



5V FLASH MODULE

PRELIMINARY \*

FEATURES

- Access Times of 50, 60, 70, 90, 120 and 150ns
- 40 pin Ceramic DIP (Package 303)
- Organized as 128Kx16 and 256Kx16
- Sector Architecture
  - 8 equal size sectors of 16KBytes each per chip
  - Any combination of sectors can be concurrently erased.
 Also supports full chip erase
- 100,000 Erase/Program Cycles Minimum (0°C to 70°C)
- Data Retention, 10 Years at 125°C
- Commercial, Industrial and Military Temperature Ranges

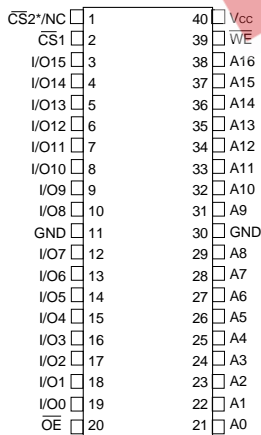
- 5 Volt Programming; 5V ±10% Supply
- Low Power CMOS
- Embedded Erase and Program Algorithms
- TTL Compatible Inputs and CMOS Outputs
- Built-in Decoupling Caps and Multiple Ground Pins for Low Noise Operation
- Page Program Operation and Internal Program Control Time

\* This data sheet describes a product under development, not fully characterized, and is subject to change without notice.

Note: Programming information available upon request.

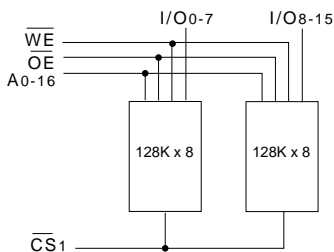
FIG. 1 PIN CONFIGURATION AND BLOCK DIAGRAM

TOP VIEW



\* CS<sub>2</sub> for 256Kx16 and NC for 128Kx16

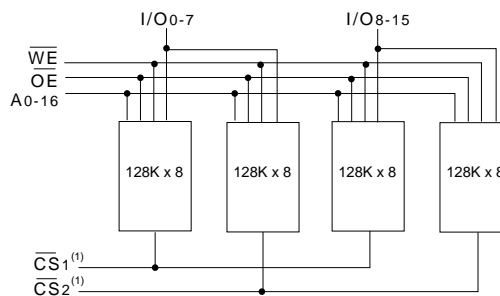
BLOCK DIAGRAM FOR WF128K16-XCX5



PIN DESCRIPTION

|                    |                   |
|--------------------|-------------------|
| A0-16              | Address Inputs    |
| I/O0-15            | Data Input/Output |
| CS <sub>1</sub> -2 | Chip Selects      |
| OE                 | Output Enable     |
| WE                 | Write Enable      |
| Vcc                | +5.0V Power       |
| GND                | Ground            |

BLOCK DIAGRAM FOR WF256K16-XCX5



NOTE:

1. CS<sub>1</sub> and CS<sub>2</sub> are used to select the lower and upper 128Kx16 of the device. CS<sub>1</sub> and CS<sub>2</sub> must not be enabled at the same time.



## ABSOLUTE MAXIMUM RATINGS (1)

| Parameter  |                    | Unit |
|--|--------------------|------|
| Operating Temperature  | -55 to +125        | °C   |
| Supply Voltage Range (V <sub>CC</sub> )                          | -2.0 to +7.0       | V    |
| Signal voltage range (any pin except A <sub>9</sub> ) (2)        | -2.0 to +7.0       | V    |
| Storage Temperature Range  | -65 to +150        | °C   |
| Lead Temperature (soldering, 10 seconds)                         | +300               | °C   |
| Data Retention Mil Temp  | 10 years           |      |
| Endurance (write/erase cycles) Mil Temp                          | 10,000 cycles min. |      |
| A <sub>9</sub> Voltage for sector protect (V <sub>ID</sub> ) (3) | -2.0 to +14.0      | V    |

## CAPACITANCE

(T<sub>A</sub> = 25°C)

| Test                           | Symbol           | Conditions                          | Max | Unit |
|--------------------------------|------------------|-------------------------------------|-----|------|
| $\overline{OE}$ capacitance    | C <sub>OE</sub>  | V <sub>IN</sub> = 0 V, f = 1.0 MHz  | 50  | pF   |
| $\overline{WE}$ capacitance    | C <sub>WE</sub>  | V <sub>IN</sub> = 0 V, f = 1.0 MHz  | 50  | pF   |
| $\overline{CS}$ capacitance    | C <sub>CS</sub>  | V <sub>IN</sub> = 0 V, f = 1.0 MHz  | 30  | pF   |
| I/O <sub>0-7</sub> capacitance | C <sub>I/O</sub> | V <sub>I/O</sub> = 0 V, f = 1.0 MHz | 30  | pF   |
| Address capacitance            | C <sub>AD</sub>  | V <sub>IN</sub> = 0 V, f = 1.0 MHz  | 50  | pF   |

This parameter is guaranteed by design but not tested.

