24C64
DATASHEET

Specification Revision History:

Version	Date	Description
V1.0	2022/09	New
V1.1	2024/05	Modify Ordering Information
V1.2	2025/02	Modify Ordering Information
V1.3	2025/03	Add application precautions and overall typesetting.

Features

- Two-Wire Serial Interface, I^2C^{TM} Compatible
  - Bi-directional data transfer protocol
- Wide-voltage Operation
  - V_{CC} =1.7V to 5.5V
- Speed:1 MHz (1.7V~5.5V)
- Standby current (max.): 1 μA, 5.5V
- Read current (max.): 0.5 mA, 5.5V
- Write current (max.): 0.8 mA, 5.5V
- Hardware Data Protection
  - Write Protect Pin
- Sequential & Random Read Features
- Memory organization: 64Kb (8,192 x 8)
- Page Size: 32 bytes
- Page write mode
- Partial page writes allowed
- Self-timed write cycle: 5 ms (max.)
- Noise immunity on inputs, besides Schmitt trigger
- High-reliability
  - Endurance: 1 million cycles
  - Data retention: 100 years
- ESD Protection > 4000V
- Industrial grade
- Packages: SOP, TSSOP, DIP, UDFN, MSOP and SOT23

General Description

The 24C64 is an industrial standard electrically erasable programmable read only memory (EEPROM) device that utilizes the industrial standard 2-wire interface for communications. The 24C64 contains a memory array of 64K bits (8,192x8), which is organized in 32-byte per page.

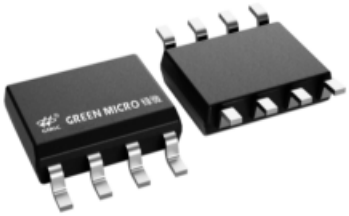
The EEPROM operates in a wide voltage range from 1.7V to 5.5V, which fits most application. The product provides low-power operations and low standby current. The device is offered in Lead-free, RoHS, halogen free or Green package. The available package types are 8-pin SOIC, TSSOP, PDIP, UDFN, MSOP and SOT23.

The 24C64 is compatible to the standard 2-wire bus protocol. The simple bus consists of Serial Clock (SCL) and Serial Data (SDA) signals. Utilizing such bus protocol, a Master device, such as a microcontroller, can usually control one or more Slave devices, alike this 24C64. The bit stream over the SDA line includes a series of bytes, which identifies a particular Slave device, an instruction, an address within that Slave device, and a series of data,

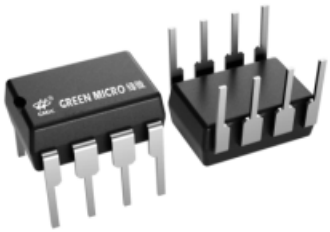
if appropriate. The 24C64 also has a Write Protect function via WP pin to cease from overwriting the data stored inside the memory array.

In order to refrain the state machine from entering into a wrong state during power-up sequence or a power toggle off-on condition, a power on reset circuit is embedded. During power-up, the device does not respond to any instructions until the supply voltage (Vcc) has reached an acceptable stable level above the reset threshold voltage. Once VCC passes the power on reset threshold, the device is reset and enters into the Standby mode. This would also avoid any inadvertent Write operations during power-up stage. During power-down process, the device will enter into standby mode, once VCC drops below the power on reset threshold voltage. In addition, the device will be in standby mode after receiving the Stop command, provided that no internal write operation is in progress. Nevertheless, it is illegal to send a command unless the VCC is within its operating level.

