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# HN27C4001TT Series

524288-word  $\times$  8-bit CMOS One Time Electrically Programmable  
ROM

# HITACHI

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## Description

The Hitachi HN27C4001TT is a 512-kword  $\times$  8-bit one time electrically programmable ROM, featuring high speed and low power dissipation. Fabricated on advanced fine process and high speed circuitry technique, the HN27C4001TT makes high speed access time possible. Therefore, it is suitable for high speed microcomputer systems. The HN27C4001TT offers high speed programming using page programming mode. This device is packaged in 32-pin plastic package, therefore, this device cannot be rewritten and erased. The packages of HN27C4001TT are surface mount thin and small outline packages. They are suitable for hand-held equipment such as a memory card.

## Features

- High speed:
  - Access time: 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:
  - Program voltage: +12.5 V DC
  - 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 (TTP-32D)
- Package
  - Surface mount thin and small outline package (TSOP) type II: HN27C4001TT series
- Device identifier mode: Manufacturer code and device code

## Ordering Information

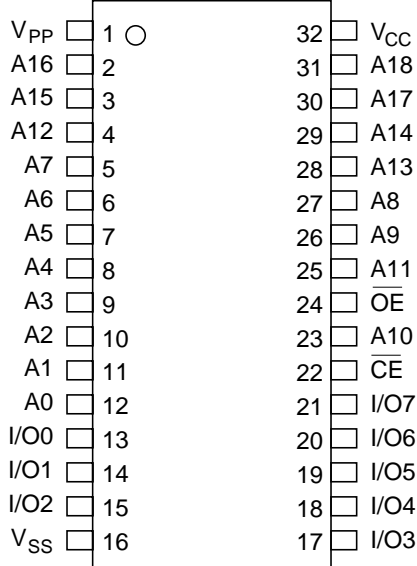
Type No.	Access Time	Package
HN27C4001TT-12	120 ns	400-mil 32-pin TSOP type II (TTP-32D)
HN27C4001TT-15	150 ns	