## NOTES:

- Stresses above the absolute maximum rating may cause permanent damage to the device. Extended operation at the maximum levels may degrade performance and affect reliability.
- Minimum DC voltage on input or I/O pins is -0.5V. During voltage transitions, inputs may overshoot V<sub>SS</sub> to -2.0 V for periods of up to 20ns. Maximum DC voltage on output and I/O pins is V<sub>CC</sub> + 0.5V. During voltage transitions, outputs may overshoot to V<sub>CC</sub> + 2.0 V for periods of up to 20ns.
- Minimum DC input voltage on A<sub>9</sub> pin is -0.5V. During voltage transitions, A<sub>9</sub> may overshoot V<sub>SS</sub> to -2V for periods of up to 20ns. Maximum DC input voltage on A<sub>9</sub> is +13.5V which may overshoot to 14.0 V for periods up to 20ns.

## RECOMMENDED OPERATING CONDITIONS

| Parameter                                 | Symbol          | Min  | Max                   | Unit |
|---|-----------------|------|-----------------------|------|
| Supply Voltage                            | V <sub>CC</sub> | 4.5  | 5.5                   | V    |
| Input High Voltage                        | V <sub>IH</sub> | 2.0  | V <sub>CC</sub> + 0.3 | V    |
| Input Low Voltage                         | V <sub>IL</sub> | -0.5 | +0.8                  | V    |
| Operating Temp. (Mil.)                    | T <sub>A</sub>  | -55  | +125                  | °C   |
| Operating Temp. (Ind.)                    | T <sub>A</sub>  | -40  | +85                   | °C   |
| A <sub>9</sub> Voltage for Sector Protect | V <sub>ID</sub> | 11.5 | 12.5                  | V    |

## DC CHARACTERISTICS - CMOS COMPATIBLE

(V<sub>CC</sub> = 5.0V, V<sub>SS</sub> = 0V, T<sub>A</sub> = -55°C to +125°C)

| Parameter   | Symbol           | Conditions   | 128K x 16             |      | 256K x 16             |      | Unit |
|---|------------------|--|-----------------------|------|-----------------------|------|------|
|   |                  |  | Min                   | Max  | Min                   | Max  |      |
| Input Leakage Current                                   | I <sub>LI</sub>  | V <sub>CC</sub> = 5.5, V <sub>IN</sub> = GND to V <sub>CC</sub>  |                       | 10   |                       | 10   | μA   |
| Output Leakage Current                                  | I <sub>LO</sub>  | V <sub>CC</sub> = 5.5, V <sub>IN</sub> = GND to V <sub>CC</sub>  |                       | 10   |                       | 10   | μA   |
| V <sub>CC</sub> Active Current for Read (1)             | I <sub>CC1</sub> | $\overline{CS} = V_{IL}, \overline{OE} = V_{IH}$                 |                       | 70   |                       | 80   | mA   |
| V <sub>CC</sub> Active Current for Program or Erase (2) | I <sub>CC2</sub> | $\overline{CS} = V_{IL}, \overline{OE} = V_{IH}$                 |                       | 100  |                       | 110  | mA   |
| V <sub>CC</sub> Standby Current                         | I <sub>CC3</sub> | V <sub>CC</sub> = 5.5, $\overline{CS} = V_{IH}, f = 5\text{MHz}$ |                       | 6    |                       | 8    | mA   |
| Output Low Voltage                                      | V <sub>OL</sub>  | I <sub>OL</sub> = 12.0 mA, V <sub>CC</sub> = 4.5                 |                       | 0.45 |                       | 0.45 | V    |
| Output High Voltage                                     | V <sub>OH1</sub> | I <sub>OH</sub> = -2.5 mA, V <sub>CC</sub> = 4.5                 | 0.85xV <sub>CC</sub>  |      | 0.85xV <sub>CC</sub>  |      | V    |
| Output High Voltage                                     | V <sub>OH2</sub> | I <sub>OH</sub> = -100 μA, V <sub>CC</sub> = 4.5                 | V <sub>CC</sub> - 0.4 |      | V <sub>CC</sub> - 0.4 |      | V    |
| Low V <sub>CC</sub> Lock Out Voltage                    | V <sub>LKO</sub> |  | 3.2                   |      | 3.2                   |      | V    |

## NOTES:

- The I<sub>CC</sub> current listed includes both the DC operating current and the frequency dependent component (at 5 MHz). The frequency component typically is less than 2 mA/MHz, with  $\overline{OE}$  at V<sub>IH</sub>.
- I<sub>CC</sub> active while Embedded Algorithm (program or erase) is in progress.
- DC test conditions: V<sub>IL</sub> = 0.3V, V<sub>IH</sub> = V<sub>CC</sub> - 0.3V



