

# N93C66

## 4 Kb Microwire Serial CMOS EEPROM

### Description

The N93C66 is a 4 kb CMOS Serial EEPROM device which is organized as either 256 registers of 16 bits (ORG pin at  $V_{CC}$ ) or 512 registers of 8 bits (ORG pin at GND). Each register can be written (or read) serially by using the DI (or DO) pin. The device features sequential read and self-timed internal write with auto-clear. On-chip Power-On Reset circuitry protects the internal logic against powering up in the wrong state.

### Features

- High Speed Operation: 4 MHz
- 1.7 V to 5.5 V Supply Voltage Range
- Selectable x8 or x16 Memory Organization
- Sequential Read
- Software Write Protection
- Power-up Inadvertent Write Protection
- Low Power CMOS Technology
- 1,000,000 Program/Erase Cycles
- 100 Year Data Retention
- Industrial Temperature Range
- 8-pad TDFN Package
- These Devices are Pb-Free, Halogen Free/BFR Free, and RoHS Compliant

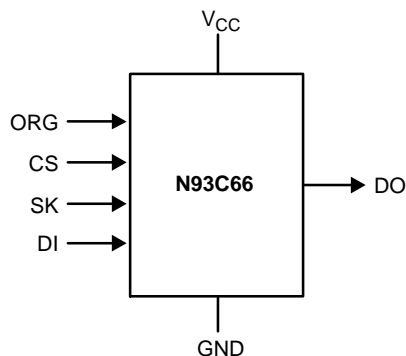


Figure 1. Functional Symbol

### N93C66 Selectable Organization:

When the ORG pin is connected to  $V_{CC}$ , the x16 organization is selected. When it is connected to ground, the x8 organization is selected. If the ORG pin is left unconnected, then an internal pull-up device will select the x16 organization.



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TDFN-8  
VP2 SUFFIX  
CASE 511AK

### PIN CONFIGURATION

(Top View)

CS	1	8	$V_{CC}$
SK	2	7	NC
DI	3	6	ORG
DO	4	5	GND

TDFN (VP2)

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

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**Table 1. PIN FUNCTION**

Pin Name	Function	Pin Name	Function
CS	Chip Select	V <sub>CC</sub>	Power Supply
SK	Clock Input	GND	Ground
DI	Serial Data Input	ORG	Memory Organization
DO	Serial Data Output	NC	No Connection

**Table 2. ABSOLUTE MAXIMUM RATINGS**

Parameters	Ratings	Units
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.

- The DC input voltage on any pin should not be lower than -0.5 V or higher than V<sub>CC</sub> + 0.5 V. During transitions, the voltage on any pin may undershoot to no less than -1.5 V or overshoot to no more than V<sub>CC</sub> + 1.5 V, for periods of less than 20 ns.

**Table 3. RELIABILITY CHARACTERISTICS** (Note 2)

Symbol	Parameter	Min	Units
N <sub>END</sub> (Note 3)	Endurance	1,000,000	Program / Erase Cycles
T <sub>DR</sub>	Data Retention	100	Years

- 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.
- Block Mode, V<sub>CC</sub> = 5 V, 25°C.

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

(V<sub>CC</sub> = +1.7 V to +5.5 V, T<sub>A</sub> = -40°C to +85°C unless otherwise specified.)

