4K-Bit SPI Serial EEPROM

FEATURES

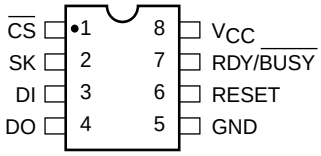
- **SPI bus compatible**
- **Low power CMOS technology**
- **2.5V to 6.0V operation**
- **Self-timed write cycle with auto-clear**
- **Hardware reset pin**
- **Hardware and software write protection**
- **Commercial, industrial and automotive temperature ranges**
- **Power-up inadvertant write protection**
- **RDY/$\overline{\text{BSY}}$ pin for end-of-write indication**
- **1,000,000 program/erase cycles**
- **100 year data retention**

DESCRIPTION

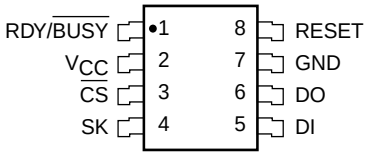
The CAT64LC40 is a 4K-bit Serial EEPROM which is configured as 256 registers by 16 bits. Each register can be written (or read) serially by using the DI (or DO) pin. The CAT64LC40 is manufactured using Catalyst's advanced CMOS EEPROM floating gate technology. It is designed to endure 1,000,000 program/erase cycles and has a data retention of 100 years. The device is available in 8-pin DIP, SOIC and TSSOP packages.

PIN CONFIGURATION

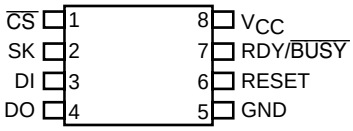
DIP Package (P, L)



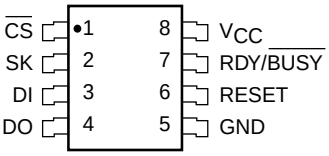
SOIC Package (J, W)



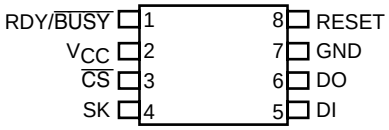
TSSOP Package (U, Y)



SOIC Package (S, V)



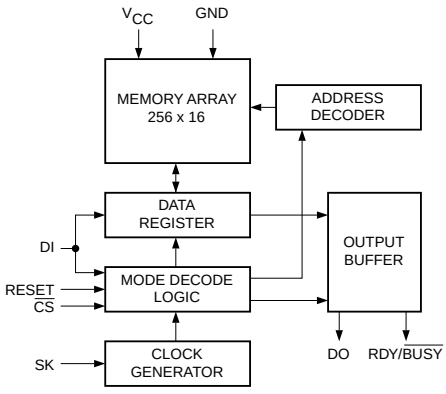
TSSOP Package (UR, YR)



PIN FUNCTIONS

Pin Name	Function
$\overline{\text{CS}}$	Chip Select
SK	Clock Input
DI	Serial Data Input
DO	Serial Data Output
V_{CC}	+2.5V to +6.0V Power Supply
GND	Ground
RESET	Reset
RDY/$\overline{\text{BUSY}}$	Ready/$\overline{\text{BUSY}}$ Status

BLOCK DIAGRAM



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[1] ..... –2.0V to +V_{CC} +2.0V

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

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

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
N_{END}[3]	Endurance	1,000,000		Cycles/Byte
T_{DR}[3]	Data Retention	100		Years
V_{ZAP}[3]	ESD Susceptibility	2000		Volts
I_{LTH}[3][4]	Latch-Up	100		mA

CAPACITANCE (T_A = 25°C, f= 1.0 MHz, V_{CC} =6.0V)

Symbol	Test	Max.	Conditions	Units
$C_{I/O}$[3]	Input/Output Capacitance (DO, RDY/$\overline{BSY}$)	8	$V_{I/O}$ = 0V	pF
C_{IN}[3]	Input Capacitance ($\overline{CS}$, SK, DI, RESET)	6	V_{IN} = 0V	pF

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 20 ns.

(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

V_{CC} = +2.5V to +6.0V, unless otherwise specified.

