

## 4-BIT DUAL SUPPLY BUS BUFFER LEVEL TRANSLATOR WITH A SIDE SERIES RESISTOR

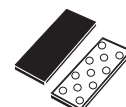
- **HIGH SPEED:**  $t_{PD} = 4.3ns$  (MAX.) at  $T_A=85^\circ C$   
 $V_{CCB} = 1.65V$ ;  $V_{CCA} = 3.0V$
- **LOW POWER DISSIPATION:**  
 $I_{CCA} = I_{CCB} = 5\mu A$ (MAX.) at  $T_A=85^\circ C$
- **SYMMETRICAL OUTPUT IMPEDANCE:**  
 $|I_{OHA}| = I_{OLA} = 10mA$  MIN at  
 $V_{CCA} = 2.75V$ ;  $V_{CCB} = 1.4V$  to  $3.6V$   
 $|I_{OHB}| = I_{OLB} = 4mA$  MIN at  
 $V_{CCB} = 1.65V$ ;  $V_{CCA} = 1.4$  to  $3.6V$
- **BALANCED PROPAGATION DELAYS:**  
 $t_{PLH} \approx t_{PHL}$
- **POWER DOWN PROTECTION ON INPUTS AND OUTPUTS**
- **26Ω SERIES RESISTOR ON A SIDE OUTPUTS**
- **OPERATING VOLTAGE RANGE:**  
 $V_{CCA}(OPR) = 1.4V$  to  $3.6V$  (1.2V Data Retent)  
 $V_{CCB}(OPR) = 1.4V$  to  $3.6V$  (1.2V Data Retent)
- **MAX DATA RATES:**  
380 Mbps (1.8V to 3.3V translation)  
260 Mbps (<1.8V to 3.3V translation)  
260 Mbps (Translate to 2.5V)  
210 Mbps (Translate to 1.5V)
- **LATCH-UP PERFORMANCE EXCEEDS**  
500mA (JESD 17)
- **ESD PERFORMANCE:**  
HBM > 2000V (MIL STD 883 method 3015);  
MM > 200V
- **R<sub>OH</sub>S Compliant for FLIPCHIP Package**

### DESCRIPTION

The ST4G3235 is a dual supply low voltage CMOS 4-BIT BUS BUFFER level translator fabricated with sub-micron silicon gate and five-layer metal wiring C<sup>2</sup>MOS technology. Designed for use as an interface between a 3.3V bus and a 2.5V or 1.8V bus in a mixed 3.3V/1.8V, 3.3V/2.5V, 1.8V/1.4V and 2.5V/1.8V supply systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

This IC is intended for one-way asynchronous communication between data buses. The input and output power down protections disable the device when both power supply are down, so that the buses are effectively isolated.

The input tolerant buffers allow to translate  $V_{CCB}$  compatible signals and greater signals than  $V_{CCB}$  up/down to  $V_{CCA}$  and viceversa.



