

# CAT28C65A/CAT28C65AI

64K-Bit CMOS E<sup>2</sup>PROM

## FEATURES

- Fast Read Access Times: 150/200/250ns
- Low Power CMOS Dissipation:
  - Active: 30mA Max.
  - Standby: 100µA Max.
- Simple Write Operation:
  - On-Chip Address and Data Latches
  - Self-Timed Write Cycle with Auto-Clear
- Fast Nonvolatile Write Cycle:
  - 10ms Max (5ms available)
- CMOS and TTL Compatible I/O
- Automatic Page Write Operation:
  - 1 to 32 Bytes in 10ms
  - Page Load Timer
- End of Write Detection:
  - DATA Polling
  - RDY/BUSY Pin
- Hardware Write Protection
- 10,000 Program/Erase Cycles
- 10 Year Data Retention

## DESCRIPTION

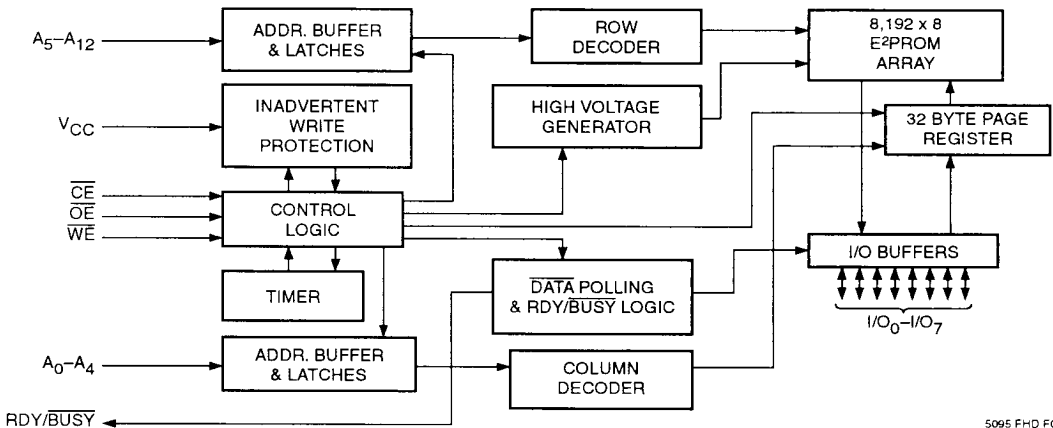
The CAT28C65A/CAT28C65AI is a fast, low power, 5V-only CMOS E<sup>2</sup>PROM organized as 8K x 8 bits. It requires a simple interface for in-system programming. On-chip address and data latches, self-timed write cycle with auto-clear and V<sub>CC</sub> power up/down write protection eliminate additional timing and protection hardware. DATA Polling and a RDY/BUSY pin signal the start and end of the self-timed write cycle. Addition-

ally, the CAT28C65A/CAT28C65AI features hardware write protection.

The CAT28C65A/CAT28C65AI is manufactured using Catalyst's advanced CMOS floating gate technology. It is designed to endure 10,000 program/erase cycles and has a data retention of 10 years. The device is available in JEDEC approved 28 pin DIP and SO or 32 pin PLCC packages.

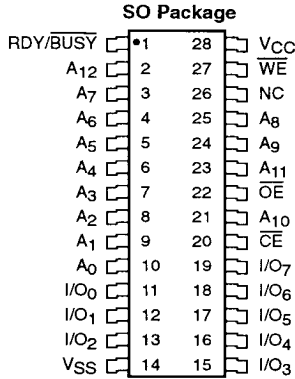
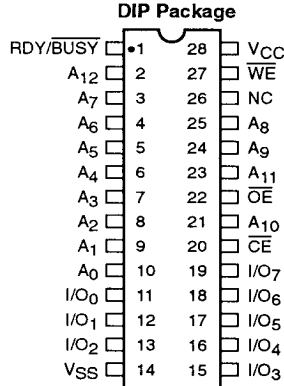
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## BLOCK DIAGRAM

