CAT28F010V5/CAT28F010V5I

1 Megabit CMOS FLASH MEMORY

FEATURES

- Fast Read Access Time: 120/150/200 ns
- Low Power CMOS Dissipation:
  - –Active: 120 mA max (CMOS/TTL levels)
  - –Standby: 1 mA max (TTL levels)
  - –Standby: 100 μA max (CMOS levels)
- High Speed Programming:
  - –10 μS per byte
  - –2 Sec Typ Chip Program
- 5V ± 10% Programming and Erase Voltage
- Stop Timer for Program/Erase
- On-Chip Address and Data Latches
- JEDEC Standard Pinouts:
  - –32 pin DIP
  - –32 pin PLCC
  - –32 pin TSOP (8 x 14; 8 x 20)
- 10,000 Program/Erase Cycles
- 10 Year Data Retention
- Electronic Signature

DESCRIPTION

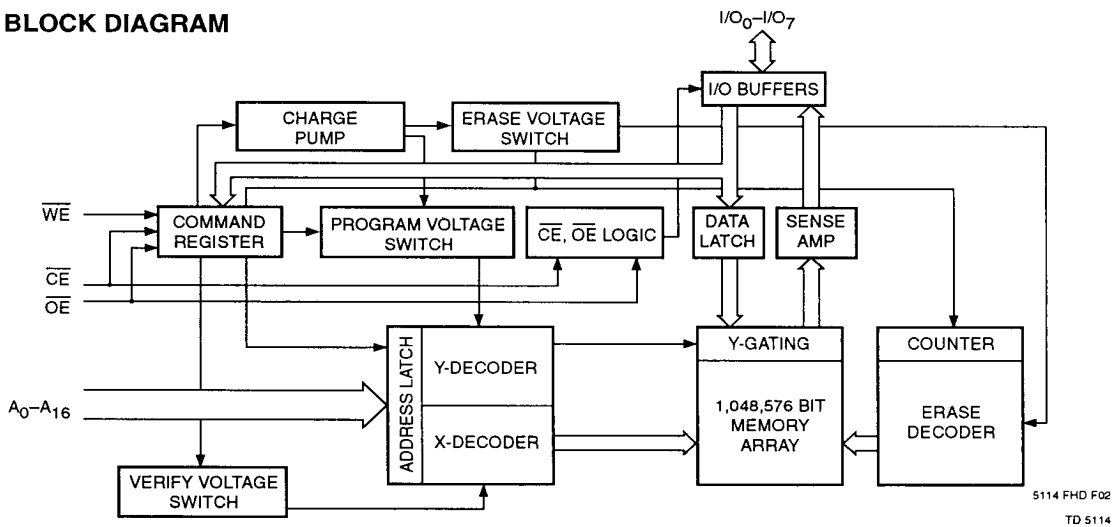
The CAT28F010V5/CAT28F010V5I is a high speed 128K x 8 bit electrically erasable and reprogrammable Flash memory ideally suited for applications requiring in-system or after-sale code updates. A single 5 volt supply handles all electrical chip erasure and programming. The memory is divided into 64 sectors of 2K bytes each.

The CAT28F010V5/CAT28F010V5I features Random Access Sector Erase by which the user can selectively erase any one of the 64 2K byte sectors. This enhances system performance since the need to erase the entire memory array is eliminated.

It is pin and Read timing compatible with standard EPROM and E^2PROM devices. Programming and Erase are performed through an operation and verify algorithm. The instructions are input via the I/O bus, using a two write cycle scheme. Address and Data are latched to free the I/O bus and address bus during the write operation.

The CAT28F010V5/CAT28F010V5I 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 32 pin plastic DIP, 32 pin PLCC or 32 pin TSOP packages.

BLOCK DIAGRAM



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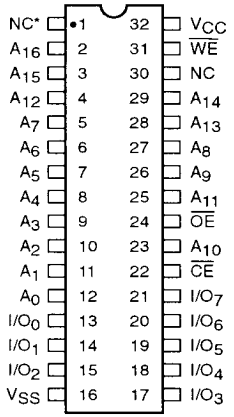
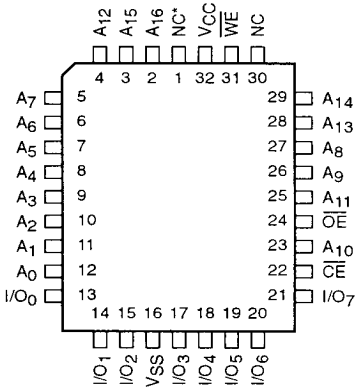
PIN CONFIGURATION

DIP Package



PLCC Package



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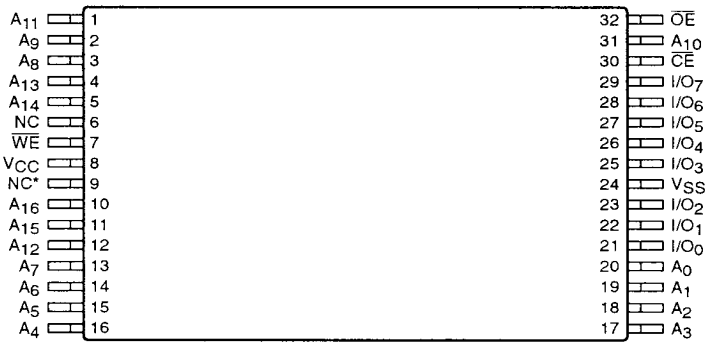
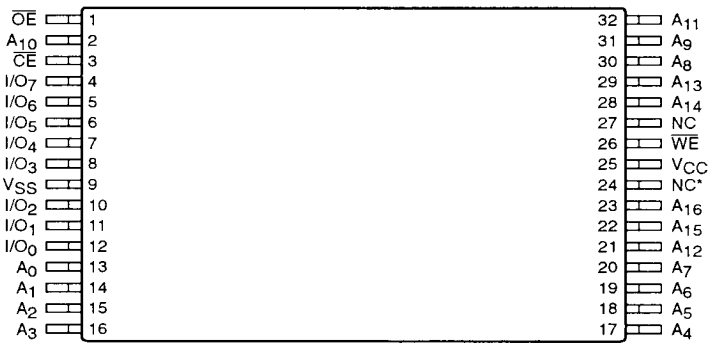
PIN FUNCTIONS

