HT24C64A 2-Wire Serial EEPROM

Description

The HT24C64A provides 65,536 bits of serial electrically erasable and programmable read-only memory (EEPROM) organized as 8,192 words of 8 bits each, with 128-bit UID and 32-byte Security Sector. The device's cascadable feature allows up to 8 devices to share a common 2-wire bus. The device is optimized for use in many industrial and commercial applications where low-power and low-voltage operations are essential.

Features

- **Low Operation Voltage: V_{CC} = 1.7V to 5.5V**
- **Internally Organized: 8,192 x 8**
- **2-wire Serial Interface**
- **Schmitt Trigger, Filtered Inputs for Noise Suppression**
- **Bi-directional Data Transfer Protocol**
- **1MHz (2.5V~5.5V) and 400 kHz (1.7V) Compatibility**
- **Write Protect Pin for Hardware Data Protection**
- **32-Byte Page Write Modes (Partial Page Writes are Allowed)**
- **Lockable 32-Byte Security Sector**
- **128-Bit Unique ID for each device**
- **Self-timed Write Cycle (5 ms max)**
- **High-reliability**
  - **Endurance: 1,000,000 Write Cycles**
  - **Data Retention: 40 Years**
- **PDIP8 Package (RoHS Compliant)**
- **SOP8, TSSOP8, TDFN8 and Thin 4-ball WLCSP Packages (RoHS Compliant and Halogen-free)**

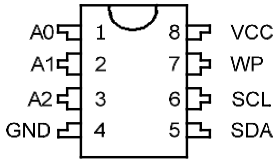
Absolute Maximum Ratings

Operating Temperature (Plastic Package)	-55℃ to +125℃
Operating Temperature (Module Package)	-20℃ to +60℃
Storage Temperature (Plastic Package)	-65℃ to +150℃
Storage Temperature (Module Package)	-25℃ to +70℃
Voltage on Any Pin with Respect to Ground	-1.0V to +7.0V
Maximum Operating Voltage	6.25V
DC Output Current	5.0 mA

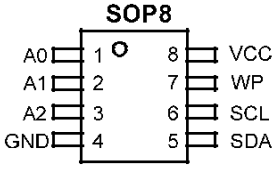
*NOTICE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Packaging Type

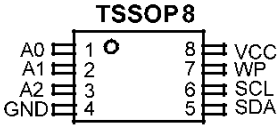
PDIP 8



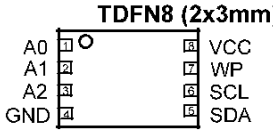
SOP8



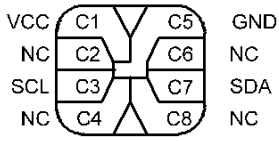
TSSOP 8



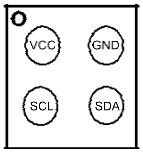
TDFN8 (2x3mm)



Module package(8Pin)



Thin 4-ball WLCSP [1]

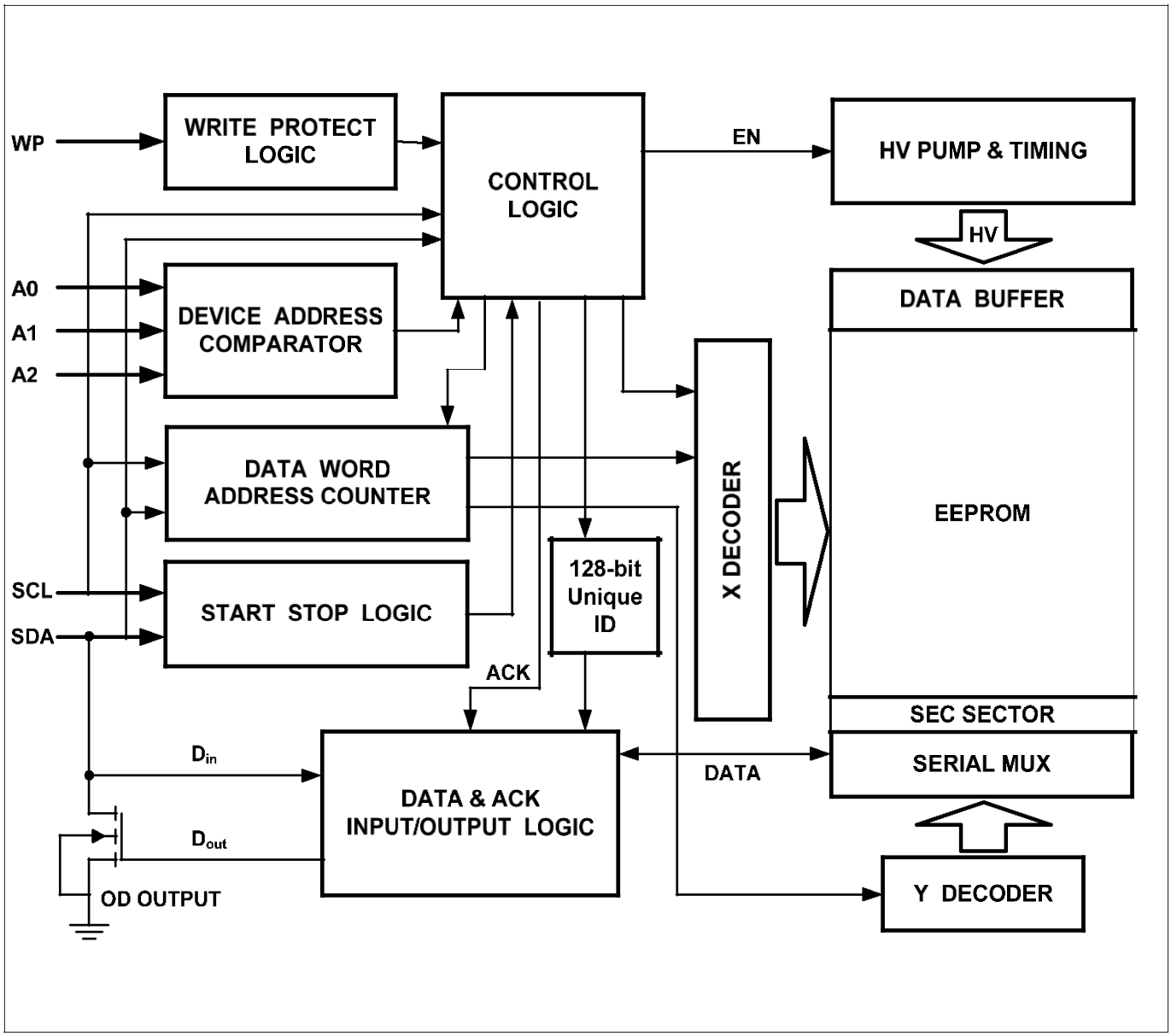


(TOP VIEW)

Note:
Please contact local sales office for detail description.

Pin Configurations

Pin Name	Function
A0~A2	Device Address Inputs
SDA	Serial Data Input/Output
SCL	Serial Clock Input
WP	Write Protect
V_{CC}	Power Supply
GND	Ground
NC	Not Connect


WP
WRITE PROTECT LOGIC
CONTROL LOGIC
EN
HV PUMP & TIMING
HV
A0
A1
A2
DEVICE ADDRESS COMPARATOR
DATA BUFFER
DATA WORD ADDRESS COUNTER
X DECODER
EEPROM
SCL
SDA
START STOP LOGIC
128-bit Unique ID
ACK
SEC SECTOR
SERIAL MUX
Din
DATA & ACK INPUT/OUTPUT LOGIC
DATA
Dout
OD OUTPUT
Y DECODER

Pin Description

SERIAL CLOCK (SCL): The SCL input is used to positive edge clock data into each EEPROM device and negative edge clock data out of each device.

SERIAL DATA (SDA): The SDA pin is bi-directional for serial data transfer. This pin is open-drain driven and may be wire-ORed with any number of other open-drain or open-collector devices.

DEVICE ADDRESSES (A2, A1, A0): The A2, A1 and A0 pins are device address inputs that are hardwired or left not connected for hardware compatibility with other FM24CXX devices. When the pins are hardwired, as many as eight 64K devices may be addressed on a single bus system (device addressing is discussed in detail under the Device Addressing section) . If the pins are left floating, the A2, A1 and A0 pins will be internally pulled down to GND if the capacitive coupling to the circuit board V_{CC} plane is <3pF, if coupling is >3pF, FMSH recommends connecting the address pins to GND.

WRITE PROTECT (WP): The HT24C64A has a Write Protect pin that provides hardware data protection. The WP pin allows normal write operations when connected to ground (GND). When the Write Protect pin is connected to VCC, all write operations to the memory are inhibited. If the pin is left floating, the WP pin will be internally pulled down to GND if the capacitive coupling to the circuit board Vcc plane is <3pF. If coupling is >3pF, FMSH recommends connecting the WP to GND. Switching WP to VCC prior to a write operation creates a software write protected function.

