FM28V020

256-Kbit (32 K × 8) F-RAM Memory

Features

- 256-Kbit ferroelectric random access memory (F-RAM) logically organized as 32 K × 8
  - High-endurance 100 trillion (10^{14}) read/writes
  - 151-year data retention (see the Data Retention and Endurance table)
  - NoDelay™ writes
  - Page mode operation
  - Advanced high-reliability ferroelectric process
- SRAM compatible
  - Industry-standard 32 K × 8 SRAM pinout
  - 70-ns access time, 140-ns cycle time
- Superior to battery-backed SRAM modules
  - No battery concerns
  - Monolithic reliability
  - True surface mount solution, no rework steps
  - Superior for moisture, shock, and vibration
  - Resistant to negative voltage undershoots
- Low power consumption
  - Active current 5 mA (typ)
  - Standby current 90 µA (typ)
- Low-voltage operation: V_{DD} = 2.0 V to 3.6 V
- Industrial temperature: –40 °C to +85 °C
- Packages:
  - 28-pin small outline integrated circuit (SOIC) package
  - 28-pin thin small outline package (TSOP) Type I
  - 32-pin thin small outline package (TSOP) Type I
- Restriction of hazardous substances (RoHS) compliant

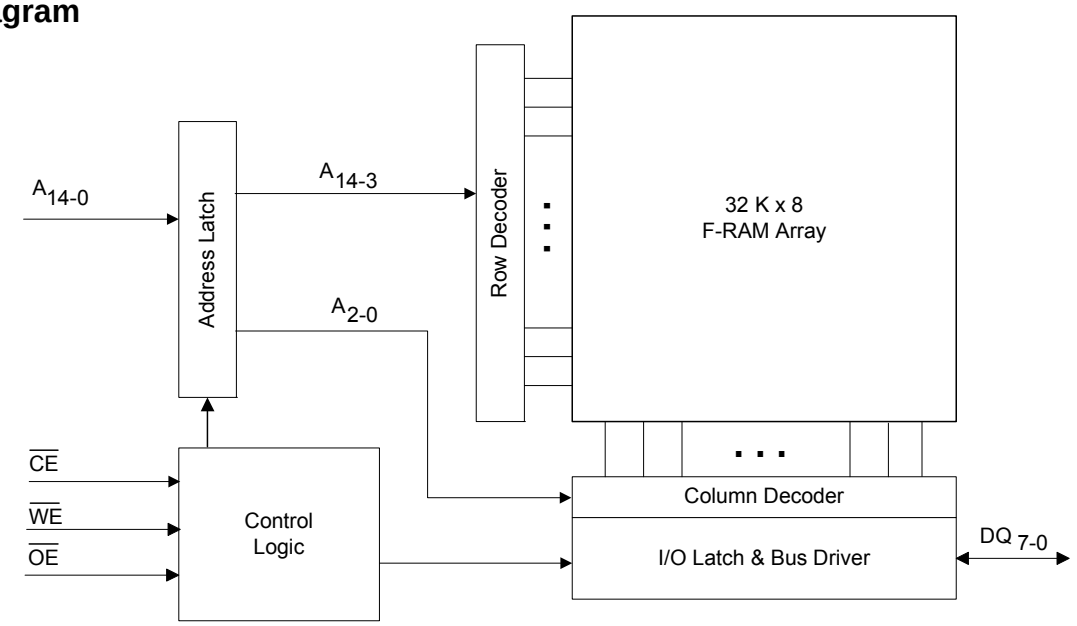
Functional Overview

The FM28V020 is a 32 K × 8 nonvolatile memory that reads and writes similar to a standard SRAM. A ferroelectric random access memory or F-RAM is nonvolatile, which means that data is retained after power is removed. It provides data retention for over 151 years while eliminating the reliability concerns, functional disadvantages, and system design complexities of battery-backed SRAM (BBSRAM). Fast write timing and high write endurance make the F-RAM superior to other types of memory.

The FM28V020 operation is similar to that of other RAM devices and therefore, it can be used as a drop-in replacement for a standard SRAM in a system. Read and write cycles may be triggered by $\overline{CE}$ or simply by changing the address. The F-RAM memory is nonvolatile due to its unique ferroelectric memory process. These features make the FM28V020 ideal for nonvolatile memory applications requiring frequent or rapid writes.

The device is available in a 28-pin SOIC, 28-pin TSOP I and 32-pin TSOP I surface mount packages. Device specifications are guaranteed over the industrial temperature range –40 °C to +85 °C.

