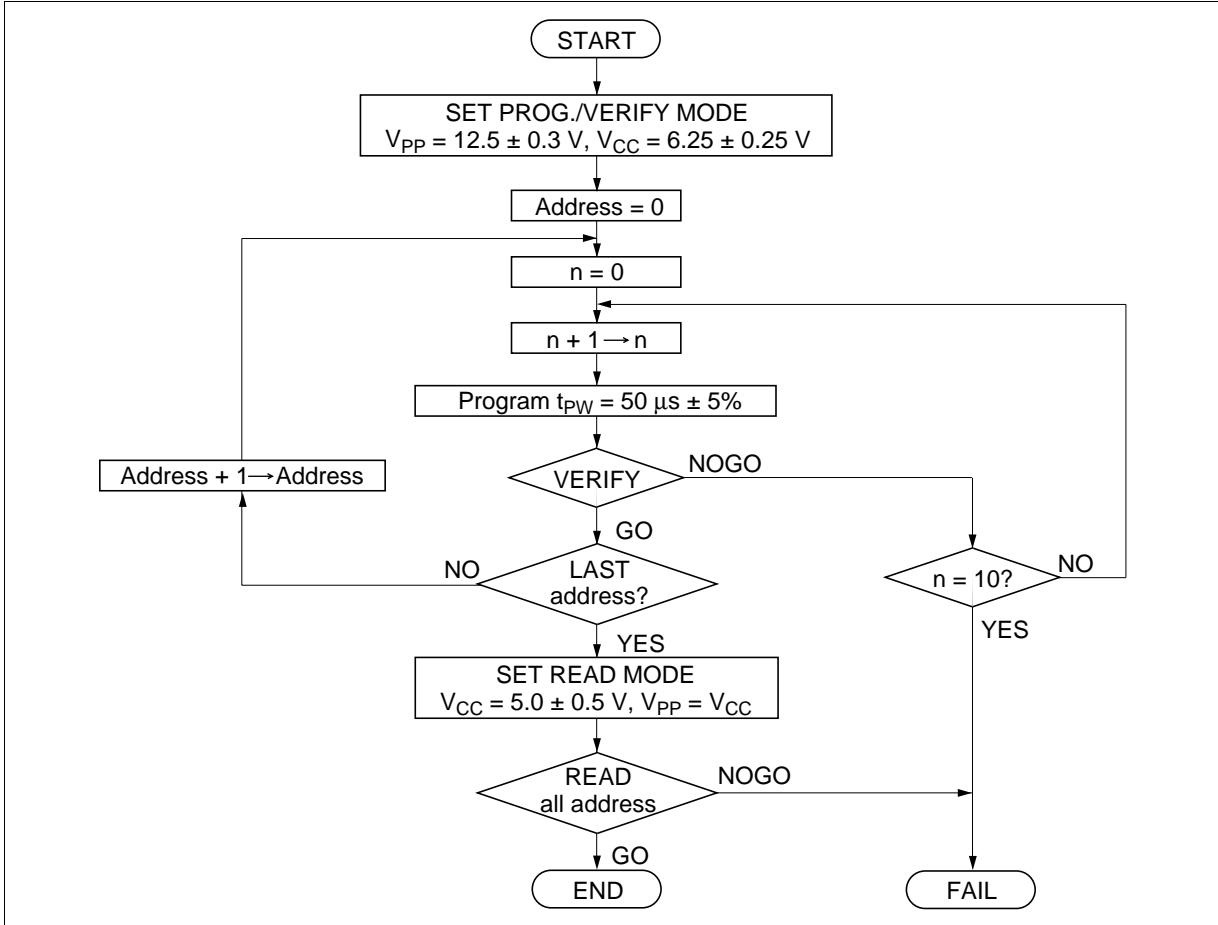
2. Page program mode will be reset when  $V_{PP}$  is set to  $V_{CC}$  or less.

Fast High-Reliability Page Programming Timing Waveform



## Fast High-Reliability Programming

This device can be applied the fast high-reliability programming algorithm shown in the following flowchart. This algorithm allows to obtain faster programming time without any voltage stress to the device nor deterioration in reliability of programmed data.