Symbol	Parameter	Test Conditions		Min	Max	Units
I <sub>CC1</sub>	Power Supply Current (Write)				1	mA
I <sub>CC2</sub>	Power Supply Current (Read)	f <sub>SK</sub> = 2 MHz			500	μA
I <sub>SB1</sub>	Power Supply Current (Standby) (x8 Mode)	V <sub>IN</sub> = GND or V <sub>CC</sub> , CS = GND ORG = GND	T <sub>A</sub> = -40°C to +85°C		2	μA
I <sub>SB2</sub>	Power Supply Current (Standby) (x16 Mode)	V <sub>IN</sub> = GND or V <sub>CC</sub> , CS = GND ORG = Float or V <sub>CC</sub>	T <sub>A</sub> = -40°C to +85°C		1	μA
I <sub>LI</sub>	Input Leakage Current	V <sub>IN</sub> = GND to V <sub>CC</sub>	T <sub>A</sub> = -40°C to +85°C		1	μA
I <sub>LO</sub>	Output Leakage Current	V <sub>OUT</sub> = GND to V <sub>CC</sub> , CS = GND	T <sub>A</sub> = -40°C to +85°C		1	μA
V <sub>IL1</sub>	Input Low Voltage	4.5 V ≤ V <sub>CC</sub> < 5.5 V		-0.1	0.8	V
V <sub>IH1</sub>	Input High Voltage	4.5 V ≤ V <sub>CC</sub> < 5.5 V		2	V <sub>CC</sub> + 1	V
V <sub>IL2</sub>	Input Low Voltage	1.7 V ≤ V <sub>CC</sub> < 4.5 V		0	V <sub>CC</sub> × 0.2	V
V <sub>IH2</sub>	Input High Voltage	1.7 V ≤ V <sub>CC</sub> < 4.5 V		V <sub>CC</sub> × 0.7	V <sub>CC</sub> + 1	V
V <sub>OL1</sub>	Output Low Voltage	4.5 V ≤ V <sub>CC</sub> < 5.5 V, I <sub>OL</sub> = 3.0 mA			0.4	V
V <sub>OH1</sub>	Output High Voltage	4.5 V ≤ V <sub>CC</sub> < 5.5 V, I <sub>OH</sub> = -400 μA		2.4		V
V <sub>OL2</sub>	Output Low Voltage	1.7 V ≤ V <sub>CC</sub> < 4.5 V, I <sub>OL</sub> = 1 mA			0.2	V
V <sub>OH2</sub>	Output High Voltage	1.7 V ≤ V <sub>CC</sub> < 4.5 V, I <sub>OH</sub> = -100 μA		V <sub>CC</sub> - 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.

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**Table 5. PIN CAPACITANCE** ( $T_A = 25^\circ\text{C}$ ,  $f = 1.0\text{ MHz}$ ,  $V_{CC} = +5.0\text{ V}$ )

Symbol	Test	Conditions	Min	Typ	Max	Units
$C_{OUT}$ (Note 4)	Output Capacitance (DO)	$V_{OUT} = 0\text{ V}$			5	pF
$C_{IN}$ (Note 4)	Input Capacitance (CS, SK, DI, ORG)	$V_{IN} = 0\text{ V}$			5	pF

4. 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.

**Table 6. A.C. CHARACTERISTICS**

( $V_{CC} = +1.7\text{ V}$  to  $+5.5\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , unless otherwise specified.) (Note 5)

Symbol	Parameter	$V_{CC} < 4.5\text{ V}$		$V_{CC} \geq 4.5\text{ V}$		Units
		Min	Max	Min	Max	
$t_{CSS}$	CS Setup Time	50		50		ns
$t_{CSH}$	CS Hold Time	0		0		ns
$t_{DIS}$	DI Setup Time	100		50		ns
$t_{DIH}$	DI Hold Time	100		50		ns
$t_{PD1}$	Output Delay to 1		0.25		0.1	$\mu\text{s}$
$t_{PD0}$	Output Delay to 0		0.25		0.1	$\mu\text{s}$
$t_{HZ}$ (Note 6)	Output Delay to High-Z		100		100	ns
$t_{EW}$	Program/Erase Pulse Width		4		4	ms
$t_{CSMIN}$	Minimum CS Low Time	0.25		0.1		$\mu\text{s}$
$t_{SKHI}$	Minimum SK High Time	0.25		0.1		$\mu\text{s}$
$t_{SKLOW}$	Minimum SK Low Time	0.25		0.1		$\mu\text{s}$
$t_{SV}$	Output Delay to Status Valid		0.25		0.1	$\mu\text{s}$
$SK_{MAX}$	Maximum Clock Frequency	DC	2000	DC	4000	kHz

5. Test conditions according to "A.C. Test Conditions" table.  
 6. 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.