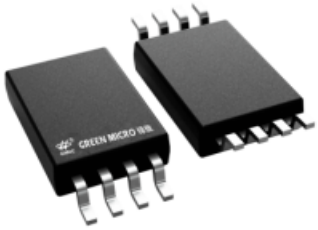
The appearance of the product



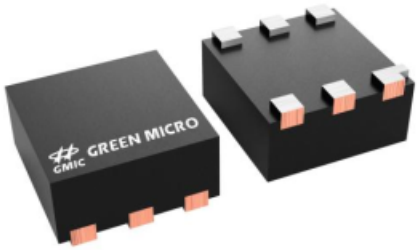
SOP-8



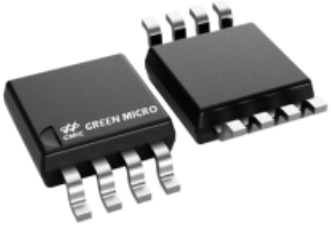
DIP-8



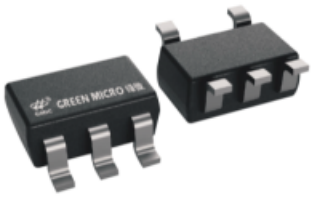
TSSOP-8



DNF-8



MSOP-8

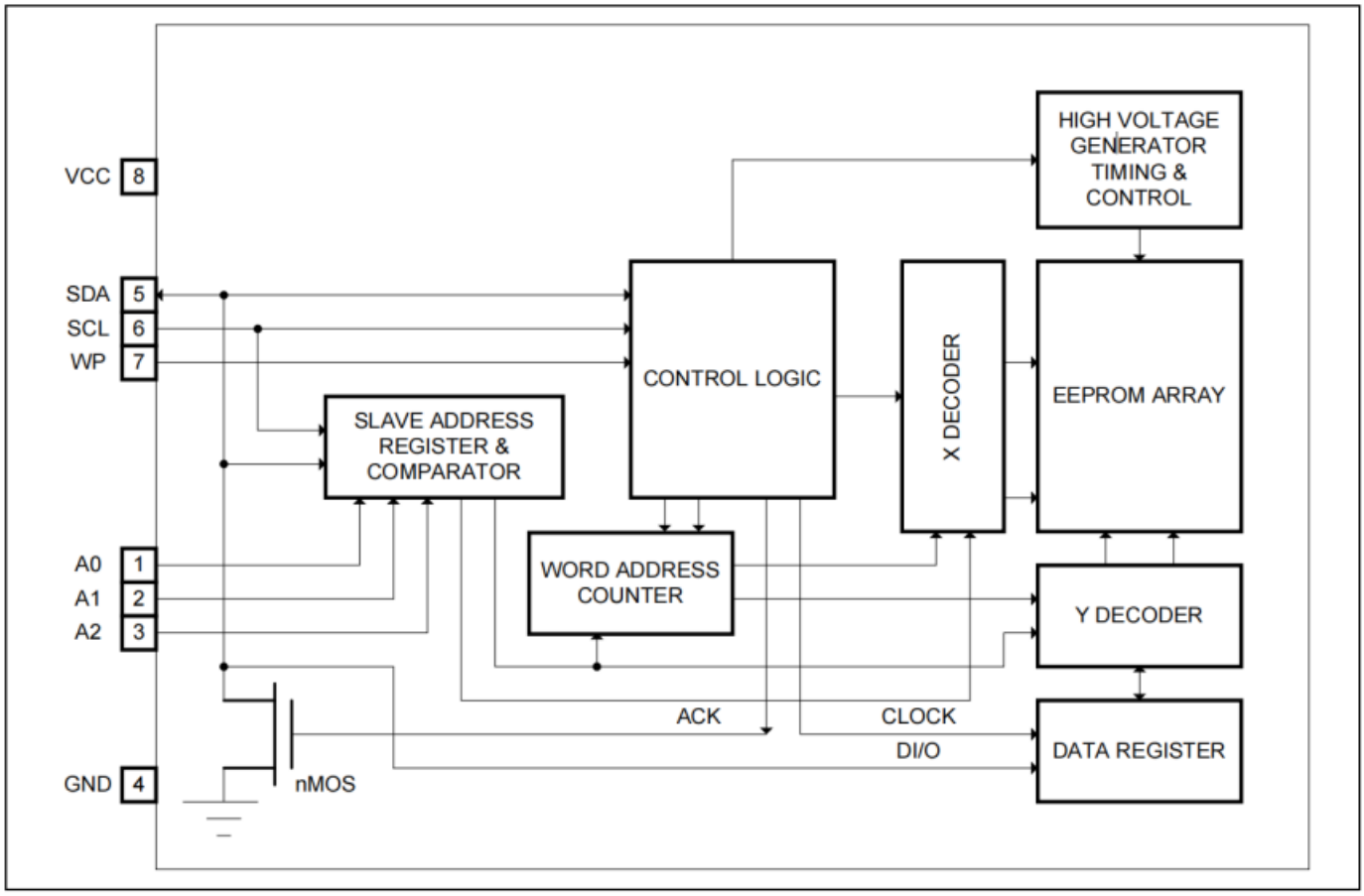


SOT23-5

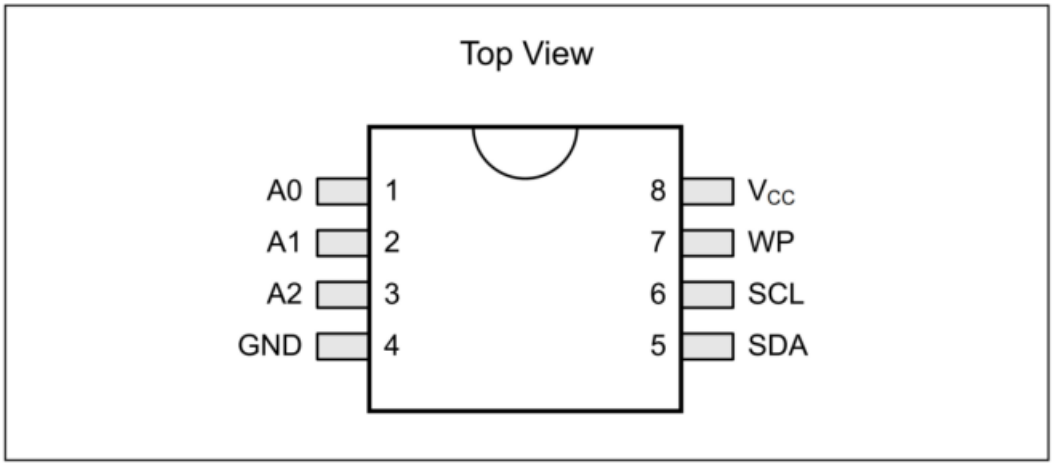
Ordering Information

Product Model	Package Type	Marking	Packing	Packing Qty
AT24C64CDR332	SOP-8	24C64 332	REEL	4000PCS/REEL
AT24C64CP332	DIP-8	24C64 332	TUBE	2000PCS/BOX
AT24C64CT332	TSSOP-8	24C64 332	REEL	3000PCS/REEL
AT24C64CS5332	SOT23-5	24C64 332	REEL	3000PCS/REEL
AT24C64CF332	DFN-8(3x3)	24C64 332	REEL	5000PCS/REEL
AT24C64CMDR332	MSOP-8	24C64 332	REEL	3000PCS/REEL
GM24C64CDR	SOP-8	24C64 32	REEL	4000PCS/REEL
GM24C64CP	DIP-8	24C64 32	TUBE	2000PCS/BOX
GM24C64CT	TSSOP-8	24C64 32	REEL	3000PCS/REEL
GM24C64CS5	SOT23-5	24C64 32	REEL	3000PCS/REEL
GM24C64CF	DFN-8(3x3)	24C64 32	REEL	5000PCS/REEL
GM24C64CMDR	MSOP-8	24C64 32	REEL	3000PCS/REEL

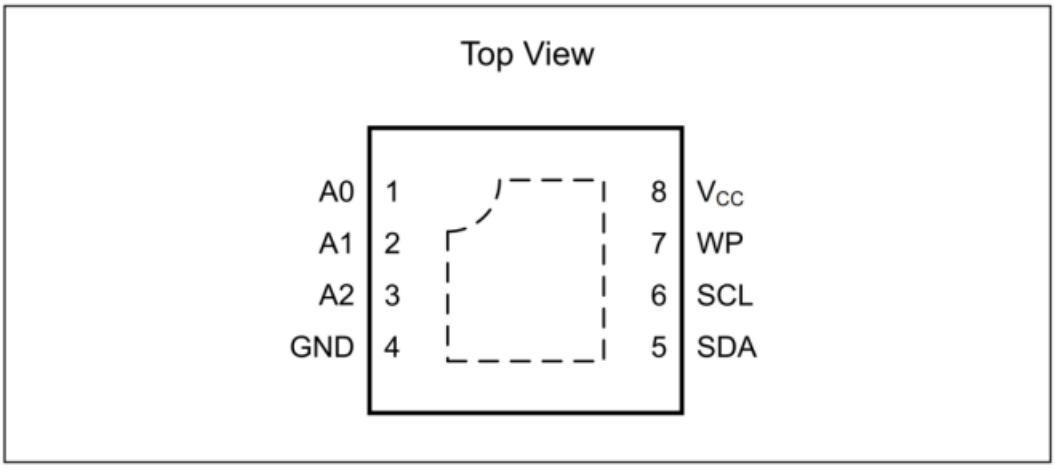
Functional Block Diagram



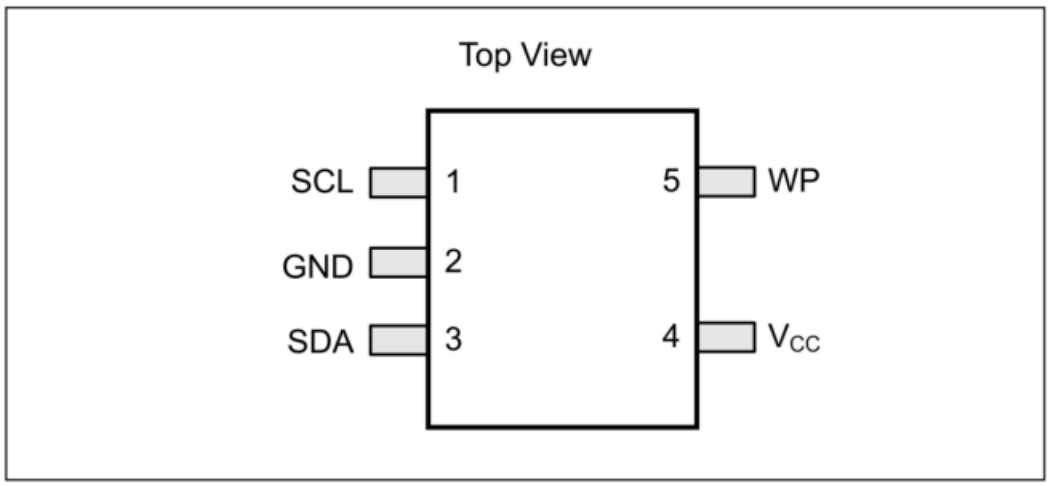
Pin Configuration



8-Pin SOIC, TSSOP, MSOP and PDIP



8-LeadUDFN



5-Lead SOT23

Pin Definition

Pin No.	Pin Name	I/O	Definition
1	A0	I	Device Address Input
2	A1	I	Device Address Input
3	A2	I	Device Address Input
4	GND	-	Ground
5	SDA	I/O	Serial Address, Data input and Data output
6	SCL	I	Serial Clock Input
7	WP	I	Write Protect Input
8	V_{CC}	-	Power Supply

Pin Descriptions

SCL

This input clock pin is used to synchronize the data transfer to and from the device.

SDA

The SDA is a bi-directional pin used to transfer addresses and data into and out of the device. The SDA pin is an open drain output and can be wired with other open drain or open collector outputs. However, the SDA pin requires a pull-up resistor connected to the power supply.

A0, A1, A2

The A0, A1 and A2 are the device address inputs.

Typically, the A0, A1, and A2 pins are for hardware addressing and a total of 8 devices can be connected on a single bus system. When A0, A1, and A2 are left floating, the inputs are defaulted to zero.

WP

WP is the Write Protect pin. While the WP pin is connected to the power supply of 24C64, the entire array becomes Write Protected (i.e. the device becomes Read only). When WP is tied to Ground or left floating, the normal write operations are allowed.

