



# MICROCHIP

# 24AA128/24LC128/24FC128

## 128K I<sup>2</sup>C™ CMOS Serial EEPROM

### Device Selection Table

Part Number	Vcc Range	Max. Clock Frequency	Temp. Ranges
24AA128	1.7-5.5V	400 kHz <sup>(1)</sup>	I
24LC128	2.5-5.5V	400 kHz	I, E
24FC128	1.7-5.5V	1 MHz <sup>(2)</sup>	I

**Note 1:** 100 kHz for Vcc < 2.5V.  
**Note 2:** 400 kHz for Vcc < 2.5V.

### Features:

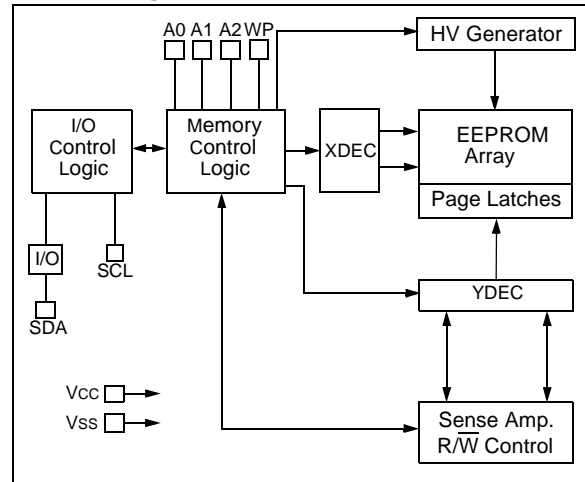
- Single supply with operation down to 1.7V for 24AA128/24FC128 devices, 2.5V for 24LC128 devices
- Low-Power CMOS Technology:
  - Write current 3 mA, typical
  - Standby current 100 nA, typical
- 2-Wire Serial Interface, I<sup>2</sup>C™ Compatible
- Cascadable up to Eight Devices
- Schmitt Trigger Inputs for Noise Suppression
- Output Slope Control to Eliminate Ground Bounce
- 100 kHz and 400 kHz Clock Compatibility
- 1 MHz Clock for FC Versions
- Page Write Time 5 ms, typical
- Self-Timed Erase/Write Cycle
- 64-Byte Page Write Buffer <adjust per device>
- Hardware Write-Protect
- ESD Protection >4000V
- More than 1 Million Erase/Write Cycles
- Data Retention > 200 years
- Factory Programming Available
- Packages include 8-lead PDIP, SOIC, TSSOP, DFN, MSOP, and Chip Scale Packages
- Pb-free and RoHS Compliant

- Temperature ranges:
  - Industrial (I): -40°C to +85°C
  - Automotive (E): -40°C to +125°C

### Description:

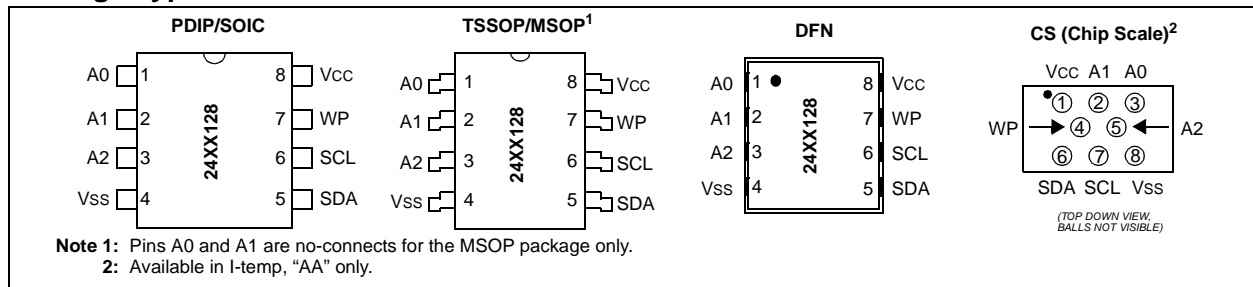
The Microchip Technology Inc. 24AA128/24LC128/24FC128 (24XX128\*) is a 16K x 8 (128 Kbit) Serial Electrically Erasable PROM (EEPROM), capable of operation across a broad voltage range (1.7V to 5.5V). It has been developed for advanced, low-power applications such as personal communications or data acquisition. This device also has a page write capability of up to 64 bytes of data. This device is capable of both random and sequential reads up to the 128K boundary. Functional address lines allow up to eight devices on the same bus, for up to 1 Mbit address space. This device is available in the standard 8-pin plastic DIP, SOIC (3.90 mm and 5.28 mm), TSSOP, MSOP, DFN, and Chip Scale packages.