### PRINCIPLES OF OPERATION

The following principles of operation of the WF128K16-XCX5 and WF256K16-XCX5 are applicable to each 128K x 8 memory chip inside the MCM. Programming of the device is accomplished by executing the program command sequence. The program algorithm, which is an internal algorithm, automatically times the program pulse widths and verifies proper cell margin. Sectors can be programmed and verified in less than 0.3 seconds. Erase is accomplished by executing the erase command sequence. The erase algorithm, which is internal, automatically preprograms the array if it is not already programmed before executing the erase operation. During erase, the device automatically times the erase pulse widths and verifies proper cell margin. The entire memory is typically erased and verified in three seconds (including pre-programming).

### BUS OPERATIONS

#### READ

The device has two control functions, both of which must be logically active, to obtain data at the outputs. Chip-Select (CS) is the power control and should be used for device selection. Output-Enable (OE) is the output control and should be used to gate data to the output pins. Figure 3 illustrates read timing waveforms.

#### OUTPUT DISABLE

With Output-Enable at a logic-high level (VIH), output from the device is disabled. Output pins are placed in a high impedance state.

#### STANDBY MODE

The device has two standby modes, a CMOS standby mode (CS input held at VCC + 0.5V), and a TTL standby mode (CS is held VIH). In the standby mode the outputs are in a high impedance state, independent of the OE input.

If the device is deselected during erasure or programming, the device will draw active current until the operation is completed.

#### WRITE

Device erasure and programming are accomplished via the command register. The contents of the register serve as input to the internal state machine. The state machine outputs dictate the function of the device.

The command register itself does not occupy an addressable memory location. The register is a latch used to store the commands, along with address and data information needed to execute the command. The command register is written by bringing Write-Enable to a logic-low level (VIL), while Chip-Select is low and OE is at VIH. Addresses are latched on the falling edge of the Write-Enable while data is latched on the rising edge of the WE pulse. Standard microprocessor write timings are used. Refer to AC Program characteristics, Figures 4 and 7.

TABLE 1 - BUS OPERATIONS

| Operation             | CS | OE              | WE | A0 | A1 | A9              | I/O    |
|-----------------------|----|-----------------|----|----|----|-----------------|--------|
| Read                  | L  | L               | H  | A0 | A1 | A9              | DOUT   |
| Standby               | H  | X               | X  | X  | X  | X               | HIGH Z |
| Output Disable        | L  | H               | H  | X  | X  | X               | HIGH Z |
| Write                 | L  | H               | L  | A0 | A1 | A9              | DIN    |
| Enable Sector Protect | L  | V <sub>DD</sub> | L  | X  | X  | V <sub>DD</sub> | X      |
| Verify Sector Protect | L  | L               | H  | L  | H  | V <sub>DD</sub> | Code   |



**AC CHARACTERISTICS – WRITE/ERASE/PROGRAM OPERATIONS,  $\overline{WE}$  CONTROLLED**

(V<sub>CC</sub> = 5.0V, V<sub>SS</sub> = 0V, T<sub>A</sub> = -55°C to +125°C)

| Parameter                                    | Symbol             |                  | -50 |      | -60 |      | -70 |      | -90 |      | -120 |      | -150 |      | Unit |
|--|--------------------|------------------|-----|------|-----|------|-----|------|-----|------|------|------|------|------|------|
|  |                    |                  | Min | Max  | Min | Max  | Min | Max  | Min | Max  | Min  | Max  | Min  | Max  |      |
| Write Cycle Time                             | t <sub>AVAV</sub>  | t <sub>wc</sub>  | 50  |      | 60  |      | 70  |      | 90  |      | 120  |      | 150  |      | ns   |
| Chip Select Setup Time                       | t <sub>ELWL</sub>  | t <sub>cs</sub>  | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns   |
| Write Enable Pulse Width                     | t <sub>WLWH</sub>  | t <sub>wp</sub>  | 25  |      | 30  |      | 35  |      | 45  |      | 50   |      | 50   |      | ns   |
| Address Setup Time                           | t <sub>AVWL</sub>  | t <sub>as</sub>  | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns   |
| Data Setup Time                              | t <sub>DVWH</sub>  | t <sub>ds</sub>  | 25  |      | 30  |      | 30  |      | 45  |      | 50   |      | 50   |      | ns   |
| Data Hold Time                               | t <sub>WHDX</sub>  | t <sub>dh</sub>  | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns   |
| Address Hold Time                            | t <sub>WLAX</sub>  | t <sub>ah</sub>  | 40  |      | 45  |      | 45  |      | 45  |      | 50   |      | 50   |      | ns   |
| Chip Select Hold Time                        | t <sub>WHEH</sub>  | t <sub>ch</sub>  | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns   |
| Write Enable Pulse Width High                | t <sub>WHWL</sub>  | t <sub>wph</sub> | 20  |      | 20  |      | 20  |      | 20  |      | 20   |      | 20   |      | ns   |
| Duration of Byte Programming Operation (min) | t <sub>WHWH1</sub> |                  | 14  |      | 14  |      | 14  |      | 14  |      | 14   |      | 14   |      | μs   |
| Chip and Sector Erase Time                   | t <sub>WHWH2</sub> |                  | 2.2 | 60   | 2.2 | 60   | 2.2 | 60   | 2.2 | 60   | 2.2  | 60   | 2.2  | 60   | sec  |
| Read Recovery Time Before Write              | t <sub>GHWL</sub>  |                  | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns   |
| V <sub>CC</sub> Setup Time                   | t <sub>VCS</sub>   |                  | 50  |      | 50  |      | 50  |      | 50  |      | 50   |      | 50   |      | μs   |
| Chip Programming Time                        |                    |                  |     | 12.5 |     | 12.5 |     | 12.5 |     | 12.5 |      | 12.5 |      | 12.5 | sec  |
| Output Enable Setup Time                     |                    | t <sub>OES</sub> | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns   |
| Output Enable Hold Time (1)                  |                    | t <sub>OEH</sub> | 10  |      | 10  |      | 10  |      | 10  |      | 10   |      | 10   |      | ns   |