Sym.	Parameter		Limits Min.	Limits Typ.	Limits Max.	Test Conditions	Units
I_{CC}	Operating Current	2.5V			0.4	f_{SK} = 250 kHz	mA
	EWEN, EWDS, READ	6.0V			1	f_{SK} = 1 MHz	mA
I_{CCP}	Program Current	2.5V			2		mA
		6.0V			3		mA
I_{SB}(1)	Standby Current				3	V_{IN} = GND or V_{CC} $\overline{CS}$ = V_{CC}	µA
I_{LI}	Input Leakage Current				2	V_{IN} = GND to V_{CC}	µA
I_{LO}	Output Leakage Current				10	V_{OUT} = GND to V_{Cc}	µA
V_{IL}	Low Level Input Voltage, DI		–0.1		V_{CC} x 0.3		V
V_{IH}	High Level Input Voltage, DI		V_{CC} x 0.7		V_{CC} + 0.5		V
V_{IL}	Low Level Input Voltage, $\overline{CS}$, SK, RESET		–0.1		V_{CC} x 0.2		V
V_{IH}	High Level Input Voltage, $\overline{CS}$, SK, RESET		V_{CC} x 0.8		V_{CC} + 0.5		V
V_{OH}(1)	High Level Output Voltage	2.5V	V_{CC} – 0.3			I_{OH} = –10µA	V
		6.0V	V_{CC} – 0.3			I_{OH} = –10µA	V
			2.4			I_{OH} = –400µA	V
V_{OL}(1)	Low Level Output Voltage	2.5V			0.4	I_{OL} = 10µA	V
		6.0V			0.4	I_{OL} = 2.1mA	V

Note:
(1) V_{OH} and V_{OL} spec applies to READY/$\overline{BUSY}$ pin also

A.C. OPERATING CHARACTERISTICS

V_{CC} = +2.5V to +6.0V, unless otherwise specified.

Symbol	Parameter		Limits			Units
			Min.	Typ.	Max.	
t_{CSS}	$\overline{CS}$ Setup Time		100			ns
t_{CSH}	$\overline{CS}$ Hold Time		100			ns
t_{DIS}	DI Setup Time		200			ns
t_{DIH}	DI Hold Time		200			ns
t_{PD1}	Output Delay to 1				300	ns
t_{PD0}	Output Delay to 0				300	ns
t_{HZ}(2)	Output Delay to High Impendance				500	ns
t_{CSMIN}	Minimum $\overline{CS}$ High Time		250			ns
t_{SKHI}	Minimum SK High Time	2.5V	1000			ns
		4.5V–6.0V	400			
t_{SKLOW}	Minimum SK Low Time	2.5V	1000			ns
		4.5V–6.0V	400			
t_{SV}	Output Delay to Status Valid				500	ns
f_{SK}	Maximum Clock Frequency	2.5V	250			kHz
		4.5V–6.0V	1000			
t_{RESS}	Reset to $\overline{CS}$ Setup Time		0			ns
t_{RESMIN}	Minimum RESET High Time		250			ns
t_{RESH}	RESET to READY Hold Time		0			ns
t_{RC}	Write Recovery		100			ns

POWER-UP TIMING(1)(3)

Symbol	Parameter	Min.	Max.	Units
t_{PUR}	Power-Up to Read Operation		10	µs
t_{PUW}	Power-Up to Program Operation		1	ms

WRITE CYCLE LIMIITS

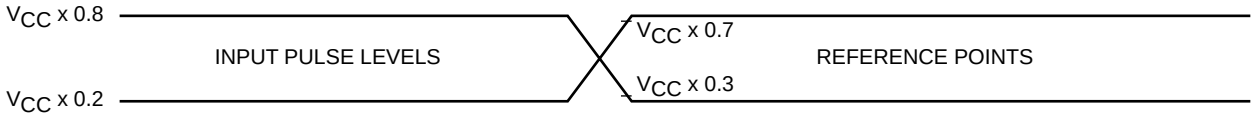
Symbol	Parameter		Min.	Max.	Units
t_{WR}	Program Cycle Time	2.5V		10	ms
		4.5V–6.0V		5	

Note:
(1) This parameter is tested initially and after a design or process change that affects the parameter.
(2) This parameter is sampled but not 100% tested.
(3) t_{PUR} and t_{PUW} are the delays required from the time V_{CC} is stable until the specified operation can be initiated.