Logic Block Diagram



Contents

Pinouts

Figure 1. 28-pin SOIC pinout

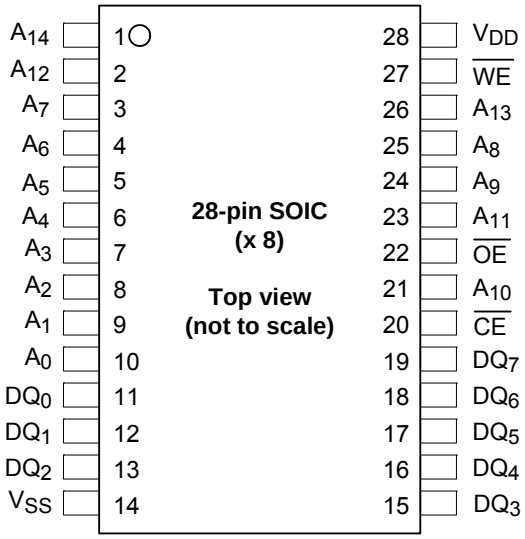


Figure 2. 28-pin TSOP I pinout

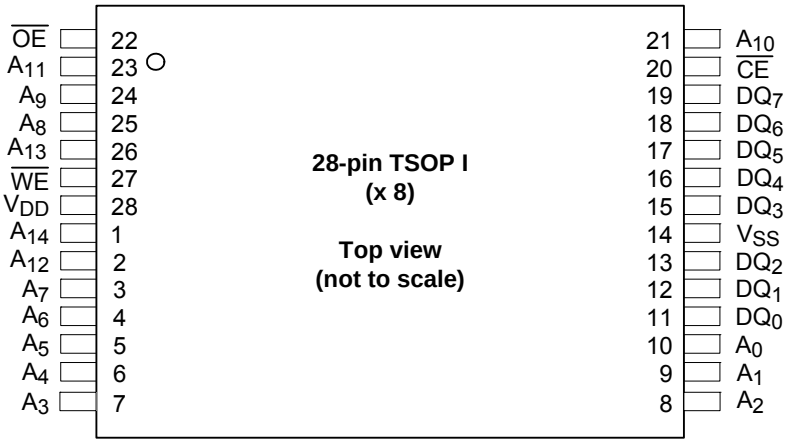
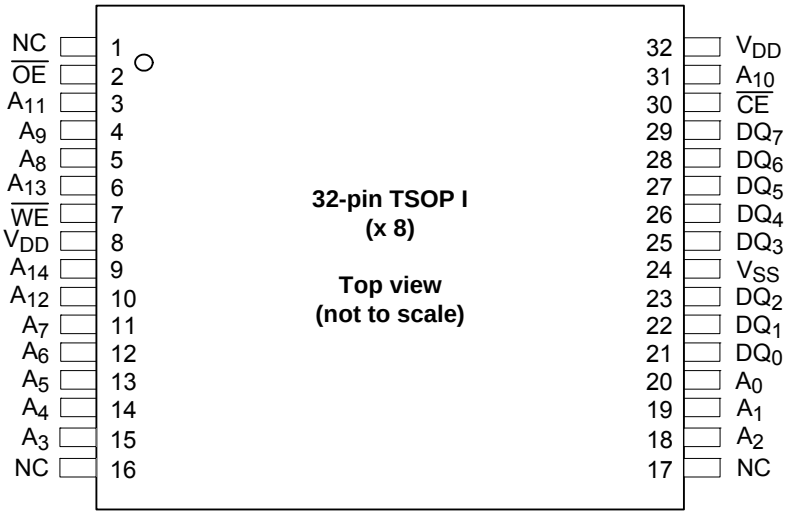


Figure 3. 32-pin TSOP I pinout



Pin Definitions

Pin Name	I/O Type	Description
A_{14}–A_0	Input	**Address inputs**: The 15 address lines select one of 32,768 bytes in the F-RAM array. The lowest two address lines A_2–A_0 may be used for page mode read and write operations.
DQ_7–DQ_0	Input/Output	**Data I/O Lines**: 8-bit bidirectional data bus for accessing the F-RAM array.
$\overline{WE}$	Input	**Write Enable**: A write cycle begins when $\overline{WE}$ is asserted. The rising edge causes the FM28V020 to write the data on the DQ bus to the F-RAM array. The falling edge of $\overline{WE}$ latches a new column address for page mode write cycles.
$\overline{CE}$	Input	**Chip Enable**: The device is selected and a new memory access begins on the falling edge of $\overline{CE}$. The entire address is latched internally at this point. Subsequent changes to the A_2–A_0 address inputs allow page mode operation.
$\overline{OE}$	Input	**Output Enable**: When $\overline{OE}$ is LOW, the FM28V020 drives the data bus when the valid read data is available. Deasserting $\overline{OE}$ HIGH tristates the DQ pins.
V_{SS}	Ground	Ground for the device. Must be connected to the ground of the system.
V_{DD}	Power supply	Power supply input to the device.
NC	No connect	No connect. This pin is not connected to the die.

Device Operation

The FM28V020 is a bytewide F-RAM memory logically organized as 32,768 × 8 and accessed using an industry-standard parallel interface. All data written to the part is immediately nonvolatile with no delay. The device offers page mode operation, which provides high-speed access to addresses within a page (row). Access to a different page requires that either $\overline{CE}$ transitions LOW or the upper address (A_{14}–A_3) changes. See the Functional Truth Table on page 14 for a complete description of read and write modes.

Memory Operation

Users access 32,768 memory locations, each with 8 data bits through a parallel interface. The F-RAM array is organized as eight blocks, each having 512 rows. Each row has eight column locations, which allow fast access in page mode operation. When an initial address is latched by the falling edge of $\overline{CE}$, subsequent column locations may be accessed without the need to toggle $\overline{CE}$. When $\overline{CE}$ is deasserted HIGH, a pre-charge operation begins. Writes occur immediately at the end of the access with no delay. The $\overline{WE}$ pin must be toggled for each write operation. The write data is stored in the nonvolatile memory array immediately, which is a feature unique to F-RAM called NoDelay writes.

Read Operation

A read operation begins on the falling edge of $\overline{CE}$. The falling edge of $\overline{CE}$ causes the address to be latched and starts a memory read cycle if $\overline{WE}$ is HIGH. Data becomes available on the bus after the access time is met. When the address is latched and the access completed, a new access to a random location (different row) may begin while $\overline{CE}$ is still LOW. The minimum cycle time for random addresses is t_{RC}. Note that unlike SRAMs, the FM28V020's $\overline{CE}$-initiated access time is faster than the address access time.

The FM28V020 will drive the data bus when $\overline{OE}$ is asserted LOW and the memory access time is met. If $\overline{OE}$ is asserted after the memory access time is met, the data bus will be driven with valid data. If $\overline{OE}$ is asserted before completing the memory access, the data bus will not be driven until valid data is available. This feature minimizes supply current in the system by eliminating transients caused by invalid data being driven to the bus. When $\overline{OE}$ is deasserted HIGH, the data bus will remain in a HI-Z state.

Write Operation

In the FM28V020, writes occur in the same interval as reads. The FM28V020 supports both $\overline{CE}$ and $\overline{WE}$ controlled write cycles. In both cases, the address is latched on the falling edge of $\overline{CE}$.

In a $\overline{CE}$-controlled write, the $\overline{WE}$ signal is asserted before beginning the memory cycle. That is, $\overline{WE}$ is LOW when the device is activated with the chip enable. In this case, the device begins the memory cycle as a write. The FM28V020 will not drive the data bus regardless of the state of $\overline{OE}$ as long as $\overline{WE}$ is LOW.

Input data must be valid when $\overline{CE}$ is deasserted HIGH. In a $\overline{WE}$-controlled write, the memory cycle begins on the falling edge of $\overline{CE}$. The $\overline{WE}$ signal falls some time later. Therefore, the memory cycle begins as a read. The data bus will be driven if $\overline{OE}$ is LOW; however, it will be HI-Z when $\overline{WE}$ is asserted LOW. The $\overline{CE}$ and $\overline{WE}$ controlled write timing cases are shown on the page 12. In the Figure 10 on page 12 diagram, the data bus is shown as a hi-Z condition while the chip is write-enabled and before the required setup time. Although this is drawn to look like a mid-level voltage, it is recommended that all DQ pins comply with the minimum V_{IH}/V_{IL} operating levels.

