



# M74HCT652

## OCTAL BUS TRANSCEIVER/REGISTER WITH 3 STATE OUTPUTS

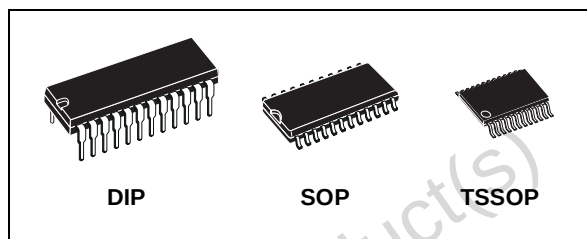
- HIGH SPEED:  
 $f_{MAX} = 55 \text{ MHz (TYP.) at } V_{CC} = 4.5V$
- LOW POWER DISSIPATION:  
 $I_{CC} = 4\mu A(\text{MAX.}) \text{ at } T_A = 25^\circ C$
- COMPATIBLE WITH TTL OUTPUTS :  
 $V_{IH} = 2V \text{ (MIN.) } V_{IL} = 0.8V \text{ (MAX)}$
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OH}| = I_{OL} = 6mA \text{ (MIN)}$
- BALANCED PROPAGATION DELAYS:  
 $t_{PLH} \approx t_{PHL}$
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 652

### DESCRIPTION

The 74HCT652 is an advanced high-speed CMOS OCTAL BUS TRANSCEIVER AND REGISTER (3-STATE) fabricated with silicon gate C<sup>2</sup>MOS technology.

This device consists of bus transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal storage registers. Enable GAB and GBA are provided to control the transceiver functions. Select AB(SAB) and select BA(SBA) control pins are provided to select whether real-time or stored data is transferred. A low input level selects real-time data, and a high selects stored data.

Data on the A or B bus, or both, can be stored in the internal D flip-flops by low-to-high transition at the appropriate clock pins (CLOCK AB or CLOCK



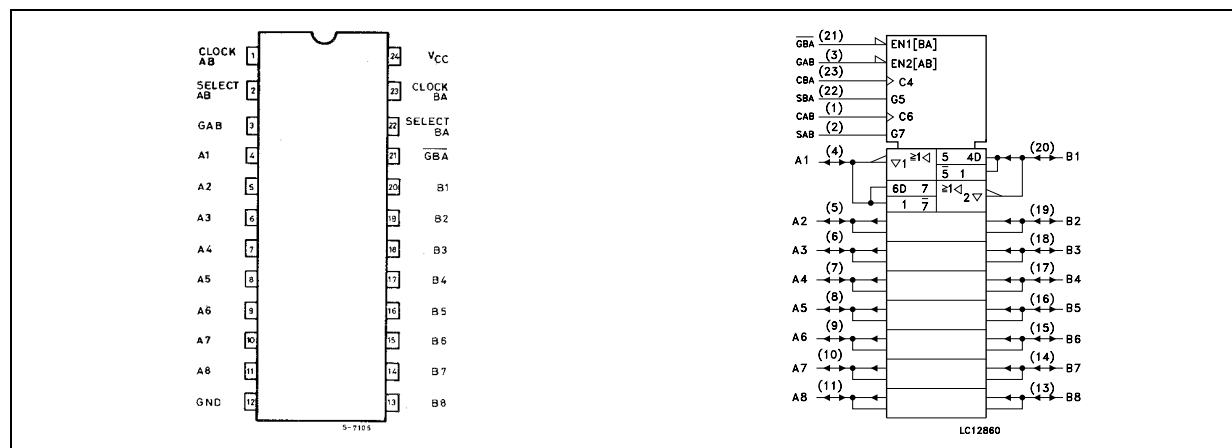
### ORDER CODES

| PACKAGE | TUBE         | T & R           |
|---------|--------------|-----------------|
| DIP     | M74HCT652B1R |                 |
| SOP     | M74HCT652M1R | M74HCT652RM13TR |
| TSSOP   |              | M74HCT652TTR    |

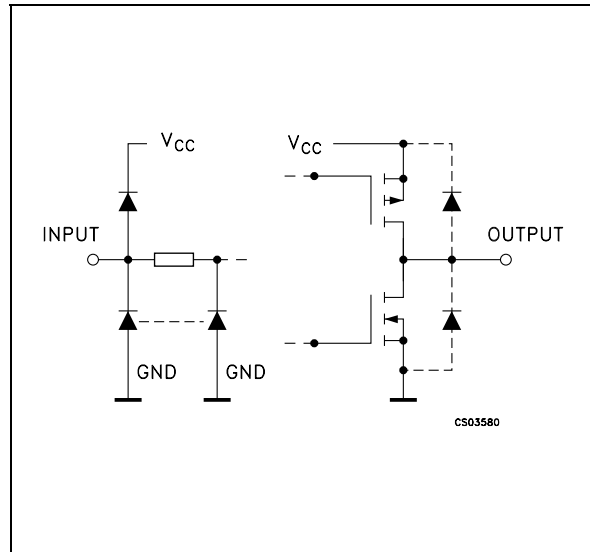
BA) regardless of the select or enable control pins. When select AB and select BA are in the real time transfer mode, it is also possible to store data without using the internal D type flip-flops by simultaneously enabling GAB and GBA. In this configuration each output reinforces its input. Thus, when all other data sources to the two sets of bus lines are at high impedance, each set of bus lines will remain at its last state.

All inputs are equipped with protection circuits against static discharge and transient excess voltage.

### PIN CONNECTION AND IEC LOGIC SYMBOLS



## INPUT AND OUTPUT EQUIVALENT CIRCUIT



## PIN DESCRIPTION

| PIN No                         | SYMBOL          | NAME AND FUNCTION                                |
|--------------------------------|-----------------|--------------------------------------------------|
| 1                              | CAB             | A to B Clock Input (LOW to HIGH, Edge-Triggered) |
| 2                              | SAB             | Select A to B Source Input                       |
| 3                              | GAB             | Direction Control Input                          |
| 4, 5, 6, 7, 8, 9, 10, 11       | A1 to A8        | A Data Inputs/Outputs                            |
| 20, 19, 18, 17, 16, 15, 14, 13 | B1 to B8        | B Data Inputs/Outputs                            |
| 21                             | GBA             | Output Enable Input (Active LOW)                 |
| 22                             | SBA             | Select B to A Source Input                       |
| 23                             | CBA             | B to A Clock Input (LOW to HIGH, Edge Triggered) |
| 12                             | GND             | Ground (0V)                                      |
| 24                             | V <sub>CC</sub> | Positive Supply Voltage                          |

