

钍地半导体
Tudi Semiconductor

Product Specification

TUDI-AT24C16C

I²C-Compatible, (2-Wire) Serial EEPROM
16-Kbit (2048 x 8)

网址 www.sztdbdt.com

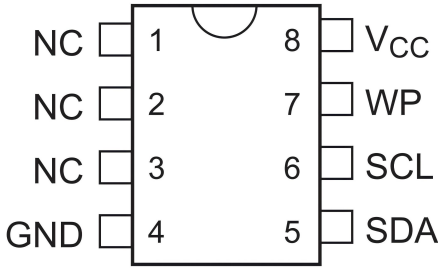
用芯智造·卓越品质

semiconductor device manufacturer

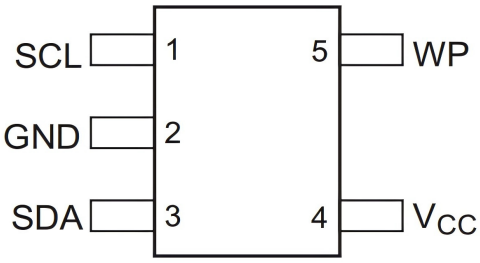
- Design
- research and development
- production
- and sales

Features

- Low-voltage and standard-voltage operation
- V_{CC} = 1.7V to 5.5V
- Internally organized as 2,048 x 8 (16K)
- I 2 C-compatible (2-wire) serial interface
- Schmitt Trigger, filtered inputs for noise suppression
- Bidirectional data transfer protocol
- 1MHz (2.5V, 2.7V, 5V), 400kHz (1.7V) compatibility
- Write Protect pin for hardware data protection
- 16-byte Page Write mode
- Partial page writes allowed
- Self-timed write cycle (5ms max)
- High-reliability
- Endurance: 1,000,000 write cycles
- Data retention: 100 years
- Green package options (Pb/Halide-free/RoHS compliant)
- 8-lead PDIP, 8-lead SOIC, 8-lead TSSOP, 5-lead SOT23
- Die options: wafer form and tape and reel



SOP8/DIP8/TSSOP8



SOT23-5

Description

The AT24C16C provides 16,384 bits of Serial Electrically Erasable and Programmable Read-Only Memory (EEPROM) organized as 2,048 words of eight bits each. The device is optimized for use in many industrial and commercial applications where low-power and low-voltage operation are essential. AT24C16C is available in space-saving 8-lead PDIP, 8-lead JEDEC SOIC, 8-lead TSSOP, 5-lead SOT23 packages and is accessed via a 2-wire serial interface.

Table 1. Pin Configuration

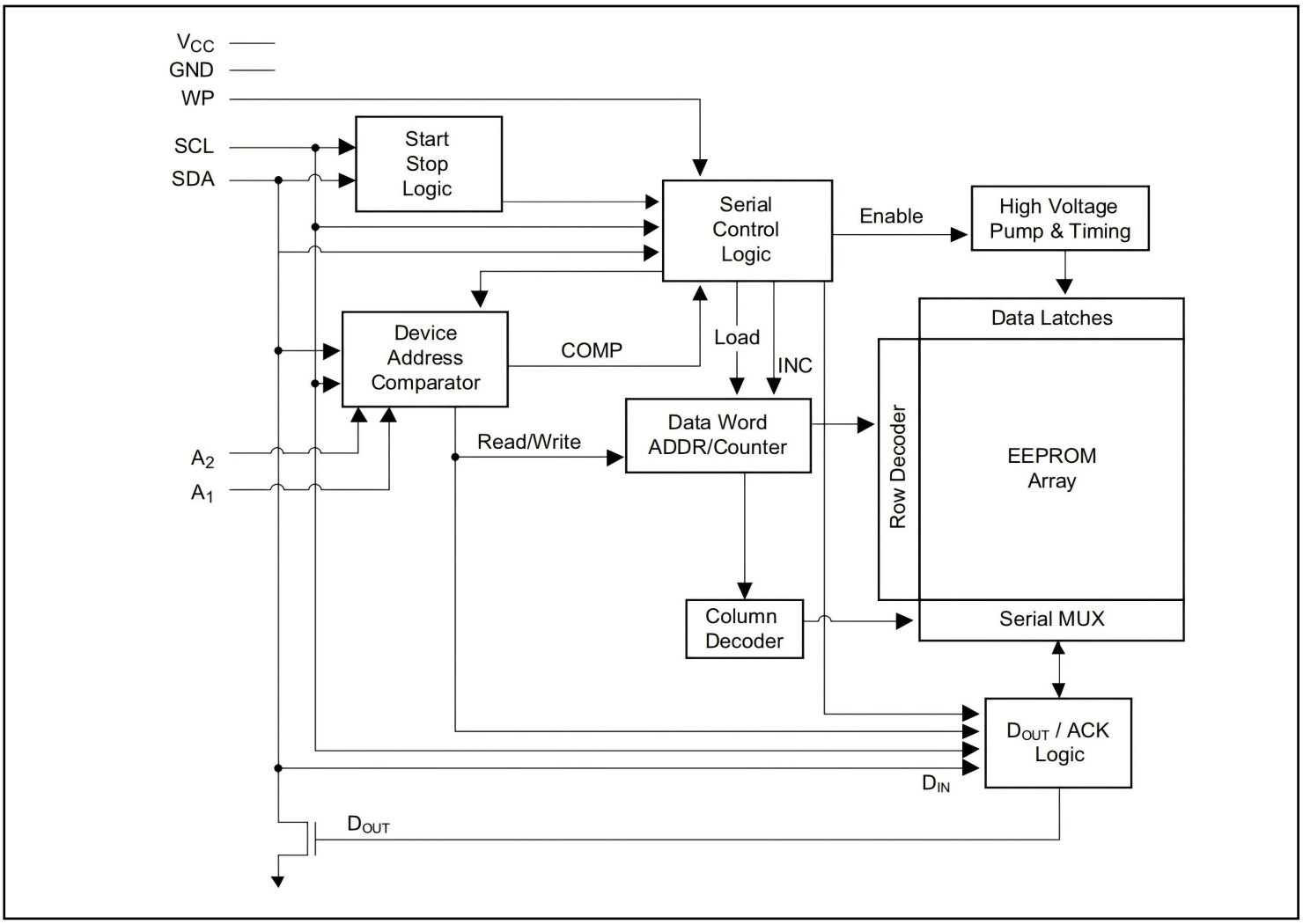
Pin Name	Function
NC	No Connect
SDA	Serial Data
SCL	Serial Clock Input
WP	Write Protect
GND	Ground
V_{CC}	Power Supply

Absolute Maximum Ratings

Operating Temperature . . . . . –55℃ to +125℃
Storage Temperature . . . . . –65℃ to +150℃
Voltage on any pin
with respect to ground . . . . . –1.0V to +7.0V
Maximum Operating Voltage. 6.25V
DC Output Current. 5.0mA

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.