**FLIPCHIP**

**Table 1: Order Codes**

PACKAGE	T & R	Comments
FLIPCHIP11	ST4G3235BJR	5000 parts per reel

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

**Figure 1: Logic Diagram**

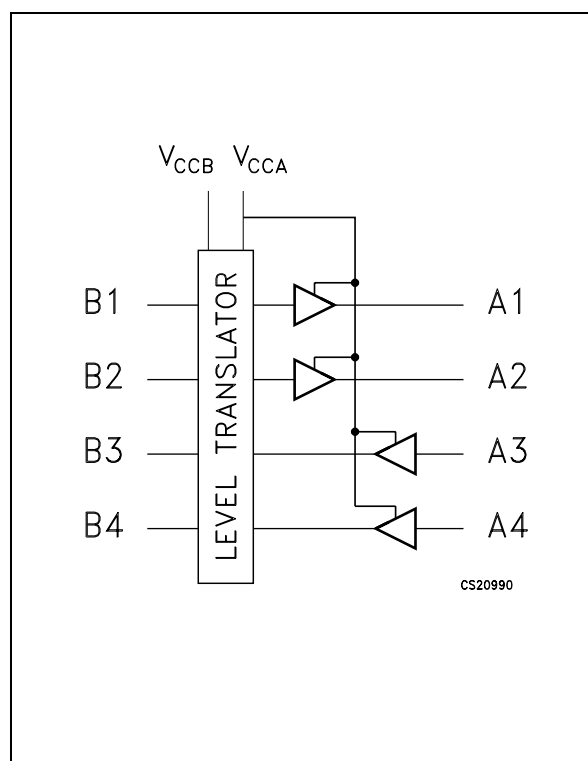


Figure 2: Input And Output Equivalent Circuit

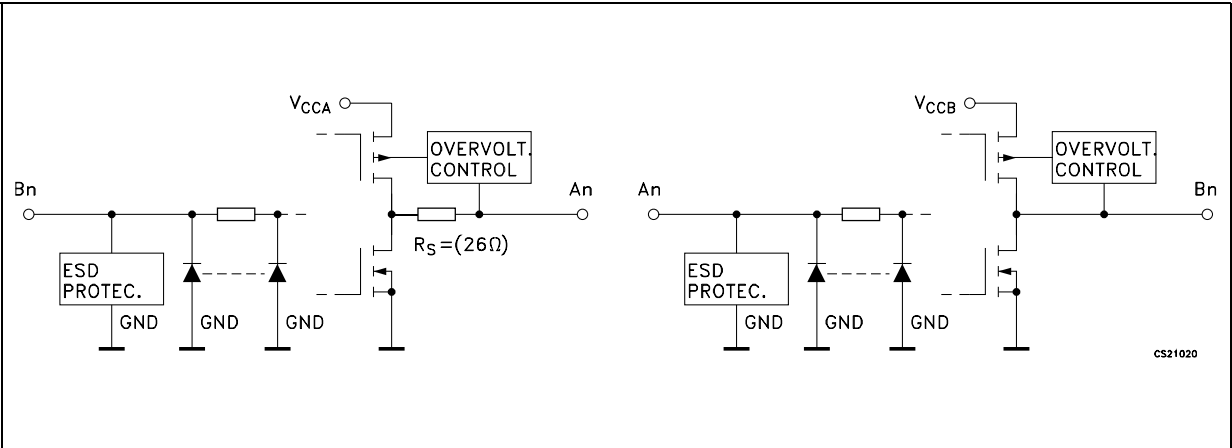


Table 2: Pin Description

PIN°	SYMBOL	NAME AND FUNCTION
A1	A4	Data Output (VCCA referred)
A3	A3	Data Output (VCCA referred)
A5	A2	Data Output (VCCA referred)
A7	A1	Data Output (VCCA referred)
C1	B4	Data Input (VCCB referred)
C3	B3	Data Input (VCCB referred)
C5	B2	Data Input (VCCB referred)
C7	B1	Data Input (VCCB referred)
B2	GND	Ground (0V)
B6	VCCA	Positive Supply Voltage
B4	VCCB	Positive Supply Voltage

Figure 3: Pin Connection (top through view)