## TRUTH TABLE

| GAB | $\overline{\text{GBA}}$ | CAB | CBA | SAB | SBA | A       | B      | FUNCTION                                                                                                                                                                     |
|-----|-------------------------|-----|-----|-----|-----|---------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| L   | H                       |     |     |     |     | INPUTS  | INPUTS | Both the A bus and the B bus are inputs                                                                                                                                      |
|     |                         | X   | X   | X   | X   | Z       | Z      | The Output functions of the A and B bus are disabled                                                                                                                         |
|     |                         |     |     | X   | X   | INPUTS  | INPUTS | Both the A and B bus are used for inputs to the internal flip-flops. Data at the bus will be stored on low to high transition of the clock inputs.                           |
| L   | L                       |     |     |     |     | OUTPUTS | INPUTS | The A bus are outputs and the B bus are inputs                                                                                                                               |
|     |                         | X*  | X   | X   | L   | L       | L      | The data at the B bus are displayed at the A bus                                                                                                                             |
|     |                         |     |     |     |     | H       | H      |                                                                                                                                                                              |
|     |                         | X*  |     | X   | L   | L       | L      | The data at the B bus are displayed at the A bus. The data of the B bus are stored to internal flip-flop on low to high transition of the clock pulse                        |
|     |                         |     |     |     |     | H       | H      |                                                                                                                                                                              |
|     |                         | X*  | X   | X   | H   | Qn      | X      | The data stored to the internal flip-flop are displayed at the A bus.                                                                                                        |
| H   | H                       |     |     |     |     | L       | L      | The data at the B bus are stored to the internal flip-flop on low to high transition of the clock pulse. The states of the internal flip-flops output directly to the A bus. |
|     |                         |     |     |     |     | H       | H      |                                                                                                                                                                              |
|     |                         | X   | X*  | L   | X   | L       | L      | The data at the A bus are displayed at the B bus                                                                                                                             |
|     |                         |     |     |     |     | H       | H      |                                                                                                                                                                              |
|     |                         |     | X*  | L   | X   | L       | L      | The data at the A bus are displayed at the B bus. The data of the A bus are stored to the internal flip-flop on low to high transition of the clock pulse.                   |
|     |                         |     |     |     |     | H       | H      |                                                                                                                                                                              |
| H   | H                       | X   | X*  | H   | X   | X       | Qn     | The data stored to the internal flip-flops are displayed at the B bus                                                                                                        |
|     |                         |     | X*  | H   | X   | L       | L      | The data at the A bus are stored to the internal flip-flop on low to high transition of the clock pulse. The states of the internal flip-flops output directly to the B bus. |
|     |                         |     |     |     |     | H       | H      |                                                                                                                                                                              |

| GAB | GBA | CAB | CBA | SAB | SBA | A       | B       | FUNCTION                                                                                                            |
|-----|-----|-----|-----|-----|-----|---------|---------|---------------------------------------------------------------------------------------------------------------------|
| H   | L   |     |     |     |     | OUTPUTS | OUTPUTS |                                                                                                                     |
|     |     | X   | X   | H   | H   | Qn      | Qn      | The data stored to the internal flip-flops are displayed at the A and B bus respectively.                           |
|     |     |     |     | H   | H   | Qn      | Qn      | The output at the A bus are displayed at the B bus, the output at the B bus are displayed at the A bus respectively |

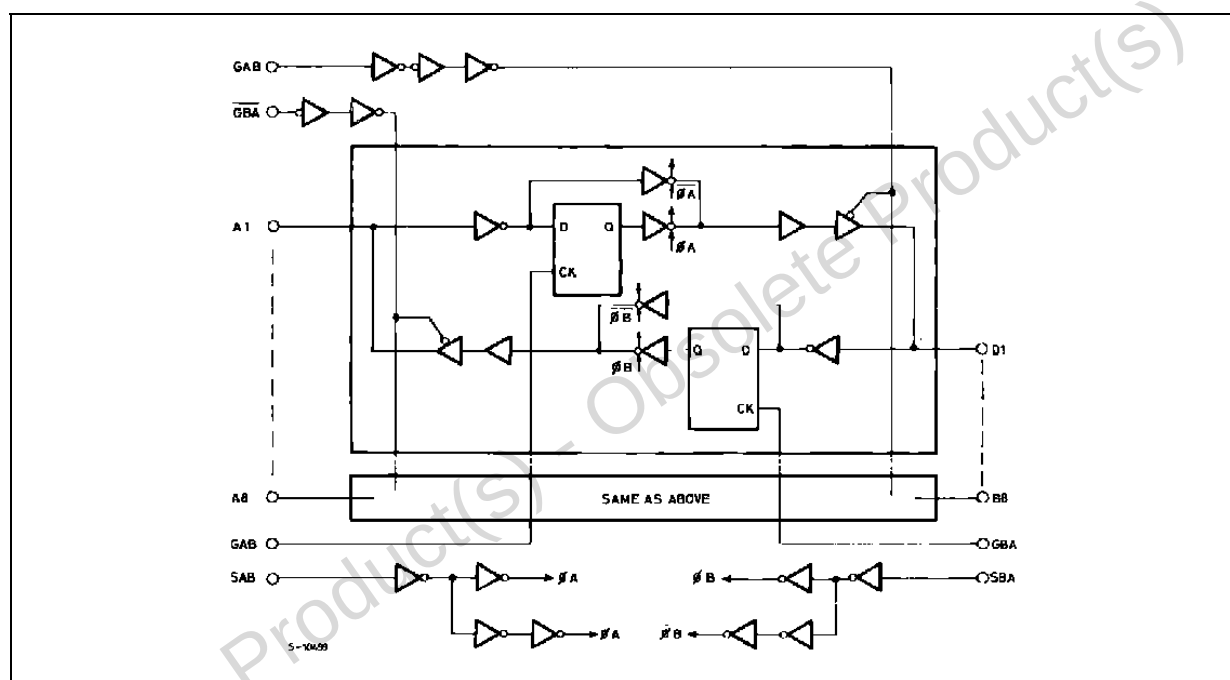
X : Don't Care

Z : High Impedance

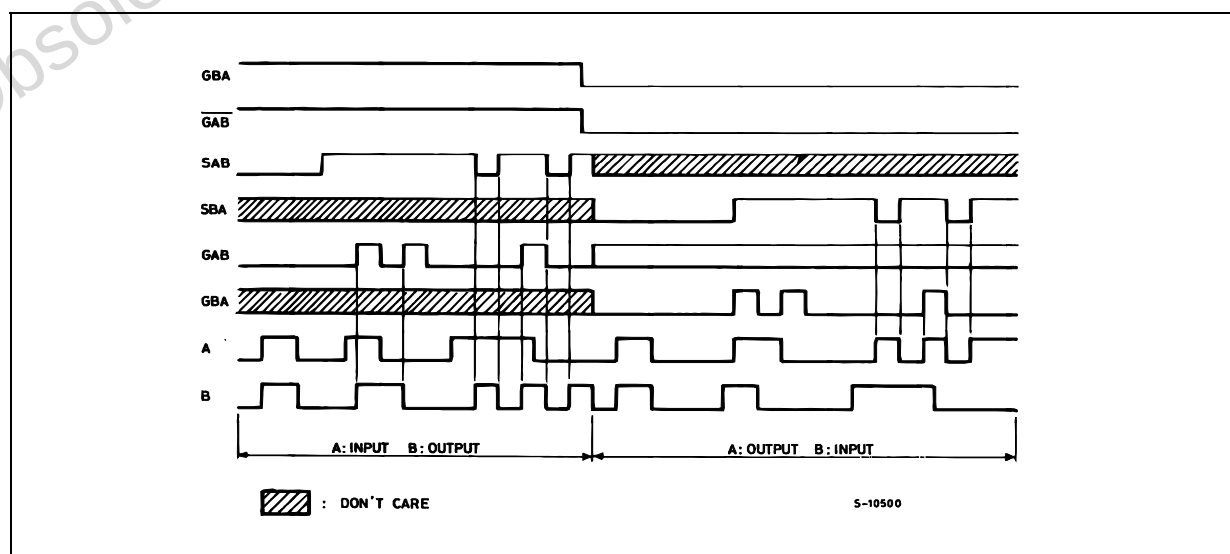
Qn : The data stored to the internal flip-flops by most recent low to high transition of the clock inputs

\* : The data at the A and B bus will be stored to the internal flip-flops on every low to high transition of the clock inputs.