INSTRUCTION SET

Instruction	Opcode	Address	Data
Read	10101000	A7 A6 A5 A4 A3 A2 A1 A0	D15 - D0
Write	10100100	A7 A6 A5 A4 A3 A2 A1 A0	D15 - D0
Write Enable	10100011	X X X X X X X X	
Write Disable	10100000	X X X X X X X X	
[Write All Locations](1)	10100001	X X X X X X X X	D15–D0

Figure 1. A.C. Testing Input/Output Waveform (2)(3)(4) (C_L = 100 pF)



Note:
(1) (Write All Locations) is a test mode operation and is therefore not included in the A.C./D.C. Operations specifications.
(2) Input Rise and Fall Times (10% to 90%) < 10 ns.
(3) Input Pulse Levels = V_{CC} x 0.2 and V_{CC} x 0.8.
(4) Input and Output Timing Reference = V_{CC} x 0.3 and V_{CC} x 0.7.

DEVICE OPERATION

The CAT64LC40 is a 4K-bit nonvolatile memory intended for use with all standard controllers. The CAT64LC40 is organized in a 256 x 16 format. All instructions are based on an 8-bit format. There are four 16-bit instructions: READ, WRITE, EWEN, and EWDS. The CAT64LC40 operates on a single power supply ranging from 2.5V to 6.0V and it has an on-chip voltage generator to provide the high voltage needed during a programming operation. Instructions, addresses and data to be written are clocked into the DI pin on the rising edge of the SK clock. The DO pin is normally in a high impedance state except when outputting data in a READ operation or outputting RDY/$\overline{BSY}$ status when polled during a WRITE operation.

The format for all instructions sent to this device includes a 4-bit start sequence, 1010, a 4-bit op code and an 8-bit address field or dummy bits. For a WRITE operation,

Figure 2. Sychronous Data Timing

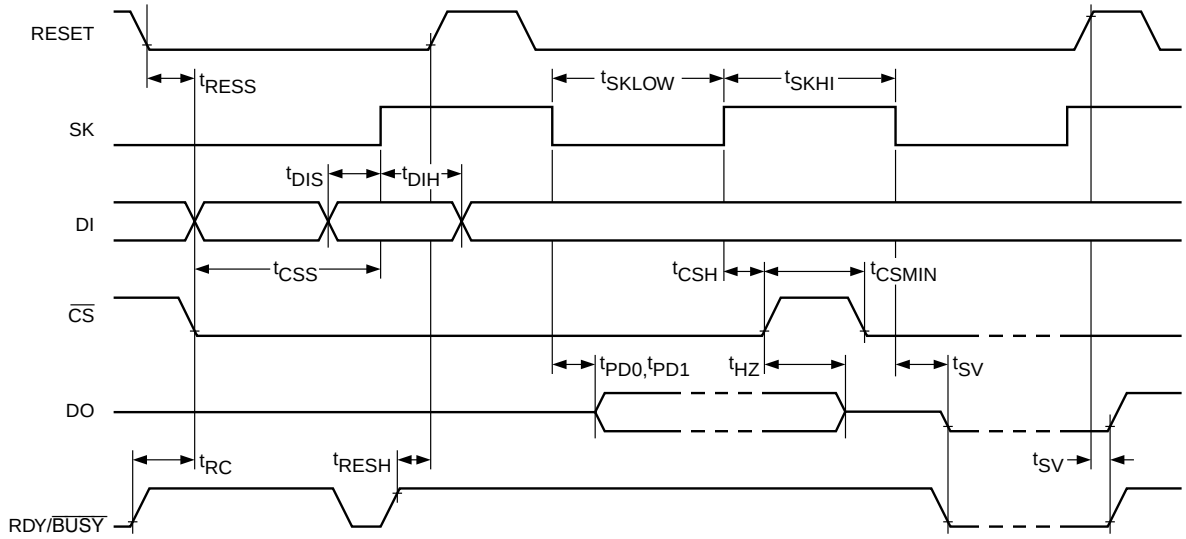
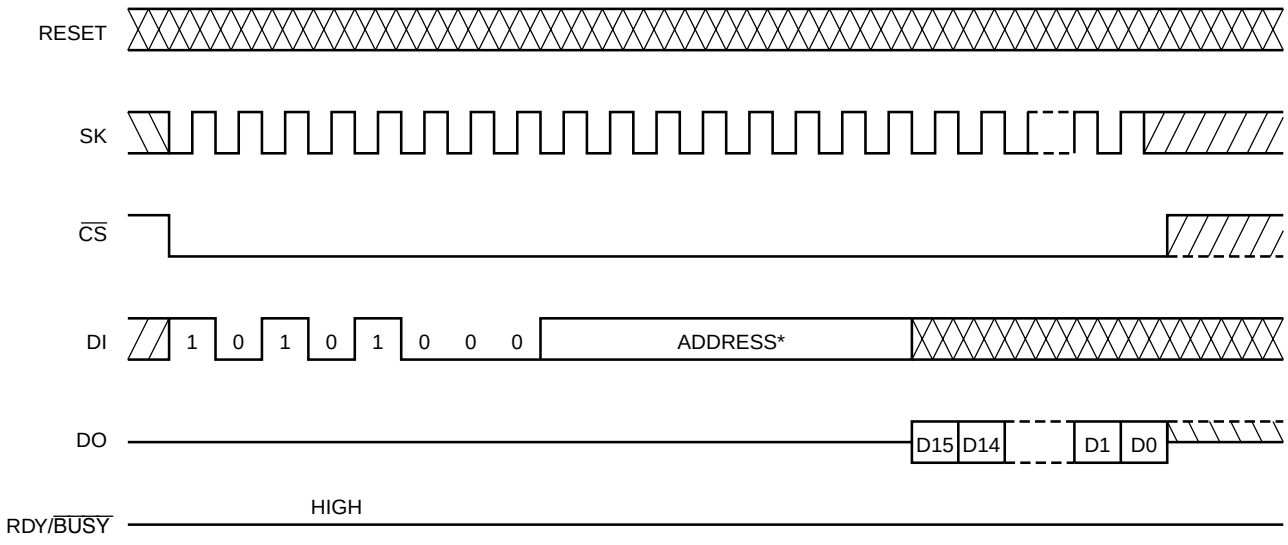