1. For Toggle and Data Polling.

**AC CHARACTERISTICS – READ ONLY OPERATIONS**

(V<sub>CC</sub> = 5.0V, V<sub>SS</sub> = 0V, T<sub>A</sub> = -55°C to +125°C)

| Parameter   | Symbol            |                  | -50 |     | -60 |     | -70 |     | -90 |     | -120 |     | -150 |     | Unit |
|---|-------------------|------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|------|-----|------|
|   |                   |                  | Min | Max | Min | Max | Min | Max | Min | Max | Min  | Max |      |     |      |
| Read Cycle Time   | t <sub>AVAV</sub> | t <sub>rc</sub>  | 50  |     | 60  |     | 70  |     | 90  |     | 120  |     | 150  |     | ns   |
| Address Access Time   | t <sub>AVQV</sub> | t <sub>acc</sub> |     | 50  |     | 60  |     | 70  |     | 90  |      | 120 |      | 150 | ns   |
| Chip Select Access Time   | t <sub>ELQV</sub> | t <sub>ce</sub>  |     | 50  |     | 60  |     | 70  |     | 90  |      | 120 |      | 150 | ns   |
| $\overline{OE}$ to Output Valid   | t <sub>GLQV</sub> | t <sub>oe</sub>  |     | 25  |     | 30  |     | 35  |     | 40  |      | 50  |      | 55  | ns   |
| Chip Select to Output High Z (1)  | t <sub>EHQZ</sub> | t <sub>df</sub>  |     | 20  |     | 20  |     | 20  |     | 25  |      | 30  |      | 35  | ns   |
| $\overline{OE}$ High to Output High Z (1)   | t <sub>GHQZ</sub> | t <sub>df</sub>  |     | 20  |     | 20  |     | 20  |     | 25  |      | 30  |      | 35  | ns   |
| Output Hold from Address, $\overline{CS}$ or $\overline{OE}$ Change, whichever is first | t <sub>AXQX</sub> | t <sub>oh</sub>  | 0   |     | 0   |     | 0   |     | 0   |     | 0    |     | 0    |     | ns   |

1. Guaranteed by design, not tested.

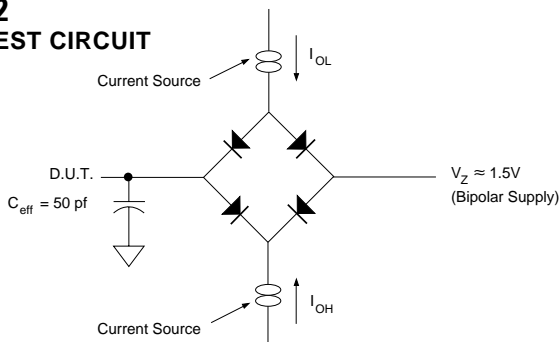


AC CHARACTERISTICS – WRITE/ERASE/PROGRAM OPERATIONS,  $\overline{CS}$  CONTROLLED

( $V_{CC} = 5.0V, V_{SS} = 0V, T_A = -55^\circ C$  to  $+125^\circ C$ )

