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2913A/C
CMOS 1K-Bit Serial EEPROM
with Memory Protection, NS Code
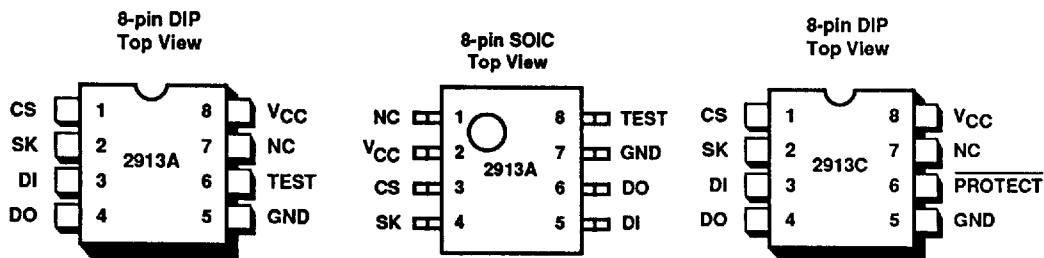
August 1992

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Features

- **Low Power Consumption**
  - *Operating: 2.0 mA max.*
  - *Standby: 1.0 µA max.*
- **Wide Operating Voltage Range**
  - *Write: 2.7 to 6.5 V*
  - *Read: 1.8 to 6.5 V*
- **Write Operation with Built-in Timer**
- **Word/Chip Erase Operation**
- **Standard Endurance 100K Cycles**
- **Data Retention: 10 Years**

- **Standard Temp Range, –40°C to +85°C**
- **Memory Protection (2913C only)**

General Description

The 2913A/C is a high speed, low power 1K-bit EEPROM that uses the CMOS floating-gate process. The organization is 64-word x 16-bit, and it is read or written serially. Continuous read operation is available, and at that time addresses are incremented bit-sequentially. Memory protection is valid in 512 bits (addresses 0 to 31) for 2913C device only.

Pin Configurations

8-pin DIP Top View (2913A)

8-pin SOIC Top View (2913A)

8-pin DIP Top View (2913C)

8-pin SOIC Top View (2913C)

CS	Chip Select
SK	Serial Clock
DI	Serial Data Input
DO	Serial Data Output
GND	Ground (0V)
V_{cc}	Power Supply Voltage(+5 V)
Test	Test Usually Open. When it is Used, Connected to GND or V_{cc}.
Protect	Memory Protection Control* Protection: Connected to GND or open Without Protection: Connected to V_{cc}
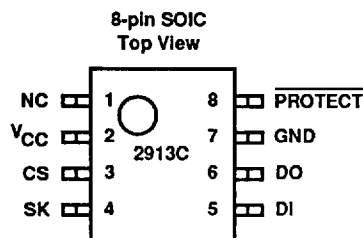
*Memory Protection
This function protects memory contents from erroneous writing when the CPU malfunctions. When the $\overline{PROTECT}$ pin is connected to GND or open, write to BANK 1 (address 0 to 31) of the memory array is inhibited. Since $\overline{PROTECT}$ pin has a built-in pull-down resistor, a memory protection functions automatically when it is open.

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Block Diagram 2913A

Block Diagram 2913C

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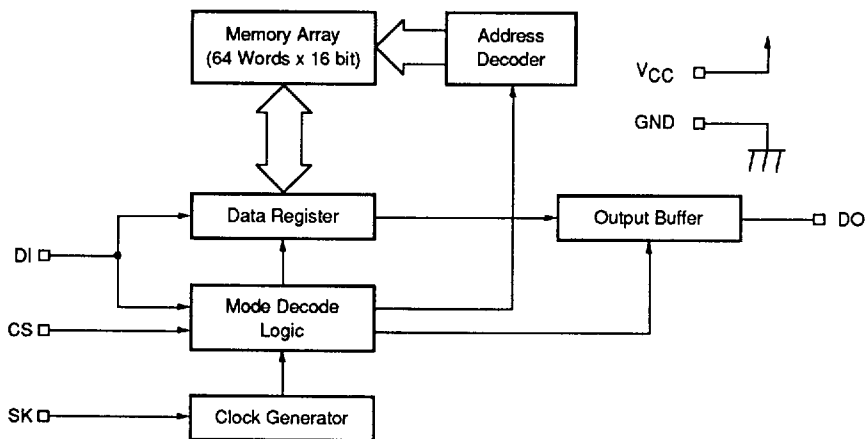
2913A/C
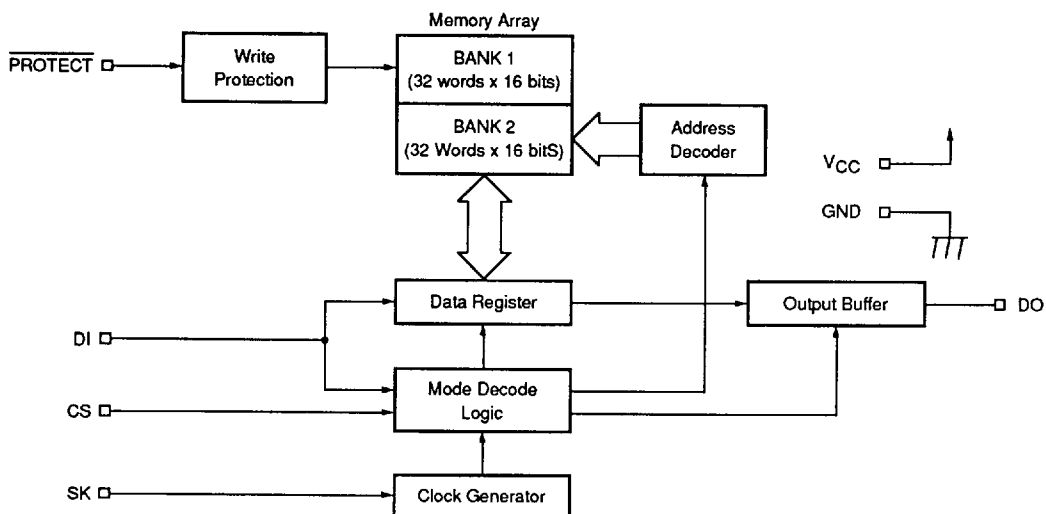
Instruction Set

Instruction	Start Bit	Op Code	Address	Data
READ (Read Data)	1	10	A_5 to A_0	D_{15} to D_0*
WRITE (Write Data)	1	01	A_5 to A_0	D_{15} to D_0
WRAL (Write All)	1	00	01xxxx	D_{15} to D_0
ERASE (Erase Data)	1	11	A_5 to A_0	—
ERAL (Erase All)	1	00	10xxxx	—
EWEN (Program Enable)	1	00	11xxxx	—
EWDS (Program Disable)	1	00	00xxxx	—

x: Don't Care

* The 16-bit data in the specified address are read, then the
data in the next address are continuously read.

Absolute Maximum Ratings

Item	Symbol	Conditions	Ratings	Unit
Power Supply Voltage	V_{CC}		−0.3 to + 7.0	V
Input Voltage	V_{IN}		−0.3 to V_{CC} + 0.3	V
Output Voltage	V_{OUT}		−0.3 to V_{CC}	V
Storage Temperature Under Bias	T_{bias}	E-2913A/C	−50 to +95	°C
Storage Temperature	T_{stg}	E-2913A/C	−65 to +150	°C

Recommended Operating Conditions

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power Supply Voltage	V_{CC}	Read	1.8	—	6.5	V
		Write	2.7	—	6.5	V
High Level Input Voltage	V_{IH}	V_{CC} = 5.0 ± 10%	2.0	—	V_{CC}	V
		V_{CC} = 2.7 to 6.5 V	0.8 x V_{CC}	—	V_{CC}	V
		V_{CC} = 1.8 to 2.7 V	0.8 x V_{CC}	—	V_{CC}	V
Low Level Input Voltage	V_{IL}	V_{CC} = 5.0 ± 10%	0.0	—	0.8	V
		V_{CC} = 2.7 to 6.5 V	0.0	—	0.15 x V_{CC}	V
		V_{CC} = 1.8 to 2.7 V	0.0	—	0.2 x V_{CC}	V
Operating Temperature	T_{opr}	E-2913A/C	−40	—	+85	°C

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DC Electrical Characteristics

| Item | Symbol | Conditions | Read/Write Operations | | | | | | Read Operation | | | Unit |
| | | | V_{cc} = 5.0 V ± 10% | | | V_{cc} = 3.0 V ±10% | | | V_{cc} = 1.8 to 2.7 V | | | |
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Current Consumption (READ)	I_{cc1}	DO Unloaded	—	—	2.0	—	—	1.0	—	—	0.5	mA
Current Consumption (PROGRAM)	I_{cc2}	DO Unloaded	—	—	5.0	—	—	2.0	—	—	—	mA

| Item | Symbol | Conditions | Read/Write Operations | | | | | | Read Operation | | | Unit |
| | | | V_{cc} = 5.0 V ± 10% | | | V_{cc} = 2.7 to 6.5V | | | V_{cc} = 1.8 to 2.7 V | | | |
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Standby Current Consumption	I_{sb}	input: V_{cc} or GND	—	—	1.0	—	—	1.0	—	—	1.0	µA
Input Leakage Current	I_{LI}	V_{IN} = GND to V_{cc}	—	0.1	1.0	—	0.1	1.0	—	0.1	1.0	µA
Output Leakage Current	I_{LO}	V_{OUT} = GND to V_{cc}	—	0.1	1.0	—	0.1	1.0	—	0.1	1.0	µA
Low Level Output Voltage	V_{OL}	CMOS I_{OL} = 100µA	—	—	0.1	—	—	0.1	—	—	0.1	V
		TTL I_{OL} = 2.1 mA	—	—	0.45	—	—	—	—	—	—	V
High Level Output Voltage	V_{OH}	CMOS V_{cc}=2.7 to 6.5 V: I_{OH}=−100µA V_{cc}=1.8 to 2.7 V: I_{OH} = −10µA	V_{cc} −0.7	—	—	V_{cc} −0.7	—	—	V_{cc} −0.3	—	—	V
		TTL, I_{OH} =−400 µA	2.4	—	—	—	—	—	—	—	—	V
Write Enable Latch Data Hold Voltage	V_{DH}		1.5	—	—	1.5	—	—	1.5	—	—	V

Endurance

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Endurance	N	2913A/C10	10^5	—	—	Cycles/Byte

Pin Capacitance

$(T_a = 25°C, f = 1.0$ MHz, $V_{cc} = 5$ V)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input Capacitance	C_{IN}	V_{IN} = 0 V	—	—	6	pF
Output Capacitance	C_{OUT}	V_{out} = 0 V	—	—	10	pF

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Measuring Conditions

Input Voltage Level	$0.1 \times V_{cc}$ to $0.9 \times V_{cc}$
Output Voltage Level	$0.5 \times V_{cc}$
Output Load	100 pF

AC Electrical Characteristics

| Item	Symbol	Read/Write Operations						Read Operation			Unit
		$V_{cc} = 5.0 \pm 10\%$			$V_{cc} = 2.7$ to 6.5V			$V_{cc} = 1.8$ to 2.7 V			
		Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
CS Setup Time	t_{CSS}	0.2	—	—	0.4	—	—	1.0	—	—	μs
CS Hold Time	t_{CSH}	0.2	—	—	0.4	—	—	1.0	—	—	μs
CS Deselect Time	t_{CDS}	0.2	—	—	0.2	—	—	0.4	—	—	μs
Data Setup Time	t_{DS}	0.2	—	—	0.4	—	—	0.8	—	—	μs
Data Hold Time	t_{DH}	0.2	—	—	0.4	—	—	0.8	—	—	μs
1 Data Output Delay	t_{PD1}	—	—	0.4	—	—	1.0	—	—	2.0	μs
0 Data Output Delay	t_{PD0}	—	—	0.4	—	—	1.0	—	—	2.0	μs
Clock Frequency	f_{SK}	0.0	—	2.0	0.0	—	0.5	0.0	—	0.2	MHz
Clock Pulse Width	t_{SKH}, t_{SKL}	0.25	—	—	1.0	—	—	2.5	—	—	μs
Output Disable Time	t_{HZ}	0	50	150	0	500	1000	—	—	—	ns
Output Enable Time	t_{SV}	0	50	150	0	500	1000	—	—	—	ns
Program Time	t_{PR}	2.0	4.0	10	2.0	4.0	10	—	—	—	ms

Timing Chart

2913A/C
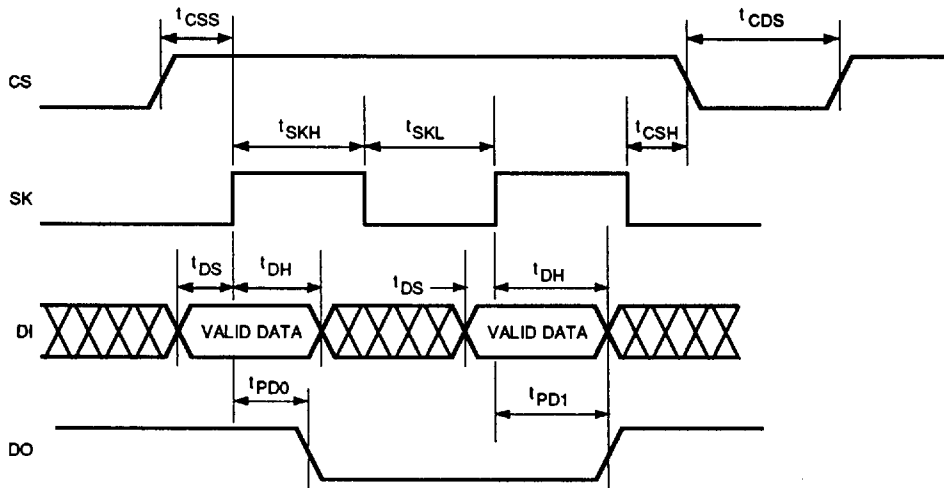
Operation

Note
- CS must be "L" between instructions.
- SK and DI must be "L" during verify operation.
- It is not necessary to erase data before WRITE or WRAL operation.

(1) Read Mode
This mode reads data from a specified address. By the READ instruction, data is triggered at the rise of SK, and output serially to the DO pin. When the final data in the specified address has been read, an SK is sent and the data in the next address is read at the rise of SK. The READ instruction is executed regardless of program enable or disable mode.

Read Mode Timing
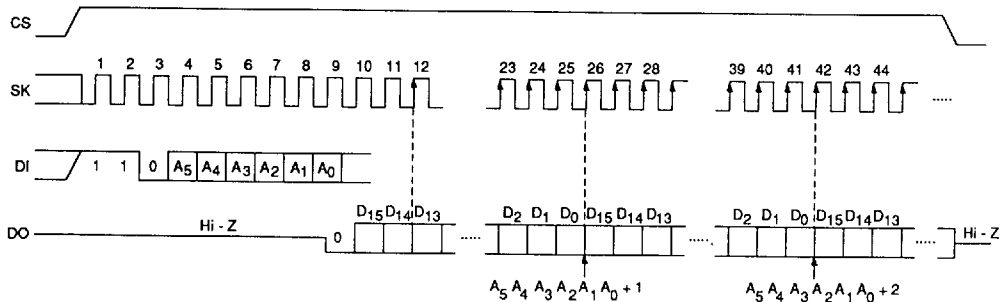
(2) Write Data Mode
After the WRITE instruction, address and data are sent in program enable mode, CS must be low once. At the falling edge of its low, data is written into the specified address. This operation is performed by the internal auto-timing generation circuit and the SK is not necessary. The READY/BUSY status can be found by CS high level and checking the DO pin. During write operation, low level is output to the DO pin, and after operation, high level is output.

Write Data Mode Timing

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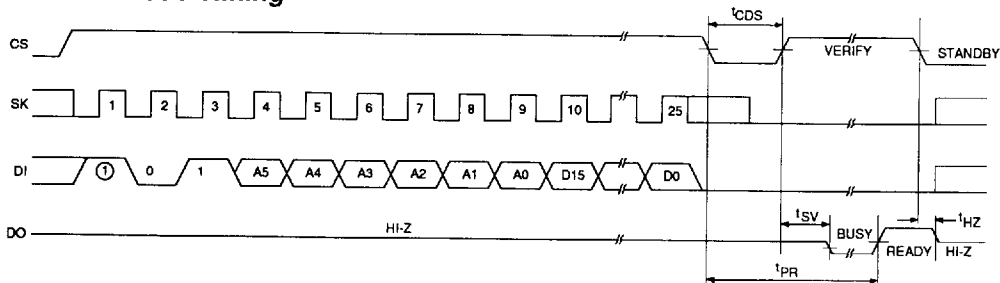
(3) Write all (WRAL) mode

After the WRAL instruction is sent, in program enable mode, CS must be low once. At the falling edge of its low, the same data is written into all memory array bits. This operation is performed by the internal auto-timing generation circuit and SK is not necessary. The READY/$\overline{BUSY}$ status can be found by CS high level and checking the DO pin. During write operation, low level is output to the DO pin, and after operation, high level is output.
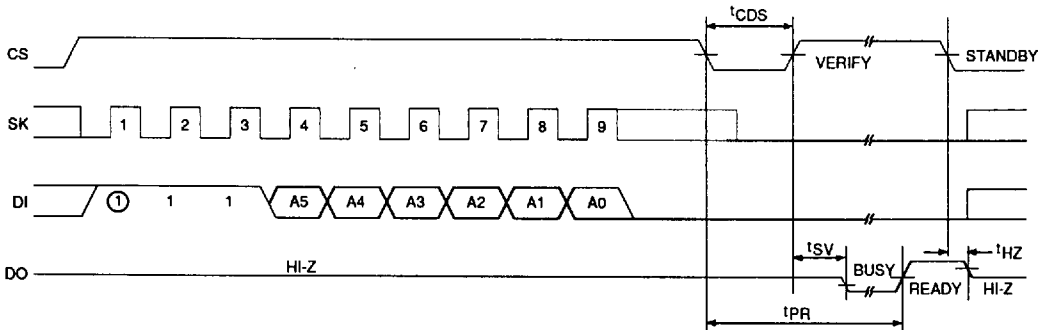
## WRAL Mode Timing
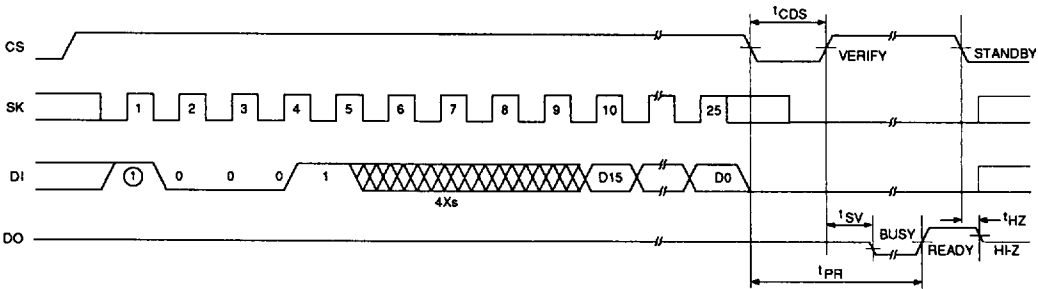
(4) Erase Data Mode

After the ERASE instruction and address are sent in program enable mode, CS must be low once. At the falling edge of its low, erase operation of data in the specified address is started. This operation is performed by the internal auto-timing generation circuit and SK is not necessary. The READY/$\overline{BUSY}$ status can be found by CS high level and checking the DO pin. During erase operation, low level is output to the DO pin, and after operation, high level is output.

Erase Data Mode Timing

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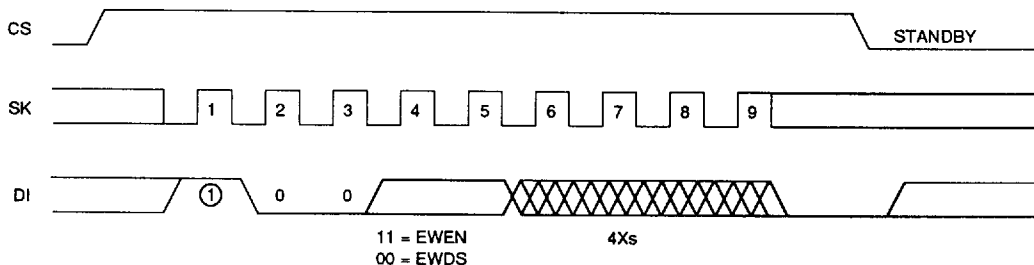MD400125/--

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(5) Erase All (ERAL) Mode

After the ERAL instruction is sent, in program enable mode, CS must be low once. At the falling edge of its low, erase operation of all memory array bits is started, and set to 1. This operation is performed by the internal auto-timing generation circuit and SK is not necessary. The READY/$\overline{BUSY}$ status can be found by CS high level and checking the DO pin. During erase operation, low level is output to the DO pin, and after operation, high level is output.
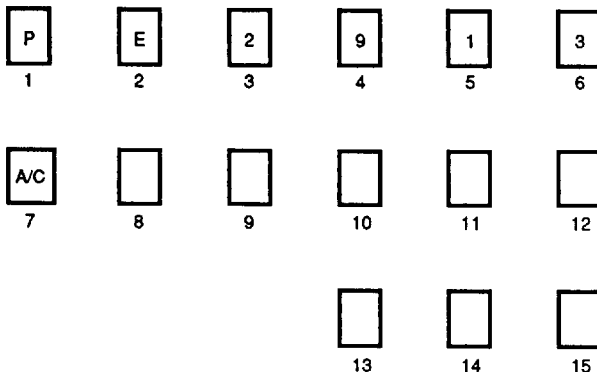
ERAL Mode Timing
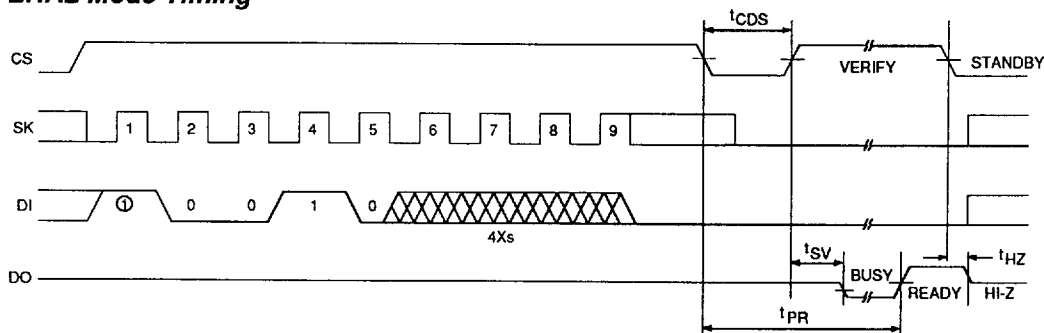
(6) Program Enable (EWEN) and Program Disable (EWDS) Modes

The EWEN instruction puts the 2913A/C into program enable (EWEN) mode. In this mode, WRITE, WRAL, ERASE and ERAL instructions are enabled. The 2913A/C remains in EWEN mode until an EWDS instruction is executed. The EWDS instruction puts the 2913A/C into program disable (EWDS) mode. The WRITE, WRAL, ERASE and ERAL instructions are ignored in the EWDS mode; this mode is used to protect data against accidental programming. The 2913A/C is in program disable mode when power is turned on.
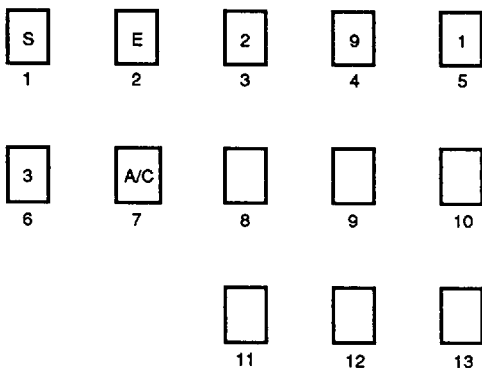
EWEN/EWDS Mode Timing

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Markings

(8-Pin DIP)

P	**E**	**2**	**9**	**1**	**3**
1	2	3	4	5	6

A/C					
7	8	9	10	11	12

13	14	15

1 PKG P=PLASTIC
2 TEMP.E −40°C TO +85°C
3 - 7 PRODUCT NAME
8 - 9 LEAVE BLANK
10 - 12 LOT NUMBER
13 ASSY MARK
14 LAST COL OF YR
15 MT OF MANUF

(8-pin SOIC)

S	**E**	**2**	**9**	**1**
1	2	3	4	5

3	**A/C**			
6	7	8	9	10

11	12	13

1 PKG S = SOIC
2 TEMP.E = −40°C TO +85°C
3 - 7 PRODUCT NAME
8 - 10 LOT NUMBER
11 ASSY MARK
12 LAST COL OF YR
13 MT OF MANUF

Ordering Information

Product Name	Rewriting/Word	Temperature	Package
PE2913A/C	10^5	−40°C to +85°C	DIP Plastic
SE2913A/C	10^5	−40°C to +85°C	SOIC Plastic

Note: Each bit is set to 1 before delivery

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