Figure 3. Read Instruction Timing



* Please check the instruction set table for address

a 16-bit data field is also required following the 8-bit address field.

The CAT64LC40 requires an active LOW $\overline{CS}$ in order to be selected. Each instruction must be preceded by a HIGH-to-LOW transition of $\overline{CS}$ before the input of the 4-bit start sequence. Prior to the 4-bit start sequence (1010), the device will ignore inputs of all other logical sequence.

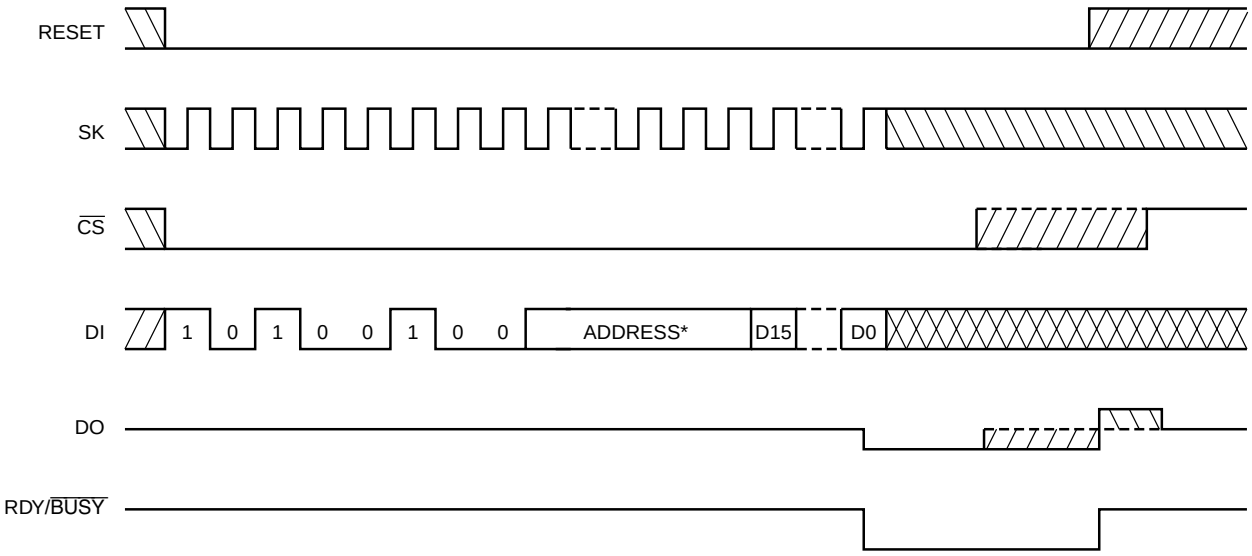
Read

Upon receiving a READ command and address (clocked into the DI pin), the DO pin will output data one t_{PD} after the falling edge of the 16th clock (the last bit of the address field). The READ operation is not affected by the RESET input.