Pin Name	Type	Function
A_0–A_{16}	Input	Address Inputs for memory addressing
I/O_0–I/O_7	I/O	Data Input/Output
$\overline{CE}$	Input	Chip Enable
$\overline{OE}$	Input	Output Enable
$\overline{WE}$	Input	Write Enable
V_{CC}		Voltage Supply
V_{SS}		Ground
NC		No Connect
NC*		Internal connection should be connected to either V_{CC} or V_{SS}

TSOP Package (Standard Pinout)



TSOP Package (Reverse Pinout)



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ABSOLUTE MAXIMUM RATINGS*

Temperature Under Bias .....–55°C to +95°C

Storage Temperature .....–65°C to +150°C

Voltage on Any Pin with
Respect to Ground(1) .....–2.0V to +V_{CC} + 2.0V

Voltage on Pin A_9 with
Respect to Ground(1) .....–2.0V to +13.5V

V_{CC} with Respect to Ground(1) .....–2.0V to +7.0V

Package Power Dissipation
Capability (T_A = 25°C) ..... 1.0 W

Lead Soldering Temperature (10 secs) .....300°C

Output Short Circuit Current(2) ..... 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_{END}(3)	Endurance	1K, 10K		Cycles/Byte	MIL-STD-883, Test Method 1033
T_{DR}(3)	Data Retention	10		Years	MIL-STD-883, Test Method 1008
V_{ZAP}(3)	ESD Susceptibility	2000		Volts	MIL-STD-883, Test Method 3015
I_{LTH}(3)(4)	Latch-Up	100		mA	JEDEC Standard 17

CAPACITANCE T_A = 25°C, f = 1.0 MHz

Symbol	Test	Limits		Units	Conditions
		Min	Max.		
C_{IN}(3)	Input Pin Capacitance		6	pF	V_{IN} = 0V
C_{OUT}(3)	Output Pin Capacitance		10	pF	V_{OUT} = 0V

Note:
(1) 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_{CC} +0.5V, which may overshoot to V_{CC} + 2.0V for periods of less than 20ns.
(2) Output shorted for no more than one second. No more than one output shorted at a time.
(3) This parameter is tested initially and after a design or process change that affects the parameter.
(4) Latch-up protection is provided for stresses up to 100 mA on address and data pins from –1V to V_{CC} +1V.

D.C. OPERATING CHARACTERISTICS

CAT28F010V5 T_A = 0°C to +70°C, V_{CC} = +5V ±10%, unless otherwise specified.
CAT28F010V5I T_A = –40°C to +85°C, V_{CC} = +5V ±10%, unless otherwise specified.

Symbol	Parameter	Limits			Test Conditions
		Min.	Max.	Unit	
I_{LI}	Input Leakage Current		±1.0	µA	$V_{IN} = V_{CC}$ or V_{SS} V_{CC} = 5.5V, $\overline{OE} = V_{IH}$
I_{LO}	Output Leakage Current		±10	µA	$V_{OUT} = V_{CC}$ or V_{SS}, V_{CC} = 5.5V, $\overline{OE} = V_{IH}$
I_{SB1}	V_{CC} Standby Current CMOS		100	µA	$\overline{CE} = V_{CC}$ ±0.5V, V_{CC} = 5.5V
I_{SB2}	V_{CC} Standby Current TTL		1.0	mA	$\overline{CE} = V_{IH}$, V_{CC} = 5.5V
I_{CC1}	V_{CC} Active Read/Verify Current		30	mA	V_{CC} = 5.5V, $\overline{CE} = V_{IL}$, I_{OUT} = 0mA, f = 6 MHz
I_{CC2}(3)	V_{CC} Programming Current		120	mA	V_{CC} = 5.5V, Programming in Progress
I_{CC3}(3)	V_{CC} Erase Current		30	mA	V_{CC} = 5.5V, Erasure in Progress
V_{IL}	Input Low Level TTL	–0.5	0.8	V	
V_{ILC}	Input Low Level CMOS	–0.5	0.8	V	
V_{OL}	Output Low Level		0.45	V	I_{OL} = 5.8mA, V_{CC} = 4.5V
V_{IH}	Input High Level TTL	2.0	V_{CC}+0.5	V	
V_{IHC}	Input High Level CMOS	0.7 V_{CC}	V_{CC}+0.5	V	
V_{OH}	Output High Level TTL	2.4		V	I_{OH} = –2.5mA, V_{CC} = 4.5V
V_{OH1}	Output High Level CMOS	0.85 V_{CC}		V	I_{OH} = –2.5mA, V_{CC} = 4.5V
V_{OH2}	Output High Level CMOS	V_{CC}–0.4		V	I_{OH} = –400µA, V_{CC} = 4.5V
V_{ID}	A_9 Signature Voltage	11.4	13.0	V	$A_9 = V_{ID}$
I_{ID}	A_9 Signature Current		200	µA	$A_9 = V_{ID}$
V_{LO}	V_{CC} Erase/Prog. Lockout Voltage	2.5		V	

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

A.C. CHARACTERISTICS, Read Operation

CAT28F010V5 T_A = 0°C to +70°C, V_{CC} = +5V ±10%, unless otherwise specified.
CAT28F010V5I T_A = –40°C to +85°C, V_{CC} = +5V ±10%, unless otherwise specified.

