MICROCHIP 24AA16H/24LC16BH/24FC16H

16K I²C Serial EEPROM with Half-Array Write-Protect

Device Selection Table

Part Number	Vcc Range	Max. Clock Frequency	Temp. Ranges	Available Packages
24AA16H	1.7V-5.5V	400 kHz(1)	I, E	MS, P, SN, MNY, ST, OT
24LC16BH	2.5V-5.5V	400 kHz	I, E	MS, P, SN, MNY, ST, OT
24FC16H	1.7V-5.5V	1 MHz	I, E	SN, OT

Note 1: 100 kHz for VCC < 2.5V.

Features

- Single Supply with Operation Down to 1.7V for 24AA16H and 24FC16H Devices, 2.5V for 24LC16BH Devices
- Low-Power CMOS Technology:
  - Read current 1 mA, maximum
  - Standby current 1 µA, maximum (I-temp.)
- Two-Wire Serial Interface, I²C Compatible
- Schmitt Trigger Inputs for Noise Suppression
- Output Slope Control to Eliminate Ground Bounce
- 100 kHz, 400 kHz and 1 MHz Compatibility
- Page Write Time: 5 ms, Maximum
- Self-Timed Erase/Write Cycle
- 16-Byte Page Write Buffer
- Hardware Write-Protect for Half-Array (400h-7FFh)
- ESD Protection >4,000V
- More than 1 Million Erase/Write Cycles
- Data Retention >200 Years
- Factory Programming Available
- RoHS Compliant
- Temperature Ranges:
  - Industrial (I): -40°C to +85°C
  - Extended (E): -40°C to +125°C
- Automotive AEC-Q100 Qualified

Packages

- 8-Lead MSOP, 8-Lead PDIP, 8-Lead SOIC, 8-Lead TDFN, 8-Lead TSSOP and 5-Lead SOT-23

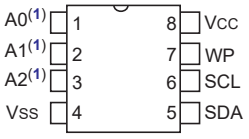
Description

The Microchip Technology Inc. 24XX16H(1) is a 16-Kbit Electrically Erasable PROM. The device is organized as eight blocks of 256 x 8-bit memory with a two-wire serial interface. Its low-voltage design permits operation down to 1.7V with standby and active currents of only 1 µA and 1 mA, respectively. The 24XX16H also has a page write capability for up to 16 bytes of data.

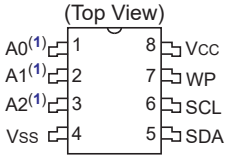
Note 1: 24XX16H is used in this document as a generic part number for the 24AA16H/24LC16BH/24FC16H devices.

Package Types

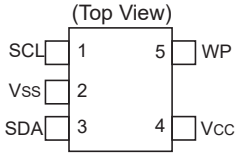
8-Lead MSOP/PDIP
(Top View)



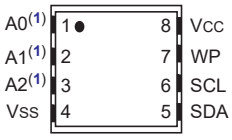
8-Lead SOIC/TSSOP
(Top View)



5-Lead SOT-23
(Top View)

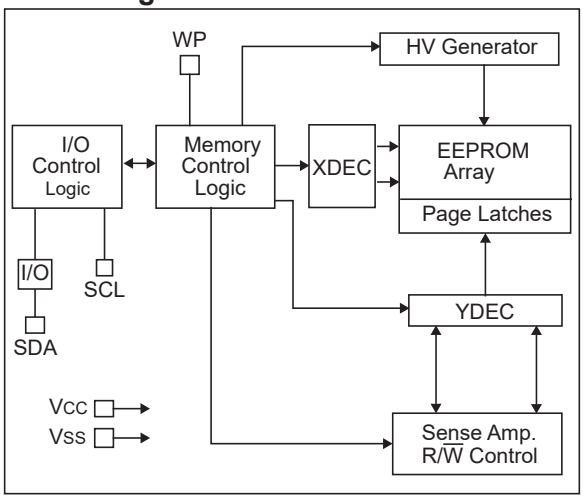


8-Lead TDFN
(Top View)



Note 1: Pins A0, A1 and A2 are not used by the 24XX16H (no internal connections).

Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings (†)

VCC.....6.5V

All inputs and outputs w.r.t. VSS ..... -0.3V 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			Industrial (I): TA = -40°C to +85°C, VCC = +1.7V to +5.5V Extended (E): TA = -40°C to +125°C, VCC = +2.5V to +5.5V (24LC16BH) Extended (E): TA = -40°C to +125°C, VCC = +1.7V to +5.5V (24FC16H)				
Param. No.	**Symbol**	**Characteristic**	**Min.**	**Typical**	**Max.**	**Units**	**Conditions**
D1	VIH	High-Level Input Voltage	0.7 VCC	—	—	V	
D2	VIL	Low-Level Input Voltage	—	—	0.3 VCC	V	
D3	VHYS	Hysteresis of Schmitt Trigger Inputs	0.05 VCC	—	—	V	**Note**
D4	VOL	Low-Level Output Voltage	—	—	0.40	V	IOL = 3.0 mA, VCC = 2.5V
D5	ILI	Input Leakage Current	—	—	±1	µA	VIN = VSS or VCC
D6	ILO	Output Leakage Current	—	—	±1	µA	VOUT = VSS or VCC
D7	CIN, COUT	Pin Capacitance (all inputs/outputs)	—	—	10	pF	VCC = 5.0V (**Note**) TA = 25°C, FCLK = 1 MHz
D8	ICCWRITE	Operating Current	—	—	3	mA	VCC = 5.5V, SCL = 400 kHz
D9	ICCREAD		—	—	1	mA	VCC = 5.5V, SCL = 400 kHz
D10	ICCS	Standby Current	—	—	1	µA	SDA = SCL = VCC WP = VSS, I-Temp.
			—	—	3	µA	SDA = SCL = VCC WP = VSS, E-Temp. (**24FC16H**)
			—	—	5	µA	SDA = SCL = VCC WP = VSS, E-Temp. (**24LC16BH**)

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

TABLE 1-2: AC CHARACTERISTICS

AC CHARACTERISTICS			Industrial (I): TA = -40°C to +85°C, VCC = +1.7V to +5.5V Extended (E): TA = -40°C to +125°C, VCC = +2.5V to +5.5V (24LC16BH) Extended (E): TA = -40°C to +125°C, VCC = +1.7V to +5.5V (24FC16H)			
Param. No.	**Symbol**	**Characteristic**	**Min.**	**Max.**	**Units**	**Conditions**
1	FCLK	Clock Frequency	—	400	kHz	2.5V ≤ VCC ≤ 5.5V
			—	100	kHz	1.7V ≤ VCC < 2.5V (**24AA16H**)
			—	1000	kHz	1.7V ≤ VCC ≤ 5.5V (**24FC16H**)
2	THIGH	Clock High Time	600	—	ns	2.5V ≤ VCC ≤ 5.5V
			4000	—	ns	1.7V ≤ VCC < 2.5V (**24AA16H**)
			260	—	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**)
3	TLOW	Clock Low Time	1300	—	ns	2.5V ≤ VCC ≤ 5.5V
			4700	—	ns	1.7V ≤ VCC < 2.5V (**24AA16H**)
			500	—	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**)
4	TR	SDA and SCL Rise Time	—	300	ns	2.5V ≤ VCC ≤ 5.5V (**Note 1**)
			—	1000	ns	1.7V ≤ VCC < 2.5V (**24AA16H**) (**Note 1**)
			—	1000	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**) (**Note 1**)
5	TF	SDA and SCL Fall Time	—	300	ns	**Note 1**
6	THD:STA	Start Condition Hold Time	600	—	ns	2.5V ≤ VCC ≤ 5.5V
			4000	—	ns	1.7V ≤ VCC < 2.5V (**24AA16H**)
			250	—	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**)
7	TSU:STA	Start Condition Setup Time	600	—	ns	2.5V ≤ VCC ≤ 5.5V
			4700	—	ns	1.7V ≤ VCC < 2.5V (**24AA16H**)
			250	—	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**)
8	THD:DAT	Data Input Hold Time	0	—	ns	**Note 2**
9	TSU:DAT	Data Input Setup Time	100	—	ns	2.5V ≤ VCC ≤ 5.5V
			250	—	ns	1.7V ≤ VCC < 2.5V (**24AA16H**)
			50	—	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**)
10	TSU:STO	Stop Condition Setup Time	600	—	ns	2.5V ≤ VCC ≤ 5.5V
			4000	—	ns	1.7V ≤ VCC < 2.5V (**24AA16H**)
			250	—	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**)
11	TSU:WP	WP Setup Time	600	—	ns	2.5V ≤ VCC ≤ 5.5V
			4000	—	ns	1.7V ≤ VCC < 2.5V (**24AA16H**)
			600	—	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**)
12	THD:WP	WP Hold Time	1300	—	ns	2.5V ≤ VCC ≤ 5.5V
			4700	—	ns	1.7V ≤ VCC < 2.5V (**24AA16H**)
			600	—	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**)
13	TAA	Output Valid from Clock	—	900	ns	2.5V ≤ VCC ≤ 5.5V (**Note 2**)
			—	3500	ns	1.7V ≤ VCC < 2.5V (**24AA16H**) (**Note 2**)
			—	450	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**) (**Note 2**)

Note 1: Characterized but not 100% tested.

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: CB = total capacitance of one bus line in pF.

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 website at www.microchip.com.

