National Semiconductor

PRELIMINARY

NMC93C06x3/C46x3/C56x3/C66x3 Extended Voltage 256-/1024/2048/4096-Bit Serial EEPROM

General Description

The NMC93C06x3/C46x3/C56x3/C66x3 are 256/1024/2048/4096 bits of CMOS electrically erasable memory divided into 16/64/128/256 16-bit registers. They are fabricated using National Semiconductor's floating-gate CMOS process for high speed and low power. They operate from a single 3.0V to 5.5V supply since V_{PP} is generated on-board. The serial organization allow the NMC93C06x3/C46x3/C56x3/C66x3 to be packaged in an 8-pin DIP or 14-pin SO package to save board space.

The memories feature a serial interface with the instruction, address, and write data, input on the Data-In (DI) pin. All read data and device status come out on the Data-Out (DO) pin. A low-to-high transition of shift clock (SK) shifts all data in and out. This serial interface is MICROWIRE™ compatible for simple interface to standard microcontrollers and microprocessors. There are 7 instructions: Read, Erase/Write Enable, Erase, Erase All*, Write, Write All*, and Erase/Write Disable. The NMC93C06x3/C46x3/C56x3/C66x3 do not require an erase cycle prior to the Write and Write All instructions. The Erase and Erase All instructions are available to maintain complete read and programming capability with the NMOS NMC9346. All programming cycles are completely self-timed for simplified operation. The busy status is available on the DO pin to indicate the completion of a programming cycle. EEPROMs are shipped in the erased state where all bits are logical 1's.

Compatibility with Other Devices

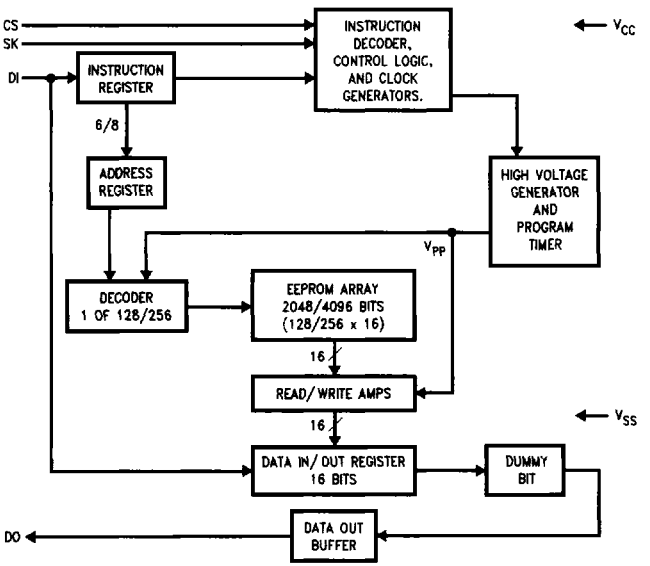
These memories are pin compatible to National Semiconductor's NMOS EEPROMs, NMC9306 and NMC9346 and CMOS EEPROMs NMC93C06x3/C46x3/C56x3/C66x3.

Features

- Typical active current 400 μA; Typical standby current 25 μA
- Reliable CMOS floating gate technology
- 3.0V to 5.5V operation in all modes
- MICROWIRE compatible serial I/O
- Self-timed programming cycle
- Device status signal during programming mode
- Sequential register read
- 40 years data retention
- 100,000 write cycles

*The instructions Erase All and Write All are functional only from V_{CC} = 4.5V to 5.5V. Their primary purpose is as test modes.