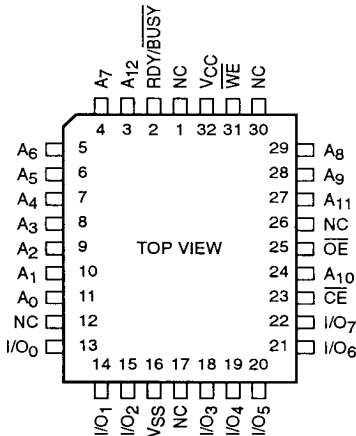


5095 FHD F02

**PIN CONFIGURATION**



**PLCC Package**



5095 FHD F01

**PIN FUNCTIONS**

Pin Name	Function
A <sub>0</sub> –A <sub>12</sub>	Address Inputs
I/O <sub>0</sub> –I/O <sub>7</sub>	Data Inputs/Outputs
RDY/BUSY	Ready/BUSY Status
CE	Chip Enable
OE	Output Enable
WE	Write Enable
V <sub>CC</sub>	5V Supply
V <sub>SS</sub>	Ground
NC	No Connect

**MODE SELECTION**

Mode	CE	WE	OE	I/O	Power
Read	L	H	L	D <sub>OUT</sub>	ACTIVE
Byte Write (WE Controlled)	L		H	D <sub>IN</sub>	ACTIVE
Byte Write (CE Controlled)		L	H	D <sub>IN</sub>	ACTIVE
Standby, and Write Inhibit	H	X	X	High-Z	STANDBY
Read and Write Inhibit	X	H	H	High-Z	ACTIVE

**CAPACITANCE** T<sub>A</sub> = 25°C, f = 1.0 MHz, V<sub>CC</sub> = 5V

Symbol	Test	Max.	Units	Conditions
C <sub>I/O</sub> (1)	Input/Output Capacitance	10	pF	V <sub>I/O</sub> = 0V
C <sub>IN</sub> (1)	Input Capacitance	6	pF	V <sub>IN</sub> = 0V

Note:

(1) This parameter is tested initially and after a design or process change that affects the parameter.

**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<sup>(2)</sup> ..... -2.0V to +V<sub>CC</sub> + 2.0V  
 V<sub>CC</sub> with Respect to Ground ..... -2.0V to +7.0V  
 Package Power Dissipation  
     Capability (T<sub>a</sub> = 25°C) ..... 1.0W  
 Lead Soldering Temperature (10 secs) ..... 300°C  
 Output Short Circuit Current<sup>(3)</sup> ..... 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	Test Method
N <sub>END</sub> <sup>(1)</sup>	Endurance	10,000		Cycles/Byte	MIL-STD-883, Test Method 1033
T <sub>DR</sub> <sup>(1)</sup>	Data Retention	100		Years	MIL-STD-883, Test Method 1008
V <sub>ZAP</sub> <sup>(1)</sup>	ESD Susceptibility	2000		Volts	MIL-STD-883, Test Method 3015
I <sub>LTH</sub> <sup>(1)(4)</sup>	Latch-Up	100		mA	JEDEC Standard 17

**D.C. OPERATING CHARACTERISTICS**

CAT28C65A T<sub>A</sub> = 0°C to +70°C, V<sub>CC</sub> = 5V ±10%, unless otherwise specified.  
 CAT28C65AI T<sub>A</sub> = -40°C to +85°C, V<sub>CC</sub> = 5V ±10%, unless otherwise specified.