### Block Diagram



\*24XX128 is used in this document as a generic part number for the 24AA128/24LC128/24FC128 devices.

### Package Types



# 24AA128/24LC128/24FC128

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings<sup>(†)</sup>

V <sub>CC</sub> .....	6.5V
All inputs and outputs w.r.t. V <sub>SS</sub> .....	-0.6V to V <sub>CC</sub> +1.0V
Storage temperature .....	-65°C to +150°C
Ambient temperature with power applied.....	-40°C to +125°C
ESD protection on all pins .....	≥ 4 kV

† NOTICE: 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 those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

**TABLE 1-1: DC CHARACTERISTICS**

DC CHARACTERISTICS			Electrical Characteristics:			
			Industrial (I): V <sub>CC</sub> = +1.7V to 5.5V TA = -40°C to +85°C			
			Automotive (E): V <sub>CC</sub> = +2.5V to 5.5V TA = -40°C to 125°C			
Param. No.	Sym.	Characteristic	Min.	Max.	Units	Conditions
D1	—	A0, A1, A2, SCL, SDA and WP pins:	—	—	—	—
D2	V <sub>IH</sub>	High-level input voltage	0.7 V <sub>CC</sub>	—	V	—
D3	V <sub>IL</sub>	Low-level input voltage	—	0.3 V <sub>CC</sub> 0.2 V <sub>CC</sub>	V V	V <sub>CC</sub> ≥ 2.5V V <sub>CC</sub> < 2.5V
D4	V <sub>HYS</sub>	Hysteresis of Schmitt Trigger inputs (SDA, SCL pins)	0.05 V <sub>CC</sub>	—	V	V <sub>CC</sub> ≥ 2.5V ( <b>Note 1</b> )
D5	V <sub>OL</sub>	Low-level output voltage	—	0.40	V	I <sub>OL</sub> = 3.0 mA @ V <sub>CC</sub> = 4.5V I <sub>OL</sub> = 2.1 mA @ V <sub>CC</sub> = 2.5V
D6	I <sub>LI</sub>	Input leakage current	—	±1	μA	V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> , WP = V <sub>SS</sub> V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> , WP = V <sub>CC</sub>
D7	I <sub>LO</sub>	Output leakage current	—	±1	μA	V <sub>OUT</sub> = V <sub>SS</sub> or V <sub>CC</sub>
D8	C <sub>IN</sub> , C <sub>OUT</sub>	Pin capacitance (all inputs/outputs)	—	10	pF	V <sub>CC</sub> = 5.0V ( <b>Note 1</b> ) TA = 25°C, F <sub>CLK</sub> = 1 MHz
D9	I <sub>CC</sub> Read	Operating current	—	400	μA	V <sub>CC</sub> = 5.5V, SCL = 400 kHz
	I <sub>CC</sub> Write		—	3	mA	V <sub>CC</sub> = 5.5V
D10	I <sub>CCS</sub>	Standby current	—	1	μA	TA = -40°C to +85°C SCL = SDA = V <sub>CC</sub> = 5.5V A0, A1, A2, WP = V <sub>SS</sub>
			—	5	μA	TA = -40°C to 125°C SCL = SDA = V <sub>CC</sub> = 5.5V A0, A1, A2, WP = V <sub>SS</sub>

