

**Advanced**

**GT93C86**

**16K-bit**

**Microwire Serial EEPROM**

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## 1 FEATURES

- Industry-standard Microwire Interface
- Wide-voltage Operation
  - $V_{cc} = 1.8V$  to  $5.5V$
- Speed
  - 1 MHz (1.8V), 2 MHz (2.5V), 3 MHz (5.5V)
- Standby current
  - 15uA (max.) 5.5V
- Operating current
  - 1mA (max.) 1.8V
- User Configured Memory Organization
  - 1,024x16-bit (ORG = Vcc or Floating) or 2,048x8-bit (ORG = 0V)
- Self timed write cycle: 5 ms (max.)
- Hardware and software write protection
  - Defaults to write-disabled state at power-up
  - Software instructions for write-enable/disable
- CMOS technology
- Versatile, easy-to-use interface
  - Automatic erase-before-write
  - Programming status indicator
  - Byte, Word and chip single erasable
  - Chip select enables power savings
- Noise immunity on inputs, besides Schmitt trigger
- High-reliability
  - Endurance: 1 million cycles
  - Data retention: 100 years
- Industrial temperature grades
- Packages: SOIC/SOP and TSSOP
- Lead-free, RoHS, Halogen free, Green

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## **2 DESCRIPTION**

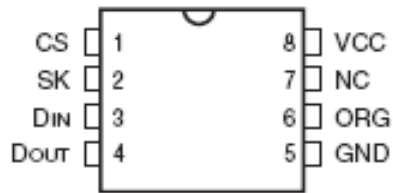
The GT93C86 is 16kb non-volatile serial EEPROM with memory array of 16,384 bits. The array can be organized as either 2,048 bytes of 8 bits or 1,024 words of 16 bits via the ORG control. Utilizing the CMOS design and process, these products provide low standby current and low power operations. The devices can operate in a wide supply voltage range from 1.8V to 5.5V, with frequency up to 3MHz.

When the ORG pin is connected to Vcc or floating, x16 is selected. Conversely, when it is connected to ground, x8 is chosen.

An instruction Op-code defines the various operations of the devices, including read, write, and mode-enable functions. To protect against inadvertent data modification, all write and erase instructions are merely accepted while the device is in write enable mode. A selected x8 byte or x16 word can be modified with a single WRITE or ERASE instruction. Additionally, the WRITE ALL or ERASE ALL instruction can program or erase the entire array, respectively. Once a device begins its self-timed program procedure, the data out pin (Dout) can indicate the READY/**BUSY** status by raising chip select (CS). The devices can output any number of consecutive bytes/words using a single READ instruction.

### 3 PIN CONFIGURATION

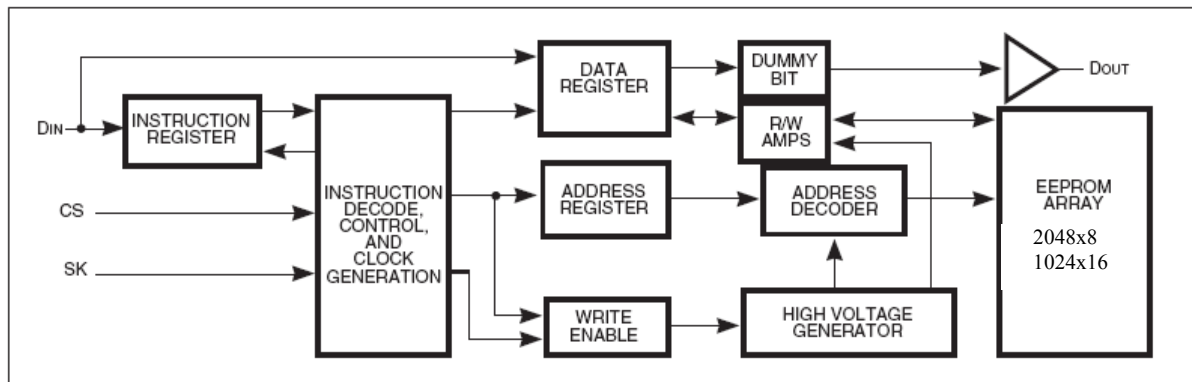
#### 8-Pin SOIC/SOP (GR), TSSOP



**Table 3.1: Pin Descriptions**

Pin Name	Descriptions
<b>CS</b>	Chip Select
<b>SK</b>	Serial Data Clock
<b>D<sub>IN</sub></b>	Serial Data Input
<b>D<sub>OUT</sub></b>	Serial Data Output
<b>GND</b>	Ground
<b>ORG</b>	Organization Select
<b>NC</b>	Not Connect
<b>V<sub>CC</sub></b>	Supply Voltage

### 4 BLOCK DIAGRAM



## 5 DEVICE OPERATION

### Device Operations

The GT93C86 is controlled by a set of instructions which are clocked-in serially on the Din pin. Before each low-to-high transition of the clock (SK), the CS pin must have already been raised to HIGH, and the Din value must be stable at either LOW or HIGH. Each instruction begins with a start bit of the logical “1” or HIGH. Following this are the Op-code, address field, and data, if appropriate. The clock signal may be held stable at any moment to suspend the device at its last state, allowing clock speed flexibility. Upon completion of bus communication, CS would be pulled LOW. The device then would enter Standby mode if no internal programming is underway.