7

Symbol	Parameter	Limits			Units	Test Conditions
		Min.	Typ.	Max.		
I <sub>CC</sub>	V <sub>CC</sub> Current (Operating, TTL)			40	mA	$\overline{CE} = \overline{OE} = V_{IL}$ , f = 1/t <sub>RC</sub> min, All I/O's Open
I <sub>CC</sub> <sup>(5)</sup>	V <sub>CC</sub> Current (Operating, CMOS)			30	mA	$\overline{CE} = \overline{OE} = V_{ILC}$ , f = 1/t <sub>RC</sub> min, All I/O's Open
I <sub>SB</sub>	V <sub>CC</sub> Current (Standby, TTL)			1	mA	$\overline{CE} = V_{IH}$ , All I/O's Open
I <sub>SB</sub> <sup>(6)</sup>	V <sub>CC</sub> Current (Standby, CMOS)			100	μA	$\overline{CE} = V_{IHC}$ , All I/O's Open
I <sub>LI</sub>	Input Leakage Current	-1		1	μA	V <sub>IN</sub> = GND to V <sub>CC</sub>
I <sub>LO</sub>	Output Leakage Current	-10		10	μA	V <sub>OUT</sub> = GND to V <sub>CC</sub> , $\overline{CE} = V_{IH}$
V <sub>IH</sub> <sup>(6)</sup>	High Level Input Voltage	2.0		V <sub>CC</sub> + 0.3	V	
V <sub>IL</sub> <sup>(5)</sup>	Low Level Input Voltage	-0.3		0.8	V	
V <sub>OH</sub>	High Level Output Voltage	2.4			V	I <sub>OH</sub> = -400μA
V <sub>OL</sub>	Low Level Output Voltage			0.4	V	I <sub>OL</sub> = 2.1mA
V <sub>WI</sub>	Write Inhibit Voltage	3.0			V	

- Note:
- (1) This parameter is tested initially and after a design or process change that affects the parameter.
  - (2) The minimum DC input voltage 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<sub>CC</sub> + 0.5V, which may overshoot to V<sub>CC</sub> + 2.0V for periods of less than 20 ns.
  - (3) Output shorted for no more than one second. No more than one output shorted at a time.
  - (4) Latch-up protection is provided for stresses up to 100mA on address and data pins from -1V to V<sub>CC</sub> + 1V.
  - (5) V<sub>ILC</sub> = -0.3V to +0.3V.
  - (6) V<sub>IHC</sub> = V<sub>CC</sub> - 0.3V to V<sub>CC</sub> + 0.3V.

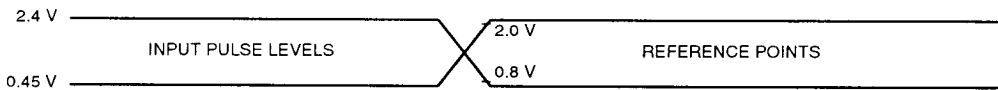
**A.C. CHARACTERISTICS, Read Cycle**

CAT28C65A  $T_A = 0^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ ,  $V_{CC} = 5\text{V} \pm 10\%$ , unless otherwise specified.

CAT28C65AI  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ ,  $V_{CC} = 5\text{V} \pm 10\%$ , unless otherwise specified.

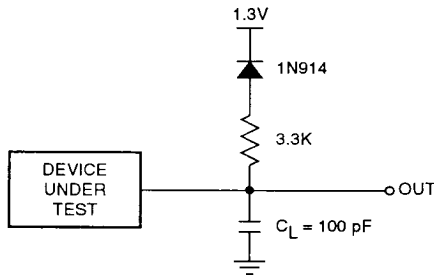
Symbol	Parameter	28C65A-15 28C65AI-15		28C65A-20 28C65AI-20		28C65A-25 28C65AI-25		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
$t_{RC}$	Read Cycle Time	150		200		250		ns
$t_{CE}$	$\overline{CE}$ Access Time		150		200		250	ns
$t_{AA}$	Address Access Time		150		200		250	ns
$t_{OE}$	$\overline{OE}$ Access Time		70		90		90	ns
$t_{LZ}^{(1)}$	$\overline{CE}$ Low to Active Output	10		10		10		ns
$t_{OLZ}^{(1)}$	$\overline{OE}$ Low to Active Output	10		10		10		ns
$t_{HZ}^{(1)(7)}$	$\overline{CE}$ High to High-Z Output		70		90		90	ns
$t_{OHZ}^{(1)(7)}$	$\overline{OE}$ High to High-Z Output		70		90		90	ns
$t_{OH}^{(1)}$	Output Hold from Address Change	20		20		20		ns