| Parameter                                      | Symbol      |           | -50 |      | -60 |      | -70 |      | -90 |      | -120 |      | -150 |      | Unit    |
|--|-------------|-----------|-----|------|-----|------|-----|------|-----|------|------|------|------|------|---------|
|  |             |           | Min | Max  | Min | Max  | Min | Max  | Min | Max  | Min  | Max  | Min  | Max  |         |
| Write Cycle Time                               | $t_{AVAV}$  | $t_{WC}$  | 50  |      | 60  |      | 70  |      | 90  |      | 120  |      | 150  |      | ns      |
| $\overline{WE}$ Setup Time                     | $t_{WLEL}$  | $t_{WS}$  | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns      |
| $\overline{CS}$ Pulse Width                    | $t_{ELEH}$  | $t_{CP}$  | 25  |      | 30  |      | 35  |      | 45  |      | 50   |      | 50   |      | ns      |
| Address Setup Time                             | $t_{AVEL}$  | $t_{AS}$  | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns      |
| Data Setup Time                                | $t_{DVEH}$  | $t_{DS}$  | 25  |      | 30  |      | 30  |      | 45  |      | 50   |      | 50   |      | ns      |
| Data Hold Time                                 | $t_{EHDX}$  | $t_{DH}$  | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns      |
| Address Hold Time                              | $t_{ELAX}$  | $t_{AH}$  | 40  |      | 45  |      | 45  |      | 45  |      | 50   |      | 50   |      | ns      |
| $\overline{WE}$ Hold from $\overline{WE}$ High | $t_{EHWH}$  | $t_{WH}$  | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns      |
| $\overline{CS}$ Pulse Width High               | $t_{EHEL}$  | $t_{CPH}$ | 20  |      | 20  |      | 20  |      | 20  |      | 20   |      | 20   |      | ns      |
| Duration of Programming Operation              | $t_{WHWH1}$ |           | 14  |      | 14  |      | 14  |      | 14  |      | 14   |      | 14   |      | $\mu s$ |
| Duration of Erase Operation                    | $t_{WHWH2}$ |           | 2.2 | 60   | 2.2 | 60   | 2.2 | 60   | 2.2 | 60   | 2.2  | 60   | 2.2  | 60   | sec     |
| Read Recovery before Write                     | $t_{GHEL}$  |           | 0   |      | 0   |      | 0   |      | 0   |      | 0    |      | 0    |      | ns      |
| Chip Programming Time                          |             |           |     | 12.5 |     | 12.5 |     | 12.5 |     | 12.5 |      | 12.5 |      | 12.5 | sec     |

FIG. 2  
AC TEST CIRCUIT



AC TEST CONDITIONS

| Parameter                        | Typ                        | Unit |
|----------------------------------|----------------------------|------|
| Input Pulse Levels               | $V_{IL} = 0, V_{IH} = 3.0$ | V    |
| Input Rise and Fall              | 5                          | ns   |
| Input and Output Reference Level | 1.5                        | V    |
| Output Timing Reference Level    | 1.5                        | V    |

NOTES:

$V_z$  is programmable from -2V to +7V.  
 $I_{OL}$  &  $I_{OH}$  programmable from 0 to 16mA.  
 Tester Impedance  $Z_0 = 75 \Omega$ .  
 $V_z$  is typically the midpoint of  $V_{OH}$  and  $V_{OL}$ .  
 $I_{OL}$  &  $I_{OH}$  are adjusted to simulate a typical resistive load circuit.  
 ATE tester includes jig capacitance.