## LOGIC DIAGRAM



## TIMING CHART



## ABSOLUTE MAXIMUM RATINGS

| Symbol                | Parameter                     | Value                  | Unit |
|-----------------------|-------------------------------|------------------------|------|
| $V_{CC}$              | Supply Voltage                | -0.5 to +7             | V    |
| $V_I$                 | DC Input Voltage              | -0.5 to $V_{CC} + 0.5$ | V    |
| $V_O$                 | DC Output Voltage             | -0.5 to $V_{CC} + 0.5$ | V    |
| $I_{IK}$              | DC Input Diode Current        | $\pm 20$               | mA   |
| $I_{OK}$              | DC Output Diode Current       | $\pm 20$               | mA   |
| $I_O$                 | DC Output Current             | $\pm 35$               | mA   |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or Ground Current | $\pm 70$               | mA   |
| $P_D$                 | Power Dissipation             | 500(*)                 | mW   |
| $T_{stg}$             | Storage Temperature           | -65 to +150            | °C   |
| $T_L$                 | Lead Temperature (10 sec)     | 300                    | °C   |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

(\*) 500mW at 65 °C; derate to 300mW by 10mW/°C from 65°C to 85°C

## RECOMMENDED OPERATING CONDITIONS

| Symbol     | Parameter                                             | Value         | Unit |
|------------|-------------------------------------------------------|---------------|------|
| $V_{CC}$   | Supply Voltage                                        | 4.5 to 5.5    | V    |
| $V_I$      | Input Voltage                                         | 0 to $V_{CC}$ | V    |
| $V_O$      | Output Voltage                                        | 0 to $V_{CC}$ | V    |
| $T_{op}$   | Operating Temperature                                 | -55 to 125    | °C   |
| $t_r, t_f$ | Input Rise and Fall Time ( $V_{CC} = 4.5$ to $5.5V$ ) | 0 to 500      | ns   |

## DC SPECIFICATIONS

| Symbol            | Parameter                             | Test Condition         |                                                                                                                                       | Value                 |      |       |             |      |              | Unit |      |
|-------------------|---------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------|-------|-------------|------|--------------|------|------|
|                   |                                       | V <sub>CC</sub><br>(V) |                                                                                                                                       | T <sub>A</sub> = 25°C |      |       | -40 to 85°C |      | -55 to 125°C |      |      |
|                   |                                       |                        |                                                                                                                                       | Min.                  | Typ. | Max.  | Min.        | Max. | Min.         |      | Max. |
| V <sub>IH</sub>   | High Level Input Voltage              | 4.5 to 5.5             |                                                                                                                                       | 2.0                   |      |       | 2.0         |      | 2.0          |      | V    |
| V <sub>IL</sub>   | Low Level Input Voltage               | 4.5 to 5.5             |                                                                                                                                       |                       |      | 0.8   |             | 0.8  |              | 0.8  | V    |
| V <sub>OH</sub>   | High Level Output Voltage             | 4.5                    | I <sub>O</sub> =-20 μA                                                                                                                | 4.4                   | 4.5  |       | 4.4         |      | 4.4          |      | V    |
|                   |                                       |                        | I <sub>O</sub> =-6.0 mA                                                                                                               | 4.18                  | 4.31 |       | 4.13        |      | 4.10         |      |      |
| V <sub>OL</sub>   | Low Level Output Voltage              | 4.5                    | I <sub>O</sub> =20 μA                                                                                                                 |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  | V    |
|                   |                                       |                        | I <sub>O</sub> =6.0 mA                                                                                                                |                       | 0.17 | 0.26  |             | 0.33 |              | 0.40 |      |
| I <sub>I</sub>    | Input Leakage Current                 | 5.5                    | V <sub>I</sub> = V <sub>CC</sub> or GND                                                                                               |                       |      | ± 0.1 |             | ± 1  |              | ± 1  | μA   |
| I <sub>oZ</sub>   | High Impedance Output Leakage Current | 5.5                    | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>O</sub> = V <sub>CC</sub> or GND                                        |                       |      | ± 0.5 |             | ± 5  |              | ± 10 | μA   |
| I <sub>CC</sub>   | Quiescent Supply Current              | 5.5                    | V <sub>I</sub> = V <sub>CC</sub> or GND                                                                                               |                       |      | 4     |             | 40   |              | 80   | μA   |
| Δ I <sub>CC</sub> | Additional Worst Case Supply Current  | 5.5                    | Per Input pin<br>V <sub>I</sub> = 0.5V or<br>V <sub>I</sub> = 2.4V<br>Other Inputs at<br>V <sub>CC</sub> or GND<br>I <sub>O</sub> = 0 |                       |      | 2.0   |             | 2.9  |              | 3.0  | mA   |

(\*) Applicable Only to GAB, GBA, CAB, CBA, SAB, SBA Input

AC ELECTRICAL CHARACTERISTICS ( $C_L = 50 \text{ pF}$ , Input  $t_r = t_f = 6 \text{ ns}$ )

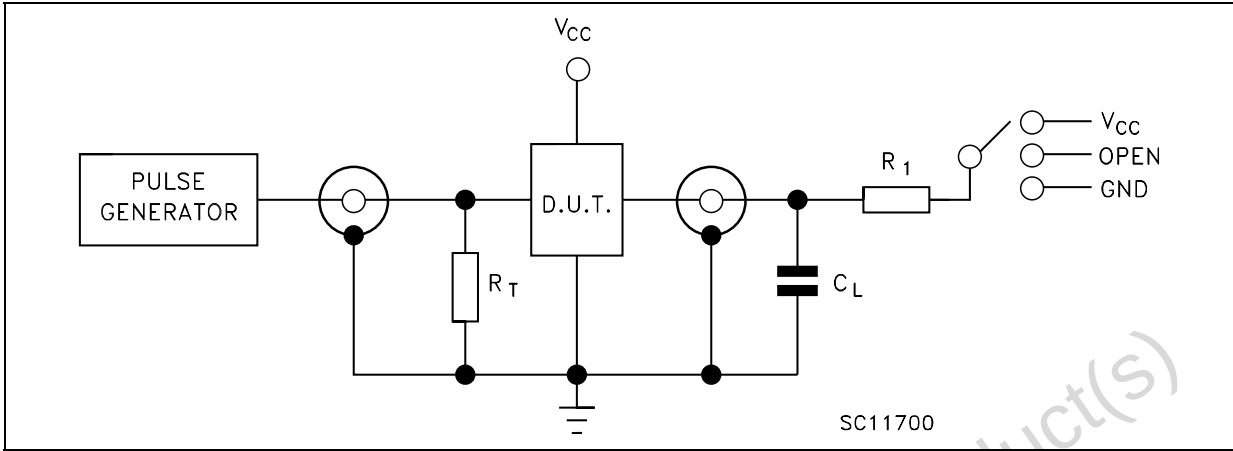
| Symbol                                 | Parameter                             | Test Condition         |                        |                       | Value                 |      |      |             |      |              |      |     | Unit |
|----------------------------------------|---------------------------------------|------------------------|------------------------|-----------------------|-----------------------|------|------|-------------|------|--------------|------|-----|------|
|                                        |                                       | V <sub>CC</sub><br>(V) | C <sub>L</sub><br>(pF) |                       | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |     |      |
|                                        |                                       |                        |                        |                       | Min.                  | Typ. | Max. | Min.        | Max. | Min.         | Max. |     |      |
| t <sub>TLH</sub> t <sub>THL</sub>      | Output Transition Time                | 4.5                    | 50                     |                       |                       | 7    | 12   |             | 15   |              |      | ns  |      |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time (BUS - BUS)    | 4.5                    | 50                     |                       |                       | 20   | 30   |             | 38   |              |      | ns  |      |
|                                        |                                       | 4.5                    | 150                    |                       |                       | 25   | 38   |             | 48   |              |      |     |      |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time (CLOCK - BUS)  | 4.5                    | 50                     |                       |                       | 29   | 44   |             | 55   |              |      | ns  |      |
|                                        |                                       | 4.5                    | 150                    |                       |                       | 34   | 52   |             | 65   |              |      |     |      |
| t <sub>PLH</sub> t <sub>PHL</sub>      | Propagation Delay Time (SELECT - BUS) | 4.5                    | 50                     |                       |                       | 24   | 34   |             | 43   |              |      | ns  |      |
|                                        |                                       | 4.5                    | 150                    |                       |                       | 29   | 42   |             | 53   |              |      |     |      |
| t <sub>PZL</sub> t <sub>PZH</sub>      | High Impedance Output Enable Time     | 4.5                    | 50                     | R <sub>L</sub> = 1 KΩ |                       | 22   | 33   |             | 41   |              |      | ns  |      |
|                                        |                                       | 4.5                    | 150                    | R <sub>L</sub> = 1 KΩ |                       | 27   | 41   |             | 51   |              |      |     |      |
| t <sub>PLZ</sub> t <sub>PHZ</sub>      | High Impedance Output Disable Time    | 4.5                    | 50                     | R <sub>L</sub> = 1 KΩ |                       | 24   | 35   |             | 44   |              |      | ns  |      |
| f <sub>MAX</sub>                       | Maximum Clock Frequency               | 4.5                    | 50                     |                       | 31                    | 55   |      | 25          |      |              |      | MHz |      |
| t <sub>W(H)</sub><br>t <sub>W(L)</sub> | Minimum Pulse Width                   | 4.5                    | 50                     |                       |                       | 8    | 15   |             | 19   |              |      | ns  |      |
| t <sub>s</sub>                         | Minimum Set-Up Time                   | 4.5                    | 50                     |                       |                       | 3    | 10   |             | 13   |              |      | ns  |      |
| t <sub>h</sub>                         | Minimum Hold Time                     | 4.5                    | 50                     |                       |                       |      | 5    |             | 5    |              |      | ns  |      |