Block Diagram



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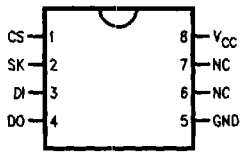
Connection Diagrams

Dual-In-Line Package (N) and 8-Pin SO (M8)



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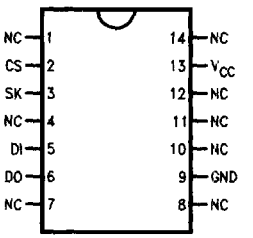
Top View

See NS Package Number N08E

Pin Names

CS	Chip Select
SK	Serial Data Clock
DI	Serial Data Input
DO	Serial Data Output
GND	Ground
V_{CC}	Power Supply

14-Pin SO Package (M)



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Top View

See NS Package Number M14A

Ordering Information

Commercial Temp. Range (0°C to +70°C)

Order Number
NMC93C06N3 NMC93C46N3/NMC93C56N3/NMC93C66N3 NMC93C46M3/NMC93C56M3/NMC93C66M3 NMC93C06M83/NMC93C46M83

Extended Temp. Range (−40°C to +85°C)

Order Number
NMC93C06EN3 NMC93C46EN3/NMC93C56EN3/NMC93C66EN3 NMC93C46EM3/NMC93C56EM3/NMC93C66EM3 NMC93C06EM83/NMC93C46EM83

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Ambient Storage Temperature	−65°C to +150°C
All Input or Output Voltages with Respect to Ground	+6.5V to −0.3V
Lead Temp. (Soldering, 10 sec.)	+300°C
ESD Rating	2000V

Operating Conditions

Ambient Operating Temperature	
NMC93C56–NMC93C66	0°C to +10°C
NMC93C56E–NMC93C66E	−40°C to +85°C
Positive Power Supply	3.0V to 5.5V

DC and AC Electrical Characteristics V_{CC} = 3.0V to 5.5V (unless otherwise specified)

Symbol	Parameter	Part Number	Conditions	Min	Max	Units
I_{CC1}	Operating Current CMOS Input Levels	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	CS = V_{IH}, SK = 0.5 MHz		2 2	mA
I_{CC2}	Operating Current TTL Input Levels	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	CS = V_{IH}, SK = 0.5 MHz		3 3	mA
I_{CC3}	Standby Current	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	CS = 0V		50 100	μA
I_{IL}	Input Leakage	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	V_{IN} = 0V to V_{CC}	−2.5 −10	2.5 10	μA
I_{OL}	Output Leakage	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	V_{IN} = 0V to V_{CC}	−2.5 −10	2.5 10	μA
V_{IL1} V_{IH1}	Input Low Voltage Input High Voltage		4.5V ≤ V_{CC} ≤ 5.5V	 2	0.8	V
V_{IL2} V_{IH2}	Input Low Voltage Input High Voltage		3V ≤ V_{CC} ≤ 4.5V	−0.1 2	0.6 V_{CC} + 1	V
V_{OL1} V_{OH1}	Output Low Voltage Output High Voltage		4.5V ≤ V_{CC} ≤ 5.5V I_{OL} = 2.1 mA I_{OH} = −400 μA	 2.4	 0.4	 V V
V_{OL2} V_{OH2}	Output Low Voltage Output High Voltage		3V ≤ V_{CC} ≤ 4.5V I_{OL} = 10 μA I_{OH} = −10 μA	 V_{CC} − 0.2	 0.2	 V V
f_{SK}	SK Clock Frequency	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E		0 0	1 0.5	MHz
t_{SKH}	SK High Time	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	(Note 2) (Note 3)	500 500		ns
t_{SKL}	SK Low Time	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	(Note 2) (Note 3)	250 500		ns
t_{CS}	Minimum CS Low Time	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	(Note 4) (Note 5)	250 500		ns
t_{CSS}	CS Setup Time	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	Relative to SK	50 100		ns
t_{PRES}	PRE Setup Time	NMC93CS06-NMC93CS66 NMC93CS06E-NMC93CS66E	Relative to SK	50 100		ns
t_{PES}	PE Setup Time	NMC93CS06-NMC93CS66 NMC93CS06E-NMC93CS66E	Relative to SK	50 100		ns

DC and AC Electrical Characteristics V_{CC} = 3.0V to 5.5V (unless otherwise specified) (Continued)