Write

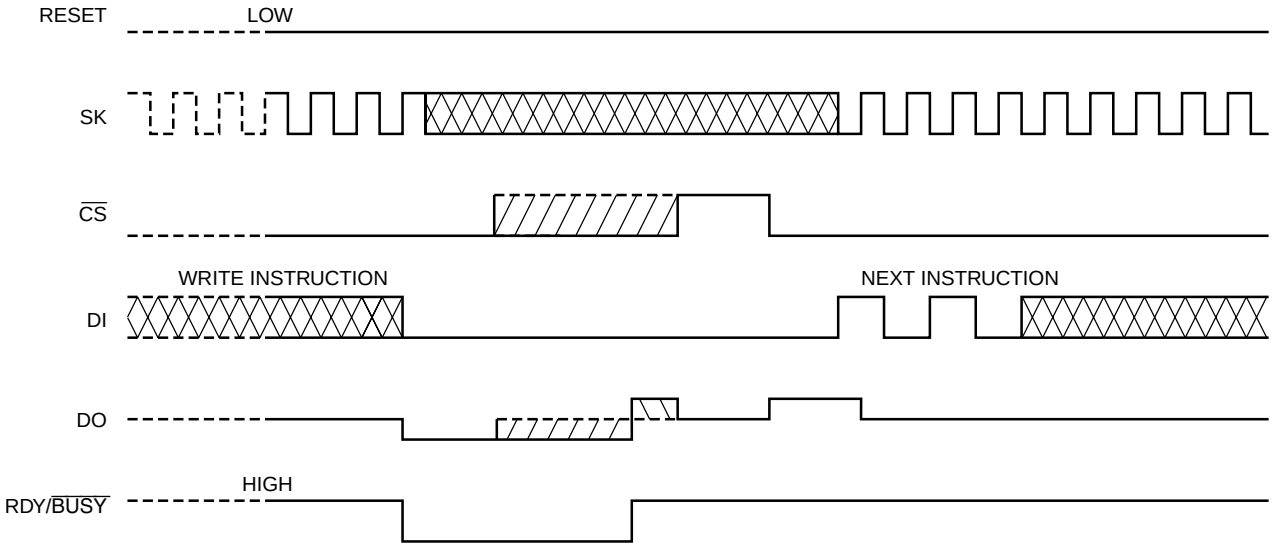
After receiving a WRITE op code, address and data, the device goes into the AUTO-Clear cycle and then the

Figure 4. Write Instruction Timing



* Please check instruction set table for address

Figure 5. Ready/BUSY Status Instruction Timing



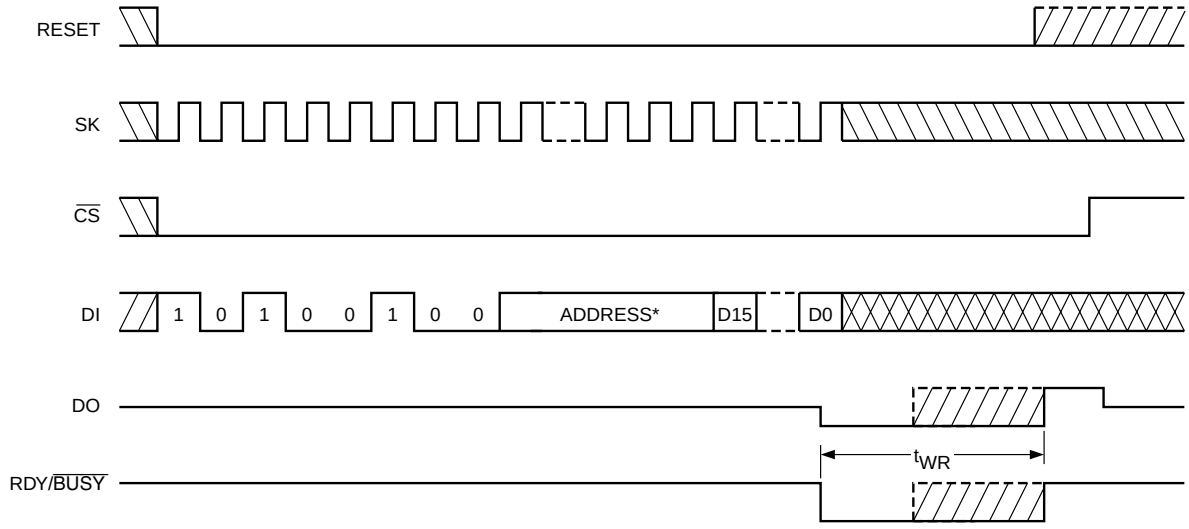
WRITE cycle. The RDY/$\overline{BSY}$ pin will output the $\overline{BUSY}$ status (LOW) one t_{SV} after the rising edge of the 32nd clock (the last data bit) and will stay LOW until the write cycle is complete. Then it will output a logical "1" until the next WRITE cycle. The RDY/$\overline{BSY}$ output is not affected by the input of $\overline{CS}$.