AC CHARACTERISTICS (Continued)			Industrial (I): TA = -40°C to +85°C, VCC = +1.7V to +5.5V Extended (E): TA = -40°C to +125°C, VCC = +2.5V to +5.5V (24LC16BH) Extended (E): TA = -40°C to +125°C, VCC = +1.7V to +5.5V (24FC16H)			
Param. No.	**Symbol**	**Characteristic**	**Min.**	**Max.**	**Units**	**Conditions**
14	TBUF	Bus Free Time: The time the bus must be free before a new transmission can start	1300	—	ns	2.5V ≤ VCC ≤ 5.5V
			4700	—	ns	1.7V ≤ VCC < 2.5V (**24AA16H**)
			500	—	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**)
15	TOF	Output Fall Time from VIH Minimum to VIL Maximum	20+0.1CB	250	ns	2.5V ≤ VCC ≤ 5.5V (**Notes 1**, **2** and **3**)
			—	250	ns	1.7V ≤ VCC < 2.5V (**24AA16H**) (**Notes 1**, **2** and **3**)
16	TSP	Input Filter Spike Suppression (SDA and SCL pins)	—	50	ns	**Note 1**
			—	100	ns	1.7V ≤ VCC ≤ 5.5V (**24FC16H**) (**Note 1**)
17	TWC	Write Cycle Time (byte or page)	—	5	ms	
18		Endurance	1,000,000	—	cycles	25°C, 5.5V, Page Mode (**Note 4**)

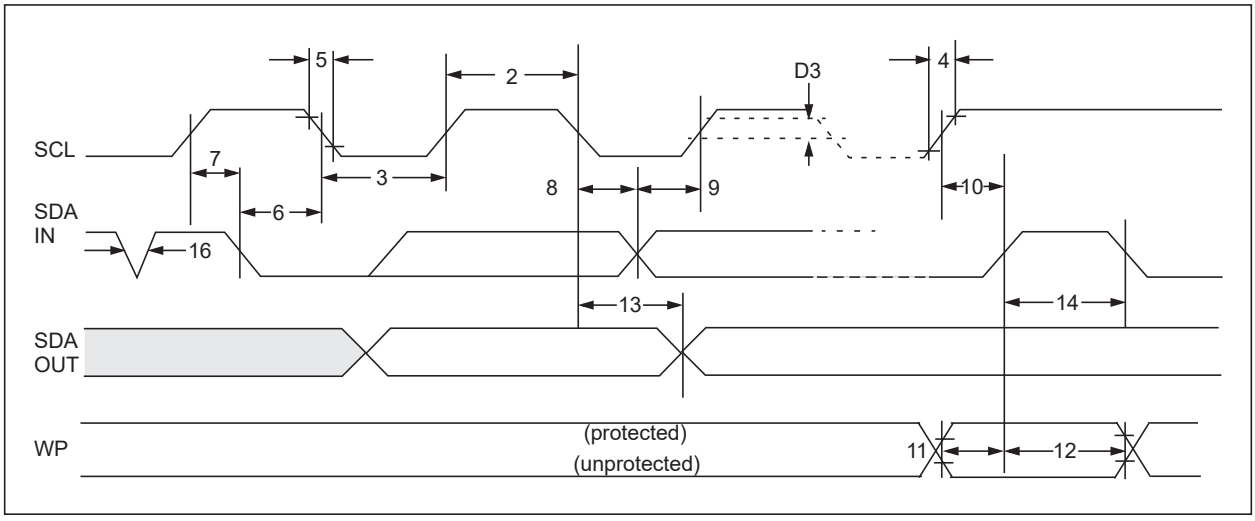
Note 1: Characterized but not 100% tested.

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: CB = total capacitance of one bus line in pF.

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 website at www.microchip.com.

FIGURE 1-1: BUS TIMING DATA



2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

Name	MSOP	PDIP	SOIC	TDFN(1)	TSSOP	SOT-23	Description
A0	1	1	1	1	1	—	Not Connected
A1	2	2	2	2	2	—	Not Connected
A2	3	3	3	3	3	—	Not Connected
VSS	4	4	4	4	4	2	Ground
SDA	5	5	5	5	5	3	Serial Address/Data I/O
SCL	6	6	6	6	6	1	Serial Clock
WP	7	7	7	7	7	5	Write-Protect Input
VCC	8	8	8	8	8	4	Power Supply

Note 1: The exposed pad on the TDFN package can be connected to VSS or left floating.

2.1 A0, A1, A2

The A0, A1 and A2 pins are not used by the 24XX16H. They may be left floating or tied to either VSS or VCC.

2.2 Serial Address/Data Input/Output (SDA)

The SDA input is a bidirectional pin used to transfer addresses and data into and out of the device. Since it is an open-drain terminal, the SDA bus requires a pull-up resistor to VCC (typical 10 kΩ for 100 kHz, 2 kΩ for 400 kHz and 1 MHz).

For normal data transfer, SDA is allowed to change only during SCL low. Changes during SCL high are reserved for indicating Start and Stop conditions.

2.3 Serial Clock (SCL)

The SCL input is used to synchronize the data transfer to and from the device.

2.4 Write-Protect (WP)

This pin must be connected to either VSS or VCC.

If tied to VSS, normal memory operation is enabled (read/write the entire memory 000-7FF).

If tied to VCC, write operations are inhibited. Half of the memory will be write-protected (400h-7FFh). Read operations are not affected.

3.0 FUNCTIONAL DESCRIPTION

The 24XX16H supports a bidirectional, two-wire bus and data transmission protocol. A device that sends data onto the bus is defined as transmitter, while a device receiving data is defined as a receiver. The bus has to be controlled by a master device which generates the Serial Clock (SCL), controls the bus access and generates the Start and Stop conditions, while the 24XX16H works as slave. Both master and slave can operate as transmitter or receiver, but the master device determines which mode is activated.

4.0 BUS CHARACTERISTICS

The following **bus protocol** has been defined:

- Data transfer may be initiated only when the bus is not busy.
- During data transfer, the data line must remain stable whenever the clock line is high. Changes in the data line while the clock line is high will be interpreted as a Start or Stop condition.

Accordingly, the following bus conditions have been defined (Figure 4-1).

4.1 Bus Not Busy (A)

Both data and clock lines remain high.

4.2 Start Data Transfer (B)

A high-to-low transition of the SDA line while the clock (SCL) is high determines a Start condition. All commands must be preceded by a Start condition.

4.3 Stop Data Transfer (C)

A low-to-high transition of the SDA line while the clock (SCL) is high determines a Stop condition. All operations must be ended with a Stop condition.

4.4 Data Valid (D)

The state of the data line represents valid data when, after a Start condition, the data line is stable for the duration of the high period of the clock signal.

The data on the line must be changed during the low period of the clock signal. There is one clock pulse per bit of data.

Each data transfer is initiated with a Start condition and terminated with a Stop condition. The number of data bytes transferred between the Start and Stop conditions is determined by the master device and is, theoretically, unlimited (although only the last sixteen will be stored when doing a write operation). When an overwrite does occur, it will replace data based on the first-in first-out (FIFO) principle.

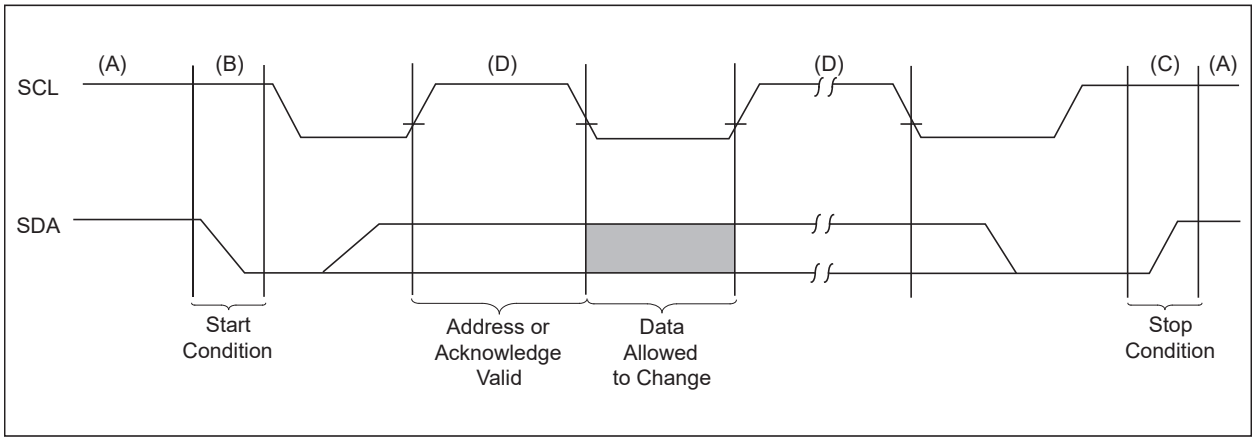
4.5 Acknowledge

Each receiving device, when addressed, is obliged to generate an Acknowledge after the reception of each byte. The master device must generate an extra clock pulse which is associated with this Acknowledge bit.

Note:	The 24XX16H does not generate any Acknowledge bits if an internal programming cycle is in progress.

The device that acknowledges has to pull down the SDA line during the Acknowledge clock pulse in such a way that the SDA line is stable-low during the high period of the Acknowledge-related clock pulse. Moreover, setup and hold times must be taken into account. During reads, a master must signal an end of data to the slave by not generating an Acknowledge bit on the last byte that has been clocked out of the slave. In this case, the slave (24XX16H) will leave the data line high to enable the master to generate the Stop condition.

FIGURE 4-1: DATA TRANSFER SEQUENCE ON THE SERIAL BUS



5.0 DEVICE ADDRESSING

A control byte is the first byte received following the Start condition from the master device. The control byte consists of a 4-bit control code. For the 24XX16H, this is set as '1010' binary for read and write operations. The next three bits of the control byte are the block-select bits (B2, B1, B0). They are used by the master device to select which of the eight 256-word blocks of memory are to be accessed. These bits, in effect, are the three Most Significant bits of the word address. It should be noted that the protocol limits the size of the memory to eight blocks of 256 words, therefore, the protocol can support only one 24XX16H. per system. The combination of the 4-bit control code and the next three bits are called the slave address.

The last bit of the control byte is the Read/$\overline{\text{Write}}$ (R/$\overline{\text{W}}$) bit and it defines the operation to be performed. When set to '1', a read operation is selected. When set to '0', a write operation is selected. Following the Start condition, the 24XX16H monitors the SDA bus, checking the device type identifier being transmitted. Upon receiving a valid slave address and the R/$\overline{\text{W}}$ bit, the slave device outputs an Acknowledge signal on the SDA line. Depending on the state of the R/$\overline{\text{W}}$ bit, the 24XX16H will select a read or write operation.

The next byte received defines the address of the first data byte within the selected block (Figure 5-2). The word address byte uses all eight bits.