Note: WP cannot be powered on earlier than Vcc, and the amplitude of WP cannot be greater than Vcc

Vcc

Supply voltage

GND

Ground of supply voltage

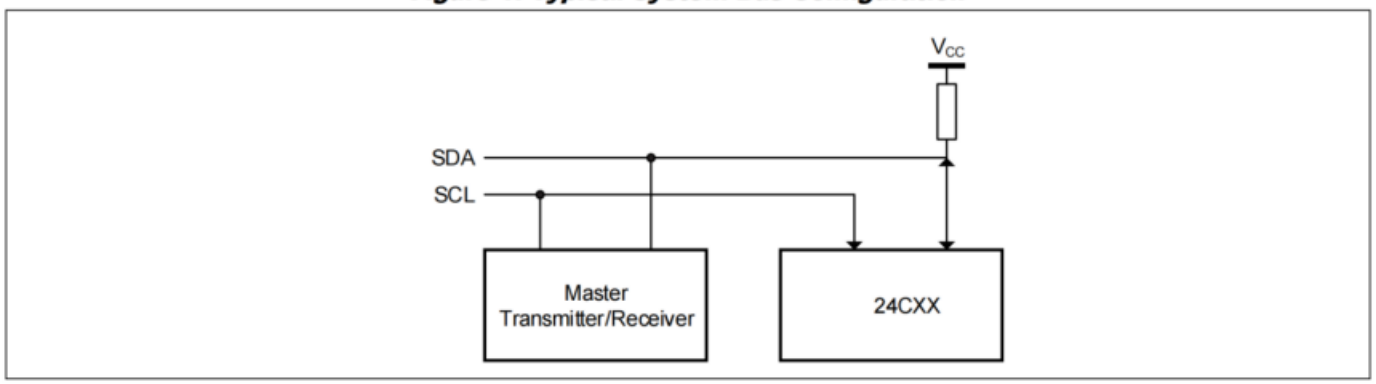
Device Operation

The 24C64 serial interface supports communications using industrial standard 2-wire bus protocol, such as I^2C.

2-WIRE Bus

The two-wire bus is defined as Serial Data (SDA), and Serial Clock (SCL). The protocol defines any device that sends data onto the SDA bus as a transmitter, and the receiving devices as receivers. The bus is controlled by Master device that generates the SCL, controls the bus access, and generates the Start and Stop conditions. The 24C64 is the Slave device.

Figure 1. Typical System Bus Configuration

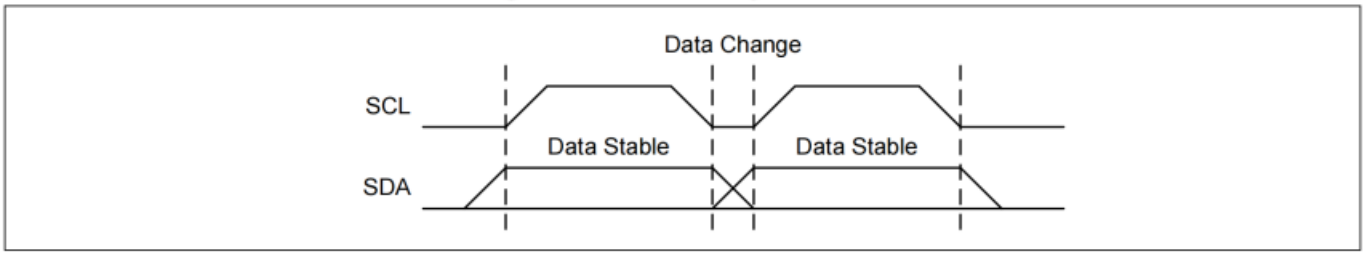


The Bus Protocol

Data transfer may be initiated only when the bus is not busy. During a data transfer, the SDA line must remain stable whenever the SCL line is high. Any changes in the SDA line while the SCL line is high will be interpreted as a Start or Stop condition.

The state of the SDA line represents valid data after a Start condition. The SDA line must be stable for the duration of the High period of the clock signal. The data on the SDA line may be changed during the Low period of the clock signal. There is one clock pulse per bit of data. Each data transfer is initiated with a Start condition and terminated by a Stop condition.

Figure 2. Data Validity Protocol



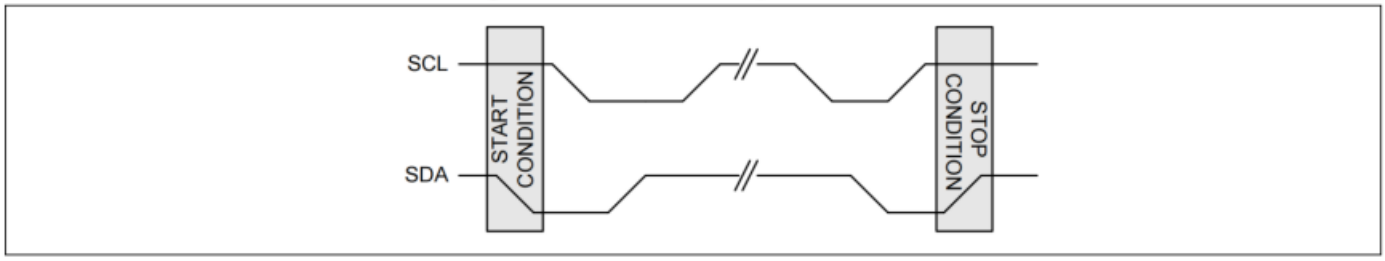
Start Condition

The Start condition precedes all commands to the device and is defined as a High to Low transition of SDA when SCL is High. The EEPROM monitors the SDA and SCL lines and will not respond until the Start condition is met.

Stop Condition

The Stop condition is defined as a Low to High transition of SDA when SCL is High. All operations must end with a Stop condition.

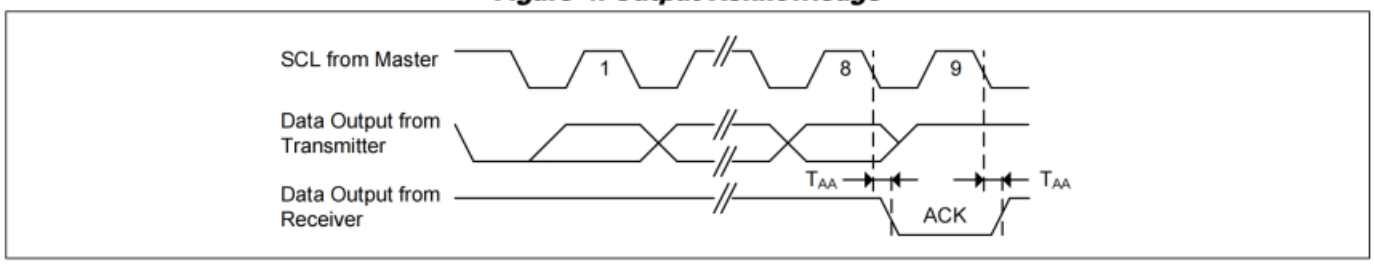
Figure 3. Start and Stop Conditions



Acknowledge

After a successful data transfer, each receiving device is required to generate an ACK. The Acknowledging device pulls down the SDA line.

Figure 4. Output Acknowledge



Reset

The 24C64 contains a reset function in case the 2-wire bus transmission on is accidentally interrupted (e.g. a power loss), or needs to be terminated mid-stream. The reset is initiated when the Master device creates a Start condition. To do this, it may be necessary for the Master device to monitor the SDA line while cycling the SCL up to nine times. (For each clock signal transition to High, the Master checks for a High level on SDA.)

Standby Mode

While in standby mode, the power consumption is minimal. The 24C64 enters into standby mode during one of the following conditions: a) After Power-up, while no Op-code is sent; b) After the completion of an operation and followed by the Stop signal, provided that the previous operation is not Write related; or c) After the completion of any internal write operations.

Device Addressing

The Master begins a transmission on by sending a Start condition, then sends the address of the particular Slave devices to be communicated. The Slave device address is 8 bits format as shown in Figure. 5.