Block Diagram



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 bidirectional 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/Page Addresses: The AT24C16C does not use the device address pins, which limits the number of devices on a single bus to one (see “ Device Addressing ”).
Write Protect (WP): AT24C16C has a Write Protect pin that provides hardware data protection. The Write Protect pin allows normal Read/Write operations when connected to Ground (GND). When the Write Protect pin is connected to Vcc, the Write Protection feature is enabled and operates as shown in Table 2.

Table 2. Write Protect

WP Pin Status	Part of the Array Protected
	AT24C16C
At V_{CC}	Full Array
At GND	Normal Read/Write Operations

Memory Organization

AT24C16C, 16K Serial EEPROM: Internally organized with 128 pages of 16 bytes each, the 16K requires a 11-bit data word address for random word addressing.

Table 3 Pin Capacitance(1)

Applicable over recommended operating range from T_A = 25°C, f = 1.0MHz, V_{CC} = 5.5V.

Symbol	Test Condition	Max	Units	Conditions
$C_{I/O}$	Input/Output capacitance (SDA)	8	pF	$V_{I/O}$=0V
C_{IN}	Input capacitance (A_0,A_1,A_2,SCL)	6	pF	V_{IN}=0V

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

Table 4. DC Characteristics

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

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
V_{CC1}	Supply Voltage		1.7		5.5	V
I_{CC}	Supply Current V_{CC}=5.0V	Read at 100kHz		0.4	1.0	mA
I_{CC}	Supply Current V_{CC}=5.0V	Write at 100kHz		2.0	3.0	mA
I_{SB1}	Standby Current V_{CC}=1.7V	V_{IN}=V_{CC} or V_{SS}			1.0	μ A
I_{SB2}	Standby Current V_{CC}=5.5V	V_{IN}=V_{CC} or V_{SS}			6.0	μA
I_{LI}	Input Leakage Current	V_{IN}=V_{CC} or V_{SS}		0.10	3.0	μA
I_{LO}	Output Leakage Current	V_{OUT}=V_{CC} or V_{SS}		0.05	3.0	μA

DC Characteristics (Continued)

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

Symbol	Parameter	Test Condition	Min	Typ	Max	Units
V_{IL}	Input Low Level(1)		-0.6		V_{cc}×0.3	V
V_{IH}	Input High Level(1)		V_{cc}×0.7		V_{cc}+0.5	V
V_{OL2}	Output Low Level V_{cc}=3.0V	I_{OL}=2.1mA			0.4	V
V_{OL1}	Output Low Level V_{cc}=1.7V	I_{OL}=0.15mA			0.2	V

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

Table 5. AC Characteristics

Applicable over recommended operating range from T_{AI} = -40℃ to 85℃, V_{CC} = +1.7V to 5.5V, CL = 1TTL Gate and 100pF (unless otherwise noted).

Symbol	Parameter	1.7V		2.5V,2.7V,5.0V		Units
		Min	Max	Min	Max	
f_{scl}	Clock Frequency,SCL		400		1000	kHz
t_{low}	Clock Pulse Width Low	1.2		0.4		μs
t_{HIGH}	Clock Pulse Width High	0.6		0.4		μs
t_I	Noise Suppression Time		100		50	ns
t_{AA}	Clock Low to Data Out Valid	0.1	0.9	0.05	0.55	μs
t_{BUF}	Time the bus must be free before a new transmission can start.	1.2		0.5		μs
$t_{HD.STA}$	Start Condition Hold Time	0.6		0.25		μs
$t_{SU.STA}$	Start Condition Setup Time	0.6		0.25		μs
$t_{HD.DAT}$	Data In Hold Time	0		0		μs
$t_{SU.DAT}$	Data In Setup Time	100		100		ns
t_R	Inputs Rise Time(1)		0.3		0.3	μS
t_F	Inputs Fall Time(1)		300		100	ns
$t_{SU.STO}$	Stop Condition Setup Time	0.6		.25		μS

AC Characteristics (Continued)

Symbol	Parameter	1.7V		2.5V,2.7V,5.0V		Units
		Min	Max	Min	Max	
t_{WR}	Write Cycle Time		5		5	ms
Endurance(1)	3.3V,25℃，Page Mode	1,000,000				Write Cycles

Note: 1. This parameter is ensured by characterization only.

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 (see 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 (see Figure 5).
Stop Condition: A low-to-high transition of SDA with SCL high is a Stop Condition. After a read sequence, the Stop Condition command will place the EEPROM in a standby power mode (see Figure 5).
Acknowledge: All addresses and data words are serially transmitted to and from the EEPROM in eight bit words. The EEPROM sends a zero to acknowledge that it has received each word. This happens during the ninth clock cycle.
Standby Mode: The AT24C16C features a low-power standby mode which is enabled:

- Upon power-up.
- After the receipt of the Stop Condition and the completion of any internal operations.

2-wire Software Reset: After an interruption in protocol, power loss or system reset, any 2-wire part can be reset by following these steps:
1. Create a Start Condition,
2. Clock nine cycles,
3. Create another Start Condition followed by Stop Condition as shown below. The device is ready for next communication after above steps have been completed.