Operation	Control Code	Block Select	R/$\overline{\text{W}}$
Read	1010	Block Address	1
Write	1010	Block Address	0

FIGURE 5-1: CONTROL BYTE ALLOCATION

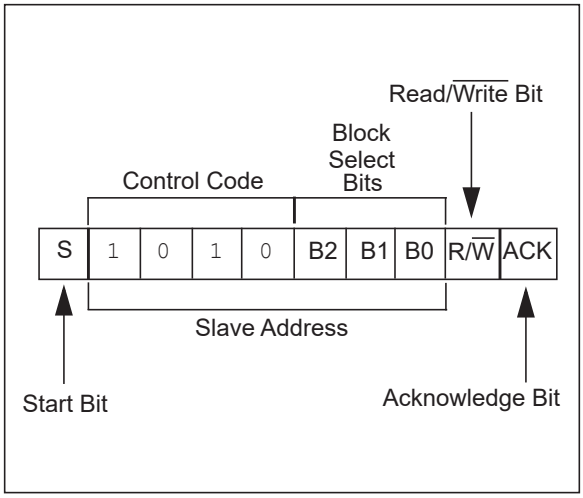
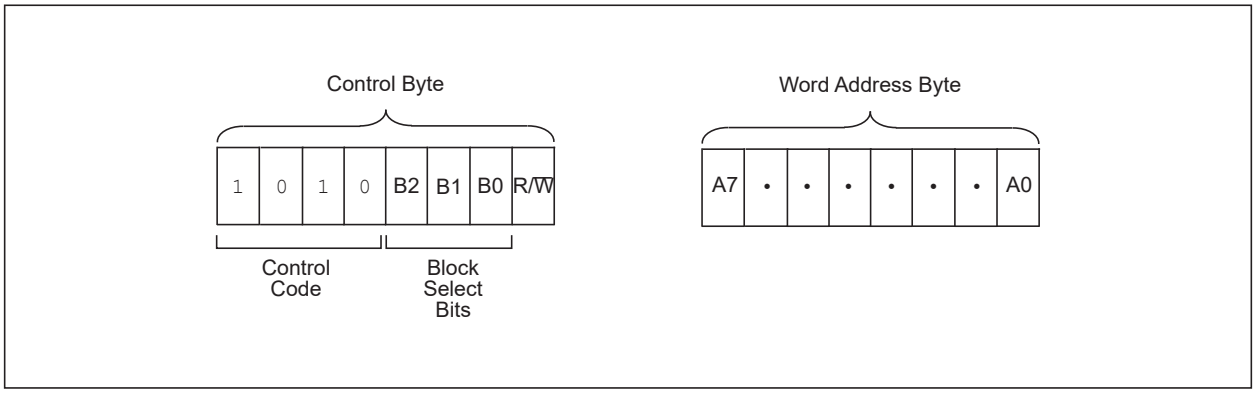


FIGURE 5-2: ADDRESS SEQUENCE BIT ASSIGNMENTS



6.0 WRITE OPERATION

6.1 Byte Write

Following the Start condition from the master, the device code (4 bits), the block address (3 bits) and the R/$\overline{W}$ bit, which is a logic-low, are placed onto the bus by the master transmitter. This indicates to the addressed slave receiver that a byte with a word address will follow after it has generated an Acknowledge bit during the ninth clock cycle. Therefore, the next byte transmitted by the master is the word address and will be written into the Address Pointer of the 24XX16H. After receiving another Acknowledge signal from the 24XX16H, the master device will transmit the data word to be written into the addressed memory location. The 24XX16H acknowledges again and the master generates a Stop condition. This initiates the internal write cycle, and, during this time, the 24XX16H will not generate Acknowledge signals (Figure 6-1).

6.2 Page Write

The write control byte, word address and first data byte are transmitted to the 24XX16H in the same way as in a byte write. However, instead of generating a Stop condition, the master transmits up to 16 data bytes to the 24XX16H, which are temporarily stored in the on-chip page buffer and will be written into the memory once the master has transmitted a Stop condition. Upon receipt of each word, the four lower-order Address Pointer bits, which form the byte counter, are internally incremented by one. The higher-order four bits of the word address and bits B2, B1 and B0 remain constant. If the master should transmit more than 16 words prior to generating the Stop condition, the Address Pointer will roll over and the previously received data will be overwritten. As with the byte write operation, once the Stop condition is received, an internal write cycle will begin (Figure 6-2).

Note:	Page write operations are limited to writing bytes within a single physical page **regardless** of the number of bytes actually being written. Physical page boundaries start at addresses that are integer multiples of the page buffer size (or 'page size') and end at addresses that are integer multiples of page size – 1. If a page write command attempts to write across a physical page boundary, the result is that the data wraps around to the beginning of the current page (overwriting data previously stored there), instead of being written to the next page, as might be expected. It is therefore necessary for the application software to prevent page write operations that would attempt to cross a page boundary.

6.3 Write Protection

The WP pin allows the user to write-protect half of the array (400h-7FFh) when the pin is tied to VCC. If the pin is tied to VSS, the write protection is disabled.

FIGURE 6-1: BYTE WRITE

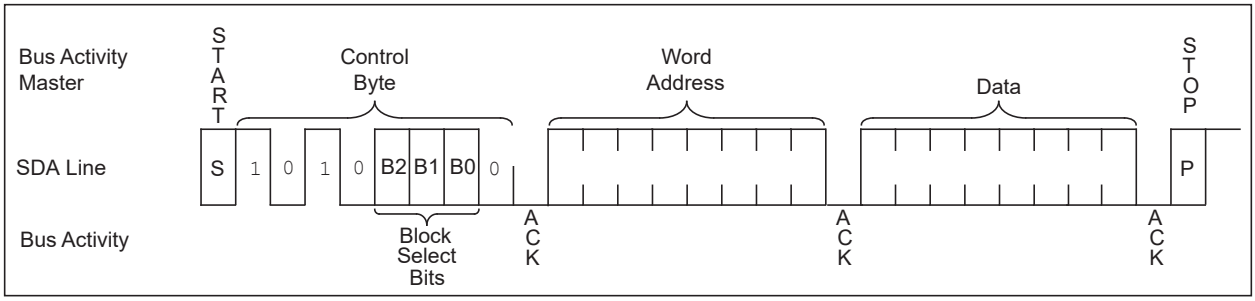
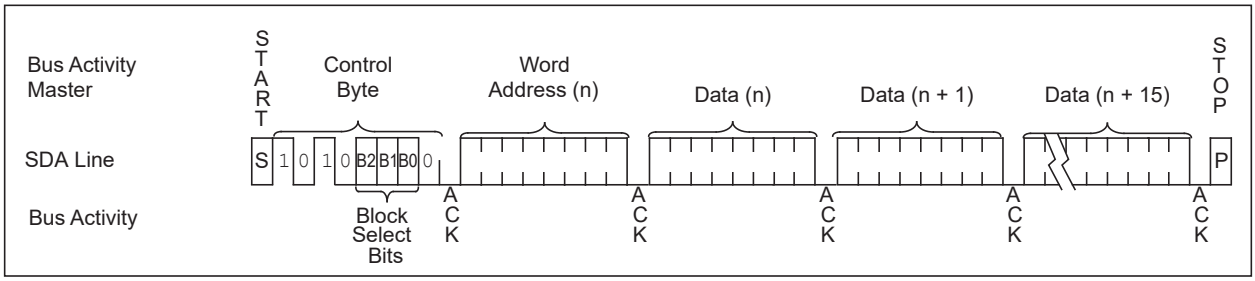


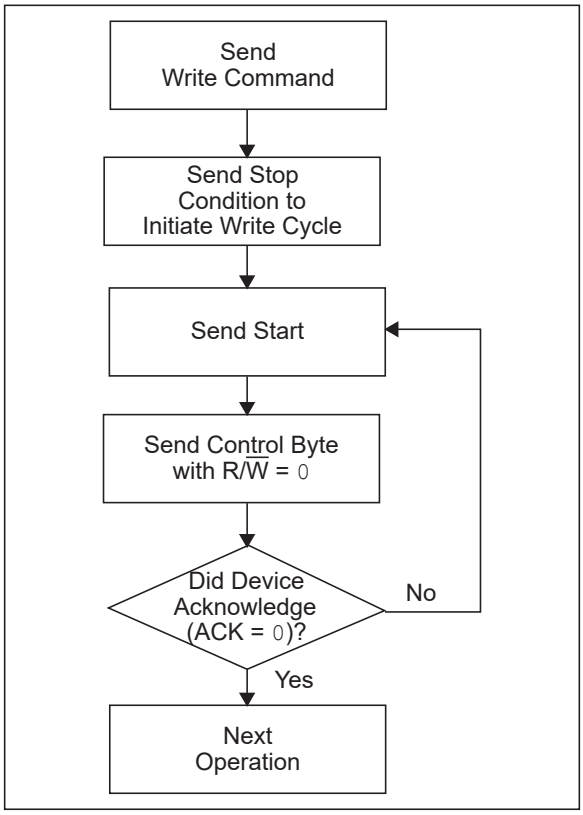
FIGURE 6-2: PAGE WRITE



7.0 ACKNOWLEDGE POLLING

Since the device will not acknowledge during a write cycle, this can be used to determine when the cycle is complete (this feature can be used to maximize bus throughput). Once the Stop condition for a write command has been issued from the master, the device initiates the internally-timed write cycle. ACK polling can then be initiated immediately. This involves the master sending a Start condition followed by the control byte for a write command (R/$\overline{W}$ = 0). If the device is still busy with the write cycle, no ACK will be returned. If the cycle is complete, the device will return the ACK and the master can then proceed with the next read or write operation. See Figure 7-1 for a flow diagram of this operation.

FIGURE 7-1: ACKNOWLEDGE POLLING FLOW



8.0 READ OPERATION

Read operations are initiated in the same way as write operations, with the exception that the R/$\overline{W}$ bit of the slave address is set to '1'. There are three basic types of read operations: current address read, random read and sequential read.