Write Protect Description

WP Pin Status	Part of the Memory Protected
	HT24C64A
WP=V_{CC}	Full Memory
WP=GND	Normal Read/Write Operations

Memory Organization

HT24C64A, 64K SERIAL EEPROM: Internally organized with 256 pages of 32 bytes each, the 64K requires a 13-bit data word address for random word addressing.

Security Sector ： The HT24C64A offers 32-byte Security Sectors which can be written and (later) permanently locked in Read-only mode. This memory may be used by the system manufacturers to store security and other important information separately from the main memory array.

Device ADDR	Page ADDR	Byte Number		
		31	…	0
1010	0	Data Memory (256P X 32B)		
	1			
	2			
	…			
	255			
1011	xxxx x00x xxxx xxxx[1]	Security Sector (32 Bytes)		
1011	xxxx xx1x xxxx xxxx[2]	Unique ID（128 Bits）		

Note: 1. Address bits ADDR<10:9> must be 00, ADDR<4:0> define byte address, other bits are don't care
2. Address bits ADDR<10:9> must be x1, ADDR<3:0> define byte address, other bits are don't care

Pin Capacitance

SYMBOL	PARAMETER	CONDITIONS	Max	Units
C_{IN} [1]	Input Capacitance	V_{IN} = 0V, f = 1MHz	6	pF
C_{OUT} [1]	Output Capacitance	V_{OUT} = 0V, f = 1MHz	8	pF

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

DC Characteristics

Applicable over recommended operating range from: T_A = -40℃ to +85℃, V_{CC} = +1.7V to +5.5V, (unless otherwise noted).

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
V_{CC}	Supply Voltage		1.7		5.5	V
I_{CC1}	Supply Current	V_{CC} = 5.0V, Read at 400KHz		0.4	1.0	mA
I_{CC2}	Supply Current	V_{CC} = 5.0V, Write at 400KHz		2.0	3.0	mA
I_{SB1}	Standby Current	V_{CC} = 1.7V, V_{IN} = V_{CC}/ V_{SS}			1.0	μA
I_{SB2}	Standby Current	V_{CC} = 5.5V, V_{IN} = V_{CC}/ V_{SS}			6.0	μA
I_{LI}	Input Leakage Current	V_{IN} = V_{CC}/V_{SS}		0.1	3.0	μA
I_{LO}	Output Leakage Current	V_{OUT} = V_{CC}/ V_{SS}		0.05	3.0	μA
V_{IL} [1]	Input Low Level		-0.6		V_{CC} x 0.3	V
V_{IH} [1]	Input High Level		V_{CC} x 0.7		V_{CC} + 0.5	V
V_{OL2}	Output Low Level 2	V_{CC} = 3.0V, I_{OL} = 2.1 mA			0.4	V
V_{OL1}	Output Low Level 1	V_{CC} =1.7V, I_{OL} = 0.15 mA			0.2	V

Note: 1. V_{IL} min and V_{IH} max are reference only and are not tested.

AC Characteristics

400 kHz AC characteristics

Recommended operating conditions: T_A = -40℃ to +85℃, V_{CC} = +1.7V to +5.5V, CL = 100 pF (unless otherwise noted). Test conditions are listed in Note 2.

Symbol	Parameter	Min	Max	Units
f_{SCL}	Clock Frequency, SCL		400	kHz
t_{LOW}	Clock Pulse Width Low	1.3		µs
t_{HIGH}	Clock Pulse Width High	0.6		µs
t_I [1]	Noise Suppression Time		80	ns
t_{AA}	Clock Low to Data Out Valid	0.1	0.9	µs
t_{BUF} [1]	Time the bus must be free before a new transmission can Start	1.3		µs
$t_{HD.STA}$	Start Hold Time	0.6		µs
$t_{SU.STA}$	Start Setup Time	0.6		µs
$t_{HD.DAT}$	Data In Hold Time	0		µs
$t_{SU.DAT}$	Data In Setup Time	100		ns
t_R	Inputs Rise Time [1]		300	ns
t_F	Inputs Fall Time [1]		300	ns
$t_{SU.STO}$	Stop Setup Time	0.6		µs
t_{DH}	Data Out Hold Time	100		ns
t_{WR}	Write Cycle Time		5	ms
Endurance [1]	3.3V, 25℃, Page Mode	1,000,000		Write Cycles

1 MHz AC characteristics

Recommended operating conditions: T_A = -40℃ to +85℃, V_{CC} = +2.5V to +5.5V, CL = 100 pF (unless otherwise noted). Test conditions are listed in Note 2.

Symbol	Parameter	Min	Max	Units
f_{SCL}	Clock Frequency, SCL		1	MHz
t_{LOW}	Clock Pulse Width Low	500		ns
t_{HIGH}	Clock Pulse Width High	320		ns
t_I [1]	Noise Suppression Time		80	ns
t_{AA}	Clock Low to Data Out Valid		450	ns
t_{BUF} [1]	Time the bus must be free before a new transmission can Start	500		ns
$t_{HD.STA}$	Start Hold Time	250		ns
$t_{SU.STA}$	Start Setup Time	250		ns
$t_{HD.DAT}$	Data In Hold Time	0		ns
$t_{SU.DAT}$	Data In Setup Time	50		ns
t_R	Inputs Rise Time [1]		120	ns
t_F	Inputs Fall Time [1]		120	ns
$t_{SU.STO}$	Stop Setup Time	250		ns
t_{DH}	Data Out Hold Time	100		ns
t_{WR}	Write Cycle Time		5	ms
Endurance [1]	3.3V, 25℃, Page Mode	1,000,000		Write Cycles

Device Operation

CLOCK and DATA TRANSITIONS: The SDA pin is normally pulled high with an external device. Data on the SDA pin may change only during SCL low time periods (refer to Figure 4). Data changes during SCL high periods will indicate a start or stop condition as defined below.

START CONDITION: A high -to-low transition of SDA with SCL high is a start condition which must precede any other command (refer to Figure 5).

STOP CONDITION: A low- to-high transition of SDA with SCL high is a stop condition. After a read sequence, the stop command will place the EEPROM in a standby power mode (refer to Figure 5).

ACKNOWLEDGE: All address and data words are serially transmitted to and from the EEPROM in 8-bit words. The EEPROM sends a zero during the ninth clock cycle to acknowledge that it has received each word.

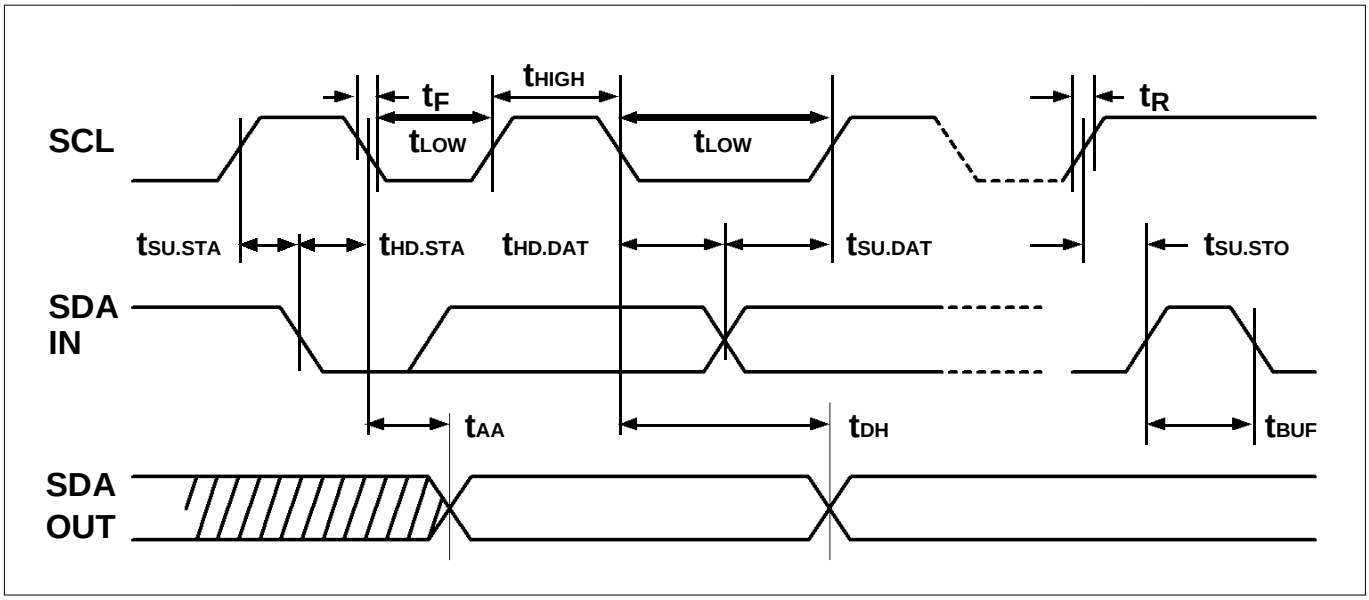
STANDBY MODE: The HT24C64A features a low-power standby mode which is enabled: (a) upon power-up and (b) after the receipt of the stop bit and the completion of any internal operations.