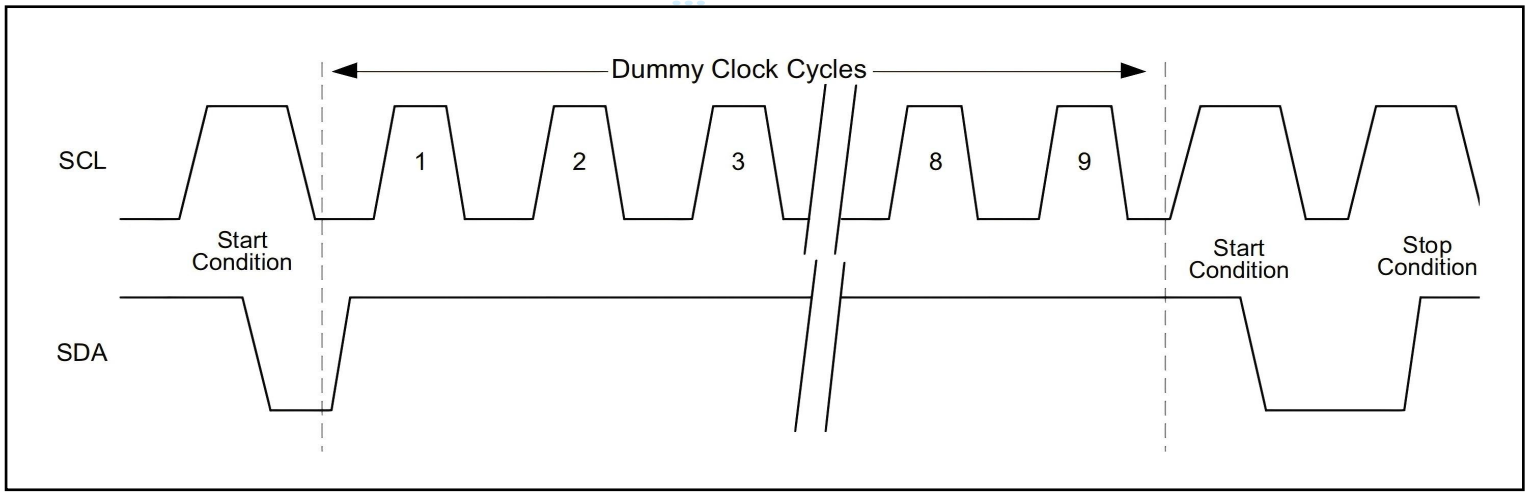


Figure 1. Software Reset

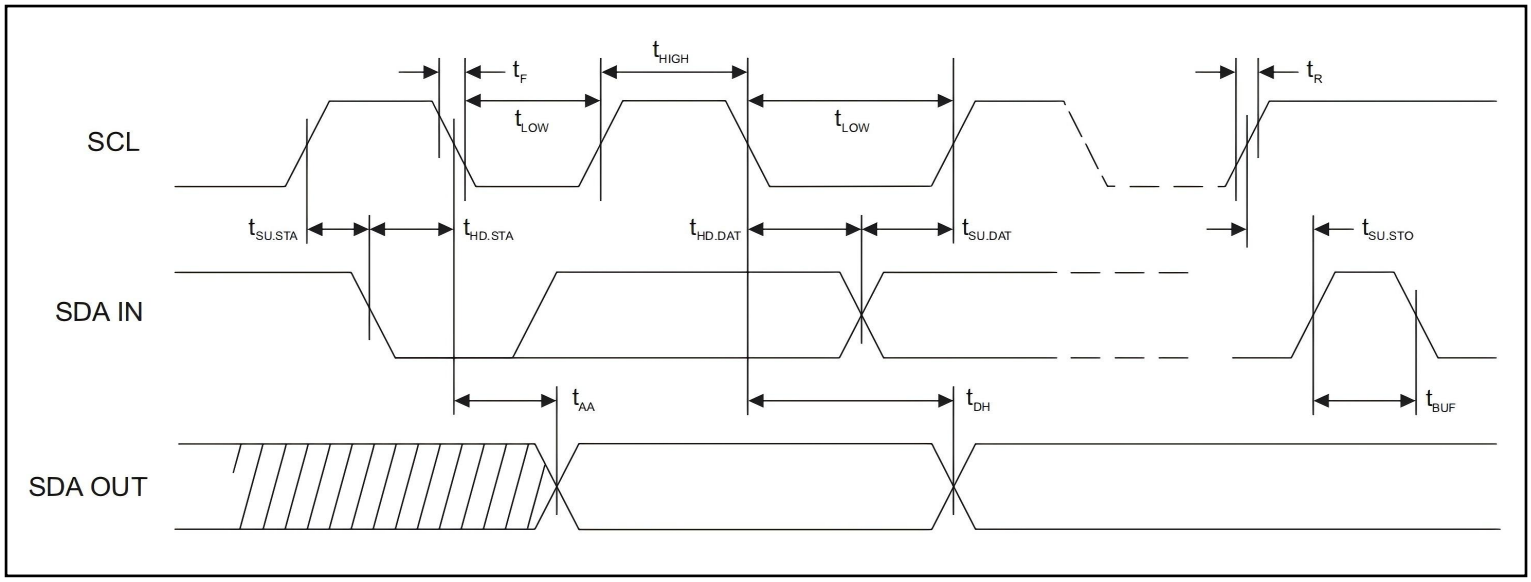


Figure 2. Bus Timing

SCL: Serial Clock, SDA: Serial Data I/O

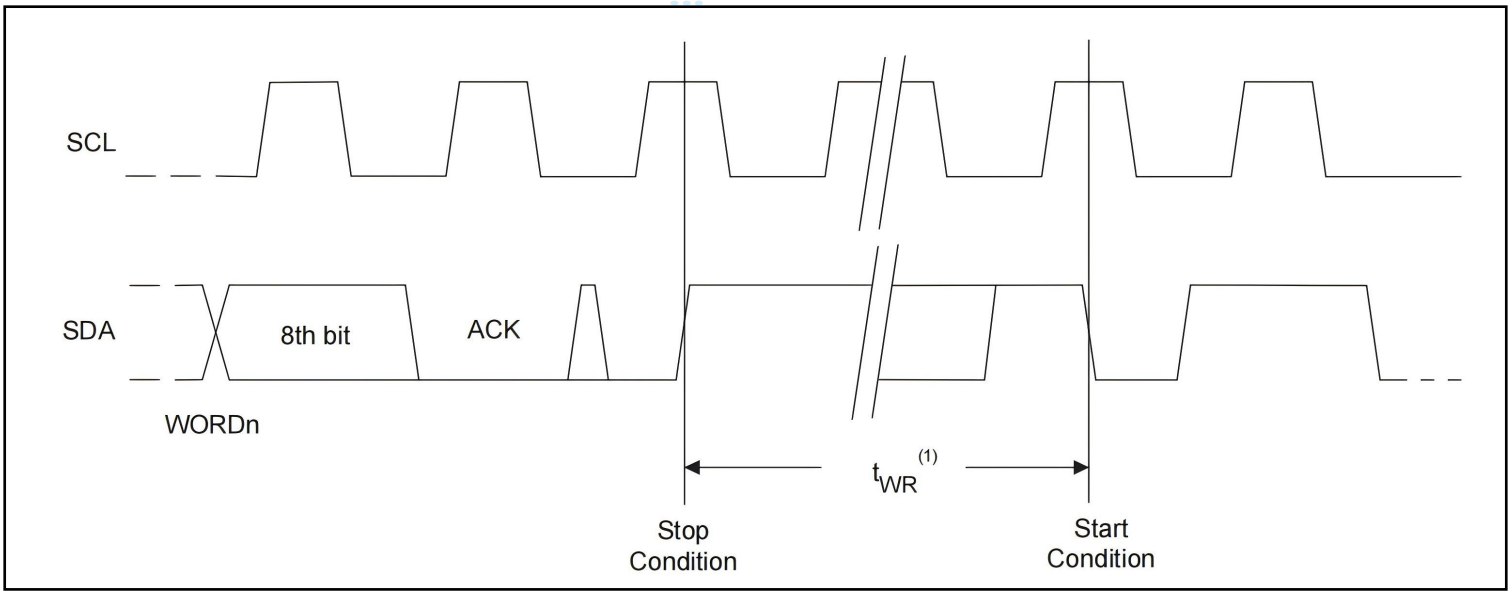


Figure 3. Write Cycle Timing

SCL: Serial Clock, SDA: Serial Data I/O

Notes: 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.

