

## GP24BC01/02/04/08/16

2-wire Serial EEPROM 1K/2K/4K/8K/16K

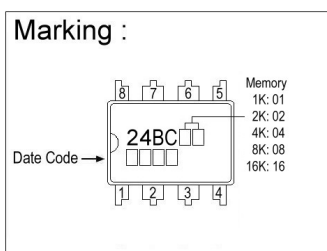
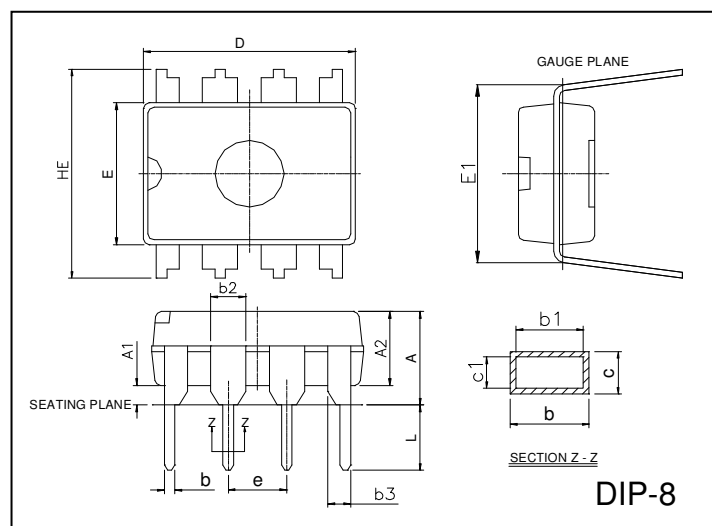
### Description

The GP24BC family provides 1K, 2K, 4K, 8K and 16K of serial electrically erasable and programmable read-only memory (EEPROM). The wide V<sub>DD</sub> range allows for low-voltage operation down to 1.8V. The device, fabricated using traditional CMOS EEPROM technology, is optimized for many industrial and commercial applications where low-voltage and low-power operation is essential. The device is accessed via a 2-wire serial interface.

### Features

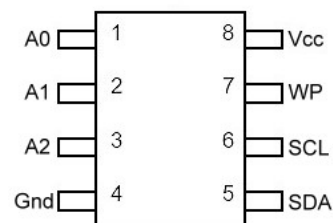
- Internally organized as 128x8 (1K), 256x8 (2K) 512x8 (4K), 1024x8 (8K), 2048x8 (16K),
- Low-voltage and standard-voltage operation: 1.8V~5.5V
- 2-wire serial interface bus
- Date retention: 100years
- High endurance: 1,000,000 Write Cycles
- 100KHz (1.8V) & 400KHz (5V) compatibility
- Bi-directional data transfer protocol
- Self-timed write cycle (5ms max)
- Write protect pin for hardware data protection
- 8-byte page (1K, 2K) and 16-byte page (4K,8K,16K) write modes
- Allows for partial page write

### Package Dimensions



| REF. | Millimeter |        | REF. | Millimeter |       |
|------|------------|--------|------|------------|-------|
|      | Min.       | Max.   |      | Min.       | Max.  |
| A    | -          | 0.5334 | c1   | 0.203      | 0.279 |
| A1   | 0.381      | -      | D    | 9.017      | 10.16 |
| A2   | 2.921      | 4.953  | E    | 6.096      | 7.112 |
| b    | 0.356      | 0.559  | E1   | 7.620      | 8.255 |
| b1   | 0.356      | 0.508  | e    | 2.540 BSC  |       |
| b2   | 1.143      | 1.778  | HE   | -          | 10.92 |
| b3   | 0.762      | 1.143  | L    | 2.921      | 3.810 |
| c    | 0.203      | 0.356  |      |            |       |

**Figure 1. Pin Configurations**



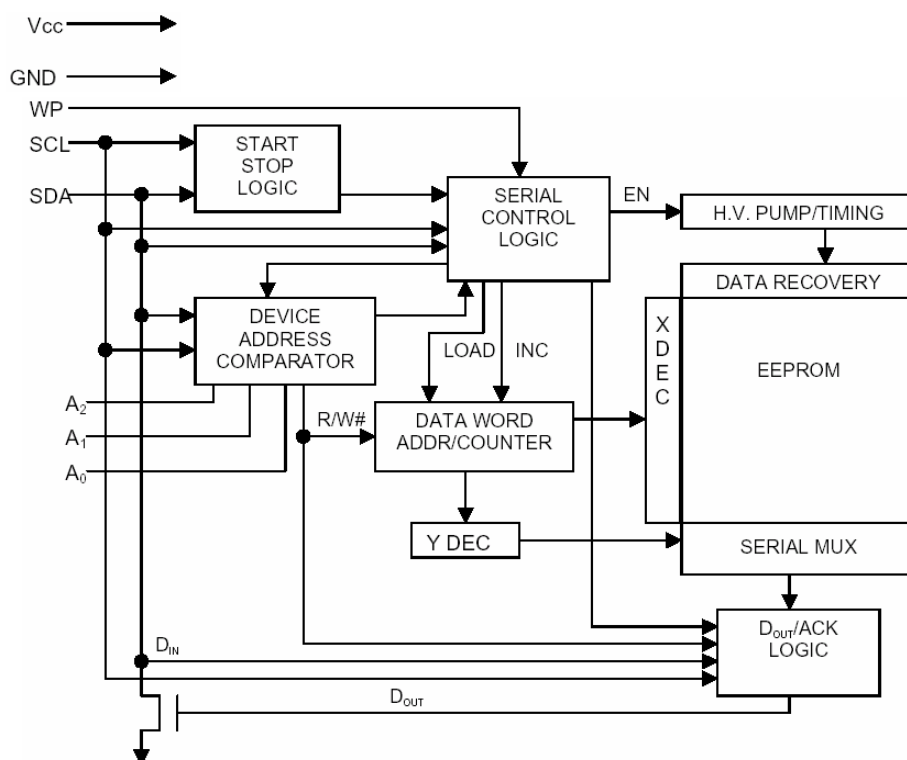
| Pin Name | Function           |
|----------|--------------------|
| A0 – A2  | Address inputs     |
| SDA      | Serial Data        |
| SCL      | Serial Clock Input |
| WP       | Write Protect      |
| Gnd      | Ground             |
| Vcc      | Power Supply       |

### Absolute Maximum Ratings

| Parameter                                 | Ratings                      | Unit |
|-------------------------------------------|------------------------------|------|
| Voltage on Any Pin with Respect to Ground | -0.8 to V <sub>CC</sub> +1.5 | V    |
| Maximum Operating Voltage                 | 6.25                         | V    |
| DC Output Current                         | 5.0                          | mA   |
| Operating Temperature Range               | -55 ~ +125                   | °C   |
| Storage Temperature Range                 | -65 ~ +150                   | °C   |

Note: 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 these specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Figure 2. Block Diagram



## PIN Descriptions

**Serial Data (SDA):** The SDA pin used for sending and receiving data bits in serial mode. Since the SDA pin is defined as an open-drain connection, a pull-up resistor is needed.

**Serial Clock (SCL):** The SCL input is used to synchronize data input and output with the clocked out on the falling edge of SCL.

**Device/Page Addresses (A<sub>2</sub>, A<sub>1</sub>, A<sub>0</sub>):** The A<sub>2</sub>, A<sub>1</sub>, and A<sub>0</sub> pins are used to address multiple devices on a single bus system and should be hard-wired.

The GP24BC01 and GP24BC02 use the A<sub>2</sub>, A<sub>1</sub> and A<sub>0</sub> pins to provide the capability for addressing up to eight 1K/2K devices on a single bus system (please see the Device Addressing section for further details)

- The GP24BC04 uses the A<sub>2</sub> and A<sub>1</sub> inputs and a total of for 4K device may be addressed on a single bus system. The A<sub>0</sub> pin is not used, but should be grounded if possible.
- The GP24BC08 only uses the A<sub>2</sub> input hardwire addressing. On a single bus system, a total of two 8K devices may be addressed. The A<sub>0</sub> and A<sub>1</sub> pins are not used, but should be grounded if possible.
- The GP24BC16 does not use the device address pins, so only one device can be connected to a single bus system. Therefore, the A<sub>0</sub>, A<sub>1</sub> and A<sub>2</sub> pins are not used, but should be grounded if possible.

**Write Protect (WP):** The GP24BC01/02/04/08/16 has a Write Protect pin that provides hardware data protection. When connected to ground, the Write Protect pin allows for normal read/write operations. If the WP pin is connected to V<sub>CC</sub>, no data can be overwritten.

## Memory Organization

The internal memory organization for the GP24BC family is arranged differently for each of the densities. The GP24BC01, for instance, is internally organized as 16 pages of 8 bytes each and requires a 7-bit data word address. The GP24BC16, on the other hand, is organized as 128 pages of 16 bytes each with an 11-bit data word address. The table below summarizes these differences.

| Density        | # of pages | Bytes per page | Data word address length |
|----------------|------------|----------------|--------------------------|
| GP24BC01 (1K)  | 16 pages   | 8 bytes        | 7 bits                   |
| GP24BC02 (2K)  | 32 pages   | 8 bytes        | 8 bits                   |
| GP24BC04 (4K)  | 32 pages   | 16 bytes       | 9 bits                   |
| GP24BC08 (8K)  | 64 pages   | 16 bytes       | 10 bits                  |
| GP24BC16 (16K) | 128 pages  | 16 bytes       | 11 bits                  |

## PIN Capacitance

Applicable over recommended operating range from  $T_A=25^{\circ}\text{C}$ ,  $f=1.0\text{MHz}$ ,  $V_{CC}=+1.8\text{V}$

| Symbol           | Test Condition                      | Max | Unit | Condition            |
|------------------|-------------------------------------|-----|------|----------------------|
| C <sub>I/O</sub> | Input/Output Capacitance (SDA)      | 8   | pF   | V <sub>I/O</sub> =0V |
| C <sub>IN</sub>  | Input Capacitance (A0, A1, A2, SCL) | 6   | pF   | V <sub>IN</sub> =0V  |

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

## DC Characteristics

Applicable over recommended operating range from:  $T_A=-40 \sim +85^{\circ}\text{C}$ ,  $V_{CC}=+1.8 \sim +5\text{V}$  (unless otherwise noted)

| Parameter                              | Symbol           | Test Condition                                        | Min                  | TYP | Max                  | Unit |
|----------------------------------------|------------------|-------------------------------------------------------|----------------------|-----|----------------------|------|
| Supply Voltage                         | V <sub>CC1</sub> |                                                       | 1.8                  | -   | 5.5                  | V    |
| Supply Voltage                         | V <sub>CC2</sub> |                                                       | 2.7                  | -   | 5.5                  | V    |
| Supply Voltage                         | V <sub>CC3</sub> |                                                       | 4.5                  | -   | 5.5                  | V    |
| Supply Current V <sub>CC</sub> =5.0V   | I <sub>CC</sub>  | READ at 100KHz                                        | -                    | 0.4 | 1.0                  | mA   |
| Supply Current V <sub>CC</sub> =5.0V   | I <sub>CC</sub>  | WRITE at 100KHz                                       | -                    | 2.0 | 3.0                  | mA   |
| Standby Current V <sub>CC</sub> =1.8V  | I <sub>SB1</sub> | V <sub>IN</sub> = V <sub>CC</sub> or V <sub>SS</sub>  | -                    | 0.6 | 3.0                  | μA   |
| Standby Current V <sub>CC</sub> =2.5V  | I <sub>SB2</sub> | V <sub>IN</sub> = V <sub>CC</sub> or V <sub>SS</sub>  | -                    | 1.4 | 4.0                  | μA   |
| Standby Current V <sub>CC</sub> =5.5V  | I <sub>SB3</sub> | V <sub>IN</sub> = V <sub>CC</sub> or V <sub>SS</sub>  | -                    | 5.0 | 18                   | μA   |
| Input Leakage Current                  | I <sub>LI</sub>  | V <sub>IN</sub> = V <sub>CC</sub> or V <sub>SS</sub>  | -                    | 0.2 | 5.0                  | μA   |
| Output Leakage Current                 | I <sub>LO</sub>  | V <sub>OUT</sub> = V <sub>CC</sub> or V <sub>SS</sub> | -                    | 0.1 | 5.0                  | μA   |
| Input Low Level <sup>(1)</sup>         | V <sub>IL</sub>  |                                                       | -0.6                 | -   | V <sub>CC</sub> x0.3 | V    |
| Input High Level <sup>(1)</sup>        | V <sub>IH</sub>  |                                                       | V <sub>CC</sub> x0.7 | -   | V <sub>CC</sub> +0.5 | V    |
| Output Low Level V <sub>CC</sub> =3.0V | V <sub>OL2</sub> | I <sub>OL</sub> =2.1mA                                | -                    | -   | 0.4                  | V    |
| Output Low Level V <sub>CC</sub> =3.0V | V <sub>OL1</sub> | I <sub>OL</sub> =0.15mA                               | -                    | -   | 0.2                  | V    |

Note 1: V<sub>IL</sub> and V<sub>IH</sub> max are reference only and are not tested.

**AC Characteristics** Applicable over recommended operating range from: TA=-40 ~ +85°C,  
VCC=+1.8 ~ 5.5V, CL=1 TTL Gate & 100pF (unless otherwise noted)

| Parameter                                                         | Symbol        | Test Condition             | Min        | TYP | Max        | Unit         |
|-------------------------------------------------------------------|---------------|----------------------------|------------|-----|------------|--------------|
| Clock Frequency, SCL                                              | fSCL          | VCC=1.8V<br>VCC=2.7 ~ 5.5V | -          | -   | 100<br>400 | KHz          |
| Clock Pulse Width Low                                             | tLOW          | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 4.7<br>1.2 | -   | -          | µs           |
| Clock Pulse Width High                                            | tHIGH         | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 4.0<br>0.6 | -   | -          | µs           |
| Noise Suppression Time (1)                                        | ti            | VCC=1.8V<br>VCC=2.7 ~ 5.5V | -          | -   | 100<br>50  | ns           |
| Clock Low to Data Out Valid                                       | tAA           | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 0.1<br>0.1 | -   | 4.5<br>0.9 | µs           |
| Time the bus must be free before a new transmission can start (1) | tBUF          | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 4.7<br>1.2 | -   | -          | µs           |
| Start Hold Time                                                   | tHD.STA       | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 4.0<br>0.6 | -   | -          | µs           |
| Start Setup Time                                                  | tSU.STA       | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 4.7<br>0.6 | -   | -          | µs           |
| Data in Hold Time                                                 | tHD.DAT       | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 0<br>0     | -   | -          | µs           |
| Data in Setup Time                                                | tUS.DAT       | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 200<br>100 | -   | -          | ns           |
| Input Rise Time (1)                                               | tR            | VCC=1.8V<br>VCC=2.7 ~ 5.5V | -          | -   | 1.0<br>0.3 | µs           |
| Input Fall Time (1)                                               | tF            | VCC=1.8V<br>VCC=2.7 ~ 5.5V | -          | -   | 300<br>300 | ns           |
| Stop Setup Time                                                   | tSU.STO       | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 4.7<br>0.6 | -   | -          | µs           |
| Data Out Hold Time                                                | tDH           | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 100<br>50  | -   | -          | ns           |
| Write Cycle Time                                                  | tWR           | VCC=1.8V<br>VCC=2.7 ~ 5.5V | -          | -   | 5<br>5     | ms           |
| 5.0V, 25°C, Byte Mode                                             | Endurance (1) | VCC=1.8V<br>VCC=2.7 ~ 5.5V | 1M<br>1M   | -   | -          | Write Cycles |

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

## Device Operation

**Clock and Data Transitions:** Transitions on the SDA pin should only occur when SCL is low (refer to the Data Validity timing diagram in Figure 5). If the SDA pin changes when SCL is high, then the transition will be interpreted as a START or STOP condition.

**START Condition:** A START condition occurs when the SDA transitions from high to low when SCL is high. The START signal is usually used to initiate a command (refer to the Start and Stop Definition timing diagram in Figure 6).

**STOP Condition:** A STOP condition occurs when the SDA transitions from low to high when SCL is high (refer to Figure 6. START and STOP Definition timing diagram). The STOP command will put the device into standby mode after no acknowledgment is issued during the read sequence.

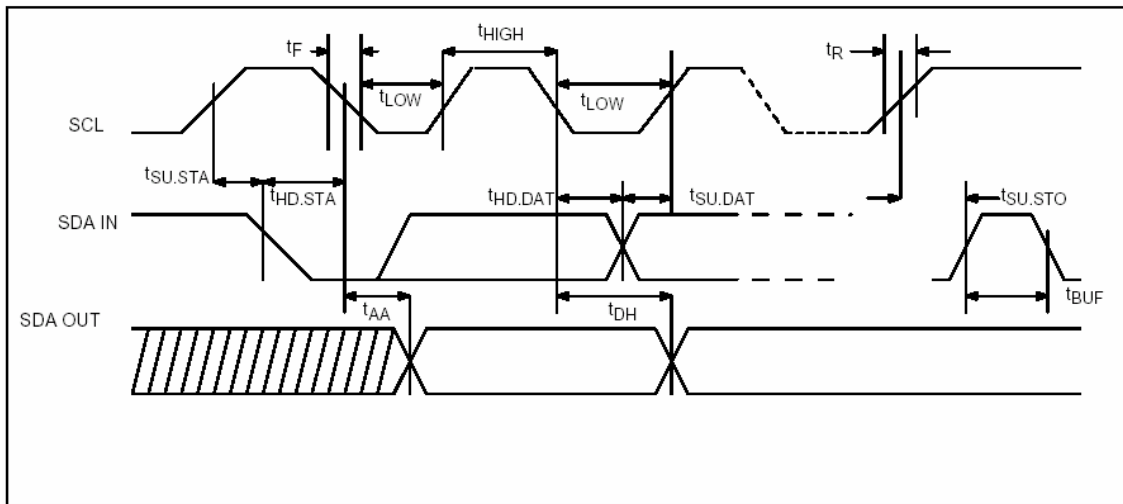
**Acknowledge:** An acknowledgement is sent by pulling the SDA low to confirm that a word has been successfully received. All addresses and data words are serially transmitted to and from the EEPROM in 8-bit words, so acknowledgments are usually issued during the 9<sup>th</sup> clock cycle.

**Standby Mode:** Standby mode is entered when the chip is initially powered-on or after a STOP command has been issued and any internal operations have been completed. .

**Memory Reset:** In the event of unexpected power or connection loss, a START condition can be issued to restart the input command sequence. If the device is currently in write cycle mode, this command will be ignored.

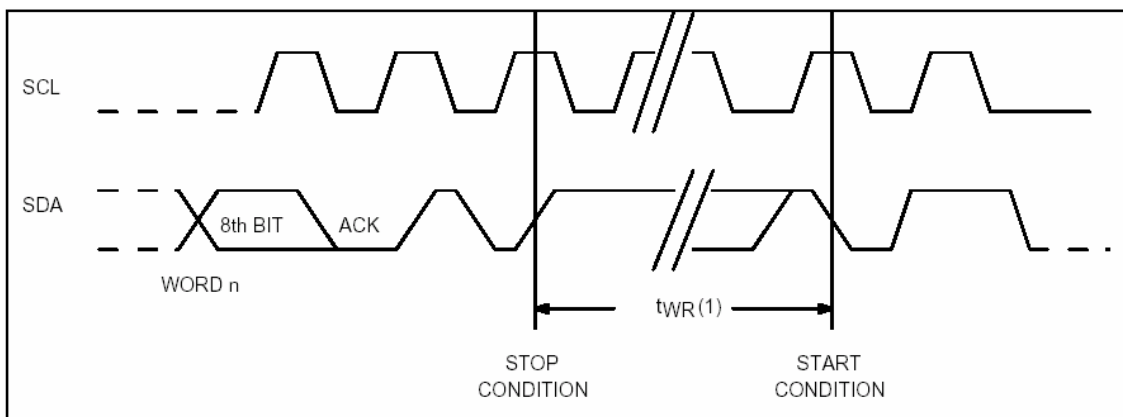
## BUS TIMING

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



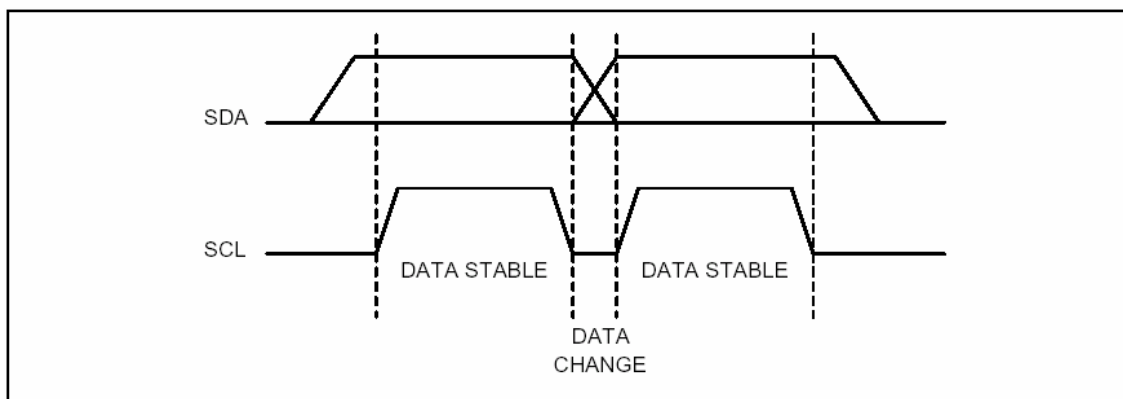
## WRITE CYCLE TIMING

Figure 4. SCL: Serial Clock, SDA: Serial Data I/O

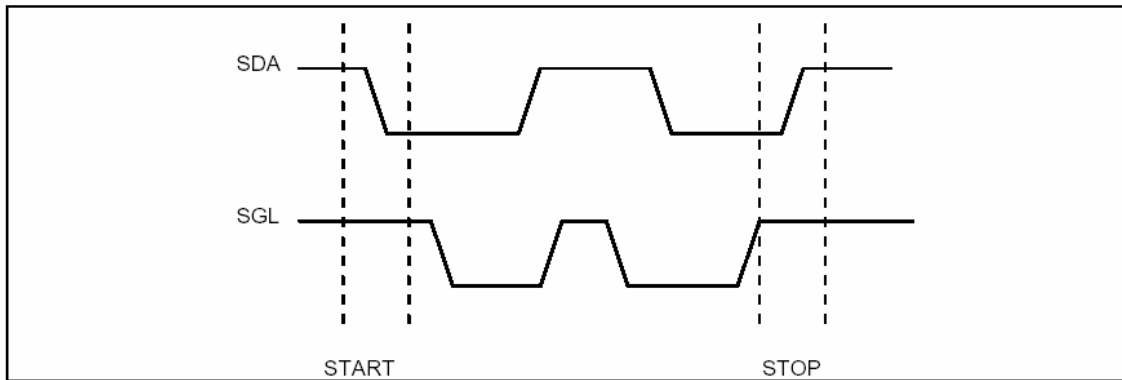


Note: 1. The write cycle time  $t_{WR}$  is the time from a valid stop condition of a write sequence to the end of the internal clear/write cycle

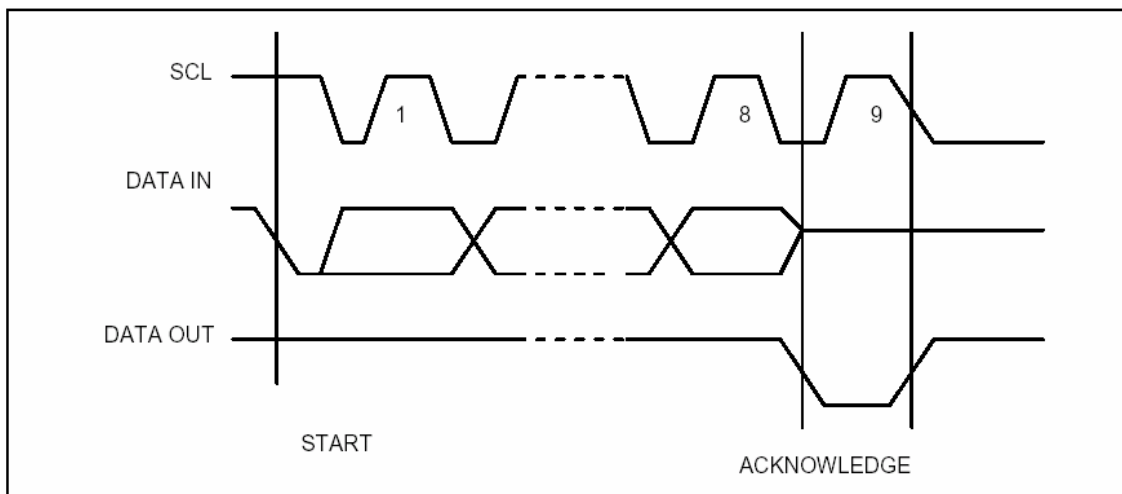
Figure 5. DATA VALIDITY



**Figure 6. START & STOP DEFINITION**



**Figure 7. Output ACKNOWLEDGE**



## Device Addressing

To enable the chip for a read or write operation, an 8-bit device address word followed by a START condition must be issued. The 1<sup>st</sup> four bits of the device address word consists of a mandatory '1010' pattern, while the 2<sup>nd</sup> four bits depend on the particular density being used (refer to Figure 8):

- In the 1K/2K chip, the next 3 bits should correspond to the hard-wired input A<sub>2</sub>, A<sub>1</sub> and A<sub>0</sub> device address bits.
- In the 4K chip, the next 3 bits are the A<sub>2</sub> and A<sub>1</sub> device address bits and a memory page address bit. The two device address bits must compare to their corresponding hard-wired input pins.
- In the 8K chip, the next 3 bits include the A<sub>2</sub> device address bits with the next 2 bits used for memory page addressing. The A<sub>2</sub> bit must compare to its corresponding hard-wired input pin.
- In the 16K chip does not use any device address bits but instead the 3 bits are used for memory page addressing.

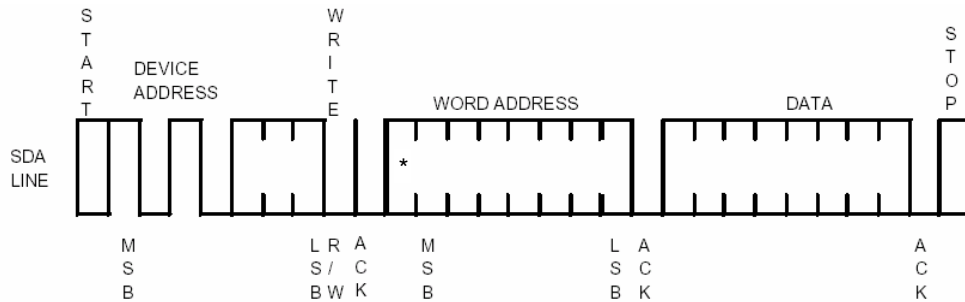
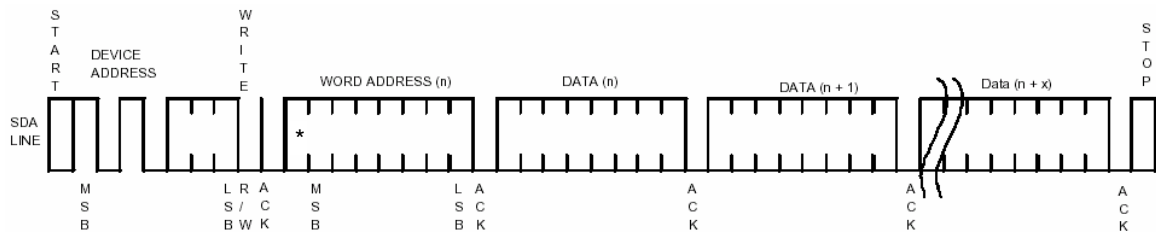
**Figure 8. Device Address**