Memory RESET: After an interruption in protocol, power loss or system reset, any 2-wire part can be reset in following these steps:

1. Clock up to 9 Cycles,
2. Look for SDA high in each cycle while SCL is high and then,
3. Create a start condition as SDA is high.

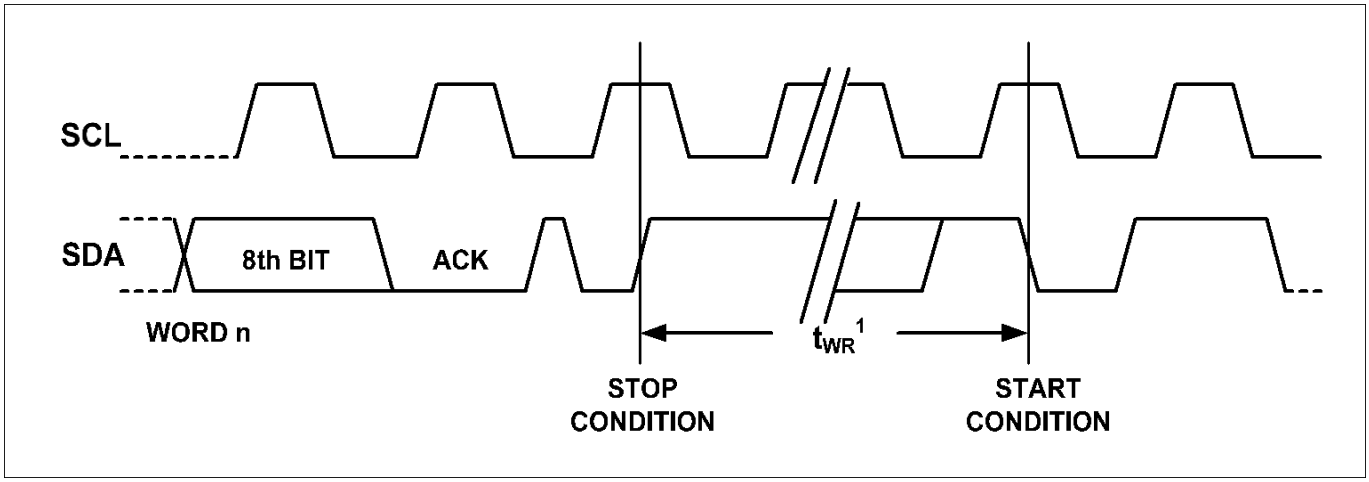
Bus Timing

Figure 2. SCL: Serial Clock, SDA: Serial Data I/O



Write Cycle Timing

Figure 3. SCL: Serial Clock, SDA: Serial Data I/O



Note: 1. The write cycle time t_{WR} is the time from a valid stop condition of a write sequence to the end of the internal clear/write cycle.

Figure 4. Data Validity

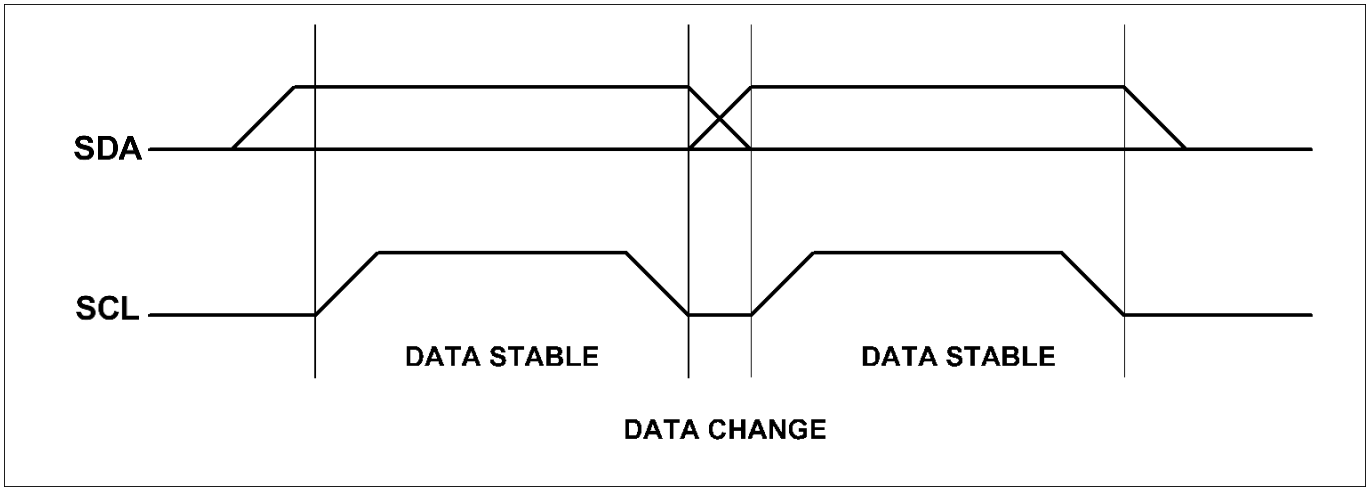


Figure 5. Start and Stop Definition

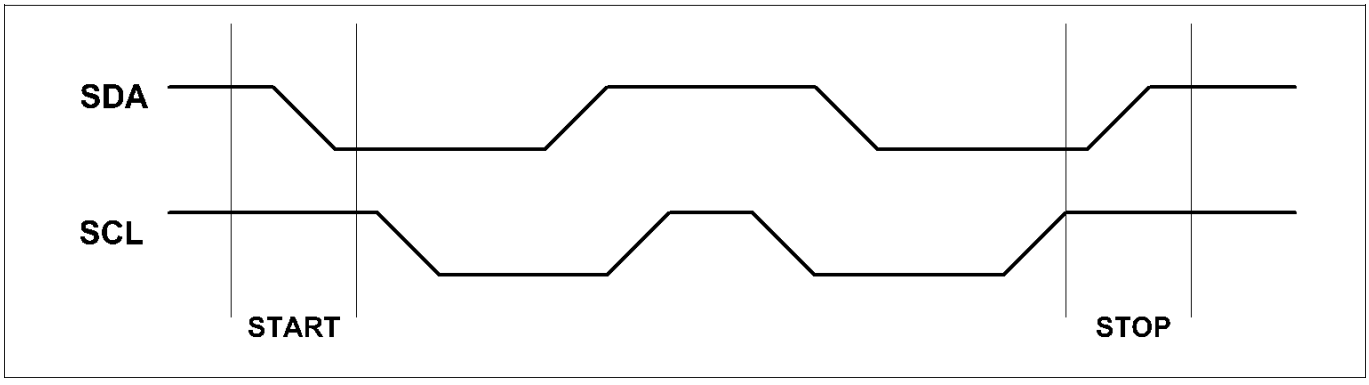
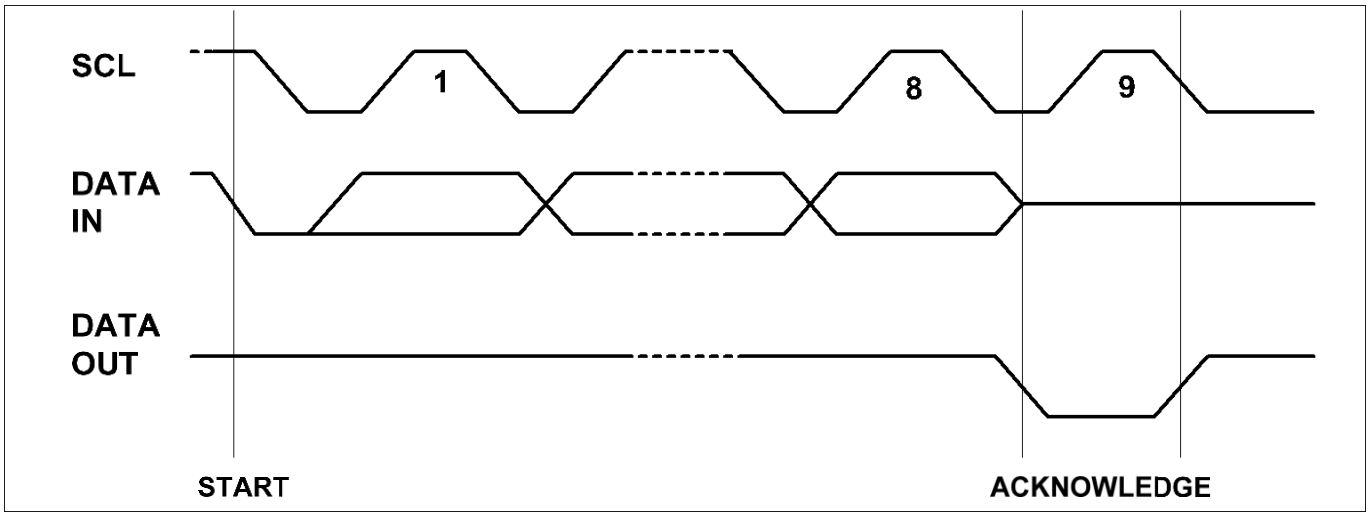


Figure 6. Output Acknowledge



Device Addressing

DATA MEMORY ACCESS: The 64K EEPROM device requires a 8-bit device address word following a start condition to enable the chip for a read or write operation (refer to Table 1).