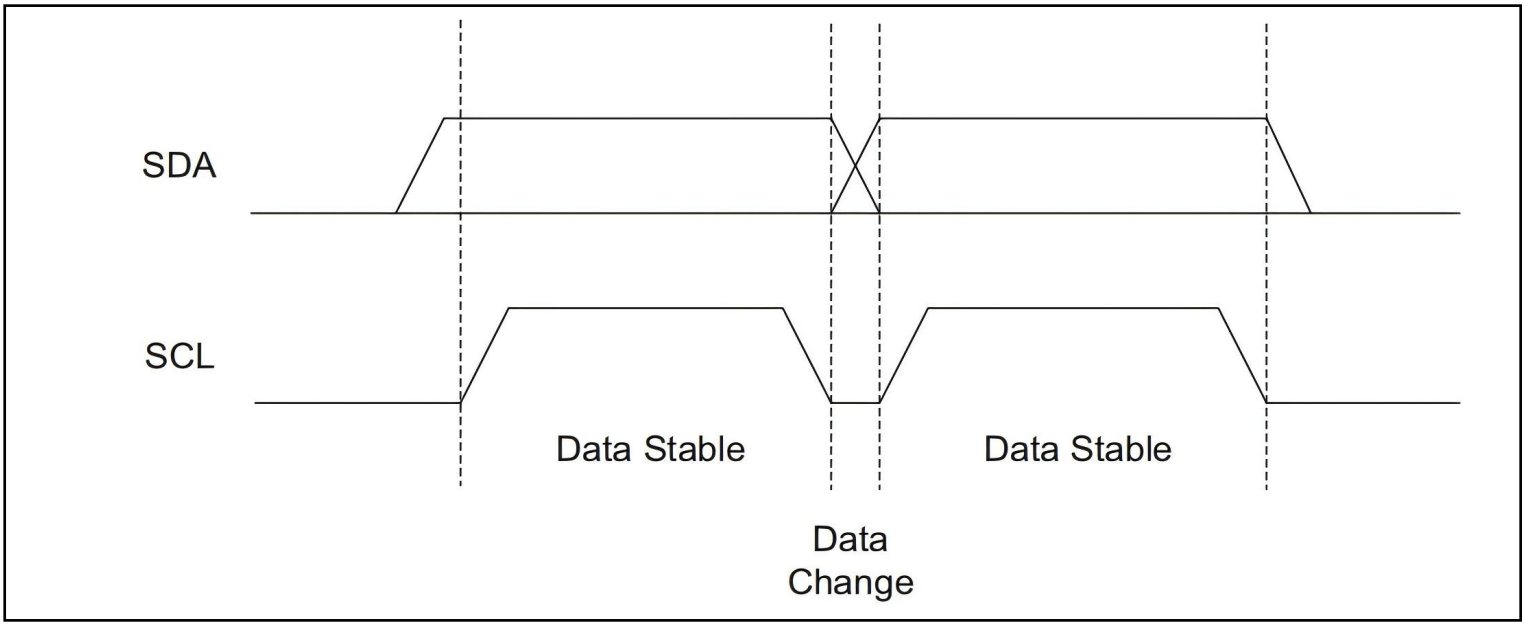


Figure 4. Data Validity

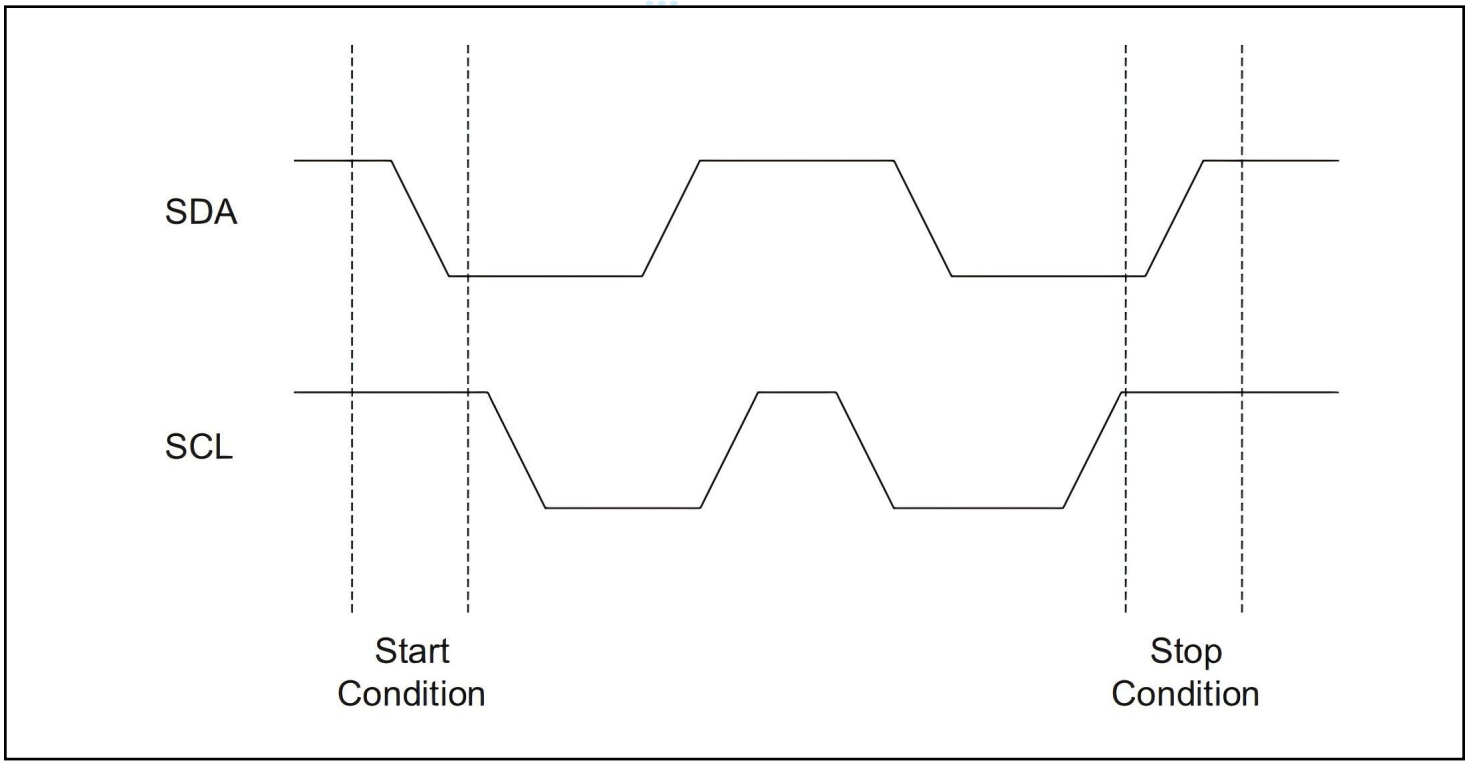


Figure 5. Start Condition and Stop Condition Definition

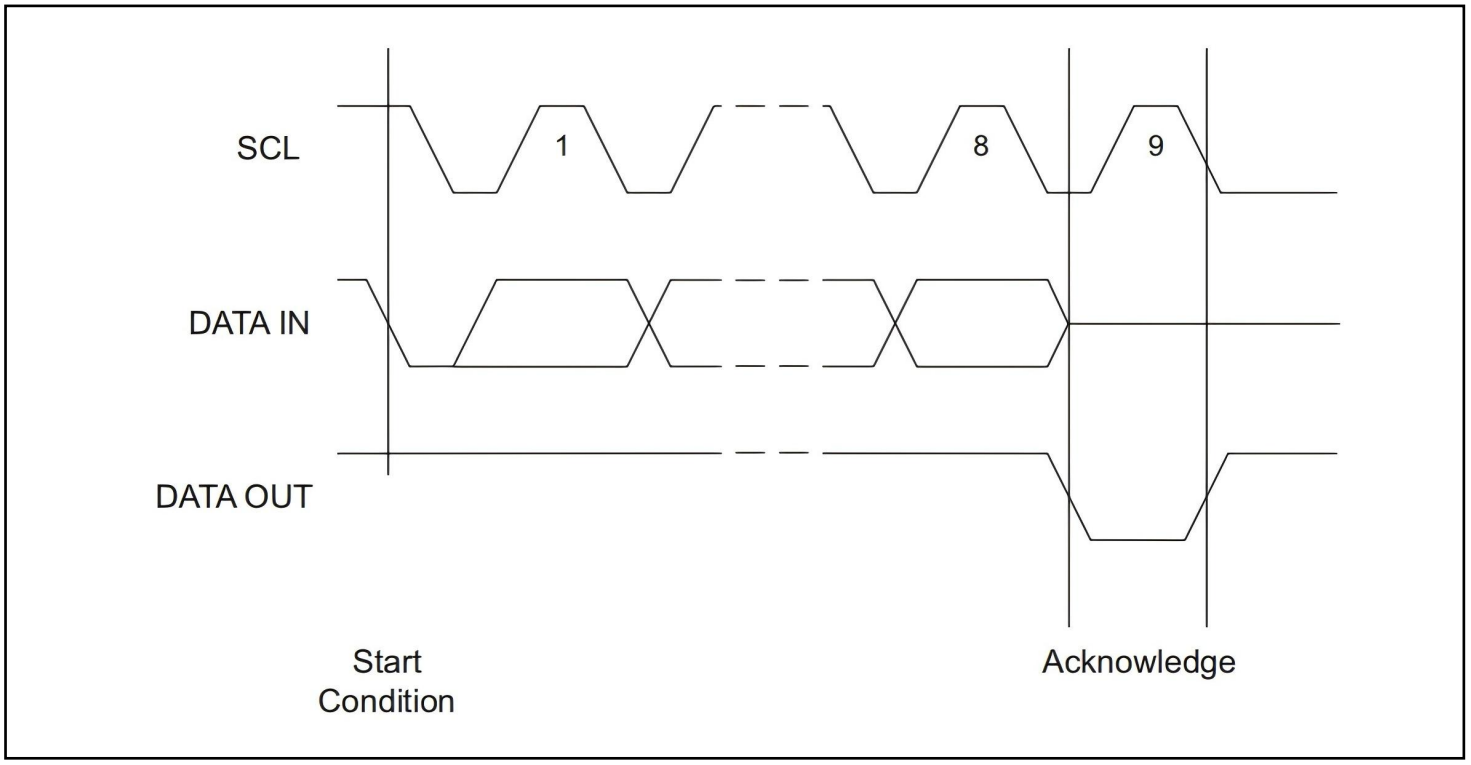


Figure 6. Output Acknowledge

Device Addressing

Standard EEPROM Access: The 16K EEPROM device requires an 8-bit device address word following a Start Condition to enable the chip for a Read or Write operation. The device address word consists of a mandatory “1010” (Ah) sequence for the first four Most Significant Bits (MSB). This is common to all the EEPROM devices.
The next three bits used for memory page addressing are the most significant bits of the data word address which follows.
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 chip will return to a standby state.