Symbol	Parameter	28F010V5-12 28F010V5I-12		28F010V5-15 28F010V5I-15		28F010V5-20 28F010V5I-20		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
t_{RC}	Read Cycle Time	120		150		200		ns
t_{CE}	$\overline{CE}$ Access Time		120		150		200	ns
t_{ACC}	Address Access Time		120		150		200	ns
t_{OE}	$\overline{OE}$ Access Time		50		55		60	ns
t_{OH}	Output Hold from Address $\overline{OE}$/$\overline{CE}$ Change	0		0		0		ns
t_{OLZ}[3][9]	$\overline{OE}$ to Output in Low-Z	0		0		0		ns
t_{LZ}[3][9]	$\overline{CE}$ to Output in Low-Z	0		0		0		ns
t_{DF}[3][5]	$\overline{OE}$ High to Output High-Z		30		35		40	ns
t_{EHQZ}[3][5]	$\overline{CE}$ High to Output High-Z		55		55		55	ns
t_{WHGL}[3]	Write Recovery Time Before Read	6		6		6		µs

Figure 1. A.C. Testing Input/Output Waveform[6][7][8]

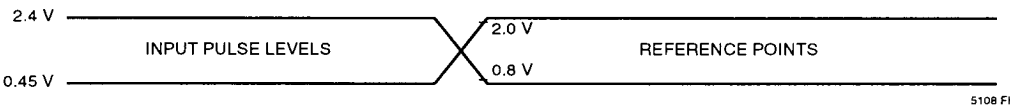
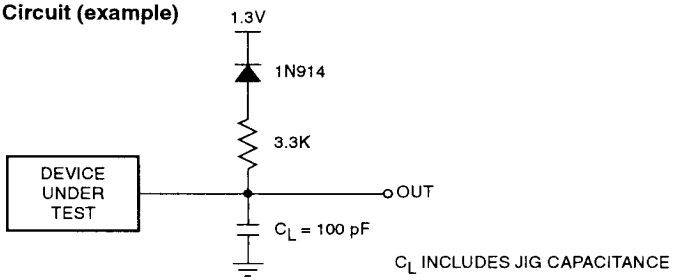


Figure 2. A.C. Testing Load Circuit (example)



Note:
(3) This parameter is tested initially and after a design or process change that affects the parameter.
(5) Output floating (High-Z) is defined as the state where the external data line is no longer driven by the output buffer.
(6) Input Rise and Fall Times (10% to 90%) < 10 ns.
(7) Input Pulse Levels = 0.45V and 2.4V.
(8) Input and Output Timing Reference = 0.8V and 2.0V.
(9) Low-Z is defined as the state where the external data may be driven by the output buffer but may not be valid.

A.C. CHARACTERISTICS, Program/Erase Operation

CAT28F010V5 T_A = 0°C to +70°C, V_{CC} = +5V ±10%, unless otherwise specified.
CAT28F010V5I T_A = –40°C to +85°C, V_{CC} = +5V ±10%, unless otherwise specified.

Symbol	Parameter	28F010V5-12 28F010V5I-12		28F010V5-15 28F010V5I-15		28F010V5-20 28F010V5I-20		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
t_{WC}	Write Cycle Time	120		150		200		ns
t_{AS}	Address Setup Time	0		0		0		ns
t_{AH}	Address Hold Time	60		60		75		ns
t_{DS}	Data Setup Time	50		50		50		ns
t_{DH}	Data Hold Time	10		10		10		ns
t_{CS}	$\overline{CE}$ Setup Time	0		0		0		ns
t_{CH}	$\overline{CE}$ Hold Time	0		0		0		ns
t_{WP}	$\overline{WE}$ Pulse Width	60		60		60		ns
t_{WPH}	$\overline{WE}$ High Pulse Width	20		20		20		ns
t_{WPWH1}(11)	Program Pulse Width	10		10		10		µs
t_{WPWH2}(11)	Erase Pulse Width	9.5		9.5		9.5		ms
t_{WPGL}	Write Recovery Time Before Read	6		6		6		µs
t_{GHWL}	Read Recovery Time Before Write	0		0		0		µs

ERASE AND PROGRAMMING PERFORMANCE

Parameter	28F010V5-12 28F010V5I-12			28F010V5-15 28F010V5I-15			28F010V5-20 28F010V5I-20			Unit
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.	
Chip Erase Time(11)(13)		10	320		10	320		15	320	sec
Chip Program Time(11)(12)		2	10		2	10		2	10	sec
Sector Erase Time(11)(13)		0.3	10		0.3	10		0.5	30	sec

Note:
(10) Program and Erase operations are controlled by internal stop timers.
(11) 'Typicals' are not guaranteed, but based on characterization data. Data taken at 25°C.
(12) Minimum byte programming time (excluding system overhead) is 16 µs (10 µs program + 6 µs write recovery), while maximum is 400 µs/byte (16 µs x 25 loops). Max chip programming time is specified lower than the worst case allowed by the programming algorithm since most bytes program significantly faster than the worst case byte.
(13) Excludes 00H Programming prior to Erasure.

FUNCTION TABLE(14)

Mode	Pins				Notes
	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	I/O	
ReadV_{IL}	V_{IL}	V_{IH}	D_{OUT}		
Output Disable	V_{IL}	V_{IH}	V_{IH}	High-Z	
Standby	V_{IH}	X	X	High-Z	
Signature (MFG)	V_{IL}	V_{IL}	V_{IH}	31H	$A_0 = V_{IL}$, $A_9 = 12V$
Signature (Device)	V_{IL}	V_{IL}	V_{IH}	B5H	$A_0 = V_{IL}$, $A_9 = 12V$
Program/Erase	V_{IL}	V_{IH}	V_{IL}	D_{IN}	See Command Table
Write Cycle	V_{IL}	V_{IH}	V_{IL}	D_{IN}	During Write Cycle
Read Cycle	V_{IL}	V_{IL}	V_{IH}	D_{OUT}	During Write Cycle

WRITE COMMAND TABLE

Mode	Pins						
	First Bus Cycle			Second Bus Cycle			
	Operation	Address	D_{IN}	Operation	Address	D_{IN}	D_{OUT}
Set Read	Write	X	00H	Read	Any		D_{OUT}
Read Sig. (MFG)	Write	X	90H	Read	00		31H
Read Sig. (Device)	Write	X	90H	Read	01		B5H
Random Sector Erase	Write	X	60H	Write	Sector Addr	60H	
Sequential Sector Erase	Write	X	20H	Write	X	20H	
Erase Verify	Write	X	A0H	Read	X		D_{OUT}
Program	Write	X	40H	Write	A_{IN}	D_{IN}	
Program Verify	Write	X	C0H	Read	X		D_{OUT}
Reset	Write	X	FFH	Write	X	FFH	

Note:
(14) Logic Levels: X = Logic 'Do not care' (V_{IH}, V_{IL})

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READ OPERATIONS

Read Mode

A Read operation is performed with both $\overline{CE}$ and $\overline{OE}$ low and with $\overline{WE}$ high. V_{PP} can be either high or low, however, if V_{PP} is high, the Set READ command has to be sent before reading data (see Write Operations). The data retrieved from the I/O pins reflects the contents of the memory location corresponding to the state of the 17 address pins. The respective timing waveforms for the read operation are shown in Figure 3. Refer to the AC Read characteristics for specific timing parameters.

Signature Mode

The signature mode allows the user to identify the IC manufacturer and the type of device while the device resides in the target system. This mode can be activated in either of two ways; through the conventional method of applying a high voltage (12V) to address pin A_9 or by sending an instruction to the command register (see Write Operations).

The conventional mode is entered as a regular READ mode by driving the $\overline{CE}$ and $\overline{OE}$ pins low (with $\overline{WE}$ high), and applying the required high voltage on address pin A_9 while all other address lines are held at V_{IL}.

A Read cycle from address 0000H retrieves the binary code for the IC manufacturer on outputs I/O_0 to I/O_7:

CATALYST Code = 00110001 (31H)

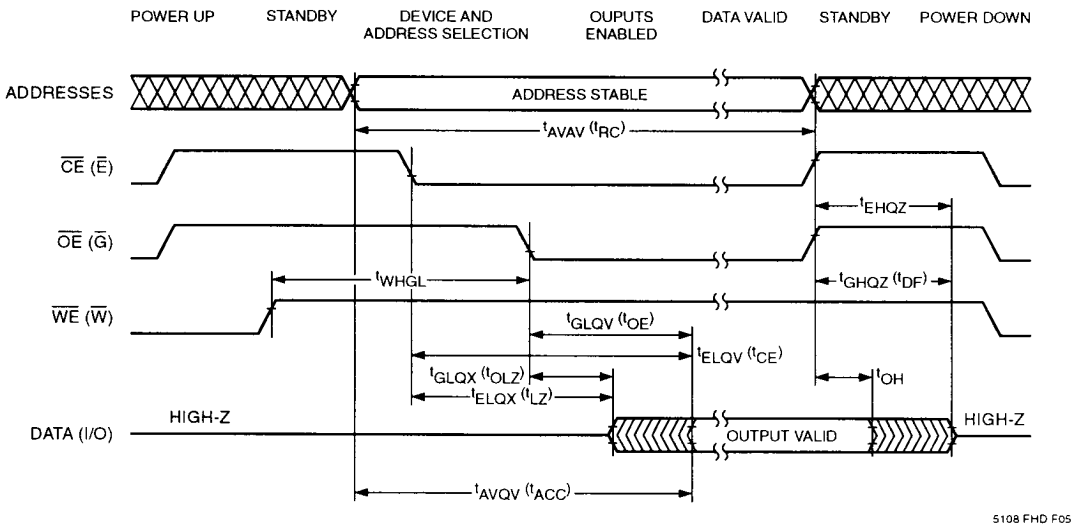
A Read cycle from address 0001H retrieves the binary code for the device on outputs I/O_0 to I/O_7.

28F010V5/28F010V5I Code = 1011 0101 (B5H)

Standby Mode

With $\overline{CE}$ at a logic-high level, the CAT28F010V5/ CAT28F010V5I is placed in a standby mode where most of the device circuitry is disabled, thereby substantially reducing power consumption. The outputs are placed in a high-impedance state.

Figure 3. A.C. Timing for Read Operation



WRITE OPERATIONS

The following operations are initiated by observing the sequence specified in the Write Command Table.

Read Mode

The device can be put into a standard READ mode by initiating a write cycle with 00H on the data bus. The subsequent read cycles will be performed similar to a standard EPROM or E²PROM Read.

