CAT93C57

2K-Bit Serial E²PROM

FEATURES

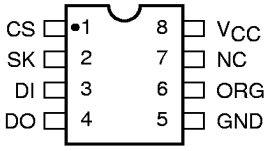
- **High Speed Operation: 1MHz**
- **Low Power CMOS Technology**
- **Wide Operating Voltage Range**
  - V_{CC} = 4.5V to 5.5V
  - V_{CC} = 2.7V to 6.0V
  - V_{CC} = 2.5V to 6.0V
  - V_{CC} = 1.8V to 6.0V
- **Selectable x8 or x16 Memory Organization**
- **Self-Timed Write Cycle with Auto-Clear**
- **Sequential Read Operation**
- **Power-Up Inadvertant Write Protection**
- **1,000,000 Program/Erase Cycles**
- **100 Year Data Retention**
- **Commercial and Industrial Temperature Ranges**

DESCRIPTION

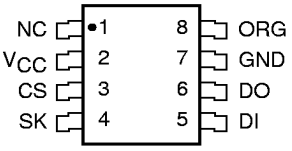
The CAT93C57 is 2K-bit Serial E²PROM memory devices which can be configured as either 128 registers by 16 bits (ORG pin at V_{CC}) or 256 registers by 8 bits (ORG pin at GND). Each register can be written (or read) serially by using the DI (or DO) pin. The CAT93C57 is manufactured using Catalyst's advanced CMOS E²PROM floating gate technology. It is designed to endure 1,000,000 program/erase cycles and has a data retention of 100 years. The device is available in 8-pin DIP or SOIC packages.

PIN CONFIGURATION

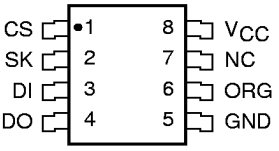
DIP Package (P)



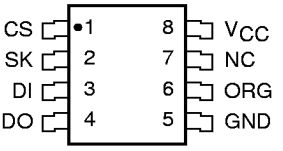
SOIC Package (J)



SOIC Package (S)



SOIC Package (K)



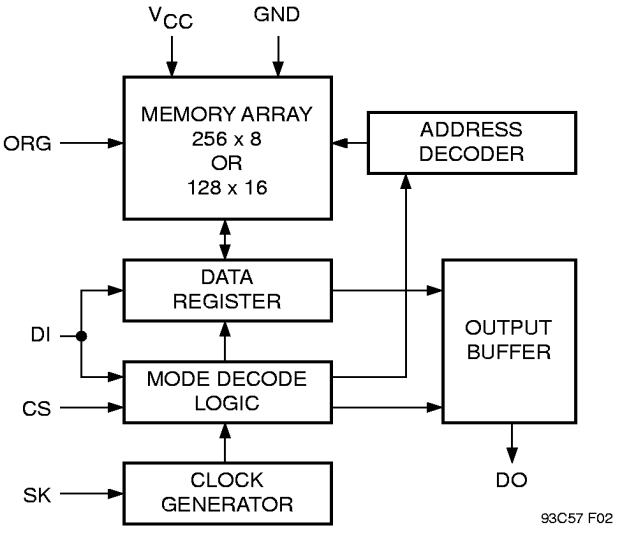
93C57 F01

PIN FUNCTIONS

Pin Name	Function
CS	Chip Select
SK	Clock Input
DI	Serial Data Input
DO	Serial Data Output
V_{CC}	1.8V to 6.0V Power Supply
GND	Ground
NC	No Connection
ORG	Memory Organization

Note: When the ORG pin is connected to V_{CC}, the 128 x 16 organization is selected. When it is connected to ground, the 256 x 8 organization is selected. If the ORG pin is left unconnected, then an internal pullup device will select the 128 x 16 organization.