Figure 1. A.C. Testing Input/Output Waveform<sup>(8)</sup>



5096 FHD F03

Figure 2. A.C. Testing Load Circuit (example)



$C_L$  INCLUDES JIG CAPACITANCE

5096 FHD F04

Note:

- (1) This parameter is tested initially and after a design or process change that affects the parameter.
- (7) Output floating (High-Z) is defined as the state when the external data line is no longer driven by the output buffer.
- (8) Input rise and fall times (10% and 90%) < 10 ns.

**A.C. CHARACTERISTICS, Write Cycle**CAT28C65A  $T_A = 0^\circ\text{C}$  to  $+70^\circ\text{C}$ ,  $V_{CC} = 5V \pm 10\%$ , unless otherwise specified.CAT28C65AI  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ ,  $V_{CC} = 5V \pm 10\%$ , unless otherwise specified.

Symbol	Parameter	28C65A-15 28C65AI-15		28C65A-20 28C65AI-20		28C65A-25 28C65AI-25		Units
		Min.	Max.	Min.	Max.	Min.	Max.	
t <sub>WC</sub>	Write Cycle Time		10		10		10	ms
t <sub>AS</sub>	Address Setup Time	0		0		0		ns
t <sub>AH</sub>	Address Hold Time	100		120		100		ns
t <sub>CS</sub>	Write Setup Time	0		0		0		ns
t <sub>CH</sub>	Write Hold Time	0		0		0		ns
t <sub>CW</sub> <sup>(9)</sup>	$\overline{\text{CE}}$ Pulse Time	150		150		150		ns
t <sub>OES</sub>	$\overline{\text{OE}}$ Setup Time	10		10		10		ns
t <sub>OEH</sub>	$\overline{\text{OE}}$ Hold Time	10		10		10		ns
t <sub>WP</sub> <sup>(9)</sup>	$\overline{\text{WE}}$ Pulse Width	150		150		150		ns
t <sub>DS</sub>	Data Setup Time	70		70		70		ns
t <sub>DH</sub>	Data Hold Time	0		0		0		ns
t <sub>INIT</sub> <sup>(1)</sup>	Write Inhibit Period After Power-up	5	20	5	20	5	20	ms
t <sub>BLC</sub> <sup>(1)(10)</sup>	Byte Load Cycle Time	10	100	10	100	10	100	$\mu\text{s}$
t <sub>DB</sub>	Time to Device Busy		120		120		120	ns

## Note:

(1) This parameter is tested initially and after a design or process change that affects the parameter.

(9) A write pulse of less than 20ns duration will not initiate a write cycle.

(10) A timer of duration t<sub>BLC</sub> max. begins with every LOW to HIGH transition of  $\overline{\text{WE}}$ . If allowed to time out, a page or byte write will begin; however a transition from HIGH to LOW within t<sub>BLC</sub> max. stops the timer.

**DEVICE OPERATION**

**Read**

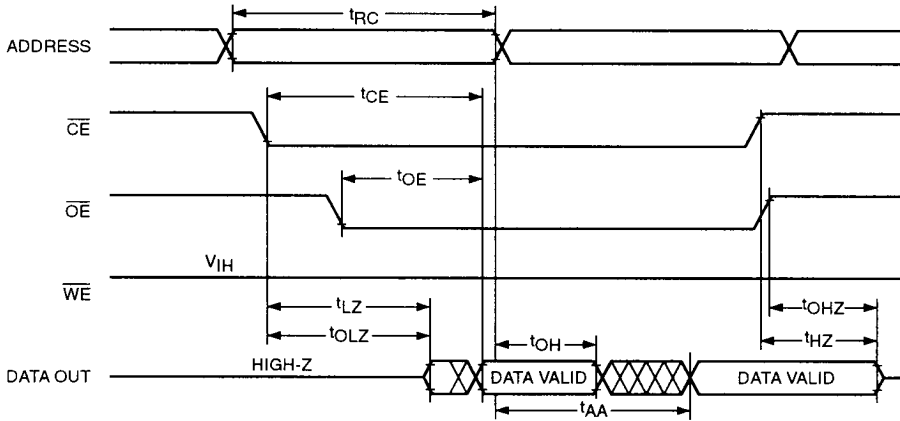
Data stored in the CAT28C65A/CAT28C65AI is transferred to the data bus when  $\overline{WE}$  is held high, and both  $\overline{OE}$  and  $\overline{CE}$  are held low. The data bus is set to a high impedance state when either  $\overline{CE}$  or  $\overline{OE}$  goes high. This