|       |     |   |   |   |                |                |                |     |
|-------|-----|---|---|---|----------------|----------------|----------------|-----|
| 1K/2K | 1   | 0 | 1 | 0 | A <sub>2</sub> | A <sub>1</sub> | A <sub>0</sub> | R/W |
|       | MSB |   |   |   | LSB            |                |                |     |
| 4K    | 1   | 0 | 1 | 0 | A <sub>2</sub> | A <sub>1</sub> | P <sub>0</sub> | R/W |
| 8K    | 1   | 0 | 1 | 0 | A <sub>2</sub> | P <sub>1</sub> | P <sub>0</sub> | R/W |
| 16K   | 1   | 0 | 1 | 0 | P <sub>2</sub> | P <sub>1</sub> | P <sub>0</sub> | R/W |

The memory page address bits, P<sub>2</sub>, P<sub>1</sub> and P<sub>0</sub> are used to select the page in the array. P<sub>2</sub> represents the most significant bit, while P<sub>1</sub> and P<sub>0</sub> are considered the next most significant bits.

The eight bit of the device address determines read or write operation. If the R/W bit is high, then a read operation is initiated. Otherwise, if the R/W bit is low, then a write operation is started.

After comparing the device address and finding a match, the EEPROM device will issue an acknowledgment by pulling SDA low. If the comparison fails, the chip will return to standby mode.

**Figure 9. Byte Write**

**Figure 10. Page Write**


(\* = DON'T CARE bit for 1K)

## Write Operations

### Byte/Page Write:

If a write operation is entered ( $R/\overline{W}=0$ ) and an acknowledgment is sent, then the next sequence requires an 8-bit data word address. After an acknowledgment is received from this word address, the 1<sup>st</sup> byte of data can be loaded. The device will send an acknowledgment after each byte to confirm the transmission.

To begin the write cycle, a STOP condition must be issued (refer to Figure 9). Both byte and page write operations are supported, so the STOP condition can be issued after the 1<sup>st</sup> byte or the last byte in the page. When the STOP condition occurs, an internal time is started, all input are disabled, and the EEPROM will not respond to any more commands until the write cycle is completed.

Note: The number of bytes in a page depends on the density used. If 1K density is used, then the page size is 8 bytes. In contrast, if the 16K density is used, then the page size is 16 bytes. Refer to the Memory Organization section for more details.

The internal page counter is incremented after each byte received, but the row location of the memory page will always remain the same. Therefore, the device will wrap around to the 1<sup>st</sup> byte in the page after the last byte in the page is received. Any further data loaded into the page buffer will overwrite the previous data loaded.

**Acknowledge Polling:** After the STOP condition is issued, the write cycle begins. Acknowledge polling can be initiated by sending a START condition followed by the device address word. If the EEPROM has completed the internal write cycle and returned to standby mode, the device will respond by sending back an acknowledgment by pulling the SDA pin low. Otherwise, the sequence will be ignored and no acknowledgment will be sent.

### Read Operations

There are three types of read operations: current address read, random address read, and sequence read. A random address read can be considered a current address read operation with an additional sequence in the beginning to load a different address into the internal counter. A sequential read occurs when subsequent bytes are clocked out after a current address read or random address read occurs.

**Current Address Read:** A current address read operation is initiated by issuing R/W=1 in the device address word (refer to Figure 11). Since the internal address counter maintains the last address incremented by one accessed during the last read or write operation, the internal address counter will always retain the last address incremented by one.

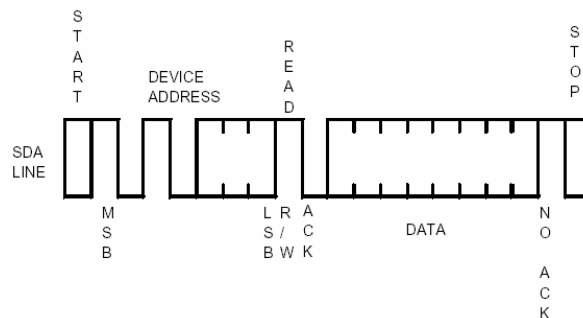
**Random Read:** To access a different address location than the one currently stored in the internal counter, a random read operation is provided. The random read is actually a combination of a “dummy” byte write sequence with a current address read command (refer to Figure 12). The “dummy” byte write loads a different address into the internal counter, and the data can then be accessed using the current address read.

**Sequential Read:** In order to access subsequent data word after a current address read or random read has been initiated, the user should send an acknowledgment to the EEPROM chip after each data byte received. If an acknowledgment is not received, then the chip will not send any more data and expect a STOP condition on the next cycle to reset back to standby more (refer to Figure 13).

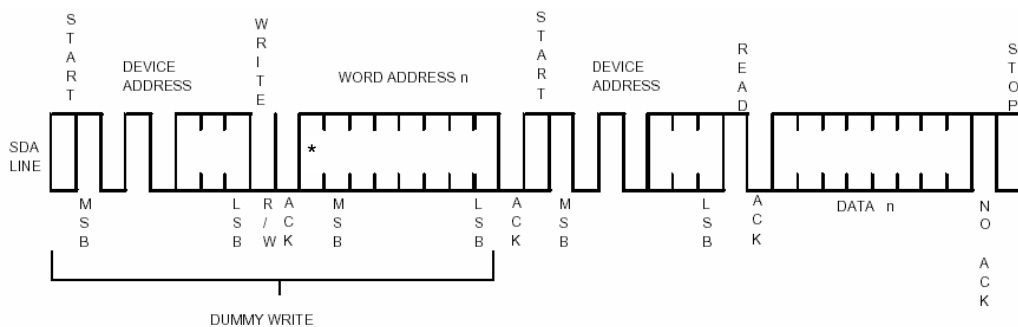
Sequential reads can be used to perform an entire chip read. Unlike the page write operation, the internal counter will increment to the next row after the last byte of the page has been reached. When the address reaches the last byte of the last memory page, the next address will increment to the 1<sup>st</sup> byte of the 1<sup>st</sup> memory page.

Once the memory address limit is reached, the data word address will “roll over” and the sequential read will continue. When the microcontroller does not respond with a zero but does generate a following stop condition, the sequential read operations is terminated.

**Figure 11. Current Address Read**

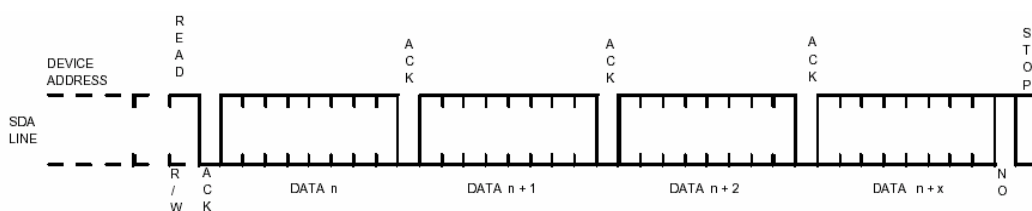


**Figure 12. Random Read**



(\* = DON'T CARE bit for 1K)

**Figure 13. Sequential Read**

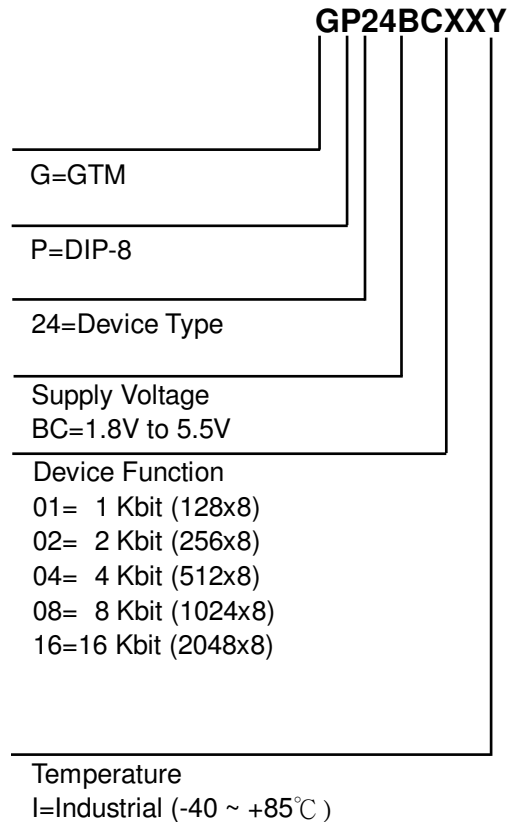




## GP24BC Ordering Information

| Ordering Code | Package | Operating Ranges         |
|---------------|---------|--------------------------|
| GP24BC01I     | DIP-8   | Industrial (-40 ~ +85°C) |
| GP24BC02I     |         |                          |
| GP24BC04I     |         |                          |
| GP24BC08I     |         |                          |
| GP24BC16I     |         |                          |

## Product Ordering Information



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- **Taiwan:** No. 17-1 Tatung Rd. Fu Kou Hsin-Chu Industrial Park, Hsin-Chu, Taiwan, R. O. C.  
 TEL : 886-3-597-7061 FAX : 886-3-597-9220, 597-0785
- **China:** (201203) No.255, Jang-Jiang Tsai-Lueng RD. , Pu-Dung-Hsin District, Shang-Hai City, China  
 TEL : 86-21-5895-7671 ~ 4 FAX : 86-21-38950165