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

# 24AA128/24LC128/24FC128

**TABLE 1-2: AC CHARACTERISTICS**

AC CHARACTERISTICS			Electrical Characteristics: Industrial (I): V <sub>CC</sub> = +1.7V to 5.5V TA = -40°C to +85°C Automotive (E): V <sub>CC</sub> = +2.5V to 5.5V TA = -40°C to 125°C			
Param. No.	Sym.	Characteristic	Min.	Max.	Units	Conditions
1	FCLK	Clock frequency	— — — —	100 400 400 1000	kHz	1.7V ≤ V <sub>CC</sub> < 2.5V 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 1.7V ≤ V <sub>CC</sub> < 2.5V 24FC128 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128
2	THIGH	Clock high time	4000 600 600 500	— — — —	ns	1.7V ≤ V <sub>CC</sub> < 2.5V 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 1.7V ≤ V <sub>CC</sub> < 2.5V 24FC128 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128
3	TLOW	Clock low time	4700 1300 1300 500	— — — —	ns	1.7V ≤ V <sub>CC</sub> < 2.5V 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 1.7V ≤ V <sub>CC</sub> < 2.5V 24FC128 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128
4	TR	SDA and SCL rise time (Note 1)	— — —	1000 300 300	ns	1.7V ≤ V <sub>CC</sub> < 2.5V 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 1.7V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128
5	TF	SDA and SCL fall time (Note 1)	— —	300 100	ns	All except, 24FC128 1.7V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128
6	THD:STA	Start condition hold time	4000 600 600 250	— — — —	ns	1.7V ≤ V <sub>CC</sub> < 2.5V 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 1.7V ≤ V <sub>CC</sub> < 2.5V 24FC128 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128
7	TSU:STA	Start condition setup time	4700 600 600 250	— — — —	ns	1.7V ≤ V <sub>CC</sub> < 2.5V 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 1.7V ≤ V <sub>CC</sub> < 2.5V 24FC128 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128
8	THD:DAT	Data input hold time	0	—	ns	(Note 2)
9	TSU:DAT	Data input setup time	250 100 100	— — —	ns	1.7V ≤ V <sub>CC</sub> < 2.5V 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 1.7V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128
10	TSU:STO	Stop condition setup time	4000 600 600 250	— — — —	ns	1.7V ≤ V <sub>CC</sub> < 2.5V 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 1.7V ≤ V <sub>CC</sub> < 2.5V 24FC128 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128
11	TSU:WP	WP setup time	4000 600 600	— — —	ns	1.7V ≤ V <sub>CC</sub> < 2.5V 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 1.7V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128
12	THD:WP	WP hold time	4700 1300 1300	— — —	ns	1.7V ≤ V <sub>CC</sub> < 2.5V 2.5V ≤ V <sub>CC</sub> ≤ 5.5V 1.7V ≤ V <sub>CC</sub> ≤ 5.5V 24FC128

**Note 1:** Not 100% tested. CB = total capacitance of one bus line in pF.

- 2:** As a transmitter, the device must provide an internal minimum delay time to bridge the undefined region (minimum 300 ns) of the falling edge of SCL to avoid unintended generation of Start or Stop conditions.
- 3:** The combined TSP and VHYS specifications are due to new Schmitt Trigger inputs, which provide improved noise spike suppression. This eliminates the need for a TI specification for standard operation.
- 4:** This parameter is not tested but ensured by characterization. For endurance estimates in a specific application, please consult the Total Endurance™ Model, which can be obtained from Microchip's web site

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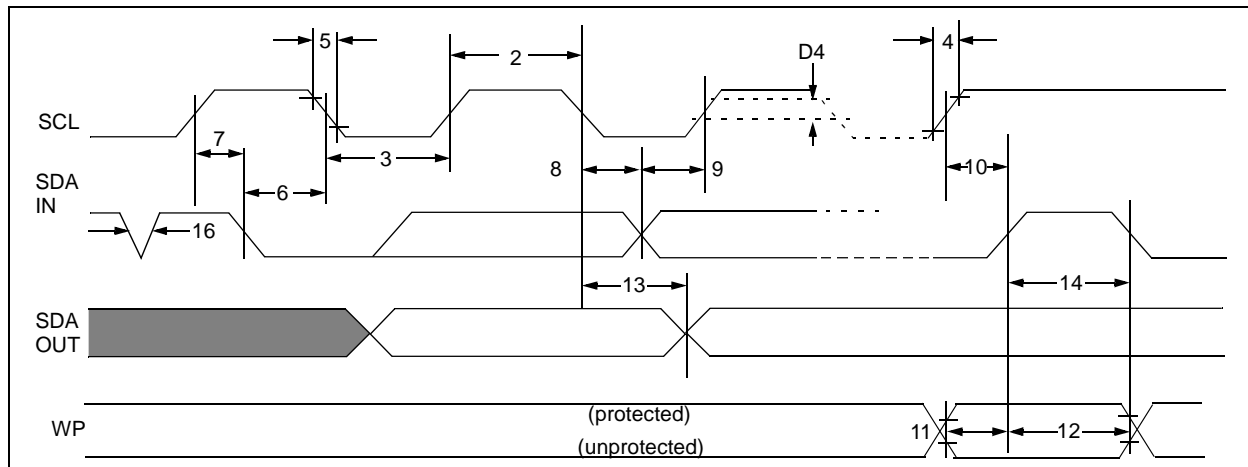
TABLE 1-2: AC CHARACTERISTICS (CONTINUED)