BLOCK DIAGRAM



93C57 F02

Stock No. 21008-02 4/97

ABSOLUTE MAXIMUM RATINGS*

Temperature Under Bias ..... –55°C to +125°C

Storage Temperature ..... –65°C to +150°C

Voltage on any Pin with Respect to Ground(1) ..... –2.0V to +V_{CC} +2.0V

V_{CC} with Respect to Ground ..... –2.0V to +7.0V

Package Power Dissipation Capability (Ta = 25°C) 1.0W

Lead Soldering Temperature (10 secs) ..... 300°C

Output Short Circuit Current(2) ..... 100 mA

*COMMENT

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions outside of those listed in the operational sections of this specification is not implied. Exposure to any absolute maximum rating for extended periods may affect device performance and reliability.

RELIABILITY CHARACTERISTICS

Symbol	Parameter	Min.	Max.	Units	Reference Test Method
N_{END}(3)	Endurance	1,000,000		Cycles/Byte	MIL-STD-883, Test Method 1033
T_{DR}(3)	Data Retention	100		Years	MIL-STD-883, Test Method 1008
V_{ZAP}(3)	ESD Susceptibility	2000		Volts	MIL-STD-883, Test Method 3015
I_{LTH}(3)(4)	Latch-Up	100		mA	JEDEC Standard 17

D.C. OPERATING CHARACTERISTICS

V_{CC} = +1.8V to 6V, unless otherwise specified.

Symbol	Parameter	Limits			Units	Test Conditions
		Min.	Typ.	Max.		
I_{CC1}	Power Supply Current (Operating)			3	mA	DI = 0.0V, f_{SK} = 1MHz V_{CC} = 5.0V, CS = 5.0V Output Open
I_{SB}	Power Supply Current (Standby)			50	µA	CS = 0V
I_{LO}	Input Leakage Current			2	µA	V_{IN} = 0V to V_{CC}
I_{LO}	Output Leakage Current (Including ORG Pin)			10	µA	V_{OUT} = 0V to V_{CC}, CS = 0V
V_{ILI} V_{IHI}	Input Low Voltage Input High Voltage	-0.1 2		0.8 V_{CC}+1	V V	4.5V≤V_{CC}<5.5V
V_{IL2} V_{IH2}	Input Low Voltage Input High Voltage	0 V_{CC}X0.7		V_{CC}X0.2 V_{CC}+1	V V	1.8V≤V_{CC}<2.7V
V_{OLI} V_{OHI}	Output Low Voltage Output High Voltage	2.4		0.4	V V	4.5V≤V_{CC}<5.5V I_{OL} = 2.1mA I_{OH} = -400µA
V_{OL2} V_{OH2}	Output Low Voltage Output High Voltage	V_{CC}-0.2		0.2	V V	1.8V≤V_{CC}<2.7V I_{OL} = 1mA I_{OH} = -100µA

(1) The minimum DC input is -0.5V. During transitions, inputs may undershoot to -2.0V for periods of less than 20 ns. Maximum DC voltage on output pins is V_{CC} +0.5V, which may overshoot to V_{CC} +2.0V for periods of less than 20 ns.
(2) Output shorted for no more than one second. No more than one output shorted at a time.
(3) This parameter is tested initially and after a design or process change that affects the parameter.
(4) Latch-up protection is provided for stresses up to 100 mA on address and data pins from –1V to V_{CC} +1V.

INSTRUCTION SET

Instruction	Start Bit	Opcode	Address		Data		Comments
			256 x 8	128 x 16	256 x 8	128 x 16	
READ	1	1 0	A7–A0	A6–A0			Read Address AN–A0
ERASE	1	1 1	A7–A0	A6–A0			Clear Address AN–A0
WRITE	1	0 1	A7–A0	A6–A0	D7–D0	D15–D0	Write Address AN–A0
EWEN	1	0 0	11XXXXXX	11XXXXX			Write Enable
EWDS	1	0 0	00XXXXXX	00XXXXX			Write Disable
ERAL	1	0 0	10XXXXXX	10XXXXX			Clear All Addresses
WRAL	1	0 0	01XXXXXX	01XXXXX	D7–D0	D15–D0	Write All Addresses

PIN CAPACITANCE

Symbol	Test	Max.	Units	Conditions
C_{OUT}(1)	OUTPUT CAPACITANCE (DO)	5	pF	V_{OUT}=OV
C_{IN}(1)	INPUT CAPACITANCE (CS, SK, DI, ORG)	5	pF	V_{IN}=OV