2-line control architecture can be used to eliminate bus contention in a system environment.

**Byte Write**

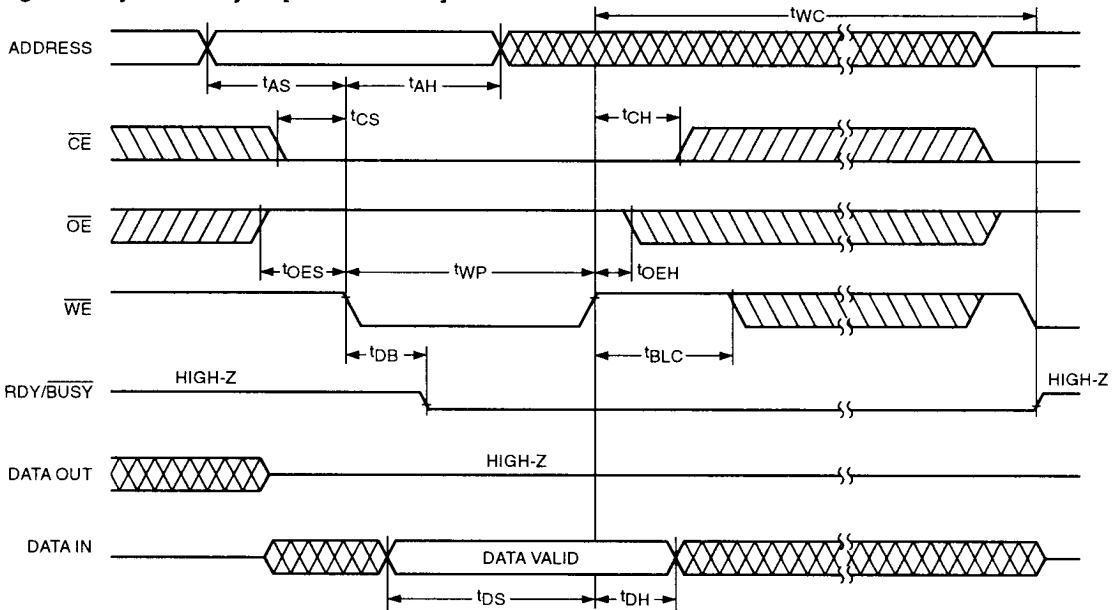
A write cycle is executed when both  $\overline{CE}$  and  $\overline{WE}$  are low, and  $\overline{OE}$  is high. Write cycles can be initiated using either  $\overline{WE}$  or  $\overline{CE}$ , with the address input being latched on the

**Figure 3. Read Cycle**



5096 FHD F05

**Figure 4. Byte Write Cycle [ $\overline{WE}$  Controlled]**



5095 FHD F06

falling edge of  $\overline{WE}$  or  $\overline{CE}$ , whichever occurs last. Data, conversely, is latched on the rising edge of  $\overline{WE}$  or  $\overline{CE}$ , whichever occurs first. Once initiated, a byte write cycle automatically erases the addressed byte and the new data is written within 10 ms.

