# MICROCHIP 24AA128/24LC128/24FC128

## 128K I²C™ CMOS Serial EEPROM

### Device Selection Table

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

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

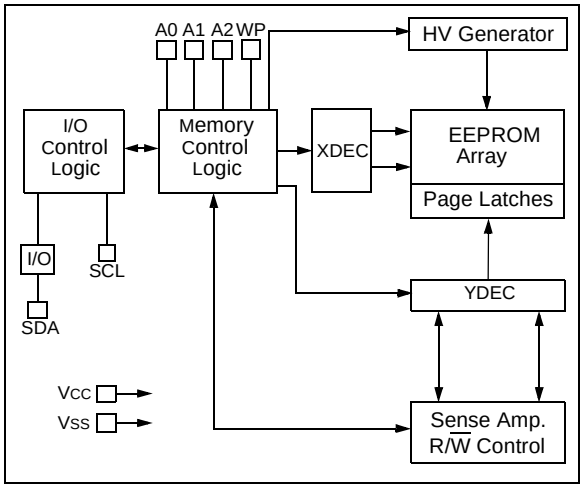
### Features:

- 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, I²C™ 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:

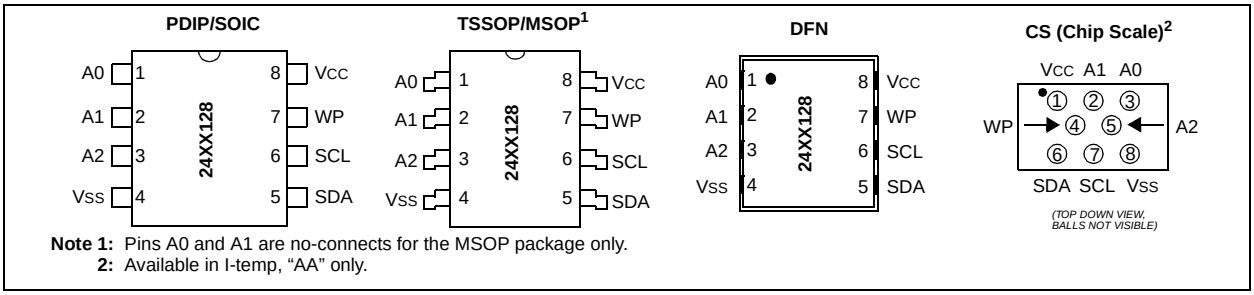
The Microchip Technology Inc. 24AA128/24LC128/24FC128 (24XX128*) is a 16K x 8 (128 Kbit) Serial Electrically Erasable PROM (EEPROM), capable of operation across a broad voltage range (1.7V to 5.5V). It has been developed for advanced, low-power applications such as personal communications or data acquisition. 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




**Note 1:** Pins A0 and A1 are no-connects for the MSOP package only.
**2:** Available in I-temp, "AA" only.

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings(†)

VCC.....6.5V

All inputs and outputs w.r.t. VSS ..... -0.6V to VCC +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:**<br>Industrial (I): VCC = +1.7V to 5.5V TA = -40°C to +85°C<br>Automotive (E): VCC = +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 | VIH | High-level input voltage | 0.7 VCC | — | V | — |
| D3 | VIL | Low-level input voltage | — | 0.3 VCC<br>0.2 VCC | V<br>V | VCC ≥ 2.5V<br>VCC < 2.5V |
| D4 | VHYS | Hysteresis of Schmitt Trigger inputs (SDA, SCL pins) | 0.05 VCC | — | V | VCC ≥ 2.5V **(Note 1)** |
| D5 | VOL | Low-level output voltage | — | 0.40 | V | IOL = 3.0 mA @ VCC = 4.5V<br>IOL = 2.1 mA @ VCC = 2.5V |
| D6 | ILI | Input leakage current | — | ±1 | µA | VIN = VSS or VCC, WP = VSS<br>VIN = VSS or VCC, WP = VCC |
| D7 | ILO | Output leakage current | — | ±1 | µA | VOUT = VSS or VCC |
| D8 | CIN,<br>COUT | Pin capacitance (all inputs/outputs) | — | 10 | pF | VCC = 5.0V **(Note 1)**<br>TA = 25°C, FCLK = 1 MHz |
| D9 | ICC Read | Operating current | — | 400 | µA | VCC = 5.5V, SCL = 400 kHz |
| | ICC Write | | — | 3 | mA | VCC = 5.5V |
| D10 | ICCS | Standby current | — | 1 | µA | TA = -40°C to +85°C<br>SCL = SDA = VCC = 5.5V<br>A0, A1, A2, WP = VSS |
| | | | — | 5 | µA | TA = -40°C to 125°C<br>SCL = SDA = VCC = 5.5V<br>A0, A1, A2, WP = VSS |