Signature Mode

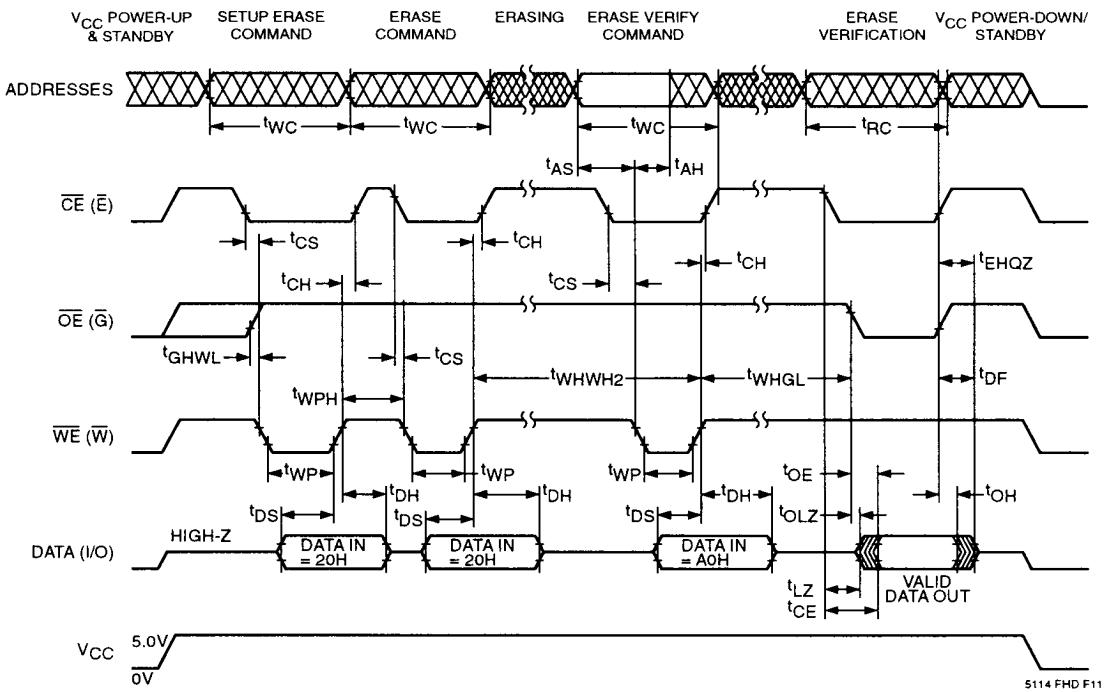
An alternative method for reading device signature (see Read Operations Signature Mode), is initiated by writing the code 90H into the command register while keeping V_{PP} high. A read cycle from address 0000H with $\overline{CE}$ and $\overline{OE}$ low (and $\overline{WE}$ high) will output the device signature.

CATALYST Code = 00110001 (31H)

A Read cycle from address 0001H retrieves the binary code for the device on outputs I/O_0 to I/O_7.

28F010V5/28F010V5I Code = 1011 0101 (B5H)

Figure 4. A.C. Timing for Erase Operation



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Erase Modes

The CAT28F010V5/CAT28F010V5I is organized as 64 sectors of 2K bytes each. The user can erase the entire memory contents (chip erase using Sequential Sector erase) by following the erase algorithm shown in Figure 6. Alternatively, the user can randomly erase any one of the 64 sectors using the Random Access Sector erase algorithm shown in Figure 5. The erase process is accomplished by first programming all bytes to "00" and then erasing all bytes to the "FF" state. An integrated stop timer allows for automatic timing control over this operation, eliminating the need for a maximum erase timing specification. Refer to AC Characteristics (Program/Erase) for specific timing parameters.

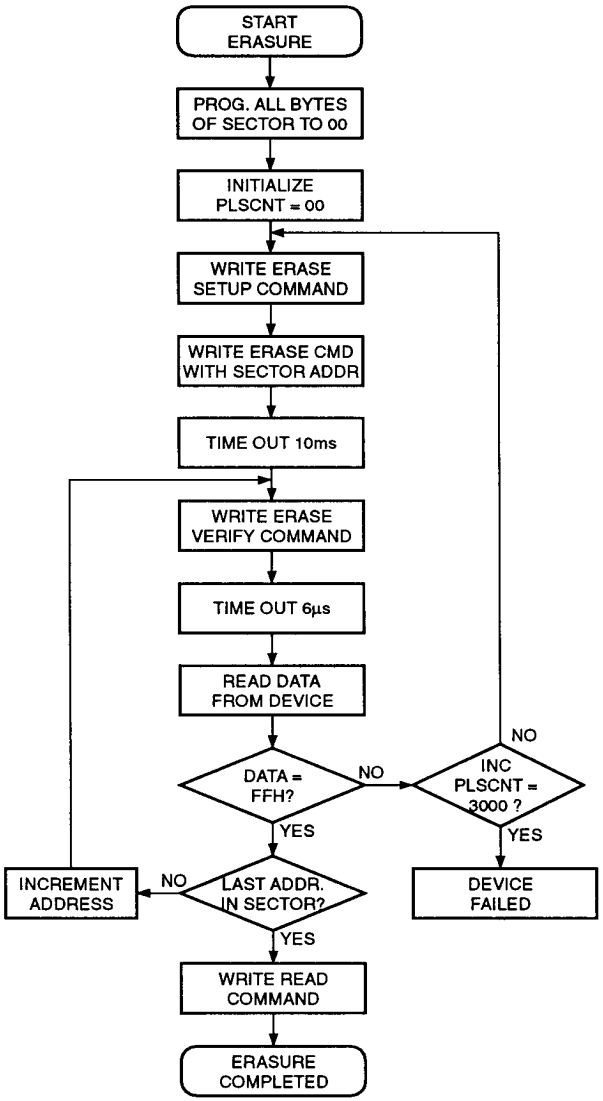
Random Access Sector Erase

The CAT28F010V5/CAT28F010V5I features a random access sector erase where an individual sector (2K bytes) can be erased independent of the other sectors (see Figure 5). To erase a sector, a write command with data 60H is first sent to the device (it is assumed that all locations within the sector have first been written to 00H). A second write command (with data = 60H) along with the beginning address of the sector to be erased is sent next (address bits A11–A16 define the sector). Finally, after sending an erase-verify command, the device will erase the specified 2K sector. The Random Access Sector Erase feature minimizes the chance of inadvertently erasing data from sectors that contain boot code or critical data.

TIMING PARAMETER SYMBOLS

Standard	JEDEC	Standard	JEDEC
t_{AS}	t_{AVWL}	t_{LZ}	t_{ELQX}
t_{AH}	t_{WLAX}	t_{OE}	t_{GLQV}
t_{CE}	t_{ELQV}	t_{OLZ}	t_{GLQX}
t_{CH}	t_{WHEH}	t_{RC}	t_{AVAV}
t_{CS}	t_{ELWL}	t_{WC}	t_{AVAV}
t_{DF}	t_{GHQZ}	t_{WP}	t_{WLWH}
t_{DH}	t_{WHDX}	t_{WPH}	t_{WHWL}
t_{DS}	t_{DVWH}		

Figure 5. Random Access Sector Erase Algorithm(15)



BUS OPERATION	COMMAND	COMMENTS
		ALL BYTES WITHIN SECTOR SHOULD BE PROGRAMMED TO 00 BEFORE AN ERASE OPERATION
		PLSCNT = PULSE COUNT
WRITE	ERASE	ACTUAL ERASE NEEDS 10ms PULSE, DATA = 60H
WRITE	ERASE	DATA = 60H ADDRESS = SECTOR ADDR
		WAIT
WRITE	ERASE VERIFY	ADDR = BYTE TO VERIFY DATA = A0H
		WAIT
READ		READ BYTE TO VERIFY ERASURE
STANDBY		COMPARE OUTPUT TO FF INC PULSE COUNT
WRITE	READ	DATA = 00H, RESETS REGISTERS FOR READ OPERATION
STANDBY		

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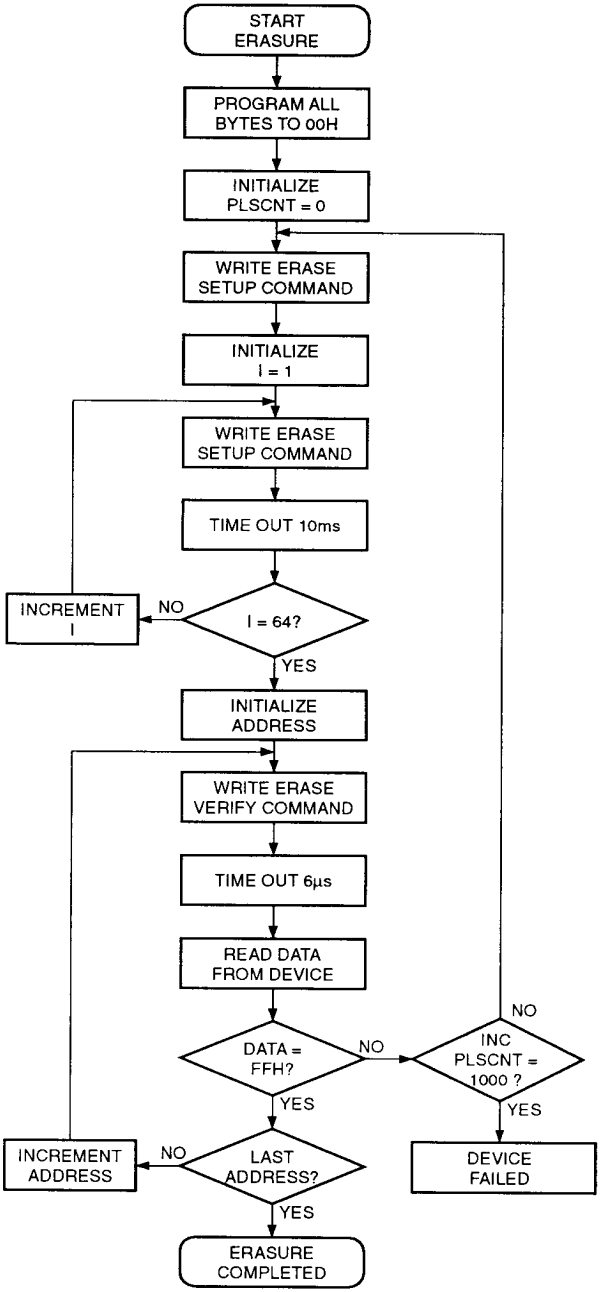
Note:
(15) The algorithm MUST BE FOLLOWED to ensure proper and reliable operation of the device.

Sequential Sector Erase

During the first Write operation, the command 20H is written into the command register. In order to commence the erase operation, the identical command of 20H has to be written again into the register. This two step process ensures against accidental erasure of the memory contents. The erase cycle is repeated 64 times to erase each of the 64 internal memory blocks sequentially. The final erase operation will be stopped at the rising edge of $\overline{WE}$, at which time the Erase Verify command (A0H) is sent to the command register. During this time, the address to be verified is sent to the address bus and latched when $\overline{WE}$ goes high.

Figure 6. Chip Erase Algorithm (using Sequential Sector Erase)(15)



BUS OPERATION	COMMAND	COMMENTS
		ALL BYTES SHALL BE PROGRAMMED TO 00 BEFORE AN ERASE OPERATION
		PLSCNT = PULSE COUNT
WRITE	ERASE	ACTUAL ERASE NEEDS 10ms PULSE, DATA = 20H
		I = SECTOR INCREMENT COUNTER
WRITE	ERASE	DATA = 20H
		WAIT
		64 ERASE COMMANDS ARE NECESSARY TO ERASE ALL SECTORS
WRITE	ERASE VERIFY	ADDR = BYTE TO VERIFY DATA = A0H
		WAIT
READ		READ BYTE TO VERIFY ERASURE
STANDBY		COMPARE OUTPUT TO FF INCR PULSE COUNT

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Note:
(15) The algorithm MUST BE FOLLOWED to ensure proper and reliable operation of the device.