Write access to the array begins on the falling edge of $\overline{WE}$ after the memory cycle is initiated. The write access terminates on the rising edge of $\overline{WE}$ or $\overline{CE}$, whichever comes first. A valid write operation requires the user to meet the access time specification before deasserting $\overline{WE}$ or $\overline{CE}$. The data setup time indicates the interval during which data cannot change before the end of the write access (rising edge of $\overline{WE}$ or $\overline{CE}$).

Unlike other nonvolatile memory technologies, there is no write delay with F-RAM. Because the read and write access times of the underlying memory are the same, the user experiences no delay through the bus. The entire memory operation occurs in a single bus cycle. Data polling, a technique used with EEPROMs to determine if a write is complete, is unnecessary.

Page Mode Operation

The FM28V020 provides the user fast access to any data within a row element. Each row has eight column-address locations. Address inputs A_2–A_0 define the column address to be accessed. An access can start anywhere within a row and other column locations may be accessed without the need to toggle the $\overline{CE}$ pin. For fast access reads, after the first data byte is driven to the bus, the column address inputs A_2–A_0 may be changed to a new value. A new data byte is then driven to the DQ pins. For fast access writes, the first write pulse defines the first write access. While $\overline{CE}$ is LOW, a subsequent write pulse along with a new column address provides a page mode write access.

Pre-charge Operation

The pre-charge operation is an internal condition in which the memory state is prepared for a new access. Pre-charge is user-initiated by driving the $\overline{CE}$ signal HIGH. It must remain HIGH for at least the minimum pre-charge time, t_{PC}.

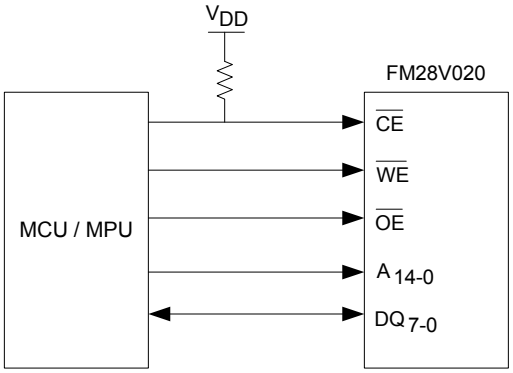
Pre-charge is also activated by changing the upper addresses, A_{14}–A_3. The current row is first closed before accessing the new row. The device automatically detects an upper order address change, which starts a pre-charge operation. The new address is latched and the new read data is valid within the t_{AA} address access time; see Figure 6 on page 11. A similar sequence occurs for write cycles; see Figure 11 on page 12. The rate at which random addresses can be issued is t_{RC} and t_{WC}, respectively.

SRAM Drop-In Replacement

The FM28V020 is designed to be a drop-in replacement for standard asynchronous SRAMs. The device does not require $\overline{CE}$ to toggle for each new address. $\overline{CE}$ may remain LOW indefinitely while V_{DD} is applied. While $\overline{CE}$ is LOW, the device automatically detects address changes and a new access begins. It also allows page mode operation at speeds up to 15 MHz.

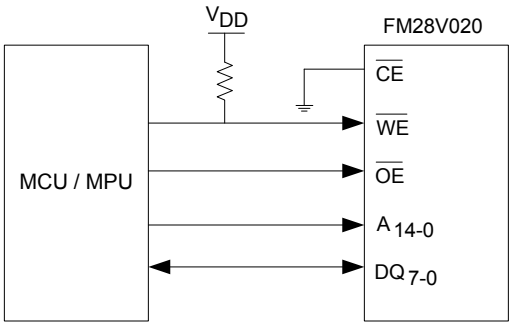
A typical application is shown in Figure 4. It shows a pull-up resistor on $\overline{CE}$, which will keep the pin HIGH during power cycles, assuming the MCU / MPU pin tristates during the reset condition.The pull-up resistor value should be chosen to ensure the $\overline{CE}$ pin tracks V_{DD} to a high enough value, so that the current drawn when $\overline{CE}$ is LOW is not an issue. A 10-kΩ resistor draws 330 µA when $\overline{CE}$ is LOW and V_{DD} = 3.3 V.

Figure 4. Use of Pull-up Resistor on $\overline{CE}$



Note that if $\overline{CE}$ is tied to ground, the user must be sure $\overline{WE}$ is not LOW at power-up or power-down events. If $\overline{CE}$ and $\overline{WE}$ are both LOW during power cycles, data will be corrupted. Figure 5 shows a pull-up resistor on $\overline{WE}$, which will keep the pin HIGH during power cycles, assuming the MCU/MPU pin tristates during the reset condition.The pull-up resistor value should be chosen to ensure the $\overline{WE}$ pin tracks V_{DD} to a high enough value, so that the current drawn when $\overline{WE}$ is LOW is not an issue. A 10-kΩ resistor draws 330 µA when $\overline{WE}$ is LOW and V_{DD} = 3.3 V.

Figure 5. Use of Pull-up Resistor on $\overline{WE}$



For applications that require the lowest power consumption, the $\overline{CE}$ signal should be active only during memory accesses. Due to the external pull-up resistor, some supply current will be drawn while $\overline{CE}$ is LOW. When $\overline{CE}$ is HIGH, the device draws no more than the maximum standby current I_{SB}.

$\overline{CE}$ toggling LOW on every address access is perfectly acceptable in FM28V020.

Endurance

The FM28V020 is capable of being accessed at least 10^{14} times – reads or writes. An F-RAM memory operates with a read and restore mechanism. Therefore, an endurance cycle is applied on a row basis. The F-RAM architecture is based on an array of rows and columns. Rows are defined by A_{14-3} and column addresses by A_2-A_0. The array is organized as 4K rows of eight bytes each. The entire row is internally accessed once whether a single byte or all eight bytes are read or written. Each byte in the row is counted only once in an endurance calculation if the addressing is contiguous in nature.

The user may choose to write CPU instructions and run them from a certain address space. Table 1 shows endurance calculations for a 256-byte repeating loop, which includes a starting address, seven-page mode accesses, and a $\overline{CE}$ pre-charge. The number of bus clock cycles needed to complete a eight-byte read transaction is 1 + 7 + 1 or 9 clocks. The entire loop causes each byte to experience only one endurance cycle. The F-RAM read and write endurance is virtually unlimited.