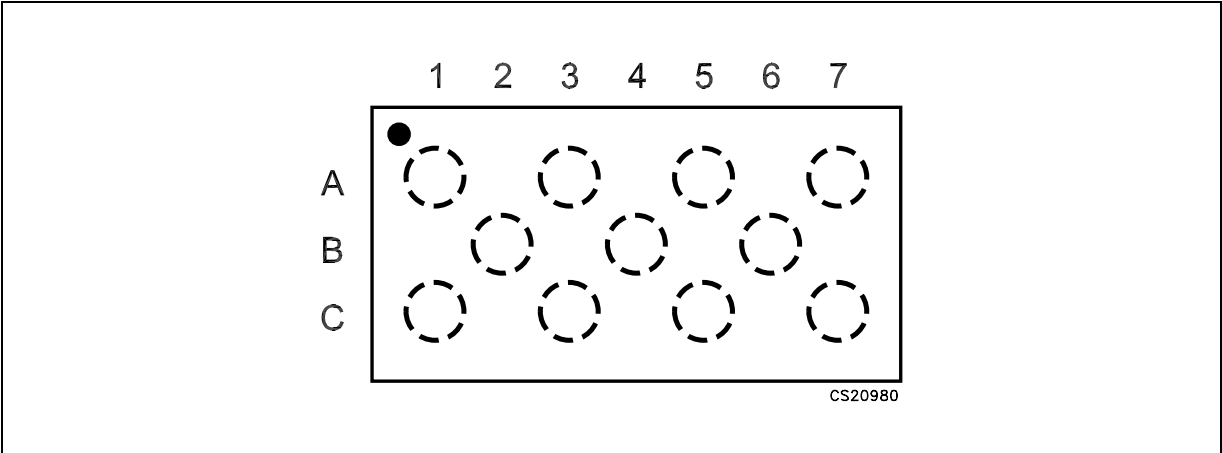


Table 3: Truth Table

INPUTS Bn ( $V_{CCB}$ Referred)	OUTPUTS An ( $V_{CCA}$ Referred)
L	L
H	H

n = 1..2

INPUTS An ( $V_{CCB}$ Referred)	OUTPUTS Bn ( $V_{CCA}$ Referred)
L	L
H	H

n = 3..4

Table 4: Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
$V_{CCA}$	Output Supply Voltage	-0.5 to +4.6	V
$V_{CCB}$	Input Supply Voltage	-0.5 to $V_{CCA} + 0.5$	V
$V_O$	DC Output Voltage (Power Down Mode: $V_{CCA}=V_{CCB}=Gnd$ )	-0.5 to +4.6	V
$V_I$	DC Input Voltage (Power Down Mode: $V_{CCA}=V_{CCB}=Gnd$ )	-0.5 to +4.6	V
$V_{OA}$	DC Output Voltage (A1, A2 Outputs)	-0.5 to $V_{CCA} + 0.5$	V
$V_{OB}$	DC Output Voltage (B3, B4 Outputs)	-0.5 to $V_{CCA} + 0.5$	V
$V_{IA}$	DC Input Voltage (A3, A4 Outputs)	-0.5 to +4.6	V
$V_{IB}$	DC Input Voltage (B1, B2 Outputs)	-0.5 to +4.6	V
$I_{IK}$	DC Input Diode Current	- 20	mA
$I_{OK}$	DC Output Diode Current	- 50	mA
$I_{OA}$	DC Output Current	$\pm 50$	mA
$I_{CCA}$	DC $V_{CCA}$ or Ground Current	$\pm 100$	mA
$I_{CCB}$	DC $V_{CCB}$ or Ground Current	$\pm 100$	mA
$P_d$	Power Dissipation	400	mW
$T_{stg}$	Storage Temperature	-65 to +150	°C
$T_L$	Lead Temperature (10 sec)	260	°C

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

Table 5: Recommended Operating Conditions

Symbol	Parameter		Value	Unit
V <sub>CCA</sub>	Supply Voltage		1.4 to 3.6	V
V <sub>CCB</sub>	Supply Voltage		1.4 to V <sub>CCA</sub>	V
V <sub>IB</sub>	Input Voltage (B1, B2)		0 to V <sub>CCB</sub>	V
V <sub>IA</sub>	Input Voltage (A3, A4)		0 to V <sub>CCA</sub>	V
V <sub>OB</sub>	Output Voltage (B3, B4)		0 to V <sub>CCB</sub>	V
V <sub>OA</sub>	Output Voltage (A1, A2)		0 to V <sub>CCA</sub>	V
T <sub>op</sub>	Operating Temperature		-40 to 85	°C
dt/dv	Input Rise and Fall Time (note 1)	V <sub>CCB</sub> = 3.0 to 3.6V	0 to 10	ns/V
		V <sub>CCB</sub> = 2.3 to 2.7V	0 to 20	ns/V
		V <sub>CCB</sub> = 1.4 to 1.95V	0 to 100	ns/V