## CAPACITIVE CHARACTERISTICS

| Symbol           | Parameter                              | Test Condition         |  | Value                 |      |      |             |      |              |      |    | Unit |
|------------------|----------------------------------------|------------------------|--|-----------------------|------|------|-------------|------|--------------|------|----|------|
|                  |                                        | V <sub>CC</sub><br>(V) |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |    |      |
|                  |                                        |                        |  | Min.                  | Typ. | Max. | Min.        | Max. | Min.         | Max. |    |      |
| C <sub>IN</sub>  | Input Capacitance                      |                        |  |                       | 5    | 10   |             | 10   |              | 10   | pF |      |
| C <sub>I/O</sub> | Bus Terminal Capacitance               |                        |  |                       | 13   |      |             |      |              |      | pF |      |
| C <sub>PD</sub>  | Power Dissipation Capacitance (note 1) |                        |  |                       | 39   |      |             |      |              |      | pF |      |

1)  $C_{PD}$  is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation.  $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/8$  (per channel)

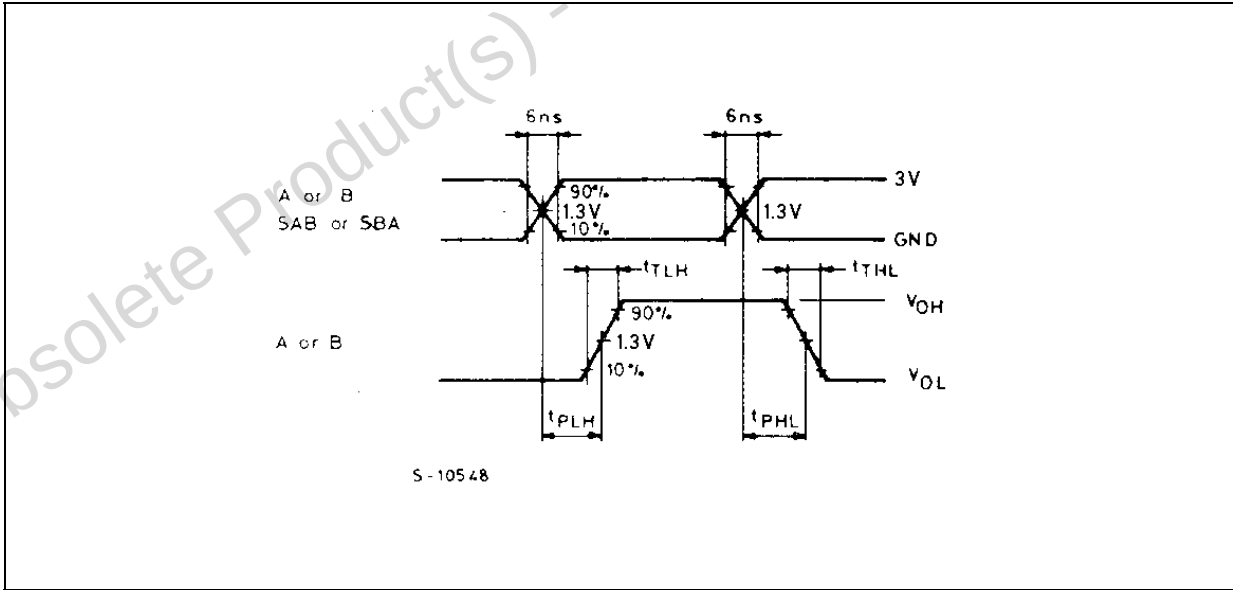
TEST CIRCUIT

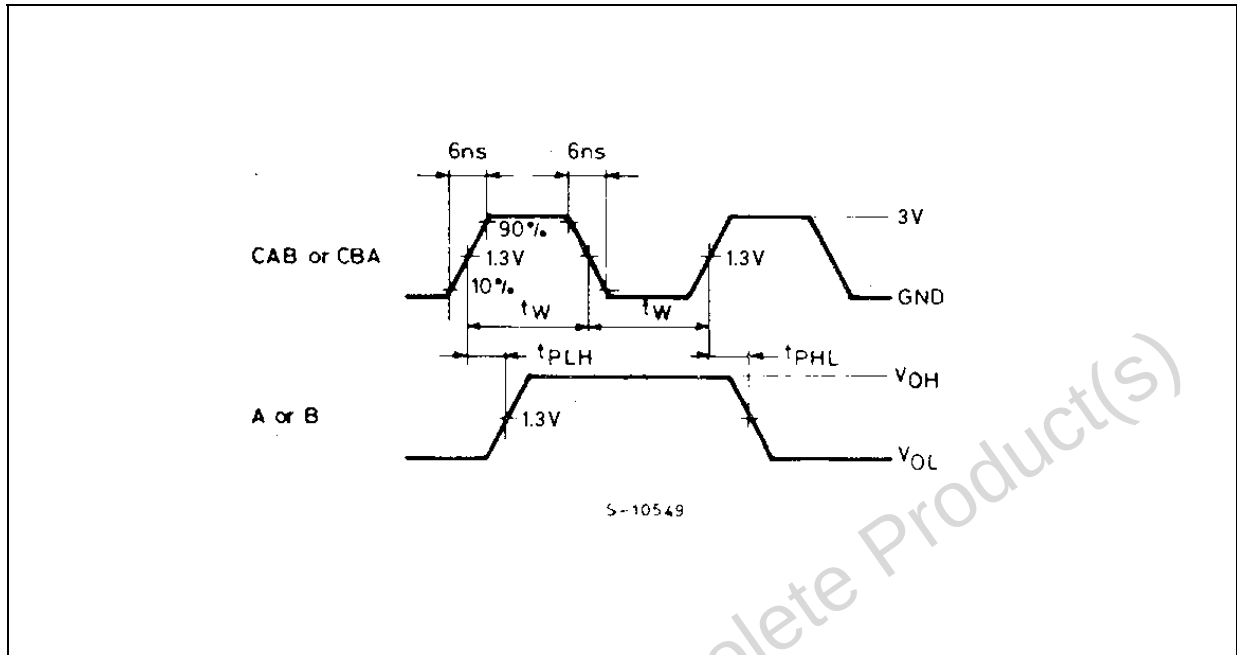
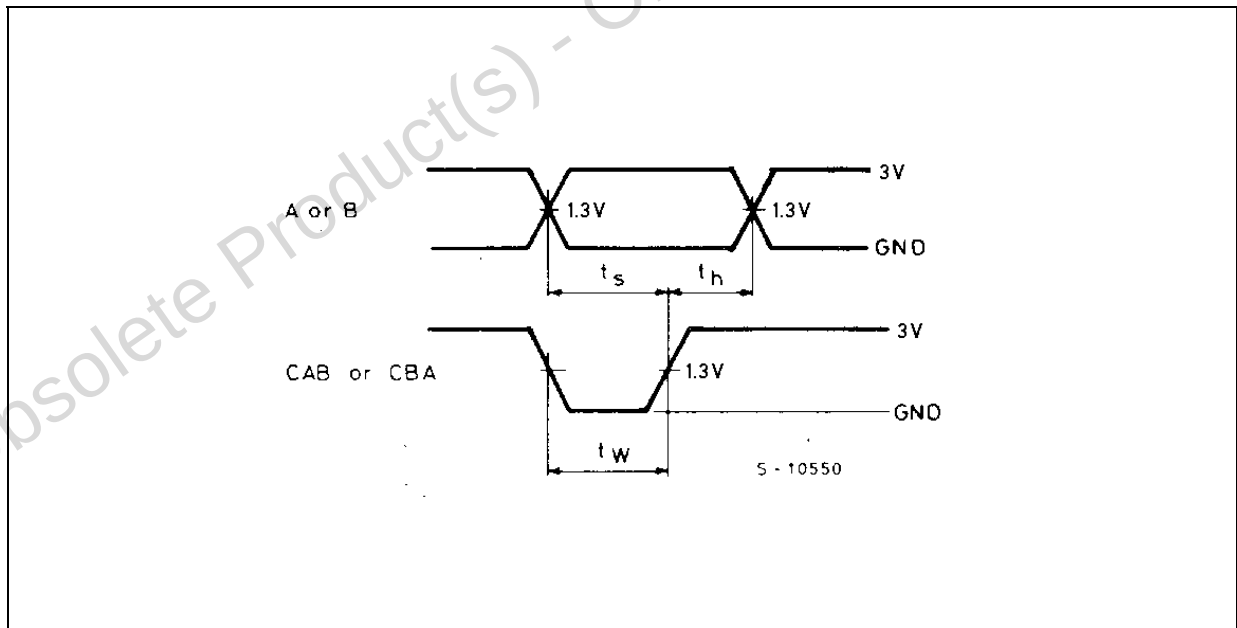


| TEST                  | SWITCH   |
|-----------------------|----------|
| $t_{PLH}$ , $t_{PHL}$ | Open     |
| $t_{PZL}$ , $t_{PLZ}$ | $V_{CC}$ |
| $t_{PZH}$ , $t_{PHZ}$ | GND      |

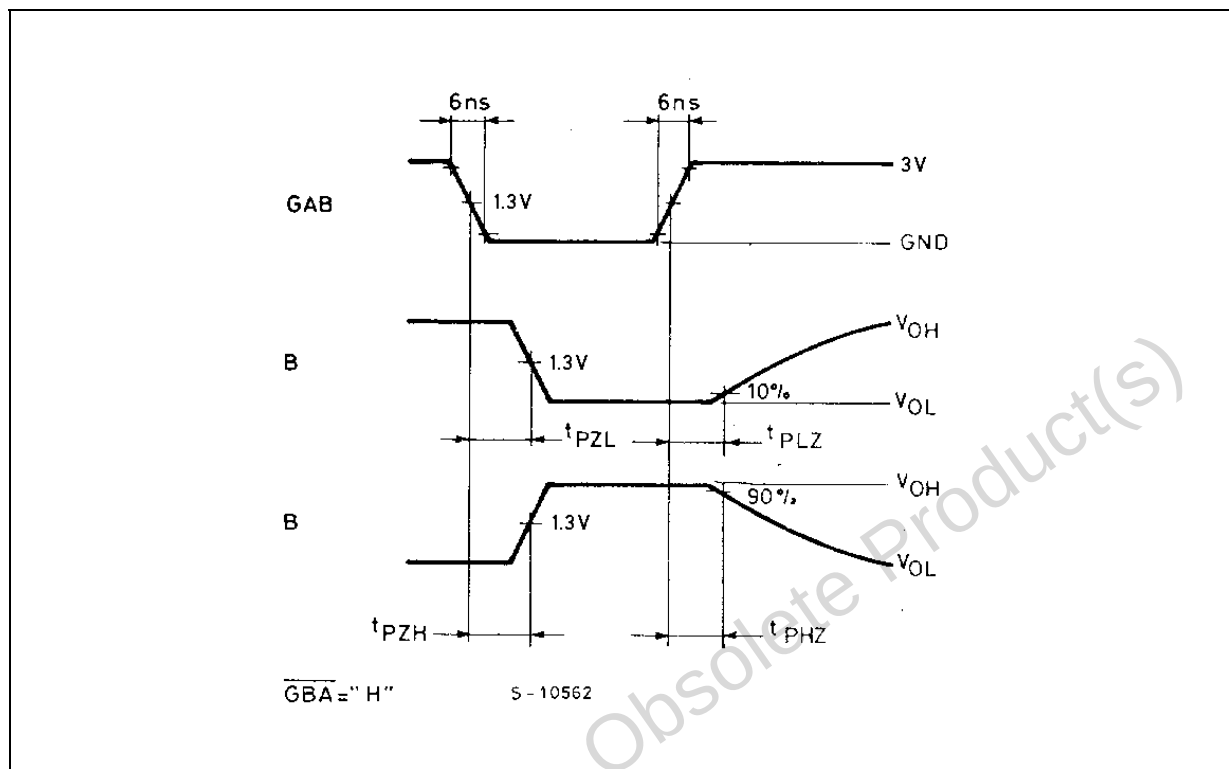
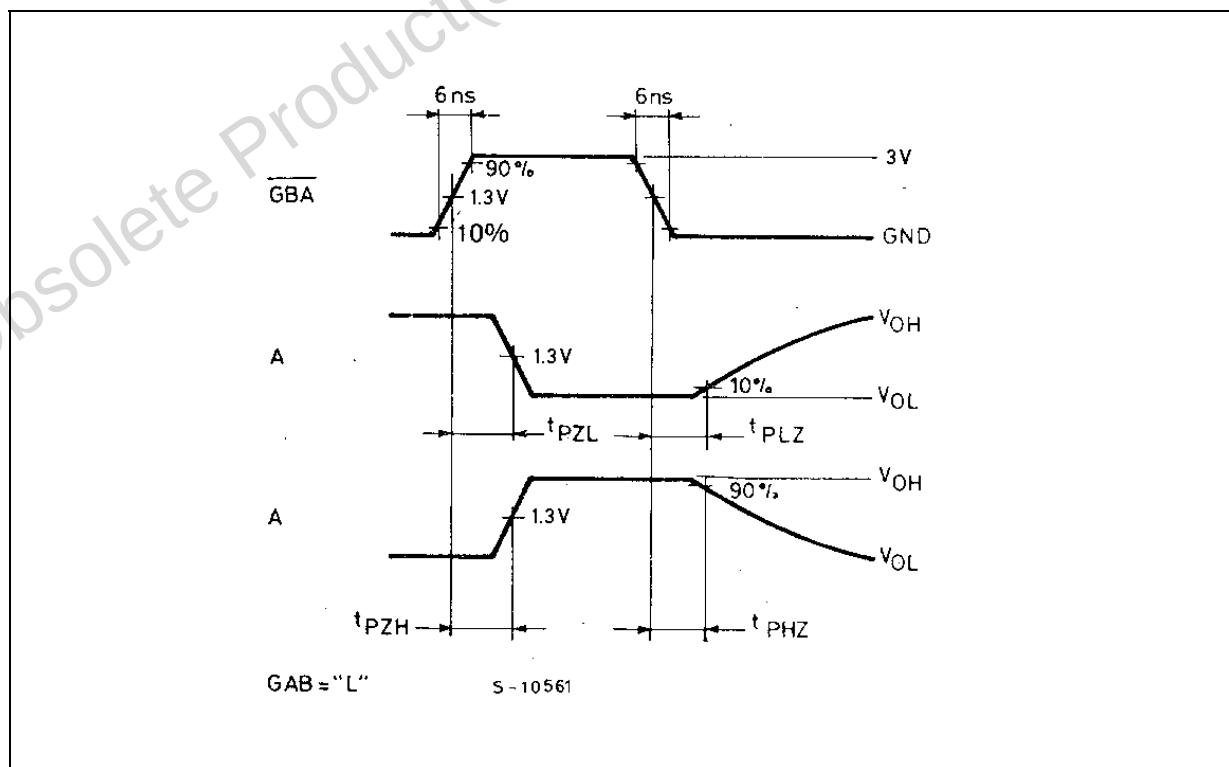
$C_L$  = 50pF/150pF or equivalent (includes jig and probe capacitance)  
 $R_1$  = 1K $\Omega$  or equivalent  
 $R_T$  =  $Z_{OUT}$  of pulse generator (typically 50 $\Omega$ )

WAVEFORM 1 : PROPAGATION DELAY TIME(f=1MHz; 50% duty cycle)



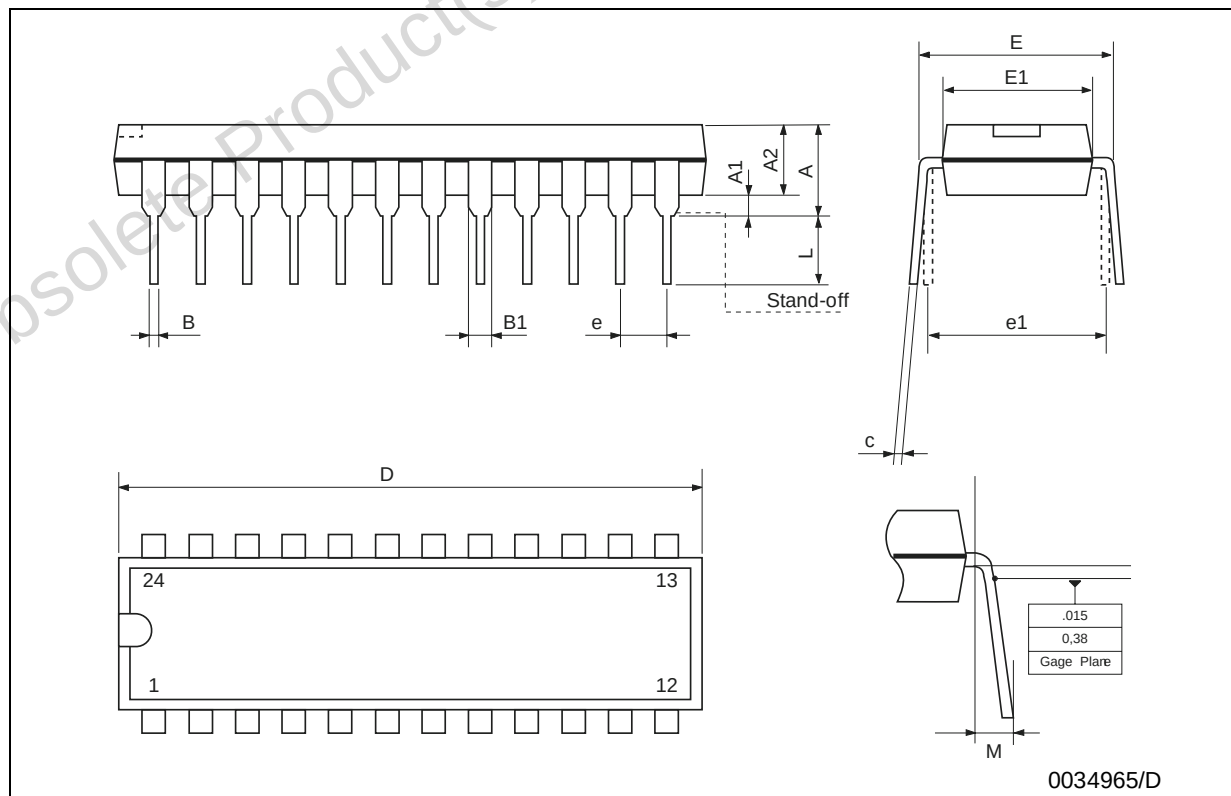
**WAVEFORM 2 : MINIMUM PULSE WIDTH, PROPAGATION DELAY** ( $f=1\text{MHz}$ ; 50% duty cycle)**WAVEFORM 3 : MINIMUM SETUP AND HOLD TIME** ( $f=1\text{MHz}$ ; 50% duty cycle)



**WAVEFORM 4 : OUTPUT ENABLE AND DISABLE TIME (f=1MHz; 50% duty cycle)****WAVEFORM 5 : OUTPUT ENABLE AND DISABLE TIME (f=1MHz; 50% duty cycle)**

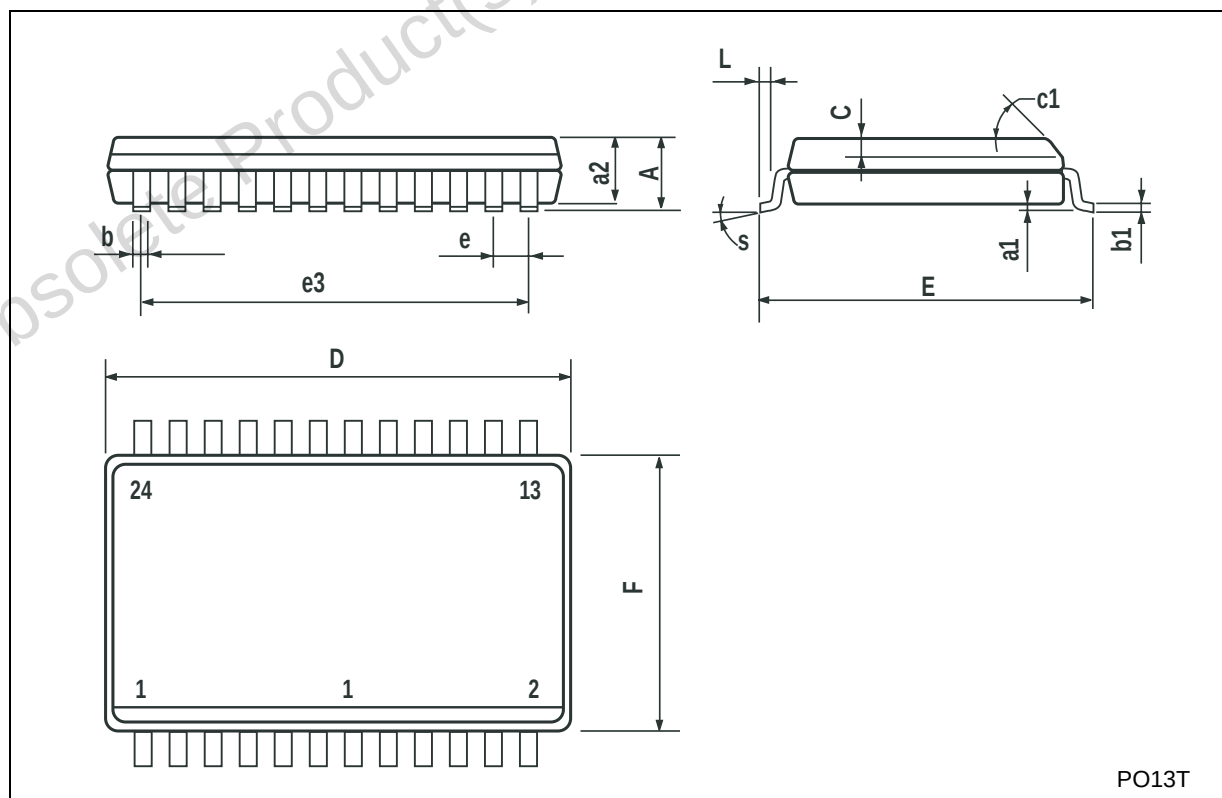
### Plastic DIP-24 (0.25) MECHANICAL DATA

| DIM. | mm.   |       |       | inch  |       |       |
|------|-------|-------|-------|-------|-------|-------|
|      | MIN.  | TYP   | MAX.  | MIN.  | TYP.  | MAX.  |
| A    |       |       | 4.32  |       |       | 0.170 |
| A1   | 0.38  |       |       | 0.015 |       |       |
| A2   |       | 3.3   |       |       | 0.130 |       |
| B    | 0.41  | 0.46  | 0.51  | 0.016 | 0.018 | 0.020 |
| B1   | 1.40  | 1.52  | 1.65  | 0.055 | 0.060 | 0.065 |
| c    | 0.20  | 0.25  | 0.30  | 0.008 | 0.010 | 0.012 |
| D    | 31.62 | 31.75 | 31.88 | 1.245 | 1.250 | 1.255 |
| E    | 7.62  |       | 8.26  | 0.300 |       | 0.325 |
| E1   | 6.35  | 6.60  | 6.86  | 0.250 | 0.260 | 0.270 |
| e    |       | 2.54  |       |       | 0.100 |       |
| E1   |       | 7.62  |       |       | 0.300 |       |
| L    | 3.18  |       | 3.43  | 0.125 |       | 0.135 |
| M    | 0°    |       | 15°   | 0°    |       | 15°   |



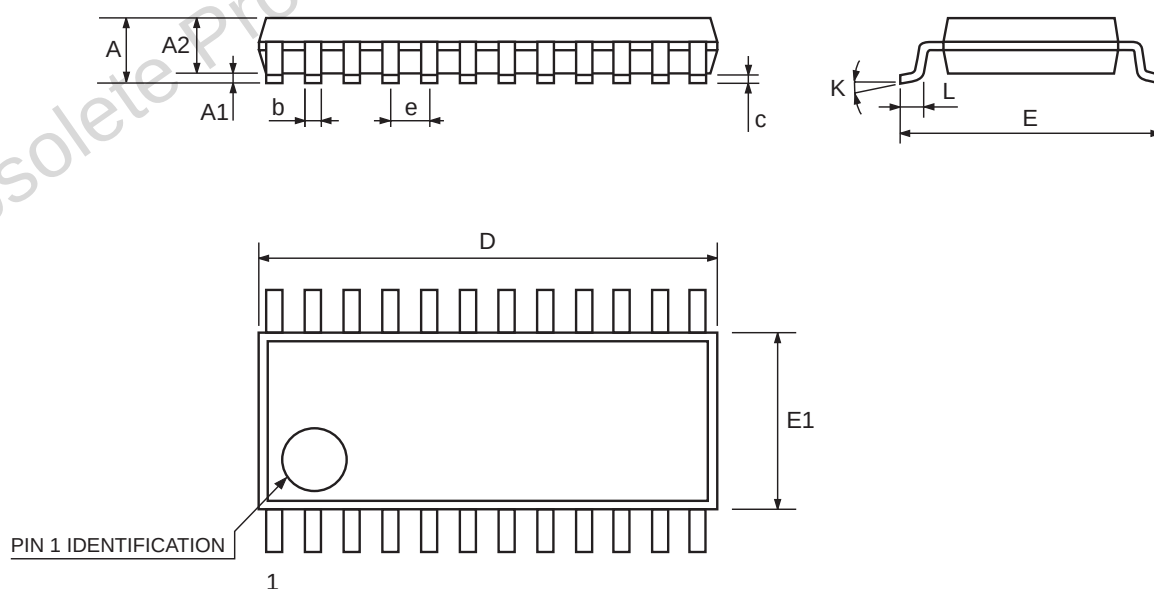
## SO-24 MECHANICAL DATA

| DIM. | mm.        |       |       | inch  |       |       |
|------|------------|-------|-------|-------|-------|-------|
|      | MIN.       | TYP   | MAX.  | MIN.  | TYP.  | MAX.  |
| A    |            |       | 2.65  |       |       | 0.104 |
| a1   | 0.1        |       | 0.2   | 0.004 |       | 0.008 |
| a2   |            |       | 2.45  |       |       | 0.096 |
| b    | 0.35       |       | 0.49  | 0.014 |       | 0.019 |
| b1   | 0.23       |       | 0.32  | 0.009 |       | 0.012 |
| C    |            | 0.5   |       |       | 0.020 |       |
| c1   | 45° (typ.) |       |       |       |       |       |
| D    | 15.20      |       | 15.60 | 0.598 |       | 0.614 |
| E    | 10.00      |       | 10.65 | 0.393 |       | 0.419 |
| e    |            | 1.27  |       |       | 0.050 |       |
| e3   |            | 13.97 |       |       | 0.550 |       |
| F    | 7.40       |       | 7.60  | 0.291 |       | 0.300 |
| L    | 0.50       |       | 1.27  | 0.020 |       | 0.050 |
| S    | 8° (max.)  |       |       |       |       |       |



## TSSOP24 MECHANICAL DATA

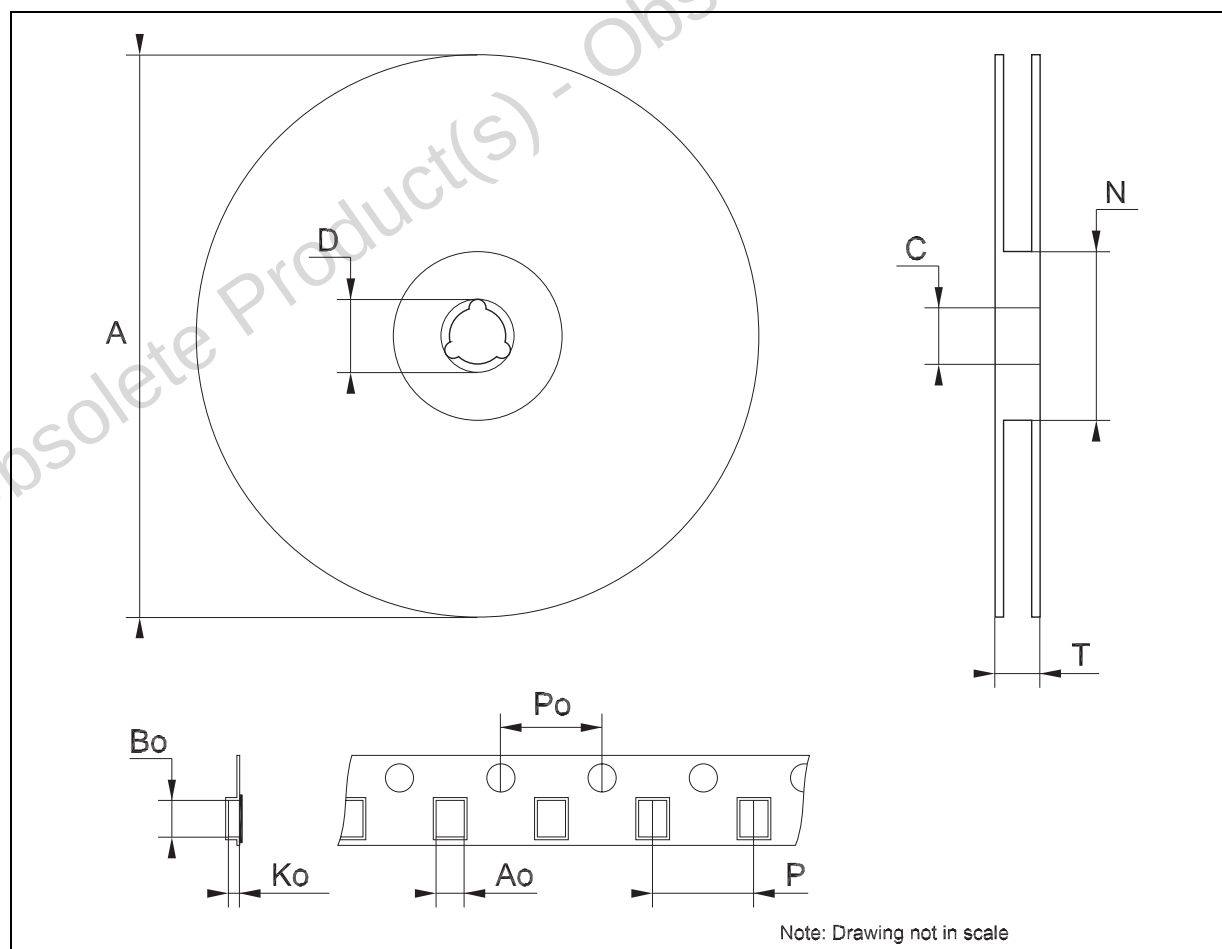
| DIM. | mm.  |          |      | inch   |            |        |
|------|------|----------|------|--------|------------|--------|
|      | MIN. | TYP      | MAX. | MIN.   | TYP.       | MAX.   |
| A    |      |          | 1.1  |        |            | 0.043  |
| A1   | 0.05 |          | 0.15 | 0.002  |            | 0.006  |
| A2   |      | 0.9      |      |        | 0.035      |        |
| b    | 0.19 |          | 0.30 | 0.0075 |            | 0.0118 |
| c    | 0.09 |          | 0.20 | 0.0035 |            | 0.0079 |
| D    | 7.7  |          | 7.9  | 0.303  |            | 0.311  |
| E    | 6.25 |          | 6.5  | 0.246  |            | 0.256  |
| E1   | 4.3  |          | 4.5  | 0.169  |            | 0.177  |
| e    |      | 0.65 BSC |      |        | 0.0256 BSC |        |
| K    | 0°   |          | 8°   | 0°     |            | 8°     |
| L    | 0.50 |          | 0.70 | 0.020  |            | 0.028  |



7047476A

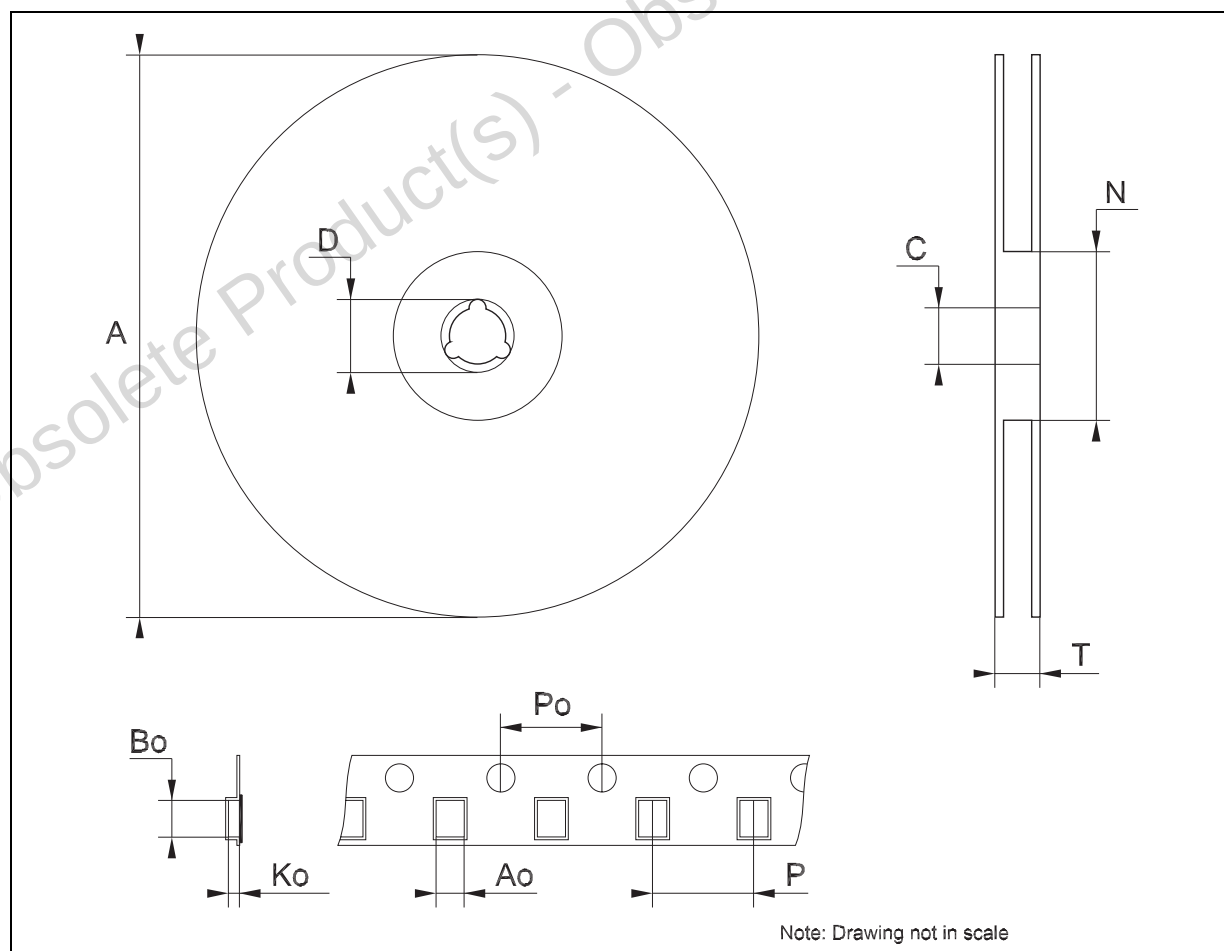
## Tape &amp; Reel SO-24 MECHANICAL DATA

| DIM. | mm.  |     |      | inch  |      |        |
|------|------|-----|------|-------|------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP. | MAX.   |
| A    |      |     | 330  |       |      | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |      | 0.519  |
| D    | 20.2 |     |      | 0.795 |      |        |
| N    | 60   |     |      | 2.362 |      |        |
| T    |      |     | 30.4 |       |      | 1.197  |
| Ao   | 10.8 |     | 11.0 | 0.425 |      | 0.433  |
| Bo   | 15.7 |     | 15.9 | 0.618 |      | 0.626  |
| Ko   | 2.9  |     | 3.1  | 0.114 |      | 0.122  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 11.9 |     | 12.1 | 0.468 |      | 0.476  |



## Tape &amp; Reel TSSOP24 MECHANICAL DATA

| DIM. | mm.  |     |      | inch  |      |        |
|------|------|-----|------|-------|------|--------|
|      | MIN. | TYP | MAX. | MIN.  | TYP. | MAX.   |
| A    |      |     | 330  |       |      | 12.992 |
| C    | 12.8 |     | 13.2 | 0.504 |      | 0.519  |
| D    | 20.2 |     |      | 0.795 |      |        |
| N    | 60   |     |      | 2.362 |      |        |
| T    |      |     | 22.4 |       |      | 0.882  |
| Ao   | 6.8  |     | 7    | 0.268 |      | 0.276  |
| Bo   | 8.2  |     | 8.4  | 0.323 |      | 0.331  |
| Ko   | 1.7  |     | 1.9  | 0.067 |      | 0.075  |
| Po   | 3.9  |     | 4.1  | 0.153 |      | 0.161  |
| P    | 11.9 |     | 12.1 | 0.468 |      | 0.476  |



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