Density	Access Area	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
16K	EEPROM	1	0	1	0	P2	P1	P0	R/$\overline{W}$
		MSB							LSB

Figure 6. Device Address

Write Operations

Byte Write: A Write operation requires an 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).

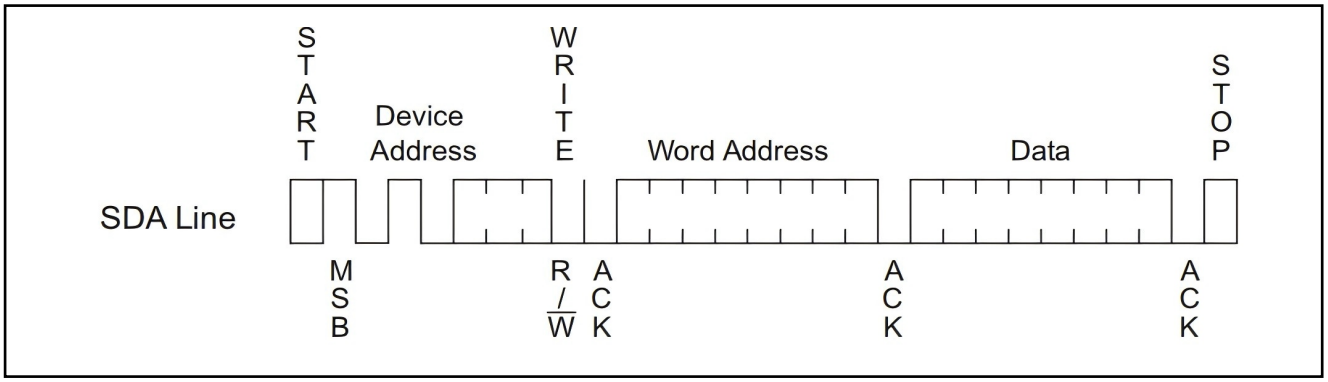


Figure 7. Byte Write

Page Write: The 16K EEPROM devices are capable of a 16-byte Page Write. A Page Write is initiated in 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 fifteen 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).

The data word address lower four 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 eight data words are transmitted to the EEPROM, the data word address will roll-over and previous data will be overwritten.

