

# 256 Kb I<sup>2</sup>C CMOS Serial EEPROM in WLCSP Package

## N24C256

### Description

The N24C256 is a 256 Kb Serial CMOS EEPROM, internally organized as 32768 words of 8 bits each.

They feature a 64-byte page write buffer and support both the Standard (100 kHz), Fast (400 kHz) and Fast-Plus (1 MHz) I<sup>2</sup>C protocol.

The Write Protect input allows hardware protection for the memory array. The A2 input allows two N24C256 devices to be connected to the same bus.

### Features

- Supports Standard, Fast and Fast-Plus I<sup>2</sup>C Protocol
- Two Selectable I<sup>2</sup>C Device Addresses
- 1.7 V to 5.5 V Supply Voltage Range
- 64-byte Page Write Buffer
- Schmitt Triggers and Noise Suppression Filters on I<sup>2</sup>C Bus Inputs (SCL and SDA)
- Low Power CMOS Technology
- 1,000,000 Program/Erase Cycles
- 100 Year Data Retention
- Industrial Temperature Range: -40°C to +85°C
- Ultra-thin 6-ball WLCSP Package
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant\*

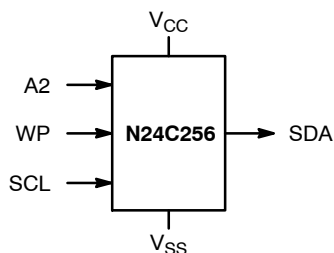


Figure 1. Functional Symbol

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



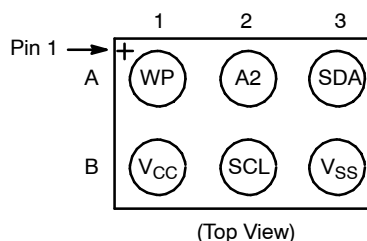
ON Semiconductor®

[www.onsemi.com](http://www.onsemi.com)



WLCSP-6  
C6A SUFFIX  
CASE 567WC

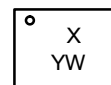
### PIN CONFIGURATION



### PIN FUNCTION

Pin Name	Function
SDA	Serial Data Input/Output
SCL	Serial Clock Input
VCC	Power Supply
VSS	Ground
WP	Hardware Write Protect
A2	Address Pin

### MARKING DIAGRAM



- X = Specific Device Code  
(See Ordering Information Table)
- Y = Production Year (Last Digit)
- W = Production Week Code

### ORDERING INFORMATION

See detailed ordering, marking and shipping information on page 9 of this data sheet.

# N24C256

**Table 1. ABSOLUTE MAXIMUM RATINGS**

Parameter	Rating	Unit
Storage Temperature	-65 to +150	°C
Voltage on Any Pin with Respect to Ground (Note 1)	-0.5 to +6.5	V

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. The DC input voltage on any pin should not be lower than -0.5 V or higher than  $V_{CC} + 1.0$  V. During transitions, the voltage on any pin may undershoot to no less than -1.5 V or overshoot to no more than  $V_{CC} + 1.5$  V, for periods of less than 20 ns.

**Table 2. RELIABILITY CHARACTERISTICS** (Note 2)

Symbol	Parameter	Min	Unit
$N_{END}$ (Note 3)	Endurance	1,000,000	Program/Erase Cycles
$T_{DR}$ (Note 4)	Data Retention	100	Years

2. These parameters are tested initially and after a design or process change that affects the parameter according to appropriate AEC-Q100 and JEDEC test methods.
3. Page Mode,  $V_{CC} = 5$  V, 25°C
4.  $T_A = 55$ °C

**Table 3. DC AND AC OPERATING CONDITIONS**

Supply Voltage / Temperature Range	Operation
$V_{CC} = 1.7$ V to 5.5 V / $T_A = -40$ °C to +85°C	READ / WRITE
$V_{CC} = 1.6$ V to 5.5 V / $T_A = -40$ °C to +85°C	READ
$V_{CC} = 1.6$ V to 5.5 V / $T_A = 0$ °C to +85°C	WRITE