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

**TABLE 1-2: AC CHARACTERISTICS**

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

**TABLE 1-2: AC CHARACTERISTICS (CONTINUED)**

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

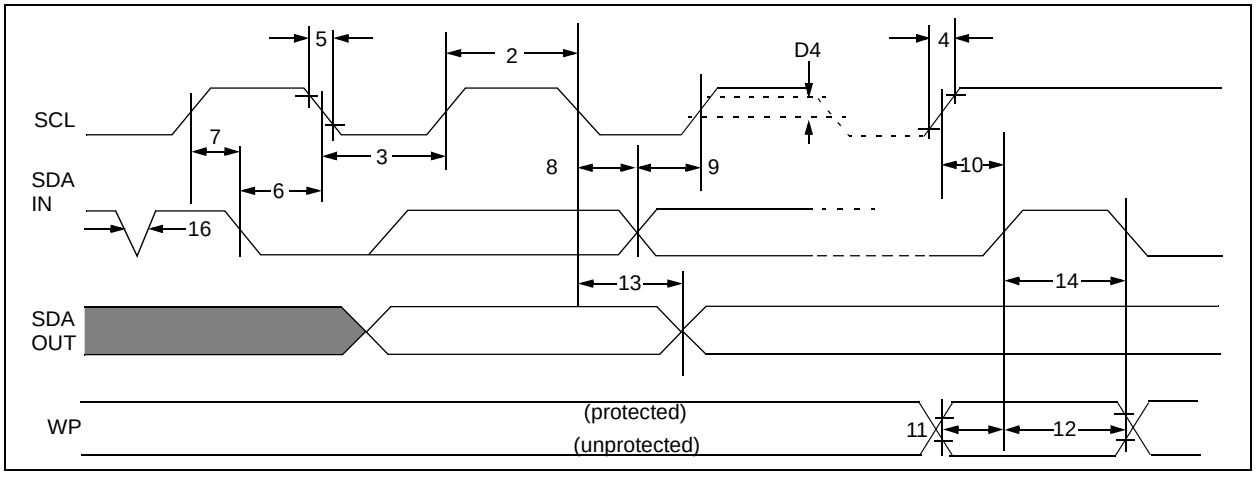
**Note 1:** Not 100% tested. $C_B$ = total capacitance of one bus line in pF.

**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.

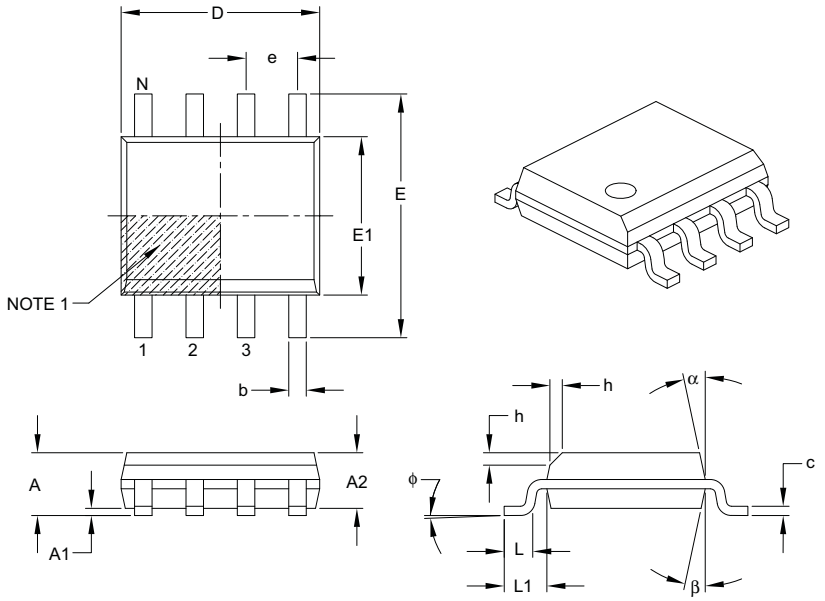
**3:** The combined $T_{SP}$ and $V_{HYS}$ specifications are due to new Schmitt Trigger inputs, which provide improved noise spike suppression. This eliminates the need for a $T_I$ specification for standard operation.