The device address word consists of a mandatory '1010'(Ah) sequence for the first four most significant bits as shown in Table 1. This is common to all the EEPROM devices.

The 64K EEPROM uses the three device address bits A2, A1, A0 to allow as many as eight devices on the same bus. These bits must compare to their corresponding hard-wired input pins. The A2, A1 and A0 pins use an internal proprietary circuit that biases them to a logic low condition if the pins are allowed to float.

The Module package device address word also consists of a mandatory '1010'(Ah) sequence for the first four most significant bits. The next 3 bits are all zero.

The eighth bit of the device address is the read/write operation select bit. A read operation is initiated if this bit is high and a write operation is initiated if this bit is low.

Upon a compare of the device address, the EEPROM will output a zero. If a compare is not made, the device will return to a standby state.

UNIQUE ID ACCESS: The HT24C64A utilizes a separate memory block containing a factory programmed 128-bit unique ID. Access to this memory location is obtained by beginning the device address word with a '1011'(Bh) sequence (refer to Table 1). The behavior of the next three bits (A2, A1 and A0) remains the same as during a standard memory addressing sequence.

The eighth bit of the device address needs be set to a one to read the Serial Number. Writing or altering the 128-bit unique ID is not possible.

For more details on accessing this special feature, See Read Operations on page 14.

SECURITY SECTOR ACCESS: The HT24C64A offers 32-byte Security Sector which can be written and (later) permanently locked in Read-only mode. Access to this memory location is obtained by beginning the device address word with a '1011'(Bh) sequence (refer to Table 1). The behavior of the next three bits (A2, A1 and A0) remains the same as during a standard memory addressing sequence.

The eighth bit of the device address is the read/write operation select bit. A read operation is initiated if this bit is high and a write operation is initiated if this bit is low.

For more details on accessing this special feature, See Write Operations and Read Operations on page 13,14.

NOISE PROTECTION: Special internal circuitry placed on the SDA and SCL pins prevent small noise spikes from activating the device.

DATA SECURITY: The Device has a hardware data protection scheme that allows the user to write protect the entire memory when the WP pin is at V_{CC}.

Table 1-1. Device Address

Access Area	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Data Memory	1	0	1	0	A2	A1	A0	R/W
Security Sector	1	0	1	1	A2	A1	A0	R/W
Security Sector Lock Bit	1	0	1	1	A2	A1	A0	R/W
Unique ID Number	1	0	1	1	A2	A1	A0	1
	MSB							LSB

Table 1-2. First Word Address

Access Area	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Data Memory	x	x	x	A12	A11	A10	A9	A8
Security Sector	x	x	x	x	x	0	0	x
Security Sector Lock Bit	x	x	x	x	x	1	0	X
Unique ID Number	x	x	x	x	x	x	1	x
	MSB							LSB

NOTE: x = Don`t care bit.

Table 1-3. Second Word Address

Access Area	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Data Memory	A7	A6	A5	A4	A3	A2	A1	A0
Security Sector	x	x	x	A4	A3	A2	A1	A0
Security Sector Lock Bit	x	x	x	x	x	x	x	x
Unique ID Number	x	x	x	x	0	0	0	0
	MSB							LSB

NOTE: x = Don`t care bit.

Write Operations

BYTE WRITE: A write operation requires two 8-bit data word address following the device address word and acknowledgment. Upon receipt of this address, the EEPROM will again respond with a zero and then clock in the first 8-bit data word. Following receipt of the 8-bit data word, the EEPROM will output a zero and the addressing device, such as a microcontroller, must terminate the write sequence with a stop condition. At this time the EEPROM enters an internally-timed write cycle, $t_{WR,}$ to the nonvolatile memory. All inputs are disabled during this write cycle and the EEPROM will not respond until the write is complete (see **Figure 7** on page 15).

PAGE WRITE: The 64K EEPROM is capable of 32-byte page writes. A page write is initiated the same way as a byte write, but the microcontroller does not send a stop condition after the first data word is clocked in. Instead, after the EEPROM acknowledges receipt of the first data word, the microcontroller can transmit up to 31 more data words. The EEPROM will respond with a zero after each data word received. The microcontroller must terminate the page write sequence with a stop condition (see **Figure 8** on page 15).

The data word address lower seven bits are internally incremented following the receipt of each data word. The higher data word address bits are not incremented, retaining the memory page row location. When the word address, internally generated, reaches the page boundary, the following byte is placed at the beginning of the same page. If more than 32 data words are transmitted to the EEPROM, the data word address will “roll over” and previous data will be overwritten.

ACKNOWLEDGE POLLING: Once the internally timed write cycle has started and the EEPROM inputs are disabled, acknowledge polling can be initiated. This involves sending a start condition followed by the device address word. The read/write bit is representative of the operation desired. Only if the internal write cycle has completed will the EEPROM respond with a zero allowing the read or write sequence to continue.

WRITE SECURITY SECTOR: Write the Security Sector is similar to the page write but requires use of device address, and the special word address seen in Table 1 on page 12. The higher address bits ADDR<12:5> are don’t care except for address bits ADDR<10:9>，which must be equal to ‘00b’. Lower address bits ADDR<4:0> define the byte address inside the Security Sector (see **Figure 12** on page 16).

If the Security Sector is locked, the data bytes transferred during the Write Security Sector operation are not acknowledged (NoAck).

LOCK SECURITY SECTOR: Lock the Security Sector is similar to the byte write but requires use of device address, and special word address seen in Table 1 on page 12. The word address bits ADDR<10:9> must be ‘10b’, all other word address bits are don’t care. The data byte must be equal to the binary value 1111 1111(see **Figure 14** on page 17).

If the Security Sector is locked, the data bytes transferred during the Lock Security Sector operation are not acknowledged (NoAck).

Read Operations

Read operations are initiated the same way as write operations with the exception that the read/write select bit in the device address word is set to one.

CURRENT ADDRESS READ: The internal data word address counter maintains the last address accessed during the last read or write operation, incremented by one. This address stays valid between operations as long as the chip power is maintained. The address "roll over" during read is from the last byte of the last memory page to the first byte of the first page. The address "roll over" during write is from the last byte of the current page to the first byte of the same page.

Once the device address with the read/write select bit set to one is clocked in and acknowledged by the EEPROM, the current address data word is serially clocked out. The microcontroller does not respond with an input zero but does generate a following stop condition (see **Figure 9** on page 15).

RANDOM READ: A random read requires a "dummy" byte write sequence to load in the data word address. Once the device address word and data word address are clocked in and acknowledged by the EEPROM, the microcontroller must generate another start condition. The microcontroller now initiates a current address read by sending a device address with the read/write select bit high. The EEPROM acknowledges the device address and serially clocks out the data word. The microcontroller does not respond with a zero but does generate a following stop condition (see **Figure 10** on page 16).

SEQUENTIAL READ: Sequential reads are initiated by either a current address read or a random address read. After the microcontroller receives a data word, it responds with an acknowledge. As long as the EEPROM receives an acknowledge, it will continue to increment the data word address and serially clock out sequential data words. When the memory address limit is reached, the data word address will "roll over" and the sequential read will continue. The sequential read operation is terminated when the microcontroller does not respond with a zero but does generate a following stop condition (see **Figure 11** on page 16)

UNIQUE ID READ: Reading the serial number is similar to the sequential read but requires use of the device address, a dummy write, and the use of specific word address seen in Table 1 on page 12. The higher address bits ADDR<12:4> are don't care except for address bits ADDR<10:9>，which must be equal to 'x1b'. Lower address bits ADDR<3:0> define the byte address inside the UID. If the application desires to read the first byte of the UID, the lower address bits ADDR<3:0> would need to be '0000b'.

When the end of the 128-bit UID number is reached (16 bytes of data), the data word address will roll-over back to the beginning of the 128-bit UID number. The Unique ID Read operation is terminated when the microcontroller does not respond with a zero (ACK) and instead issues a Stop condition (see **Figure 16** on page 18).

READ SECURITY SECTOR ： Read the Security Sector is similar to the random read but requires use of device address, a dummy write, and the use of specific word address seen in Table 1 on page 12. The higher address bits ADDR<12:5> are don't care except for address bits ADDR<10:9>，which must be equal to '00b'. The lower address bits ADDR<4:0> define the byte address inside the Security Sector.

The internal byte address is automatically incremented to the next byte address after each byte of data is clocked out. When the last byte (1Fh) is reached, it will roll over to 00h, the first byte of the Security Sector, and continue to increment. (see **Figure 13** on page 17).