Symbol	Parameter	Part Number	Conditions	Min	Max	Units
t_{DIS}	DI Setup Time	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	Relative to SK	100 200		ns
t_{CSH}	CS Hold Time		Relative to SK	0		ns
t_{DIH}	DI Hold Time	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	Relative to SK	100 200		ns
t_{PD1}	Output Delay to "1"	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	AC Test		500 1000	ns
t_{PD0}	Output Delay to "0"	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	AC Test		500 1000	ns
t_{SV}	CS to Status Valid	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	AC Test		500 1000	ns
t_{DF}	CS to DO in TRI-STATE®	NMC93C06-NMC93C66 NMC93C06E-NMC93C66E	AC Test CS = V_{IL}		100 200	ns
t_{WP}	Write Cycle Time				15	ms
	Endurance		Number of Data Changes per Bit	Typical 100,000		Cycles

Note 1: Stress 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 these or any other conditions above those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: The SK frequency specification for Commercial parts specifies a minimum SK clock period of 2 μs, therefore in an SK clock cycle t_{SKH} + t_{SKL} must be greater than or equal to 2 μs. For example if t_{SKL} = 250 ns then the minimum t_{SKH} = 1750 ns in order to meet the SK frequency specification.

Note 3: The SK frequency specification for Extended Temperature parts specifies a minimum SK clock period of 2 μs, therefore in an SK clock cycle t_{SKH} + t_{SKL} must be greater than or equal to 2 μs. For example, if the t_{SKL} = 500 ns then the minimum t_{SKH} = 1.5 μs in order to meet the SK frequency specification.

Note 4: For Commercial parts CS must be brought low for a minimum of 250 ns (t_{CS}) between consecutive instruction cycles.

Note 5: For Extended Temperature parts CS must be brought low for a minimum of 500 ns (t_{CS}) between consecutive instruction cycles.

Note 6: This parameter is periodically sampled and not 100% tested.

Capacitance (Note 6)

T_A = 25°C f = 1 MHz

Symbol	Test	Typ	Max	Units
C_{OUT}	Output Capacitance		5	pF
C_{IN}	Input Capacitance		5	pF

AC Test Conditions

Output Load	1 TTL Gate and C_L = 100 pF
Input Pulse Levels	0.4V to 2.4V
Timing Measurement Reference Level	
Input	1V and 2V
Output	0.8V and 2V

Functional Description

The NMC93C06/C46/C56/C66 have 7 instructions as described below. Note that the MSB of any instruction is a "1" and is viewed as a start bit in the interface sequence. The next 10-bits carry the op code and the 8-bit address for register selection.

Read (READ):

The Read (READ) instruction outputs serial data on the DO pin. After a READ instruction is received, the instruction and address are decoded, followed by data transfer from the selected memory register into a 16-bit serial-out shift register. A dummy bit (logical 0) precedes the 16-bit data output string. Output data changes are initiated by a low to high transition of the SK clock.

Erase/Write Enable (EWEN):

When V_{CC} is applied to the part, it powers up in the Erase/Write Disable (EWDS) state. Therefore, all programming modes must be preceded by an Erase/Write Enable (EWEN) instruction. Once an Erase/Write Enable instruction is executed, programming remains enabled until an Erase/Write Disable (EWDS) instruction is executed or V_{CC} is removed from the part.

Erase (ERASE):

The ERASE instruction will program all bits in the specified register to the logical '1' state. CS is brought low following the loading of the last address bit. This falling edge of the CS pin initiates the self-timed programming cycle.

The DO pin indicates the READY/BUSY status of the chip if CS is brought high after a minimum of 250 ns (t_{CS}). DO = logical '0' indicates that programming is still in progress. DO = logical '1' indicates that the register, at the address specified in the instruction, has been erased, and the part is ready for another instruction.

Write (WRITE):

The Write (WRITE) instruction is followed by 16 bits of data to be written into the specified address. After the last bit of data is put on the data-in (DI) pin, CS must be brought low before the next rising edge of the SK clock. This falling edge of CS initiates the self-timed programming cycle. The DO pin indicates the READY/BUSY status of the chip if CS is brought high after a minimum of 250 ns (t_{CS}). DO = logical 0 indicates that programming is still in progress. DO = logical 1 indicates that the register at the address specified in the instruction has been written with the data pattern specified in the instruction and the part is ready for another instruction.

