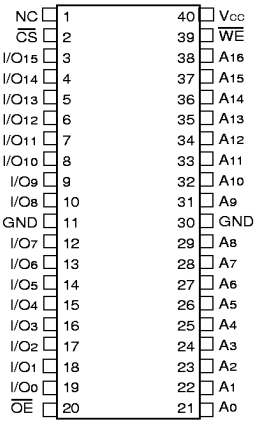
128Kx16 CMOS EEPROM

FIG. 1

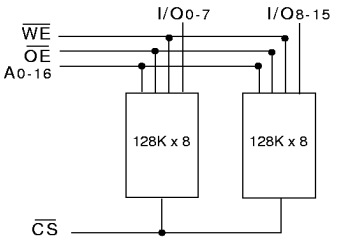
PIN CONFIGURATION



PIN DESCRIPTION

A_{0-16}	Address Inputs
I/O_{0-15}	Data Input/Output
$\overline{CS}$	Chip Select
$\overline{OE}$	Output Enable
$\overline{WE}$	Write Enable
V_{CC}	+5.0V Power
GND	Ground

BLOCK DIAGRAM



128Kx16 BIT CMOS EEPROM MODULE FEATURES

- Read Access Times of 150, 200, 250, 300ns
- 40 Pin, Hermetic Ceramic DIP (Package 303)
- Commercial, Industrial and Military Temperature Ranges
- MIL-STD-883 Compliant Devices Available
- Write Endurance 10,000 Cycles
- Data Retention at 25°C, 10 Years
- Low Power CMOS Operation
- Automatic Page Write Operation
- Page Write Cycle Time 10ms Max.
- Data Polling for End of Write Detection
- Hardware and Software Data Protection
- TTL Compatible Inputs and Outputs
- 256Kx16 Organization Also Available In The Same Package

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol		Unit
Operating Temperature	T_A	-55 to +125	°C
Storage Temperature	T_{STG}	-65 to +150	°C
Signal Voltage Any Pin	V_G	-0.6 to + 6.25	V
Voltage on $\overline{OE}$ and A9		-0.6 to +13.5	V
Thermal Resistance junction to case	θ_{JC}	28	°C/W
Lead Temperature (soldering -10 secs)		+300	°C

NOTE:
Stresses 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 this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

TRUTH TABLE

$\overline{CS}$	$\overline{OE}$	$\overline{WE}$	Mode	Data I/O
H	X	X	Standby	High Z
L	L	H	Read	Data Out
L	H	L	Write	Data In
X	H	X	Out Disable	High Z/Data Out
X	X	H	Write	
X	L	X	Inhibit	

CAPACITANCE

(T_A = +25°C)

Parameter	Symbol	Condition	Max	Unit
Input Capacitance	C_{IN}	V_{IN} = 0V, f = 1MHz	50	pF
Output Capacitance	C_{OUT}	$V_{I/O}$ = 0V, f = 1MHz	40	pF

This parameter is guaranteed by design but not tested.

RECOMMENDED OPERATING CONDITIONS

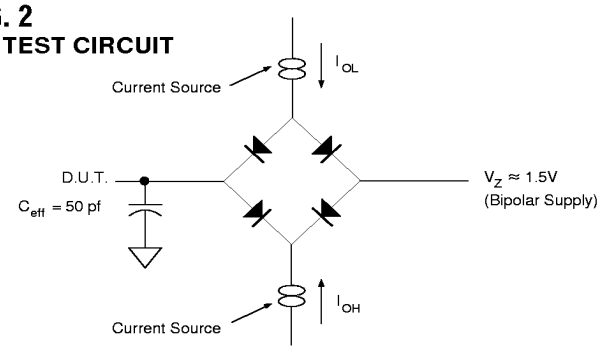
Parameter	Symbol	Min	Max	Unit
Supply Voltage	V_{CC}	4.5	5.5	V
Input High Voltage	V_{IH}	2.0	V_{CC} + 0.3	V
Input Low Voltage	V_{IL}	-0.3	+0.8	V
Operating Temp. (Mil.)	T_A	-55	+125	°C
Operating Temp. (Ind.)	T_A	-40	+85	°C