READ LOCK STATUS： There are two ways to check the lock status of the Security Sector.

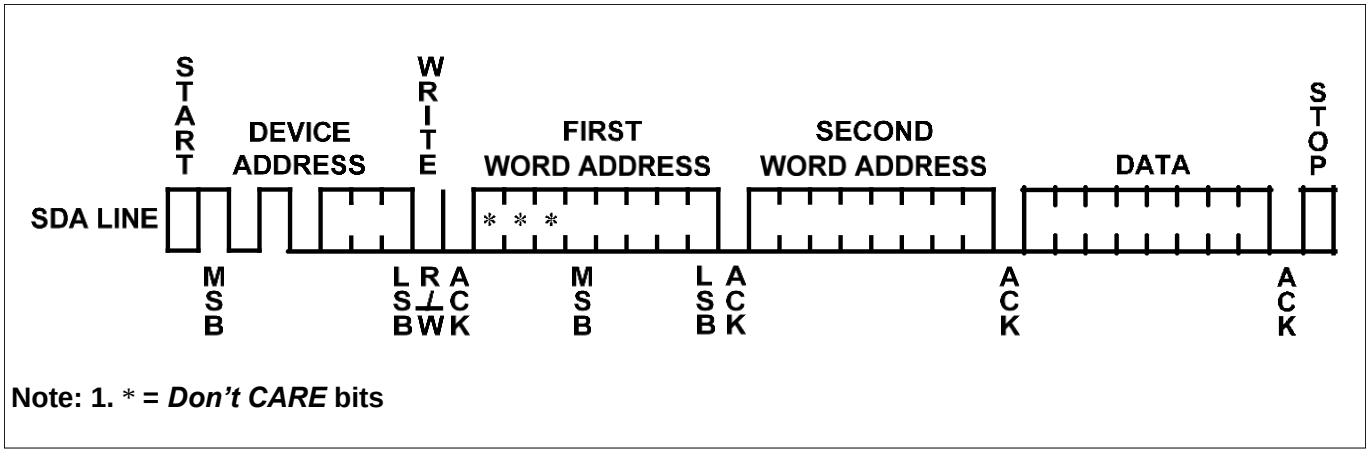
1. The first way is initiated by a Security Sector Write, the EEPROM will acknowledge if the Security Sector is unlocked, while it will not acknowledge if the Security Sector is locked.

Once the acknowledge bit is read, it is recommended to generate a Start condition followed by a Stop condition, so that:

- ⌘ Start: the truncated command is not executed because the Start condition resets the device internal logic
- ⌘ Stop: the device is then set back into Standby mode by the Stop condition.

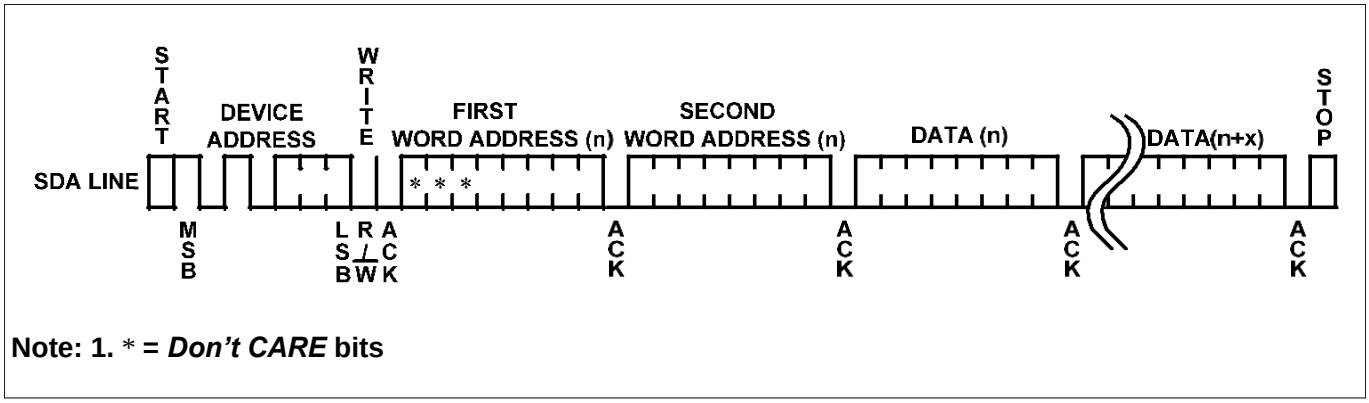
2. The second way is initiated by a Lock Status Read. Lock Status Read is similar to the random read but requires use of device address seen in Table 1 on page 12, a dummy write, and the use of specific word address. The address bits ADDR<10:9> must be '10b', all other address bits are Don't Care. The Lock bit is the BIT1 of the byte read on SDA. It is at "1" when the lock is active and at "0" when the lock is not active. The same data is shifted out repeatedly until the microcontroller does not respond with a zero but does generate a following stop condition (see **Figure 15** on page 18).

Figure 7. Byte Write



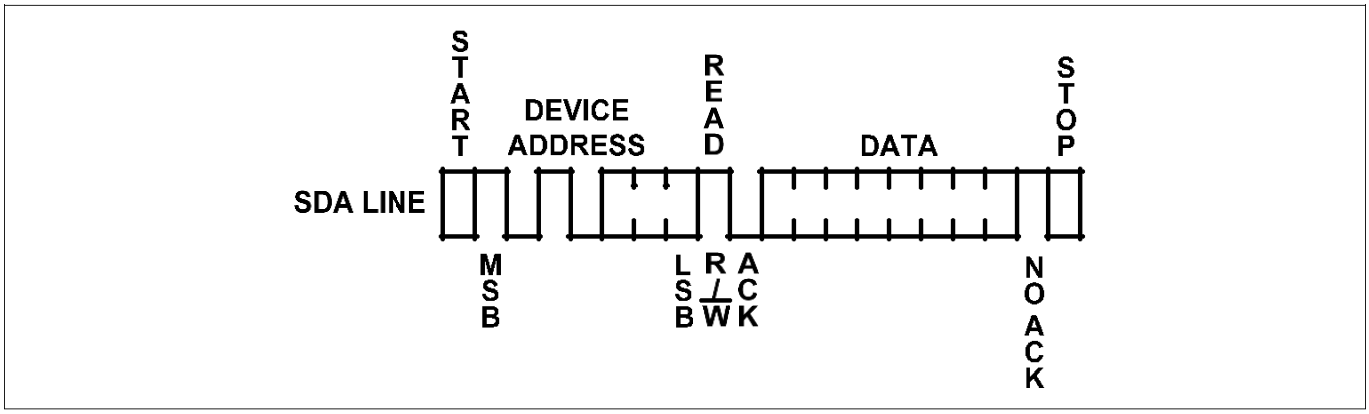
Note: 1. * = *Don't CARE* bits

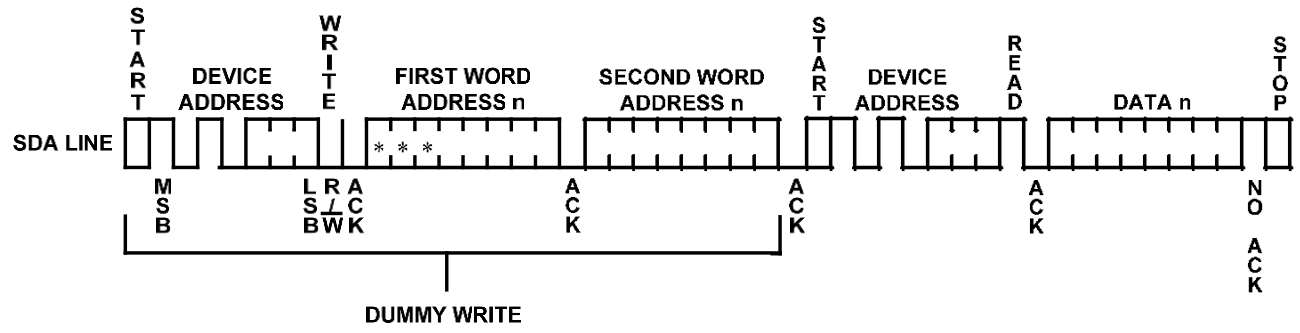
Figure 8. Page Write



Note: 1. * = *Don't CARE* bits

Figure 9. Current Address Read





Note: 1. * = *Don't CARE* bits.