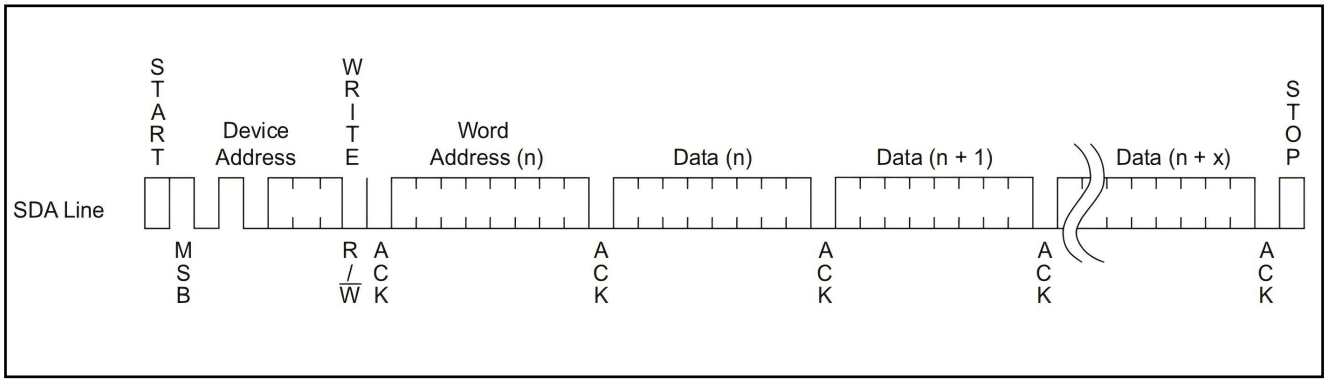


Figure 8. Page Write

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.

Read Operations

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

- Current Address Read
- Random Address Read
- Sequential Read.

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).

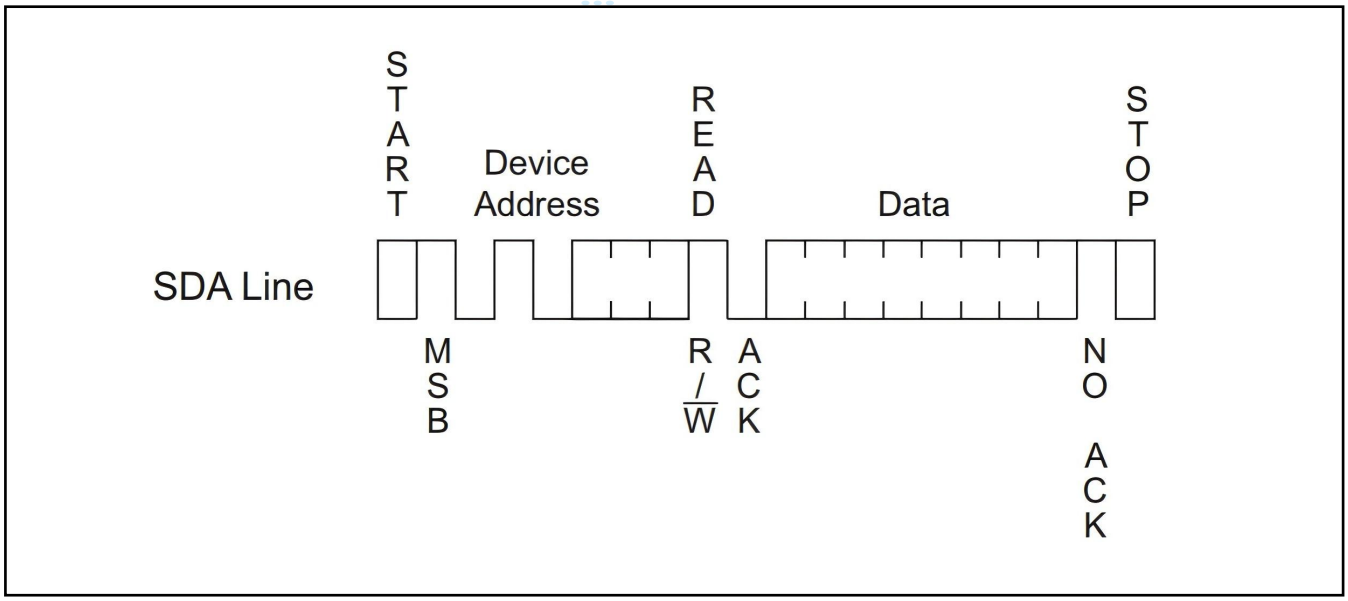


Figure 9. Current Address Read

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).

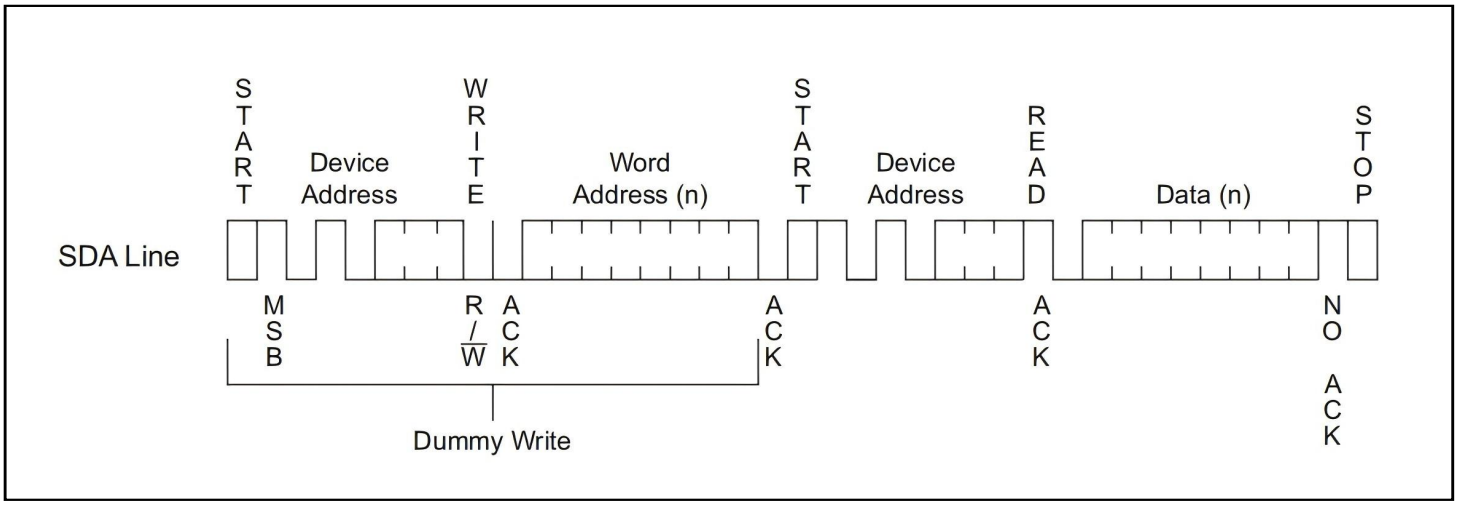


Figure 10. Random Read

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 Figure11).