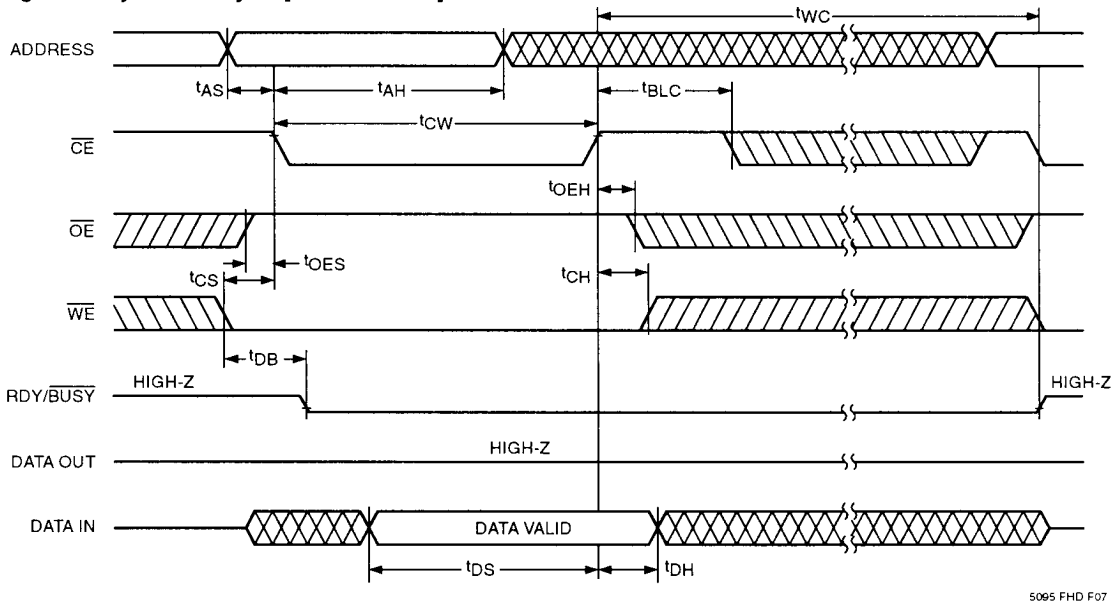
**Page Write**

The page write mode of the CAT28C65A/CAT28C65AI (essentially an extended BYTE WRITE mode) allows from 1 to 32 bytes of data to be programmed within a

single E<sup>2</sup>PROM write cycle. This effectively reduces the byte-write time by a factor of 32.

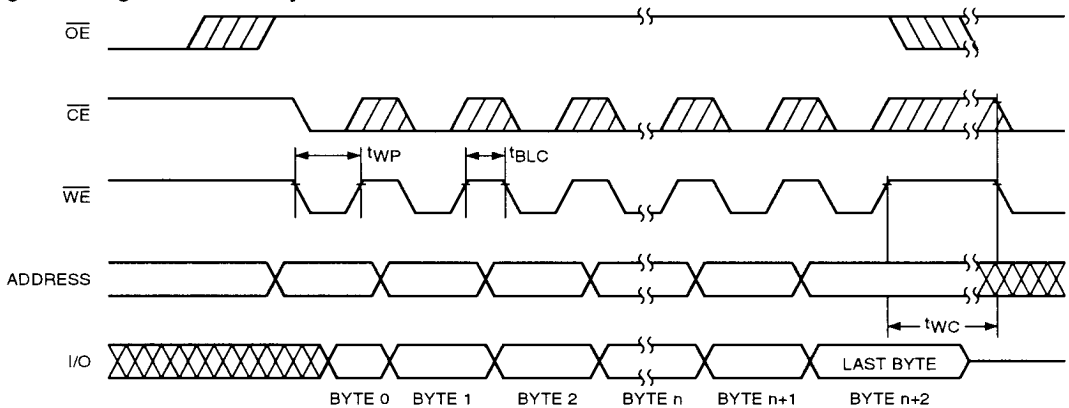
Following an initial WRITE operation ( $\overline{WE}$  pulsed low, for  $t_{WP}$ , and then high) the page write mode can begin by issuing sequential  $\overline{WE}$  pulses, which load the address and data bytes into a 32 byte temporary buffer. The page address where data is to be written, specified by bits A<sub>5</sub> to A<sub>12</sub>, is latched on the last falling edge of  $\overline{WE}$ . Each byte within the page is defined by address bits A<sub>0</sub> to A<sub>4</sub>