**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.

**FIGURE 1-1: BUS TIMING DATA**



## 8-Lead Plastic Small Outline (SN) – Narrow, 3.90 mm Body [SOIC]




| Units | | MILLIMETERS | | |
|---|---|---|---|---|
| Dimension Limits | | MIN | NOM | MAX |
| Number of Pins | N | | 8 | |
| Pitch | e | | 1.27 BSC | |
| Overall Height | A | – | – | 1.75 |
| Molded Package Thickness | A2 | 1.25 | – | – |
| Standoff § | A1 | 0.10 | – | 0.25 |
| Overall Width | E | | 6.00 BSC | |
| Molded Package Width | E1 | | 3.90 BSC | |
| Overall Length | D | | 4.90 BSC | |
| Chamfer (optional) | h | 0.25 | – | 0.50 |
| Foot Length | L | 0.40 | – | 1.27 |
| Footprint | L1 | | 1.04 REF | |
| Foot Angle | φ | 0° | – | 8° |
| Lead Thickness | c | 0.17 | – | 0.25 |
| Lead Width | b | 0.31 | – | 0.51 |
| Mold Draft Angle Top | α | 5° | – | 15° |
| Mold Draft Angle Bottom | β | 5° | – | 15° |

**Notes:**

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic.
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
4. 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 C04-057B

## PRODUCT IDENTIFICATION SYSTEM

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

| PART NO. | X | /XX |
|---|---|---|
| Device | Temperature Range | Package |

| | | | |
|---|---|---|---|
| **Device:** | 24AA128: | | 128 Kbit 1.7V $I^2C$ Serial EEPROM |
| | 24AA128T: | | 128 Kbit 1.7V $I^2C$ Serial EEPROM (Tape and Reel) |
| | 24LC128: | | 128 Kbit 2.5V $I^2C$ Serial EEPROM |
| | 24LC128T: | | 128 Kbit 2.5V $I^2C$ Serial EEPROM (Tape and Reel) |
| | 24FC128: | | 128 Kbit High Speed $I^2C$ Serial EEPROM |
| | 24FC128T: | | 128 Kbit High Speed $I^2C$ Serial EEPROM (Tape and Reel) |
| **Temperature Range:** | I | = | -40°C to +85°C |
| | E | = | -40°C to +125°C |
| **Package:** | P | = | Plastic DIP (300 mil body), 8-lead |
| | SN | = | Plastic SOIC (3.90 mm body), 8-lead |
| | 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(1) | = | Chip Scale (CS), 8-lead (I-temp, **"**AA**"**, Tape and Reel only) |

**Note 1: "**15K**"** indicates 150K technology

**Examples:**

a) 24AA128-I/P: Industrial Temp., 1.7V, PDIP package.

b) 24AA128T-I/SN: Tape and Reel, Industrial Temp., 1.7V, SOIC package.

c) 24AA128-I/ST: Industrial Temp., 1.7V, TSSOP package.

d) 24AA128-I/MS: Industrial Temp., 1.7V, MSOP package.

e) 24LC128-E/P: Extended Temp., 2.5V, PDIP package.

f) 24LC128-I/SN: Industrial Temp., 2.5V, SOIC package.

g) 24LC128T-I/SN: Tape and Reel, Industrial Temp., 2.5V, SOIC package.

h) 24LC128-I/MS: Industrial Temp., 2.5V, MSOP package.

i) 24FC128-I/P: Industrial Temp., 1.7V, High Speed, PDIP package.

j) 24FC128-I/SN: Industrial Temp., 1.7V, High Speed, SOIC package.

k) 24FC128T-I/SN: Tape and Reel, Industrial Temp., 1.7V, High Speed, SOIC package

l) 24AA128T-I/CS15K:Industrial Temp., 1.7V, CS package, Tape and Reel