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# HN27C4001TT Series

## Pin Arrangement

HN27C4001TT Series

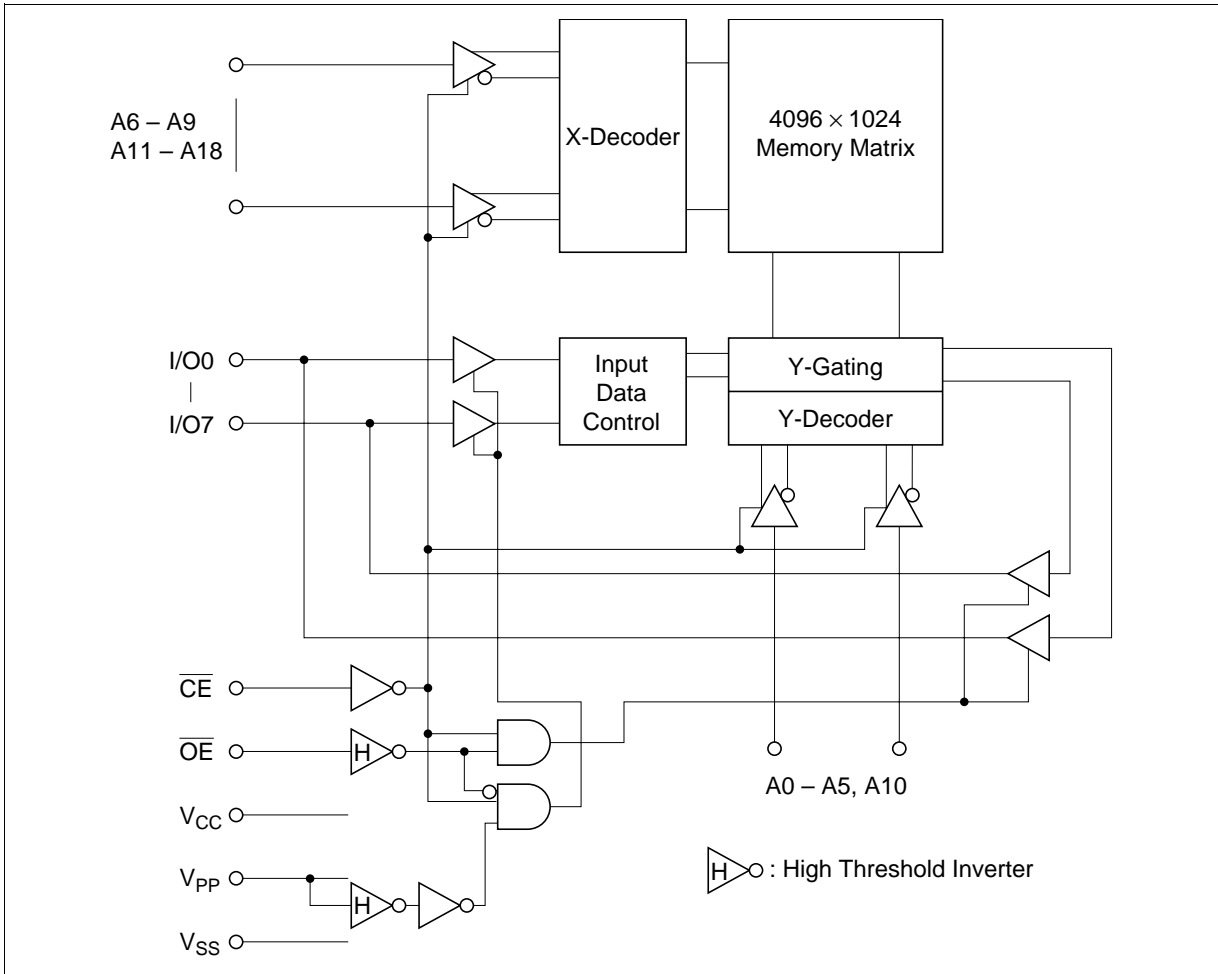


(Top view)

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

Notes: 1. X: Don't care.

2.  $V_{\text{H}}$ : 12.0 V  $\pm$  0.5 V.

## Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
All input and output voltages <sup>1</sup>	$V_{\text{in}}, V_{\text{out}}$	-0.6 <sup>2</sup> to +7.0	V
A9, $\overline{\text{OE}}$ input voltage <sup>1</sup>	$V_{\text{ID}}$	-0.6 <sup>2</sup> to +13.0	V
$V_{\text{PP}}$ voltage <sup>1</sup>	$V_{\text{PP}}$	-0.6 to +13.5	V
$V_{\text{CC}}$ voltage <sup>1</sup>	$V_{\text{CC}}$	-0.6 to +7.0	V
Operating temperature range	$T_{\text{opr}}$	0 to +70	°C
Storage temperature range <sup>3</sup>	$T_{\text{stg}}$	-55 to +125	°C
Storage temperature under bias	$T_{\text{bias}}$	-10 to +80	°C

Notes: 1. Relative to  $V_{\text{SS}}$ .

2.  $V_{\text{in}}, V_{\text{out}}, V_{\text{ID}}$  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	$C_{in}$	—	—	12	pF	$V_{in} = 0\text{ V}$
Output capacitance	$C_{out}$	—	—	20	pF	$V_{out} = 0\text{ V}$

**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	$\mu\text{A}$	$V_{in} = 5.5\text{ V}$
Output leakage current	$I_{LO}$	—	—	2	$\mu\text{A}$	$V_{out} = 5.5\text{ V}/0.45\text{ V}$
$V_{PP}$ current	$I_{PP1}$	—	1	20	$\mu\text{A}$	$V_{PP} = 5.5\text{ V}$
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	$I_{out} = 0\text{ mA}$ , $f = 1\text{ MHz}$
	$I_{CC2}$	—	—	90	mA	$I_{out} = 0\text{ mA}$ , $f = 8.4\text{ MHz}$
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	$I_{OH} = -400\text{ }\mu\text{A}$

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.