8.1 Current Address Read

The 24XX16H contains an Address Pointer that maintains the address of the last word accessed, internally incremented by one. Therefore, if the previous access (either a read or write operation) was to address **n**, the next current address read operation would access data from address **n + 1**. Upon receipt of the slave address with R/$\overline{W}$ bit set to '1', the 24XX16H issues an Acknowledge and transmits the 8-bit data word. The master will not acknowledge the transfer, but does generate a Stop condition and the 24XX16H discontinues transmission (Figure 8-1).

8.2 Random Read

Random read operations allow the master to access any memory location in a random manner. To perform this type of read operation, the word address must first be set. This is accomplished by sending the word address to the 24XX16H as part of a write operation. Once the word address is sent, the master generates a Start condition following the Acknowledge. This terminates the write operation, but not before the internal Address Pointer is set. The master then issues the control byte again, but with the R/$\overline{W}$ bit set to a '1'. The 24XX16H will then issue an Acknowledge and transmits the 8-bit data word. The master will not acknowledge the transfer, but does generate a Stop condition and the 24XX16H discontinues transmission (Figure 8-2).

8.3 Sequential Read

Sequential reads are initiated in the same way as a random read or current read, except that once the 24XX16H transmits the first data byte, the master issues an Acknowledge (as opposed to a Stop condition in a random read). This directs the 24XX16H to transmit the next sequentially addressed 8-bit word (Figure 8-3).

To provide sequential reads the 24XX16H contains an internal Address Pointer which is incremented by one at the completion of each operation. This Address Pointer allows the entire memory contents to be serially read during one operation.

8.4 Noise Protection

The SCL and SDA inputs have Schmitt Trigger and filter circuits which suppress noise spikes to assure proper device operation even on a noisy bus.

FIGURE 8-1: CURRENT ADDRESS READ

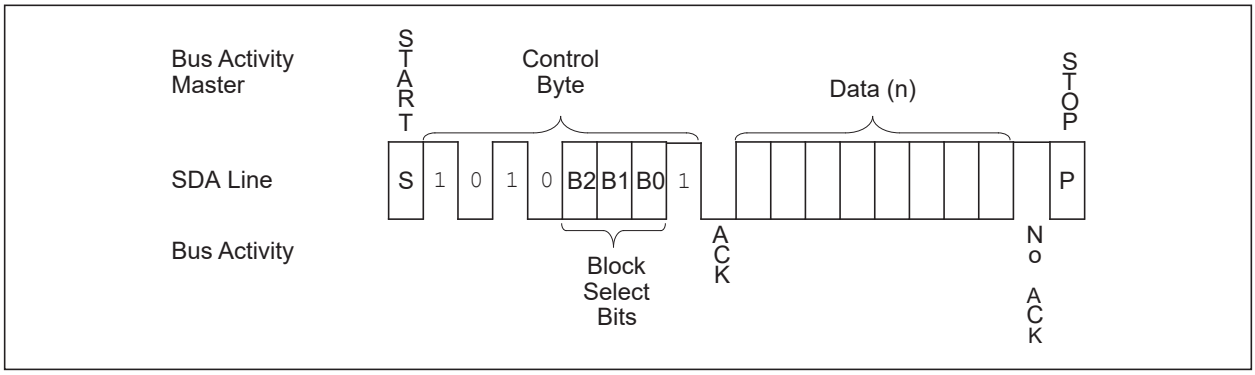


FIGURE 8-2: RANDOM READ

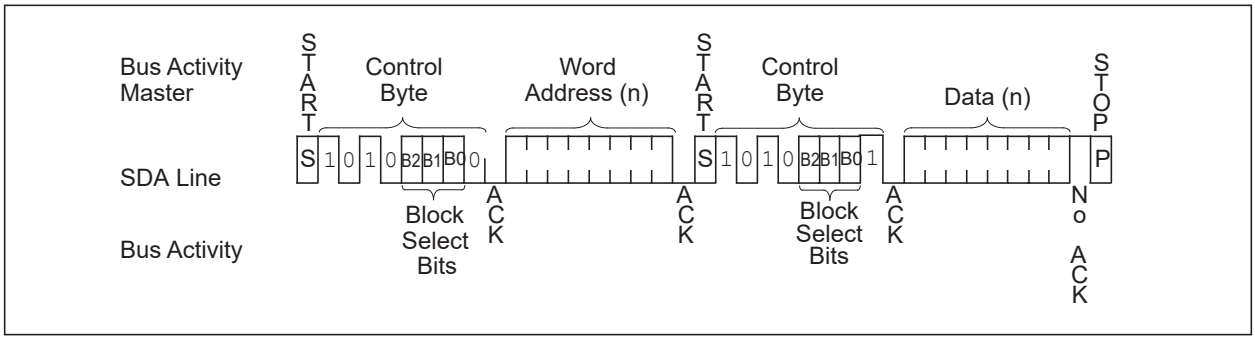
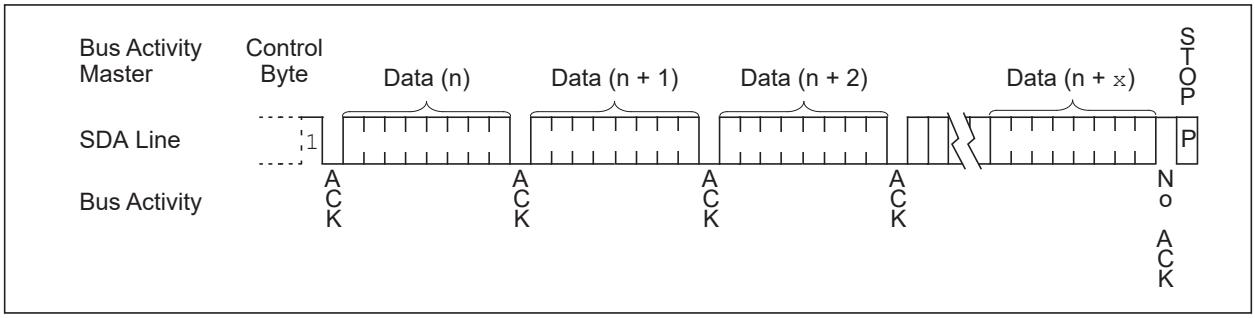


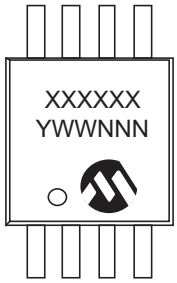
FIGURE 8-3: SEQUENTIAL READ



9.0 PACKAGING INFORMATION

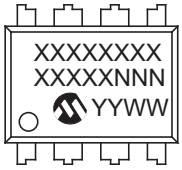
9.1 Package Marking Information*

8-Lead MSOP

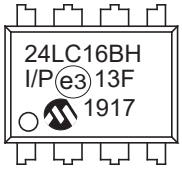


Example

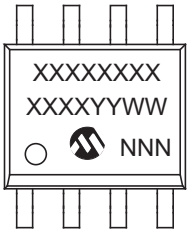
8-Lead PDIP (300 mil)



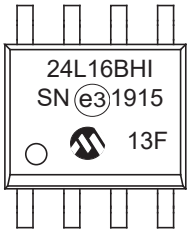
Example



8-Lead SOIC (3.90 mm)

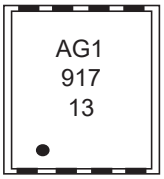


Example

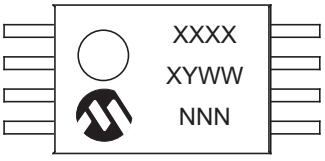


8-Lead 2x3 TDFN

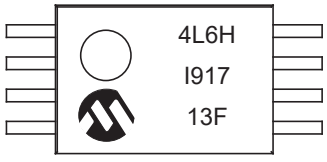
Example



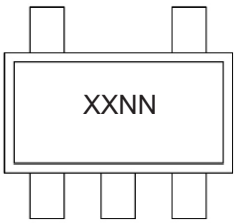
8-Lead TSSOP



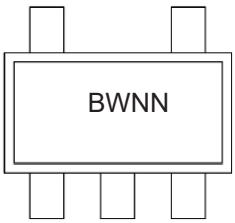
Example



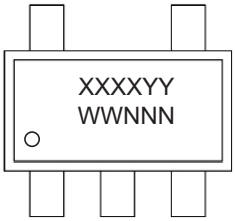
5-Lead SOT-23 (**1-Line Marking**)



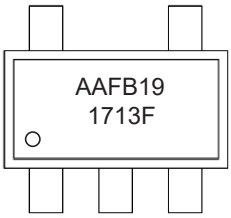
Example



5-Lead SOT-23 (**2-Line Marking**)



Example



Part Number	1st Line Marking Codes							
	MSOP	PDIP	SOIC	TDFN		TSSOP	SOT-23	
				I-Temp.	E-Temp.		I-Temp.	E-Temp.
24AA16H	4A16HT(1)	24AA16H	24AA16HT(1)	AG1	—	4A6H	BWNN(2,3)	—
24LC16BH	4L16HT(1)	24LC16BH	24L16BHT(1)	AG4	AG5	4L6H	5QNN(2,3)	5RNN(2,3)
24FC16H	—	—	24FC16H	—	—	—	AAFAYY(4)	AAFAYY(4)

Note 1: T = Temperature grade (I, E)

2: NN = Alphanumeric traceability code

3: These parts use the 1-line SOT-23 marking format

4: These parts use the 2-line SOT-23 marking format

Legend:	XX...X	Part number or part number code
	T	Temperature (I, E)
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code (2 characters for small packages)
	(e3)	JEDEC® designator for Matte Tin (Sn)