DC CHARACTERISTICS

(V_{CC} = 5.0V, GND = 0V, T_A = -55°C to +125°C)

Parameter	Symbol	Conditions	128K x 16			Unit
			Min	Typ	Max	
Input Leakage Current	I_{LI}	V_{CC} = 5.5, V_{IN} = GND to V_{CC}			10	µA
Output Leakage Current	I_{LO}	$\overline{CS}$ = V_{IH}, $\overline{OE}$ = V_{IH}, V_{OUT} = GND to V_{CC}			10	µA
Dynamic Supply Current	I_{CC}	$\overline{CS}$ = V_{IL}, $\overline{OE}$ = V_{IH}, f = 5MHz, Vcc = 5.5			125	mA
Standby Current	I_{SB}	$\overline{CS}$ = V_{IH}, $\overline{OE}$ = V_{IH}, f = 5MHz, Vcc = 5.5			1.2	mA
Output Low Voltage	V_{OL}	I_{OL} = 2.1mA, Vcc = 4.5V			0.45	V
Output High Voltage	V_{OH}	I_{OH} = -400µA, Vcc = 4.5V	2.4			V

FIG. 2
AC TEST CIRCUIT



AC TEST CONDITIONS

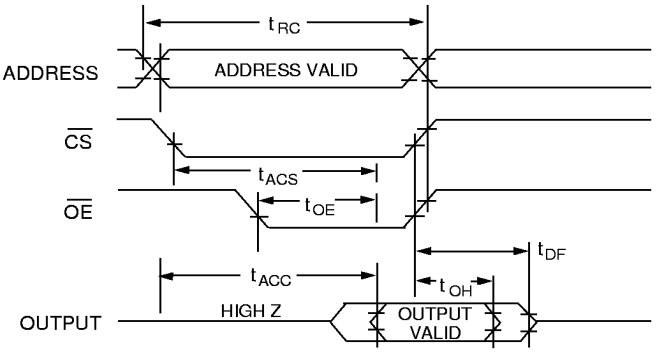
Parameter	Typ	Unit
Input Pulse Levels	V_{IL} = 0, V_{IH} = 3.0	V
Input Rise and Fall	5	ns
Input and Output Reference Level	1.5	V
Output Timing Reference Level	1.5	V

NOTES:
V_Z is programmable from -2V to +7V.
I_{OL} & I_{OH} programmable from 0 to 16mA.
Tester Impedance Z_0 = 75 Ω.
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.

READ

Figure 3 shows read cycle waveforms. A read cycle begins with selection address, chip select and output enable. Chip select is accomplished by placing the $\overline{CS}$ line low. Output enable is done by placing the $\overline{OE}$ line low. The memory places the selected data byte on I/O0 through D7 after the access time. The output of the memory is placed in a high impedance state shortly after either the $\overline{OE}$ line or $\overline{CS}$ line is returned to a high level.

FIG. 3
READ WAVEFORMS



NOTE:
$\overline{OE}$ may be delayed up to t_{ACS}-t_{OE} after the falling edge of $\overline{CS}$ without impact on t_{OE} or by t_{ACC}-t_{OE} after an address change without impact on t_{ACC}.

AC READ CHARACTERISTICS (SEE FIGURE 3)

(V_{CC} = 5.0V, GND = 0V, T_A = -55°C to +125°C)

Parameter	Symbol	-150		-200		-250		-300		Unit
		Min	Max	Min	Max	Min	Max	Min	Max	
Read Cycle Time	t_{RC}	150		200		250		300		ns
Address Access Time	t_{ACC}		150		200		250		300	ns
Chip Select Access Time	t_{ACS}		150		200		250		300	ns
Output Hold from Address Change, $\overline{OE}$ or $\overline{CS}$	t_{OH}	0		0		0		0		ns
Output Enable to Output Valid	t_{OE}		85		85		100		125	ns
Chip Select or Output Enable to High Z Output	t_{DF}		70		70		70		70	ns

WRITE

Write operations are initiated when both $\overline{CS}$ and $\overline{WE}$ are low and $\overline{OE}$ is high. The EEPROM devices support both a $\overline{CS}$ and $\overline{WE}$ controlled write cycle. The address is latched by the falling edge of either $\overline{CS}$ or $\overline{WE}$, whichever occurs last.