# HN27C4001TT Series

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

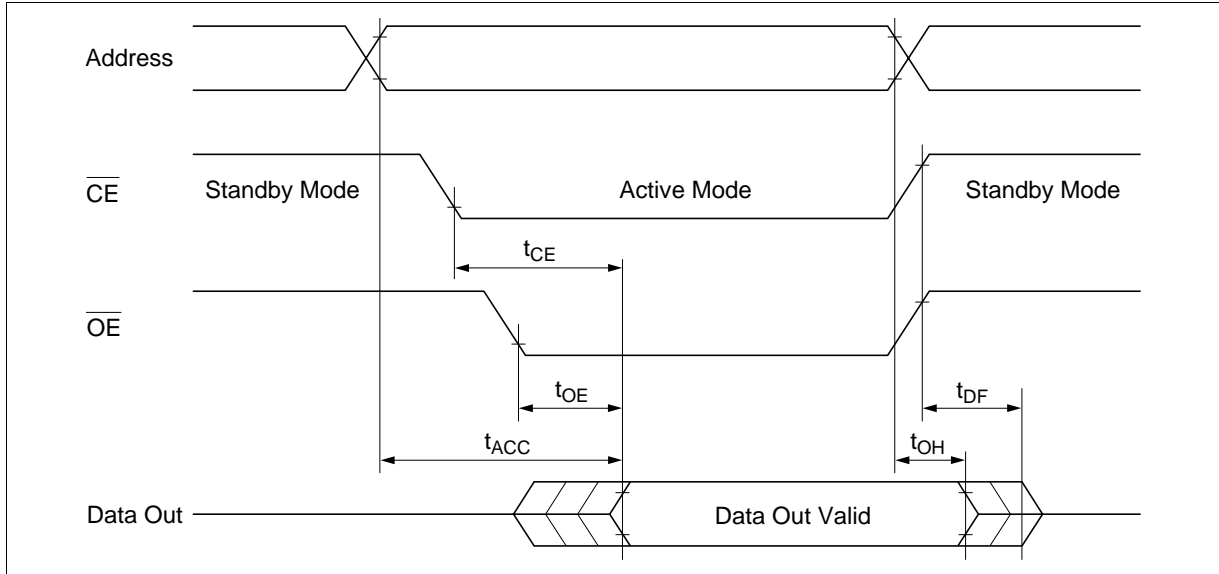
## Test Conditions

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

Parameter	Symbol	HN27C4001TT				Unit	Test Conditions
		-12		-15			
		Min	Max	Min	Max		
Address to output delay	$t_{ACC}$	—	120	—	150	ns	$\overline{CE} = \overline{OE} = V_{IL}$
$\overline{CE}$ to output delay	$t_{CE}$	—	120	—	150	ns	$\overline{OE} = V_{IL}$
$\overline{OE}$ to output delay	$t_{OE}$	—	60	—	70	ns	$\overline{CE} = V_{IL}$
$\overline{OE}$ high to output float <sup>1</sup>	$t_{DF}$	0	40	0	50	ns	$\overline{CE} = V_{IL}$
Address to output hold	$t_{OH}$	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 fast high-reliability 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.

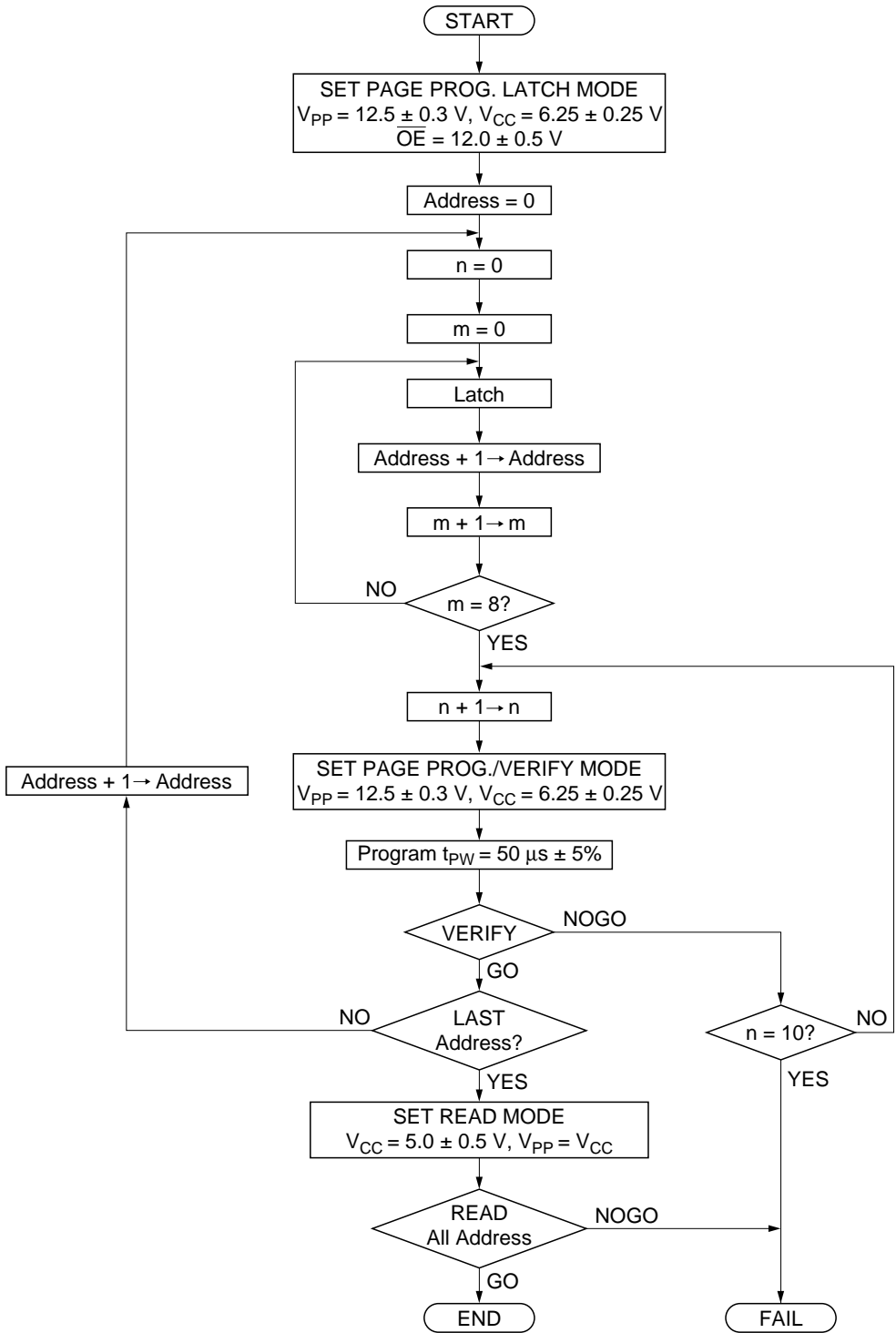
### **Page Program Set**

Apply 12 V to  $\overline{OE}$  pin after applying 12.5 V to  $V_{PP}$  to set a page program mode. The device operates in a page program mode until reset.