AC CHARACTERISTICS			Electrical Characteristics:			
			Industrial (I): $V_{CC} = +1.7V$ to $5.5V$ $T_A = -40^{\circ}C$ to $+85^{\circ}C$			
			Automotive (E): $V_{CC} = +2.5V$ to $5.5V$ $T_A = -40^{\circ}C$ to $125^{\circ}C$			
Param. No.	Sym.	Characteristic	Min.	Max.	Units	Conditions
13	TAA	Output valid from clock (Note 2)	— — — —	3500 900 900 400	ns	$1.7V \leq V_{CC} < 2.5V$ $2.5V \leq V_{CC} \leq 5.5V$ $1.7V \leq V_{CC} < 2.5V$ 24FC128 $2.5V \leq V_{CC} \leq 5.5V$ 24FC128
14	TBUF	Bus free time: Time the bus must be free before a new transmission can start	4700 1300 1300 500	— — — —	ns	$1.7V \leq V_{CC} < 2.5V$ $2.5V \leq V_{CC} \leq 5.5V$ $1.7V \leq V_{CC} < 2.5V$ 24FC128 $2.5V \leq V_{CC} \leq 5.5V$ 24FC128
15	TOF	Output fall time from $V_{IH}$ minimum to $V_{IL}$ maximum $C_B \leq 100$ pF	$10 + 0.1C_B$	250 250	ns	All except, 24FC128 (Note 1) 24FC128 (Note 1)
16	TSP	Input filter spike suppression (SDA and SCL pins)	—	50	ns	All except, 24FC128 (Notes 1 and 3)
17	TWC	Write cycle time (byte or page)	—	5	ms	—
18	—	Endurance	1,000,000	—	cycles	$25^{\circ}C$ (Note 4)

Note 1: Not 100% tested.  $C_B$  = total capacitance of one bus line in pF.

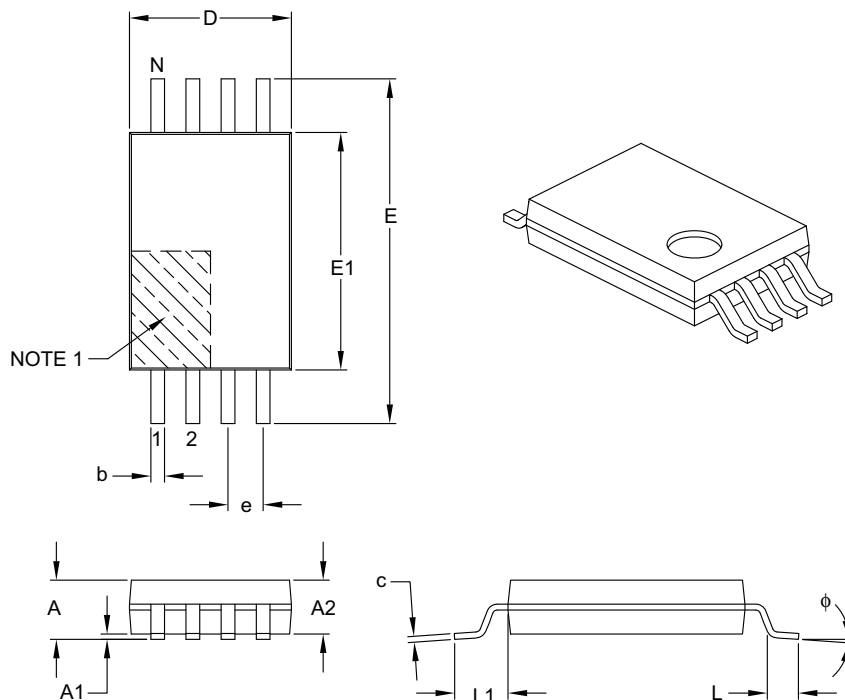
- 2: As a transmitter, the device must provide an internal minimum delay time to bridge the undefined region (minimum 300 ns) of the falling edge of SCL to avoid unintended generation of Start or Stop conditions.
- 3: The combined TSP and  $V_{HYS}$  specifications are due to new Schmitt Trigger inputs, which provide improved noise spike suppression. This eliminates the need for a TI specification for standard operation.
- 4: This parameter is not tested but ensured by characterization. For endurance estimates in a specific application, please consult the Total Endurance™ Model, which can be obtained from Microchip's web site at [www.microchip.com](http://www.microchip.com).