The four most significant bits of the Slave address are fixed (1010) for 24C64.

The next three bits, A0, A1 and A2, of the Slave address are specifically related to EEPROM. Up to eight 24C64 units can be connected to the 2-wire bus.

The last bit of the Slave address specifies whether a Read or Write operation is to be performed. When this bit is set to 1, Read operation is selected. While it is set to 0, Write operation is selected.

After the Master transmits the Start condition and Slave address byte appropriately, the associated 2-wire Slave device, 24C64, will respond with ACK on the SDA line. Then 24C64 will pull down the SDA on the ninth clock cycle, signaling that it received the eight bits of data.

The 24C64 then prepares for a Read or Write operation by monitoring the bus.

Figure 5. Slave Address

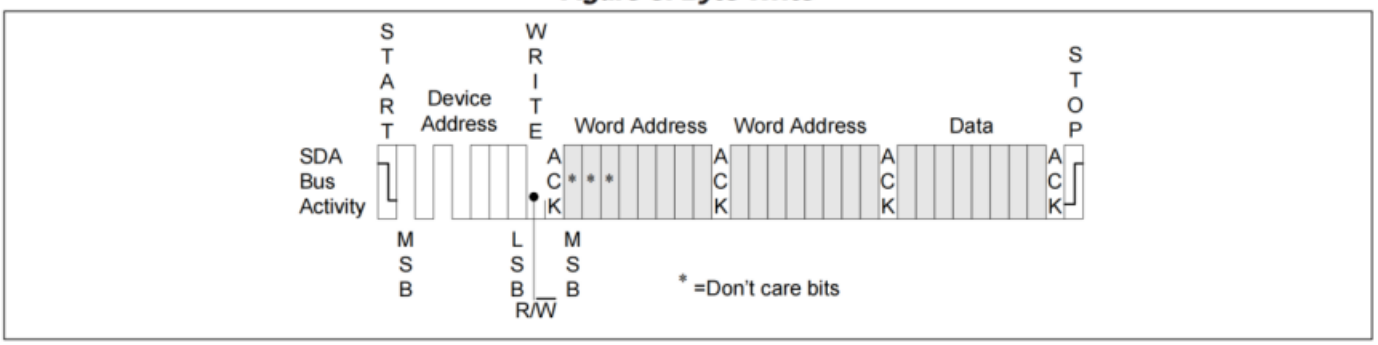
Bit	7	6	5	4	3	2	1	0
	1	0	1	0	A2	A1	A0	R/$\overline{W}$

Write Operation

Byte Write

In the Byte Write mode, the Master device sends the Start condition and the Slave address information (with the R/W set to Zero) to the Slave device. After the Slave generates an ACK, the Master sends the byte address that is to be written into the address pointer of the 24C64. After receiving another ACK from the Slave, the Master device transmits the data byte to be written into the address memory location. The 24C64 acknowledges once more and the Master generates the Stop condition, at which time the device begins its internal programming cycle. While this internal cycle is in progress, the device will not respond to any request from the Master device.

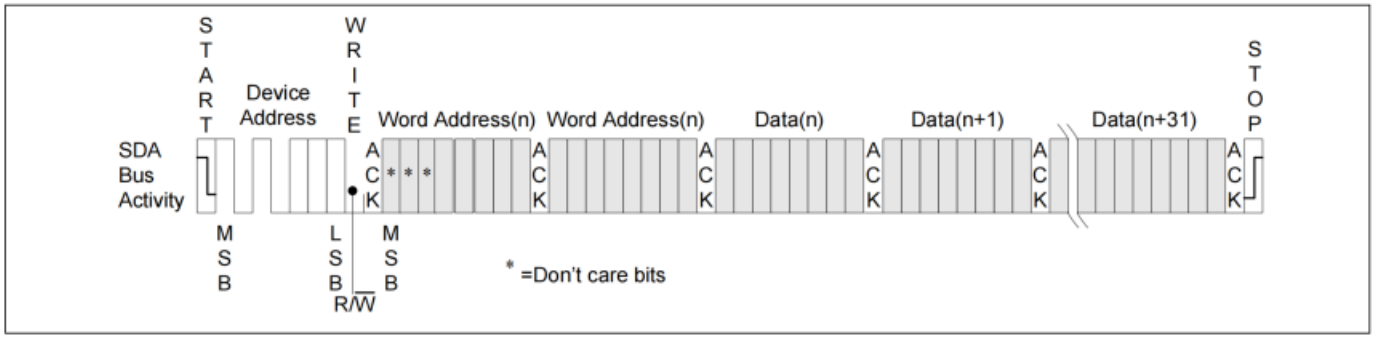
Figure 8. Byte Write



Page Write

The 24C64 is capable of 32-byte Page-Write operation. A Page-Write is initiated in the same manner as a Byte Write, but instead of terminating the internal Write cycle after the first data word is transferred, the Master device can transmit up to 31 more bytes. After the receipt of each data word, the EEPROM responds immediately with an ACK on SDA line, and the five lower order data word address bits are internally incremented by one, while the higher order bits of the data word address remain constant. If a byte address is incremented from the last byte of a page, it returns to the first byte of that page. If the Master device should transmit more than 32 bytes prior to issuing the Stop condition, the address counter will "roll over," and the previously written data will be overwritten. Once all 32 bytes are received and the Stop condition has been sent by the Master, the internal programming cycle begins. At this point, all received data is written to the 24C64 in a single Write cycle. All inputs are disabled until completion of the internal Write cycle.

Figure 9. Page Write



Acknowledge (ACK) Polling

The disabling of the inputs can be used to take advantage of the typical Write cycle time. Once the Stop condition is issued to indicate the end of the host's Write operation, the 24C64 initiates the internal Write cycle. ACK polling can be initiated immediately. This involves issuing the Start condition followed by the Slave address for a Write operation. If the EEPROM is still busy with the Write operation, no ACK will be returned. If the 24C64 has completed the Write operation, an ACK will be returned and the host can then proceed with the next Read or Write operation.

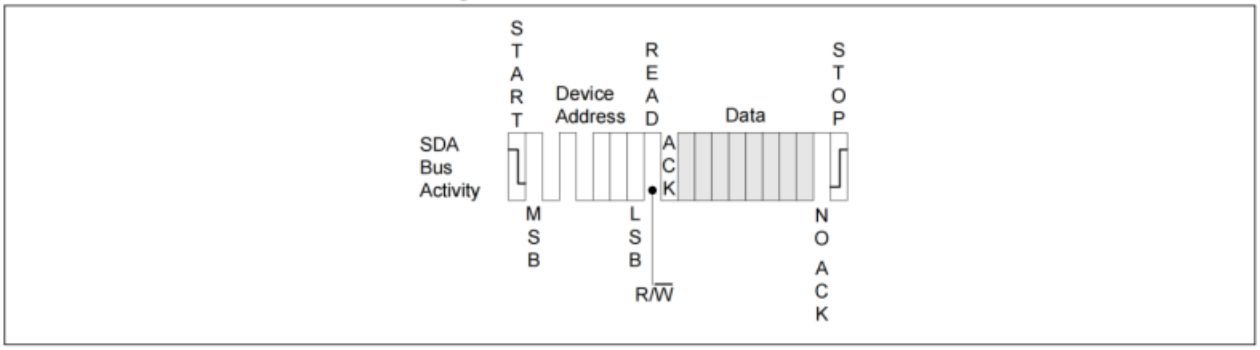
Read Operation

Read operations are initiated in the same manner as Write operations, except that the (R/W) bit of the Slave address is set to "1". There are three Read operation options: current address read, random address read and sequential read.

Current Address Read

The 24C64 contains an internal address counter which maintains the address of the last byte accessed, incremented by one. For example, if the previous operation is either a Read or Write operation addressed to the address location n, the internal address counter would increment to address location n+1. When the EEPROM receives the Slave Addressing Byte with a Read operation (R/W bit set to "1"), it will respond an ACK and transmit the 8-bit data byte stored at address location n+1. The Master should not acknowledge the transfer but should generate a Stop condition so the 24C64 discontinues transmission. If 'n' is the last byte of the memory, the data from location '0' will be transmitted. (Refer to Figure 10. Current Address Read Diagram.)