### **Page Program Reset**

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

Fast High-Reliability Page Programming Flowchart



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	$\mu\text{A}$	$V_{in} = 6.5 \text{ V}/0.45 \text{ V}$
$V_{PP}$ supply current	$I_{PP}$	—	—	70	$\text{mA}$	$\overline{CE} = V_{IL}$
Operating $V_{CC}$ current	$I_{CC}$	—	—	50	$\text{mA}$	
Input voltage	$V_{IL}$	$-0.1^{*5}$	—	0.8	$\text{V}$	
	$V_{IH}$	2.2	—	$V_{CC} + 0.5^{*6}$	$\text{V}$	
	$V_H$	11.5	12.0	12.5	$\text{V}$	
Output voltage during verify	$V_{OL}$	—	—	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  $\overline{CE} = \text{low}$ .
  - $V_{IL} \text{ min} = -0.6 \text{ V}$  for pulse width  $\leq 20 \text{ ns}$ .
  - If  $V_{IH}$  is over the specified maximum value, programming operation cannot be guaranteed.

# HN27C4001TT 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

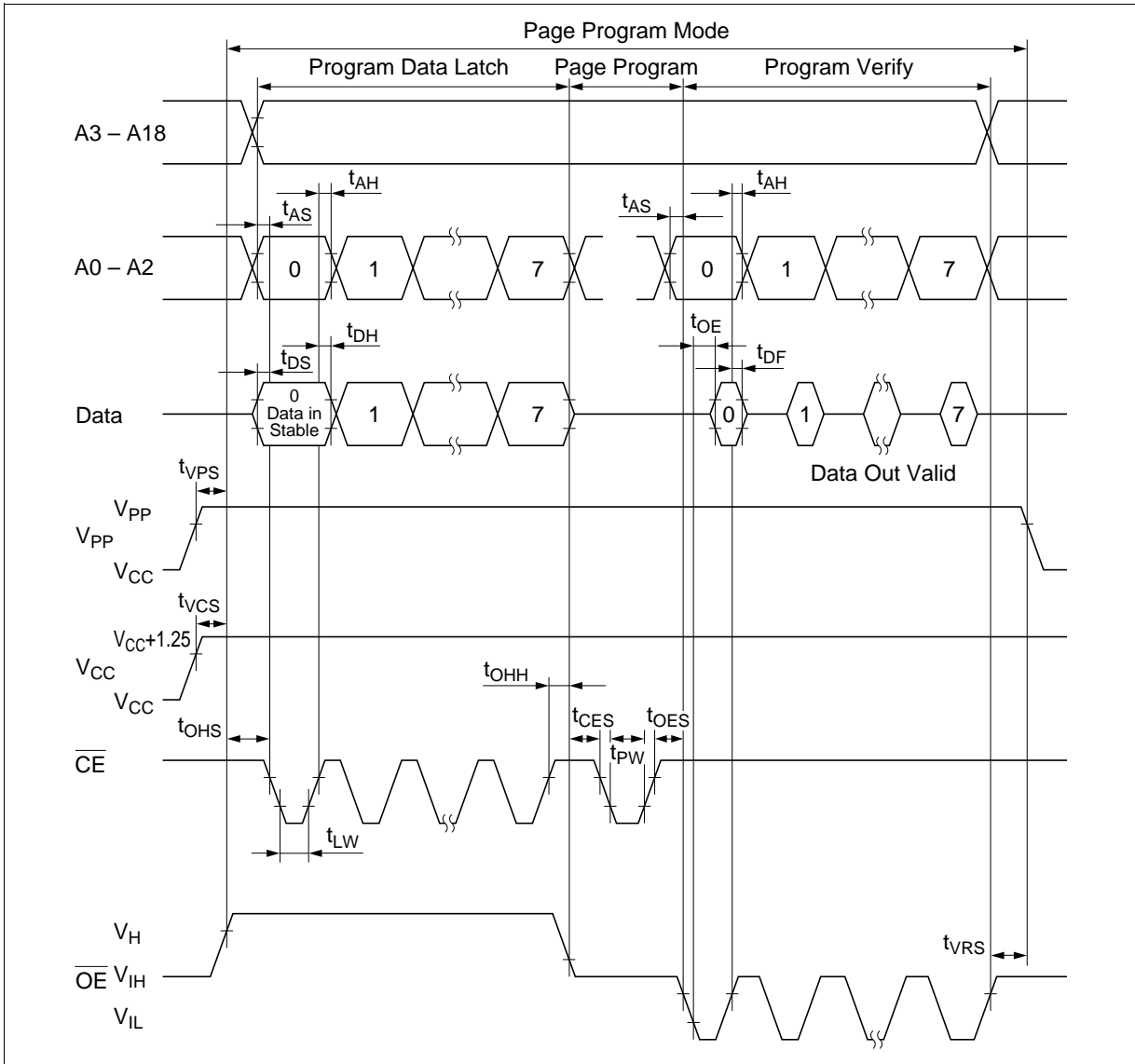
- Input pulse levels: 0.45 to 2.4 V
- Input rise and fall time:  $\leq 20 \text{ ns}$
- Reference levels for measuring timing: Inputs: 0.8 V, 2.0 V,  
Outputs: 0.8 V, 2.0 V