Figure 11. Sequential Read

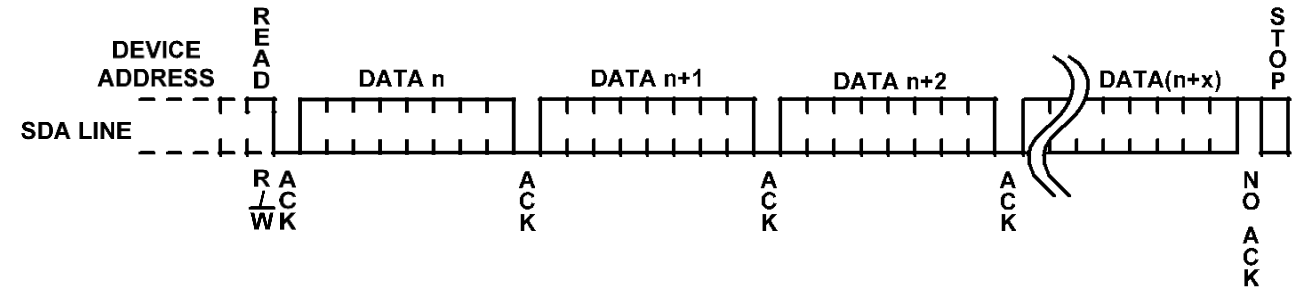
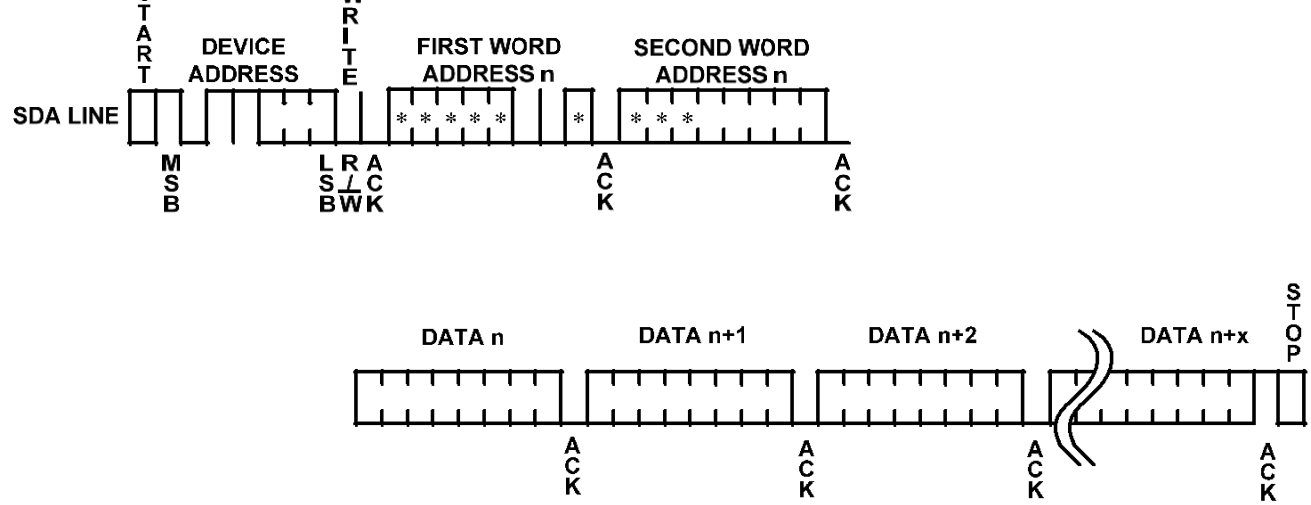
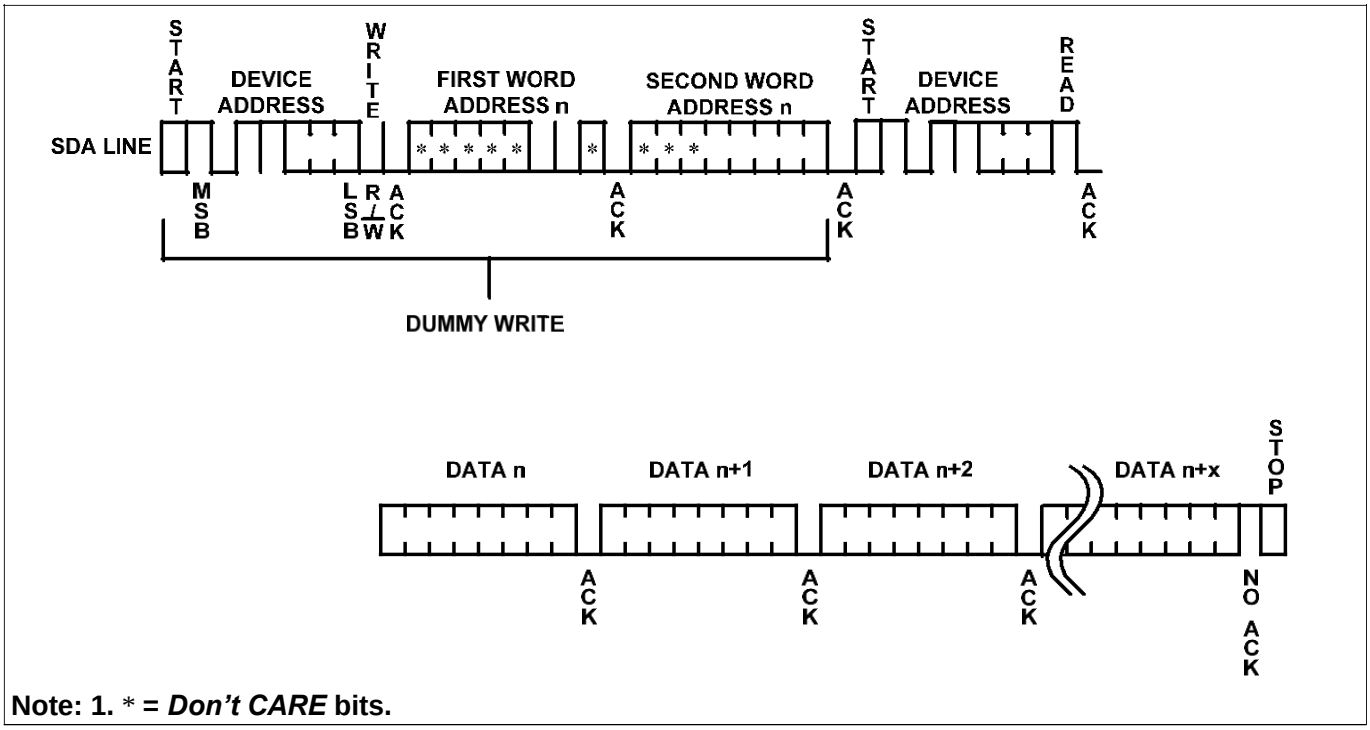


Figure 12. Write Security Sector



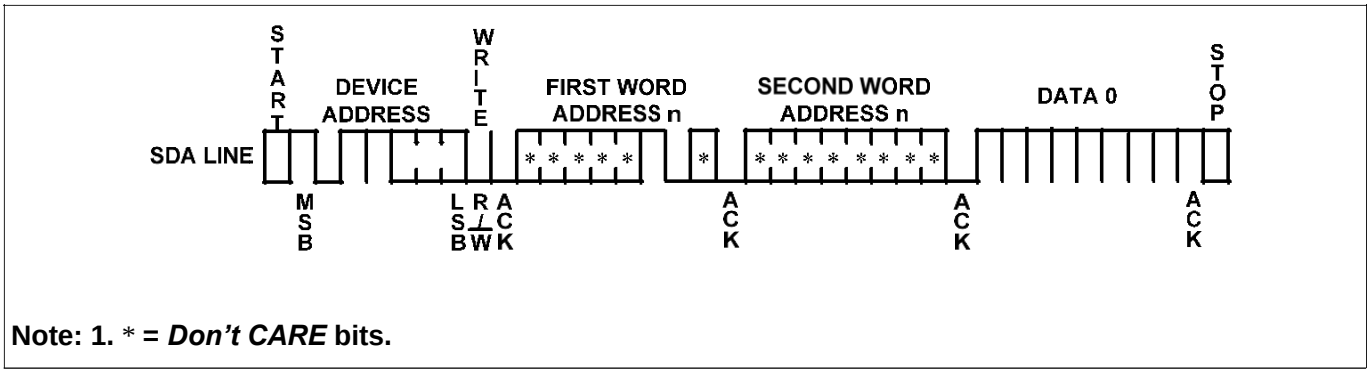
Note: 1. * = *Don't CARE* bits.