**Figure 5. Byte Write Cycle [ $\overline{CE}$  Controlled]**



5095 FHD F07

**Figure 6. Page Mode Write Cycle**



5096 FHD F10

7

(which can be loaded in any order) during the first and subsequent write cycles. Each successive byte load cycle must begin within  $t_{BLC\ MIN}$  of the rising edge of the preceding  $\overline{WE}$  pulse. There is no page write window limitation as long as  $\overline{WE}$  is pulsed low within  $t_{BLC\ MIN}$ .

Upon completion of the page write sequence,  $\overline{WE}$  must stay high a minimum of  $t_{BLC\ MAX}$  for the internal automatic program cycle to commence. This programming cycle consists of an erase cycle, which erases any data that existed in each addressed cell, and a write cycle, which writes new data back into the cell. A page write will only write data to the locations that were addressed and will not rewrite the entire page.

**DATA Polling**

DATA polling is provided to indicate the completion of a byte write cycle. Once a byte write cycle is initiated, attempting to read the last byte written will output the complement of that data on I/O<sub>7</sub> (I/O<sub>0</sub>–I/O<sub>6</sub> are indeterminate) until the programming cycle is complete. Upon completion of the self-timed byte write cycle, all I/O's will output true data during a read cycle.

**Ready/BUSY (RDY/BUSY)**

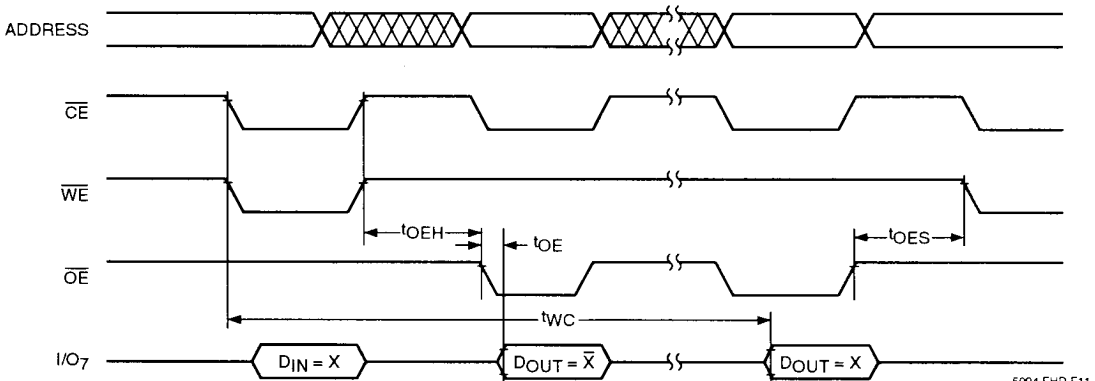
The RDY/BUSY pin is an open drain output which indicates device status during programming. It is pulled low during the write cycle and released at the end of programming. Several devices may be OR-tied to the same RDY/BUSY line.

**HARDWARE DATA PROTECTION**

The following is a list of hardware data protection features that are incorporated into the CAT28C65A/CAT28C65AI.

- (1)  $V_{CC}$  sense provides for write protection when  $V_{CC}$  falls below 3.0V min.
- (2) A power on delay mechanism,  $t_{INIT}$  (see AC characteristics), provides a 5 to 20 ms delay before a write sequence, after  $V_{CC}$  has reached 3.0V min.
- (3) Write inhibit is activated by holding any one of  $\overline{OE}$  low,  $\overline{CE}$  high or  $\overline{WE}$  high.
- (4) Noise pulses of less than 20 ns on the  $\overline{WE}$  or  $\overline{CE}$  inputs will not result in a write cycle.

Figure 7. DATA Polling



5094 FHD F11