The data is latched internally by the rising edge of either $\overline{CS}$ or $\overline{WE}$, whichever occurs first. A byte write operation will automatically continue to completion.

WRITE CYCLE TIMING

Figures 4 and 5 show the write cycle timing relationships. A write cycle begins with address application, write enable and chip select. Chip select is accomplished by placing the $\overline{CS}$ line low. Write enable consists of setting the $\overline{WE}$ line low. The write cycle begins when the last of either $\overline{CS}$ or $\overline{WE}$ goes low.

The $\overline{WE}$ line transition from high to low also initiates an internal 150µsec delay timer to permit page mode operation. Each subsequent $\overline{WE}$ transition from high to low that occurs before the completion of the 150µsec time out will restart the timer from zero. The operation of the timer is the same as a retriggerable one-shot.

AC WRITE CHARACTERISTICS

(VCC = 5V, GND = 0V, TA = -55°C to +125°C)

Parameter	Symbol	128K x 16		Unit
		Min	Max	
Write Cycle Time, TYP = 6ms	t_{WC}		10	ms
Address Set-up Time	t_{AS}	0		ns
Write Pulse Width ($\overline{WE}$ or $\overline{CS}$)	t_{WP}	150		ns
Chip Select Set-up Time	t_{CS}	0		ns
Address Hold Time (1)	t_{AH}	50		ns
Data Hold Time	t_{DH}	10		ns
Chip Select Hold Time	t_{CH}	0		ns
Data Set-up Time	t_{DS}	100		ns
Output Enable Set-up Time	t_{OES}	0		ns
Output Enable Hold Time	t_{OEH}	0		ns
Write Pulse Width High	t_{WPH}	50		ns

FIG. 4
WRITE WAVEFORMS
$\overline{WE}$ CONTROLLED

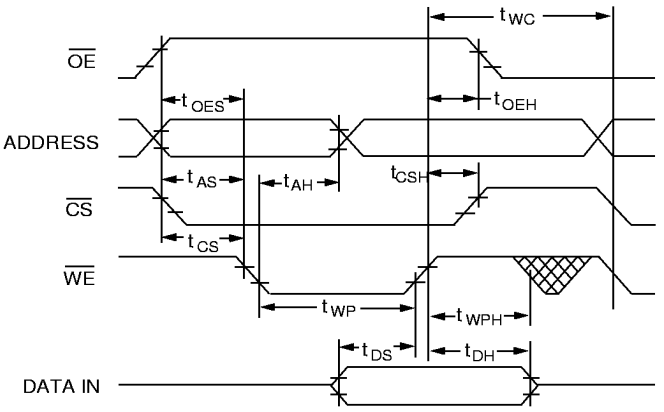
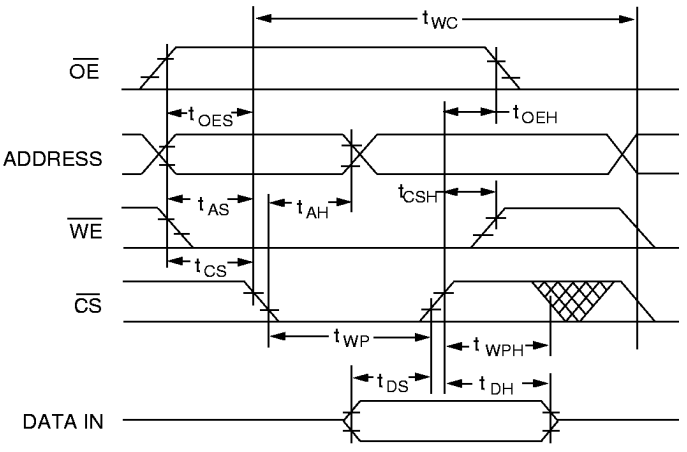


FIG. 5
WRITE WAVEFORMS
$\overline{CS}$ CONTROLLED



DATA POLLING

Operation with data polling permits a faster method of writing to the EEPROM. The actual time to complete the memory programming cycle is faster than the guaranteed maximum.

