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.
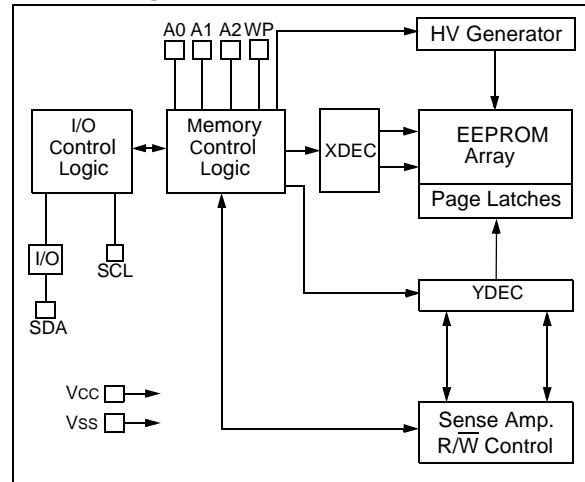 **2:** 400 kHz for Vcc < 2.5V.

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
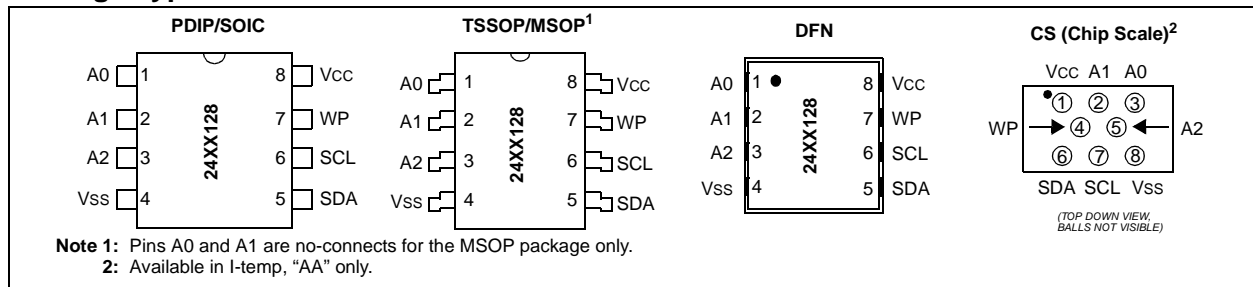 - Automotive (E):   -40°C to +125°C

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.

24AA128/24LC128/24FC128

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	$\geq$ 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): VCC = +1.7V to 5.5V TA = -40°C to +85°C 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 0.2 VCC	V V	VCC $\geq$ 2.5V VCC < 2.5V	
D4	VHYS	Hysteresis of Schmitt Trigger inputs (SDA, SCL pins)	0.05 VCC	—	V	VCC $\geq$ 2.5V **(Note 1)**	
D5	VOL	Low-level output voltage	—	0.40	V	IOL = 3.0 mA @ VCC = 4.5V IOL = 2.1 mA @ VCC = 2.5V	
D6	ILI	Input leakage current	—	±1	µA	VIN = VSS or VCC, WP = VSS VIN = VSS or VCC, WP = VCC	
D7	ILO	Output leakage current	—	±1	µA	VOUT = VSS or VCC	
D8	CIN, COUT	Pin capacitance (all inputs/outputs)	—	10	pF	VCC = 5.0V **(Note 1)** 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 SCL = SDA = VCC = 5.5V A0, A1, A2, WP = VSS	
			—	5	µA	TA = -40°C to 125°C SCL = SDA = VCC = 5.5V 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: 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
1	F_{CLK}	Clock frequency	— — — —	100 400 400 1000	kHz	$1.7V \leq V_{CC} < 2.5V$ $2.5V \leq V_{CC} \leq 5.5V$ $1.7V \leq V_{CC} < 2.5V$ 24FC128 $2.5V \leq V_{CC} \leq 5.5V$ 24FC128
2	T_{HIGH}	Clock high time	4000 600 600 500	— — — —	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
3	T_{LOW}	Clock low time	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
4	T_R	SDA and SCL rise time **(Note 1)**	— — —	1000 300 300	ns	$1.7V \leq V_{CC} < 2.5V$ $2.5V \leq V_{CC} \leq 5.5V$ $1.7V \leq V_{CC} \leq 5.5V$ 24FC128
5	T_F	SDA and SCL fall time **(Note 1)**	— —	300 100	ns	All except, 24FC128 $1.7V \leq V_{CC} \leq 5.5V$ 24FC128
6	$T_{HD:STA}$	Start condition hold time	4000 600 600 250	— — — —	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
7	$T_{SU:STA}$	Start condition setup time	4700 600 600 250	— — — —	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
8	$T_{HD:DAT}$	Data input hold time	0	—	ns	**(Note 2)**
9	$T_{SU:DAT}$	Data input setup time	250 100 100	— — —	ns	$1.7V \leq V_{CC} < 2.5V$ $2.5V \leq V_{CC} \leq 5.5V$ $1.7V \leq V_{CC} \leq 5.5V$ 24FC128
10	$T_{SU:STO}$	Stop condition setup time	4000 600 600 250	— — — —	ns	$1.7 V \leq V_{CC} < 2.5V$ $2.5 V \leq V_{CC} \leq 5.5V$ $1.7V \leq V_{CC} < 2.5V$ 24FC128 $2.5 V \leq V_{CC} \leq 5.5V$ 24FC128
11	$T_{SU:WP}$	WP setup time	4000 600 600	— — —	ns	$1.7V \leq V_{CC} < 2.5V$ $2.5V \leq V_{CC} \leq 5.5V$ $1.7V \leq V_{CC} < 2.5V$ 24FC128
12	$T_{HD:WP}$	WP hold time	4700 1300 1300	— — —	ns	$1.7V \leq V_{CC} < 2.5V$ $2.5V \leq V_{CC} \leq 5.5V$ $1.7V \leq V_{CC} < 2.5V$ 24FC128