1)  $V_I$  from 0.8V to 2.0V at  $V_{CC} = 3.0V$

Table 6: DC Specification for  $V_{CCA}$ 

Symbol	Parameter	Test Condition			Value					Unit
		V <sub>CCB</sub> (V)(*)	V <sub>CCA</sub> (V)(*)		T <sub>A</sub> = 25 °C			-40 to 85 °C		
					Min.	Typ.	Max.	Min.	Max.	
V <sub>IHA</sub>	High Level Input Voltage (A3-A4)	1.4 to 3.6V	1.4		0.65V <sub>CCA</sub>			0.65V <sub>CCA</sub>		V
			1.8		0.65V <sub>CCA</sub>			0.65V <sub>CCA</sub>		
			2.5		1.6			1.6		
			3.3		2.0			2.0		
V <sub>ILA</sub>	Low Level Input Voltage (A3-A4)	1.4 to 3.6V	1.4				0.35V <sub>CCA</sub>		0.35V <sub>CCA</sub>	V
			1.8				0.35V <sub>CCA</sub>		0.35V <sub>CCA</sub>	
			2.5				0.7		0.7	
			3.3				0.8		0.8	
V <sub>OHA</sub>	High Level Output Voltage (A1-A2)	1.4 to 3.6V	1.4	I <sub>O</sub> =-100μA	1.2			1.2		V
			2.75	I <sub>O</sub> =-0.4mA	2.5			2.5		
			2.75	I <sub>O</sub> =-10mA	2.2			2.2		
			2.3	I <sub>O</sub> =-6mA	1.8			1.8		
			1.65	I <sub>O</sub> =-2mA	1.4			1.4		
			1.4	I <sub>O</sub> =-1mA	1.1			1.1		
V <sub>OLA</sub>	Low Level Output Voltage (A1-A2)	1.4 to 3.6V	1.4	I <sub>O</sub> =100μA			0.20		0.20	V
			2.75	I <sub>O</sub> =1mA			0.40		0.40	
			2.75	I <sub>O</sub> =10mA			0.55		0.55	
			2.3	I <sub>O</sub> =6mA			0.40		0.40	
			1.65	I <sub>O</sub> =2mA			0.25		0.25	
			1.4	I <sub>O</sub> =1mA			0.20		0.20	
I <sub>IA</sub>	Input Leakage Current (A3-A4)	2.7	3.6	V <sub>IA</sub> =V <sub>CCA</sub> or GND			± 0.5		± 5	μA
		1.4	2.7	V <sub>IA</sub> =3.6V or GND			± 0.5		± 5	μA
I <sub>OFF</sub>	Power Off Leakage Current	0	0	V <sub>IB</sub> =GND to 3.6V V <sub>OA</sub> =GND to 3.6V V <sub>IA</sub> =GND to 3.6V V <sub>OB</sub> =GND to 3.6V			± 1.0		± 10	μA
I <sub>CCIA</sub>	Quiescent Supply Current	1.4 to 3.6V	1.4 to 3.6V	V <sub>IA</sub> =V <sub>CCA</sub> or GND V <sub>IB</sub> =V <sub>CCB</sub> or GND			0.5		5	μA
ΔI <sub>CCIA</sub>	Maximum Quiescent Supply Current / Input (An)	2.7	3.6	V <sub>IA</sub> =V <sub>CCA</sub> - 0.6V					0.75	mA
		1.95	3.6	V <sub>IA</sub> =V <sub>CCA</sub> or GND						
		1.95	2.7	V <sub>IB</sub> =V <sub>CCB</sub> or GND						

(\*)  $V_{CC}$  range =  $3.3 \pm 0.3$ ;  $2.5 \pm 0.2\text{V}$ ;  $1.8 \pm 0.15\text{V}$

Table 7: DC Specification for  $V_{CCB}$ 

Symbol	Parameter	Test Condition			Value					Unit
		V <sub>CCB</sub> (V)(*)	V <sub>CCA</sub> (V)(*)		T <sub>A</sub> = 25 °C			-40 to 85 °C		
					Min.	Typ.	Max.	Min.	Max.	
V <sub>IHB</sub>	High Level Input Voltage (B1-B2)	1.4	1.4 to 3.6V		0.65V <sub>CCB</sub>			0.65V <sub>CCB</sub>		V
		1.8			0.65V <sub>CCB</sub>			0.65V <sub>CCB</sub>		
		2.5			1.6			1.6		
		3.3			2.0			2.0		
V <sub>ILB</sub>	Low Level Input Voltage (B1-B2)	1.4	1.4 to 3.6V				0.35V <sub>CCB</sub>		0.35V <sub>CCB</sub>	V
		1.8					0.35V <sub>CCB</sub>		0.35V <sub>CCB</sub>	
		2.5					0.7		0.7	
		3.3					0.8		0.8	
V <sub>OHB</sub>	High Level Output Voltage (B3-B4)	1.4	1.4 to 3.6V	I <sub>O</sub> =-100μA	1.3			1.3		V
		1.8		I <sub>O</sub> =-100μA	1.6			1.6		
		2.75		I <sub>O</sub> =-24mA	2.2			2.2		
		2.75		I <sub>O</sub> =-18mA	1.7			1.7		
		2.3		I <sub>O</sub> =-4mA	1.44			1.44		
		1.65		I <sub>O</sub> =-4mA	1.5			1.5		
		1.4		I <sub>O</sub> =-2mA	1.25			1.25		
V <sub>OLB</sub>	Low Level Output Voltage (B3-B4)	1.4	1.4 to 3.6V	I <sub>O</sub> =100μA			0.1		0.1	V
		1.8		I <sub>O</sub> =100μA			0.2		0.2	
		2.75		I <sub>O</sub> =24mA			0.55		0.55	
		2.75		I <sub>O</sub> =18mA			0.35		0.35	
		2.3		I <sub>O</sub> =4mA			0.39		0.39	
		1.65		I <sub>O</sub> =4mA			0.20		0.20	
		1.4		I <sub>O</sub> =2mA			0.15		0.15	
I <sub>IB</sub>	Input Leakage Current (B1-B2)	2.7	3.6	V <sub>IB</sub> =V <sub>CCB</sub> or GND			± 0.5		± 5	μA
		1.4	2.7	V <sub>IB</sub> =3.6V or GND			± 0.5		± 5	μA
I <sub>OFF</sub>	Power Off Leakage Current	0	0	V <sub>IB</sub> =GND to 3.6V V <sub>OA</sub> =GND to 3.6V V <sub>IA</sub> =GND to 3.6V V <sub>OB</sub> =GND to 3.6V			± 1.0		± 10	μA
I <sub>CCIB</sub>	Quiescent Supply Current	1.4 to 3.6V	1.4 to 3.6V	V <sub>IA</sub> =V <sub>CCA</sub> or GND V <sub>IB</sub> =V <sub>CCB</sub> or GND			0.5		5	μA
ΔI <sub>CCIB</sub>	Maximum Quiescent Supply Current / Input (Bn)	2.7	3.6	V <sub>IB</sub> =V <sub>CCB</sub> - 0.6V					0.75	mA
		1.95	3.6	V <sub>IB</sub> =V <sub>CCB</sub> or GND						
		1.95	2.7	V <sub>IB</sub> =V <sub>CCA</sub> or GND						

