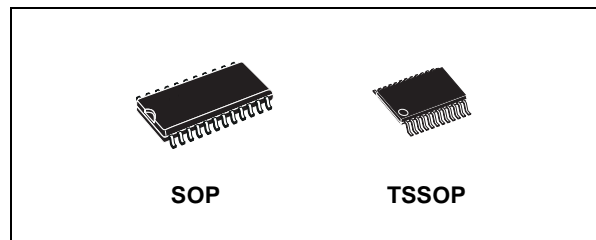




# 74LCX652

## LOW VOLT. CMOS OCTAL BUS TRANSCEIVER/REGISTER WITH 5 VOLT TOLERANT INPUTS AND OUTPUTS(3-STATE)

- 5V TOLERANT INPUTS AND OUTPUTS
- HIGH SPEED :  
 $t_{PD} = 7.0 \text{ ns (MAX.) at } V_{CC} = 3V$
- POWER DOWN PROTECTION ON INPUTS AND OUTPUTS
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OH}| = I_{OL} = 24\text{mA (MIN) at } V_{CC} = 3V$
- PCI BUS LEVELS GUARANTEED AT 24 mA
- BALANCED PROPAGATION DELAYS:  
 $t_{PLH} \cong t_{PHL}$
- OPERATING VOLTAGE RANGE:  
 $V_{CC(OPR)} = 2.0V \text{ to } 3.6V \text{ (1.5V Data Retention)}$
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 652
- LATCH-UP PERFORMANCE EXCEEDS 500mA (JESD 17)
- ESD PERFORMANCE:  
 $HBM > 2000V \text{ (MIL STD 883 method 3015);}$   
 $MM > 200V$



### ORDER CODES

PACKAGE	TUBE	T & R
SOP	74LCX652M1R	74LCX652RM13TR
TSSOP		74LCX652TTR

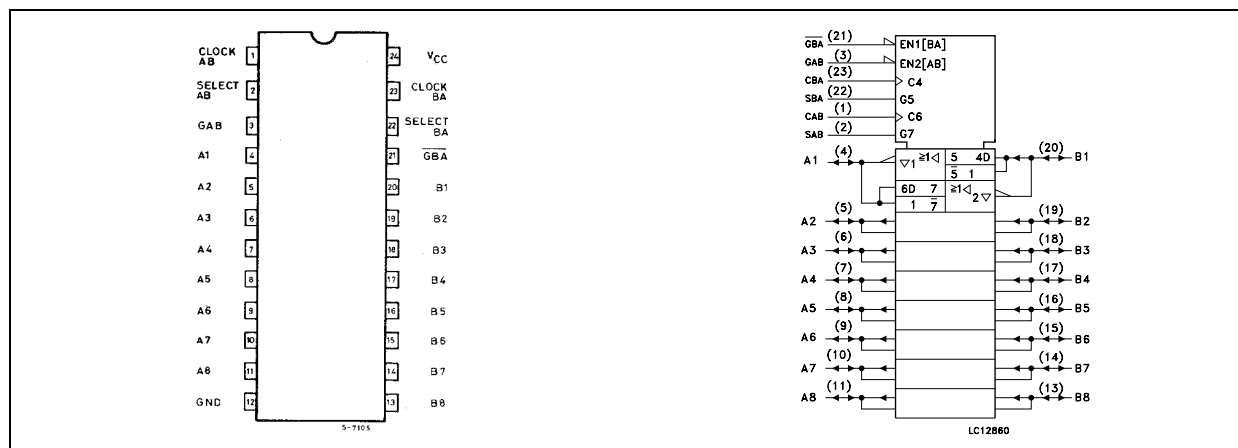
This device consists of bus transceiver circuits with 3 state, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal storage registers. Enable (GAB) and (GBA) pins are provided to control the transceiver functions. Select AB and Select BA control pins are provided to select whether real-time or stored data is transferred. A low input level selects real-time, and a high selects stored data.

Data on the A or B bus, or both, can be stored in the internal D flip-flop by low to high transitions at the appropriate clock pins (CAB or CBA) 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

### DESCRIPTION

The 74LCX652 is a low voltage CMOS OCTAL BUS TRANSCEIVER AND REGISTER (3-STATE) fabricated with sub-micron silicon gate and double-layer metal wiring C<sup>2</sup>MOS technology. It is ideal for low power and high speed 3.3V applications; it can be interfaced to 5V signal environment for both inputs and outputs.

### PIN CONNECTION AND IEC LOGIC SYMBOLS

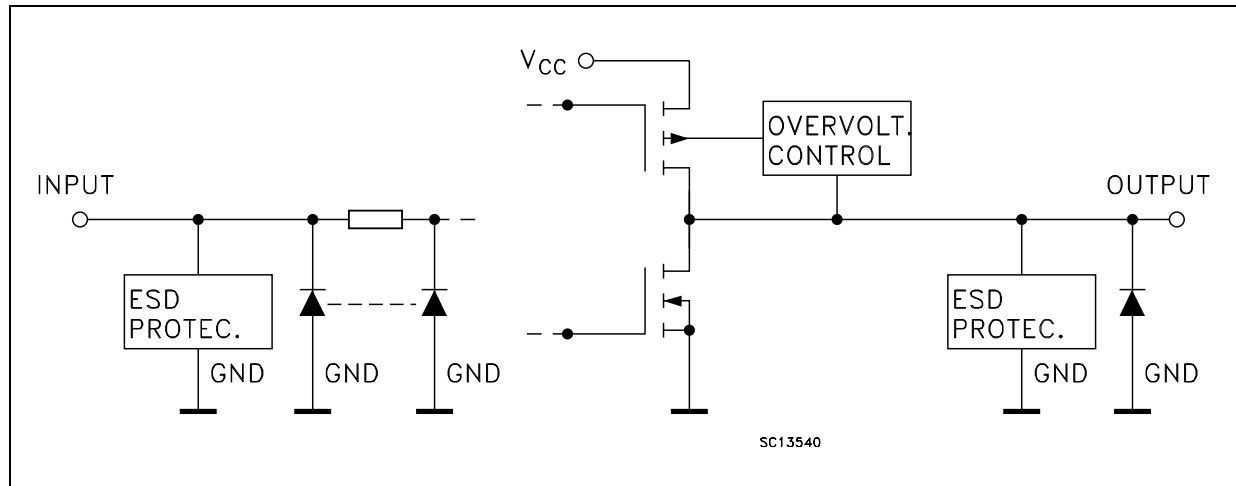


## M74LCX652

without using the internal D-type flip-flops by simultaneously enabling GAB or  $\overline{\text{GBA}}$ . In this configuration each output reinforces its input. It has same speed performance at 3.3V than 5V AC/ACT family, combined with a lower power consumption.

All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.







### INPUT AND OUTPUT EQUIVALENT CIRCUIT



### PIN DESCRIPTION

PIN No	SYMBOL	NAME AND FUNCTION
1	CLOCK AB (CAB)	A to B Clock Input (LOW to HIGH, Edge-Triggered)
2	SELECT AB (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	SELECT BA (SBA)	Select B to A Source Input
23	CLOCK BA (CBA)	B to A Clock Input (LOW to HIGH, Edge Triggered)
12	GND	Ground (0V)
24	$V_{CC}$	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	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.		
X*		X	H	L	L	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	H	H		
H	H					INPUTS	OUTPUTS	The A bus are inputs and the B bus are outputs.	
		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	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	
X	X*	H	X	X	X	Qn		The data stored to the internal flip-flops are displayed at the B bus	
	X*	H	X	L	L	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.	
	X*	H	X	H	H	H	H		
H	L					OUTPUTS	OUTPUTS	Both the A bus and the B bus are outputs	
		X	X	H	H	Qn	Qn	The data stored to the internal flip-flops are displayed at the A and B bus respectively.	

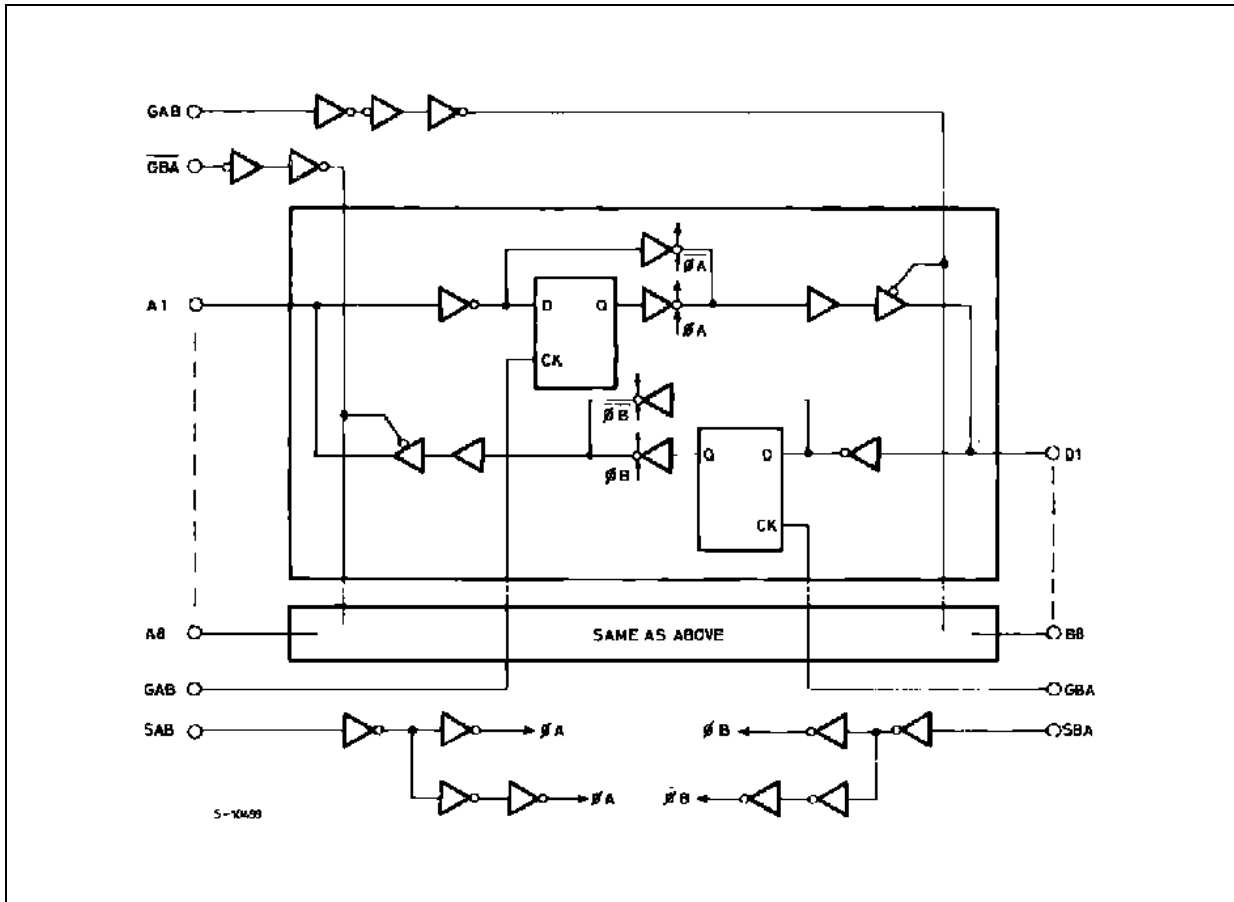
X : Don't Care

Z : High Impedance

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

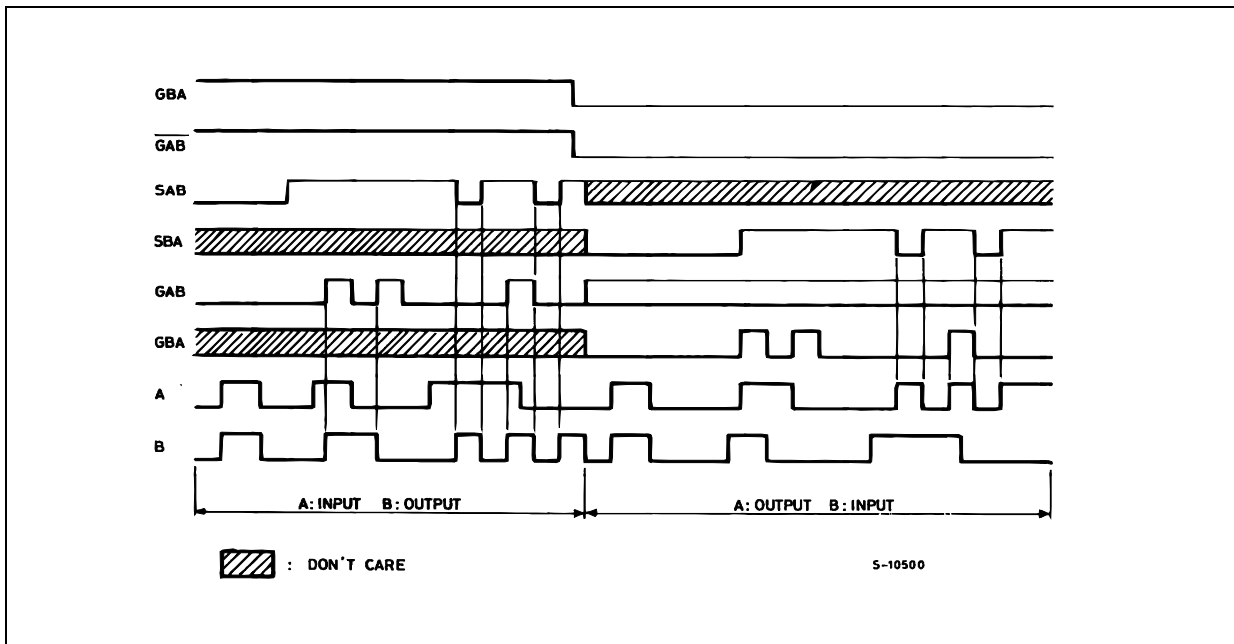
\* : The data at the A and B bus will be stored to the internal flip-flops on every low to high transition of the clock inputs.

LOGIC DIAGRAM



This logic diagram has not been used to estimate propagation delays

TIMING CHART



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage	-0.5 to +7.0	V
$V_I$	DC Input Voltage	-0.5 to +7.0	V
$V_O$	DC Output Voltage (OFF State)	-0.5 to +7.0	V
$V_O$	DC Output Voltage (High or Low State) (note 1)	-0.5 to $V_{CC} + 0.5$	V
$I_{IK}$	DC Input Diode Current	- 50	mA
$I_{OK}$	DC Output Diode Current (note 2)	- 50	mA
$I_O$	DC Output Current	$\pm 50$	mA
$I_{CC}$	DC Supply Current per Supply Pin	$\pm 100$	mA
$I_{GND}$	DC Ground Current per Supply Pin	$\pm 100$	mA
$T_{stg}$	Storage Temperature	-65 to +150	$^{\circ}C$
$T_L$	Lead Temperature (10 sec)	300	$^{\circ}C$

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

1)  $I_O$  absolute maximum rating must be observed

2)  $V_O < GND$

**RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage (note 1)	2.0 to 3.6	V
$V_I$	Input Voltage	0 to 5.5	V
$V_O$	Output Voltage (OFF State)	0 to 5.5	V
$V_O$	Output Voltage (High or Low State)	0 to $V_{CC}$	V
$I_{OH}, I_{OL}$	High or Low Level Output Current ( $V_{CC} = 3.0$ to $3.6V$ )	$\pm 24$	mA
$I_{OH}, I_{OL}$	High or Low Level Output Current ( $V_{CC} = 2.7V$ )	$\pm 12$	mA
$T_{op}$	Operating Temperature	-55 to 125	$^{\circ}C$
dt/dv	Input Rise and Fall Time (note 2)	0 to 10	ns/V

1) Truth Table guaranteed: 1.5V to 3.6V

2)  $V_{IN}$  from 0.8V to 2V at  $V_{CC} = 3.0V$

**DC SPECIFICATIONS**

Symbol	Parameter	Test Condition		Value				Unit
		V <sub>CC</sub> (V)		-40 to 85 °C		-55 to 125 °C		
				Min.	Max.	Min.	Max.	
V <sub>IH</sub>	High Level Input Voltage	2.7 to 3.6		2.0		2.0		V
V <sub>IL</sub>	Low Level Input Voltage					0.8		0.8
V <sub>OH</sub>	High Level Output Voltage	2.7 to 3.6	I <sub>O</sub> =-100 μA	V <sub>CC</sub> -0.2		V <sub>CC</sub> -0.2		V
		2.7	I <sub>O</sub> =-12 mA	2.2		2.2		
		3.0	I <sub>O</sub> =-18 mA	2.4		2.4		
			I <sub>O</sub> =-24 mA	2.2		2.2		
V <sub>OL</sub>	Low Level Output Voltage	2.7 to 3.6	I <sub>O</sub> =100 μA		0.2		0.2	V
		2.7	I <sub>O</sub> =12 mA		0.4		0.4	
		3.0	I <sub>O</sub> =16 mA		0.4		0.4	
			I <sub>O</sub> =24 mA		0.55		0.55	
I <sub>I</sub>	Input Leakage Current	2.7 to 3.6	V <sub>I</sub> = 0 to 5.5V		± 5		± 5	μA
I <sub>off</sub>	Power Off Leakage Current	0	V <sub>I</sub> or V <sub>O</sub> = 5.5V		10		10	μA
I <sub>OZ</sub>	High Impedance Output Leakage Current	2.7 to 3.6	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>O</sub> = 0 to V <sub>CC</sub>		± 5		± 5	μA
I <sub>CC</sub>	Quiescent Supply Current	2.7 to 3.6	V <sub>I</sub> = V <sub>CC</sub> or GND		10		10	μA
			V <sub>I</sub> or V <sub>O</sub> = 3.6 to 5.5V		± 10		± 10	
ΔI <sub>CC</sub>	I <sub>CC</sub> incr. per Input	2.7 to 3.6	V <sub>IH</sub> = V <sub>CC</sub> - 0.6V		500		500	μA

**DYNAMIC SWITCHING CHARACTERISTICS**

Symbol	Parameter	Test Condition		Value			Unit
		V <sub>CC</sub> (V)		T <sub>A</sub> = 25 °C			
				Min.	Typ.	Max.	
V <sub>OLP</sub>	Dynamic Low Level Quiet Output (note 1)	3.3	C <sub>L</sub> = 50pF V <sub>IL</sub> = 0V, V <sub>IH</sub> = 3.3V		0.8		V
V <sub>OLV</sub>					-0.8		

1) Number of outputs defined as "n". Measured with "n-1" outputs switching from HIGH to LOW or LOW to HIGH. The remaining output is measured in the LOW state.

## AC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Condition				Value				Unit
		V <sub>CC</sub> (V)	C <sub>L</sub> (pF)	R <sub>L</sub> (Ω)	t <sub>s</sub> = t <sub>r</sub> (ns)	-40 to 85 °C		-55 to 125 °C		
						Min.	Max.	Min.	Max.	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (CAB or CBA to An or Bn)	2.7	50	500	2.5	1.5	9.5	1.5	9.5	ns
		3.0 to 3.6				1.5	8.5	1.5	8.5	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (An to Bn or Bn to An)	2.7	50	500	2.5	1.5	8.0	1.5	8.0	ns
		3.0 to 3.6				1.5	7.0	1.5	7.0	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time (SAB or SBA to An or Bn)	2.7	50	500	2.5	1.5	9.5	1.5	9.5	ns
		3.0 to 3.6				1.5	8.5	1.5	8.5	
t <sub>PZL</sub> t <sub>PZH</sub>	Output Enable Time (GAB, GBA to An or Bn)	2.7	50	500	2.5	1.5	9.5	1.5	9.5	ns
		3.0 to 3.6				1.5	8.5	1.5	8.5	
t <sub>PLZ</sub> t <sub>PHZ</sub>	Output Disable Time (GAB, GBA to An or Bn)	2.7	50	500	2.5	1.5	9.5	1.5	9.5	ns
		3.0 to 3.6				1.5	8.5	1.5	8.5	
t <sub>S</sub>	Setup Time, HIGH or LOW level Data to CAB, CBA	2.7	50	500	2.5	2.5		2.5		ns
		3.0 to 3.6				2.5		2.5		
t <sub>H</sub>	Hold Time, HIGH or LOW level Data to CAB, CBA	2.7	50	500	2.5	1.5		1.5		ns
		3.0 to 3.6				1.5		1.5		
t <sub>W</sub>	CAB, CBA Pulse Width, HIGH or LOW	2.7	50	500	2.5	4.0		4.0		ns
		3.0 to 3.6				3.3		3.3		
f <sub>MAX</sub>	Clock Pulse Frequency	3.0 to 3.6	50	500	2.5	150		150		MHz
t <sub>OSLH</sub> t <sub>OSHL</sub>	Output To Output Skew Time (note1, 2)	3.0 to 3.6	50	500	2.5		1.0		1.0	ns

1) Skew is defined as the absolute value of the difference between the actual propagation delay for any two outputs of the same device switching in the same direction, either HIGH or LOW (t<sub>OSLH</sub> = |t<sub>PLHm</sub> - t<sub>PLHn</sub>|, t<sub>OSHL</sub> = |t<sub>PHLm</sub> - t<sub>PHLn</sub>|)

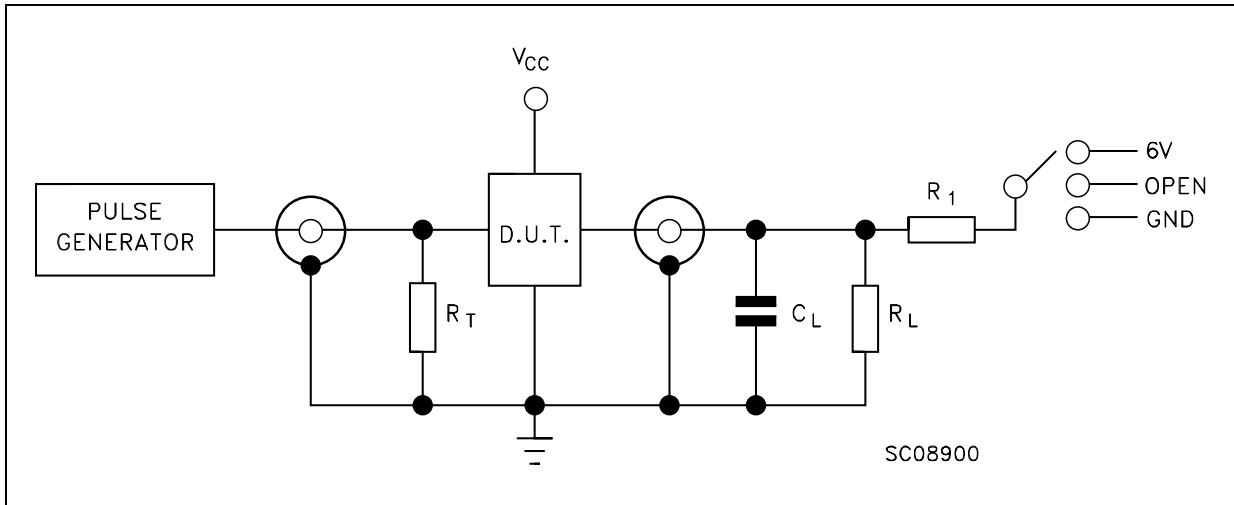
2) Parameter guaranteed by design

## CAPACITIVE CHARACTERISTICS

Symbol	Parameter	Test Condition		Value			Unit
		V <sub>CC</sub> (V)		T <sub>A</sub> = 25 °C			
				Min.	Typ.	Max.	
C <sub>IN</sub>	Input Capacitance	3.3	V <sub>IN</sub> = 0 to V <sub>CC</sub>		6		pF
C <sub>I/O</sub>	I/O Capacitance	3.3	V <sub>IN</sub> = 0 to V <sub>CC</sub>		10		pF
C <sub>PD</sub>	Power Dissipation Capacitance (note 1)	3.3	f <sub>IN</sub> = 10MHz V <sub>IN</sub> = 0 or V <sub>CC</sub>		36		pF

1) C<sub>PD</sub> 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<sub>CC(opr)</sub> = C<sub>PD</sub> × V<sub>CC</sub> × f<sub>IN</sub> + I<sub>CC</sub>/8 (per circuit)

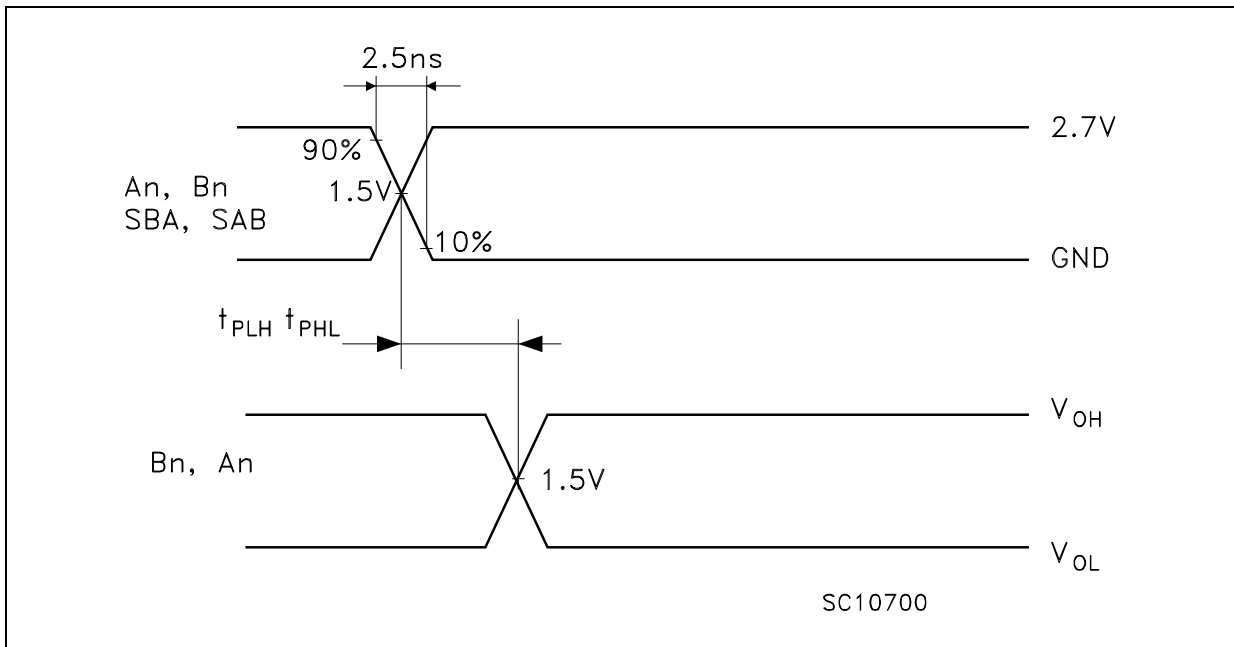
TEST CIRCUIT



TEST	SWITCH
$t_{PLH}$ , $t_{PHL}$	Open
$t_{PZL}$ , $t_{PLZ}$	6V
$t_{PZH}$ , $t_{PHZ}$	GND

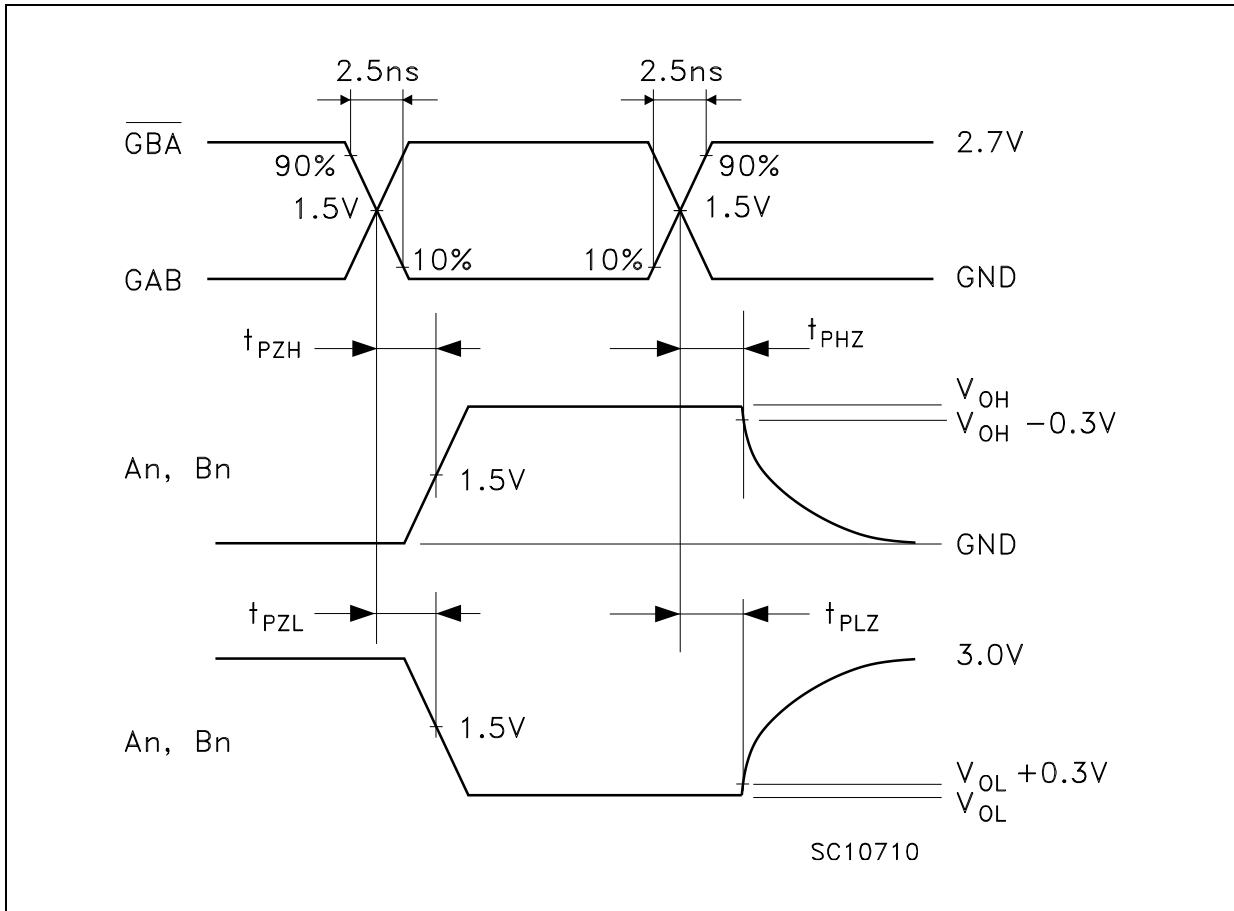
$C_L$  = 50 pF or equivalent (includes jig and probe capacitance)  
 $R_L = R_1 = 500\Omega$  or equivalent  
 $R_T = Z_{OUT}$  of pulse generator (typically 50 $\Omega$ )

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

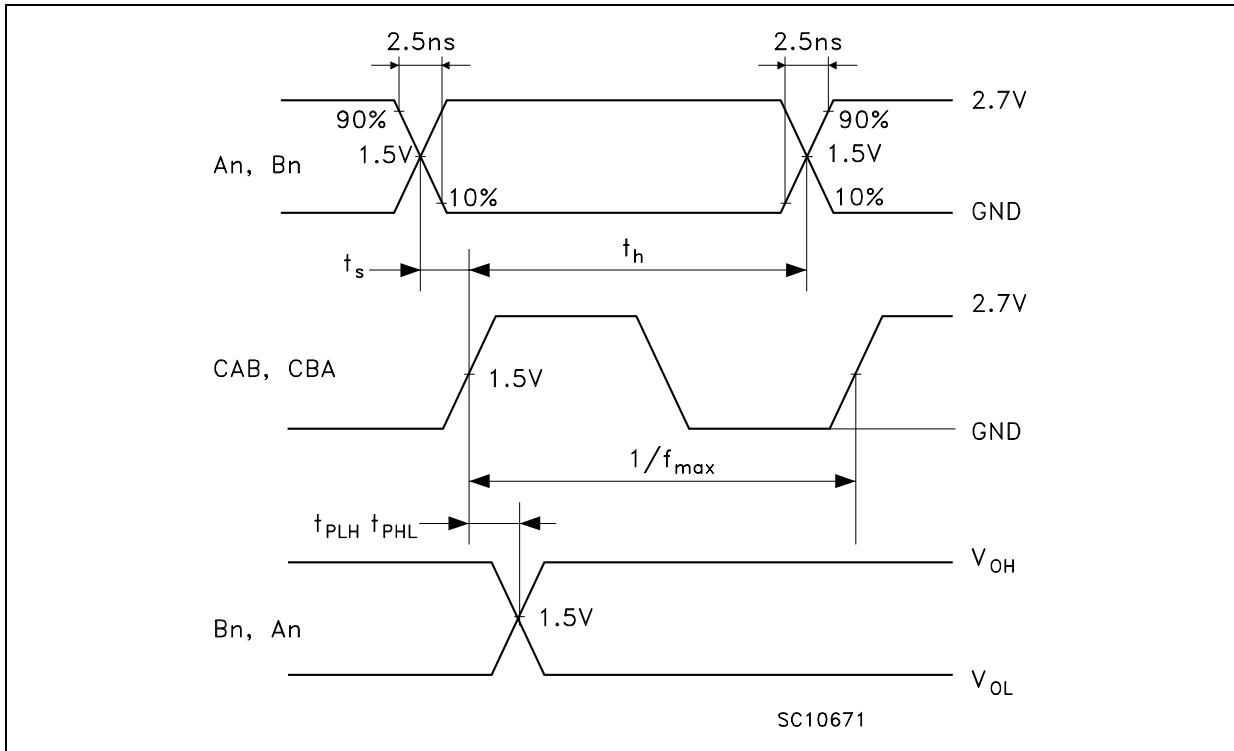




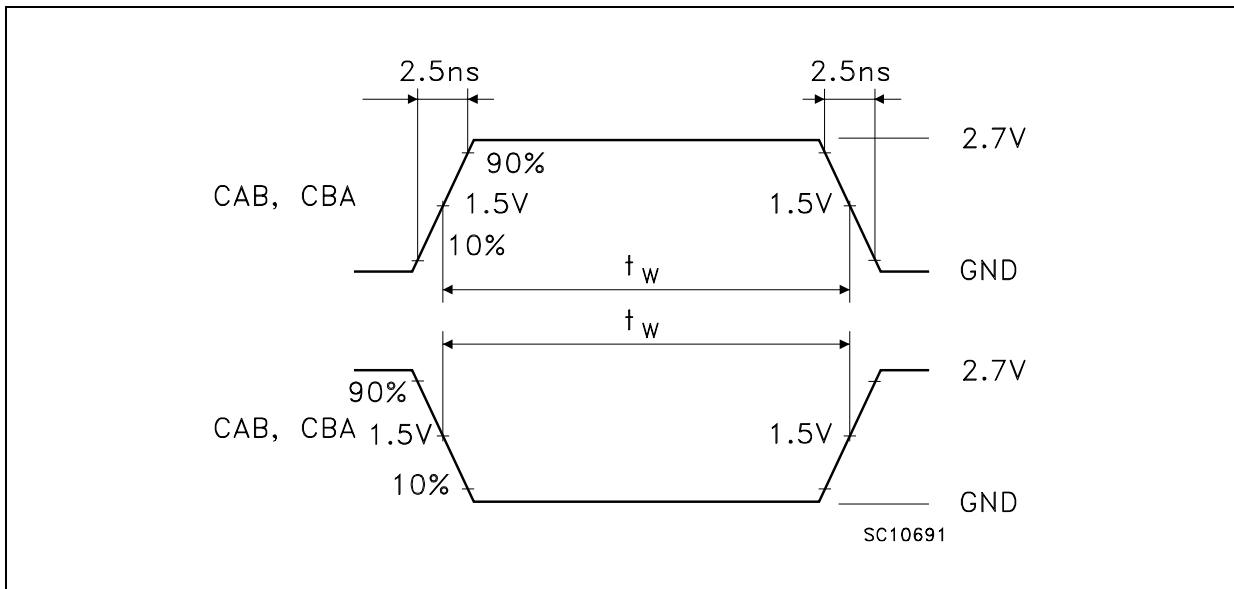
WAVEFORM 2: OUTPUT ENABLE AND DISABLE TIME (f=1MHz; 50% duty cycle)



WAVEFORM 3 : SETUP AND HOLD TIME, MAXIMUM CK FREQUENCY (f=1MHz; 50% duty cycle)

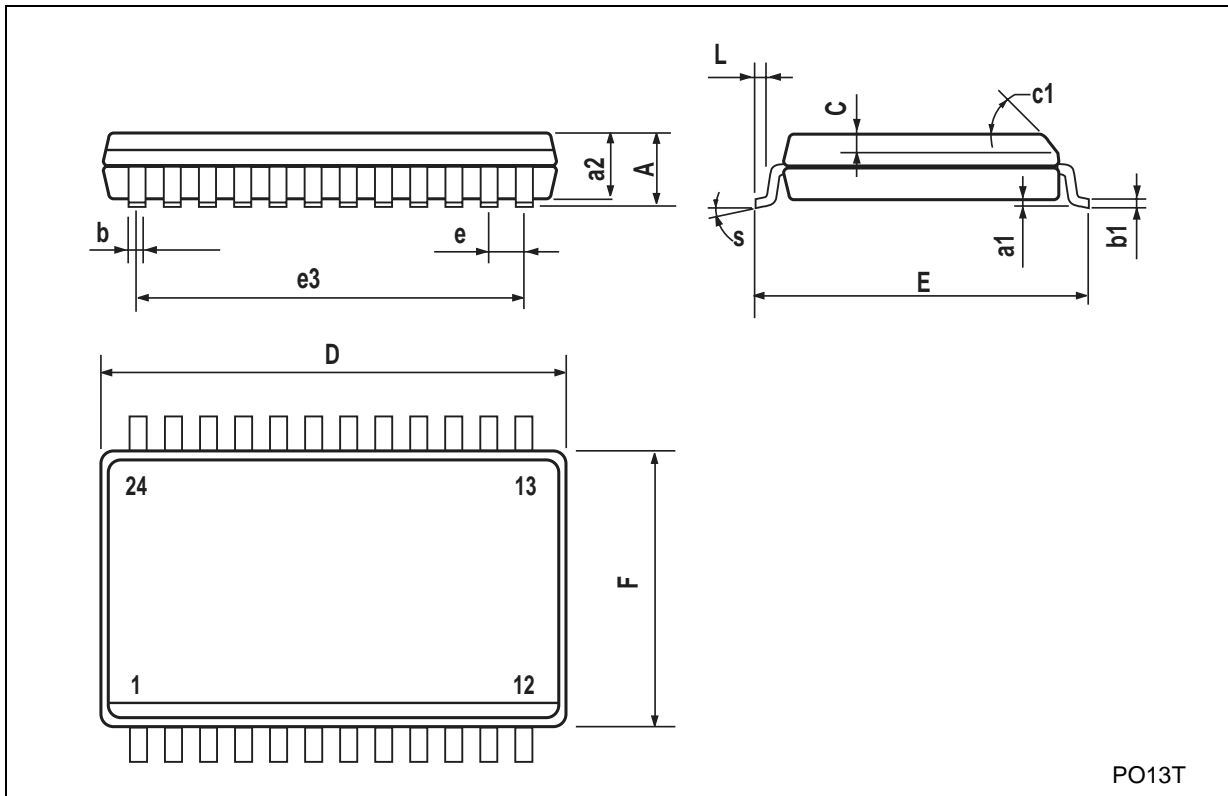


WAVEFORM 4 : PULSE WIDTH (f=1MHz; 50% duty cycle)



**SO-24 MECHANICAL DATA**

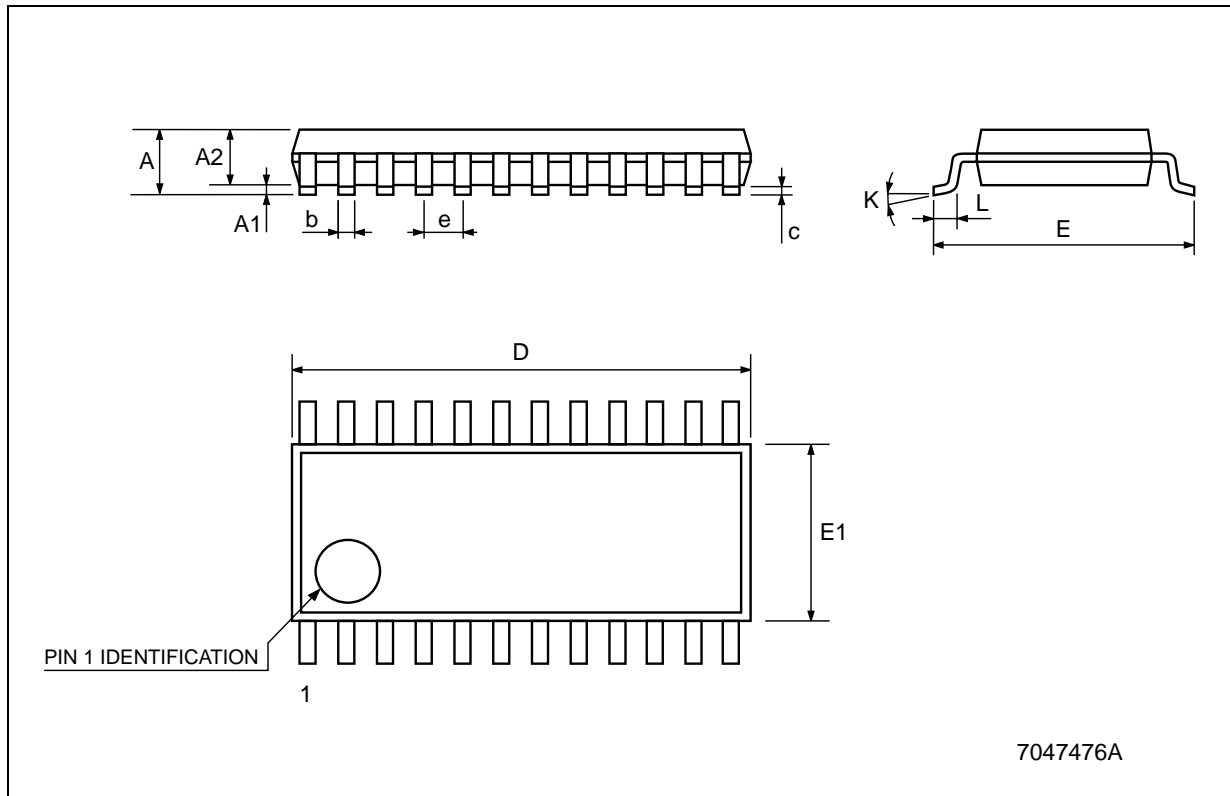
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			2.65			0.104
a1	0.1		0.2	0.004		0.008
a2			2.45			0.096
b	0.35		0.49	0.014		0.019
b1	0.23		0.32	0.009		0.012
C		0.5			0.020	
c1	45° (typ.)					
D	15.20		15.60	0.598		0.614
E	10.00		10.65	0.393		0.419
e		1.27			0.050	
e3		13.97			0.550	
F	7.40		7.60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



PO13T

**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



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