**Table 4. D.C. OPERATING CHARACTERISTICS**

Symbol	Parameter	Test Conditions	Min	Max	Unit
$I_{CCR}$	Read Current	Read, $f_{SCL} = 400$ kHz/1 MHz		1	mA
$I_{CCW}$	Write Current			2	mA
$I_{SB}$	Standby Current	All I/O Pins at GND or $V_{CC}$	$V_{CC} < 2.5$ V	1	$\mu$ A
			$V_{CC} > 2.5$ V	2	
$I_L$	I/O Pin Leakage	Pin at GND or $V_{CC}$		2	$\mu$ A
$V_{IL1}$	Input Low Voltage	$V_{CC} \geq 2.5$ V	-0.5	$0.3 V_{CC}$	V
$V_{IL2}$	Input Low Voltage	$V_{CC} < 2.5$ V	-0.5	$0.25 V_{CC}$	V
$V_{IH1}$	Input High Voltage	$V_{CC} \geq 2.5$ V	$0.7 V_{CC}$	$V_{CC} + 1$	V
$V_{IH2}$	Input High Voltage	$V_{CC} < 2.5$ V	$0.75 V_{CC}$	$V_{CC} + 1$	V
$V_{OL1}$	Output Low Voltage	$V_{CC} \geq 2.5$ V, $I_{OL} = 3.0$ mA		0.4	V
$V_{OL2}$	Output Low Voltage	$V_{CC} < 2.5$ V, $I_{OL} = 1.0$ mA		0.2	V

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

**Table 5. PIN IMPEDANCE CHARACTERISTICS**

Symbol	Parameter	Conditions	Max	Unit
$C_{IN}$ (Note 5)	SDA I/O Pin Capacitance	$V_{IN} = 0$ V	8	pF
$C_{IN}$ (Note 5)	Input Capacitance (other pins)	$V_{IN} = 0$ V	6	pF

5. These parameters are tested initially and after a design or process change that affects the parameter according to appropriate AEC-Q100 and JEDEC test methods.

# N24C256

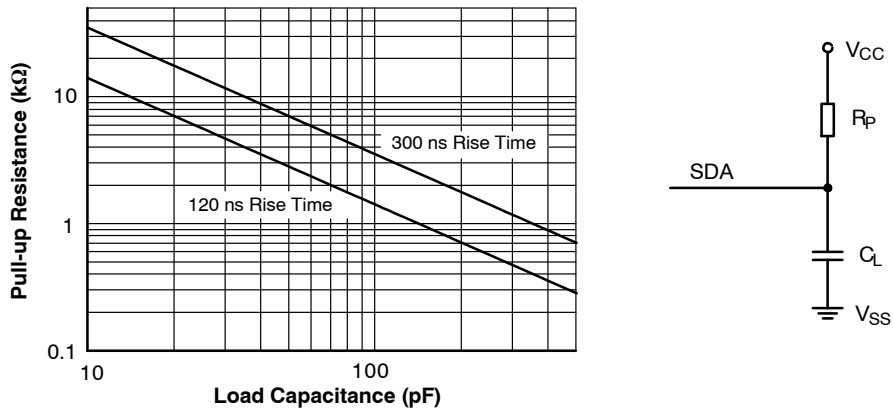
**Table 6. A.C. CHARACTERISTICS** (Note 6)