**Table 7. POWER-UP TIMING** (Notes 7, 8)

Symbol	Parameter	Max	Units
$t_{PUR}$	Power-up to Read Operation	1	ms
$t_{PUW}$	Power-up to Write Operation	1	ms

7. 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.  
 8.  $t_{PUR}$  and  $t_{PUW}$  are the delays required from the time  $V_{CC}$  is stable until the specified operation can be initiated.

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**Table 8. A.C. TEST CONDITIONS**

Input Rise and Fall Times	≤ 50 ns	
Input Pulse Voltages	0.4 V to 2.4 V	4.5 V ≤ V <sub>CC</sub> ≤ 5.5 V
Timing Reference Voltages	0.8 V, 2.0 V	4.5 V ≤ V <sub>CC</sub> ≤ 5.5 V
Input Pulse Voltages	0.2 V <sub>CC</sub> to 0.7 V <sub>CC</sub>	1.7 V ≤ V <sub>CC</sub> ≤ 4.5 V
Timing Reference Voltages	0.5 V <sub>CC</sub>	1.7 V ≤ V <sub>CC</sub> ≤ 4.5 V
Output Load	Current Source I <sub>OLmax</sub> /I <sub>OHmax</sub> ; CL = 100 pF	

## Device Operation

The N93C66 is a 4096-bit nonvolatile memory intended for use with industry standard microprocessors. The N93C66 can be organized as either registers of 16 bits or 8 bits. When organized as X16, seven 11-bit instructions control the reading, writing and erase operations of the device. When organized as X8, seven 12-bit instructions control the reading, writing and erase operations of the device. The device operates on a single power supply and will generate on chip, the high voltage required during any write operation.

Instructions, addresses, and write data are clocked into the DI pin on the rising edge of the clock (SK). The DO pin is normally in a high impedance state except when reading data from the device, or when checking the ready/busy status after a write operation. The serial communication protocol follows the timing shown in Figure 2.

The ready/busy status can be determined after the start of internal write cycle by selecting the device (CS high) and polling the DO pin; DO low indicates that the write operation is not completed, while DO high indicates that the device is ready for the next instruction. If necessary, the DO pin may be placed back into a high impedance state during chip select by shifting a dummy “1” into the DI pin. The DO pin will enter the high impedance state on the rising edge of the clock (SK). Placing the DO pin into the high impedance state is recommended in applications where the DI pin and the DO pin are to be tied together to form a common DI/O pin.

The format for all instructions sent to the device is a logical “1” start bit, a 2-bit (or 4-bit) opcode, 8-bit address (an additional bit when organized X8) and for write operations a 16-bit data field (8-bit for X8 organizations). The instruction format is shown in Instruction Set table.

**Table 9. INSTRUCTION SET**

Instruction	Start Bit	Opcode	Address		Data		Comments
			x8	x16	x8	x16	
READ	1	10	A8-A0	A7-A0			Read Address AN – A0
ERASE	1	11	A8-A0	A7-A0			Clear Address AN – A0
WRITE	1	01	A8-A0	A7-A0	D7-D0	D15-D0	Write Address AN – A0
EWEN	1	00	11XXXXXXXX	11XXXXXXXX			Write Enable
EWDS	1	00	00XXXXXXXX	00XXXXXXXX			Write Disable
ERAL	1	00	10XXXXXXXX	10XXXXXXXX			Clear All Addresses
WRAL	1	00	01XXXXXXXX	01XXXXXXXX	D7-D0	D15-D0	Write All Addresses

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## Read

Upon receiving a READ command and an address (clocked into the DI pin), the DO pin of the N93C66 will come out of the high impedance state and, after sending an initial dummy zero bit, will begin shifting out the data addressed (MSB first). The output data bits will toggle on the rising edge of the SK clock and are stable after the specified time delay ( $t_{PD0}$  or  $t_{PD1}$ ).

For the N93C66 after the initial data word has been shifted out and CS remains asserted with the SK clock continuing to toggle, the device will automatically increment to the next address and shift out the next data word in a sequential READ mode. As long as CS is continuously asserted and SK continues to toggle, the device will keep incrementing to the next address automatically until it reaches to the end of the address space, then loops back to address 0. In the sequential READ mode, only the initial data word is preceded by a

dummy zero bit. All subsequent data words will follow without a dummy zero bit. The READ instruction timing is illustrated in Figure 3.