Erase All (ERAL):

The ERAL instruction will simultaneously program all registers in the memory array and set each bit to the logical '1' state. The Erase All cycle is identical to the ERASE cycle except for the different op-code. As in the ERASE mode, the DO pin indicates the READY/BUSY status of the chip if CS is brought high after a minimum of 250 ns (t_{CS}). The ERAL instruction is valid only at V_{CC} = 5.0V ±10%.

Write All (WRAL):

The (WRAL) instruction will simultaneously program all registers with the data pattern specified in the instruction. As in the WRITE mode, the DO pin indicates the READY/BUSY status of the chip if CS is brought high after a minimum of 250 ns (t_{CS}). The WRAL instruction is valid only at V_{CC} = 5.0V ±10%.

Erase/Write Disable (EWDS):

To protect against accidental data disturb, the Erase/Write Disable (EWDS) instruction disables all programming modes and should follow all programming operations. Execution of a READ instruction is independent of both the EWEN and EWDS instructions.

Instruction Set for the NMC93C06 and NMC93C46

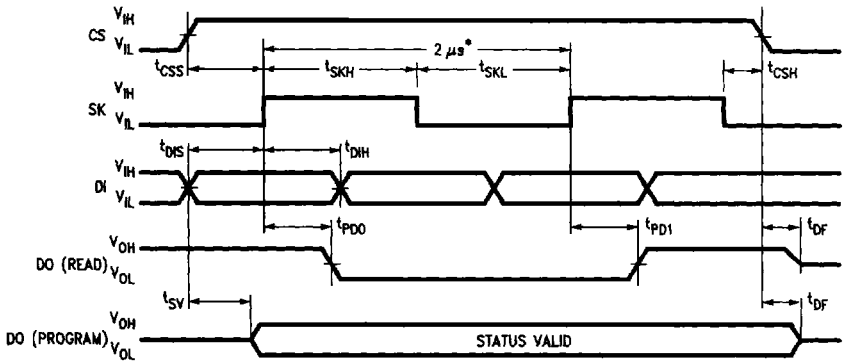
Instruction	SB	Op Code	Address	Data	Comments
READ	1	10	A5–A0		Reads data stored in memory, at specified address.
EWEN	1	00	11XXXX		Write enable must precede all programming modes.
ERASE	1	11	A5–A0		Erase register A5A4A3A2A1A0.
WRITE	1	01	A5–A0	D15–D0	Writes register.
ERAL	1	00	10XXXX		Erases all registers. Valid only at V_{CC} = 4.5V to 5.5V.
WRAL	1	00	01XXXX	D15–D0	Writes all registers. Valid only at V_{CC} = 4.5V to 5.5V.
EWDS	1	00	00XXXX		Disables all programming instructions.

Instruction Set for the NMC93C56 and NMC93C66

Instruction	SB	Op Code	Address	Data	Comments
READ	1	10	A7–A0		Reads data stored in memory, at specified address.
EWEN	1	00	11XXXXXX		Write enable must precede all programming modes.
ERASE	1	11	A7–A0		Erase register A7A6A5A4A3A2A1A0.
ERAL	1	00	10XXXXXX		Erases all registers. Valid only at V_{CC} = 4.5V to 5.5V.
WRITE	1	01	A7–A0	D15–D0	Writes register if address is unprotected.
WRAL	1	00	01XXXXXX	D15–D0	Writes all registers. Valid only when Protect Register is cleared. Valid only at V_{CC} = 4.5V to 5.5V.
EWDS	1	00	00XXXXXX		Disables all programming instructions.

Timing Diagrams

Synchronous Data Timing



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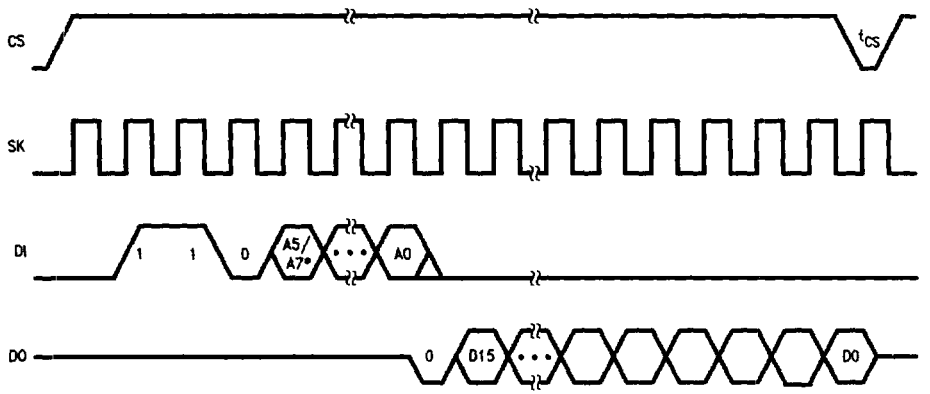
*This is the minimum SK period (Note 2).

READ:



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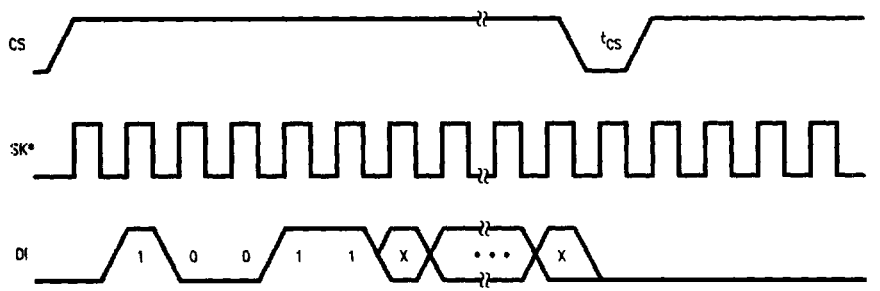
*Address bits A_5 and A_4 become "don't care" for NMC93C06.

*Address bit A_7 becomes a "don't care" for NMC93C56.

EWEN:



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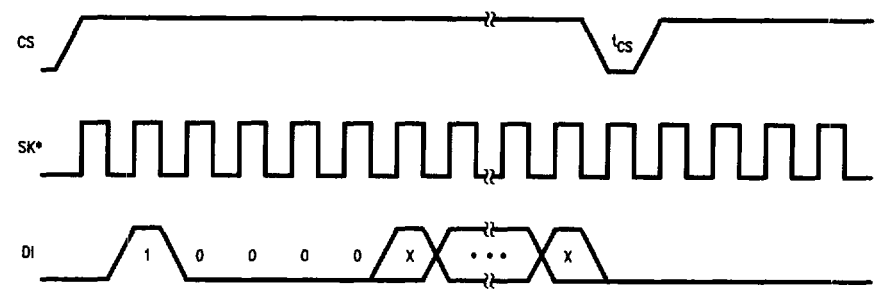
*The NMC93C56 and NMC93C66 require a minimum of 11 clocks. The NMC93C06 and NMC93C46 require a minimum of 9 clock cycles.

Timing Diagrams (Continued)

EWDS:



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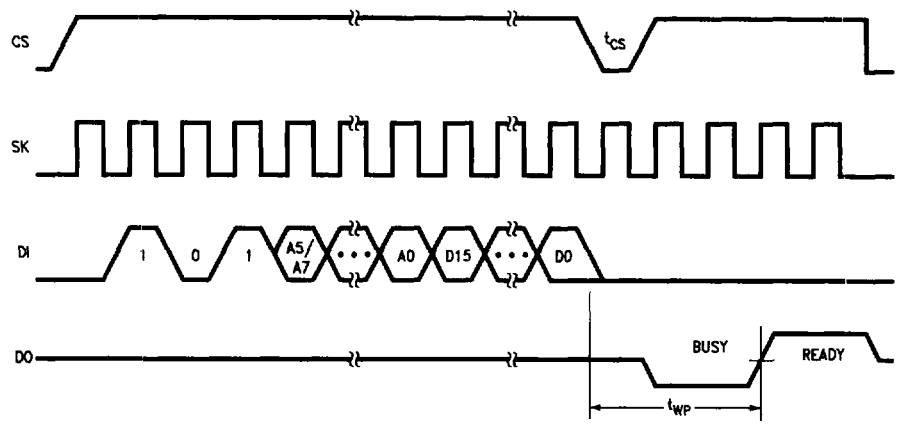
*The NMC93C56 and NMC93C66 require a minimum of 11 clocks. The NMC93C06 and NMC93C46 require a minimum of 9 clock cycles.