Symbol	Parameter	Standard $V_{CC} = 1.7$ to $5.5$ $T_A = -40$ to $85^\circ\text{C}$		Fast $V_{CC} = 1.7$ to $5.5$ $T_A = -40$ to $85^\circ\text{C}$		Fast-Plus $V_{CC} = 1.7$ to $5.5$ $T_A = -40$ to $85^\circ\text{C}$		Unit
		Min	Max	Min	Max	Min	Max	
$F_{SCL}$	Clock Frequency		100		400		1,000	kHz
$t_{HD:STA}$	START Condition Hold Time	4		0.6		0.25		$\mu\text{s}$
$t_{LOW}$	Low Period of SCL Clock	4.7		1.3		0.45		$\mu\text{s}$
$t_{HIGH}$	High Period of SCL Clock	4		0.6		0.40		$\mu\text{s}$
$t_{SU:STA}$	START Condition Setup Time	4.7		0.6		0.25		$\mu\text{s}$
$t_{HD:DAT}$	Data In Hold Time	0		0		0		$\mu\text{s}$
$t_{SU:DAT}$	Data In Setup Time	250		100		50		ns
$t_R$ (Note 7)	SDA and SCL Rise Time		1,000	20	300		100	ns
$t_F$ (Note 7)	SDA and SCL Fall Time		300	20	300		100	ns
$t_{SU:STO}$	STOP Condition Setup Time	4		0.6		0.25		$\mu\text{s}$
$t_{BUF}$	Bus Free Time Between STOP and START	4.7		1.3		0.5		$\mu\text{s}$
$t_{AA}$	SCL Low to Data Out Valid		3.5		0.9		0.40	$\mu\text{s}$
$t_{DH}$	Data Out Hold Time	100		100		50		ns
$T_i$ (Note 7)	Noise Pulse Filtered at SCL and SDA Inputs		100		50		50	ns
$t_{WR}$	Write Cycle Time		5		5		5	ms
$T_{PU}$ (Notes 7, 8)	Power-up to Ready Mode		0.35		0.35		0.35	ms

- 6. Test conditions according to "A.C. Test Conditions" table.
- 7. Tested initially and after a design or process change that affects this parameter.
- 8.  $t_{PU}$  is the delay between the time  $V_{CC}$  is stable and the device is ready to accept commands.

**Table 7. A.C. TEST CONDITIONS**

Parameter	Condition
Input Levels	$0.2 \times V_{CC}$ to $0.8 \times V_{CC}$
Input Rise and Fall Times	$\leq 50$ ns
Input Reference Levels	$0.3 \times V_{CC}$ , $0.7 \times V_{CC}$
Output Reference Levels	$0.5 \times V_{CC}$
Output Load	Current Source: $I_{OL} = 3$ mA ( $V_{CC} \geq 2.5$ V); $I_{OL} = 1$ mA ( $V_{CC} < 2.5$ V); $C_L = 100$ pF



**Figure 2. Maximum Pull-up Resistance vs. Load Capacitance**

**Power-On Reset (POR)**

The N24C256 incorporates Power-On Reset (POR) circuitry which protects the device against powering up in the wrong state.

The N24C256 will power up into Standby mode after  $V_{CC}$  exceeds the POR trigger level and will power down into Reset mode when  $V_{CC}$  drops below the POR trigger level. This bi-directional POR feature protects the device against ‘brown-out’ failure following a temporary loss of power.

**Pin Description**

- **SCL:** The Serial Clock input pin accepts the Serial Clock generated by the Master.
- **SDA:** The Serial Data I/O pin receives input data and transmits data stored in EEPROM. In transmit mode, this pin is open drain. Data is acquired on the positive edge, and is delivered on the negative edge of SCL.
- **WP:** WP is the Write Protect pin. While the WP pin is connected to the power supply, the entire array becomes Write Protected (i.e. the device becomes Read only). When WP is tied to Ground or left floating, the normal write operations are allowed.
- **A2:** The A2 pin is a device address input. If A2 is left floating, the input defaults to zero. When A2 is set to logic-0 the device address is 0xA1/0xA0 for read/write. When A2 is set to logic-1 the device address is 0xA9/0xA8 for read/write.

**Functional Description**

The N24C256 supports the Inter-Integrated Circuit (I<sup>2</sup>C) Bus data transmission protocol, which defines a device that sends data to the bus as a transmitter and a device receiving data as a receiver. Data flow is controlled by a Master device, which generates the serial clock and all START and STOP conditions. The N24C256 acts as a Slave device. Master and Slave alternate as either transmitter or receiver.

**I<sup>2</sup>C Bus Protocol**

The I<sup>2</sup>C bus consists of two ‘wires’, SCL and SDA. The two wires are connected to the  $V_{CC}$  supply via pull-up

resistors. Master and Slave devices connect to the 2-wire bus via their respective SCL and SDA pins. The transmitting device pulls down the SDA line to ‘transmit’ a ‘0’ and releases it to ‘transmit’ a ‘1’.