Figure 13. Read Security Sector

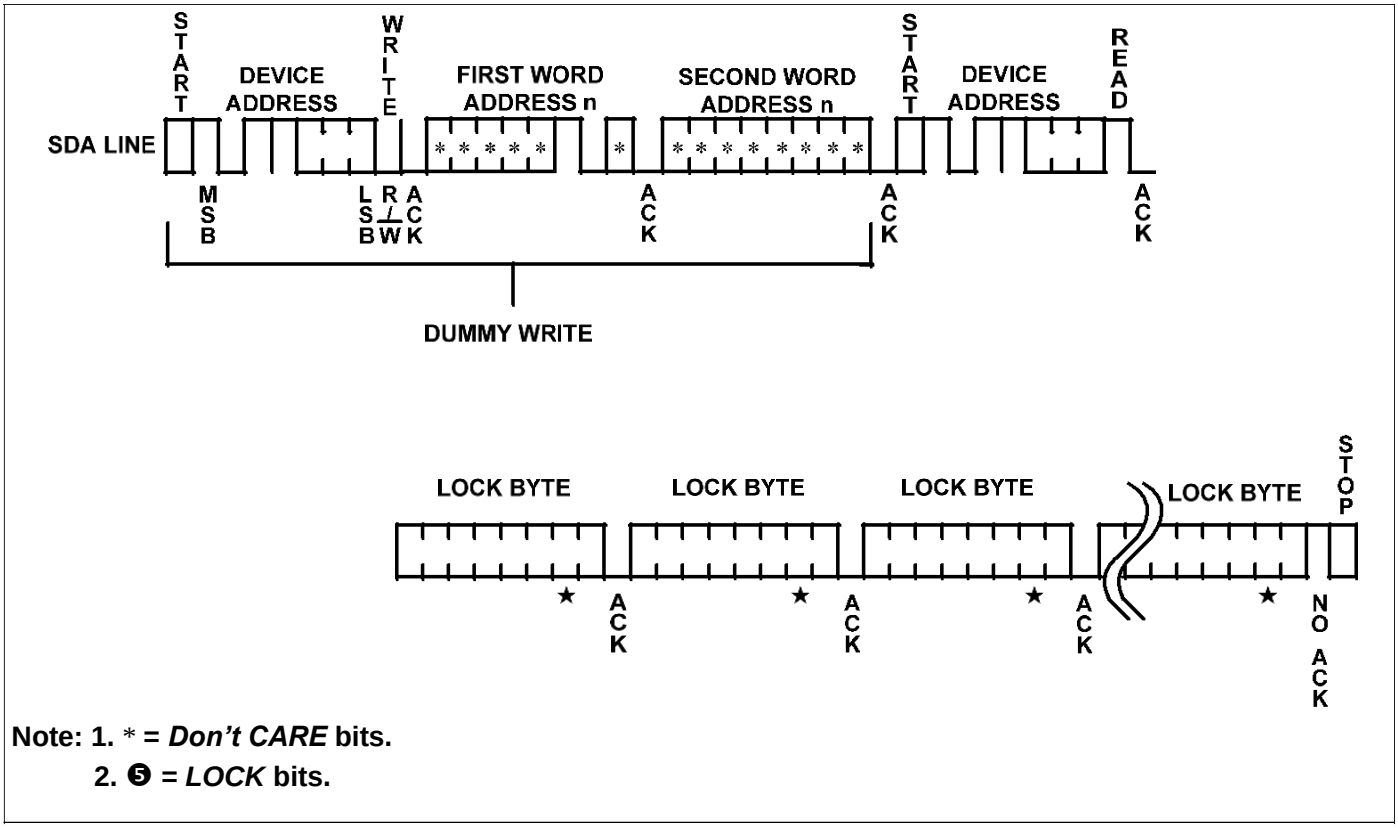


Note: 1. * = ***Don't CARE*** bits.

Figure 14. Lock Security Sector



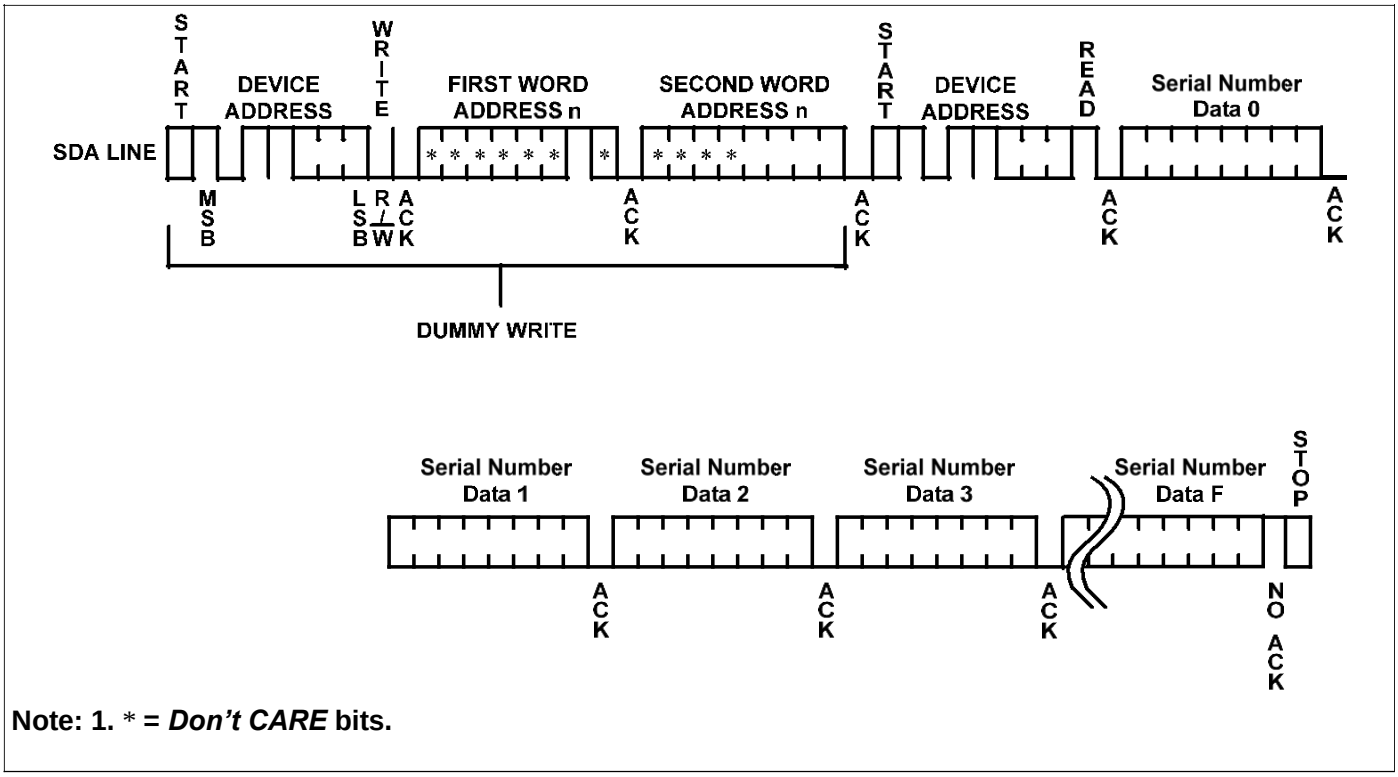
Note: 1. * = ***Don't CARE*** bits.



Note: 1. * = *Don't CARE* bits.

2. ❺ = *LOCK* bits.

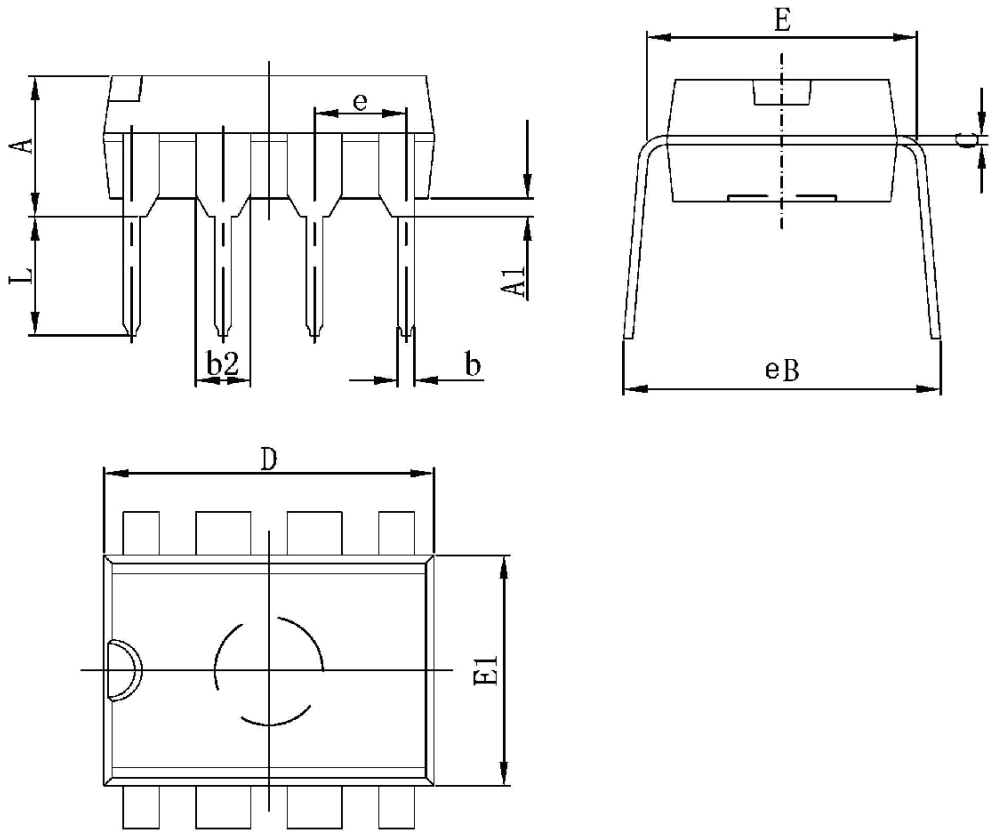
Figure 16. Read Unique ID



Note: 1. * = *Don't CARE* bits.