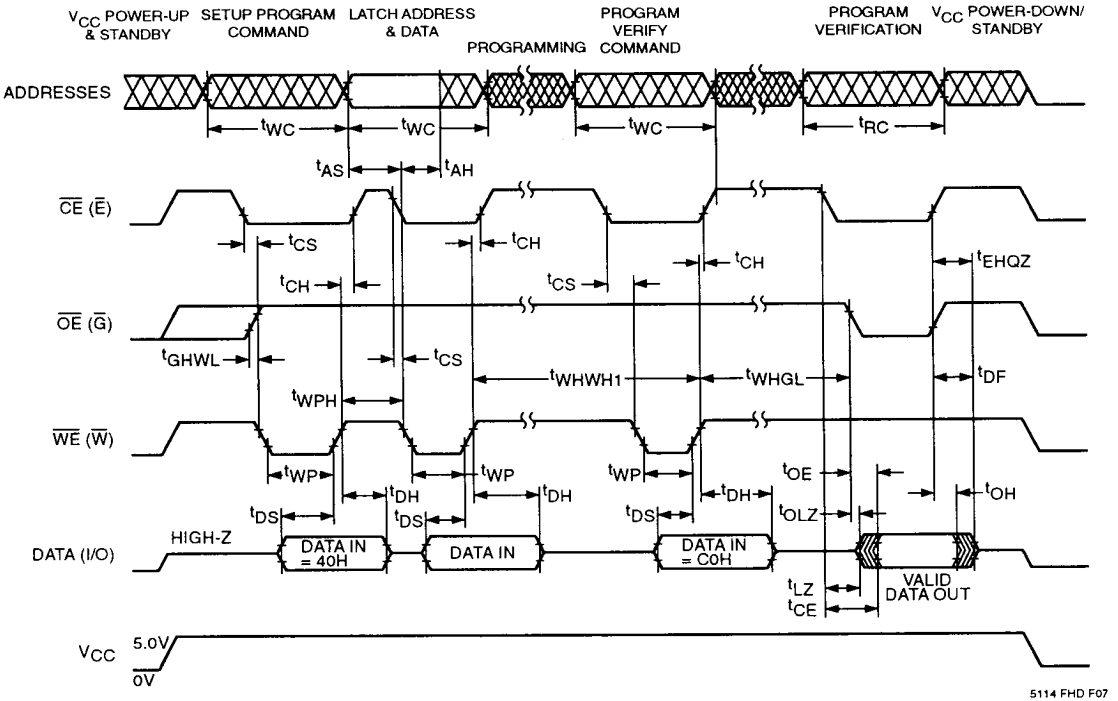
ERASE-VERIFY MODE

The Erase-verify operation is performed on every byte after each erase pulse to verify that the bits have been erased.

Programming Mode

The programming operation is initiated using the programming algorithm of Figure 7. During the first write cycle, the command 40H is written into the command register. During the second write cycle, the address of the memory location to be programmed is latched on the falling edge of $\overline{WE}$, while the data is latched on the rising edge of $\overline{WE}$. The program operation terminates with the next rising edge of $\overline{WE}$. An integrated stop timer allows for automatic timing control over this operation, eliminating the need for a maximum program timing specification. Refer to AC Characteristics (Program/Erase) for specific timing parameters.

Figure 7. A.C. Timing for Programming Operation



Program-Verify Mode

A Program-verify cycle is performed to ensure that all bits have been correctly programmed following each byte programming operation. The specific address is already latched from the write cycle just completed, and stays latched until the verify is completed. The Program-verify operation is initiated by writing C0H into the command register. An internal reference generates the necessary high voltages so that the user does not need to modify V_{CC}. Refer to AC Characteristics (Program/Erase) for specific timing parameters.

TIMING PARAMETER SYMBOLS

Standard	JEDEC	Standard	JEDEC
t_{AS}	t_{AVWL}	t_{LZ}	t_{ELQX}
t_{AH}	t_{WLAX}	t_{OE}	t_{GLQV}
t_{CE}	t_{ELQV}	t_{OLZ}	t_{GLQX}
t_{CH}	t_{WHEH}	t_{RC}	t_{AVAV}
t_{CS}	t_{ELWL}	t_{WC}	t_{AVAV}
t_{DF}	t_{GHQZ}	t_{WP}	t_{WLWH}
t_{DH}	t_{WHDX}	t_{WPH}	t_{WHWL}
t_{DS}	t_{DVWH}		

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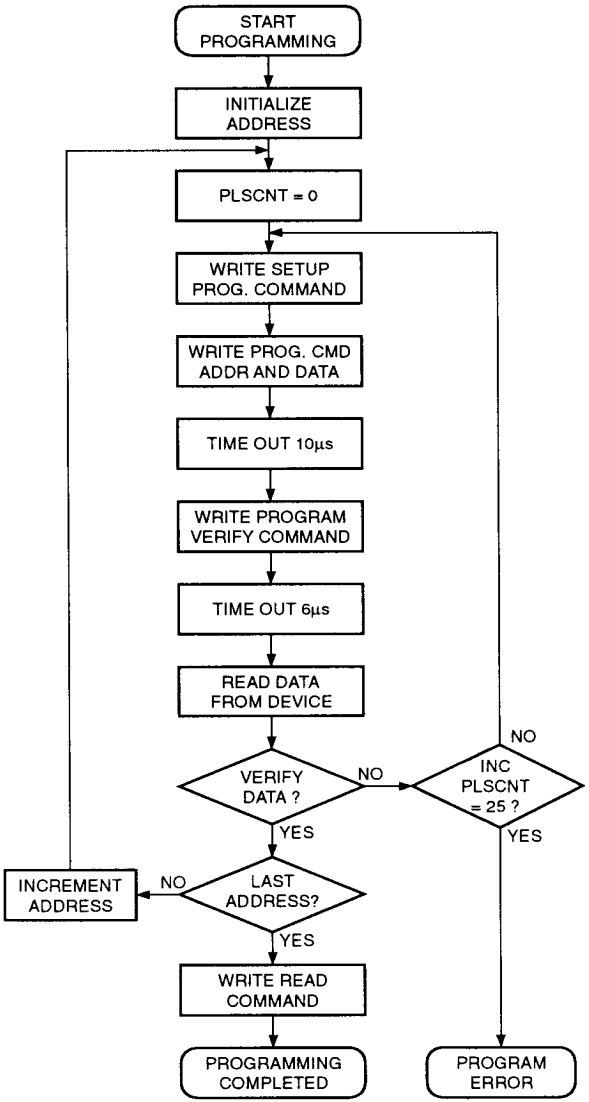
Figure 8. Programming Algorithm(15)