**FIG. 3**  
AC WAVEFORMS FOR READ OPERATIONS

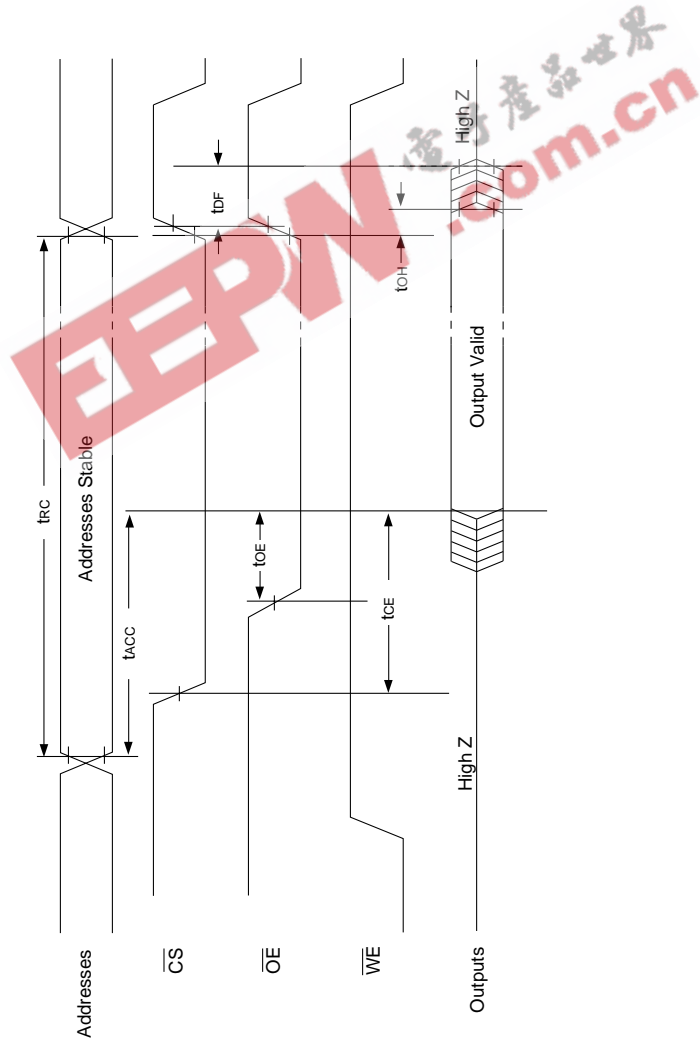
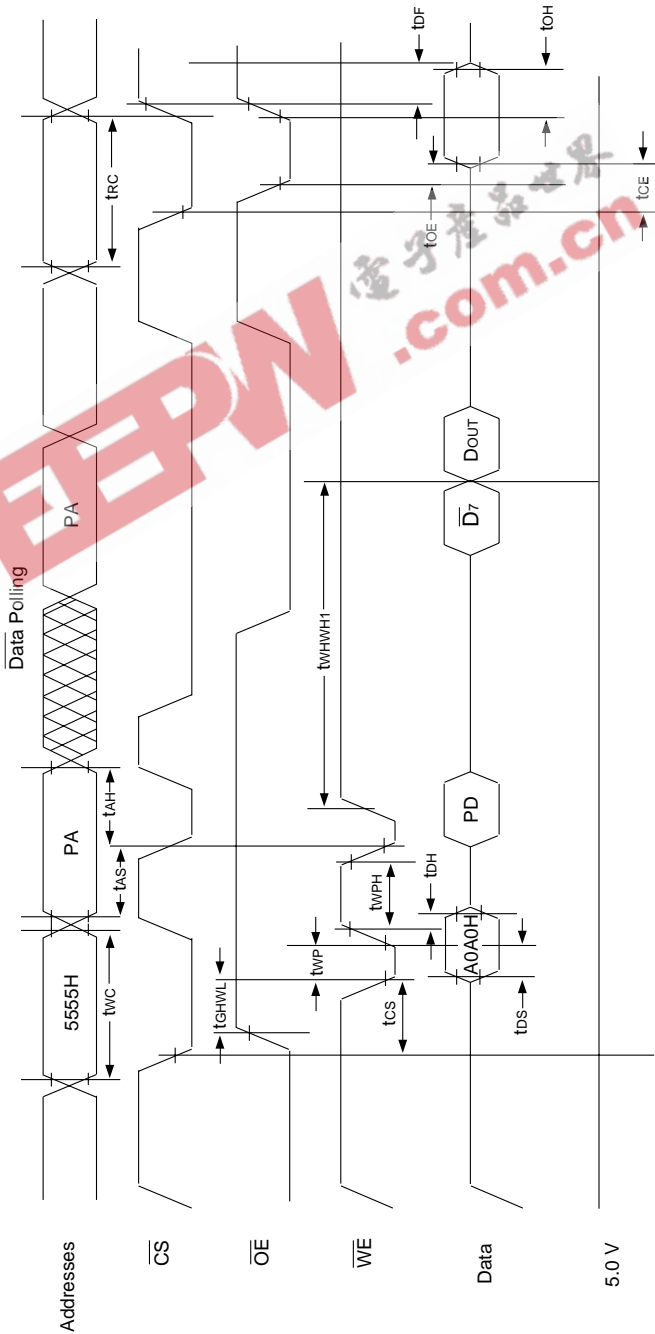