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	—	—	$\mu\text{s}$	
$\overline{OE}$ 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	—	—	$\mu\text{s}$	
$\overline{CE}$ initial 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 condition and data is no longer driven.

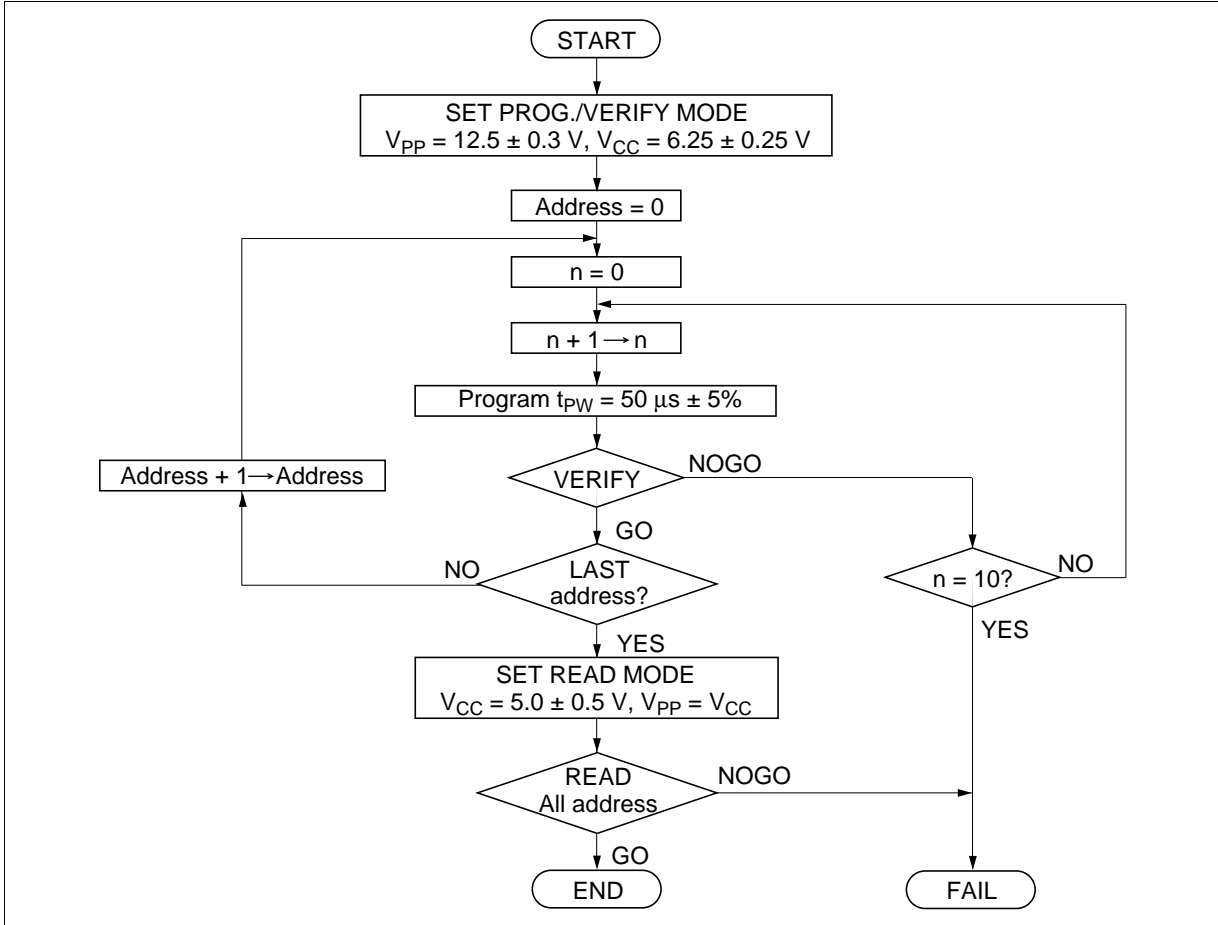
2. Page program mode will be reset when  $V_{PP}$  is set to  $V_{CC}$  or less.