BUS OPERATION	COMMAND	COMMENTS
		INITIALIZE ADDRESS
		INITIALIZE PULSE COUNT PLSCNT = PULSE COUNT
1ST WRITE CYCLE	WRITE SETUP	DATA = 40H
2ND WRITE CYCLE	PROGRAM	VALID ADDRESS AND DATA
		WAIT
1ST WRITE CYCLE	PROGRAM VERIFY	DATA = C0H
		WAIT
READ		READ BYTE TO VERIFY PROGRAMMING
STANDBY		COMPARE DATA OUTPUT TO DATA EXPECTED
1ST WRITE CYCLE	READ	DATA = 00H SETS THE REGISTER FOR READ OPERATION

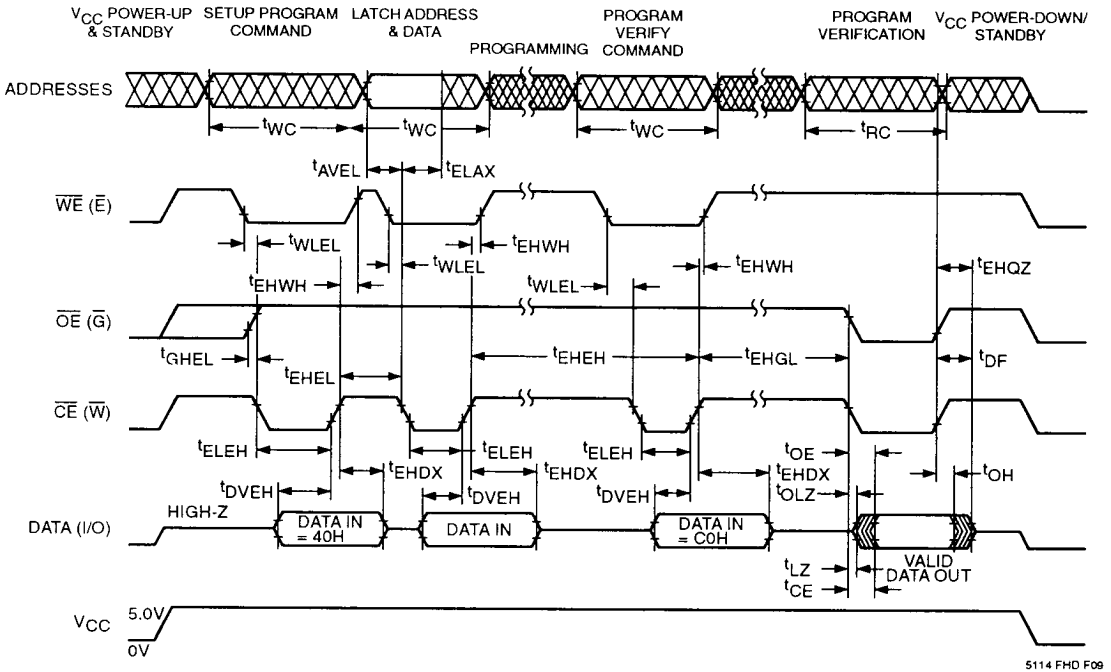
5114 FHD F06

Note:
(15) The algorithm MUST BE FOLLOWED to ensure proper and reliable operation of the device.

Abort/Reset

An Abort/Reset command is available to allow the user to safely abort an erase or program sequence. Two consecutive program operations with FFH on the data bus will abort an erase or a program operation. The Abort/Reset operation also resets the sector pointer in the sequential sector erase mode. The Abort/Reset operation can interrupt at any time in a program or erase operation, and the device is reset to the Read mode. If an Abort/Reset command is sent prior to completion of an erase or program sequence, a partial erase or program may occur. If a program operation is aborted by the Reset command, the byte in progress can later be programmed. If an erase operation is aborted by the reset command, the erase operation can be continued after the abort.

Figure 9. Alternate A.C. Timing for Program Operation



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POWER SUPPLY DECOUPLING

To reduce the effect of transient power supply voltage spikes, it is good practice to use a 0.1µF ceramic capacitor between V_{CC} and V_{SS}. These high-frequency capacitors should be placed as close as possible to the device for optimum decoupling.

It is recommended after a power up to issue an Abort/ Reset command when operating in particularly noisy environments. No power supply sequencing is required.

TIMING PARAMETER SYMBOLS

Standard	JEDEC
t_{WC}	t_{AVAV}
t_{OLZ}	t_{GLQX}
t_{LZ}	t_{ELQX}
t_{CE}	t_{ELQV}
t_{DE}	t_{ELQV}
t_{DF}	t_{GHQZ}

ALTERNATE $\overline{CE}$-CONTROLLED WRITES

Symbol	Parameter	28F010V5-12 28F010V5I-12		28F010V5-15 28F010V5I-15		28F010V5-20 28F010V5I-20		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
t_{AVAV}	Write Cycle Time	120		150		200		ns
t_{AVEL}	Address Setup Time	0		0		0		ns
t_{ELAX}	Address Hold Time	80		80		95		ns
t_{DVEH}	Data Setup Time	50		50		50		ns
t_{EHDX}	Data Hold Time	10		10		10		ns
t_{EHGL}	Write Recovery Time Before Read	6		6		6		µs
t_{GHEL}	Read Recovery Time Before Write	0		0		0		µs
t_{WLEL}	$\overline{WE}$ Setup Time Before $\overline{CE}$	0		0		0		ns
t_{EHWH}	Write Enable Hold Time	0		0		0		ns
t_{ELEH}	Write Pulse Width	70		70		80		ns
t_{EHEL}	Write Pulse Width High	20		20		20		ns