Data transfer may be initiated only when the bus is not busy (see A.C. Characteristics).

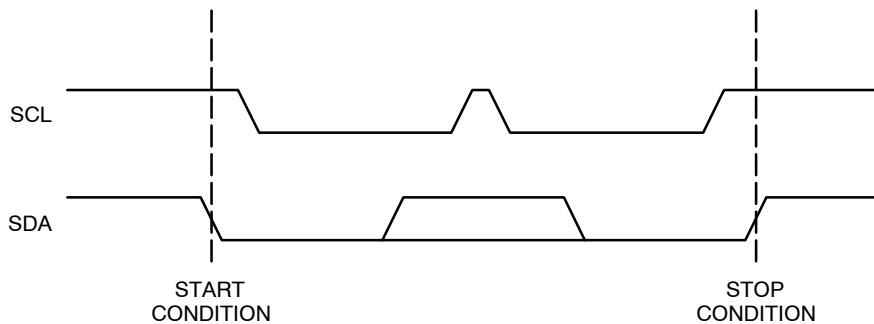
During data transfer, the SDA line must remain stable while the SCL line is HIGH. An SDA transition while SCL is HIGH will be interpreted as a START or STOP condition (Figure 3). The START condition precedes all commands. It consists of a HIGH to LOW transition on SDA while SCL is HIGH. The STOP acts as a ‘wake-up’ call to all receivers. Absent a START, a Slave will not respond to commands. The STOP condition completes all commands. It consists of a LOW to HIGH transition on SDA while SCL is HIGH.

**Device Addressing**

The Master initiates data transfer by creating a START condition on the bus. The Master then broadcasts an 8-bit serial Slave address. The first 4 bits of the Slave address are set to 1010. The next 3 bits must match the logic state of A2, 0 and 0. The last bit, R/W, specifies whether a Read (1) or Write (0) operation is to be performed.

**Acknowledge**

After processing the Slave address, the Slave responds with an acknowledge (ACK) by pulling down the SDA line during the 9<sup>th</sup> clock cycle (Figure 5). The Slave will also acknowledge all address bytes and every data byte presented in Write mode if the addressed location is not write protected. In Read mode the Slave shifts out a data byte, and then releases the SDA line during the 9<sup>th</sup> clock cycle. As long as the Master acknowledges the data, the Slave will continue transmitting. The Master terminates the session by not acknowledging the last data byte (NoACK) and by issuing a STOP condition. Bus timing is illustrated in Figure 6.