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
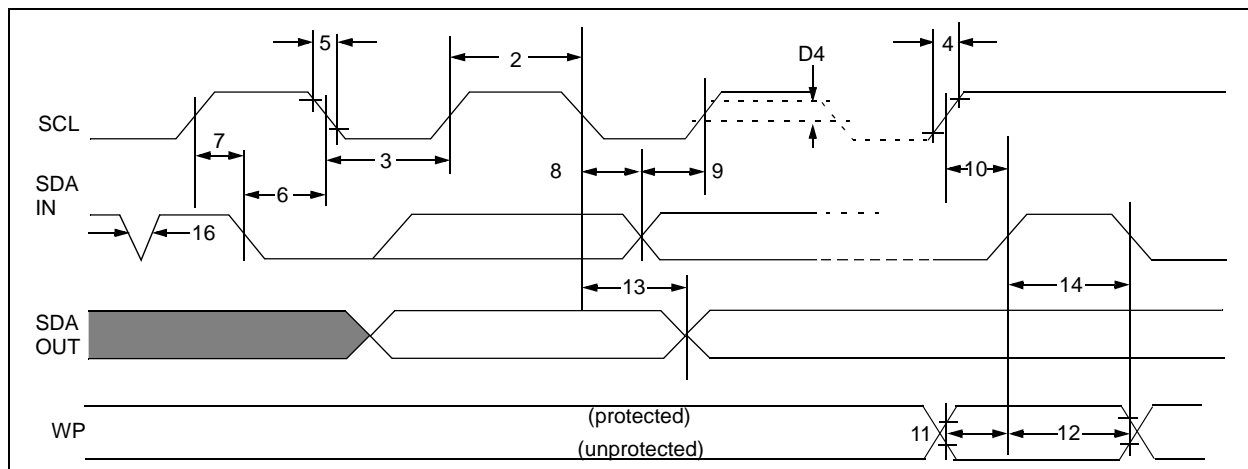
24AA128/24LC128/24FC128

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)**	— — — —	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	T_{BUF}	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	T_{OF}	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	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)**

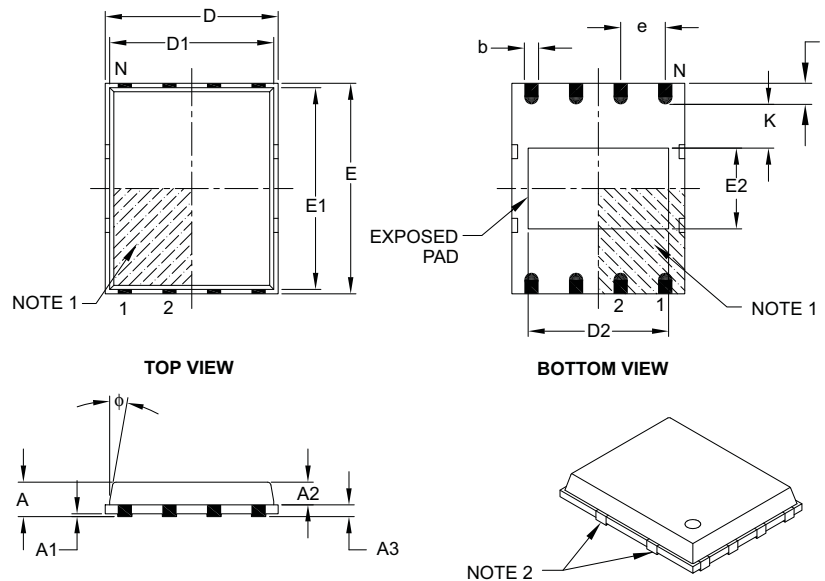**Note 1:** Not 100% tested. C_B = total capacitance of one bus line in pF.

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

FIGURE 1-1: BUS TIMING DATA

24AA128/24LC128/24FC128

8-Lead Plastic Dual Flat, No Lead Package (MF) – 6x5 mm Body [DFN-S]
PUNCH SINGULATED

TOP VIEW

BOTTOM VIEW

	Units	MILLIMETERS		
	Dimension Limits	MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		1.27 BSC	
Overall Height	A	–	0.85	1.00
Molded Package Thickness	A2	–	0.65	0.80
Standoff	A1	0.00	0.01	0.05
Base Thickness	A3		0.20 REF	
Overall Length	D		4.92 BSC	
Molded Package Length	D1		4.67 BSC	
Exposed Pad Length	D2	3.85	4.00	4.15
Overall Width	E		5.99 BSC	
Molded Package Width	E1		5.74 BSC	
Exposed Pad Width	E2	2.16	2.31	2.46
Contact Width	b	0.35	0.40	0.47
Contact Length	L	0.50	0.60	0.75
Contact-to-Exposed Pad	K	0.20	–	–
Model Draft Angle Top	φ	–	–	12°

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package may have one or more exposed tie bars at ends.
3. 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 C04-113B

© 2008 Microchip Technology Inc.

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^{2}C Serial EEPROM	
24AA128T:	128 Kbit 1.7V I^{2}C Serial EEPROM (Tape and Reel)	
24LC128:	128 Kbit 2.5V I^{2}C Serial EEPROM	
24LC128T:	128 Kbit 2.5V I^{2}C Serial EEPROM (Tape and Reel)	
24FC128:	128 Kbit High Speed I^{2}C Serial EEPROM	
24FC128T:	128 Kbit High Speed I^{2}C 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