An alternative to get RDY/$\overline{BSY}$ status is from the DO pin. During a write cycle, asserting a LOW input to the $\overline{CS}$ pin will cause the DO pin to output the RDY/$\overline{BSY}$ status. Bringing $\overline{CS}$ HIGH will bring the DO pin back to a high impedance state again. After the device has completed a WRITE cycle, the DO pin will output a logical "1" when the device is deselected. The rising edge of the first "1" input on the DI pin will reset DO back to the high impedance state again.

The WRITE operation can be halted anywhere in the operation by the RESET input. If a RESET pulse occurs during a WRITE operation, the device will abort the operation and output a READY status.

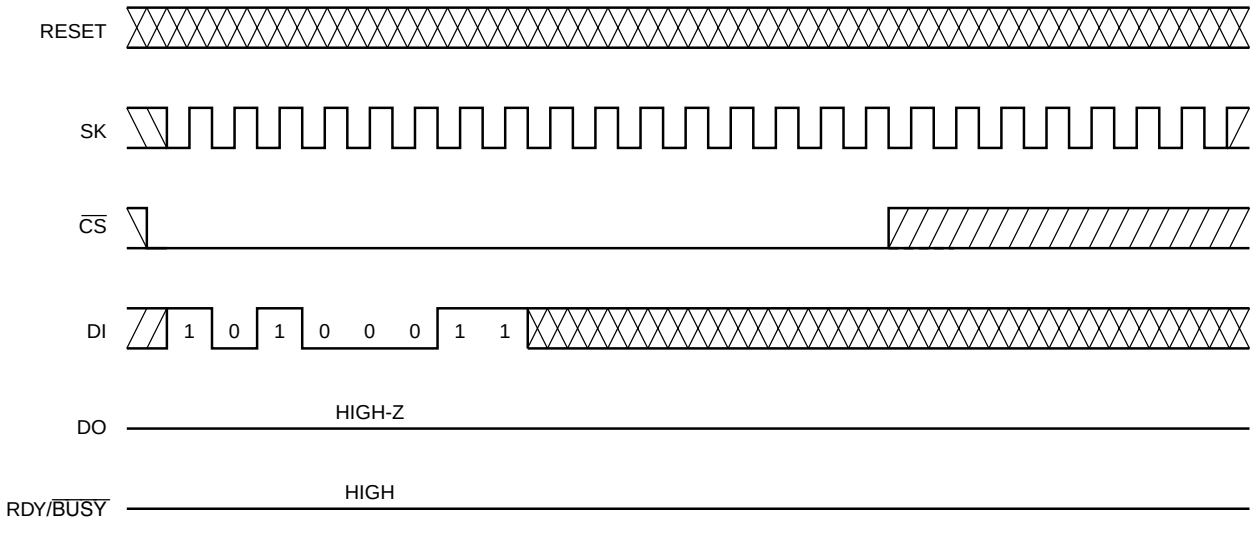
NOTE: Data may be corrupted if a RESET occurs while the device is $\overline{BUSY}$. If the reset occurs before the $\overline{BUSY}$ period, no writing will be initiated. However, if RESET occurs after the $\overline{BUSY}$ period, new data will have been written over the old data.

Figure 6. RESET During $\overline{BUSY}$ Instruction Timing



* Please check instruction set table for address

Figure 7. EWEN Instruction Timing



5064 FHD F09

RESET

The RESET pin, when set to HIGH, will reset or abort a WRITE operation. When RESET is set to HIGH while the WRITE instruction is being entered, the device will not execute the WRITE instruction and will keep DO in High-Z condition.