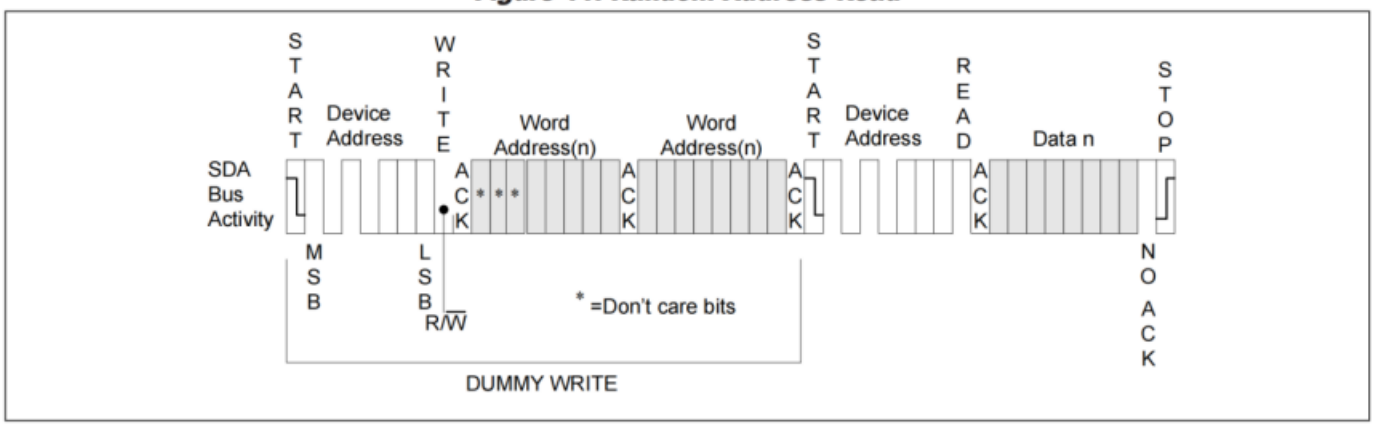
Figure 10. Current Address Read



Random Address Read

Selective Read operations allow the Master device to select at random any memory location for a Read operation. The Master device first performs a 'dummy' Write operation by sending the Start condition, Slave address and byte address of the location it wishes to read. After the 24C64 acknowledges the byte address, the Master device resends the Start condition and the Slave address, this time with the R/W bit set to one. The EEPROM then responds with its ACK and sends the data requested. The Master device does not send an ACK but will generate a Stop condition. (Refer to Figure 11. Random Address Read Diagram.)

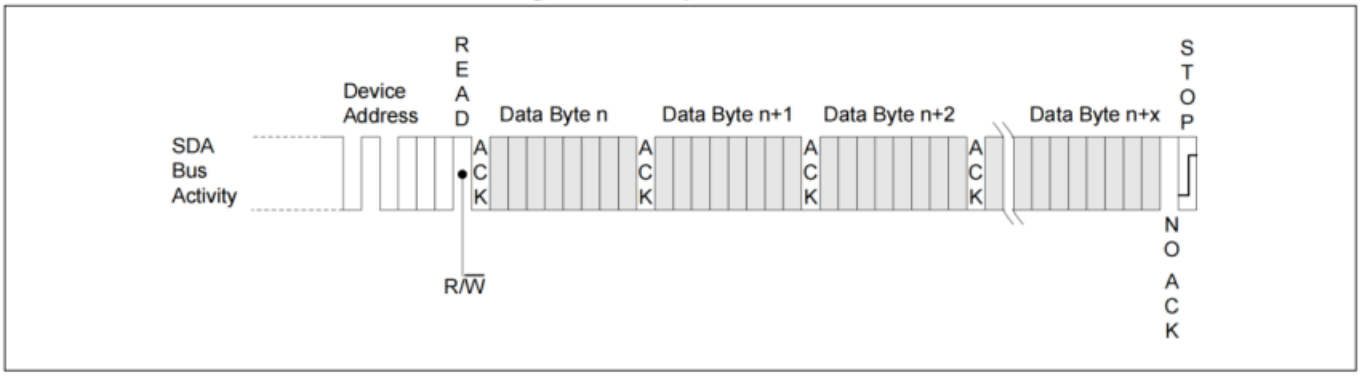
Figure 11. Random Address Read



Sequential Read

Sequential Reads can be initiated as either a Current Address Read or Random Address Read. After the 24C64 sends the initial byte sequence, the Master device now responds with an ACK indicating it requires additional data from the 24C64. The EEPROM continues to output data for each ACK received. The Master device terminates the sequential Read operation by pulling SDA High (no ACK) indicating the last data word to be read, followed by a Stop condition. The data output is sequential, with the data from address n followed by the data from address n+1,n+2 ... etc. The address counter increments by one automatically, allowing the entire memory contents to be serially read during sequential Read operation. When the memory address boundary of the array is reached, the address counter "rolls over" to address 0, and the device continues to output data. (Refer to Figure 12. Sequential Read Diagram).

Figure 12. Sequential Read



Timing Diagrams

Figure 5-11. Bus Timing

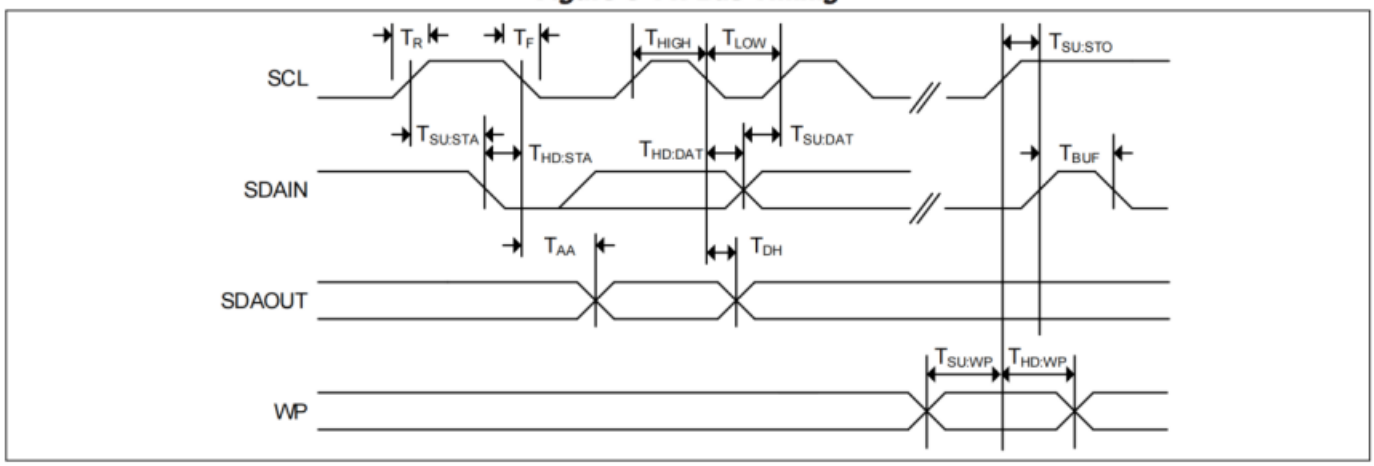
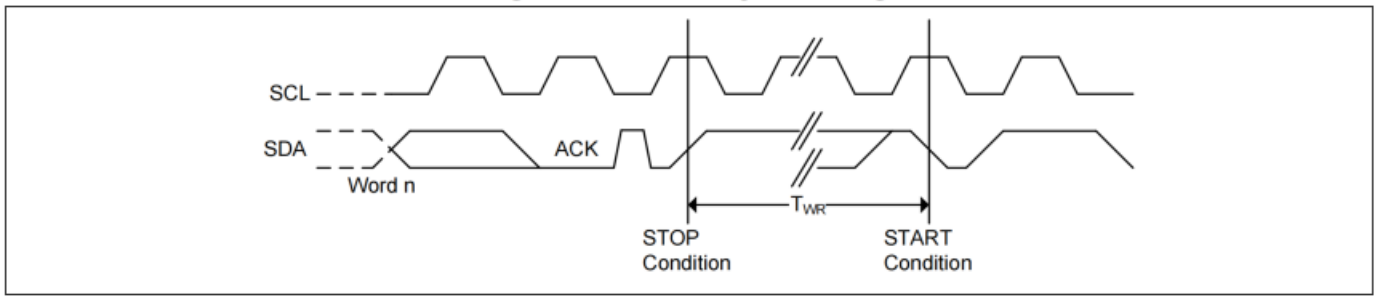