Table 1. Time to Reach 100 Trillion Cycles for Repeating 256-byte Loop

Bus Freq (MHz)	Bus Cycle Time (ns)	256-byte Transaction Time (µs)	Endurance Cycles/sec	Endurance Cycles/year	Years to Reach 10^{14} Cycles
10	100	28.8	34,720	1.09×10^{12}	91.7
5	200	57.6	17,360	5.47×10^{11}	182.8

Maximum Ratings

Exceeding maximum ratings may shorten the useful life of the device. These user guidelines are not tested.

Storage temperature ..... –55 °C to +125 °C

Maximum junction temperature ..... 95 °C

Supply voltage on V_{DD} relative to V_{SS} .....–1.0 V to + 4.5 V

Voltage applied to outputs in High Z state .....–0.5 V to V_{DD} + 0.5 V

Input voltage ..... –1.0 V to + 4.5 V and $V_{IN} < V_{DD}$ + 1.0 V

Transient voltage (< 20 ns) on any pin to ground potential .....–2.0 V to V_{CC} + 2.0 V

Package power dissipation capability (T_A = 25 °C) ..... 1.0 W

Surface mount Pb soldering temperature (3 seconds) ..... +260 °C

DC output current (1 output at a time, 1s duration) .... 15 mA

Static discharge voltage

Human Body Model (AEC-Q100-002 Rev. E) ..... 2 kV

Charged Device Model (AEC-Q100-011 Rev. B) .. 1.25 kV

Machine Model (AEC-Q100-003 Rev. E) ..... 200 V

Latch-up current ..... > 140 mA

Operating Range

Range	Ambient Temperature (T_A)	V_{DD}
Industrial	–40 °C to +85 °C	2.0 V to 3.6 V

DC Electrical Characteristics

Over the Operating Range

Parameter	Description	Test Conditions	Min	Typ [1]	Max	Unit
V_{DD}	Power supply voltage		2.0	3.3	3.6	V
I_{DD}	V_{DD} supply current	V_{DD} = 3.6 V, $\overline{CE}$ cycling at min. cycle time. All inputs toggling at CMOS levels (0.2 V or V_{DD} – 0.2 V), all DQ pins unloaded.	–	5	8	mA
I_{SB}	Standby current	V_{DD} = 3.6 V, $\overline{CE}$ at V_{DD}, All other pins are static and at CMOS levels (0.2 V or V_{DD} – 0.2 V)	–	90	150	µA
I_{LI}	Input leakage current	V_{IN} between V_{DD} and V_{SS}	–	–	±1	µA
I_{LO}	Output leakage current	V_{OUT} between V_{DD} and V_{SS}	–	–	±1	µA
V_{IH}	Input HIGH voltage		0.7 × V_{DD}	–	V_{DD} + 0.3	V
V_{IL}	Input LOW voltage		– 0.3	–	0.3 × V_{DD}	V
V_{OH1}	Output HIGH voltage	I_{OH} = –1.0 mA, V_{DD} > 2.7 V	2.4	–	–	V
V_{OH2}	Output HIGH voltage	I_{OH} = –100 µA	V_{DD} – 0.2	–	–	V
V_{OL1}	Output LOW voltage	I_{OL} = 1 mA, V_{DD} > 2.7 V	–	–	0.4	V
V_{OL2}	Output LOW voltage	I_{OL} = 150 µA	–	–	0.2	V

Data Retention and Endurance

Parameter	Description	Test condition	Min	Max	Unit
T_{DR}	Data retention	At +85 °C	10	–	Years
		At +75 °C	38	–	
		At +65 °C	151	–	
NV_C	Endurance	Over operating temperature	10^{14}	–	Cycles

Note

1. Typical values are at 25 °C, V_{DD} = V_{DD} (typ). Not 100% tested.

Capacitance

Parameter	Description	Test Conditions	Max	Unit
$C_{I/O}$	Input/Output capacitance (DQ)	T_A = 25 °C, f = 1 MHz, V_{DD} = V_{DD}(Typ)	8	pF
C_{IN}	Input capacitance		6	pF

Thermal Resistance

Parameter	Description	Test Conditions	28-pin SOIC	28-pin TSOP I	32-pin TSOP I	Unit
Θ_{JA}	Thermal resistance (junction to ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, in accordance with EIA/JESD51.	59	108	84	°C/W
Θ_{JC}	Thermal resistance (junction to case)		30	29	26	°C/W

AC Test Conditions

Input pulse levels .....0 V to 3 V

Input rise and fall times (10%–90%) ..... ≤ 3 ns

Input and output timing reference levels ..... 1.5 V

Output load capacitance..... 30 pF

AC Switching Characteristics

Over the Operating Range

Parameters [2]		Description	Min	Max	Unit
Cypress Parameter	Alt Parameter				
SRAM Read Cycle					
t_{CE}	t_{ACE}	Chip enable access time	–	70	ns
t_{RC}	–	Read cycle time	140	–	ns
t_{AA}	–	Address access time	–	140	ns
t_{OH}	t_{OHA}	Output hold time	20	–	ns
t_{AAP}	–	Page mode address access time	–	40	ns
t_{OHP}	–	Page mode output hold time	3	–	ns
t_{CA}	–	Chip enable active time	70	–	ns
t_{PC}	–	Pre-charge time	70	–	ns
t_{AS}	t_{SA}	Address setup time (to $\overline{CE}$ LOW)	0	–	ns
t_{AH}	t_{HA}	Address hold time ($\overline{CE}$ Controlled)	70	–	ns
t_{OE}[3]	t_{DOE}	Output enable access time	–	20	ns
t_{HZ}[4, 5]	t_{HZCE}	Chip Enable to output HI-Z	–	10	ns
t_{OHZ}[4, 5]	t_{HZOE}	Output enable HIGH to output HI-Z	–	10	ns

Notes
2. Test conditions assume a signal transition time of 3 ns or less, timing reference levels of 0.5 × V_{DD}, input pulse levels of 0 to 3 V, output loading of the specified I_{OL}/I_{OH} and load capacitance shown in AC Test Conditions on page 8.
3. For V_{DD} < 2.7 V, t_{OE} max is 25 ns.
4. t_{HZ} and t_{OHZ} are specified with a load capacitance of 5 pF. Transition is measured when the outputs enter a high impedance state.
5. This parameter is characterized but not 100% tested.