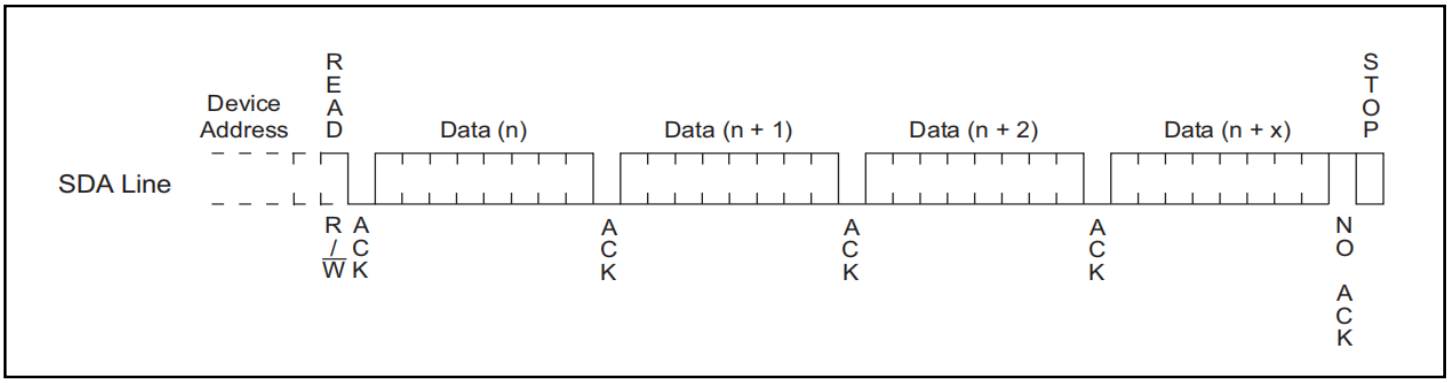


Figure 11. Sequential Read

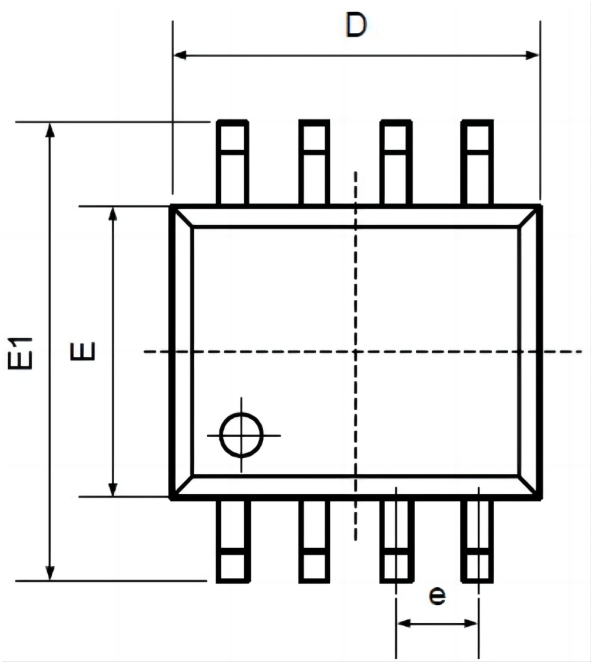
Order information

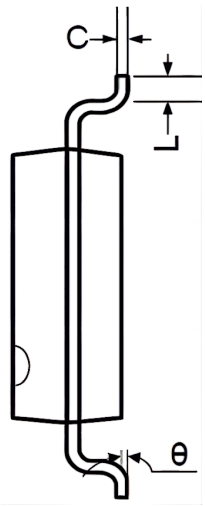
Order Number	Package	Package Quantity	Marking On The park	Temperature
AT24C16C-SSHM-T-TUDI	SOP8	Tape,Reel,4000	16CM	-40℃ to 85℃
AT24C16C-XHM-T-TUDI	TSSOP8	Tape,Reel,4000	24C16C	
			16CM	
AT24C16C-STUM-T-TUDI	SOT23	Tape,Reel,3000	24C16C	
			16CMU	
AT24C16C-PUM-TUDI	DIP8	Tube,50,A box of 2000	24C16C	
			16CM	

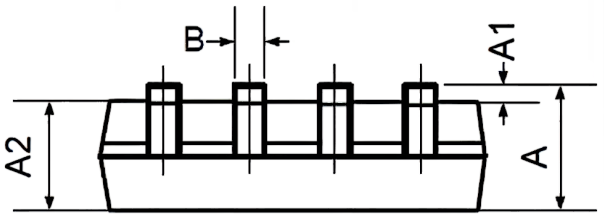
Revision history

	Date	Revision	Page
V1.0	2022/5	New	1-18
V1.1	2025/1	Update model and PDF template	1-20