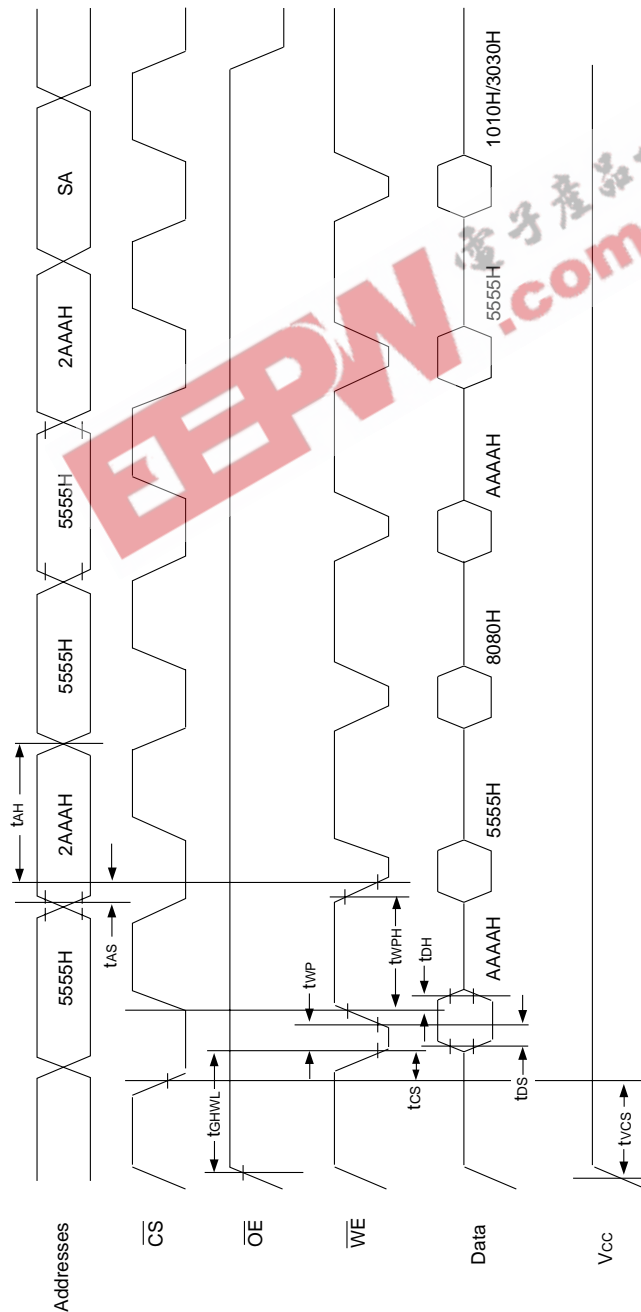
FIG. 4 AC WAVEFORMS FOR WRITE/ERASE/PROGRAM OPERATIONS, WE CONTROLLED



- NOTES:**
1. PA is the address of the memory location to be programmed.
  2. PD is the data to be programmed.
  3. D7 is the output of the complement of the data written (for each chip).
  4. DOUT is the output of the data written to the device.
  5. Figure indicates last two bus cycles of four bus cycle sequence.