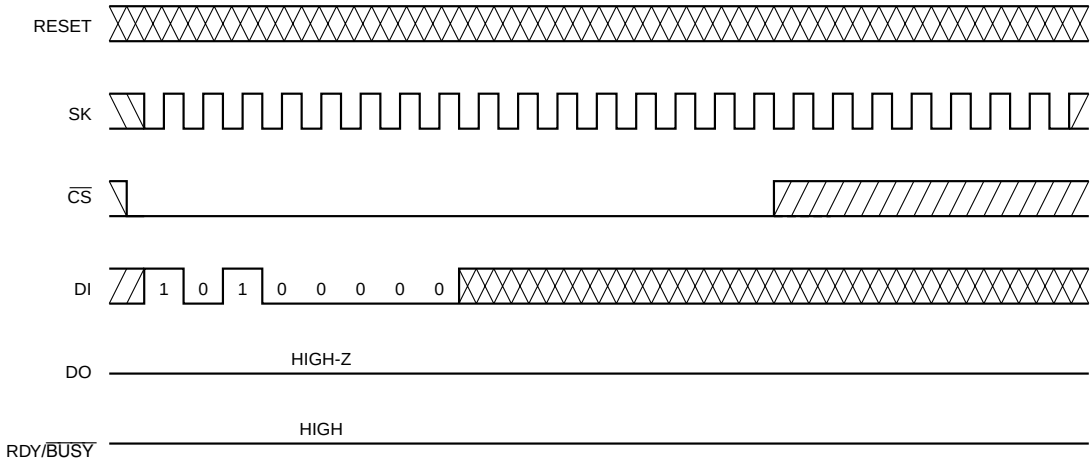
When RESET is set to HIGH, while the device is in a clear/write cycle, the device will abort the operation and will display READY status on the RDY/$\overline{BSY}$ pin and on the DO pin if $\overline{CS}$ is low.

The RESET input affects only the WRITE and WRITE ALL operations. It does not reset any other operations such as READ, EWEN and EWDS.