Figure 5-12. Write Cycle Timing



Electrical Characteristics

Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
V_S	Supply Voltage	-0.5 to + 6.5	V
V_P	Voltage on Any Pin	-0.5 to + 6.5	V
T_{BIAS}	Temperature Under Bias	-55 to +125	°C
T_{STG}	Storage Temperature	-65 to +150	°C
I_{OUT}	Output Current	5	mA

Note: Stress greater than 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 condition outside those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Operating Range

Range	Ambient Temperature (TA)	VCC
Industrial	-40°C to +85°C	1.7V to 5.5V

Note: Giantec offers Industrial grade for Commercial applications (0。 C to +70。 C).

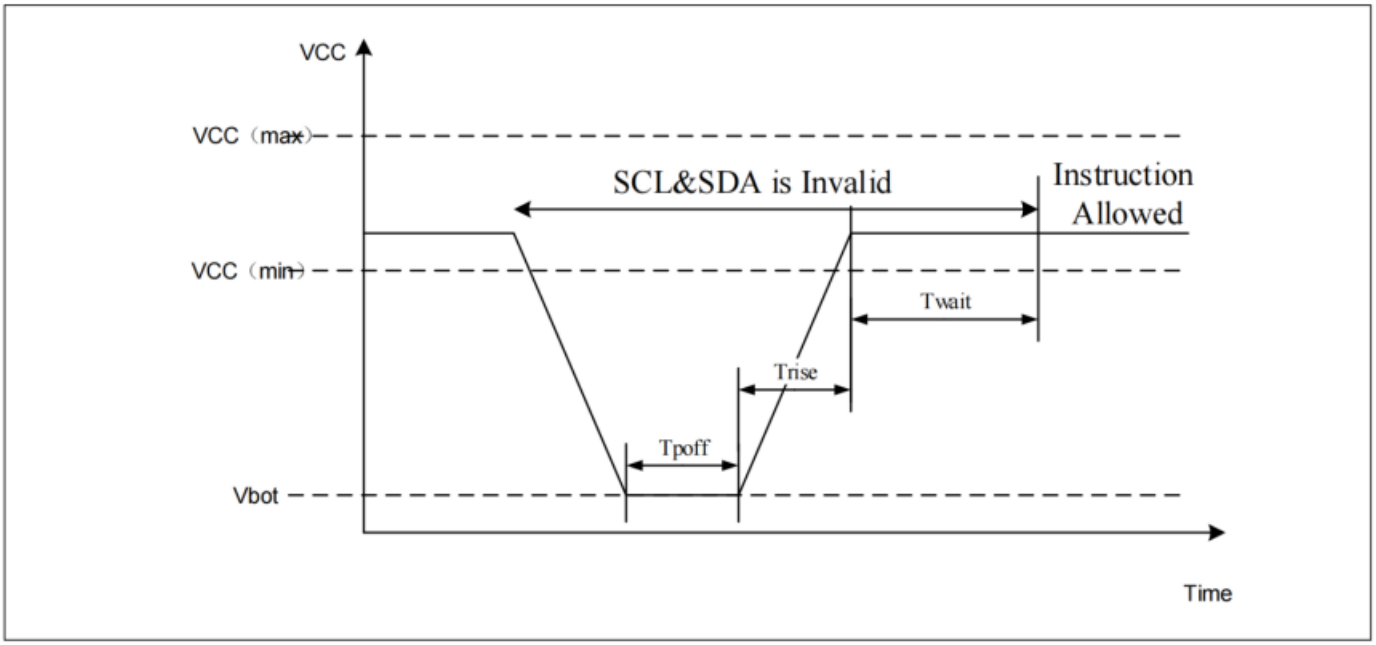
Capacitance

Symbol	Parameter[1, 2]	Conditions	Max.	Unit
C_{IN}	Input Capacitance	V_{IN} = 0V	6	pF
$C_{I/O}$	Input / Output Capacitance	$V_{I/O}$ = 0V	8	pF

Notes: [1] Tested initially and after any design or process changes that may affect these parameters and not 100% tested.

[2] Test conditions: TA = 25°C, f = 1 MHz, VCC = 5.0V.

Power Up/Down and Voltage Drop



Power down-up Timing

Symbol	Parameter	min	max	unit
V_{bot}	VCC at power off		0.2	V
Tpoff	VCC at power off time	100		ms
Trise	Vbot to VCC min	0.01	5	ms
Twait	VCC Min to Instruction	2		ms

* All parameters may be changed after the design or process change.

DC Electrical Characteristic

Industrial: TA = -40°C to +85°C, VCC = 1.7V ~ 5.5V

Symbol	Parameter [1]	V_{CC}	Test Conditions	Min.	Typ.	Max.	Unit
V_{CC}	Supply Voltage			1.7		5.5	V
V_{IH}	Input High Voltage			0.7*V_{CC}		V_{CC}+0.5	V
V_{IL}	Input Low Voltage			-0.5		0.3* V_{CC}	V
I_{LI}	Input Leakage Current	5 V	V_{IN} = V_{CC} max	—		2	μA
I_{LO}	Output Leakage Current	5V				2	μA
V_{OL1}	Output Low Voltage	1.7V	I_{OL} = 0.15 mA	—		0.2	V
V_{OL2}	Output Low Voltage	2.5V	I_{OL} = 2.1 mA	—		0.4	V
I_{SB1}	Standby Current	1.7V	V_{IN} = V_{CC} or GND	—	0.2	1	μA
I_{SB2}	Standby Current	2.5V	V_{IN} = V_{CC} or GND		0.3	1	μA
I_{SB3}	Standby Current	5.5V	V_{IN} = V_{CC} or GND	—	0.5	1	μA
I_{CC1}	Read Current	1.7V	Read at 400 KHz	—		0.15	mA
		5.5V	Read at 1 MHz	—		0.5	mA
I_{CC2}	Write Current	1.7V	Write at 400 KHz			0.5	mA
		1.7V	Write at 1 MHz	—		0.6	mA
		5.5V	Write at 1 MHz	—		0.8	mA

Note: The parameters are characterized but not 100% tested.

AC Electrical Characteristic

Industrial: TA = -40°C to +85°C, Supply voltage = 1.7V to 5.5V

Symbol	Parameter [1] [2]	1.7V≤VCC≤5.5V				Unit
		Min.	Max.	Min.	Max.	
F_{SCL}	SCK Clock Frequency		400		1000	KHz
T_{LOW}	Clock Low Period	1200	—	600	—	ns
T_{HIGH}	Clock High Period	600		400		ns
T_R	Rise Time (SCL and SDA)	—	300	—	300	ns
T_F	Fall Time (SCL and SDA)		300		100	ns
$T_{SU:STA}$	Start Condition Setup Time	500	—	200	—	ns
$T_{SU:STO}$	Stop Condition Setup Time	500		200		ns
$T_{HD:STA}$	Start Condition Hold Time	500	—	200	—	ns
$T_{SU:DAT}$	Data In Setup Time	100	—	40	—	ns
$T_{HD:DAT}$	Data In Hold Time	0	—	0	—	ns
T_{AA}	Clock to Output Access time (SCL Low to SDA Data Out Valid)	100	900	50	400	ns
T_{DH}	Data Out Hold Time (SCL Low to SDA Data Out Change)	100	—	50	—	ns
T_{WR}	Write Cycle Time	—	5	—	5	ms
T_{BUF}	Bus Free Time Before New Transmission	1000	—	400	—	ns
$T_{SU:WP}$	WP pin Setup Time	1000		600		ns
$T_{HD:WP}$	WP pin Hold Time	1000	—	400	—	ns
T	Noise Suppression Time		100		50	ns

Notes: [1] The parameters are characterized but not 100% tested.