Fast High-Reliability Programming Flowchart

**DC Characteristics** ( $V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$ ,  $V_{PP} = 12.5 \text{ V} \pm 0.3 \text{ V}$ ,  $T_a = 25^\circ\text{C} \pm 5^\circ\text{C}$ )

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Input leakage current	$I_{LI}$	—	—	2	$\mu\text{A}$	$V_{in} = 6.5 \text{ V} / 0.45 \text{ V}$
$V_{PP}$ supply current	$I_{PP}$	—	—	40	$\text{mA}$	$\overline{CE} = V_{IL}$
Operating $V_{CC}$ current	$I_{CC}$	—	—	50	$\text{mA}$	
Input voltage	$V_{IL}$	$-0.1^{15}$	—	0.8	$\text{V}$	
	$V_{IH}$	2.2	—	$V_{CC} + 0.5^{16}$	$\text{V}$	
Output voltage	$V_{OL}$	—	—	0.45	$\text{V}$	$I_{OL} = 2.1 \text{ mA}$
	$V_{OH}$	2.4	—	—	$\text{V}$	$I_{OH} = -400 \mu\text{A}$

- Notes:
- $V_{CC}$  must be applied simultaneously or before  $V_{PP}$  and removed simultaneously or after  $V_{PP}$ .
  - $V_{PP}$  must not exceed 13.5 V including overshoot.
  - An influence may be had upon device reliability if the device is installed or removed while  $V_{PP} = 12.5 \text{ V}$ .
  - Do not alter  $V_{PP}$  either  $V_{IL}$  to 12.5 V or 12.5 V to  $V_{IL}$  when  $\overline{CE} = \text{low}$ .
  - $V_{IL}$  min =  $-0.6 \text{ V}$  for pulse width  $\leq 20 \text{ ns}$ .
  - If  $V_{IH}$  is over the specified maximum value, programming operation cannot be guaranteed.

## HN27C4001G Series

**AC Characteristics** ( $V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$ ,  $V_{PP} = 12.5 \text{ V} \pm 0.3 \text{ V}$ ,  $T_a = 25^\circ\text{C} \pm 5^\circ\text{C}$ )