The EEPROM features a method to determine when the internal programming cycle is completed. After a write cycle is initiated, the EEPROM will respond to read cycles to provide the microprocessor with the status of the programming cycle. The status consists of the last data byte written being returned with data bit I/O7 and I/O15 complemented during the programming cycle, then I/O7 and I/O15 true after completion.

DATA POLLING AC CHARACTERISTICS

(V_{CC} = 5V, GND = 0V, T_A = -55°C to +125°C)

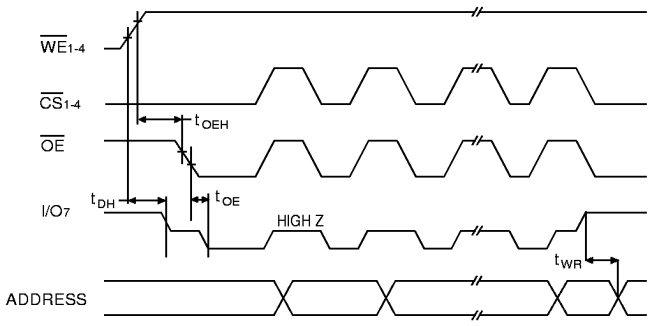
Parameter	Symbol	Min	Max	Unit
Data Hold Time	t_{DH}	10		ns
Output Enable Hold Time	t_{OEH}	10		ns
Output Enable To Output Delay	t_{OE}		100	ns
Write Recovery Time	t_{WR}	0		ns

Data polling allows a simple bit test operation to determine the status of the EEPROM. During the internal programming cycle, a read of the last word written will produce the complement of the data on I/O7 and I/O15. For example, if the data written consisted of I/O7 and I/O15 = HIGH, then the data read back would consist of I/O7 and I/O15 = LOW.

A polled word write sequence would consist of the following steps:

1. write word to EEPROM
2. store last word and last address written
3. release a time slice to other tasks
4. read word from EEPROM - last address
5. compare I/O7 and I/O15 to stored value
   - **a)** If different, write cycle is not completed, go to step 3.
   - **b)** If same, write cycle is completed, go to step 1 or step 3.

FIG. 6
DATA POLLING WAVEFORMS



PAGE WRITE OPERATION

These devices have a page write operation that allows one to 128 words to be written into the device and then simultaneously written during the internal programming period. Successive words may be loaded in the same manner after the first data word has been loaded. An internal timer begins a time out operation at each write cycle. If another write cycle is completed within 150µs or less, a new time out period begins. Each write cycle restarts the delay period. The write cycles can be continued as long as the interval is less than the time out period.

The usual procedure is to increment the least significant address lines from A_0 through A_6 at each write cycle. In this manner a page of up to 128 words can be loaded into the EEPROM in a burst mode before beginning the relatively long interval programming cycle.

After the 150µs time out is completed, the EEPROM begins an internal write cycle. During this cycle the entire page of words will be written at the same time. The internal programming cycle is the same regardless of the number of words accessed.

The page address must be the same for each word load and must be valid during each high to low transition of WE (or CS). The block address also must be the same for each word load and must remain valid throughout the WE (or CS) low pulse. The page and block address lines are summarized below:

PAGE MODE CHARACTERISTICS

(V_{CC} = 5.0V, GND = 0V, T_A = -55°C to +125°C)

Parameter	Symbol	Min	Max	Unit
Write Cycle Time, TYP = 6ms	t_{WC}		10	ms
Data Set-up Time	t_{DS}	100		ns
Data Hold Time	t_{DH}	10		ns
Write Pulse Width	t_{WP}	150		ns
Word Load Cycle Time	t_{BLC}		150	µs
Write Pulse Width High	t_{WPH}	50		ns