A.C. CHARACTERISTICS

SYMBOL	PARAMETER	Limits						UNITS	Test Conditions
		V_{CC} = 1.8V-6V*		V_{CC} = 2.7V -6V V_{CC} = 2.5V-6V		V_{CC} = 4.5V-5.5V			
		Min.	Max.	Min.	Max.	Min.	Max.		
t_{CSS}	CS Setup Time	200		100		50		ns	C_L = 100pF
t_{CSH}	CS Hold Time	0		0		0		ns	
t_{DIS}	DI Setup Time	400		200		100		ns	
t_{DIH}	DI Hold Time	400		200		100		ns	
t_{PD1}	Output Delay to 1		1		0.5		0.25	µs	
t_{PD0}	Output Delay to 0		1		0.5		0.25	µs	
t_{HZ}(3)	Output Delay to High-Z		400		200		100	ns	
t_{EW}	Program/Erase Pulse Width		10		10		10	ms	
t_{CSMIN}	Minimum CS Low Time	1		0.5		0.25		µs	
t_{SKHI}	Minimum SK High Time	1		0.5		0.25		µs	
t_{SKLOW}	Minimum SK Low Time	1		0.5		0.25		µs	
t_{SV}	Output Delay to Status Valid		1		0.5		0.25	µs	
SK_{MAX}	Maximum Clock Frequency	DC	250	DC	500	DC	1000	KHZ	

Note:
* Preliminary data
(1) This parameter is tested initially and after a design or process change that affects the parameter.

DEVICE OPERATION

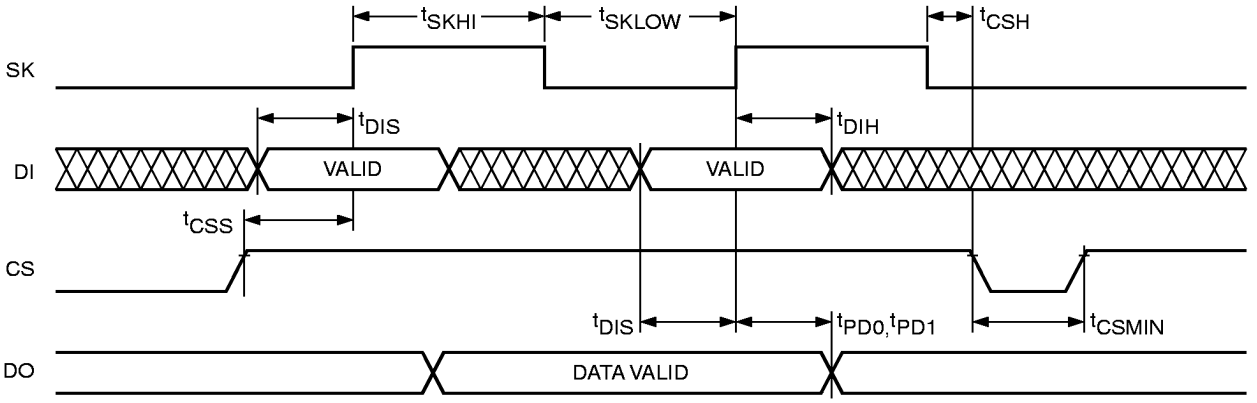
The CAT93C57 is a 2048-bit nonvolatile memory intended for use with industry standard microprocessors. The CAT93C57 can be organized as either 128 registers by 16 bits, or as 256 registers by 8 bits. Seven 10-bit instructions (11-bit instruction in 256 by 8 organization) control the reading, writing and erase operations of the device. The CAT93C57 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 ready/busy status can be determined after a write operation 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 falling 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 CAT93C57 is a logical "1" start bit, a 2-bit (or 4-bit) op code, a 7-bit address (8-bit address when organized as 256 x 8), and for write operations a 16-bit data field (8-bit data field when organized as 256 x 8).