AC Switching Characteristics (continued)

Over the Operating Range

Parameters [2]		Description	Min	Max	Unit
Cypress Parameter	Alt Parameter				
SRAM Write Cycle					
t_{WC}	t_{WC}	Write cycle time	140	–	ns
t_{CA}	–	Chip enable active time	70	–	ns
t_{CW}	t_{SCE}	Chip enable to write enable HIGH	70	–	ns
t_{PC}	–	Pre-charge time	70	–	ns
t_{PWC}	–	Page mode write enable cycle time	35	–	ns
t_{WP}	t_{PWE}	Write enable pulse width	18	–	ns
t_{AS}	t_{SA}	Address setup time (to $\overline{CE}$ LOW)	0	–	ns
t_{AH}	t_{HA}	Address hold time ($\overline{CE}$ Controlled)	70	–	ns
t_{ASP}	–	Page mode address setup time (to $\overline{WE}$ LOW)	5	–	ns
t_{AHP}	–	Page mode address hold time (to $\overline{WE}$ LOW)	20	–	ns
t_{WLC}	t_{PWE}	Write enable LOW to chip disabled	25	–	ns
t_{WLA}	–	Write enable LOW to A_{14-3} change	25	–	ns
t_{AWH}	–	A_{14-3} change to write enable HIGH	140	–	ns
t_{DS}	t_{SD}	Data input setup time	15	–	ns
t_{DH}	t_{HD}	Data input hold time	0	–	ns
t_{WZ}[6, 7]	t_{HZWE}	Write enable LOW to output HI-Z	–	10	ns
t_{WX}[7]	–	Write enable HIGH to output driven	5	–	ns
t_{WS}[7, 8]	–	Write enable to $\overline{CE}$ LOW setup time	0	–	ns
t_{WH}[7, 8]	–	Write enable to $\overline{CE}$ HIGH hold time	0	–	ns

Notes
6. t_{WZ} is specified with a load capacitance of 5 pF. Transition is measured when the outputs enter a high impedance state.
7. This parameter is characterized but not 100% tested.
8. The relationship between $\overline{CE}$ and $\overline{WE}$ determines if a $\overline{CE}$ or $\overline{WE}$ controlled write occurs.

Figure 6. Read Cycle Timing 1 ($\overline{CE}$ LOW, $\overline{OE}$ LOW)

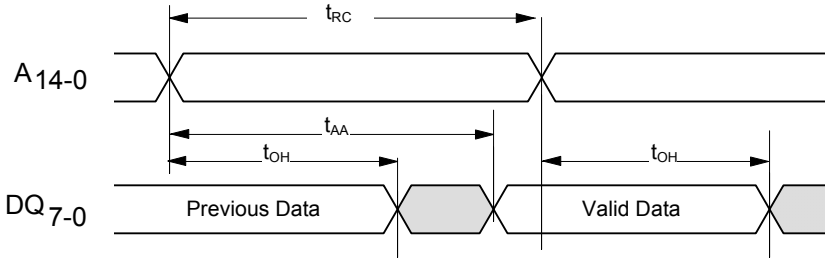


Figure 7. Read Cycle Timing 2 ($\overline{CE}$ Controlled)

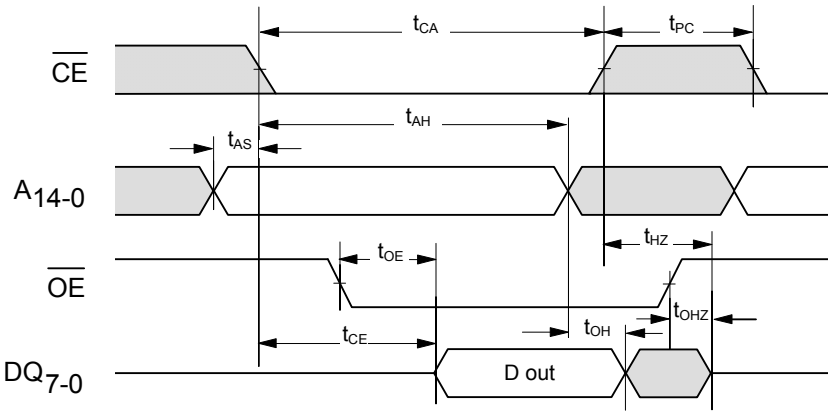
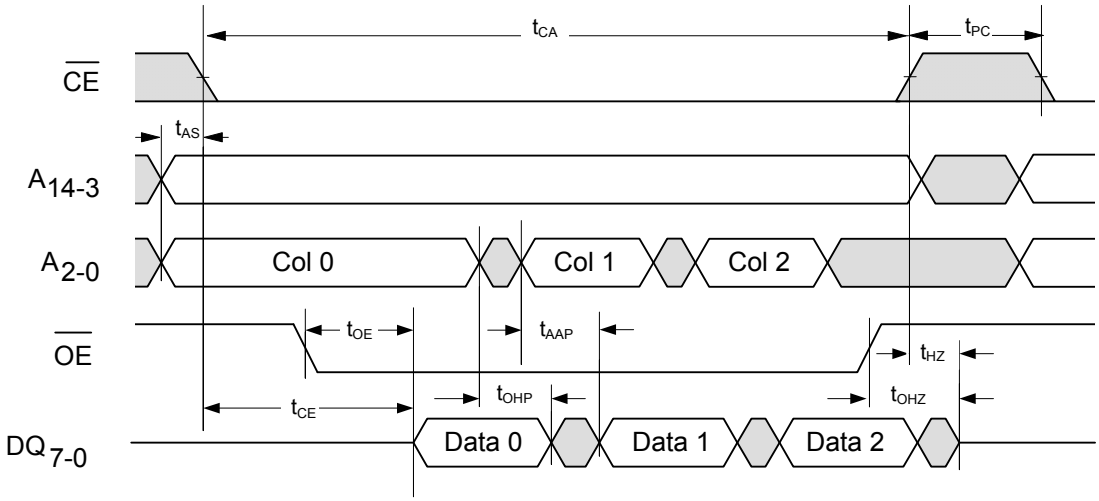


Figure 8. Page Mode Read Cycle Timing [9]



Note
9. Although sequential column addressing is shown, it is not required

Figure 9. Write Cycle Timing 1 ($\overline{WE}$ Controlled) [10]