## Erase/Write Enable and Disable

The device powers up in the write disable state. Any writing after power-up or after an EWDS (erase/write disable) instruction must first be preceded by the EWEN (erase/write enable) instruction. Once the write instruction is enabled, it will remain enabled until power to the device is removed, or the EWDS instruction is sent. The EWDS instruction can be used to disable all N93C66 write and erase instructions, and will prevent any accidental writing or clearing of the device. Data can be read normally from the device regardless of the write enable/disable status. The EWEN and EWDS instructions timing is shown in Figure 4.

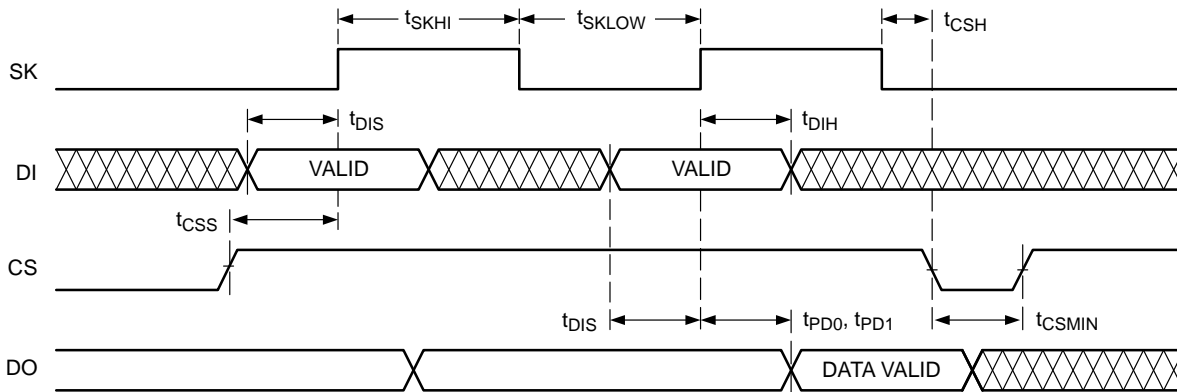


Figure 2. Synchronous Data Timing

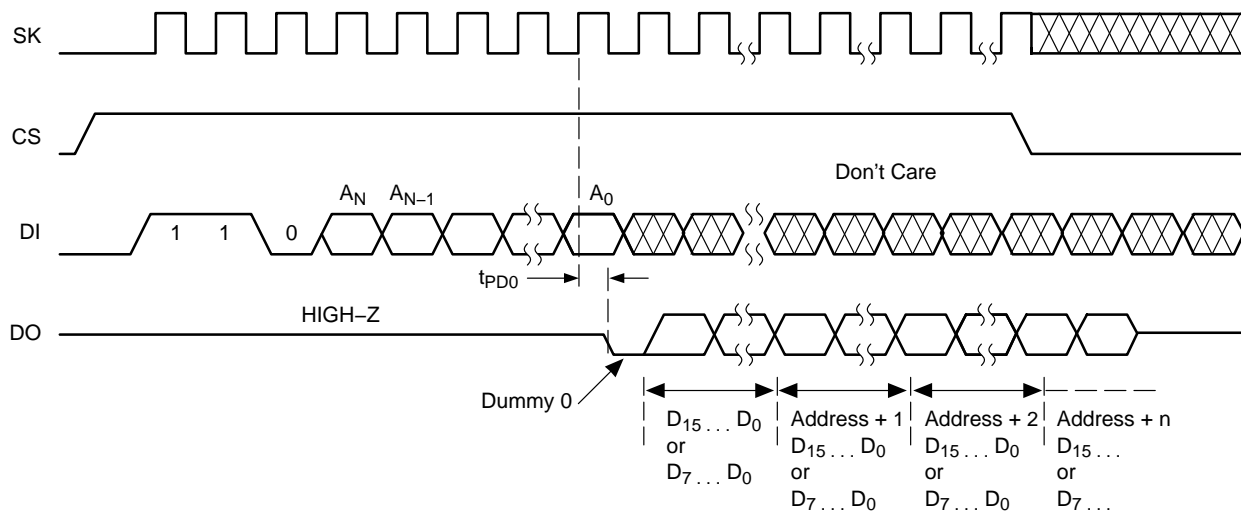


Figure 3. READ Instruction Timing

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## Write

After receiving a WRITE command (Figure 5), address and the data, the CS (Chip Select) pin must be deselected for a minimum of  $t_{CSMIN}$ . The falling edge of CS will start the self clocking clear and data store cycle of the memory location specified in the instruction. The clocking of the SK pin is not necessary after the device has entered the self clocking mode. The ready/busy status of the N93C66 can be determined by selecting the device and polling the DO pin. Since this device features Auto-Clear before write, it is NOT necessary to erase a memory location before it is written into.

## Erase

Upon receiving an ERASE command and address, the CS (Chip Select) pin must be deasserted for a minimum of  $t_{CSMIN}$  (Figure 6). The falling edge of CS will start the self clocking clear cycle of the selected memory location. The clocking of the SK pin is not necessary after the device has entered the self clocking mode. The ready/busy status of the N93C66 can be determined by selecting the device and polling the DO pin. Once cleared, the content of a cleared location returns to a logical "1" state.

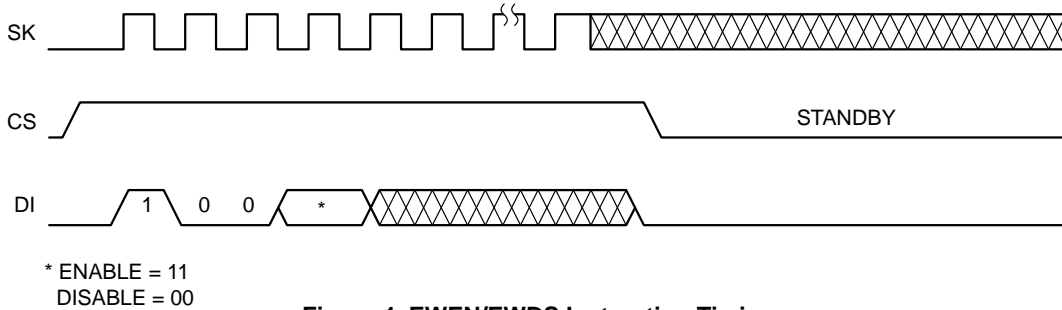


Figure 4. EWEN/EWDS Instruction Timing

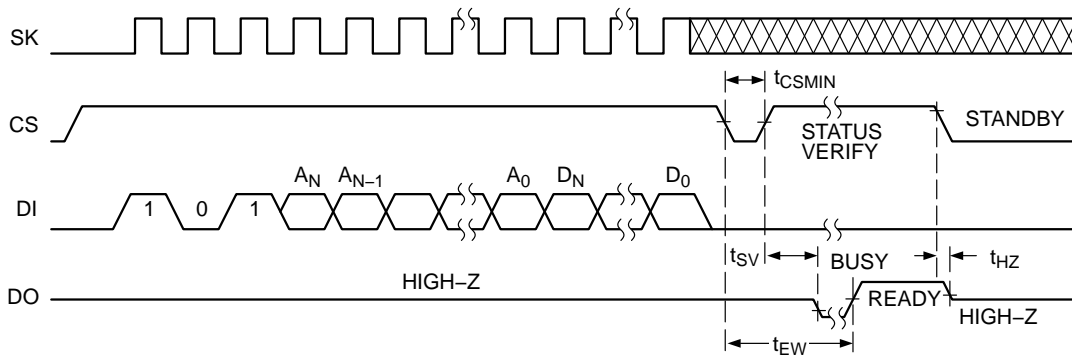


Figure 5. Write Instruction Timing

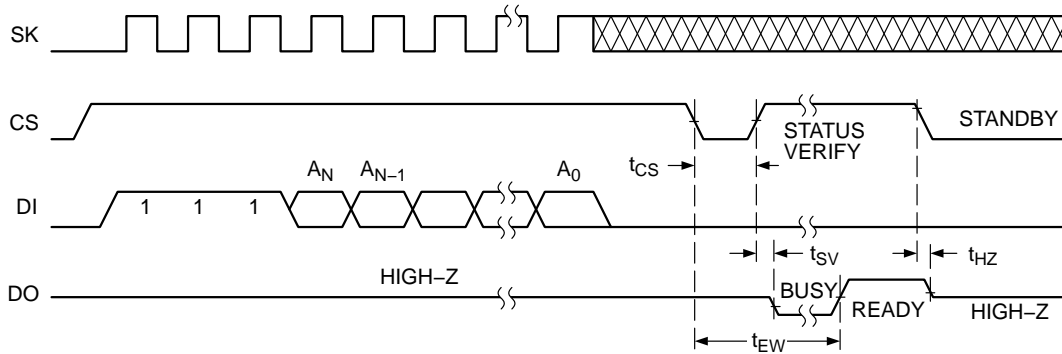


Figure 6. Erase Instruction Timing

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## Erase All

Upon receiving an ERAL command (Figure 7), the CS (Chip Select) pin must be deselected for a minimum of  $t_{CSMIN}$ . The falling edge of CS will start the self clocking clear cycle of all memory locations in the device. The clocking of the SK pin is not necessary after the device has entered the self clocking mode. The ready/busy status of the device can be determined by selecting the device and polling the DO pin. Once cleared, the contents of all memory bits return to a logical "1" state.

## Write All

Upon receiving a WRAL command and data, the CS (Chip Select) pin must be deselected for a minimum of  $t_{CSMIN}$  (Figure 8). The falling edge of CS will start the self clocking data write to all memory locations in the device. The clocking of the SK pin is not necessary after the device has entered the self clocking mode. The ready/busy status of the device can be determined by selecting the device and polling the DO pin. It is not necessary for all memory locations to be cleared before the WRAL command is executed.