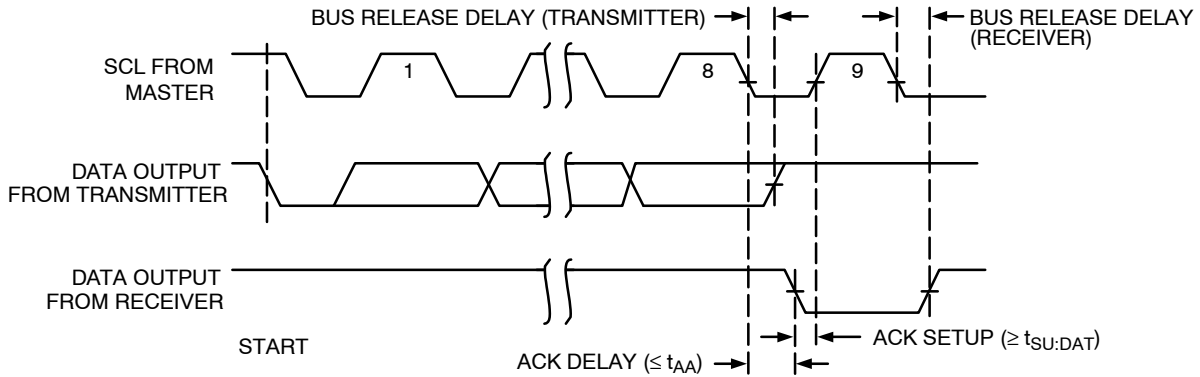


**Figure 3. START/STOP Conditions**

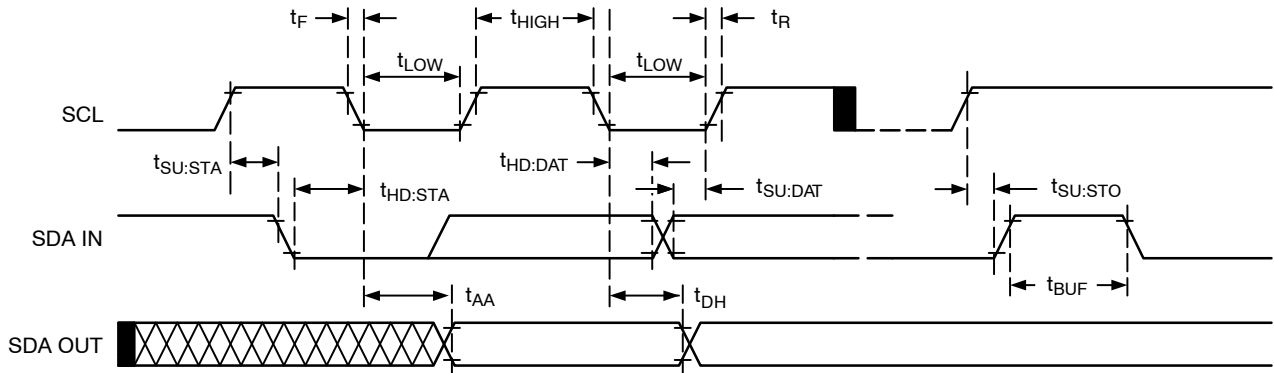
# N24C256

Memory Array Access	1	0	1	0	A2	0	0	R/W
---------------------	---	---	---	---	----	---	---	-----

**Figure 4. Slave Address Bits**



**Figure 5. Acknowledge Timing**



**Figure 6. Bus Timing**

## Write Operations

### Byte Write

In Byte Write mode the Master sends a START, followed by Slave address, two byte address and data to be written (Figure 7). The Slave, N24C256 acknowledges all 4 bytes, and the Master then follows up with a STOP, which in turn starts the internal Write operation (Figure 8). During the internal Write cycle ( $t_{WR}$ ), the N24C256 will not acknowledge any Read or Write request from the Master.

### Page Write

The N24C256 contains 32,768 bytes of data, arranged in 512 pages of 64 bytes each. A two byte address word, following the Slave address, points to the first byte to be written into the memory array. The most significant 8 bits

from the address active bits (a14 to a6) identify the page and the last 6 bits (a5 to a0) identify the byte within the page. Up to 64 bytes can be written in one Write cycle (Figure 9). The internal byte address counter is automatically incremented after each data byte is loaded. If the Master transmits more than 64 data bytes, then earlier bytes will be overwritten by later bytes in a 'wrap-around' fashion (within the selected page). The internal Write cycle starts immediately following the STOP.

### Acknowledge Polling

The ready/busy status of the N24C256 can be ascertained by sending Read or Write requests immediately following the STOP condition that initiated the internal Write cycle. As long as internal Write is in progress, the N24C256 will not acknowledge the Slave address.

# N24C256

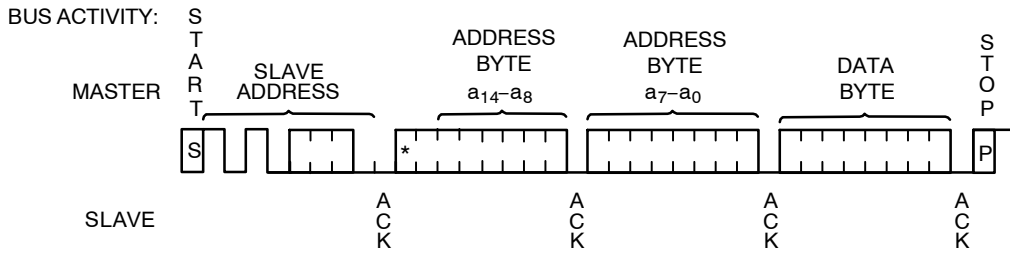


Figure 7. Byte Write Sequence

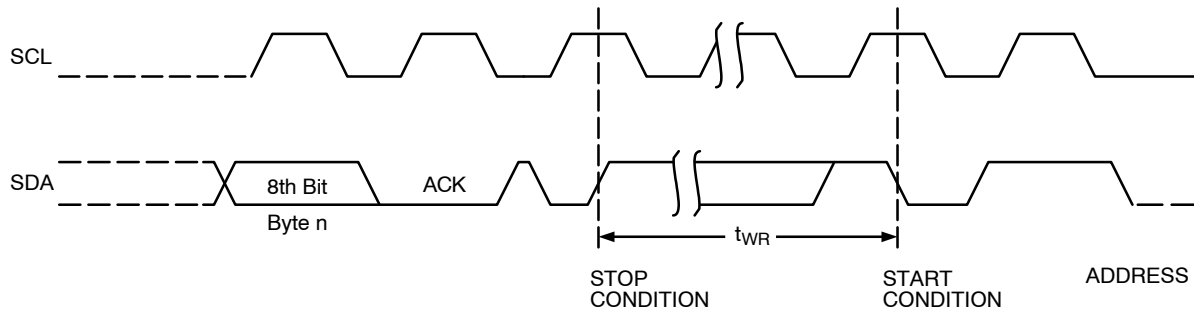


Figure 8. Write Cycle Timing

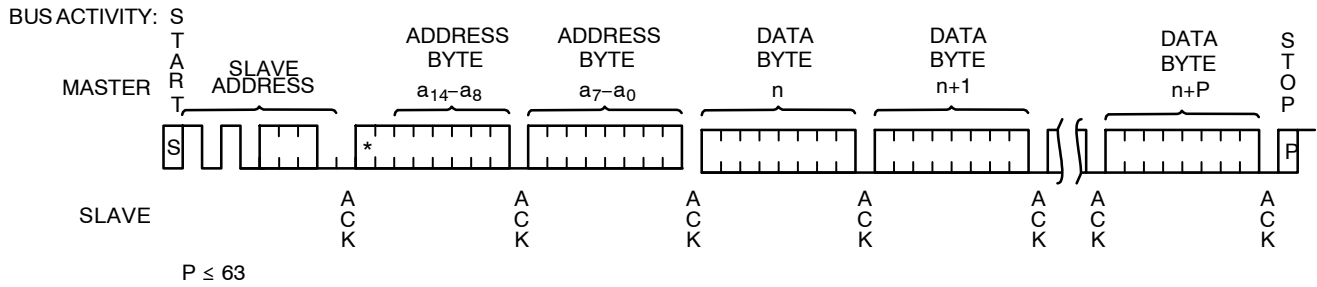


Figure 9. Page Write Sequence

# N24C256

## Read Operations

### Immediate Read

Upon receiving a Slave address with the  $R/\bar{W}$  bit set to '1', the N24C256 will interpret this as a request for data residing at the current byte address in memory. The N24C256 will acknowledge the Slave address, will immediately shift out the data residing at the current address, and will then wait for the Master to respond. If the Master does not acknowledge the data (NoACK) and then follows up with a STOP condition (Figure 10), the N24C256 returns to Standby mode.

### Selective Read

To read data residing at a specific location, the internal address counter must first be initialized as described under Byte Write. If rather than following up the two address bytes with data, the Master instead follows up with an Immediate Read sequence, then the N24C256 will use the 14 active

address bits to initialize the internal address counter and will shift out data residing at the corresponding location. If the Master does not acknowledge the data (NoACK) and then follows up with a STOP condition (Figure 11), the N24C256 returns to Standby mode.

### Sequential Read

If during a Read session the Master acknowledges the 1<sup>st</sup> data byte, then the N24C256 will continue transmitting data residing at subsequent locations until the Master responds with a NoACK, followed by a STOP (Figure 12). In contrast to Page Write, during Sequential Read the address count will automatically increment to and then wrap-around at end of memory (rather than end of page).

### Delivery State

The N24C256 is shipped erased, i.e., all memory array bytes are FFh.

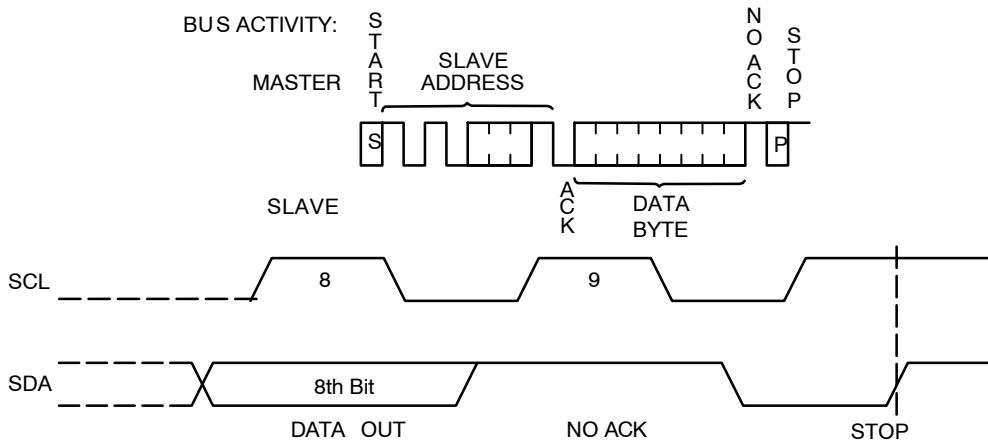


Figure 10. Immediate Read Sequence and Timing

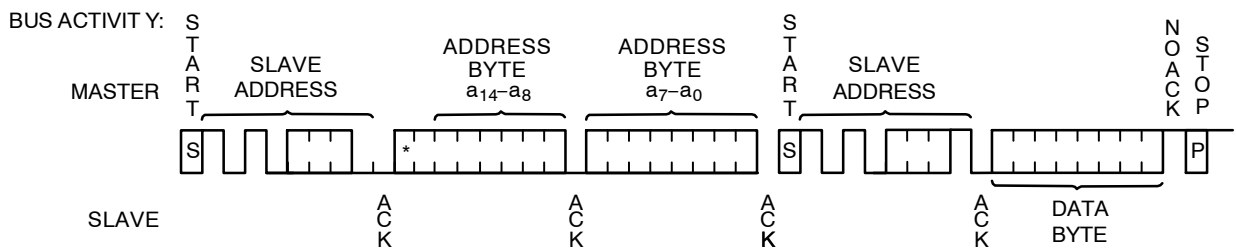


Figure 11. Selective Read Sequence

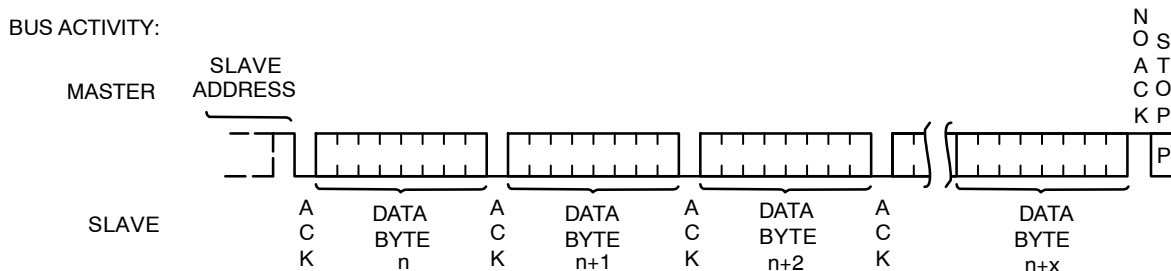


Figure 12. Sequential Read Sequence

## N24C256

**Table 8. ORDERING INFORMATION** (Notes 9 thru 11)

Device Order Number	Specific Device Marking	Package Type	Temperature Range	Lead Finish	Shipping <sup>†</sup>
N24C256C6DYT3G	T	WLCSP 6-ball	Industrial (-40°C to +85°C)	N/A	5,000 / Tape & Reel

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

9. All packages are RoHS-compliant (Lead-free, Halogen-free).

10. For detailed information and a breakdown of device nomenclature and numbering systems, please see the ON Semiconductor Device Nomenclature document, TND310/D, available at [www.onsemi.com](http://www.onsemi.com)

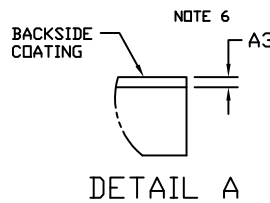
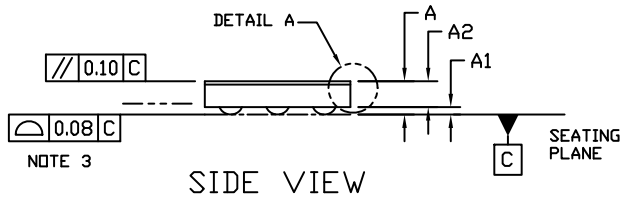
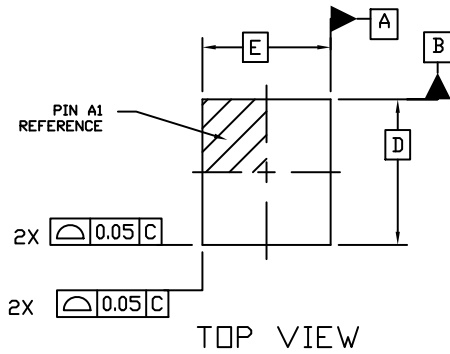
11. **Caution:** The EEPROM devices delivered in WLCSP must never be exposed to ultraviolet light. When exposed to ultraviolet light the EEPROM cells lose their stored data.



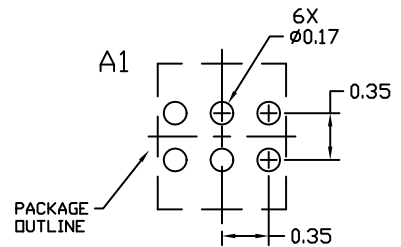
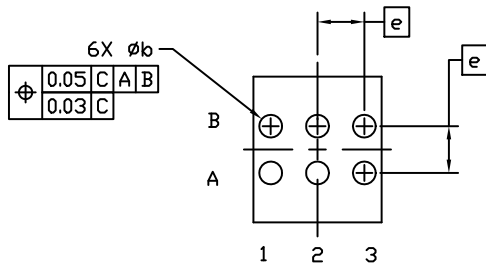


**WLCSP6, 1.09x0.96x0.3**  
**CASE 567WC**  
**ISSUE O**

DATE 13 MAR 2018



DIM	MILLIMETERS	
	MIN.	MAX.
A	---	0.30
A1	0.045	0.065
A2	0.195 REF	
A3	0.025 REF	
b	0.15	0.19
D	1.09 BSC	
E	0.96 BSC	
e	0.35 BSC	



**GENERIC MARKING DIAGRAM\***



X = Specific Device Code  
 Y = Year  
 W = Work Week

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. COPLANARITY APPLIES TO THE SPHERICAL CROWNS OF THE SOLDER BALLS.
4. DATUM C, THE SEATING PLANE, IS DEFINED BY THE SPHERICAL CROWNS OF THE SOLDER BALLS.
5. DIMENSION b IS MEASURED AT THE MAXIMUM SOLDER BALL DIAMETER PARALLEL TO DATUM C.
6. BACKSIDE COATING IS OPTIONAL.

<b>DOCUMENT NUMBER:</b>	<b>98AON85367G</b>	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
<b>DESCRIPTION:</b>	<b>WLCSP6, 1.09x0.96x0.3</b>	<b>PAGE 1 OF 1</b>

ON Semiconductor and are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. ON Semiconductor does not convey any license under its patent rights nor the rights of others.

**onsemi**, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

---

## ADDITIONAL INFORMATION

### TECHNICAL PUBLICATIONS:

Technical Library: [www.onsemi.com/design/resources/technical-documentation](http://www.onsemi.com/design/resources/technical-documentation)  
onsemi Website: [www.onsemi.com](http://www.onsemi.com)

### ONLINE SUPPORT: [www.onsemi.com/support](http://www.onsemi.com/support)

For additional information, please contact your local Sales Representative at [www.onsemi.com/support/sales](http://www.onsemi.com/support/sales)