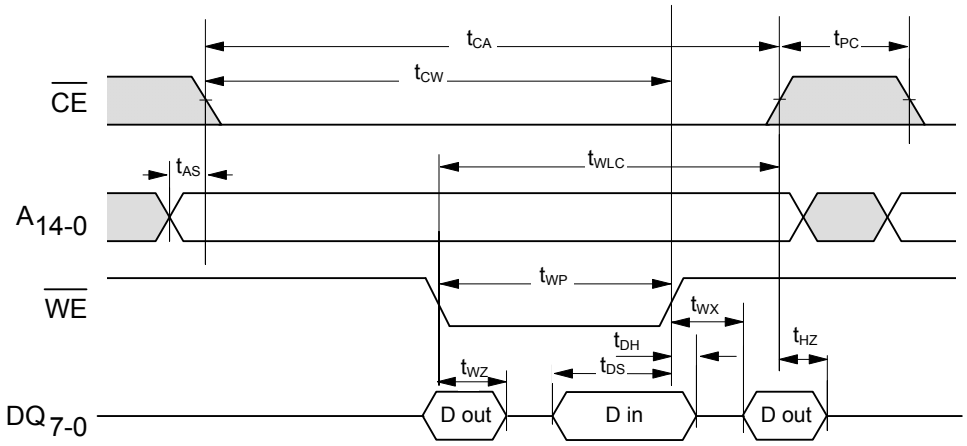


Figure 10. Write Cycle Timing 2 ($\overline{CE}$ Controlled)

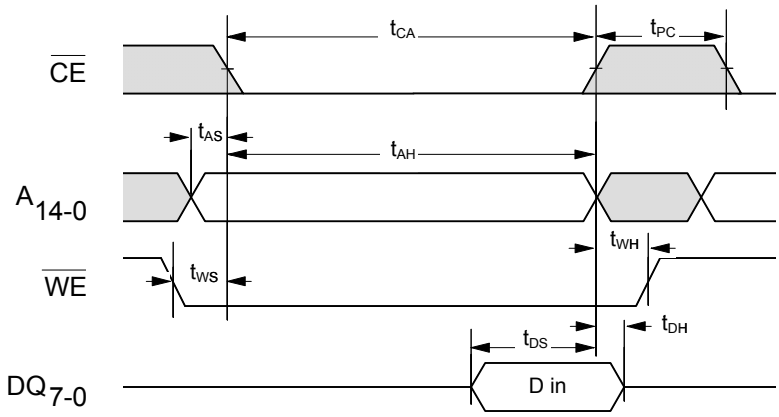
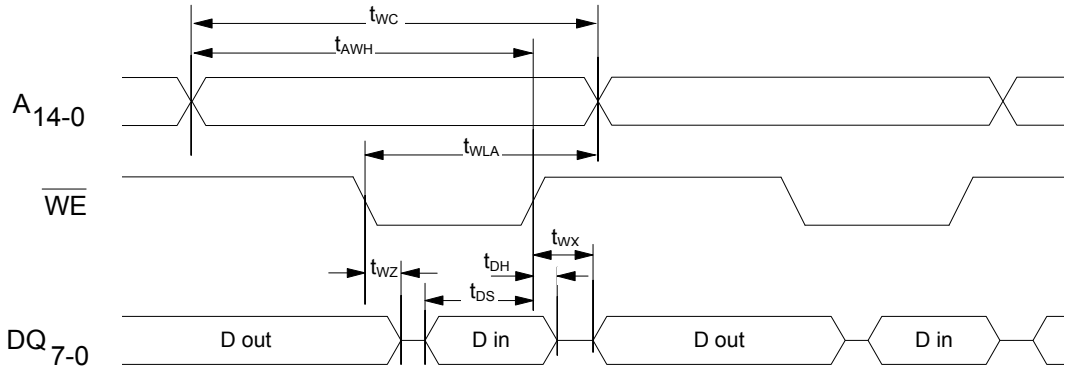
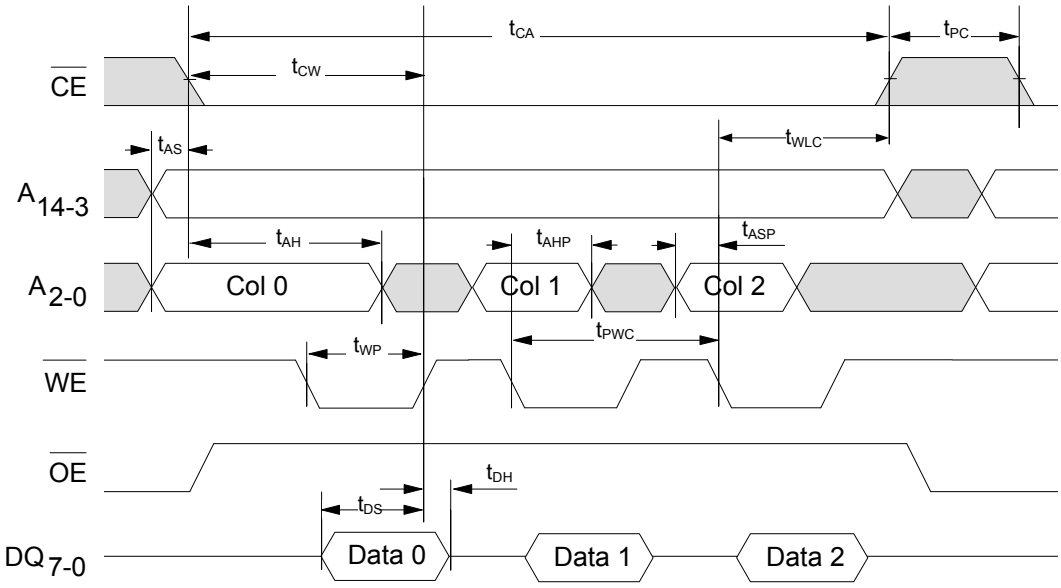


Figure 11. Write Cycle Timing 3 ($\overline{CE}$ LOW) [10]



Note
10. $\overline{OE}$ (not shown) is LOW only to show the effect of $\overline{WE}$ on DQ pins.

Figure 12. Page Mode Write Cycle Timing

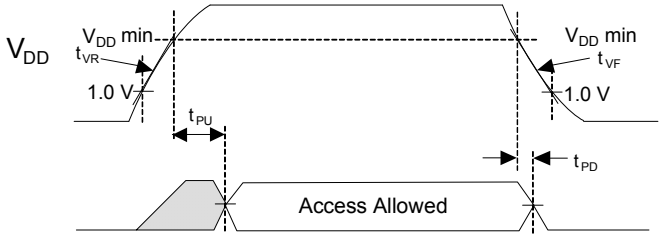


Power Cycle Timing

Over the Operating Range

Parameter	Description	Min	Max	Unit
t_{PU}	Power-up (after V_{DD} min. is reached) to first access time	250	–	µs
t_{PD}	Last write ($\overline{WE}$ HIGH) to power down time	0	–	µs
t_{VR}[11]	V_{DD} power-up ramp rate	50	–	µs/V
t_{VF}[11]	V_{DD} power-down ramp rate	100	–	µs/V

Figure 13. Power Cycle Timing



Note
11. Slope measured at any point on the V_{DD} waveform.