[2] AC measurement conditions:

R_L (connects to VCC): 1.3 kΩ (2.5V, 5.0V), 10 kΩ (1.7V)

C_L = 100 pF

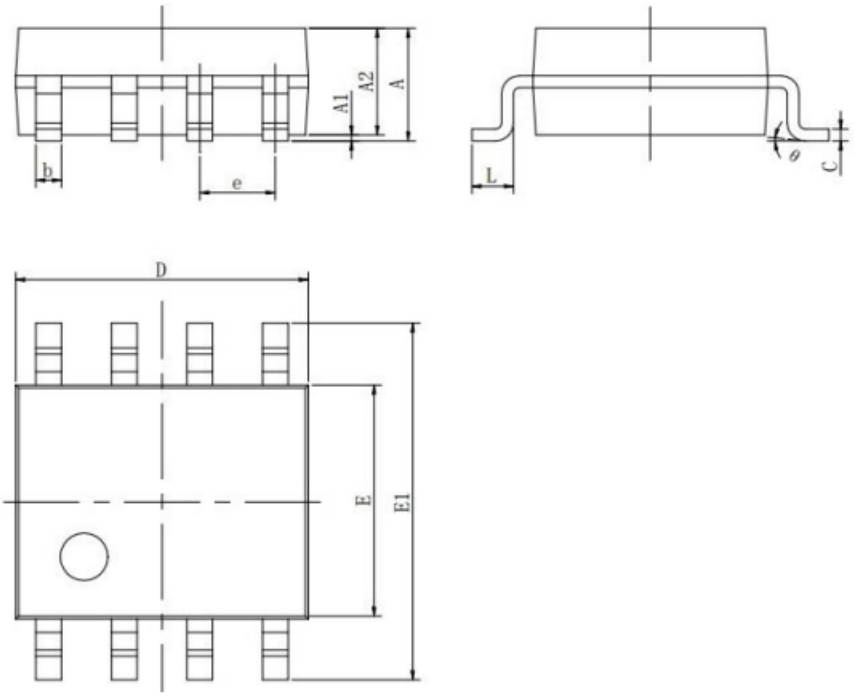
Input pulse voltages: 0.3*VCC to 0.7*VCC

Input rise and fall times: ≤50 ns

Timing reference voltages: half V_{CC} level

Package Information

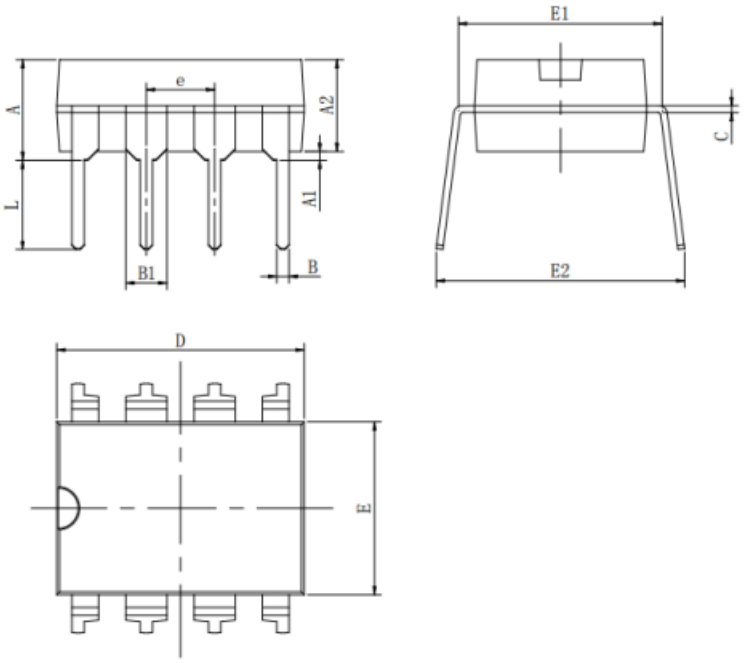
SOP-8 Unit : mm



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.800	0.053	0.071
A1	0.050	0.250	0.004	0.010
A2	1.250	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
C	0.170	0.250	0.006	0.010
D	4.780	5.000	0.185	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

DIP-8

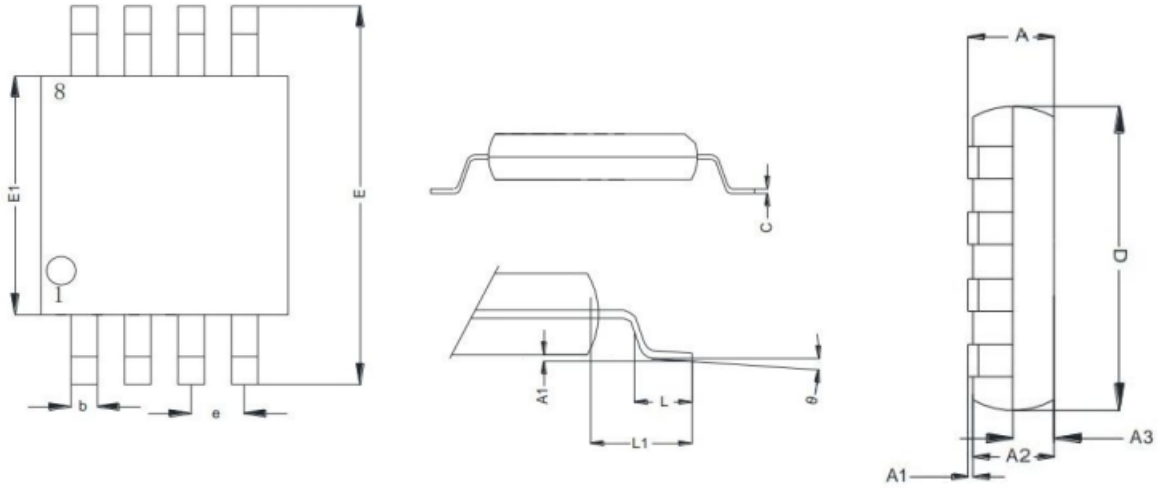
Unit:mm



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.380	0.570	0.015	0.022
B1	1.524(BSC)		0.060(BSC)	
C	0.204	0.360	0.008	0.014
D	9.000	9.400	0.354	0.370
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540(BSC)		0.100(BSC)	
L	3.000	3.600	0.118	0.142
E2	8.400	9.000	0.331	0.354