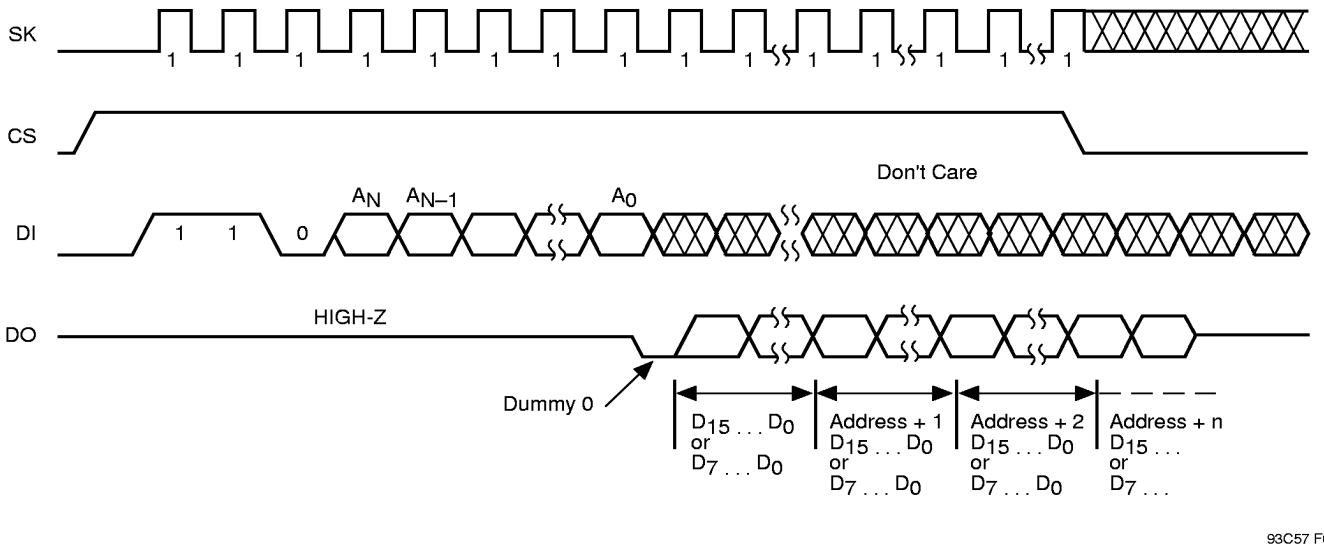
Figure 1. Sychronous Data Timing (1)



93C57 F03

Note:
(1) The ORG pin is used to configure the device for x8 or x16 operation. When x8 organization is selected, AN = A7 and DN = D7. When x16 organization is selected, AN = A6 and DN = D15.

Figure 2. Read Instruction Timing (1)



93C57 F04

Note:
(1) The ORG pin is used to configure the device for x8 or x16 operation. When x8 organization is selected, AN = A7 and DN = D7. When x16 organization is selected, AN = A6 and DN = D15.

Read

Upon receiving a READ command and an address (clocked into the DI pin), the DO pin of the CAT93C57 will come out of the high impedance state and, after sending an initial dummy zero bit, will begin shifting out the data addressed. 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}).

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 preceeded by a dummy zero bit. All subsequent data words will follow without a dummy zero bit.

Write

After receiving a WRITE command, address and the data, the CS (chip select) pin must be deselected for a minimum of 250ns (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 CAT93C57 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 the WRITE command is sent.

Figure 3. Write Instruction Timing (1)

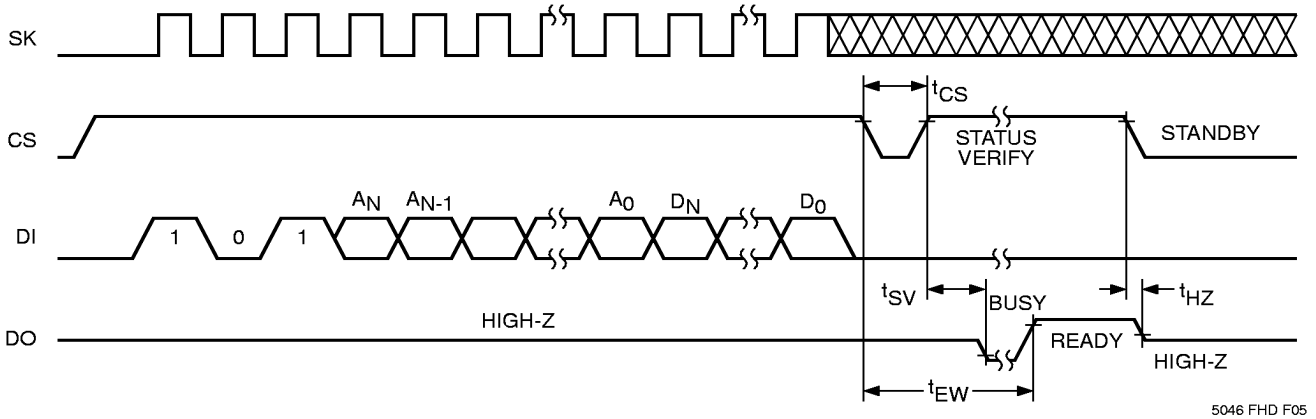
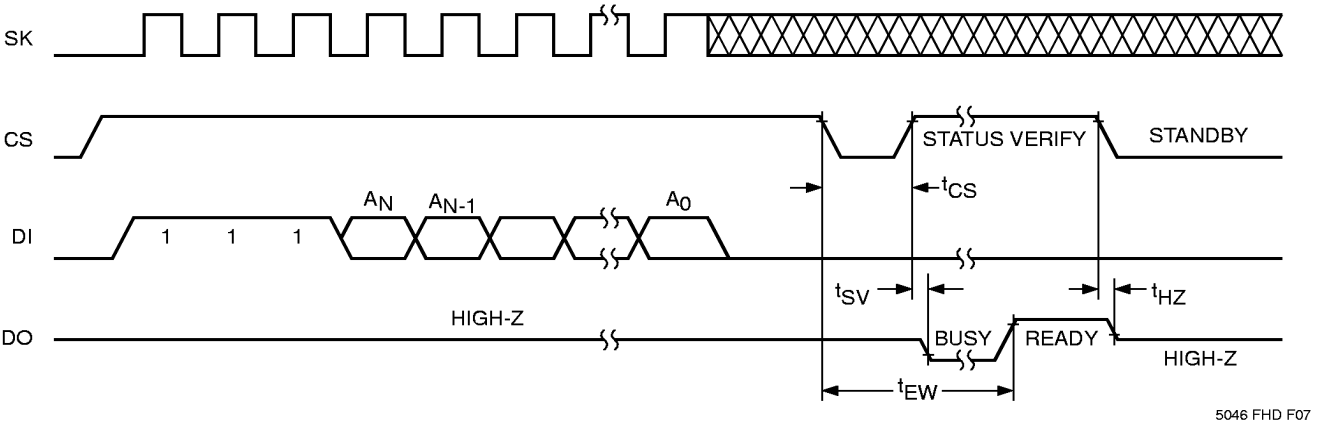


Figure 4. Erase Instruction Timing (1)



Note:
(1) The ORG pin is used to configure the device for x8 or x16 operation. When x8 organization is selected, AN = A7 and DN = D7. When x16 organization is selected, AN = A6 and DN = D15.

Erase

Upon receiving an ERASE command and address, the CS (chip select) pin must be deselected for a minimum of 250ns (t_{CSMIN}). The falling edge of CS will start the self clocking clear 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 CAT93C57 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.

Erase/Write Enable and Disable

The CAT93C57 powers up in the write disable state. Any writing after power-up or after an EWDS (write disable) instruction must first be preceded by the EWEN (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 CAT93C57 write and clear 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.

Erase All

Upon receiving an ERAL command, the CS (chip select) pin must be deselected for a minimum of 250ns (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 CAT93C57 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.

Figure 5. EWEN/EWDS Instruction Timing (1)

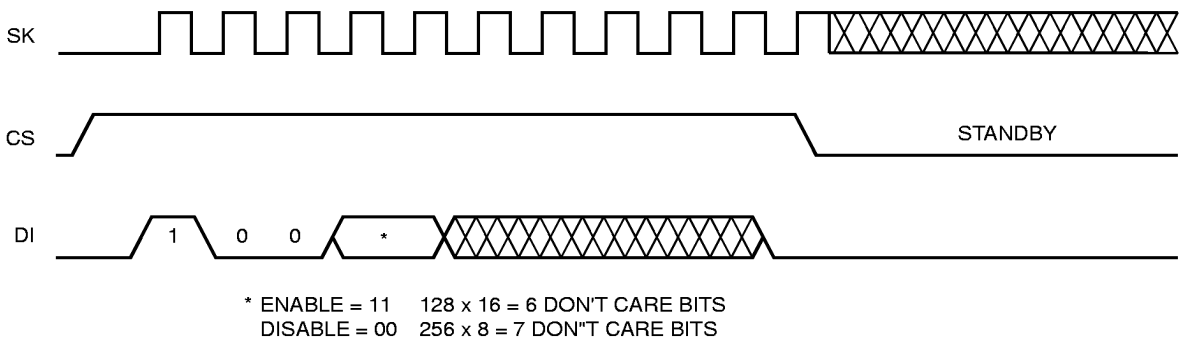
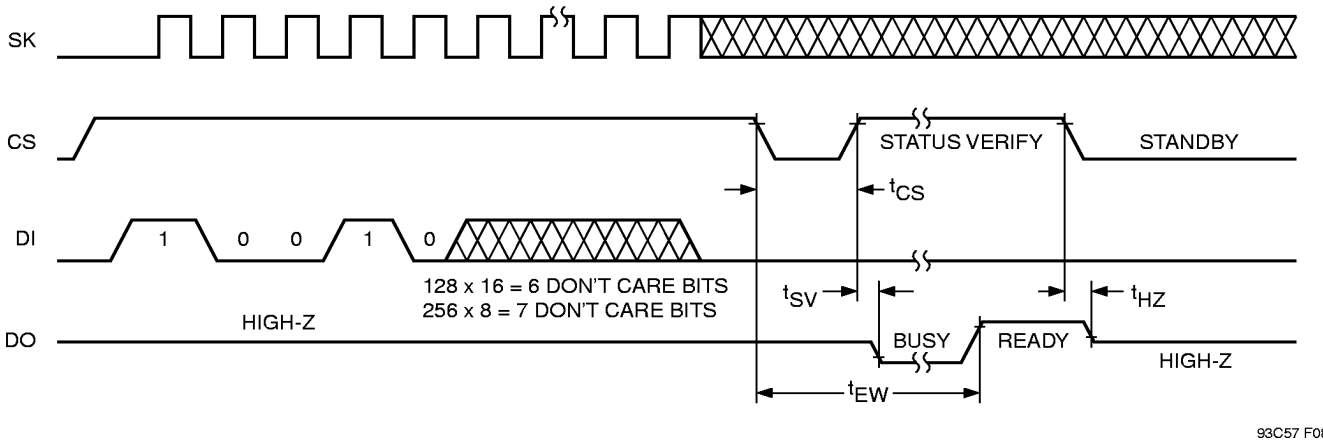


Figure 6. ERAL Instruction Timing (1)