Functional Truth Table

$\overline{CE}$	$\overline{WE}$	A_{14}-A_3	A_2-A_0	Operation [12, 13]
H	X	X	X	Standby/Idle
↓ L	H H	V V	V V	Read
L	H	No Change	Change	Page Mode Read
L	H	Change	V	Random Read
↓ L	L L	V V	V V	$\overline{CE}$-Controlled Write[13]
L	↓	V	V	$\overline{WE}$-Controlled Write [13, 14]
L	↓	No Change	V	Page Mode Write [15]
↑ L	X X	X X	X X	Starts pre-charge

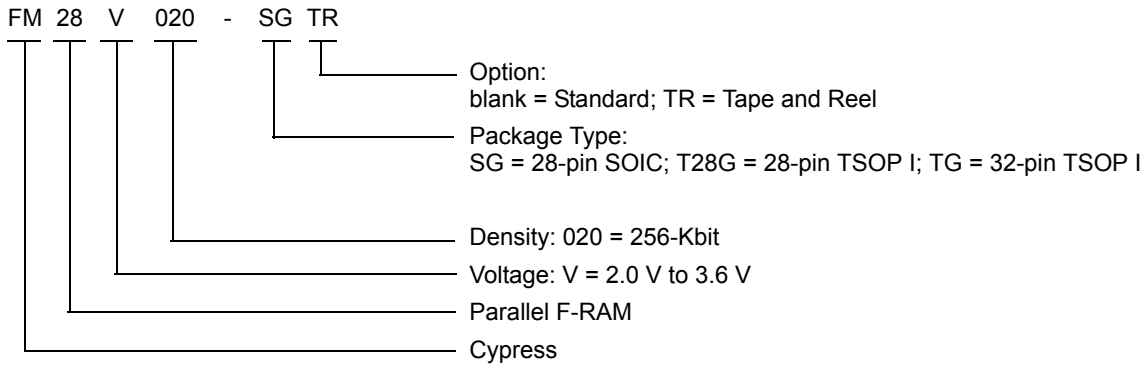
Notes
12. H = Logic HIGH, L = Logic LOW, V = Valid Data, X = Don't Care, ↓ = toggle LOW, ↑ = toggle HIGH.
13. For write cycles, data-in is latched on the rising edge of $\overline{CE}$ or $\overline{WE}$, whichever comes first.
14. $\overline{WE}$-controlled write cycle begins as a Read cycle and then A_{14}-A_3 is latched.
15. Addresses A_2-A_0 must remain stable for at least 15 ns during page mode operation.

Ordering Information

Access time (ns)	Ordering Code	Package Diagram	Package Type	Operating Range
70	FM28V020-SG	51-85026	28-pin SOIC	Industrial
	FM28V020-SGTR	51-85026	28-pin SOIC	
	FM28V020-T28G	001-91155	28-pin TSOP I	
	FM28V020-T28GTR	001-91155	28-pin TSOP I	
	FM28V020-TG	001-91156	32-pin TSOP I	
	FM28V020-TGTR	001-91156	32-pin TSOP I	

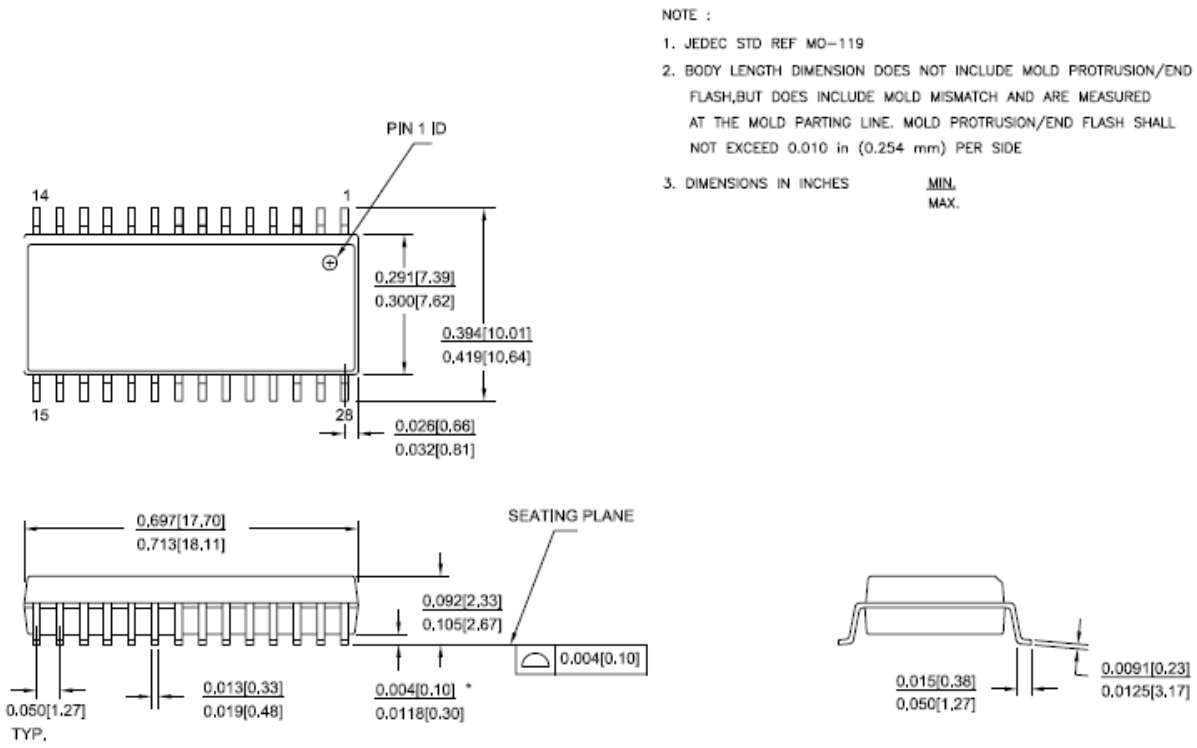
All the above parts are Pb-free.