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	$\mu\text{A}$	$V_{in} = 6.5\text{ V}/0.45\text{ V}$
Output voltage	$V_{OL}$	—	—	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	$V_{IL}$	$-0.1^{*5}$	—	0.8	V	
	$V_{IH}$	2.2	—	$V_{CC} + 0.5^{*6}$	V	
$V_{PP}$ supply current	$I_{PP}$	—	—	40	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  $\overline{CE} = \text{low}$ .
  - $V_{IL}$  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.

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

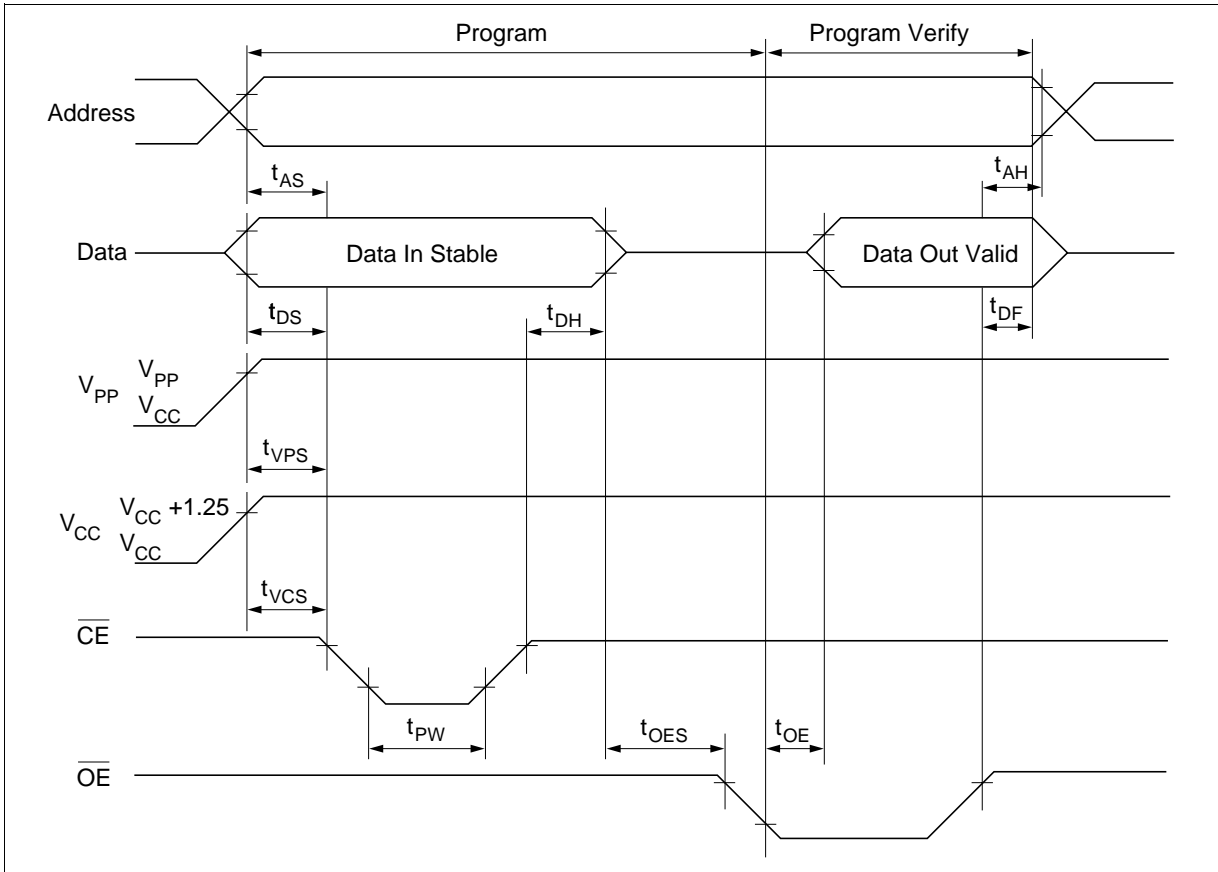
### Test Conditions

- Input pulse levels: 0.45 to 2.4 V
- Input rise and fall time:  $\leq 20\text{ ns}$
- Reference levels for measuring timings: 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	—	—	$\mu\text{s}$	
$\overline{OE}$ 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	—	—	$\mu\text{s}$	
$\overline{CE}$ initial programming pulse width	$t_{PW}$	47.5	50.0	52.5	$\mu\text{s}$	
Data valid from $\overline{OE}$	$t_{OE}$	0	—	150	ns	