FIGURE 1-1: BUS TIMING DATA



# 24AA128/24LC128/24FC128

## 8-Lead Plastic Thin Shrink Small Outline (ST) – 4.4 mm Body [TSSOP]



Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Pins	N	8		
Pitch	e	0.65 BSC		
Overall Height	A	–	–	1.20
Molded Package Thickness	A2	0.80	1.00	1.05
Standoff	A1	0.05	–	0.15
Overall Width	E	6.40 BSC		
Molded Package Width	E1	4.30	4.40	4.50
Molded Package Length	D	2.90	3.00	3.10
Foot Length	L	0.45	0.60	0.75
Footprint	L1	1.00 REF		
Foot Angle	$\phi$	0°	–	8°
Lead Thickness	c	0.09	–	0.20
Lead Width	b	0.19	–	0.30

### Notes:

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
- Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-086B

# 24AA128/24LC128/24FC128

## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

<u>PART NO.</u>	<u>X</u>	<u>XX</u>	<b>Examples:</b>
Device	Temperature Range	Package	
<b>Device:</b>			
24AA128:	128 Kbit 1.7V I <sup>2</sup> C Serial EEPROM		a) 24AA128-I/P: Industrial Temp., 1.7V, PDIP package.
24AA128T:	128 Kbit 1.7V I <sup>2</sup> C Serial EEPROM (Tape and Reel)		b) 24AA128T-I/SN: Tape and Reel, Industrial Temp., 1.7V, SOIC package.
24LC128:	128 Kbit 2.5V I <sup>2</sup> C Serial EEPROM		c) 24AA128-I/ST: Industrial Temp., 1.7V, TSSOP package.
24LC128T:	128 Kbit 2.5V I <sup>2</sup> C Serial EEPROM (Tape and Reel)		d) 24AA128-I/MS: Industrial Temp., 1.7V, MSOP package.
24FC128:	128 Kbit High Speed I <sup>2</sup> C Serial EEPROM		e) 24LC128-E/P: Extended Temp., 2.5V, PDIP package.
24FC128T:	128 Kbit High Speed I <sup>2</sup> C Serial EEPROM (Tape and Reel)		f) 24LC128-I/SN: Industrial Temp., 2.5V, SOIC package.
<b>Temperature Range:</b>			g) 24LC128T-I/SN: Tape and Reel, Industrial Temp., 2.5V, SOIC package.
I	= -40°C to +85°C		h) 24LC128-I/MS: Industrial Temp., 2.5V, MSOP package.
E	= -40°C to +125°C		i) 24FC128-I/P: Industrial Temp., 1.7V, High Speed, PDIP package.
<b>Package:</b>			j) 24FC128-I/SN: Industrial Temp., 1.7V, High Speed, SOIC package.
P	= Plastic DIP (300 mil body), 8-lead		k) 24FC128T-I/SN: Tape and Reel, Industrial Temp., 1.7V, High Speed, SOIC package
SN	= Plastic SOIC (3.90 mm body), 8-lead		l) 24AA128T-I/CS15K: Industrial Temp., 1.7V, CS package, Tape and Reel
SM	= Plastic SOIC (5.28 mm body), 8-lead		
ST	= Plastic TSSOP (4.4 mm), 8-lead		
MF	= Dual, Flat, No Lead (DFN) (6x5 mm body), 8-lead		
MS	= Plastic Micro Small Outline (MSOP), 8-lead		
CS15K <sup>(1)</sup>	= Chip Scale (CS), 8-lead (I-temp, "AA", Tape and Reel only)		
<b>Note 1:</b> "15K" indicates 150K technology			