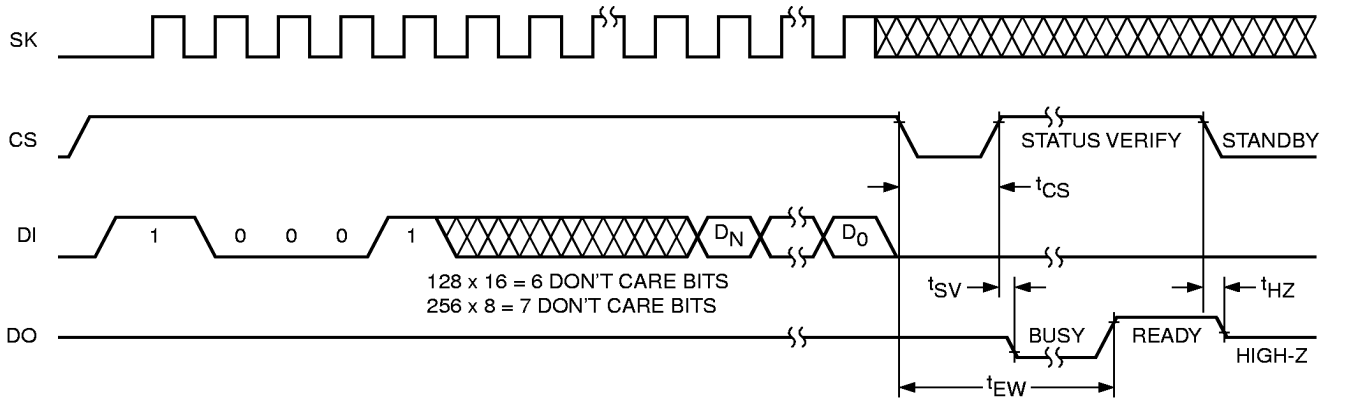


Note:
(1) The ORG pin is used to configure the device for x8 or x16 operation. When x8 organization is selected, AN = A7 and DN = D7. When x16 organization is selected, AN = A6 and DN = D15.

Write All

Upon receiving a WRAL command and data, the CS (chip select) pin must be deselected for a minimum of 250ns (t_{CSMIN}). 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 CAT93C57 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.

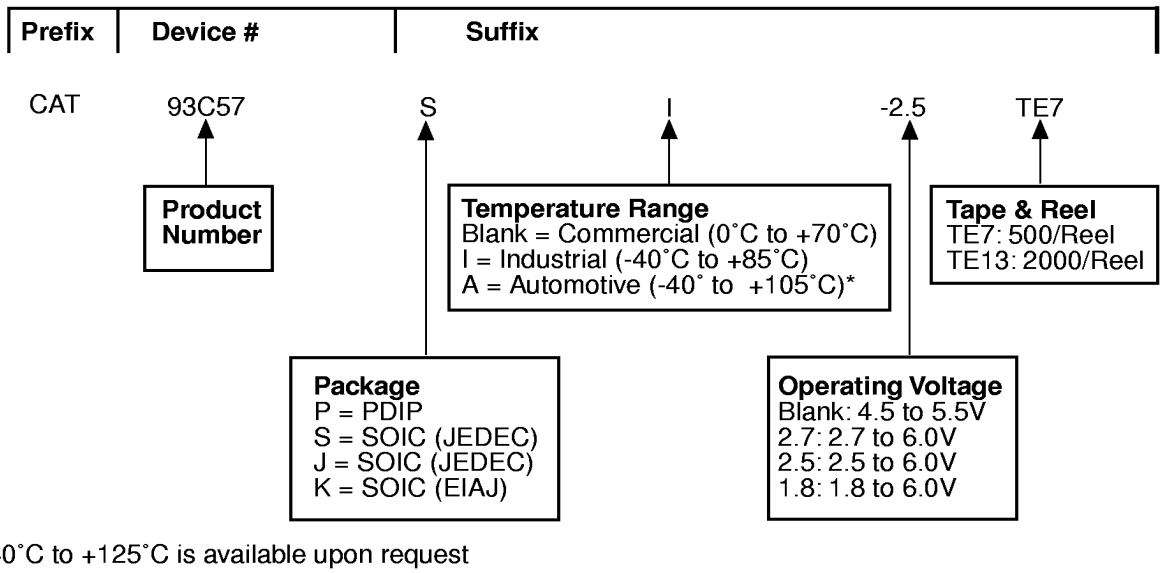
Figure 7. WRAL Instruction Timing (1)



93C57 F09

Note:
(1) The ORG pin is used to configure the device for x8 or x16 operation. When x8 organization is selected, AN = A7 and DN = D7. When x16 organization is selected, AN = A6 and DN = D15.

PIN CONFIGURATION



* -40˚C to +125˚C is available upon request

93C57 F10

Notes:
(1) The device used in the above example is a 93C57SI-2.5TE7 (SOIC, Industrial Temperature, 2.5 Volt to 6 Volt Operating Voltage, Tape & Reel)