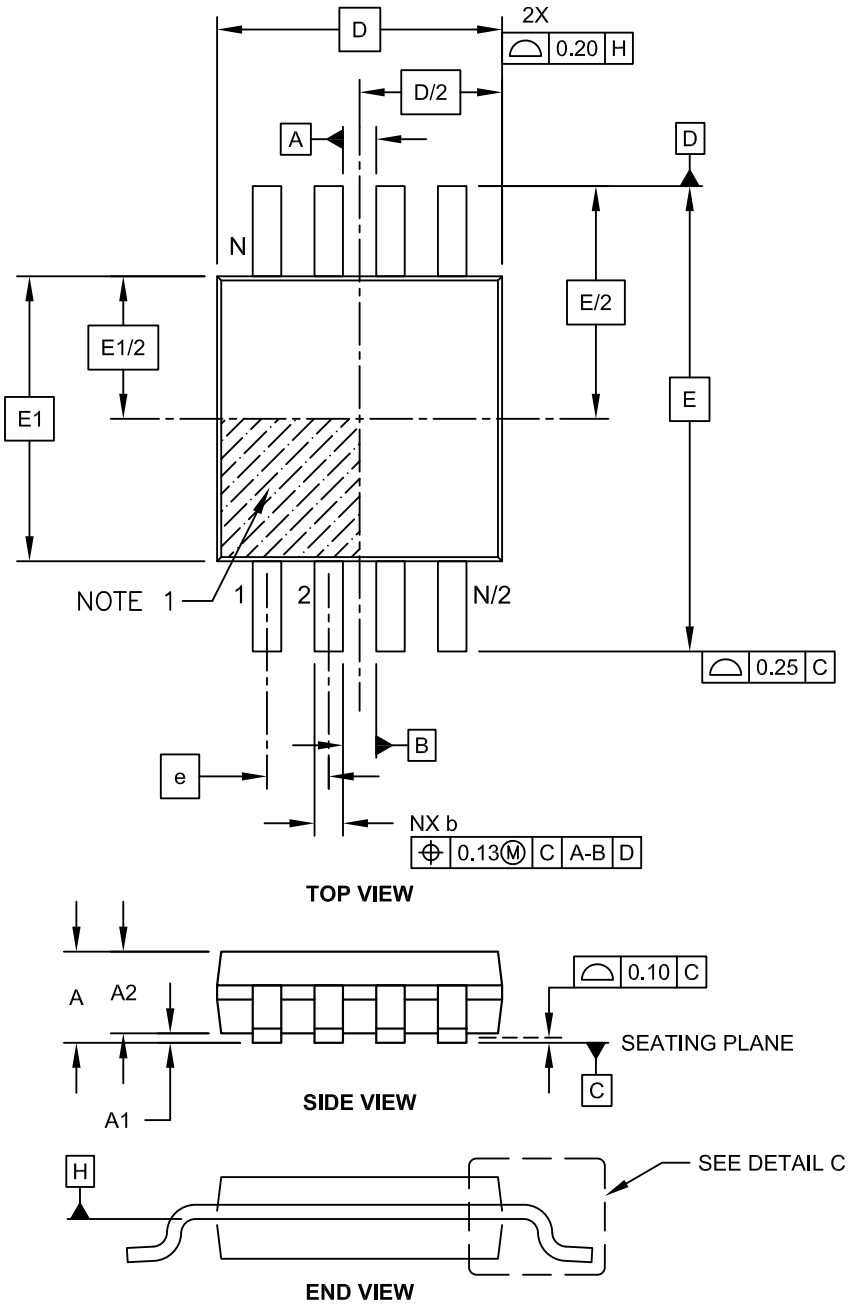
***** Standard OTP marking consists of Microchip part number, year code, week code, and traceability code.

Note: For very small packages with no room for the JEDEC® designator (e3), the marking will only appear on the outer carton or reel label.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

8-Lead Plastic Micro Small Outline Package (MS) [MSOP]

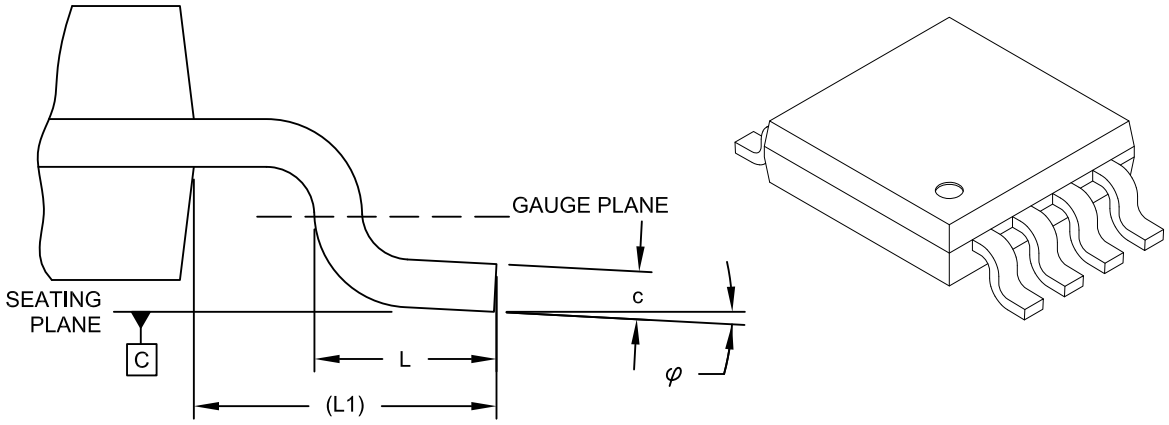
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-111C Sheet 1 of 2

8-Lead Plastic Micro Small Outline Package (MS) [MSOP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



DETAIL C

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		0.65 BSC	
Overall Height	A	-	-	1.10
Molded Package Thickness	A2	0.75	0.85	0.95
Standoff	A1	0.00	-	0.15
Overall Width	E		4.90 BSC	
Molded Package Width	E1		3.00 BSC	
Overall Length	D		3.00 BSC	
Foot Length	L	0.40	0.60	0.80
Footprint	L1		0.95 REF	
Foot Angle	φ	0°	-	8°
Lead Thickness	c	0.08	-	0.23
Lead Width	b	0.22	-	0.40

Notes:

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

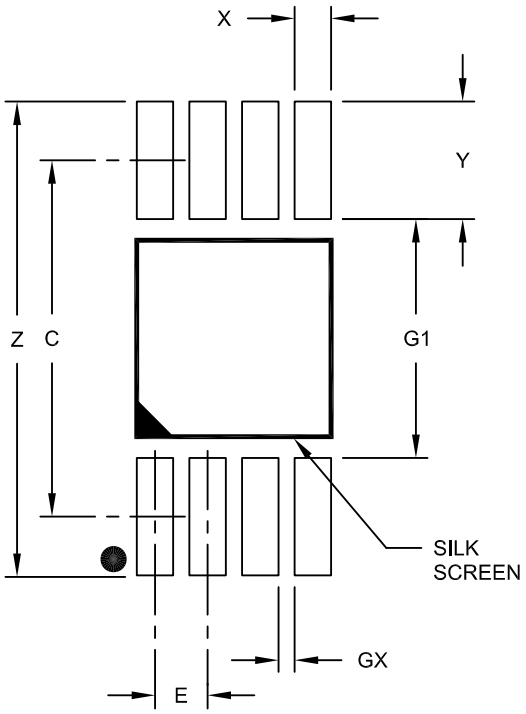
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

Microchip Technology Drawing C04-111C Sheet 2 of 2

8-Lead Plastic Micro Small Outline Package (MS) [MSOP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.65 BSC	
Contact Pad Spacing	C		4.40	
Overall Width	Z			5.85
Contact Pad Width (X8)	X1			0.45
Contact Pad Length (X8)	Y1			1.45
Distance Between Pads	G1	2.95		
Distance Between Pads	GX	0.20		

Notes:

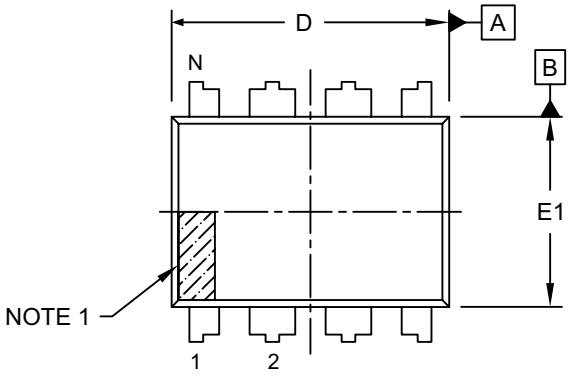
1. Dimensioning and tolerancing per ASME Y14.5M

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

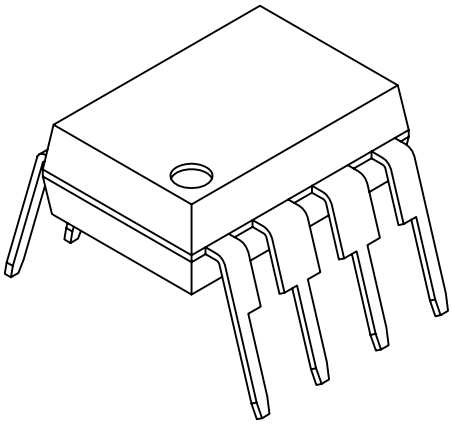
Microchip Technology Drawing No. C04-2111A

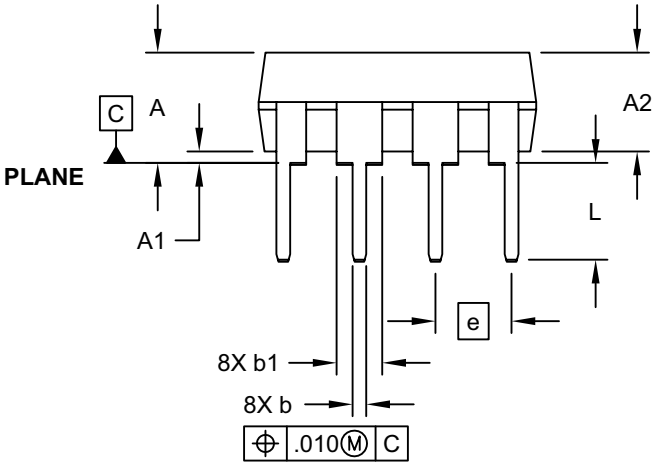
8-Lead Plastic Dual In-Line (P) - 300 mil Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging

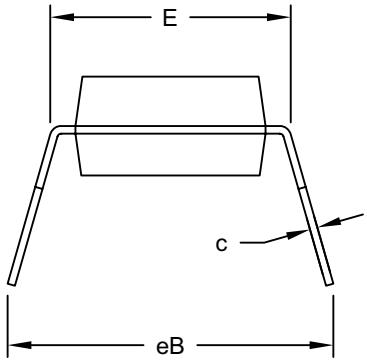


TOP VIEW





SIDE VIEW

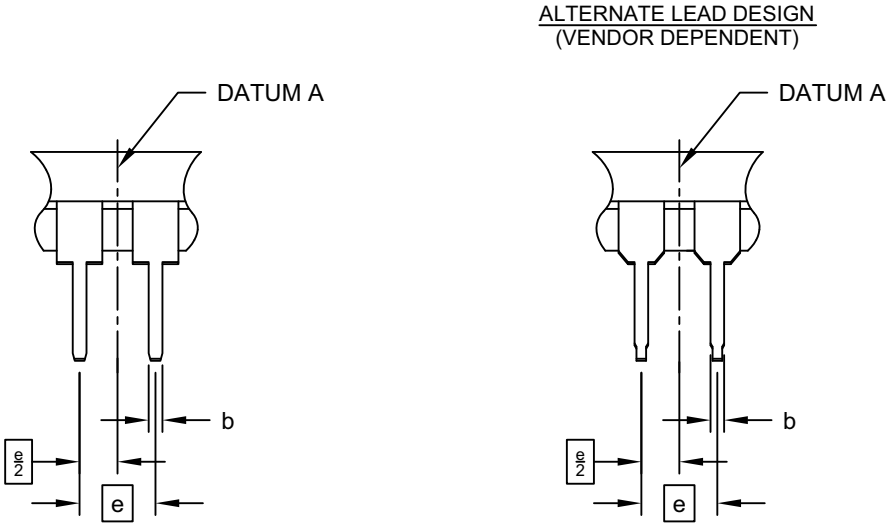


END VIEW

Microchip Technology Drawing No. C04-018D Sheet 1 of 2

8-Lead Plastic Dual In-Line (P) - 300 mil Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		.100 BSC	
Top to Seating Plane	A	-	-	.210
Molded Package Thickness	A2	.115	.130	.195
Base to Seating Plane	A1	.015	-	-
Shoulder to Shoulder Width	E	.290	.310	.325
Molded Package Width	E1	.240	.250	.280
Overall Length	D	.348	.365	.400
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.040	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	-	-	.430

Notes:

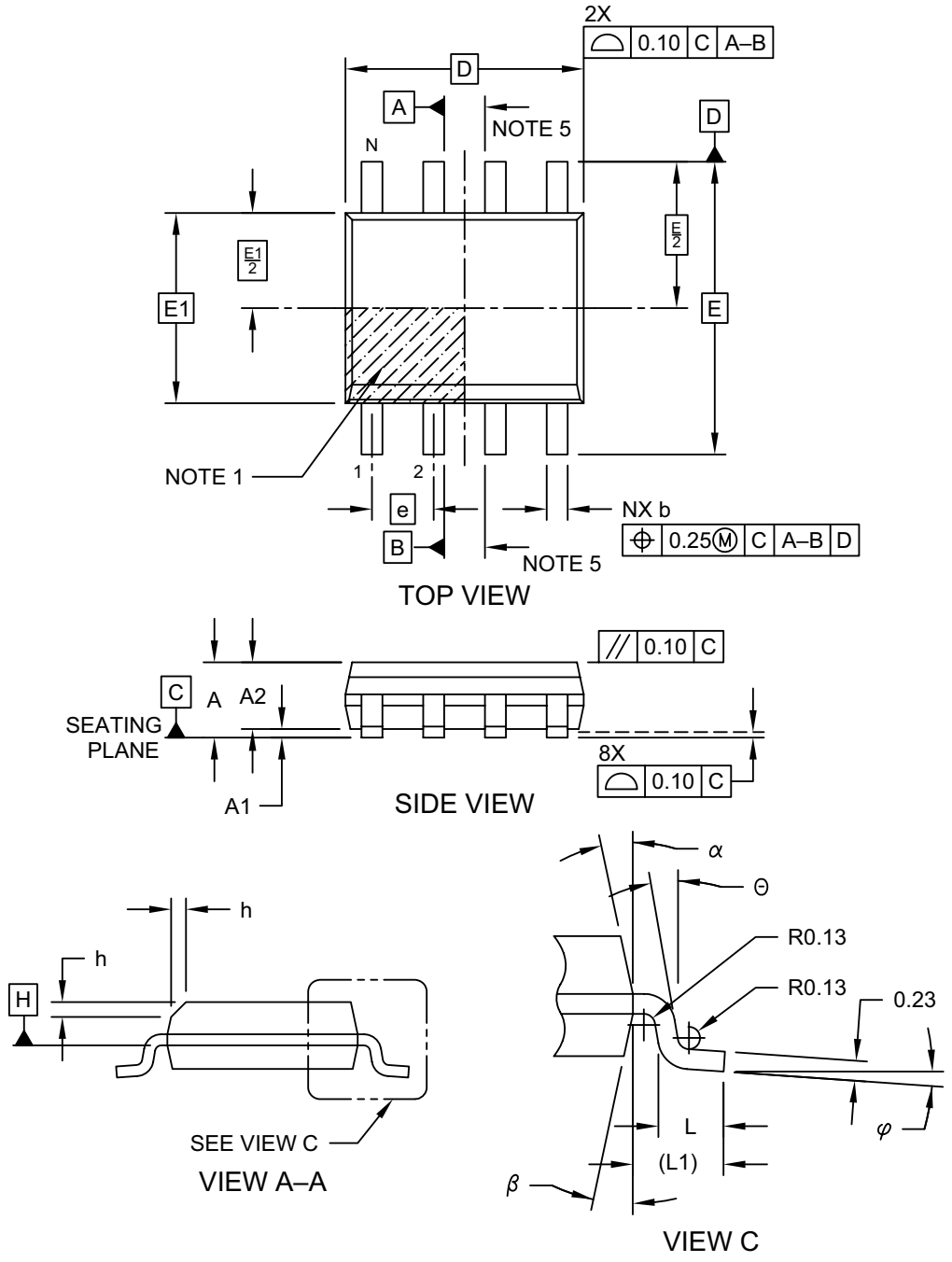
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-018D Sheet 2 of 2

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm (.150 In.) Body [SOIC]

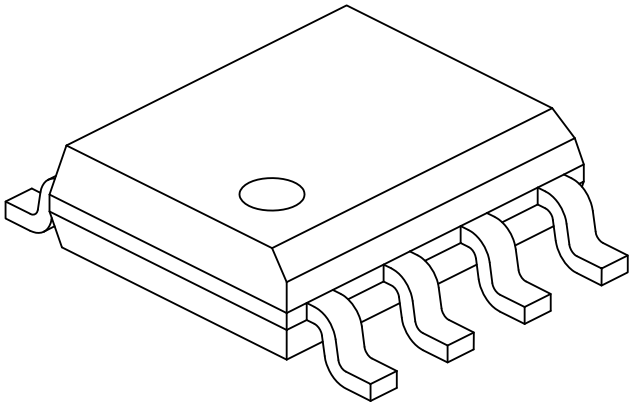
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing No. C04-057-SN Rev D Sheet 1 of 2

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm (.150 In.) Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



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 0.15mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M

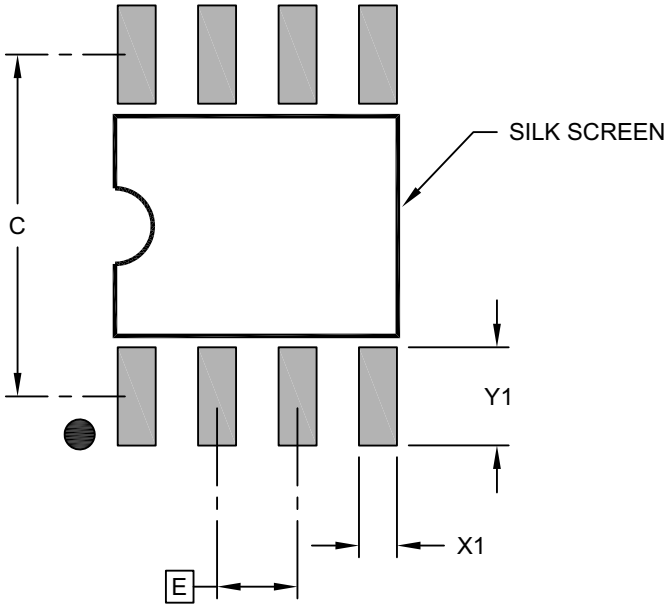
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.
5. Datums A & B to be determined at Datum H.

Microchip Technology Drawing No. C04-057-SN Rev D Sheet 2 of 2

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

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	1.27 BSC		
Contact Pad Spacing	C		5.40	
Contact Pad Width (X8)	X1			0.60
Contact Pad Length (X8)	Y1			1.55

Notes:

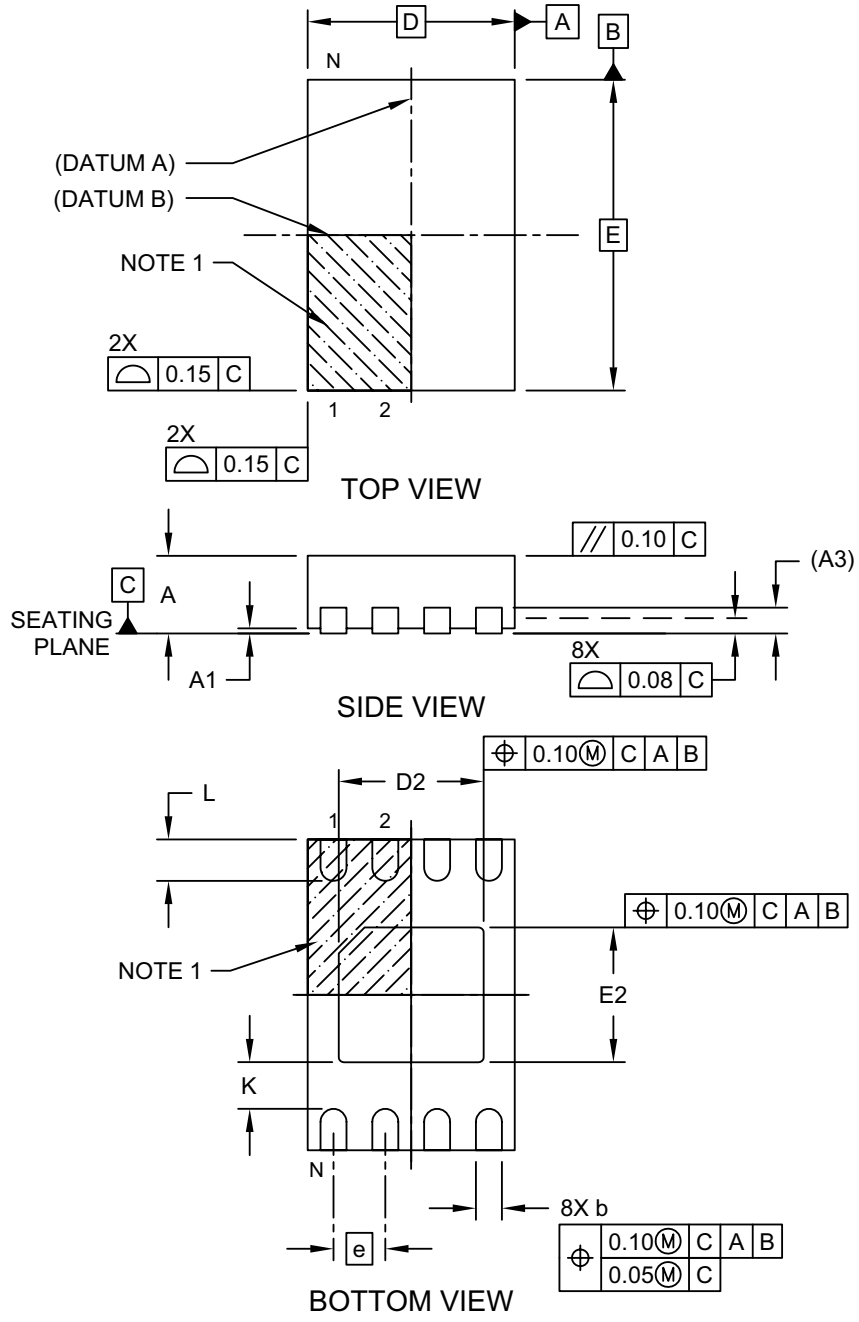
1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing C04-2057-SN Rev B

8-Lead Plastic Dual Flat, No Lead Package (MN) – 2x3x0.8 mm Body [TDFN]
With 1.4x1.3 mm Exposed Pad (JEDEC Package type WDFN)

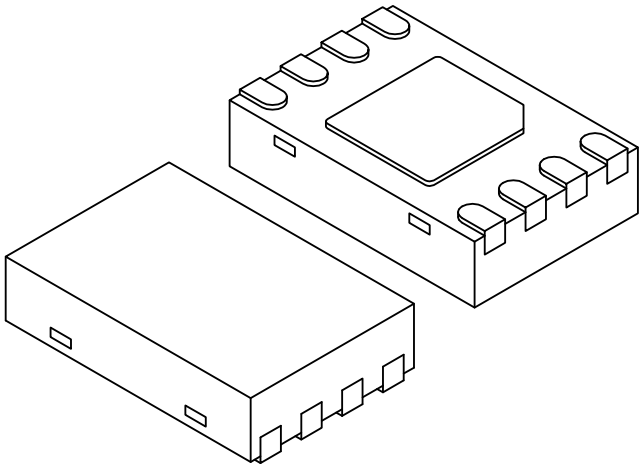
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing No. C04-129-MN Rev E Sheet 1 of 2

8-Lead Plastic Dual Flat, No Lead Package (MN) – 2x3x0.8 mm Body [TDFN] With 1.4x1.3 mm Exposed Pad (JEDEC Package type WDFN)

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		0.50 BSC	
Overall Height	A	0.70	0.75	0.80
Standoff	A1	0.00	0.02	0.05
Contact Thickness	A3		0.20 REF	
Overall Length	D		2.00 BSC	
Overall Width	E		3.00 BSC	
Exposed Pad Length	D2	1.35	1.40	1.45
Exposed Pad Width	E2	1.25	1.30	1.35
Contact Width	b	0.20	0.25	0.30
Contact Length	L	0.25	0.30	0.45
Contact-to-Exposed Pad	K	0.20	-	-

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. Package is saw singulated
4. Dimensioning and tolerancing per ASME Y14.5M

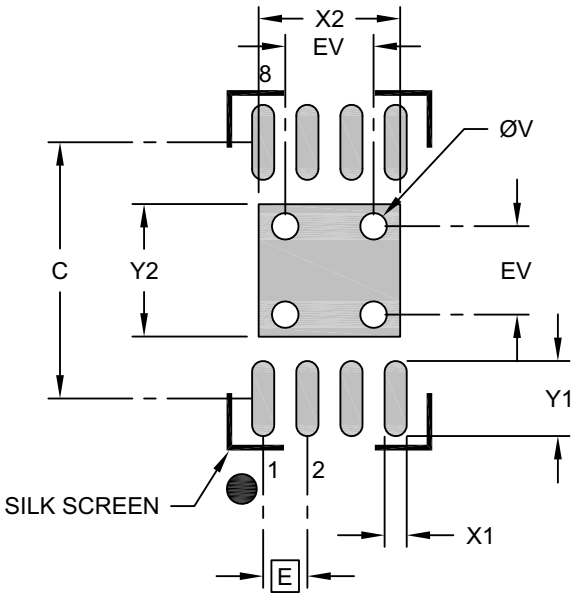
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

Microchip Technology Drawing No. C04-129-MN Rev E Sheet 2 of 2

8-Lead Plastic Dual Flat, No Lead Package (MN) – 2x3x0.8 mm Body [TDFN]
With 1.4x1.3 mm Exposed Pad (JEDEC Package type WDFN)

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.50 BSC	
Optional Center Pad Width	X2			1.60
Optional Center Pad Length	Y2			1.50
Contact Pad Spacing	C		2.90	
Contact Pad Width (X8)	X1			0.25
Contact Pad Length (X8)	Y1			0.85
Thermal Via Diameter	V		0.30	
Thermal Via Pitch	EV		1.00	

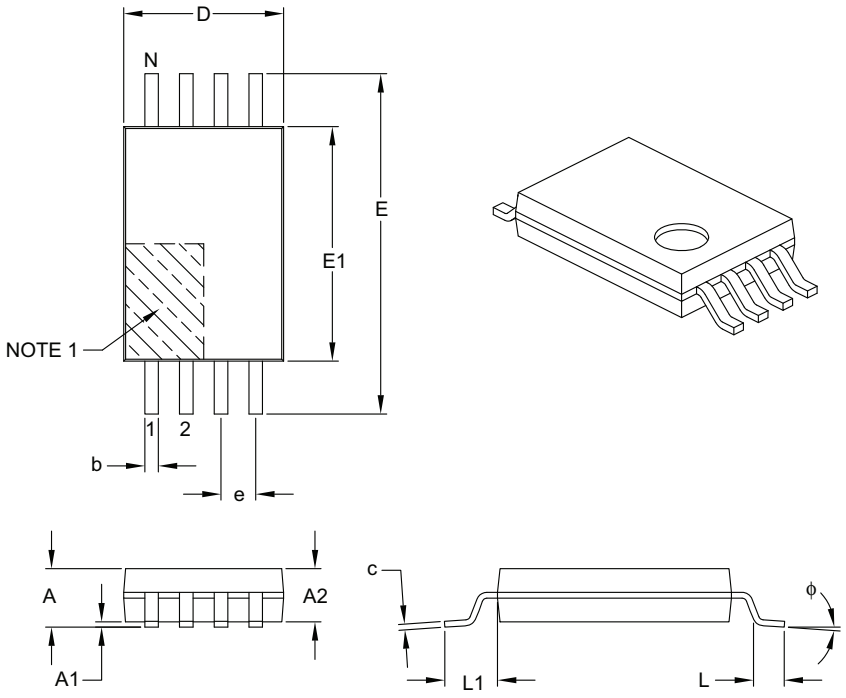
Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing No. C04-129-MN Rev. B

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

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		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	ϕ	0°	–	8°
Lead Thickness	c	0.09	–	0.20
Lead Width	b	0.19	–	0.30

Notes:

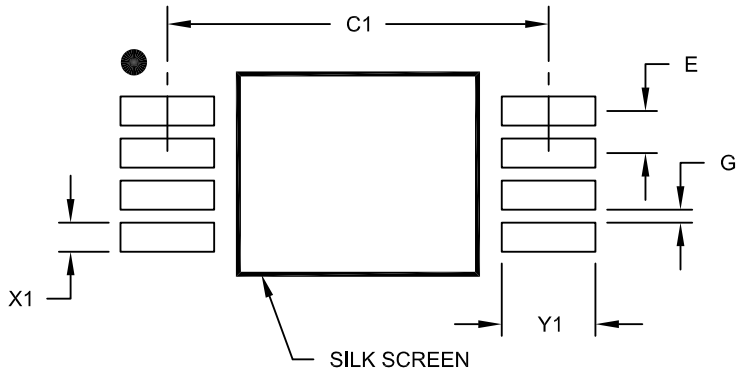
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
3. Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-086B

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

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.65 BSC		
Contact Pad Spacing	C1		5.90	
Contact Pad Width (X8)	X1			0.45
Contact Pad Length (X8)	Y1			1.45
Distance Between Pads	G	0.20		

Notes:

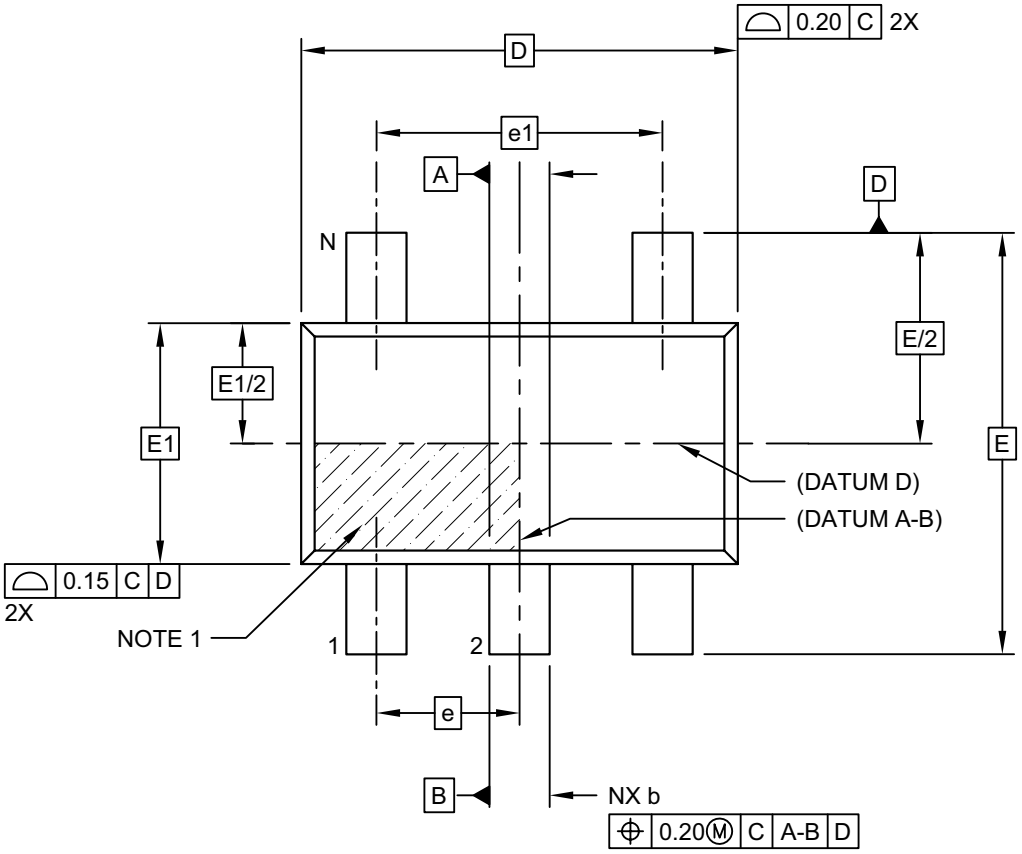
1. Dimensioning and tolerancing per ASME Y14.5M

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

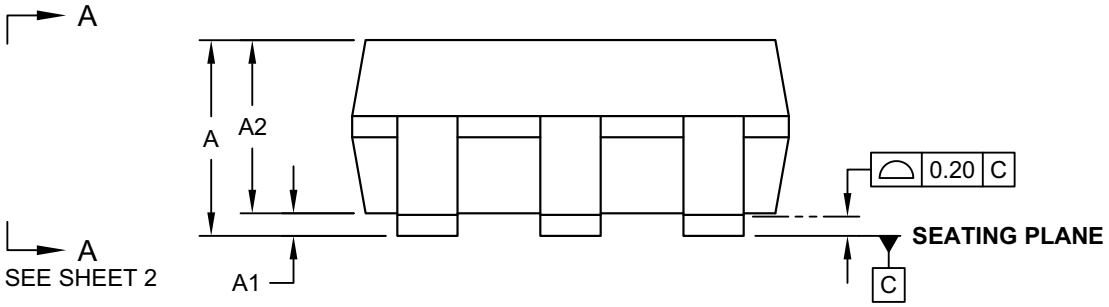
Microchip Technology Drawing No. C04-2086A

5-Lead Plastic Small Outline Transistor (OT) [SOT23]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



TOP VIEW

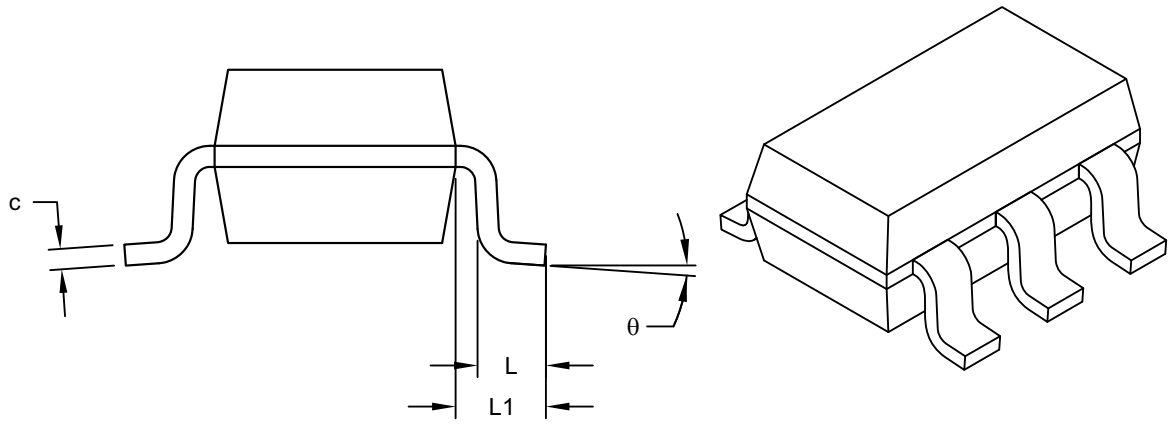


SIDE VIEW

Microchip Technology Drawing C04-091-OT Rev F Sheet 1 of 2

5-Lead Plastic Small Outline Transistor (OT) [SOT23]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



VIEW A-A
SHEET 1

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		5	
Pitch	e		0.95 BSC	
Outside lead pitch	e1		1.90 BSC	
Overall Height	A	0.90	-	1.45
Molded Package Thickness	A2	0.89	-	1.30
Standoff	A1	-	-	0.15
Overall Width	E		2.80 BSC	
Molded Package Width	E1		1.60 BSC	
Overall Length	D		2.90 BSC	
Foot Length	L	0.30	-	0.60
Footprint	L1		0.60 REF	
Foot Angle	ϕ	0°	-	10°
Lead Thickness	c	0.08	-	0.26
Lead Width	b	0.20	-	0.51

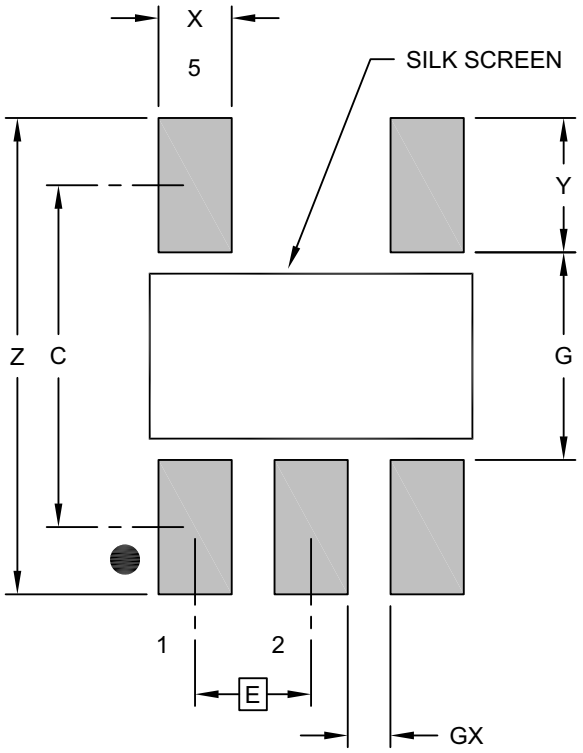
Notes:

1. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.25mm per side.
2. 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 C04-091-OT Rev F Sheet 2 of 2

5-Lead Plastic Small Outline Transistor (OT) [SOT23]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.95 BSC	
Contact Pad Spacing	C		2.80	
Contact Pad Width (X5)	X			0.60
Contact Pad Length (X5)	Y			1.10
Distance Between Pads	G	1.70		
Distance Between Pads	GX	0.35		
Overall Width	Z			3.90

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2091-OT Rev F

APPENDIX A: REVISION HISTORY

Revision B (12/2019)

Added the 24FC16H device; Updated Package Drawings; Updated formating throughout for clarification.

Revision A (11/2008)

Initial release of this document.

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PART NO.	[X](1)	-X	/XX
Device	Tape and Reel Option	Temperature Range	Package

Device:	24AA16H: = 1.7V, 16-Kbit I^2C Serial EEPROM 24LC16BH:= 2.5V, 16-Kbit I^2C Serial EEPROM 24FC16H: = 1.7V, High Speed, 16-Kbit I^2C Serial EEPROM
Tape and Reel Option:	Blank = Standard packaging (tube or tray) T = Tape and Reel(1)
Temperature Range:	I = -40°C to +85°C (Industrial) E = -40°C to +125°C (Extended)
Package:	MS = Plastic Micro Small Outline Package, 8-lead (MSOP) P = Plastic Dual In-Line – 300 mil Body, 8-lead (PDIP) SN = Plastic Small Outline - Narrow, 3.90 mm Body, 8-lead (SOIC) OT = Plastic Small Outline Transistor, 5-lead (SOT-23) (Tape and Reel only) MNY = Plastic Dual Flat, No Lead Package - 2x3x0.8 mm Body, 8-lead (TDFN) ST = Plastic Thin Shrink Small Outline – 4.4 mm, 8-lead (TSSOP)

Examples:

a) 24AA16H-I/P: Industrial Temperature, 1.7V, PDIP package.

b) 24AA16H-I/SN: Industrial Temperature, 1.7V, SOIC package.

c) 24AA16HT-I/OT: Tape and Reel, Industrial Temperature, 1.7V, SOT-23 package.

d) 24LC16BH-I/P: Industrial Temperature, 2.5V, PDIP package.

e) 24LC16BH-E/SN: Extended Temperature, 2.5V, SOIC package.

f) 24LC16BHT-I/OT: Tape and Reel, Industrial Temperature, 2.5V, SOT-23 package.

g) 24AA16HT-I/MNY: Tape and Reel, Industrial Temperature, 1.7V, TDFN package.

h) 24FC16H-I/SN: Industrial Temperature, 1.7V, SOIC package.

i) 24FC16HT-E/OT: Tape and Reel, Extended Temperature, 1.7V, SOT-23 package.

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

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