WRITE:



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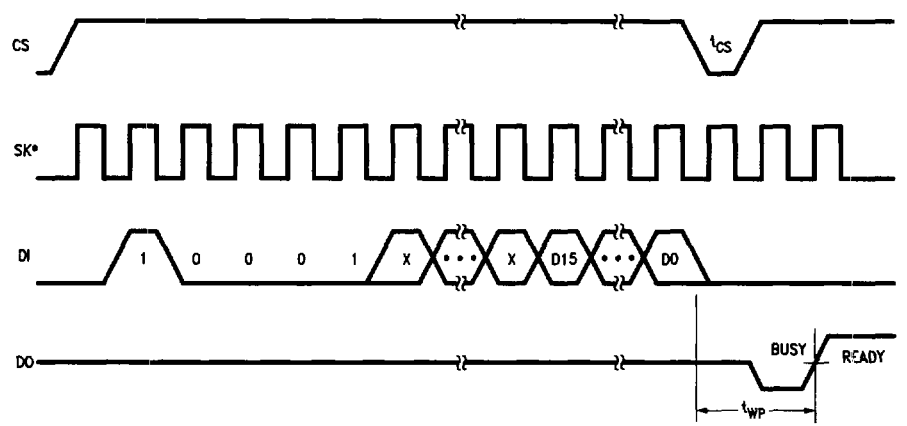
*Address bit A_5 and A_4 become "don't care" for NMC93C06.

*Address bit A_7 becomes a "don't care" for NMC93C56.

WRAL:†



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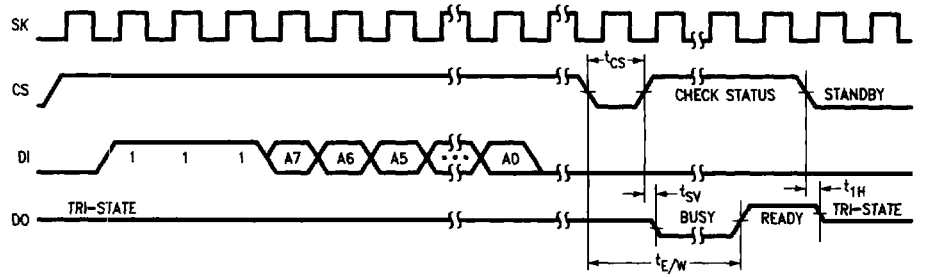
*The NMC93C56 and NMC93C66 require a minimum of 11 clocks. The NMC93C06 and NMC93C46 require a minimum of 9 clock cycles.

†Valid only at V_{CC} = 4.5V to 5.5V.

Timing Diagrams (Continued)

ERASE:



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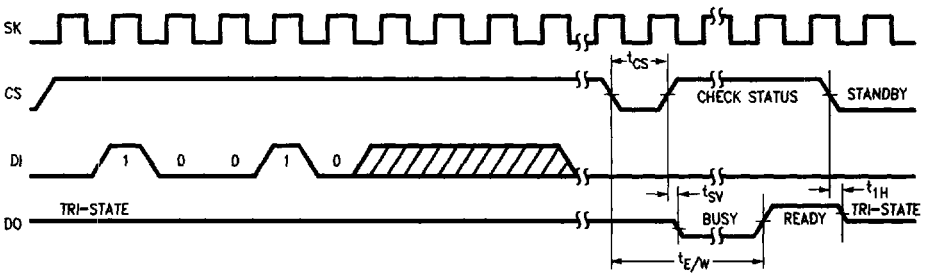
ERAL:†



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†Valid only at V_{CC} = 4.5V to 5.5V.