FIG. 7
PAGE WRITE WAVEFORMS

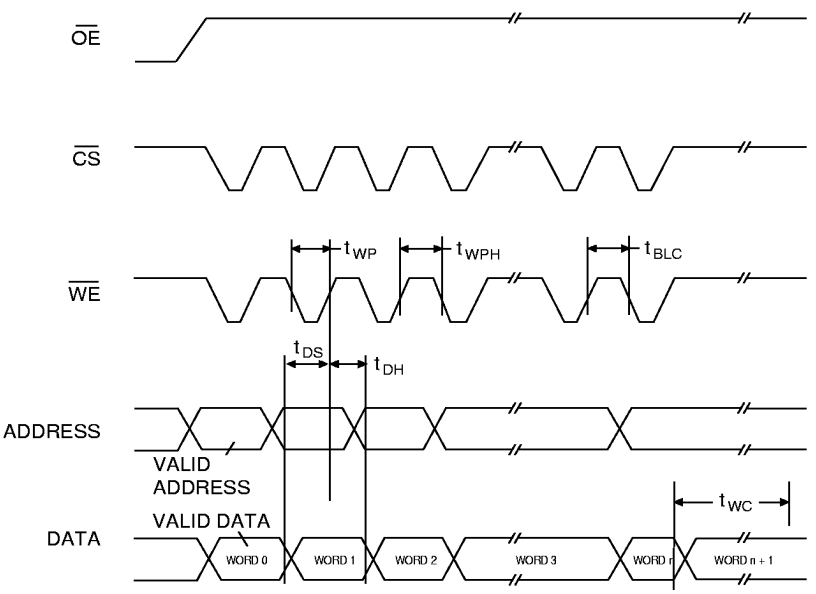
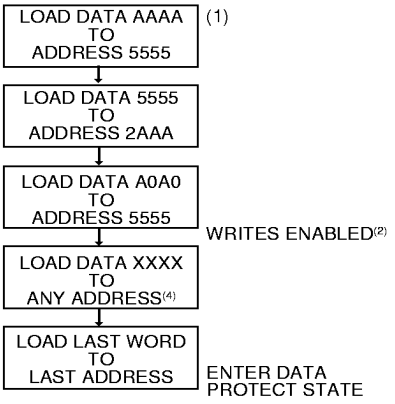
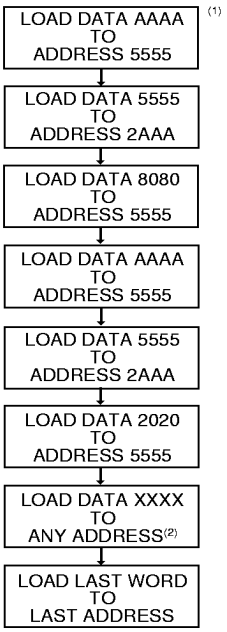


FIG. 8
SOFTWARE BLOCK DATA PROTECTION ENABLE ALGORITHM



NOTES:
1. Data Format: I/O_{15} - I/O_0 (Hex);
   Address Format: A_{16} - A_0 (Hex).
2. Write Protect state will be activated at end of write even if no other data is loaded.
3. Write Protect state will be deactivated at end of write period even if no other data is loaded.
4. 1 to 128 words of data may be loaded in the 128Kx16.

FIG. 9
SOFTWARE BLOCK DATA PROTECTION DISABLE ALGORITHM



NOTES:
1. Data Format: I/O_{15} - I/O_0 (Hex);
   Address Format: A_{16} - A_0 (Hex).
2. 1 to 128 words of data may be loaded in the 128Kx16.

SOFTWARE DATA PROTECTION

A software write protection feature may be enabled or disabled by the user. When shipped by White Microelectronics, the devices have the feature disabled. Write access to the device is unrestricted.

To enable software write protection, the user writes three access code words to three special internal locations. Once write protection has been enabled, each write to the EEPROM must use the same three byte write sequence to permit writing. After setting software data protection, any attempt to write to the device without the three-byte command sequence will start the internal write timers. No data will be written to the device, however, for the duration of t_{WC}. The write protection feature can be disabled by a six byte write sequence of specific data to specific locations. Power transitions will not reset the software write protection.

The software write protection guards against inadvertent writes during power transitions or unauthorized modification using a PROM programmer.

HARDWARE DATA PROTECTION

Several methods of hardware data protection have been implemented in the White Microelectronics EEPROM. These are included to improve reliability during normal operations.