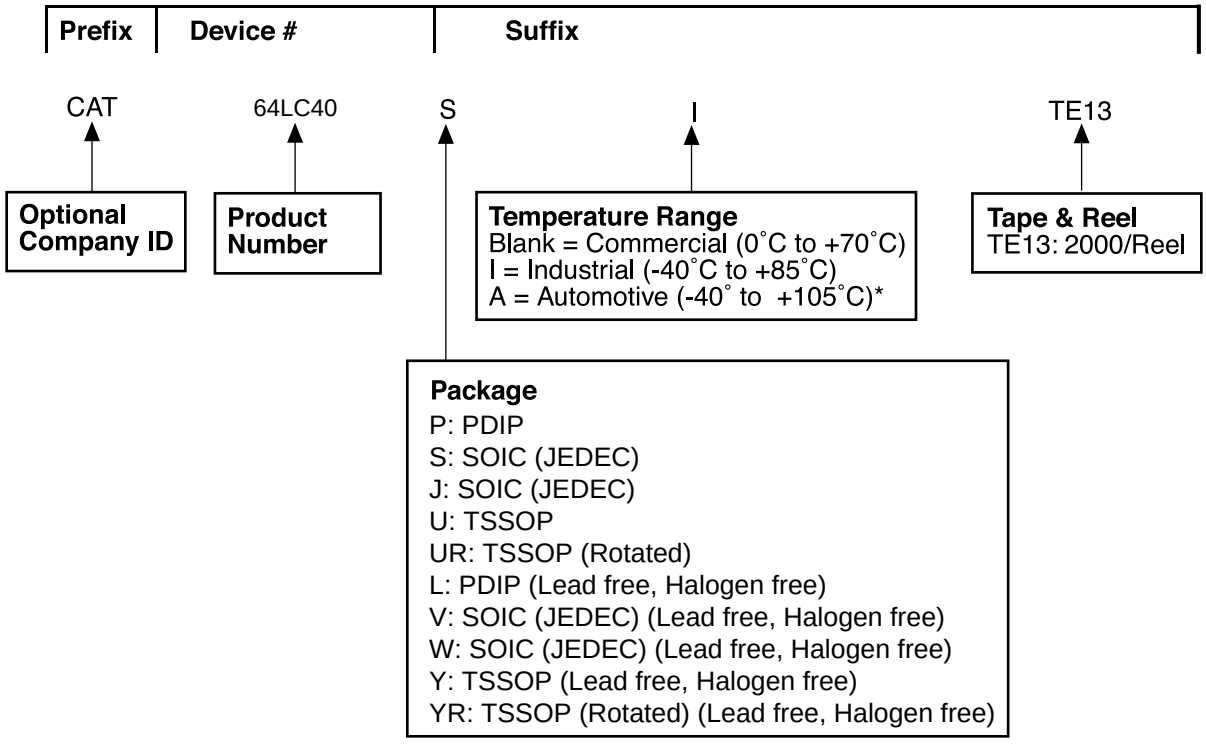
ERASE/WRITE ENABLE and DISABLE

The CAT64LC40 powers up in the erase/write disabled state. After power-up or while the device is in an erase/write disabled state, any write operation must be preceded by an execution of the EWEN instruction. Once enabled, the device will stay enabled until an EWDS has been executed or a power-down has occured. The EWDS is used to prevent any inadvertent over-writing of the data. The EWEN and EWDS instructions have no affect on the READ operation and are not affected by the RESET input.

Figure 8. EWDS Instruction Timing



ORDERING INFORMATION

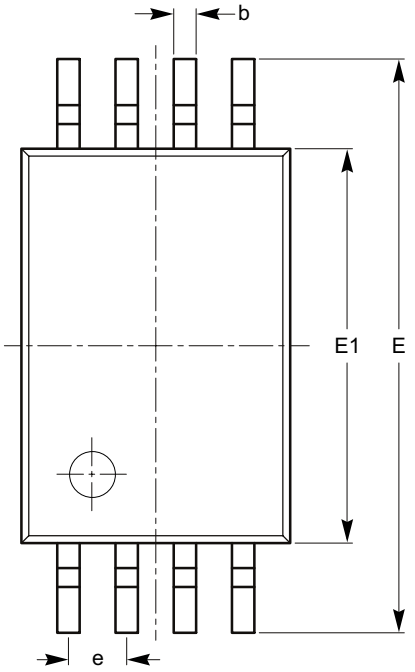


* -40˚C to +125˚C is available upon request

Notes:
(1) The device used in the above example is a 64LC40SI-TE13 (SOIC, Industrial Temperature, Tape & Reel)

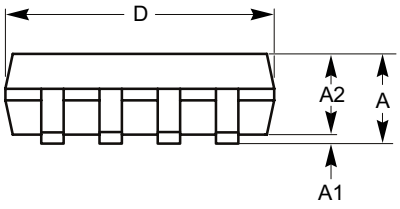
PACKAGING OUTLINE DRAWING

TSSOP 8-Lead (U)

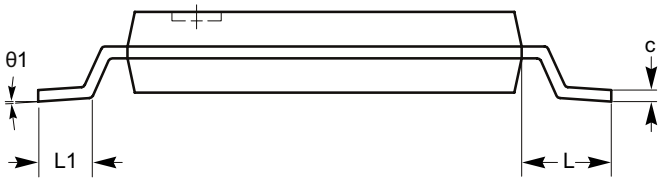


TOP VIEW

SYMBOL	MIN	NOM	MAX
A			1.20
A1	0.05		0.15
A2	0.80	0.90	1.05
b	0.19		0.30
c	0.09		0.20
D	2.90	3.00	3.10
E	6.30	6.40	6.50
E1	4.30	4.40	4.50
e	0.65 BSC		
L	1.00 REF		
L1	0.50	0.60	0.75
θ1	0°		8°



SIDE VIEW



END VIEW

For current Tape and Reel information, download the PDF file from: http://www.catsemi.com/documents/tapeandreel.pdf.

Notes:
1. All dimensions are in millimeters. Angles in degrees.
2. Complies with JEDEC standard MO-153.

REVISION HISTORY

Date	Revision	Description
3-Sep-04	B	Added Green packages in all areas Updated DC Operating Characteristics table & notes
17-Nov-04	C	Changed I_{SB} from 1µA, Max to 3µA, Max in DC Operating Characteristics table
21-May-06	D	Discontinued the CAT64LC10 and CATLC205
11-Nov-08	E	Update Package Outline Drawing Change logo and fine print to ON Semicondctor

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855
Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center:
Phone: 81-3-5773-3850

ON Semiconductor Website: www.onsemi.com

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative