

Features

- Fast Read Access Time – 150 ns
- Automatic Page Write Operation
 - Internal Address and Data Latches for 64 Bytes
 - Internal Control Timer
- Fast Write Cycle Times
 - Page Write Cycle Time: 10 ms
 - 1 to 64-byte Page Write Operation
- Low Power Dissipation
 - 50 mA Active Current
 - 200 μ A CMOS Standby Current
- Hardware and Software Data Protection
- DATA Polling for End of Write Detection
- High Reliability CMOS Technology
 - Endurance: 10^4
 - Data Retention: 10 Years
- Single 5V $\pm$ 10% Supply
- CMOS and TTL Compatible Inputs and Outputs
- JEDEC Approved Byte-wide Pinout
- Military and Industrial Temperature Ranges

1. Description

The FT28C256 is a high-performance electrically erasable and programmable read-only memory. Its 256K of memory is organised as 32,768 words by 8 bits. Manufactured with advanced non-volatile CMOS technology, the device offers access times to 150 ns with power dissipation of just 440 mW. When the device is deselected, the CMOS standby current is less than 200 μ A.

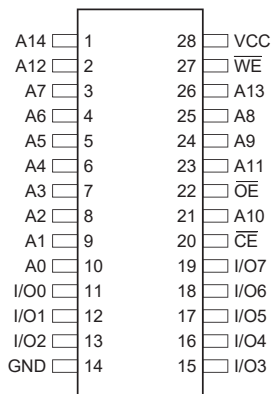
The FT28C256 is accessed like a Static RAM for the read or write cycle without the need for external components. The device contains a 64-byte page register to allow writing of up to 64 bytes simultaneously. During a write cycle, the addresses and 1 to 64 bytes of data are internally latched, freeing the address and data bus for other operations. Following the initiation of a write cycle, the device will automatically write the latched data using an internal control timer. The end of a write cycle can be detected by DATA Polling of I/O7. Once the end of a write cycle has been detected a new access for a read or write can begin.

The FT28C256 has additional features to ensure high quality and manufacturability. The device utilises internal error correction for extended endurance and improved data retention characteristics. An optional software data protection mechanism is available to guard against inadvertent writes. The device also includes an extra 64 bytes of EEPROM for device identification or tracking.

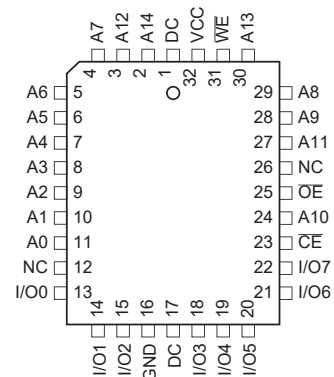
2. Pin Configurations

Pin Name	Function
A0 - A14	Addresses
$\overline{\text{CE}}$	Chip Enable
$\overline{\text{OE}}$	Output Enable
$\overline{\text{WE}}$	Write Enable
I/O0 - I/O7	Data Inputs/Outputs
NC	No Connect
DC	Don't Connect

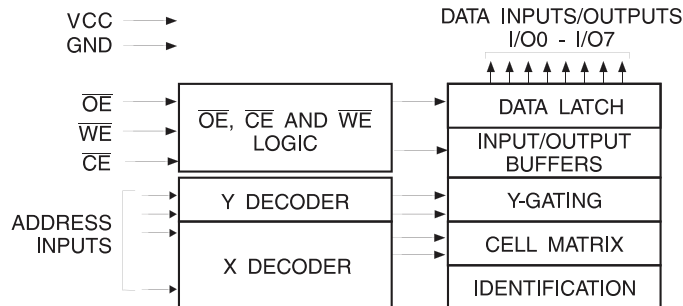
2.2.1 8-lead SBDIP/Flatpack



2.2 32-pad LCC



3. Block Diagram



4. Device Operation

4.1 Read

The FT28C256 is accessed like a Static RAM. When $\overline{CE}$ and $\overline{OE}$ are low and $\overline{WE}$ is high, the data stored at the memory location determined by the address pins is asserted on the outputs. The outputs are put in the high impedance state when either $\overline{CE}$ or $\overline{OE}$ is high. This dual-line control gives designers flexibility in preventing bus contention in their system.

4.2 Byte Write

A low pulse on the $\overline{WE}$ or $\overline{CE}$ input with $\overline{CE}$ or $\overline{WE}$ low (respectively) and $\overline{OE}$ high initiates a write cycle. The address is latched on the falling edge of $\overline{CE}$ or $\overline{WE}$, whichever occurs last. The data is latched by the first rising edge of $\overline{CE}$ or $\overline{WE}$. Once a byte write has been started it will automatically time itself to completion. Once a programming operation has been initiated and for the duration of t_{WC} , a read operation will effectively be a polling operation.

4.3 Page Write

The page write operation of the FT28C256 allows 1 to 64 bytes of data to be written into the device during a single internal programming period. A page write operation is initiated in the same manner as a byte write; the first byte written can then be followed by 1 to 63 additional bytes. Each successive byte must be written within 150 μs (t_{BLC}) of the previous byte. If the t_{BLC} limit is exceeded the FT28C256 will cease accepting data and commence the internal programming operation. All bytes during a page write operation must reside on the same page as defined by the state of the A6 - A14 inputs. For each $\overline{WE}$ high to low transition during the page write operation, A6 - A14 must be the same.

The A0 to A5 inputs are used to specify which bytes within the page are to be written. The bytes may be loaded in any order and may be altered within the same load period. Only bytes which are specified for writing will be written; unnecessary cycling of other bytes within the page does not occur.

4.4 DATA Polling

The FT28C256 features $\overline{DATA}$ Polling to indicate the end of a write cycle. During a byte or page write cycle an attempted read of the last byte written will result in the complement of the written data to be presented on I/O7. Once the write cycle has been completed, true data is valid on all outputs, and the next write cycle may begin. $\overline{DATA}$ Polling may begin at anytime during the write cycle.

4.5 Toggle Bit

In addition to $\overline{\text{DATA}}$ Polling the FT28C256 provides another method for determining the end of a write cycle. During the write operation, successive attempts to read data from the device will result in I/O6 toggling between one and zero. Once the write has completed, I/O6 will stop toggling and valid data will be read. Reading the toggle bit may begin at any time during the write cycle.

4.6 Data Protection

If precautions are not taken, inadvertent writes may occur during transitions of the host system power supply. The 28C256 incorporates both hardware and software features that will protect the memory against inadvertent writes.

4.6.1 Hardware Protection

Hardware features protect against inadvertent writes to the FT28C256 in the following ways: (a) V_{CC} sense – if V_{CC} is below 3.8V (typical) the write function is inhibited; (b) V_{CC} power-on delay – once V_{CC} has reached 3.8V the device will automatically time out 5 ms (typical) before allowing a write; (c) write inhibit – holding any one of $\overline{\text{OE}}$ low, $\overline{\text{CE}}$ high or $\overline{\text{WE}}$ high inhibits write cycles; and (d) noise filter – pulses of less than 15 ns (typical) on the $\overline{\text{WE}}$ or $\overline{\text{CE}}$ inputs will not initiate a write cycle.

4.6.2 Software Data Protection

A software controlled data protection feature has been implemented on the FT28C256. When enabled, the software data protection (SDP), will prevent inadvertent writes. The SDP feature may be enabled or disabled by the user; the FT28C256 is shipped from Force with SDP disabled.

SDP is enabled by the host system issuing a series of three write commands; three specific bytes of data are written to three specific addresses (refer to “Software Data Protection” algorithm). After writing the 3-byte command sequence and after t_{WC} the entire FT28C256 will be protected against inadvertent write operations. It should be noted, that once protected the host may still perform a byte or page write to the FT28C256. This is done by preceding the data to be written by the same 3-byte command sequence used to enable SDP.

Once set, SDP will remain active unless the disable command sequence is issued. Power transitions do not disable SDP and SDP will protect the FT28C256 during power-up and power-down conditions. All command sequences must conform to the page write timing specifications. The data in the enable and disable command sequences is not written to the device and the memory addresses used in the sequence may be written with data in either a byte or page write operation.

After setting SDP, any attempt to write to the device without the 3-byte command sequence will start the internal write timers. No data will be written to the device; however, for the duration of t_{WC} , read operations will effectively be polling operations.

4.7 Device Identification

An extra 64 bytes of EEPROM memory are available to the user for device identification. By raising A9 to 12V $\pm 0.5V$ and using address locations 7FC0H to 7FFFH the additional bytes may be written to or read from in the same manner as the regular memory array.

4.8 Optional Chip Erase Mode

The entire device can be erased using a 6-byte software code. Please see “Software Chip Erase” application note for details.

5. DC and AC Operating Range

		FT28C256-15	FT28C256-20	FT28C256-25
Operating Temperature (Case)	Ind.	-40°C - 85°C	-40°C - 85°C	-40°C - 85°C
	Mil.	-55°C - 125°C	-55°C - 125°C	-55°C - 125°C
V _{CC} Power Supply		5V ± 10%	5V ± 10%	5V ± 10%

6. Operating Modes

Mode	$\overline{CE}$	$\overline{OE}$	$\overline{WE}$	I/O
Read	V _{IL}	V _{IL}	V _{IH}	D _{OUT}
Write ⁽²⁾	V _{IL}	V _{IH}	V _{IL}	D _{IN}
Standby/Write Inhibit	V _{IH}	X ⁽¹⁾	X	High Z
Write Inhibit	X	X	V _{IH}	
Write Inhibit	X	V _{IL}	X	
Output Disable	X	V _{IH}	X	High Z
Chip Erase	V _{IL}	V _H ⁽³⁾	V _{IL}	High Z

- Notes:
1. X can be V_{IL} or V_{IH}.
 2. Refer to AC programming waveforms.
 3. V_H = 12.0V ± 0.5V.

7. Absolute Maximum Ratings*

Temperature under Bias	-55°C to +125°C
Storage Temperature	-65°C to +150°C
All Input Voltages (including NC Pins) with Respect to Ground	-0.6V to +6.25V
All Output Voltages with Respect to Ground	-0.6V to V _{CC} + 0.6V
Voltage on $\overline{OE}$ and A9 with Respect to Ground	-0.6V to +13.5V

***NOTICE:** Stresses beyond 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 beyond 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

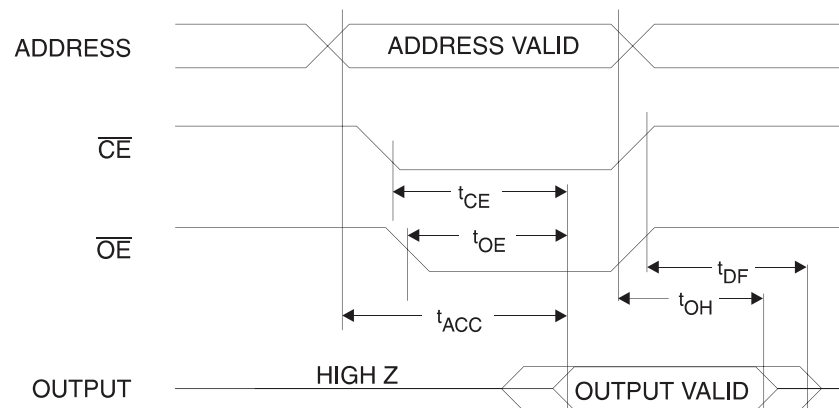
8. DC Characteristics

Symbol	Parameter	Condition	Min	Max	Units
I _{LI}	Input Load Current	V _{IN} = 0V to V _{CC} + 1V		10	μA
I _{LO}	Output Leakage Current	V _{I/O} = 0V to V _{CC}		10	μA
I _{SB1}	V _{CC} Standby Current CMOS	$\overline{CE} = V_{CC} - 0.3V$ to V _{CC} + 1V	Ind.	200	μA
			Mil.	300	μA
I _{SB2}	V _{CC} Standby Current TTL	$\overline{CE} = 2.0V$ to V _{CC} + 1V		3	mA
I _{CC}	V _{CC} Active Current	f = 5 MHz; I _{OUT} = 0 mA		50	mA
V _{IL}	Input Low Voltage			0.8	V
V _{IH}	Input High Voltage		2.0		V
V _{OL}	Output Low Voltage	I _{OL} = 2.1 mA		0.45	V
V _{OH}	Output High Voltage	I _{OH} = -400 μA	2.4		V

9. AC Read Characteristics

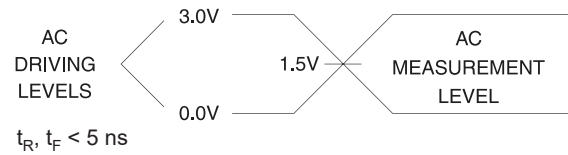
Symbol	Parameter	FT28C256-15		FT28C256-20		FT28C256-25	
		Min	Max	Min	Max	Min	Max
t_{ACC}	Address to Output Delay		150		200		250
$t_{CE}^{(1)}$	$\overline{CE}$ to Output Delay		150		200		250
$t_{OE}^{(2)}$	$\overline{OE}$ to Output Delay	0	70	0	80	0	100
$t_{DF}^{(3)(4)}$	$\overline{CE}$ or $\overline{OE}$ to Output Float	0	50	0	55	0	60
t_{OH}	Output Hold from $\overline{OE}$, $\overline{CE}$ or Address, whichever occurred first	0		0		0	

10. AC Read Waveforms⁽¹⁾⁽²⁾⁽³⁾⁽⁴⁾

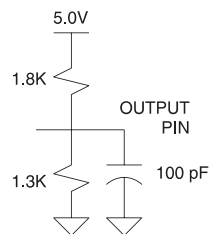


- Notes:
- $\overline{CE}$ may be delayed up to $t_{ACC} - t_{CE}$ after the address transition without impact on t_{ACC} .
 - $\overline{OE}$ may be delayed up to $t_{CE} - t_{OE}$ after the falling edge of $\overline{CE}$ without impact on t_{CE} or by $t_{ACC} - t_{OE}$ after an address change without impact on t_{ACC} .
 - t_{DF} is specified from $\overline{OE}$ or $\overline{CE}$ whichever occurs first ($C_L = 5$ pF).
 - This parameter is characterised and is not 100% tested.

11. Input Test Waveforms and Measurement Level



12. Output Test Load



13. Pin Capacitance

$f = 1 \text{ MHz}$, $T = 25^\circ\text{C}^{(1)}$

Symbol	Typ	Max	Units	Conditions
C_{IN}	4	6	pF	$V_{IN} = 0V$
C_{OUT}	8	12	pF	$V_{OUT} = 0V$

Note: 1. This parameter is characterised and is not 100% tested.

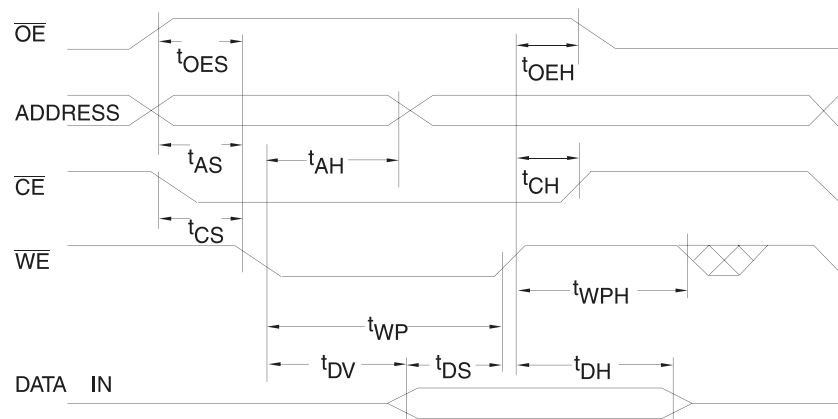
14. AC Write Characteristics

Symbol	Parameter	Min	Max	Units
t_{AS}, t_{OES}	Address, $\overline{OE}$ Setup Time	0		ns
t_{AH}	Address Hold Time	50		ns
t_{CS}	Chip Select Setup Time	0		ns
t_{CH}	Chip Select Hold Time	0		ns
t_{WP}	Write Pulse Width ($\overline{WE}$ or $\overline{CE}$)	100		ns
t_{DS}	Data Setup Time	50		ns
t_{DH}, t_{OEh}	Data, $\overline{OE}$ Hold Time	0		ns
t_{DV}	Time to Data Valid	NR ⁽¹⁾		

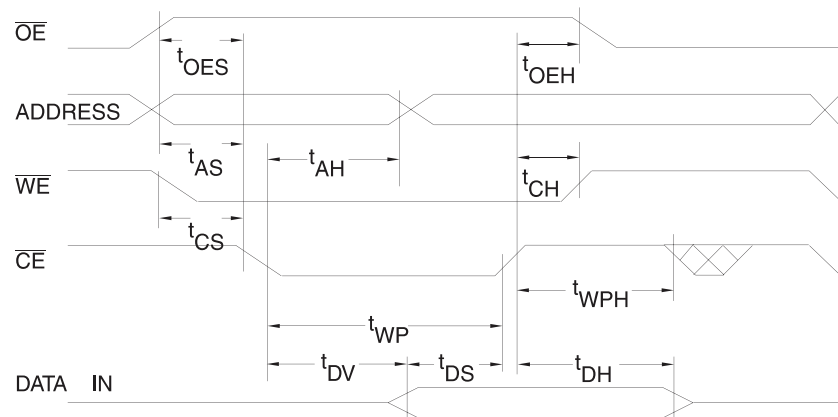
Note: 1. NR = No Restriction

15. AC Write Waveforms

15.1 $\overline{WE}$ Controlled



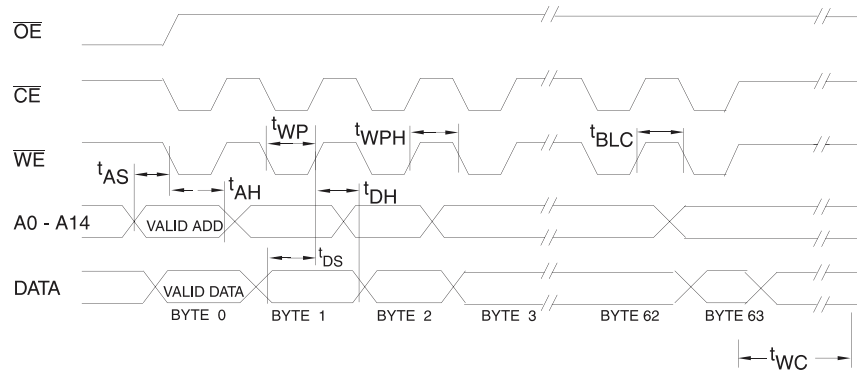
15.2 $\overline{CE}$ Controlled



16. Page Mode Characteristics

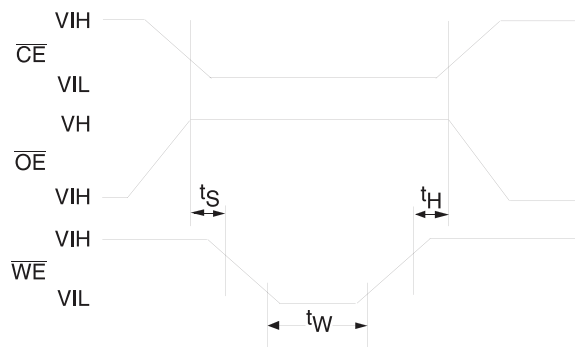
Symbol	Parameter	Min	Max	Units
t_{WC}	Write Cycle Time		10	ms
t_{AS}	Address Setup Time	0		ns
t_{AH}	Address Hold Time	50		ns
t_{DS}	Data Setup Time	50		ns
t_{DH}	Data Hold Time	0		ns
t_{WP}	Write Pulse Width	100		ns
t_{BLC}	Byte Load Cycle Time		150	μ s
t_{WPH}	Write Pulse Width High	50		ns

17. Page Mode Write Waveforms⁽¹⁾⁽²⁾



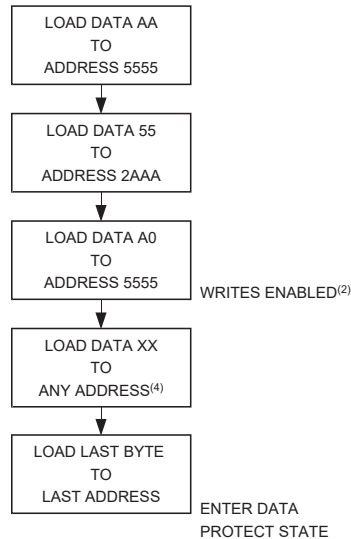
- Notes:
1. A6 through A14 must specify the same page address during each high to low transition of $\overline{WE}$ (or $\overline{CE}$).
 2. $\overline{OE}$ must be high only when $\overline{WE}$ and $\overline{CE}$ are both low.

18. Chip Erase Waveforms



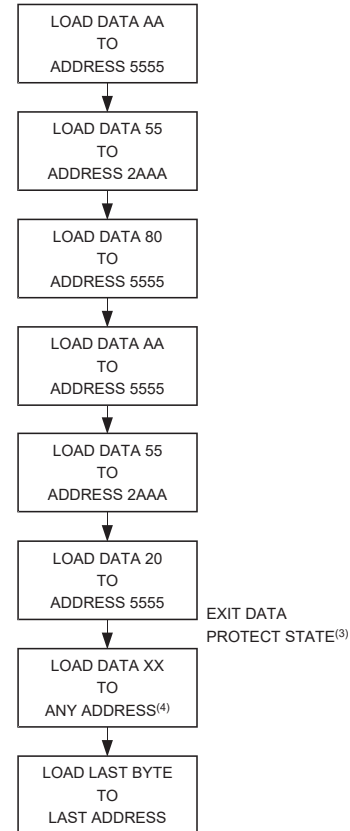
$t_S = t_H = 5 \mu\text{sec (min.)}$
 $t_W = 10 \text{ msec (min.)}$
 $V_H = 12.0V \pm 0.5V$

19. Software Data Protection Enable Algorithm⁽¹⁾

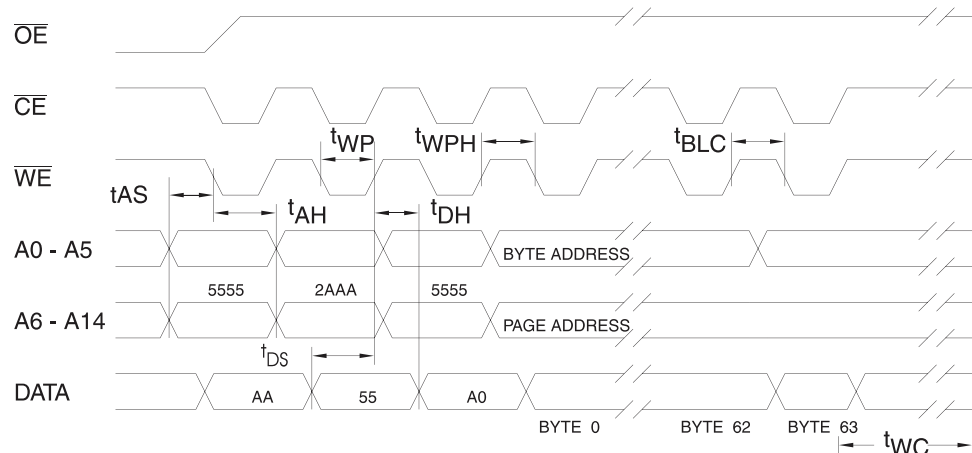


- Notes:
1. Data Format: I/O7 - I/O0 (Hex); Address Format: A14 - A0 (Hex).
 2. Write Protect state will be activated at end of write even if no other data is loaded.
 3. Write Protect state will be deactivated at end of write period even if no other data is loaded.
 4. 1 to 64 bytes of data are loaded.

20. Software Data Protection Disable Algorithm⁽¹⁾



21. Software Protected Write Cycle Waveforms⁽¹⁾⁽²⁾



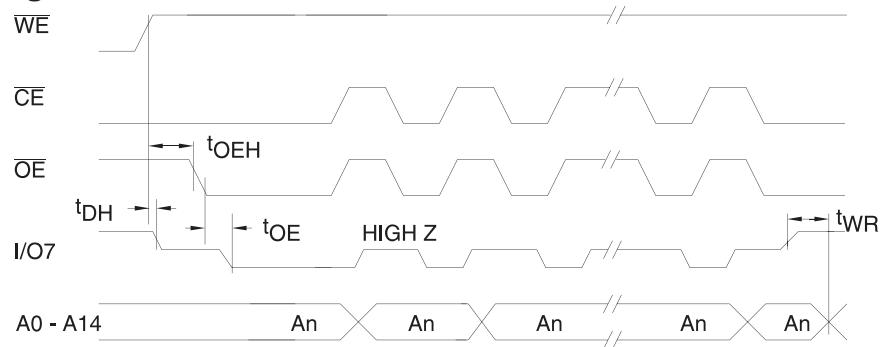
- Notes:
1. A6 through A14 must specify the same page address during each high to low transition of $\overline{WE}$ (or $\overline{CE}$) after the software code has been entered.
 2. $\overline{OE}$ must be high only when $\overline{WE}$ and $\overline{CE}$ are both low.

22. Data Polling Characteristics⁽¹⁾

Symbol	Parameter	Min	Typ	Max	Units
t_{DH}	Data Hold Time	0			ns
$t_{OE\overline{H}}$	$\overline{OE}$ Hold Time	0			ns
t_{OE}	$\overline{OE}$ to Output Delay ⁽²⁾				ns
t_{WR}	Write Recovery Time	0			ns

Notes: 1. These parameters are characterised and not 100% tested.
2. See "AC Read Characteristics" on page 6.

23. Data Polling Waveforms

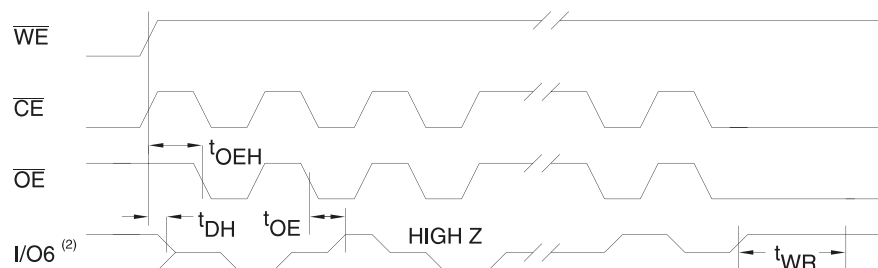


24. Toggle Bit Characteristics⁽¹⁾

Symbol	Parameter	Min	Typ	Max	Units
t_{DH}	Data Hold Time	10			ns
$t_{OE\overline{H}}$	$\overline{OE}$ Hold Time	10			ns
t_{OE}	$\overline{OE}$ to Output Delay ⁽²⁾				ns
t_{OEHP}	$\overline{OE}$ High Pulse	150			ns
t_{WR}	Write Recovery Time	0			ns

Notes: 1. These parameters are characterised and not 100% tested.
2. See "AC Read Characteristics" on page 6.

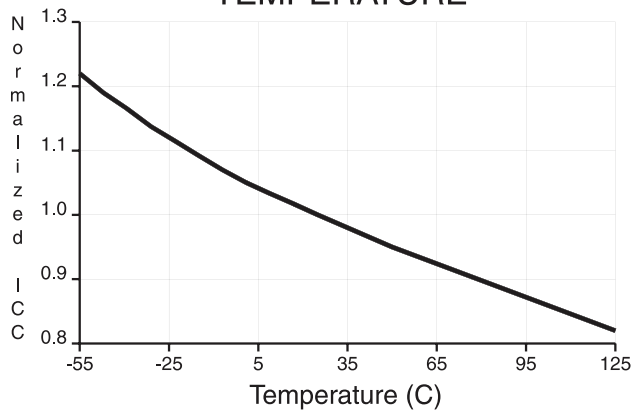
25. Toggle Bit Waveforms⁽¹⁾⁽²⁾⁽³⁾



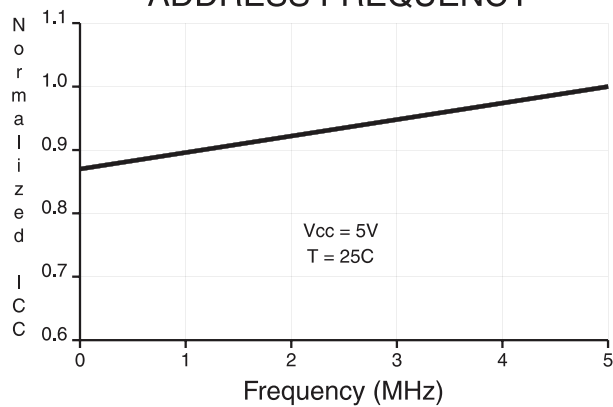
Notes: 1. Toggling either $\overline{OE}$ or $\overline{CE}$ or both $\overline{OE}$ and $\overline{CE}$ will operate toggle bit.
2. Beginning and ending state of I/O6 will vary.
3. Any address location may be used but the address should not vary.

26. Normalised I_{CC} Graphs

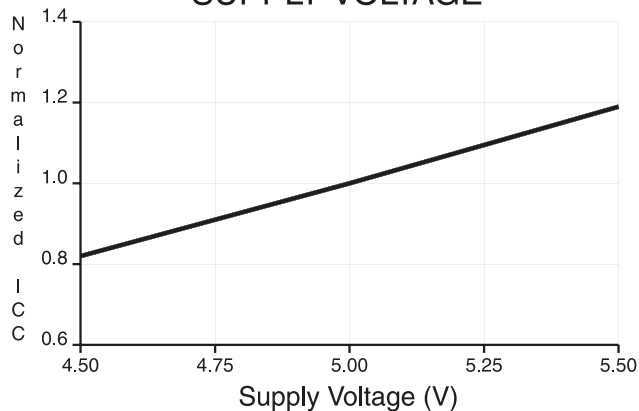
NORMALISED SUPPLY CURRENT vs.
TEMPERATURE



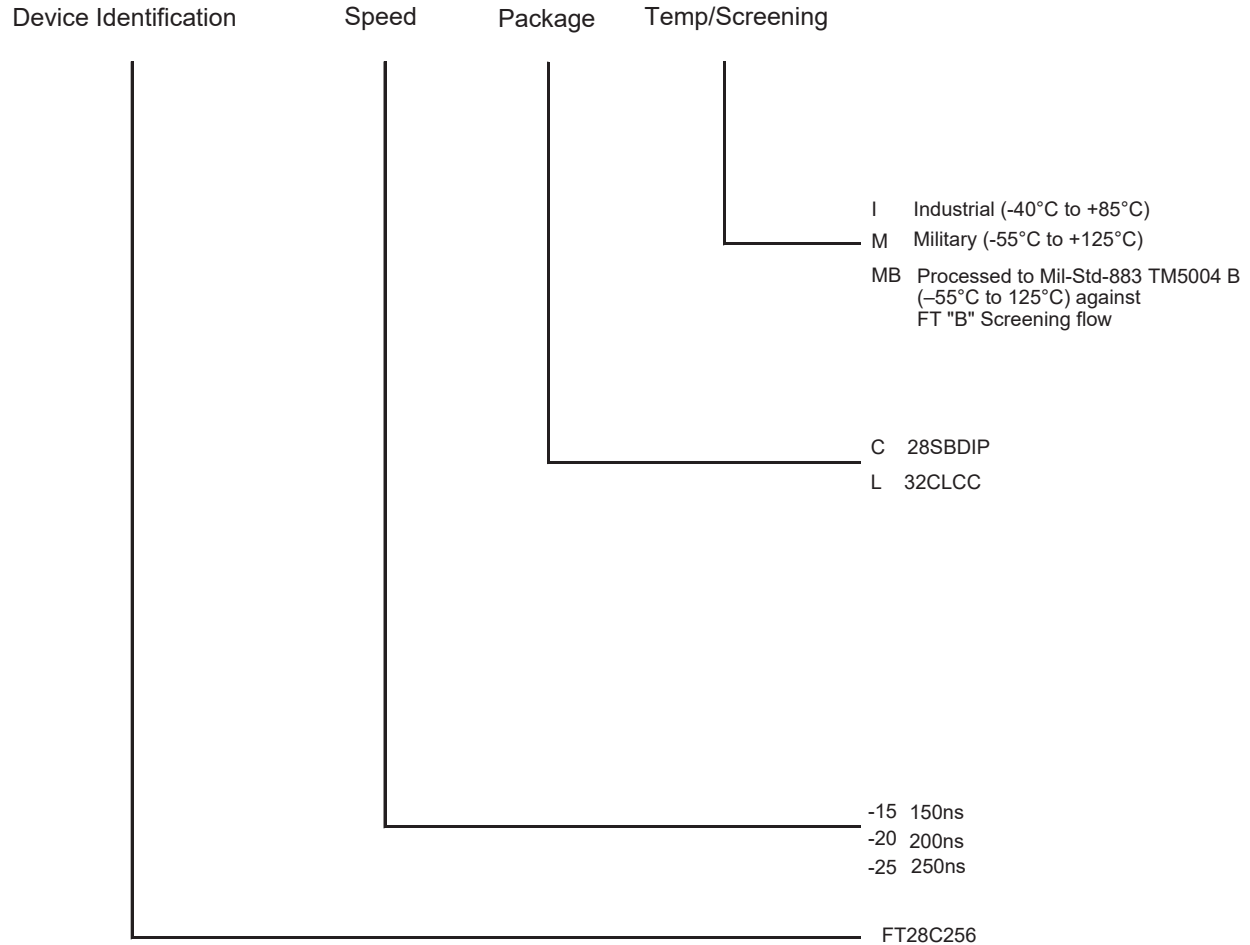
NORMALISED SUPPLY CURRENT vs.
ADDRESS FREQUENCY



NORMALISED SUPPLY CURRENT vs.
SUPPLY VOLTAGE



27. Ordering Information

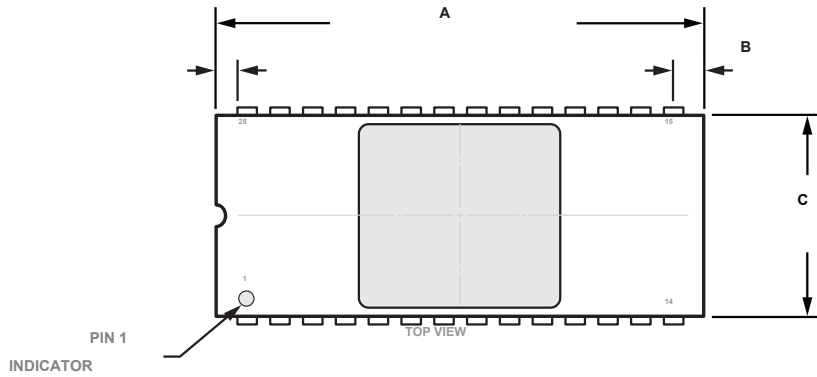


27.1 Packaging Information

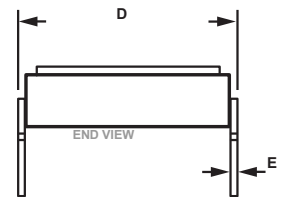
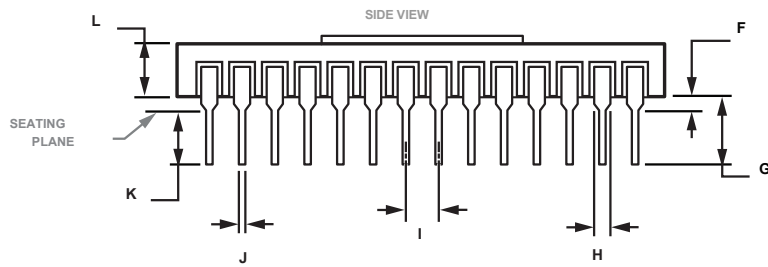
Package Type	
28SBDIP	28-lead, Ceramic Side Brazed Dual In-Line Package
32CLCC	32-Pad, Non-windowed, Ceramic Leadless Chip Carrier
32SOIC	32-Lead, Non-windowed, Ceramic Flatpack

*Additional packages available upon request

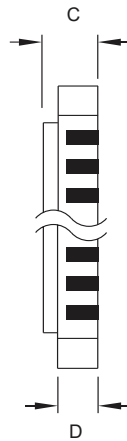
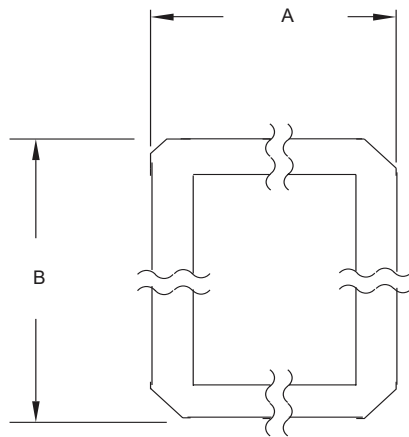
27.1.1 28SBDIP



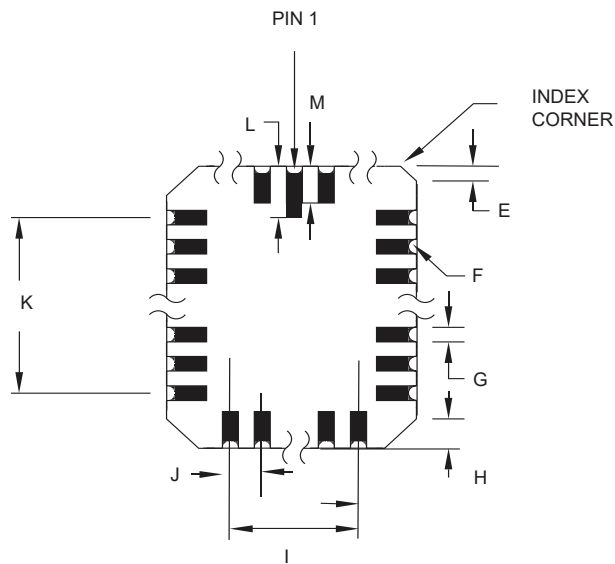
28SBDIP			
	MIN	NOM	MAX
A	1.260	1.400	1.540
B	0.030	0.050	0.070
C	0.585	0.595	0.605
D	0.600	0.610	0.620
E	0.008	0.010	0.012
F	0.060	0.050	0.060
G	0.056	0.068	0.080
H	0.050 TYP		
I	0.095	0.100	0.105
J	0.016	0.018	0.020
K	0.016	0.018	0.020
L	0.076	0.085	0.094
DIMENSIONS IN INCHES			



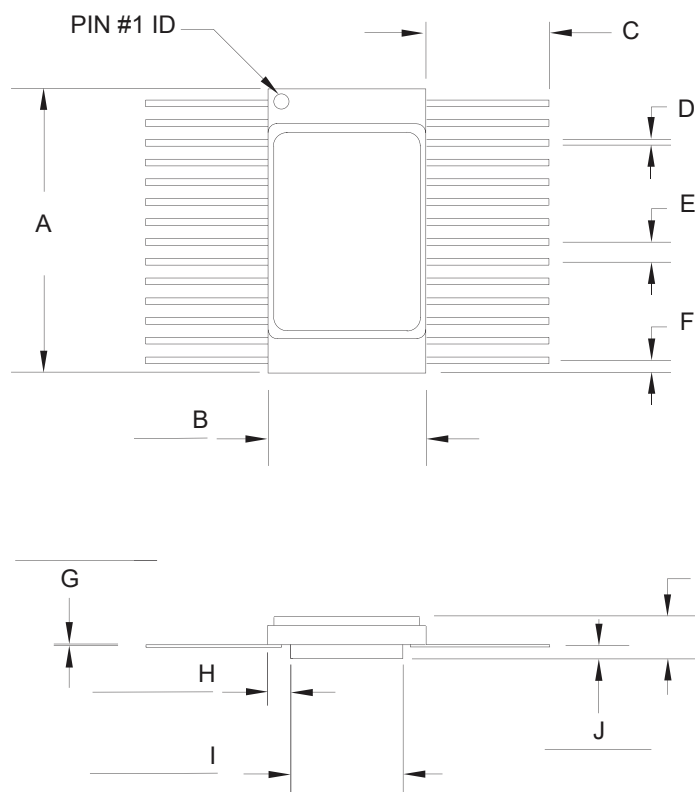
27.1.2 32CLCC



FT32CLCC			
	MIN	NOM	MAX
A	11.30	11.43	11.56
B	13.82	13.97	14.12
C			
D	1.60	1.78	1.96
E	C0.50		
F	R0.23		
G	0.56	0.64	0.72
H	C1.00		
I	7.49	7.62	7.75
J	1.27 TYP		
K	10.03	10.16	10.29
L	1.96	2.16	2.36
M	1.14	1.27	1.40
MILLIMETERS			



27.1.3 32Flatpack



32Flatpack			
	MIN	NOM	MAX
A	18.08 [0.712]		18.49 [0.728]
B	9.75 [0.384]		10.87 [0.416]
C	6.35 [0.250]		9.40 [0.370]
D	0.38 [0.015]		0.56 [0.022]
E		1.27 [0.050]	
F			1.14 [0.045]
G	0.10 [0.004]		0.23 [0.009]
H	1.09 [0.043]		1.96 [0.077]
I	6.95 [0.274]		7.26 [0.286]
J	0.66 [0.026]		1.14 [0.045]
K	2.29 [0.090]		3.02 [0.119]

28. Force Technologies - B - SCREENING FLOW

The device shall be screened as specified in the table below. Manufactured batches shall have Lots tests carried out in accordance with Mil-Std-883 (Sample size determined by MIL-PRF-38535 Appendix D unless alternatively defined below)

Screening	Method	QA test condition	Sample Size
Internal Visual (Pre-Cap)	Mil-Std-883 TM2010	Cond B	100%
Die Shear	Mil-Std-883 TM2019		Lot Sample
Bond Pull	Mil-Std-883 TM2011		Lot Sample
Temperature Cycle	Mil-Std-883 TM1010	Cond C, 10 Cycles Min	100%
Constant Acceleration	Mil-Std-883 TM2001	Cond E (Min), Y1 Orientation.	100%
Visual Inspect	Review for catastrophic failures		100%
Pre-Burn In Electrical	In accordance with applicable device specification.		100%
Burn In	Mil-Std-883 TM1015	160 hours at +125°C Min	100%
PDA Calculation	5% PDA	Check for burn in Failure rate	Data Review
Final Electrical Test	In accordance with applicable device specification.		100% -55°C T min +25°C +125°C T max
Seal a. Fine Leak b. Gross Leak	Mil-Std-883 TM1014		100%
External Visual	Mil-Std-883 TM2009		100%
Marking & Inspect	As FT WIP documentation	Laser Flow WP1024	100%
Data Preparation	As FT QA documentation	AS9100 Rev D	100%
Dry Bake store/ship	As FT WIP documentation	Bake and Dry WP1033	100%

29. Revision History

Rev	Date	Description
- 1	2007	- Original
- 2	March 2014	- Added 28-Lead Side Brazed Package
- 3	March 2014	- 10 ⁵ Write Cycle Option Removed From Front Page
- 4	October 2025	- Removed Plastic Package Options - Updated Package Drawings - Added Screening Table - Format Chanages



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