MSOP-8

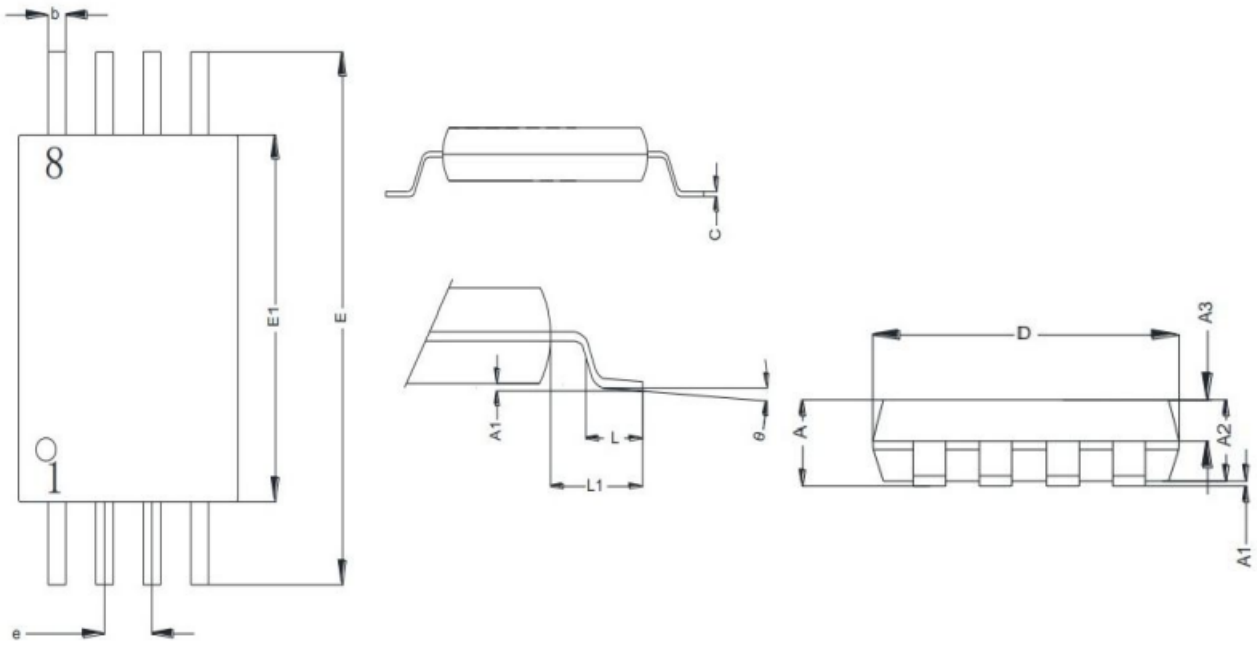
Unit : mm



Symbol	Min	Typ	Max
A			1.100
A1	0.050		0.150
A2	0.750	0.850	0.950
A3	0.300	0.350	0.400
b	0.280		0.360
C	0.150		0.190
D	2.900	3.000	3.100
E	4.700	4.900	5.100
E1	2.900	3.000	3.100
e	-	0650	
L	0.400		0.700
L1		0.950	
θ	0		8°

TSSOP-8

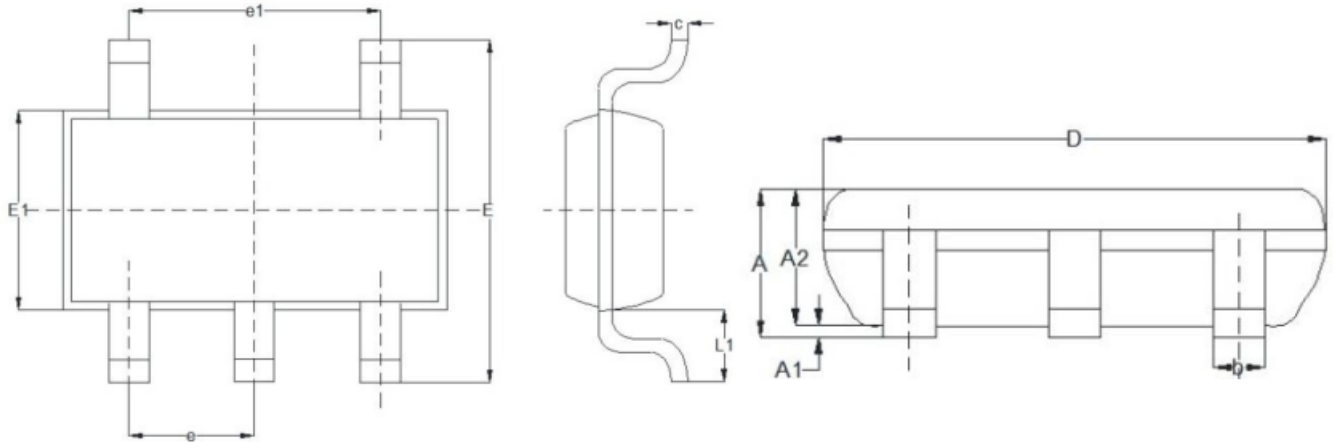
Unit : mm



Symbol	Min	Typ	Max
A			1.200
A1	0.050	-	0.150
A2	0.900		
A3	0.390	0.440	0.490
b	0.200		0.280
C	0.090		0.200
D	2.900	3.000	3.100
E	6.200	6.400	6.600
E1	4.300	4.400	4.500
e		0.650	
L	0.450	-	0.750
L1		1.000	-
θ	0		8°

SOT23-5

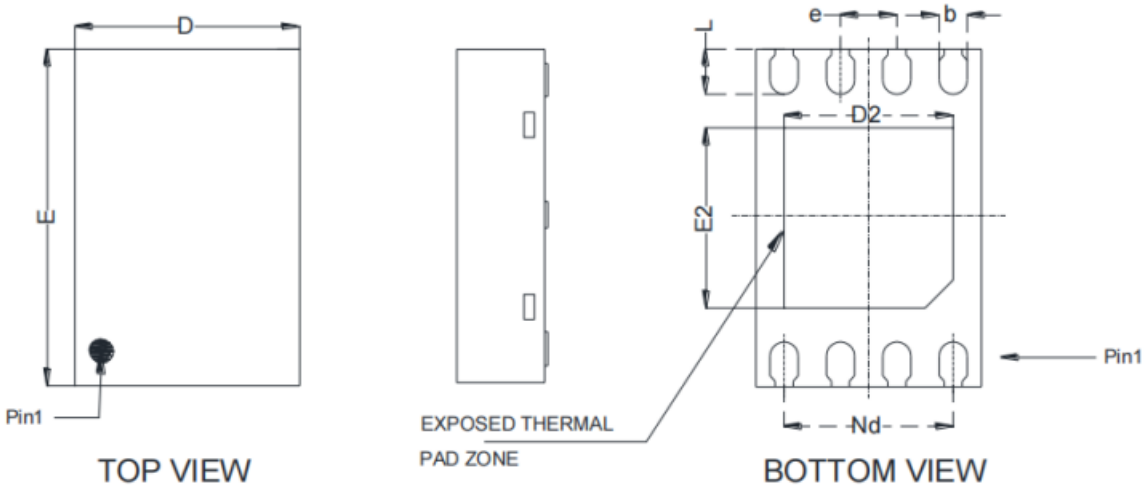
Unit : mm



Symbol	Min	Typ	Max
A	1.000		1.250
A1	0.030		0.090
A2	1.050		1.150
c	0.080		0.200
D	2.900BSC		
E	2.800BSC		
E1	1.600BSC		
e	0.950BSC		
e1	1.900BSC		
L1	0.600REF		
b	0.300		0.450

DFN8(UN)

Unit : mm



Symbol	Min	Typ	Max
A	0.45	0.50	0.55
A1	0.00	0.02	0.05
b	0.18	0.24	0.30
D	1.90	2.00	2.10
D2	1.30		1.60
E	2.90	3.00	3.10
E2	1.20		1.70
e		0.50	
L	0.25	-	0.50
c	0.10	0.15	0.20
Nd	-	1.50	

Important Notice:

- Green Micro chip reserves the right to change products and documents without notice. Customers should obtain and verify the completeness of the latest technical information before placing orders. Meanwhile, Green Micro chip shall not assume any responsibility or obligation for non-officially revised documents.
- Any parameters in the entire product specification are for reference only, and actual application testing shall prevail. When customers use the products for system design, they must comply with safety regulations and independently assume the following responsibilities: selecting suitable Green Micro chip products according to application requirements; completing design verification and full-link testing of the application; and ensuring that the application complies with safety regulations or other requirements of the target market. Customers shall bear all personal or property losses caused by design defects or illegal operations, which shall have no relation to Green Micro chip.
- Green Micro chip products are prohibited from being used in scenarios such as life support, military equipment, and key aerospace applications. All accidents and legal liabilities arising from out-of-scope use shall be borne by the user, and Green Micro chip shall not be held responsible.

All technical resources of Green Micro chip (including data sheets and reference designs) are provided "as is", without guarantee of no defects or universality, and without any express or implied warranties. The documents are only authorized for product development and research described in this document. Unauthorized use of intellectual property, public reproduction, and reverse engineering are strictly prohibited. All claims and losses caused by illegal use shall be borne by the user, and Green Micro chip shall not be liable.