- Note:
- $t_{DF}$  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

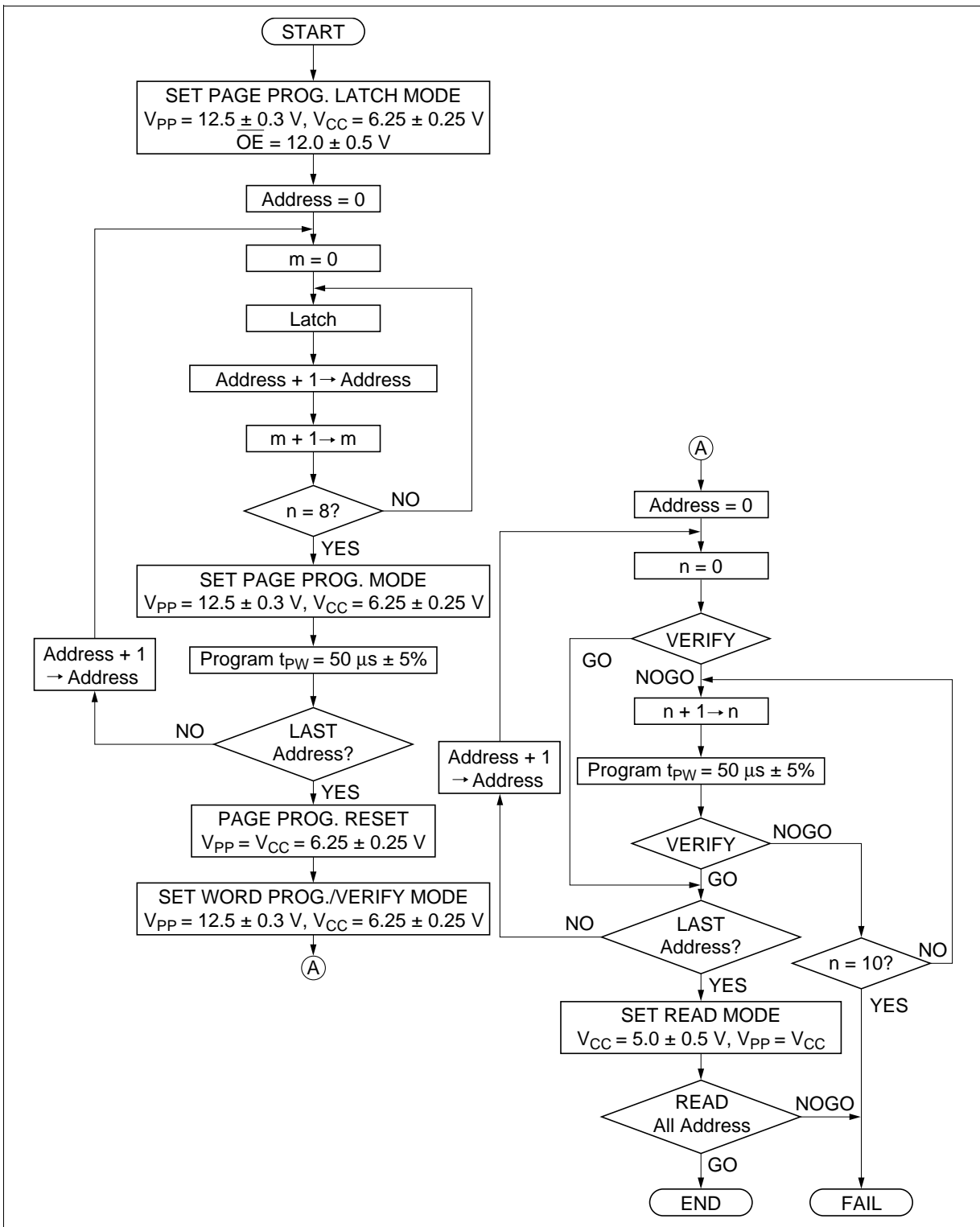


## Optional Page Programming

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

## HN27C4001TT Series

**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	$V_{IL}$	$-0.1^{*5}$	—	0.8	V	
	$V_{IH}$	2.2	—	$V_{CC} + 0.5^{*6}$	V	
	$V_H$	11.5	12.0	12.5	V	
$V_{PP}$ supply current	$I_{PP}$	—	—	70	mA	$\overline{CE} = V_{IL}$

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

**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**

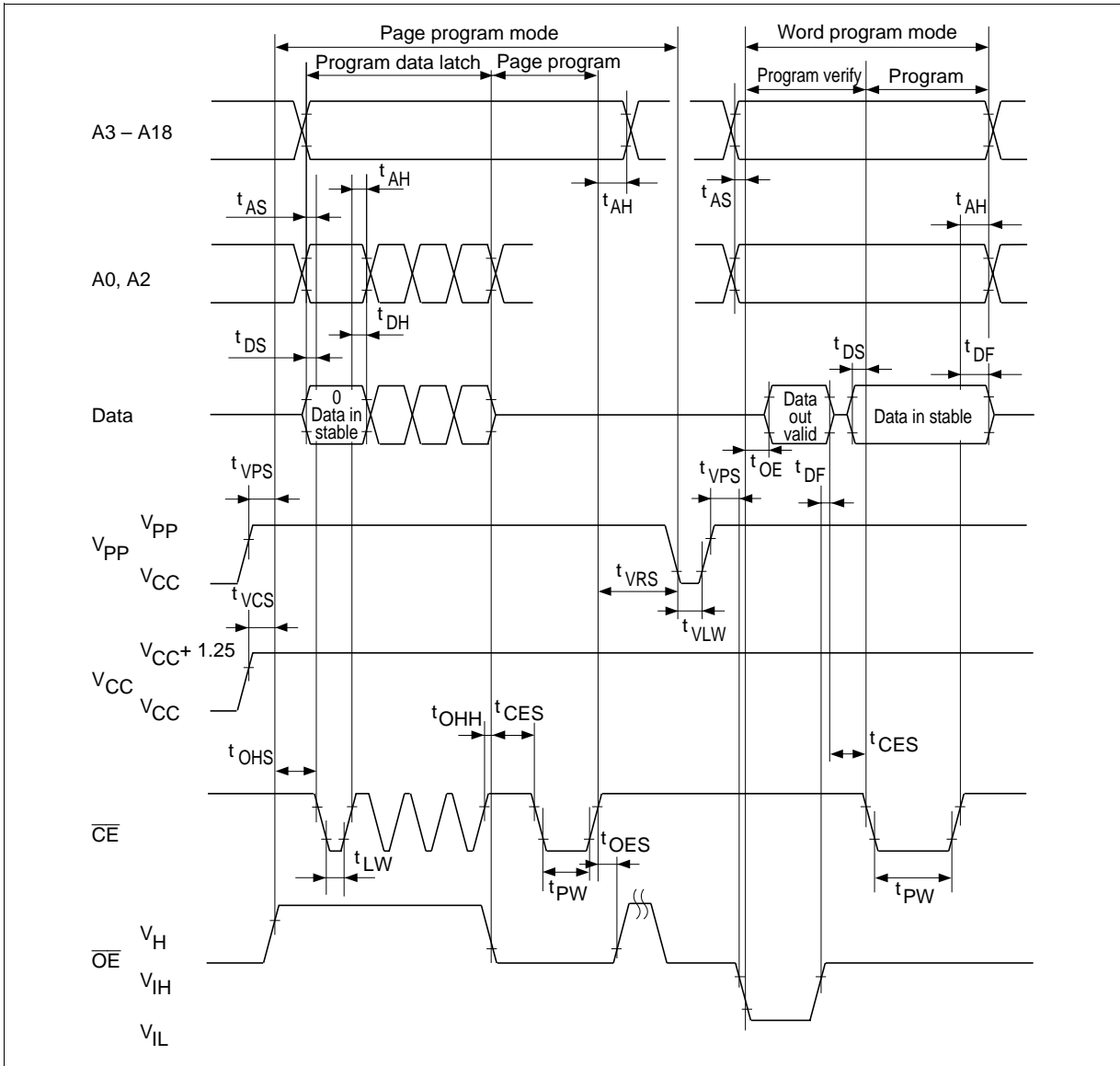
- Input pulse levels: 0.45 to 2.4 V
- Input rise and fall time:  $\leq 20 \text{ ns}$
- Reference levels for measuring timings: 0.8 V, 2.0 V

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	—	—	$\mu\text{s}$	
$\overline{OE}$ 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	—	—	$\mu\text{s}$	
$\overline{CE}$ initial 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.

## Optional Page Programming Timing Waveform



## Mode Description

### Device Identifier Mode

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

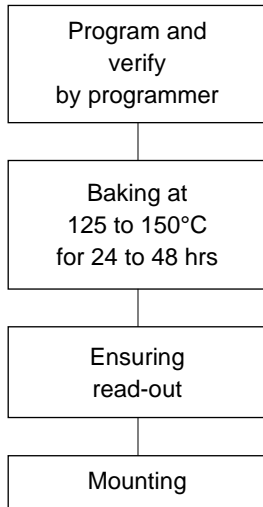
### HN27C4001TT Identifier Code

Identifier	A0 (12)	I/O7 (21)	I/O6 (20)	I/O5 (19)	I/O4 (18)	I/O3 (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.  $A9 = 12.0\text{ V} \pm 0.5\text{ V}$ .
  3.  $\overline{CE}, \overline{OE} = V_{IL}$ .
  4. A1 – A8, A10 – A18: Don't care.

## Recommended Screening Conditions

Before mounting, please make the screening (baking without bias) shown in the right.



Recommended  
Screening Conditions

# HN27C4001TT Series

## Package Dimensions

HN27C4001TT Series (TTP-32D)

Unit: mm