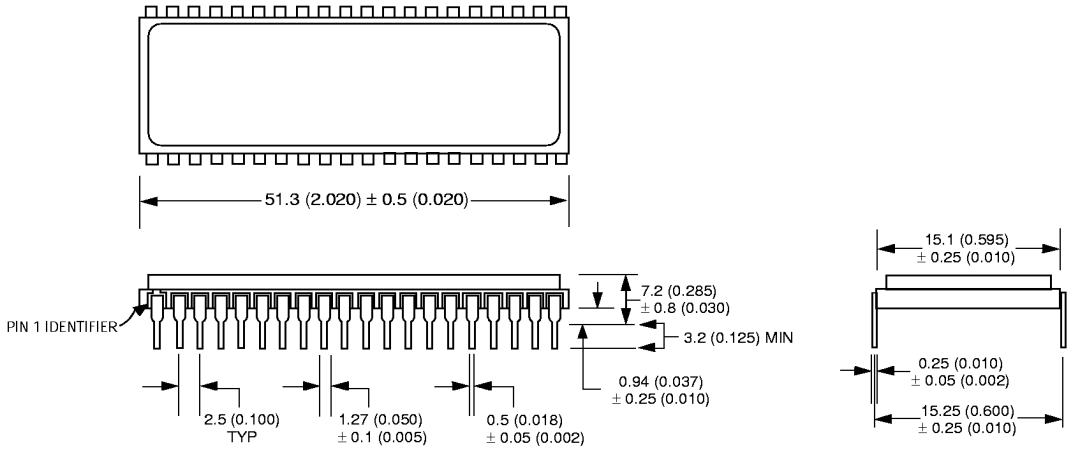
a) Vcc power on delay
As V_{CC} climbs past 3.8V typical the device will wait 5msec typical before allowing write cycles.

b) Vcc sense
While below 3.8V typical write cycles are inhibited.

c) Write inhibiting
Holding $\overline{OE}$ low and either $\overline{CS}$ or $\overline{WE}$ high inhibits write cycles.

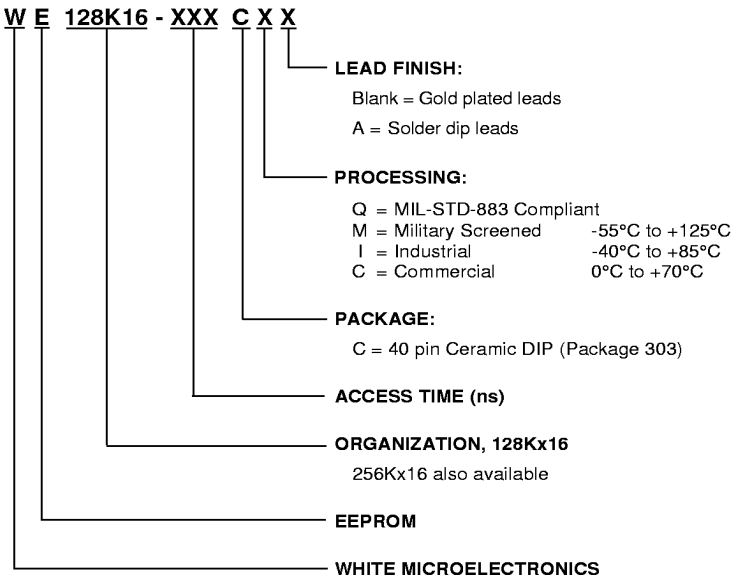
d) Noise filter
Pulses of <8ns (typ) on $\overline{WE}$ or $\overline{CS}$ will not initiate a write cycle.

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



ALL LINEAR DIMENSIONS ARE MILLIMETERS AND PARENTHETICALLY IN INCHES

ORDERING INFORMATION



DEVICE TYPE	SPEED	PACKAGE	SMD NO.
128K x 16 EEPROM Module	300ns	40 pin DIP (C)	5962-96689 01HXX*
128K x 16 EEPROM Module	250ns	40 pin DIP (C)	5962-96689 02HXX*
128K x 16 EEPROM Module	200ns	40 pin DIP (C)	5962-96689 03HXX*
128K x 16 EEPROM Module	150ns	40 pin DIP (C)	5962-96689 04HXX*