Packaging Information

PDIP 8

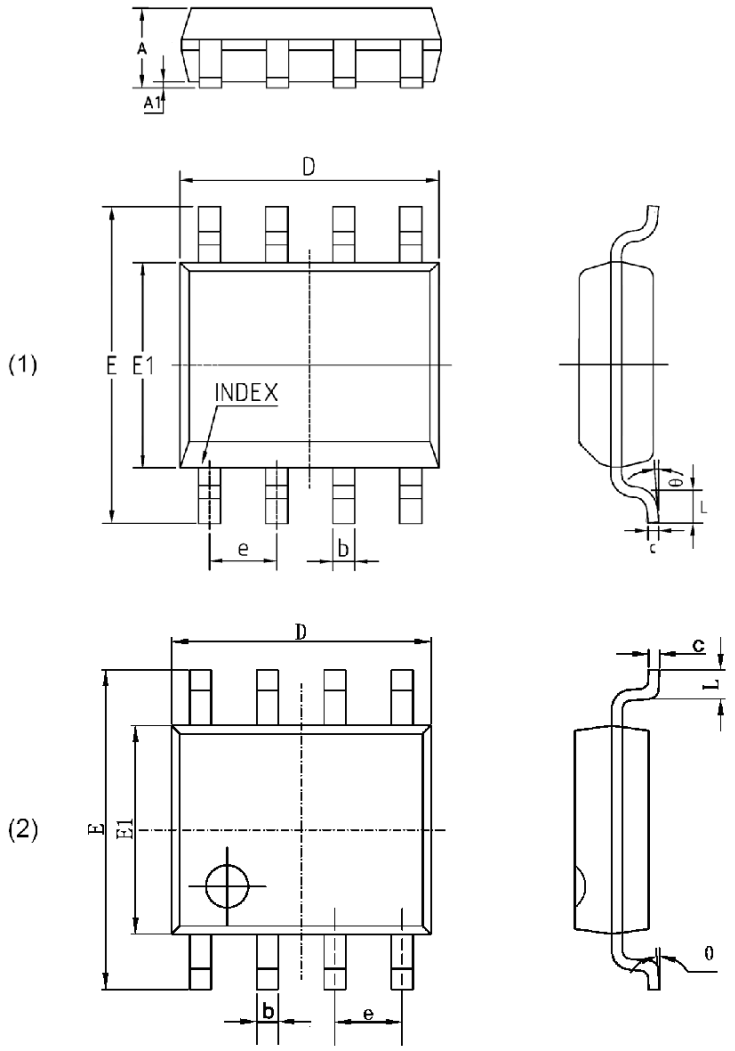


Symbol	MIN	MAX
A	---	5.000
A1	0.380	---
b	0.380	0.570
b2	1.300	1.700
C	0.200	0.360
D	9.000	10.000
E1	6.100	7.000
E	7.320	8.250
e	2.540(BSC)	
L	2.920	3.810
eB	---	10.900

NOTE:

1. Dimensions are in Millimeters.

SOP 8

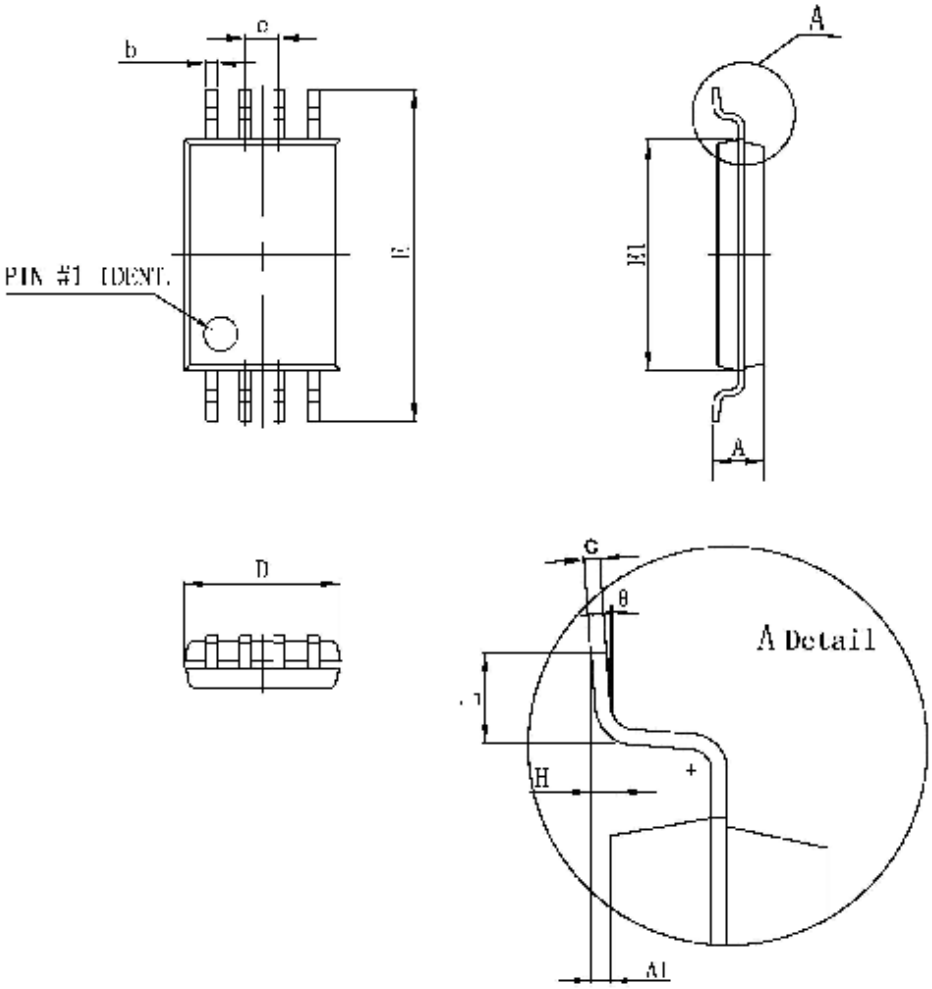


Symbol	MIN	MAX
A	1.350	1.750
A1	0.050	0.250
b	0.330	0.510
c	0.150	0.250
D	4.700	5.150
E1	3.800	4.000
E	5.800	6.200
e	1.270(BSC)	
L	0.400	1.270
θ	0°	8°

NOTE:

1. Dimensions are in Millimeters.

TSSOP8

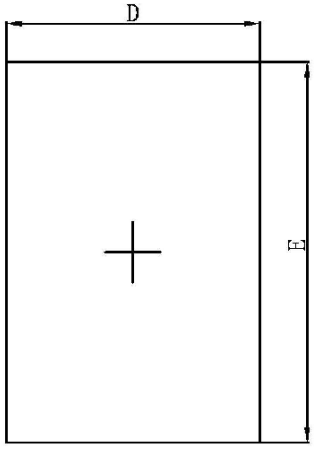


Symbol	MIN	MAX
D	2.900	3.100
E1	4.300	4.500
b	0.190	0.300
c	0.090	0.200
E	6.250	6.550
A		1.200
A1	0.050	0.150
e	0.650 (BSC)	
L	0.450	0.750
θ	0°	8°

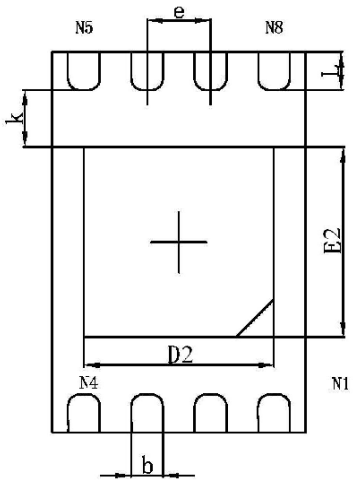
NOTE:

1. **Dimensions are in Millimeters.**

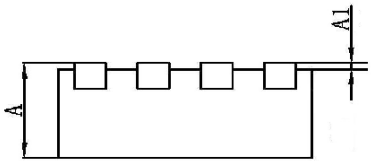
TDFN8 (2x3mm)



Top View



Bottom View



Side View

Symbol	MIN	MAX
A	0.700	0.800
A1	0.000	0.050
D	1.900	2.100
E	2.900	3.100
D2	1.400	1.600
E2	1.400	1.600
k	0.200(MIN)	
b	0.200	0.300
e	0.500(TYP)	
L	0.200	0.400

NOTE:

1. **Dimensions are in Millimeters.**