**FIG. 5**  
**AC WAVEFORMS CHIP/SECTOR ERASE OPERATIONS**



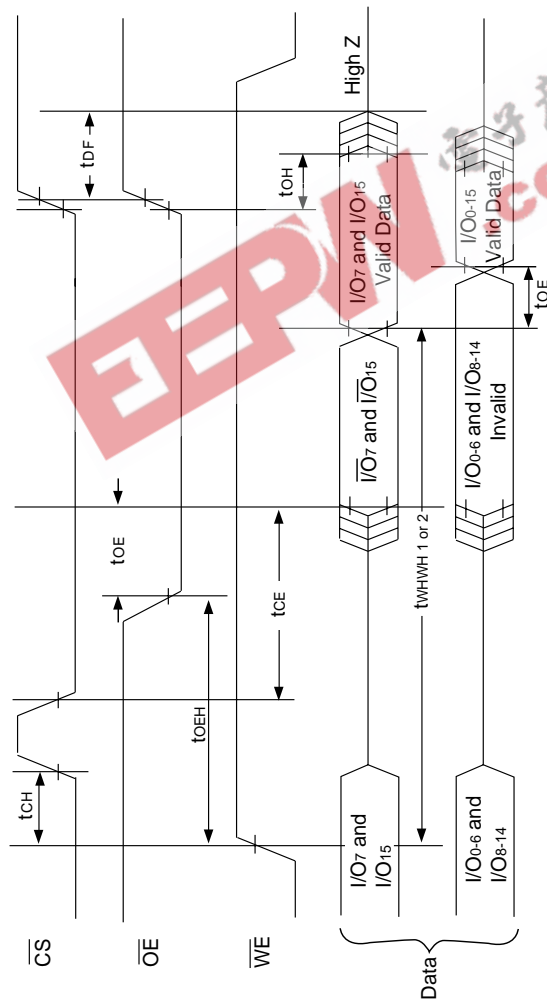
**NOTES:**

1. SA is the sector address for Sector Erase.



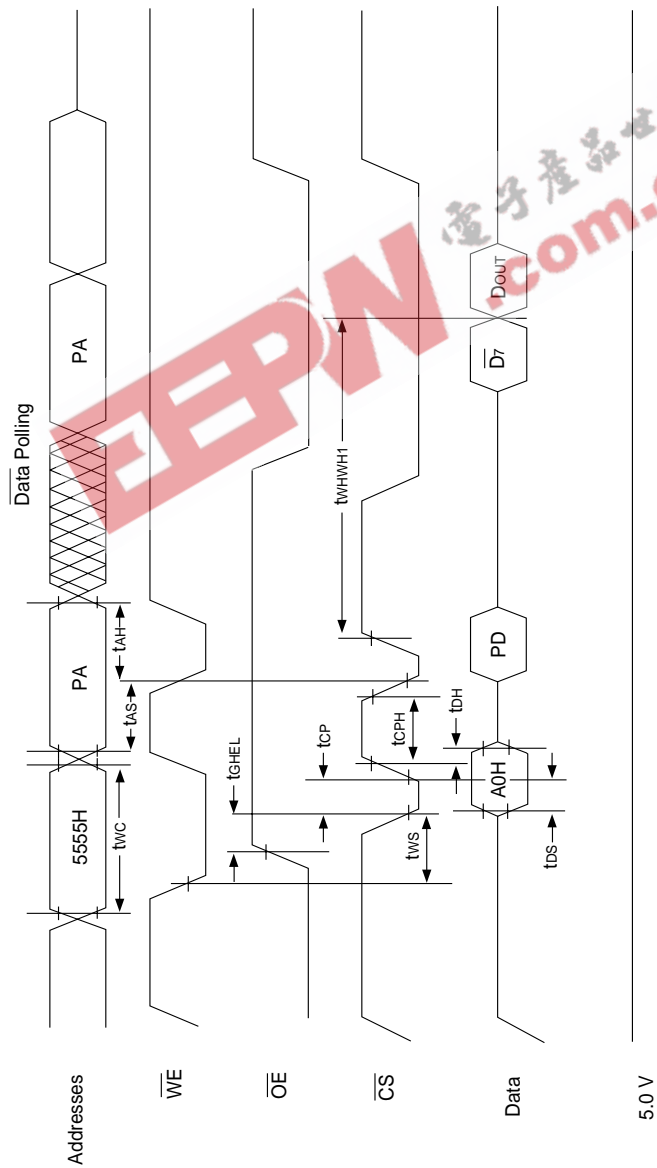


**FIG. 6**  
AC WAVEFORMS FOR DATA POLLING DURING  
EMBEDDED ALGORITHM OPERATIONS





**FIG. 7**  
AC WAVEFORMS FOR WRITE/ERASE/PROGRAM OPERATIONS,  $\overline{CS}$  CONTROLLED

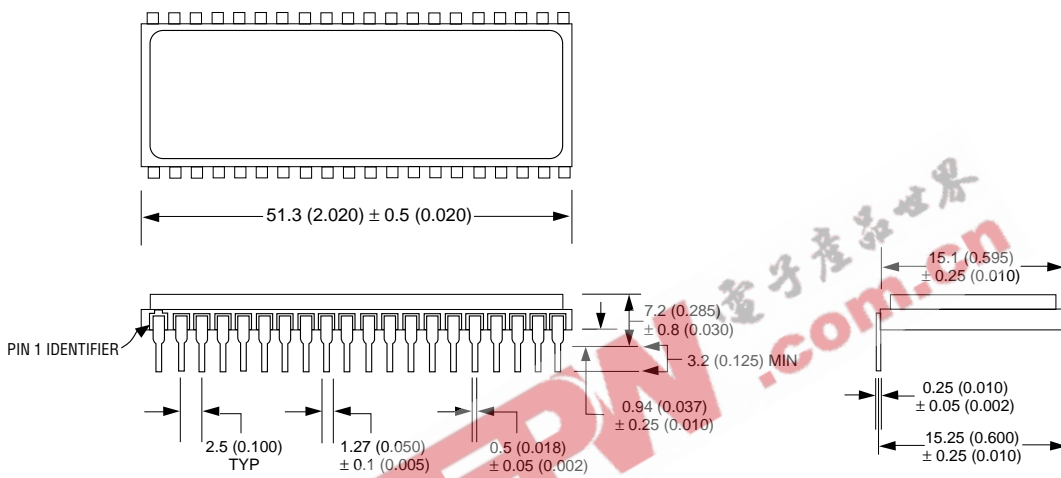


**NOTES:**

1. PA represents the address of the memory location to be programmed.
2. PD represents the data to be programmed at byte address.
3.  $\overline{D7}$  is the output of the complement of the data written to the device (for each chip).
4. D<sub>out</sub> is the output of the data written to the device.
5. Figure indicates the last two bus cycles of a four bus cycle sequence.



PACKAGE 303: 40 PIN, CERAMIC DIP, SINGLE CAVITY SIDE BRAZED



ALL LINEAR DIMENSIONS ARE MILLIMETERS AND PARENTHETICALLY IN INCHES

ORDERING INFORMATION

WF XXXK16 - XXX C X 5 X

LEAD FINISH:

- Blank = Gold plated leads
- A = Solder dip leads

V<sub>PP</sub> PROGRAMMING VOLTAGE

5 = 5V

DEVICE GRADE:

- Q = Compliant
- M = Military Screened -55°C to 125°C
- I = Industrial -40°C to +85°C
- C = Commercial 0 to +70°C

PACKAGE TYPE:

C = 40 Pin Ceramic 0.600" DIP (Package 303)

ACCESS TIME (ns)

ORGANIZATION, 128K x 16 or 256K x 16

Flash PROM

WHITE MICROELECTRONICS