Ordering Code Definitions



Package Diagrams

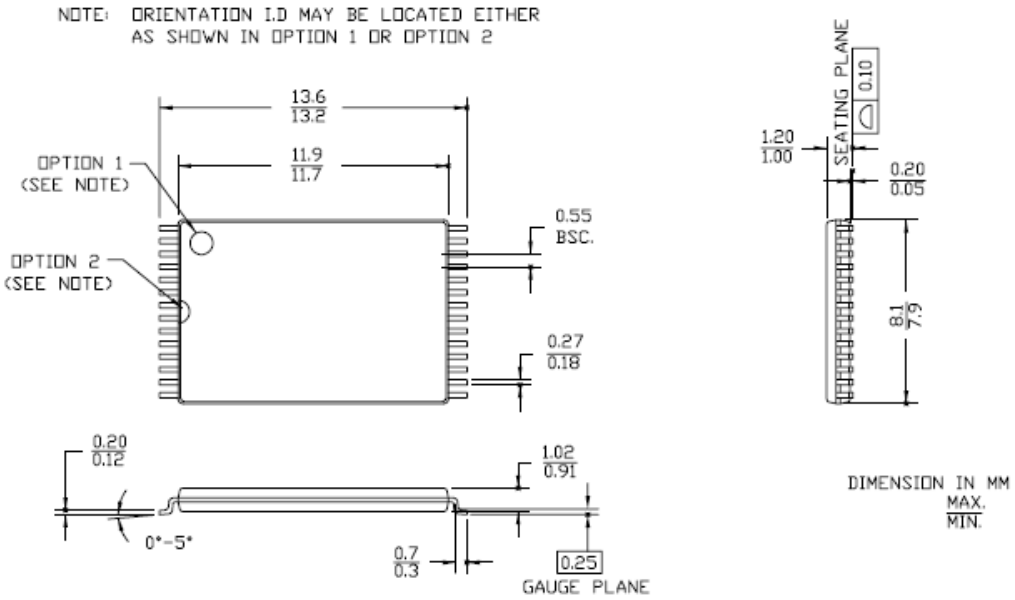
Figure 14. 28-pin SOIC Package Outline, 51-85026



51-85026 *G

Package Diagrams (continued)

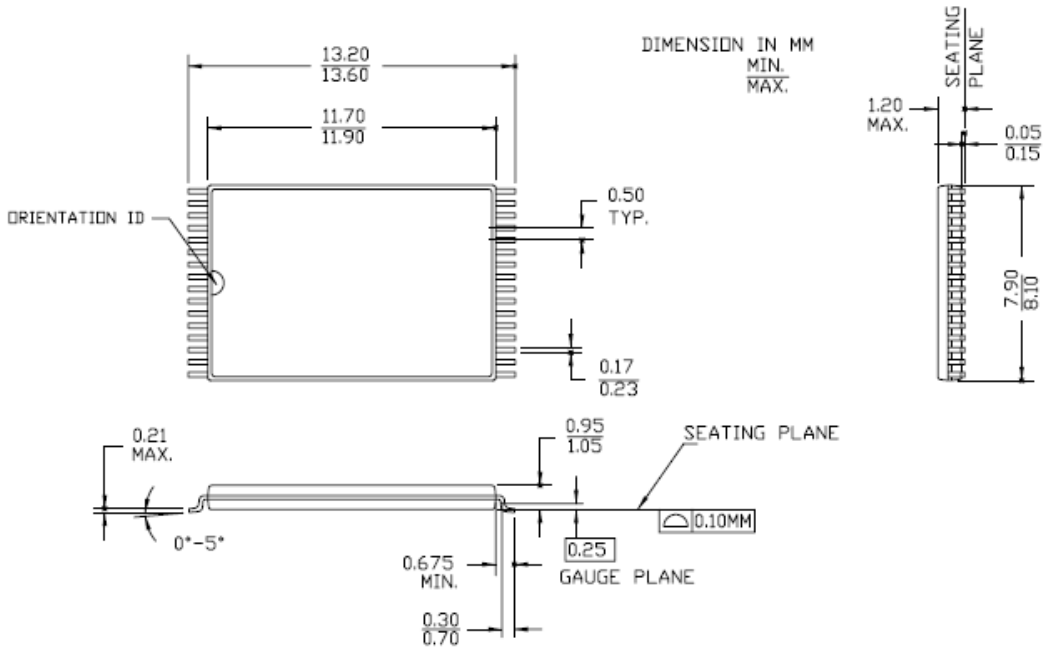
Figure 15. 28-pin TSOP I Package Outline, 001-91155



001-91155 **

Package Diagrams (continued)

Figure 16. 32-pin TSOP I Package Outline, 001-91156



001-91156 **

Acronyms

Acronym	Description
CPU	Central Processing Unit
CMOS	Complementary Metal Oxide Semiconductor
JEDEC	Joint Electron Devices Engineering Council
JESD	JEDEC Standards
EIA	Electronic Industries Alliance
F-RAM	Ferroelectric Random Access Memory
I/O	Input/Output
MCU	Microcontroller Unit
MPU	Microprocessor Unit
RoHS	Restriction of Hazardous Substances
RW	Read and Write
SRAM	Static Random Access Memory
TSOP	Thin Small Outline Package

Document Conventions

Units of Measure

Symbol	Unit of Measure
°C	degree Celsius
Hz	hertz
kHz	kilohertz
kΩ	kilohm
MHz	megahertz
µA	microampere
µF	microfarad
µs	microsecond
mA	milliampere
ms	millisecond
MΩ	megaohm
ns	nanosecond
Ω	ohm
%	percent
pF	picofarad
V	volt
W	watt

Document History Page

Document Title: FM28V020, 256-Kbit (32 K × 8) F-RAM Memory Document Number: 001-86204				
Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	3912932	GVCH	02/25/2013	New data sheet.
*A	3924836	GVCH	03/07/2013	Changed to Production status Added 28-pin TSOP package type Changed I_{DD} limit min spec from 7 mA to 5 mA and max spec from 12 mA to 8 mA. Read Cycle AC Parameters: Changed t_{AAP} spec value from 60 ns to 40 ns and t_{OE} spec value from 15 ns to 20 ns Write Cycle AC Parameters: Changed t_{PWC} spec value from 30 ns to 35 ns and t_{AHP} spec value from 15 ns to 20 ns
*B	4000965	GVCH	05/15/2013	Added Appendix A - Errata for FM28V020
*C	4045491	GVCH	06/30/2013	All errata items are fixed and the errata is removed.
*D	4274812	GVCH	03/11/2014	Converted to Cypress standard format Updated Maximum Ratings table - Removed Moisture Sensitivity Level (MSL) - Added junction temperature and latch up current Updated Data Retention and Endurance table Added Thermal Resistance table Removed Package Marking Scheme (top mark)

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