Package SOP8

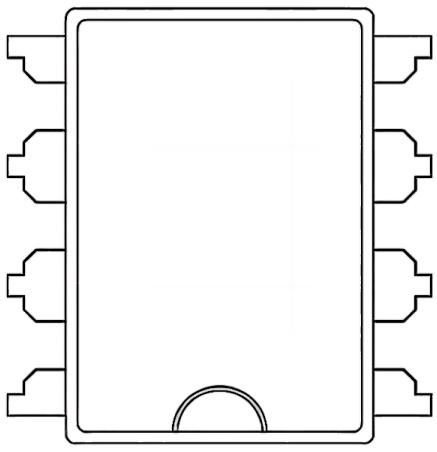


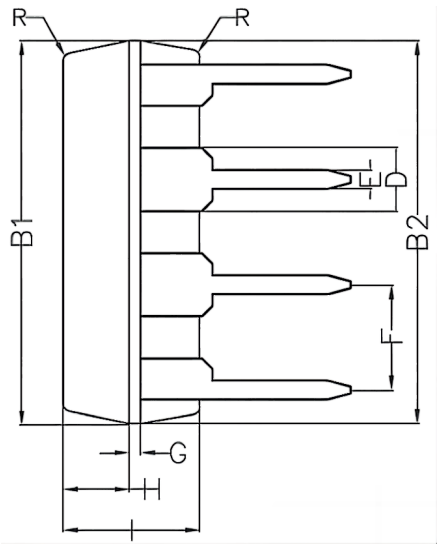


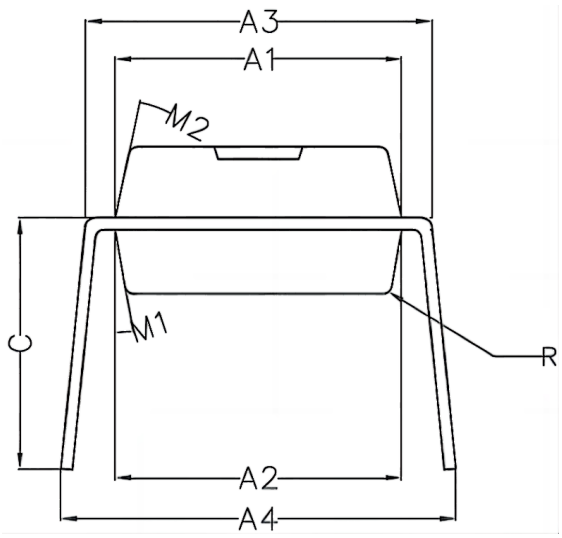


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Package DIP8

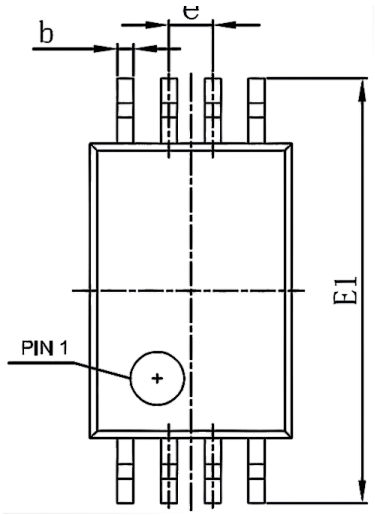


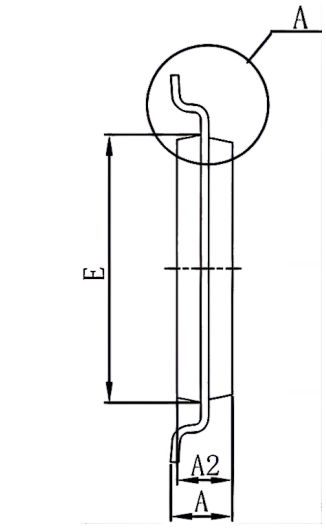


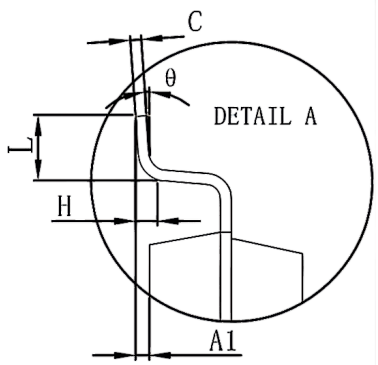


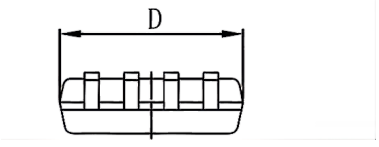
Symbol	Min	Non	Max
A1	6.28	6.33	6.38
A2	6.33	6.38	6.43
A3	7.52	7.62	7.72
A4	7.80	8.40	9.00
B1	9.15	9.20	9.25
B2	9.20	9.25	9.30
C		5.57	
D		1.52	
E	0.43	0.45	0.47
F		2.54	
G		0.25	
H	1.54	1.59	1.64
工	3.22	3.27	3.32
R		0.20	
M1	9°	10°	11°
M2	11°	12°	13°

Package TSSOP8



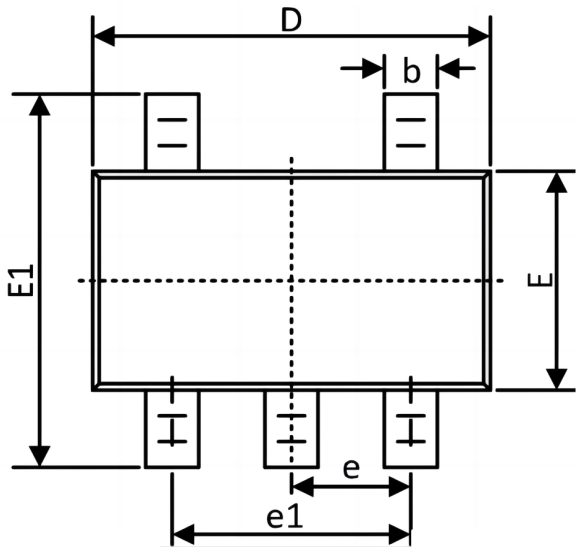


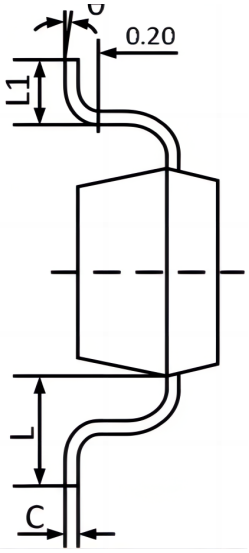


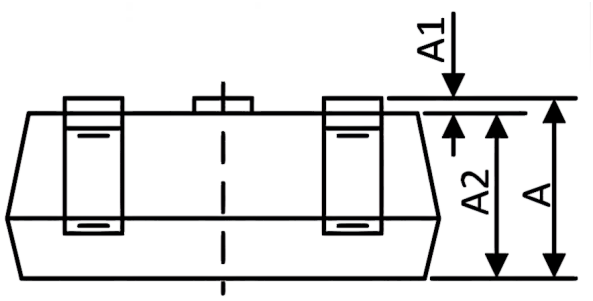


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
C	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.65(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°		1°	

Package SOT23-5







Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
C	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

Important statement:

●TUDI Semiconductor reserves the right to modify the product manual without prior notice! Before placing an order, customers need to confirm whether the obtained information is the latest version and verify the completeness of the relevant information.

●Any semi-guide product is subject to failure or malfunction under specified conditions. It is the buyer's responsibility to comply with safety standards when using TUDI Semiconductor products for system design and whole machine manufacturing.And take the appropriate safety measures to avoid the potential in the risk of loss of personal injury or loss of property situation!

●TUDI Semiconductor products have not been licensed for life support, military, and aerospace applications,and therefore TUDI Semiconductor is not responsible for any consequences arising from the use of this product in these areas.

●If any or all TUDI Semiconductor products (including technical data, services) described or contained in this document are subject to any applicable local export control laws and regulations, they may not be exported without an export license from the relevant authorities in accordance with such laws.

●The specifications of any and all TUDI Semiconductor products described or contained in this document specify the performance, characteristics, and functionality of said products in their standalone state, but do not guarantee the performance, characteristics, and functionality of said products installed in Customer's products or equipment. In order to verify symptoms and conditions that cannot be evaluated in a standalone device, the Customer should ultimately evaluate and test the device installed in the Customer's product device.

●TUDI Semiconductor documentation is only allowed to be copied without any alteration of the content and with the relevant authorization.TUDI Semiconductor assumes no responsibility or liability for altered documents.

●TUDI Semiconductor is committed to becoming the preferred semiconductor brand for customers, and TUDI Semiconductor will strive to provide customers with better performance and better quallity products.