### Read (READ)

The READ instruction is the only instruction that outputs serial data on the DOUT pin. After the read instruction and address have been decoded, data is transferred from the selected memory array into a serial shift register. (Please note that one logical “0” bit precedes the actual 8 or 16-bit output data string.) The output on DOUT changes during the low-to-high transitions of SK (see Figure 3).

The GT93C86 is designed to output a continuous stream of memory content in response to a single read operation instruction. To utilize this function, the system asserts a read instruction specifying a start location address. Once the 8 or 16 bits of the addressed register have been clocked out, the data in consecutively higher address locations is output. The address will wrap around continuously with CS HIGH until the chip select (CS) control pin is brought LOW. This allows for single instruction data dumps to be executed with a minimum of firmware overhead.

### Write Enable (WEN)

The write enable (WEN) instruction must be executed before any device programming (WRITE, WRALL, ERASE, and ERAL) can be done. When Vcc is applied, this device powers up in the write disabled state. The device then remains in a write disabled state until a WEN instruction is executed. Thereafter, the device remains enabled until a WDS instruction is executed or until Vcc is removed. (See Figure 4.) (Note: Chip select must remain LOW until Vcc reaches its operational value.)

### Write Disable (WDS)

The write disable (WDS) instruction disables all programming capabilities. This protects the entire device against accidental modification of data until a WEN instruction is executed. (When Vcc is applied, this part powers up in the write disabled state.) To protect data, a WDS instruction should be executed upon completion of each programming operation.

### Write (WRITE)

The WRITE instruction writes 8 or 16 bits of data into the specified memory location. After the last data bit has been applied to Din, and before the next rising edge of SK, CS must be brought LOW. If the device is write-enabled, then the falling edge of CS initiates the self-timed programming cycle (see WEN). If CS is brought HIGH, after a minimum wait of 200 ns after the falling edge of CS (tcs) DOUT will indicate the READY/BUSY status of the chip. Logical “0” means programming is still in progress; logical “1” means the selected memory array has been written, and the part is ready for another instruction (see Figure 5). The READY/BUSY status will not be available if the CS input goes HIGH after the end of the self-timed programming cycle (twp).

### Write All Memory (WRAL)

The write all (WRALL) instruction programs entire memory with the data pattern specified in the instruction. As with the WRITE instruction, the falling edge of CS must occur to initiate the self-timed programming cycle. If CS is then brought HIGH after a minimum wait of 200 ns (tcs), the DOUT pin indicates the READY/BUSY status of the chip (see Figure 6).

### Erase (ERASE)

After the erase instruction is entered, CS must be brought LOW. The falling edge of CS initiates the self-timed internal programming cycle. Bringing CS HIGH after a minimum of tcs, will cause DOUT to indicate the READ/BUSY status of the chip: a logical “0” indicates programming is still in progress; a logical “1” indicates the erase cycle is complete and the part is ready for another instruction (see Figure 8).

**Erase All Memory (ERAL)**

Full chip erase is provided for ease of programming. Erasing the entire chip involves setting all bits in the entire memory array to a logical “1” (see Figure 9).

**Power-On Reset (POR)**

The device incorporates a Power-On Reset (POR) circuitry which protects the internal logic against powering up into a wrong state. The device will power up into Standby mode after  $V_{CC}$  exceeds the POR trigger level and will power down into Reset mode when  $V_{CC}$  drops below the POR trigger level. This POR feature protects the device being ‘brown-out’ due to a sudden power loss or power cycling.

In order to refrain the state machine entering into a wrong state during power-up sequence or a power toggle off-on condition, a power on reset (POR) circuit is embedded. During power-up, the device does not respond to any instruction until  $V_{CC}$  has reached a minimum stable level above the reset threshold voltage. Once  $V_{CC}$  passes the POR threshold, the device is reset and enters in Standby mode. This can also avoid any inadvertent Write operations during power-up stage. During power-down process, the device must enter into standby mode, once  $V_{CC}$  drops below the power on reset threshold voltage. In addition, the device will enter standby mode after current operation completes, provided that no internal write operation is in progress.

**INSTRUCTION SET - GT93C86 (16Kb)**

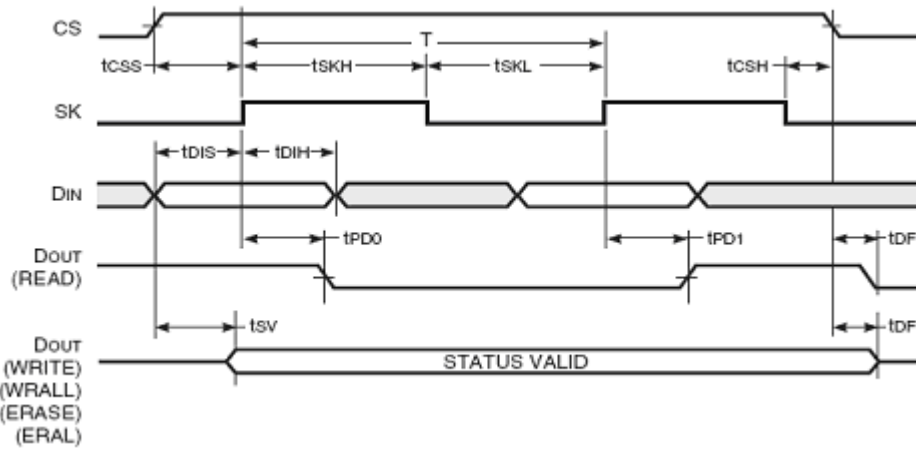
Instruction <sup>[2]</sup>	Start Bit	OP Code	8-bit Organization (ORG = GND)			16-bit Organization (ORG = Vcc or Floating)		
			Address <sup>[1]</sup>	Data <sup>[1]</sup>	Required Clock Cycles	Address <sup>[1]</sup>	Data <sup>[1]</sup>	Required Clock Cycles
WDS (Write Disable)	1	00	00x xxxx xxxx	—	14	00 xxxx xxxx	—	13
WEN (Write Enable)	1	00	11x xxxx xxxx	—	14	11 xxxx xxxx	—	13
ERAL (Erase All Memory)	1	00	10x xxxx xxxx	—	14	10 xxxx xxxx	—	13
WRAL (Write All Memory)	1	00	01x xxxx xxxx	(D <sub>7</sub> -D <sub>0</sub> )	22	01 xxxx xxxx	(D <sub>15</sub> -D <sub>0</sub> )	29
WRITE	1	01	(A <sub>10</sub> -A <sub>0</sub> )	(D <sub>7</sub> -D <sub>0</sub> )	22	(A <sub>9</sub> -A <sub>0</sub> )	(D <sub>15</sub> -D <sub>0</sub> )	29
READ	1	10	(A <sub>10</sub> -A <sub>0</sub> )	—	14	(A <sub>9</sub> -A <sub>0</sub> )	—	13
ERASE	1	11	(A <sub>10</sub> -A <sub>0</sub> )	—	14	(A <sub>9</sub> -A <sub>0</sub> )	—	13

**Notes:**

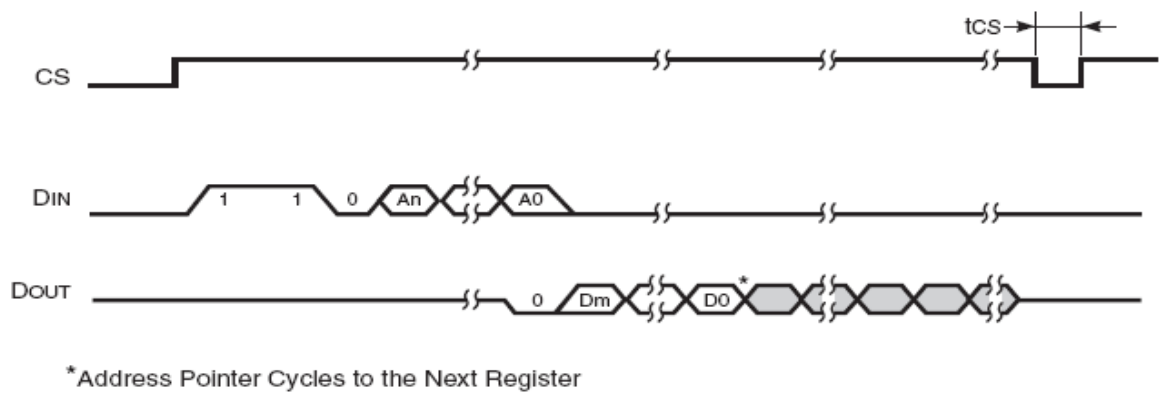
1. x = Don't care bit.
2. Exact number of clock cycles is required for each Op-code instruction.

## 6 TIMING DIAGRAMS

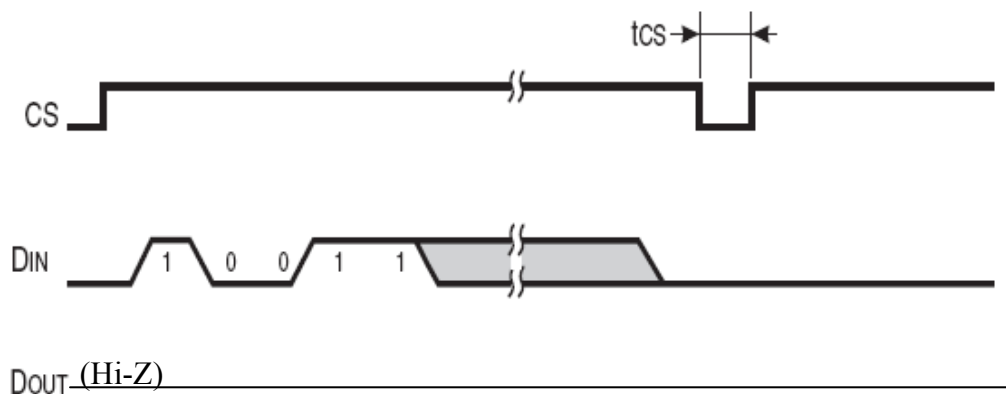
**Fig. 2: Synchronous Data Timing**



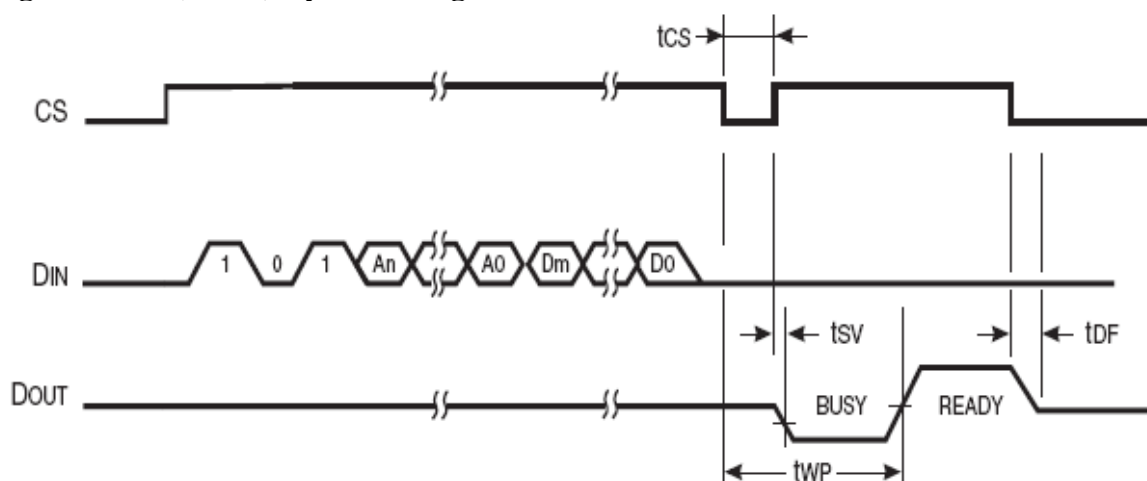
**Fig. 3: Read Cycle Timing**



**Fig. 4: Write Enable (WEN) Cycle Timing**



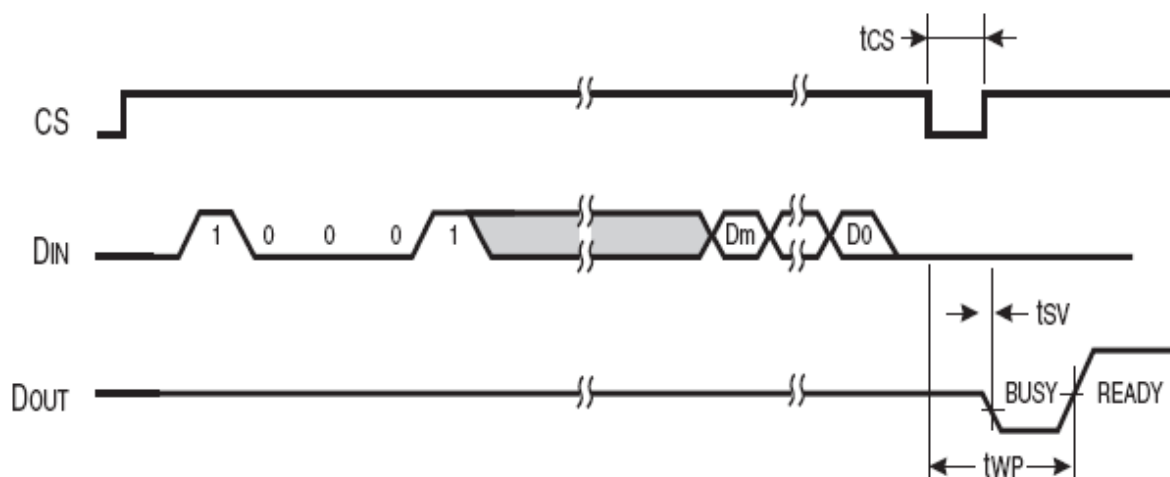
**Fig. 5: Write (Write) Cycle Timing**



**Notes:**

1. After the completion of the instruction (DOUT is in READY status) then it may perform another instruction. If device is in **BUSY** status (DOUT indicates **BUSY** status) then attempting to perform another instruction could cause device malfunction.
2. To determine address bits  $A_n$ - $A_0$  and data bits  $D_m$ - $D_0$ , see Instruction Set for the specific device.

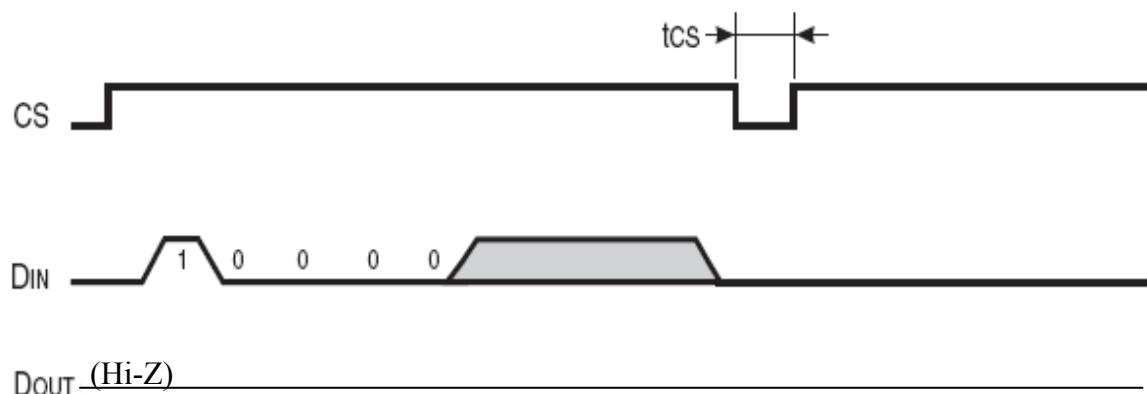
**Fig. 6: Write All (WRALL) Cycle Timing**



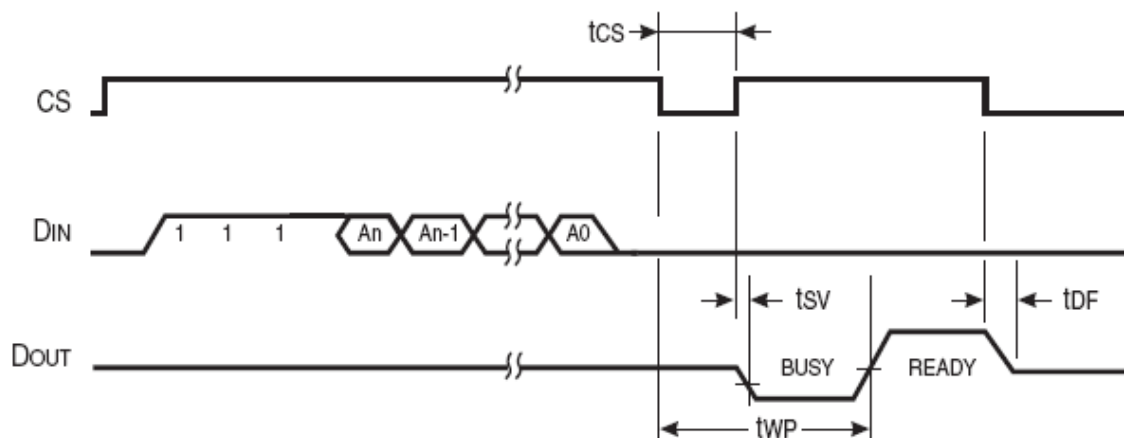
**Notes:**

1. After the completion of the instruction (DOUT is in READY status) then it may perform another instruction. If device is in **BUSY** status (DOUT indicates **BUSY** status) then attempting to perform another instruction could cause device malfunction.
2. To determine data bits  $D_m$ - $D_0$ , see Instruction Set for the appropriate device.

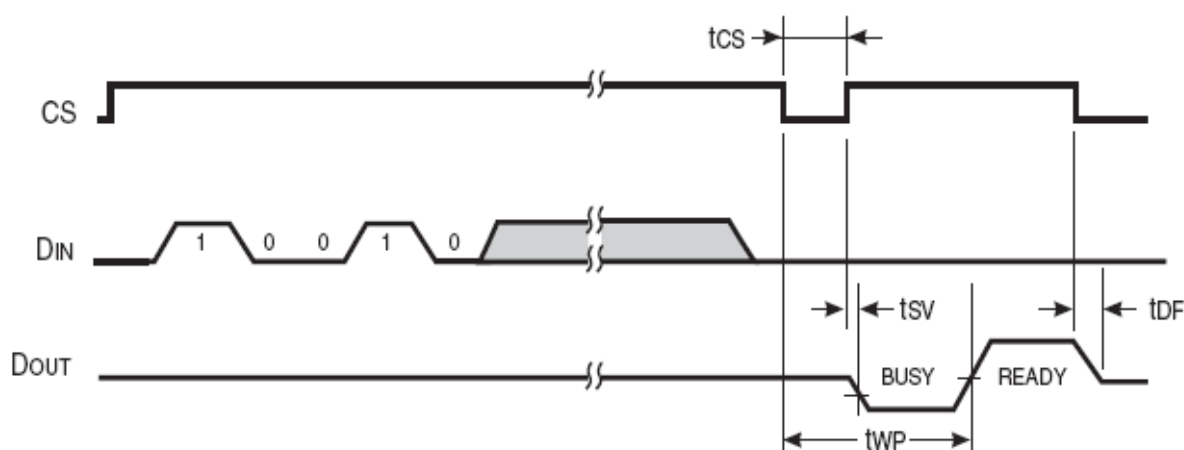
**Fig. 7: Write Disable (WDS) Timing**



**Fig. 8: Erase (Erase) Cycle Timing**



**Fig. 9: Erase All (ERAL) Cycle Timing**



**Note for Figures 8 and 9:**

1. After the completion of the instruction (DOUT is in READY status) then it may perform another instruction. If device is in **BUSY** status (DOUT indicates **BUSY** status) then attempting to perform another instruction could cause device malfunction.
2. To determine data bits  $A_n - A_0$ , see Instruction Set for the appropriate device.

## 7 ABSOLUTE MAXIMUM RATINGS

**Table 7.1: Absolute Maximum Ratings** <sup>[1]</sup>

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply Voltage	-0.5 to +6.5	V
V <sub>P</sub>	Voltage on Any Pin	-0.5 to V <sub>CC</sub> + 0.5	V
T <sub>BIAS</sub>	Temperature Under Bias	-55 to +125	°C
T <sub>STG</sub>	Storage Temperature	-65 to +150	°C
I <sub>OUT</sub>	Output Current	5	mA

<sup>[1]</sup> 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 conditions 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

**Table 7.2: Industrial Operation**

V <sub>CC</sub>	Ambient Temperature (T <sub>A</sub> )	Grade
1.8V to 5.5V	-40°C to +85°C	Industrial (I)

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

## CAPACITANCE

<sup>[1,2]</sup>

Symbol	Parameter	Conditions	Max.	Unit
C <sub>IN</sub>	Input Capacitance	V <sub>IN</sub> = 0V	6	pF
C <sub>OUT</sub>	Input /Output Capacitance	V <sub>OUT</sub> = 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: T<sub>A</sub> = 25°C, f = 1 MHz, V<sub>CC</sub> = 5.0V.

## 8 DC ELECTRICAL CHARACTERISTICS

**Table 8.1: DC Characteristics**
 $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  for Industrial

Symbol	Parameter	Test Conditions	Min.	Max.	Unit
$V_{OL1}$	Output LOW Voltage	$V_{CC} = 1.8\text{V} \sim 2.7\text{V}$ , $I_{OL} = 100 \mu\text{A}$	—	0.2	V
$V_{OL2}$	Output LOW Voltage	$V_{CC} = 2.7\text{V} \sim 5.5\text{V}$ , $I_{OL} = 2.1 \text{mA}$	—	0.4	V
$V_{OH1}$	Output HIGH Voltage	$V_{CC} = 1.8\text{V} \sim 2.7\text{V}$ , $I_{OH} = -0.1\text{mA}$	$V_{CC} - 0.2$	—	V
$V_{OH2}$	Output HIGH Voltage	$V_{CC} = 2.7\text{V} \sim 5.5\text{V}$ , $I_{OH} = -0.4\text{mA}$	2.4	—	V
$V_{IH}$	Input HIGH Voltage	1.8V to 5.5V	$0.7 * V_{CC}$	$V_{CC} + 1$	V
$V_{IL}$	Input LOW Voltage	1.8V to 5.5V	-0.3	$0.2 * V_{CC}$	V
$I_{L1}$	Input Leakage Current	$V_{IN} = 0\text{V}$ to $V_{CC}$ (CS, SK, DIN, ORG)	0	2.5	$\mu\text{A}$
$I_{LO}$	Output Leakage Current	$V_{OUT} = 0\text{V}$ to $V_{CC}$ , CS = 0V	0	2.5	$\mu\text{A}$

## POWER SUPPLY CHARACTERISTICS

**Table 8.2: Power Supply Characteristics**
 $(T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  for Industrial)

Symbol	Parameter	Vcc	Test Conditions	Min.	Typ.	Max.	Unit
Vcc	Supply Voltage			1.8		5.5	V
$I_{SB1}$	Standby current	1.8	CS = GND, SK = GND, ORG = Vcc or Floating (x16), DIN = Vcc or GND	—	0.1	1	$\mu\text{A}$
		2.5		—	0.1	2	$\mu\text{A}$
		5.5		—	0.2	4	$\mu\text{A}$
$I_{SB2}$	Standby current	1.8	CS = GND, SK = GND, ORG = GND (x8), DIN = Vcc or GND	—	6	10	$\mu\text{A}$
		2.5		—	6	10	$\mu\text{A}$
		5.5		—	10	15	$\mu\text{A}$
$I_{CC-Read}$	Read current	1.8	CS = $V_{IH}$ , SK = 1 MHz, CMOS input levels	—	0.1	1	mA
		2.5	CS = $V_{IH}$ , SK = 2 MHz, CMOS input levels	—	0.2	1	mA
		5.5	CS = $V_{IH}$ , SK = 2 MHz, CMOS input levels	—	0.5	2	mA
$I_{CC-Write}$	Write current	1.8	CS = $V_{IH}$ , SK = 1 MHz, CMOS input levels	—	0.5	1	mA
		2.5	CS = $V_{IH}$ , SK = 2 MHz, CMOS input levels	—	1	2	mA
		5.5	CS = $V_{IH}$ , SK = 2 MHz, CMOS input levels	—	2	3	mA

## 9 AC ELECTRICAL CHARACTERISTICS

### AC Characteristics - Industrial

**Table 9.1: AC Characteristics - Industrial**
 $(T_A = -40^{\circ}\text{C to } +85^{\circ}\text{C, Supply voltage} = 1.8\text{V to } 5.5\text{V})$ 

Symbol	Parameter <sup>[1]</sup>	1.8V ≤ V <sub>CC</sub> < 2.5V		2.5V ≤ V <sub>CC</sub> < 4.5V		4.5V ≤ V <sub>CC</sub> < 5.5V		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
f <sub>SCK</sub>	SCK Clock Frequency	0	1	0	2	0	3	MHz
t <sub>R</sub>	Input Rise Time	—	10	—	10	—	10	ns
t <sub>F</sub>	Input Fall Time	—	10	—	10	—	10	ns
t <sub>SKH</sub>	SK High Time	250	—	200	—	200	—	ns
t <sub>SKL</sub>	SK Low Time	250	—	200	—	100	—	ns
t <sub>CS</sub>	Minimum CS LOW Time	250	—	200	—	200	—	ns
t <sub>CSS</sub>	CS Setup Time	200	—	100	—	50	—	ns
t <sub>CSH</sub>	CS Hold Time	0	—	0	—	0	—	ns
t <sub>DIS</sub>	D <sub>IN</sub> Setup Time	100	—	50	—	50	—	ns
t <sub>DIH</sub>	D <sub>IN</sub> Hold Time	50	—	50	—	50	—	ns
t <sub>PD1</sub>	Output Delay to “1”	—	400	—	200	—	100	ns
t <sub>PD0</sub>	Output Delay to “0”	—	400	—	200	—	100	ns
t <sub>SV</sub>	CS to Status Valid	—	400	—	200	—	200	ns
t <sub>DF</sub>	CS to Dout in 3-state	—	100	—	100	—	100	ns
t <sub>WP</sub>	Write Cycle Time	—	10	—	5	—	5	ms

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

2. AC measurement conditions:

C<sub>L</sub> = 100 pF

Input pulse voltages: per V<sub>IL</sub> and V<sub>IH</sub> spec

Input rise and fall times: ≤ 10 ns

Timing reference voltages: half V<sub>CC</sub> level

**10 ORDERING INFORMATION****Industrial Grade: 1.8V to 5.5V, -40°C to +85°C, Lead-free**

<b>Product</b>	<b>Voltage Range</b>	<b>Part Number*</b>	<b>Package (8-pin)*</b>
GT93C86	1.8V to 5.5V	GT93C86-2GRLI-TR	150-mil SOIC/SOP (JEDEC)
		GT93C86-2ZLI-TR	3 x 4.4 mm TSSOP

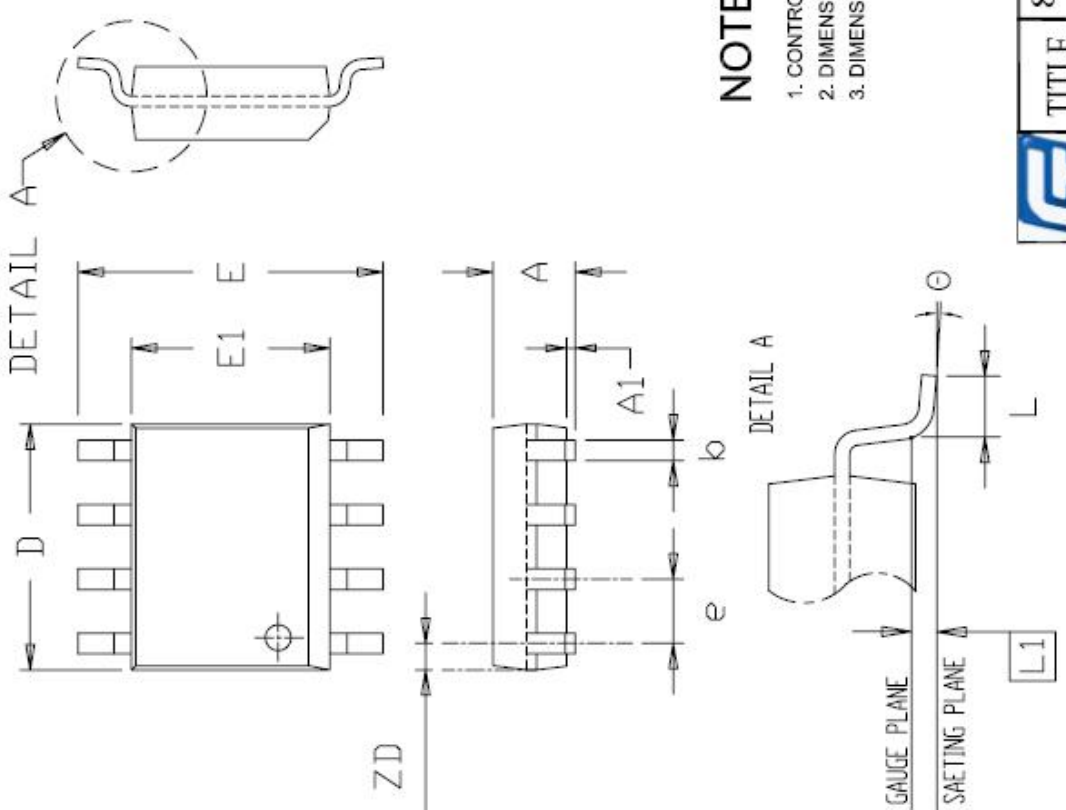
\*

1. Contact Giantec Sales Representatives for availability and other package information.
2. The listed part numbers are packed in tape and reel “-TR” (4K per reel).
3. For tube/bulk packaging, remove “-TR” at the end of the P/N.
4. Refer to Giantec website for related declaration document on lead free, RoHS, halogen free, or Green, whichever is applicable.
5. Giantec offers Industrial grade for Commercial applications (0°C to +70°C).

# 11 PACKAGE INFORMATION


## SOIC/SOP (JEDEC)

SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MTN.	NOM.	MAX.	MTN.	NOM.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
b	0.33		0.51	0.013		0.020
D	4.80		5.00	0.189		0.197
E	5.80		6.20	0.228		0.244
E1	3.80		4.00	0.150		0.157
e	1.27 BSC.			0.050 BSC.		
L	0.38		1.27	0.015		0.050
L1	0.25 BSC.			0.010 BSC.		
ZD	0.545 REF.			0.021 REF.		
ø	0		8°	0		8°

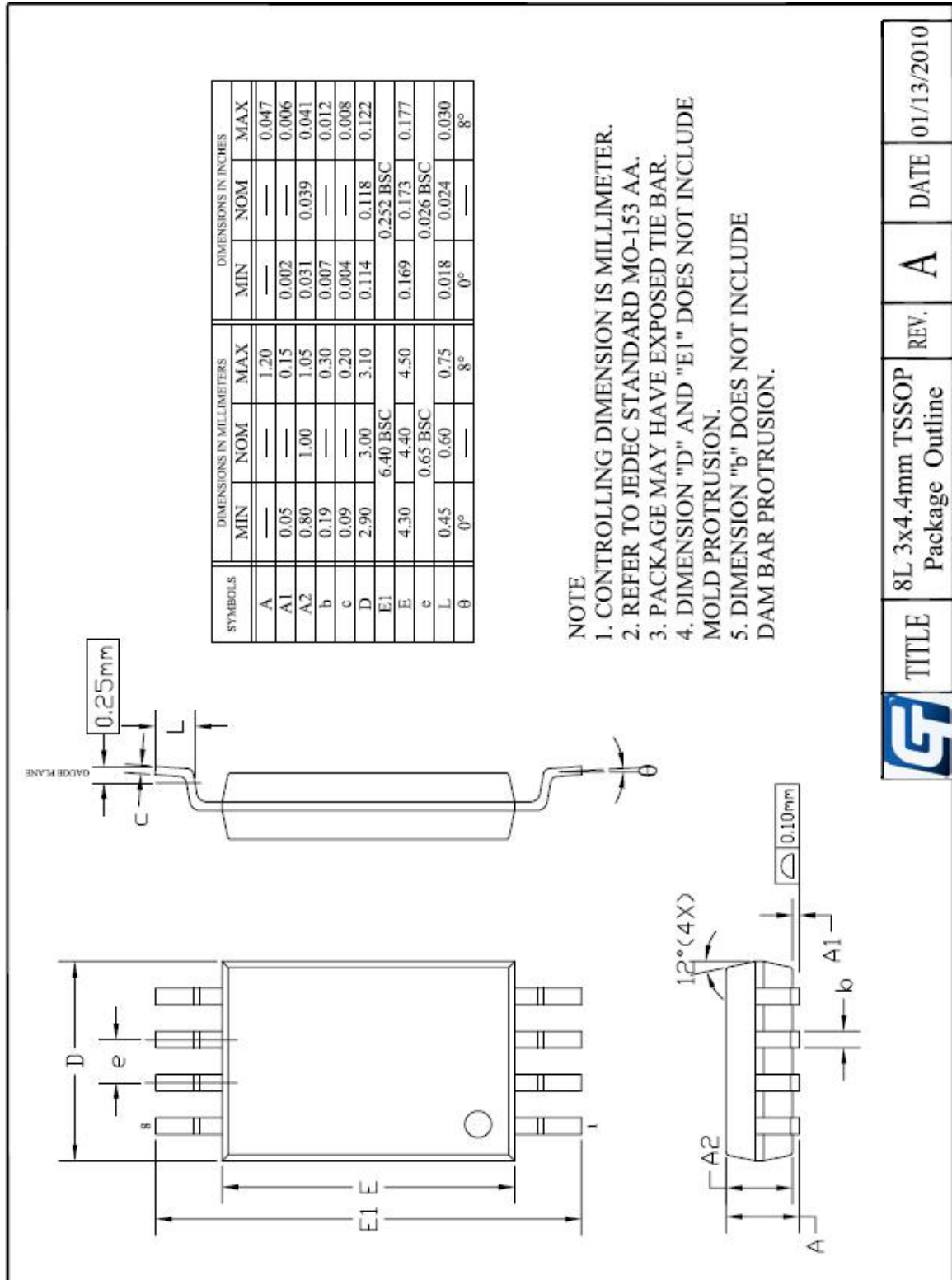


**NOTE :**

1. CONTROLLING DIMENSION : MM
2. DIMENSION D AND E1 DO NOT INCLUDE MOLD PROTRUSION.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION/INTRUSION.

	TITLE	8L 150mil SOP Package Outline	REV.	A	DATE	01/13/2010
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**TSSOP**



	TITLE	REV.	DATE
	8L 3x4.4mm TSSOP Package Outline	A	01/13/2010

**12 REVISION HISTORY**

<b>Revision</b>	<b>Date</b>	<b>Page</b>	<b>Descriptions</b>
a0	3/23/2010	All	Initial version