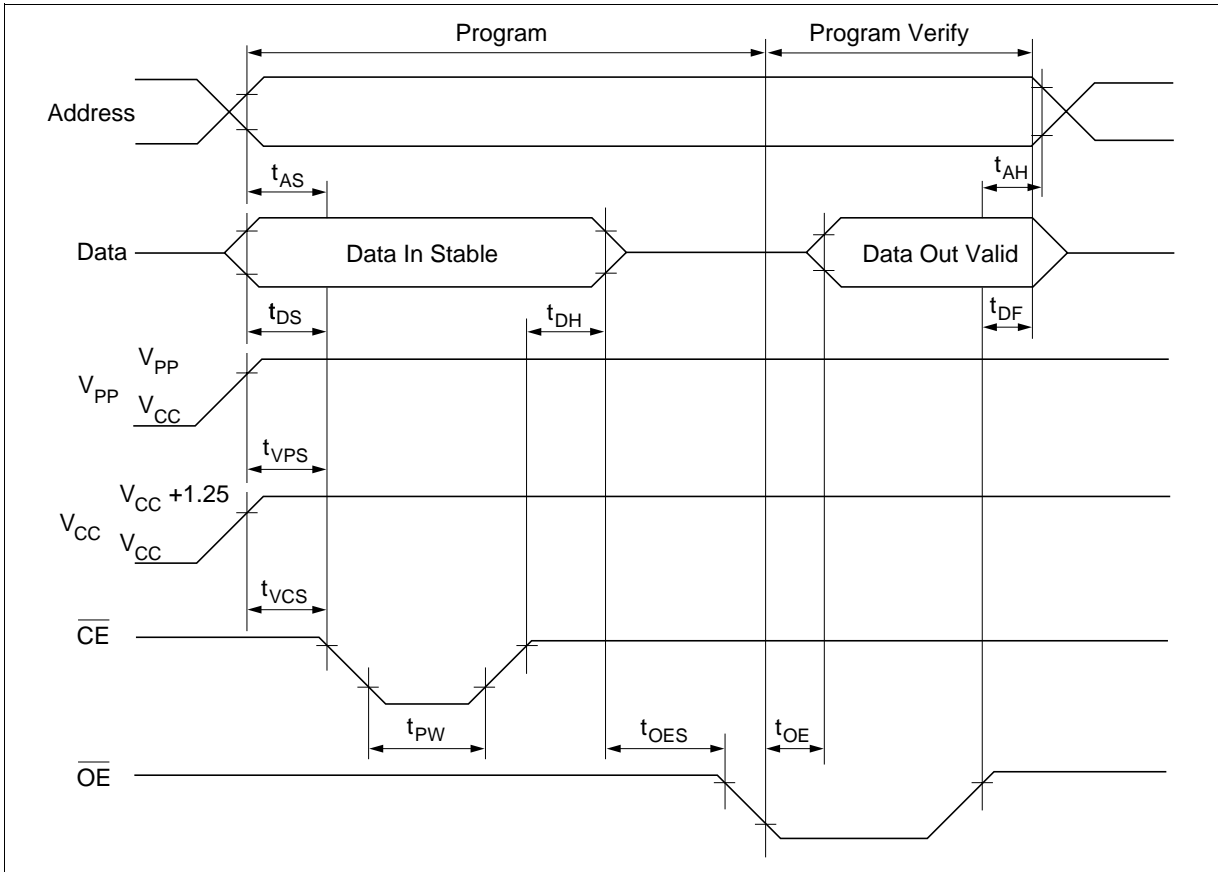
### Test Conditions

- Input pulse levels: 0.45 to 2.4 V
- Input rise and fall time:  $\leq 20 \text{ ns}$
- Reference levels for measuring timing: Inputs: 0.8 V, 2.0 V  
Outputs: 0.8 V, 2.0 V

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Address setup time	$t_{AS}$	2	—	—	$\mu\text{s}$	
$\overline{\text{OE}}$ setup time	$t_{OES}$	2	—	—	$\mu\text{s}$	
Data setup time	$t_{DS}$	2	—	—	$\mu\text{s}$	
Address hold time	$t_{AH}$	0	—	—	$\mu\text{s}$	
Data hold time	$t_{DH}$	2	—	—	$\mu\text{s}$	
$\overline{\text{OE}}$ to output float delay	$t_{DF}^{*1}$	0	—	130	ns	
$V_{PP}$ setup time	$t_{VPS}$	2	—	—	$\mu\text{s}$	
$V_{CC}$ setup time	$t_{VCS}$	2	—	—	$\mu\text{s}$	
$\overline{\text{CE}}$ programming pulse width	$t_{PW}$	47.5	50.0	52.5	$\mu\text{s}$	
Data valid from $\overline{\text{OE}}$	$t_{OE}$	0	—	150	ns	

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

Fast High-Reliability Programming Timing Waveform

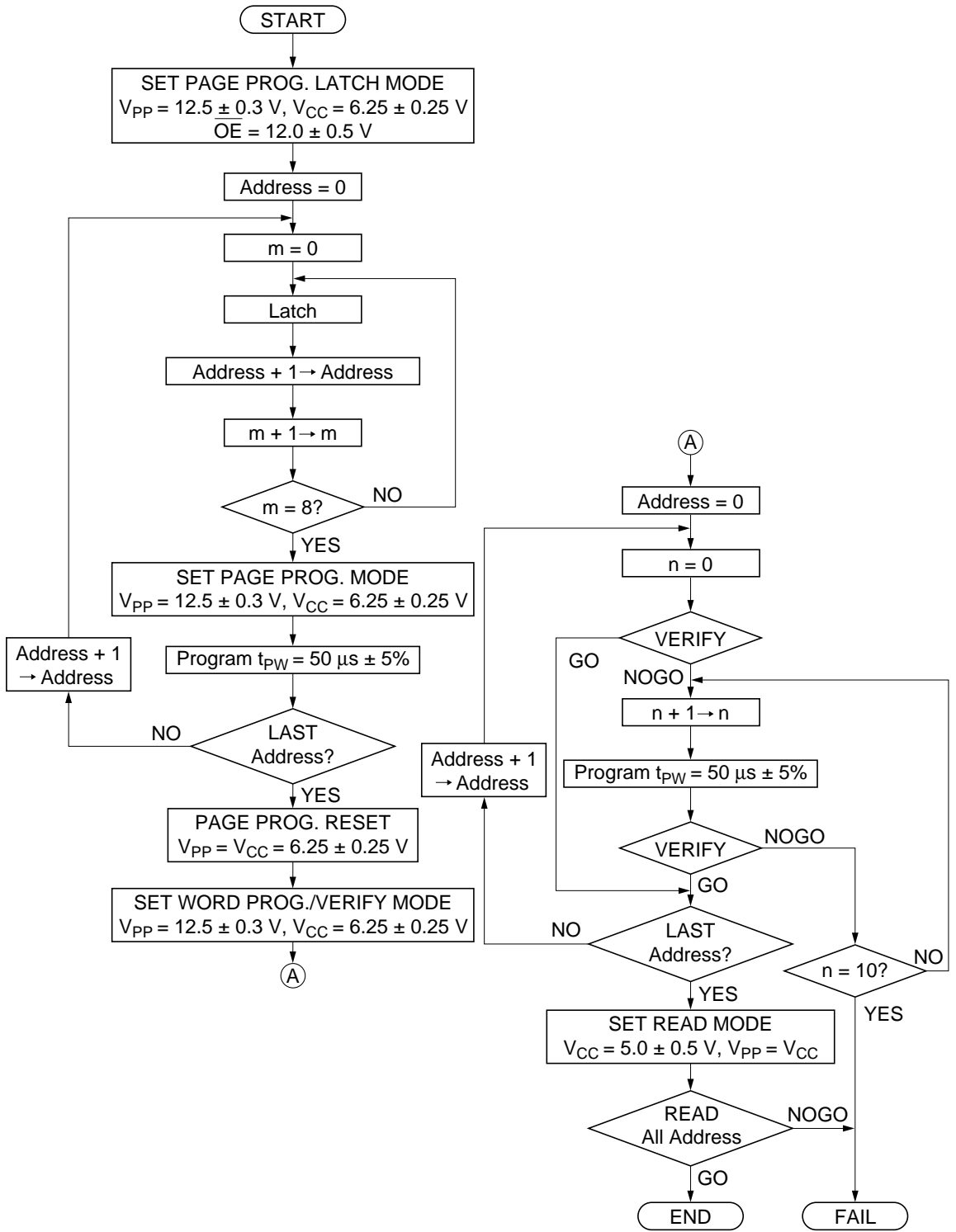


Optional Page Programming

This device can be applied the optional page programming algorithm shown in the following flowchart. This algorithm allows to obtain faster programming time without any voltage stress to the device nor deterioration in reliability of programmed data.

This programming algorithm is the combination of page programming and byte verify. It can avoid the increase of programming verify time when a programmer with slow machine cycle is used, and shorten the total programming time.

Regarding the timing specifications for page programming and byte verify, please refer to the specifications for fast high-reliability page programming and fast high-reliability programming.



Optional Page Programming Flowchart



**DC Characteristics** ( $V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$ ,  $V_{PP} = 12.5 \text{ V} \pm 0.3 \text{ V}$ ,  $T_a = 25^\circ\text{C} \pm 5^\circ\text{C}$ )

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Input leakage current	$I_{LI}$	—	—	2	$\mu\text{A}$	$V_{in} = 6.5 \text{ V} / 0.45 \text{ V}$
Output voltage during verify	$V_{OL}$	—	—	0.45	V	$I_{OL} = 2.1 \text{ mA}$
	$V_{OH}$	2.4	—	—	V	$I_{OH} = -400 \mu\text{A}$
Operating $V_{CC}$ current	$I_{CC}$	—	—	50	mA	
Input voltage	$V_{IL}$	$-0.1^{15}$	—	0.8	V	
	$V_{IH}$	2.2	—	$V_{CC} + 0.5^{16}$	V	
	$V_H$	11.5	12.0	12.5	V	
$V_{PP}$ supply current	$I_{PP}$	—	—	70	mA	$\overline{CE} = V_{IL}$

- Notes:
- $V_{CC}$  must be applied simultaneously or before  $V_{PP}$  and removed simultaneously or after  $V_{PP}$ .
  - $V_{PP}$  must not exceed 13.5 V including overshoot.
  - An influence may be had upon device reliability if the device is installed or removed while  $V_{PP} = 12.5 \text{ V}$ .
  - Do not alter  $V_{PP}$  either  $V_{IL}$  to 12.5 V or 12.5 V to  $V_{IL}$  when  $\overline{CE} = \text{low}$ .
  - $V_{IL} \text{ min} = -0.6 \text{ V}$  for pulse width  $\leq 20 \text{ ns}$ .
  - If  $V_{IH}$  is over the specified maximum value, programming operation cannot be guaranteed.

## HN27C4001G Series

**AC Characteristics** ( $V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$ ,  $V_{PP} = 12.5 \text{ V} \pm 0.3 \text{ V}$ ,  $T_a = 25^\circ\text{C} \pm 5^\circ\text{C}$ )

### Test Conditions

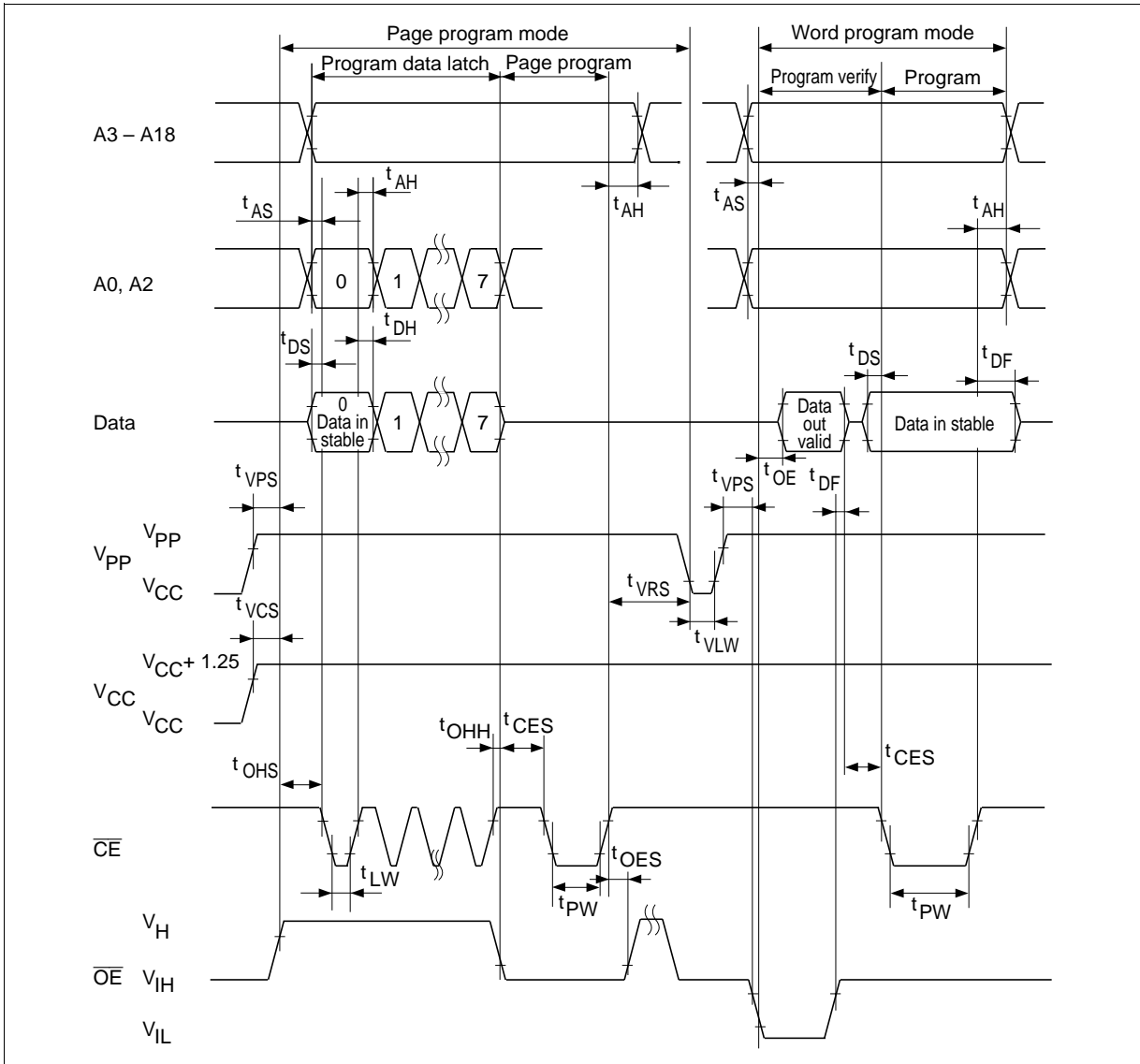
- Input pulse levels: 0.45 to 2.4 V
- Input rise and fall time:  $\leq 20 \text{ ns}$
- Reference levels for measuring timing: Inputs: 0.8 V, 2.0 V  
Outputs: 0.8 V, 2.0 V

Parameter	Symbol	Min	Typ	Max	Unit	Test Conditions
Address setup time	$t_{AS}$	2	—	—	$\mu\text{s}$	
$\overline{OE}$ setup time	$t_{OES}$	2	—	—	$\mu\text{s}$	
Data setup time	$t_{DS}$	2	—	—	$\mu\text{s}$	
Address hold time	$t_{AH}$	0	—	—	$\mu\text{s}$	
Data hold time	$t_{DH}$	2	—	—	$\mu\text{s}$	
$\overline{OE}$ high to output float delay	$t_{DF}^{*1}$	0	—	130	ns	
$V_{PP}$ setup time	$t_{VPS}$	2	—	—	$\mu\text{s}$	
$V_{CC}$ setup time	$t_{VCS}$	2	—	—	$\mu\text{s}$	
$\overline{CE}$ programming pulse width	$t_{PW}$	47.5	50.0	52.5	$\mu\text{s}$	
$\overline{CE}$ setup time	$t_{CES}$	2	—	—	$\mu\text{s}$	
Data valid from $\overline{OE}$	$t_{OE}$	0	—	150	ns	
$\overline{CE}$ pulse width during data latch	$t_{LW}$	1	—	—	$\mu\text{s}$	
$\overline{OE} = V_H$ setup time	$t_{OHS}$	2	—	—	$\mu\text{s}$	
$\overline{OE} = V_H$ hold time	$t_{OHH}$	2	—	—	$\mu\text{s}$	
Page programming reset time <sup>*2</sup>	$t_{VLW}$	1	—	—	$\mu\text{s}$	
$V_{PP}$ hold time <sup>*2</sup>	$t_{VRS}$	1	—	—	$\mu\text{s}$	

Notes: 1.  $t_{DF}$  is defined as the time at which the output achieves the open circuit condition and data is no longer driven.

2. Page program mode will be reset when  $V_{PP}$  is set to  $V_{CC}$  or less.

Option Page Programming Timing Waveform



Erase

Erase of HN27C4001G is performed by exposure to ultraviolet light of 2537 Å and all the output data are changed to “1” after this erasure procedure. The minimum integrated dose (i.e. UV intensity x exposure time) for erasure is 15 W· sec/cm<sup>2</sup>.

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## HN27C4001G Series

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### Mode Description

#### Device Identifier Mode

The device identifier mode allows the reading out of binary codes that identify manufacturer and type of device, from outputs of EPROM. By this mode, the device will be automatically matched its own corresponding programming algorithm, using programming equipment.

#### HN27C4001G Identifier Code

Identifier	A0 (12)	I/O7 (21)	I/O6 (20)	I/O5 (19)	I/O4 (18)	I/O (17)	I/O2 (15)	I/O1 (14)	I/O0 (13)	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.  $V_{CC} = 5.0\text{ V} \pm 10\%$
  2.  $A_9 = 12.0\text{ V} \pm 0.5\text{ V}$
  3.  $\overline{CE}, \overline{OE} = V_{IL}$
  4. A1 – A8, A10 – A18: Don't care.