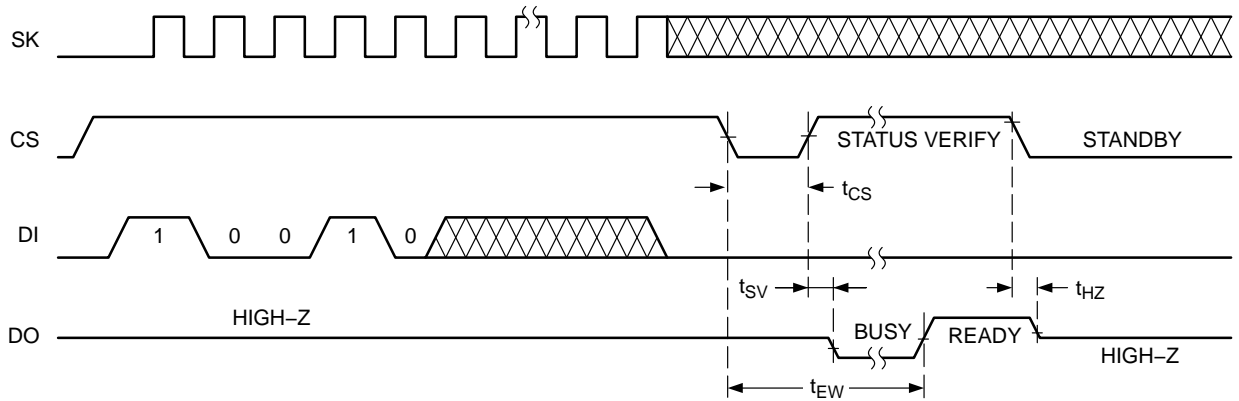


Figure 7. ERAL Instruction Timing

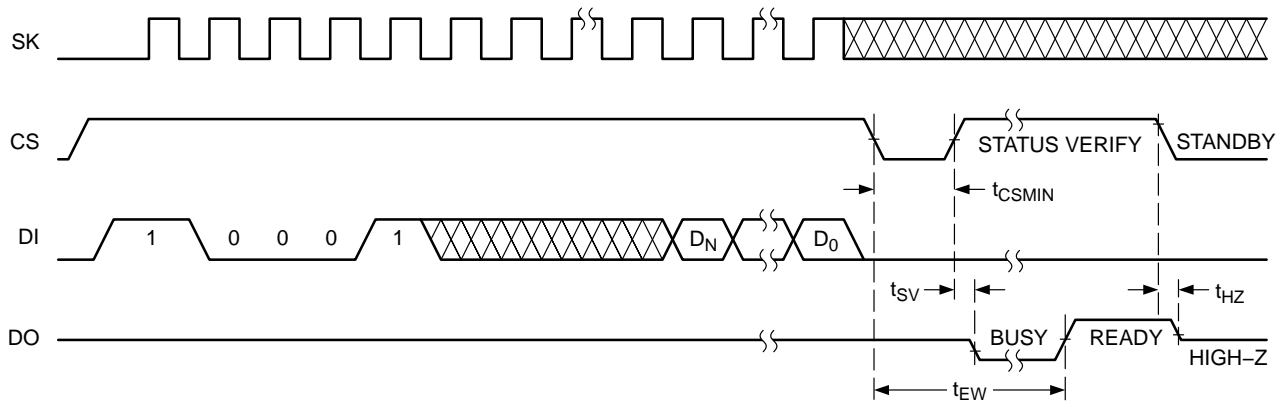


Figure 8. WRAL Instruction Timing

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

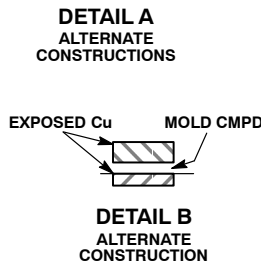
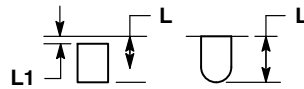
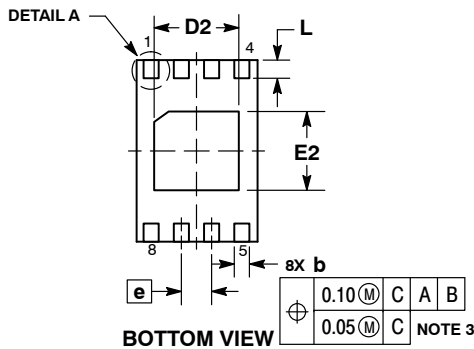
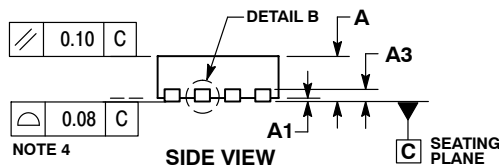
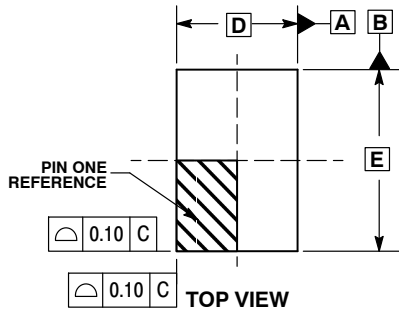
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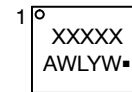


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.25MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

DIM	MILLIMETERS	
	MIN	MAX
A	0.70	0.80
A1	0.00	0.05
A3	0.20 REF	
b	0.20	0.30
D	2.00 BSC	
D2	1.30	1.50
E	3.00 BSC	
E2	1.20	1.40
e	0.50 BSC	
L	0.20	0.40
L1	---	0.15

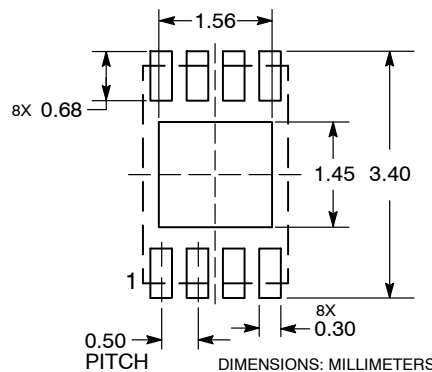
### GENERIC MARKING DIAGRAM\*



- XXXXX = Specific Device Code
- A = Assembly Location
- WL = Wafer Lot
- Y = Year
- W = Work Week
- = Pb-Free Package

\*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.

### RECOMMENDED SOLDERING FOOTPRINT\*



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

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