(\*)  $V_{CC}$  range =  $3.3 \pm 0.3$ ;  $2.5 \pm 0.2\text{V}$ ;  $1.8 \pm 0.15\text{V}$

Table 8: Dynamic Switching Characteristics

Symbol	Parameter	Test Condition			Value					Unit
		V <sub>CCB</sub> (V)	V <sub>CCA</sub> (V)		T <sub>A</sub> = 25 °C			-40 to 85 °C		
					Min.	Typ.	Max.	Min.	Max.	
V <sub>OLPA</sub>	Dynamic Low Level Quiet An Output	1.4	1.8	C <sub>L</sub> = 30pF V <sub>ILB</sub> = 0V V <sub>IHB</sub> = V <sub>CCB</sub>		0.2				V
		1.4-1.8	2.5			0.25				
		1.8-2.5	3.3			0.35				
V <sub>OLVA</sub>	Dynamic Low Level Quiet An Output	1.4	1.8			-0.2				V
		1.4-1.8	2.5			-0.25				
		1.8-2.5	3.3			-0.35				
V <sub>OHVA</sub>	Dynamic High Level Quiet An Output	1.4	1.8			1.6				V
		1.4-1.8	2.5			2.1				
		1.8-2.5	3.3			2.7				
V <sub>OLPB</sub>	Dynamic Low Level Quiet Bn Output	1.4	1.8-2.5	C <sub>L</sub> = 30pF V <sub>ILA</sub> = 0V V <sub>IHA</sub> = V <sub>CCA</sub>		0.2				V
		1.8	2.5-3.3			0.25				
		2.5	3.3			0.6				
V <sub>OLVB</sub>	Dynamic Low Level Quiet Bn Output	1.4	1.8-2.5			-0.2				V
		1.8	2.5-3.3			-0.25				
		2.5	3.3			-0.36				
V <sub>OHVB</sub>	Dynamic High Level Quiet Bn Output	1.4	1.8-2.5			1.2				V
		1.8	2.5-3.3			1.4				
		2.5	3.3			1.9				

Table 9: AC Electrical Characteristics

Symbol	Parameter	Test Condition			Value		Unit
		V <sub>CCB</sub> (V)	V <sub>CCA</sub> (V)		-40 to 85 °C		
					Min.	Max.	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time Bn to An	2.3 to 3.6	1.4	C <sub>L</sub> = 10 pF	2.0	6.5	ns
		1.4 to 1.95	1.4		2.0	6.8	
		2.3 to 3.6	1.65 to 1.95		2.0	5.2	
		1.4 to 1.95	1.65 to 1.95		2.0	5.6	
		1.4 to 1.95	2.3 to 2.7		2.0	4.6	
		1.4 to 1.95	3.0 to 3.6		2.0	4.3	
		2.3 to 2.7	3.0 to 3.6		1.0	3.6	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time Bn to An	2.3 to 3.6	1.4	C <sub>L</sub> = 30 pF R <sub>L</sub> = 500 Ω	2.0	7.5	ns
		1.4 to 1.95	1.4		2.0	7.5	
		2.3 to 3.6	1.65 to 1.95		2.0	6.5	
		1.4 to 1.95	1.65 to 1.95		2.0	6.7	
		1.4 to 1.95	2.3 to 2.7		2.0	5.9	
		1.4 to 1.95	3.0 to 3.6		2.0	5.7	
		2.3 to 2.7	3.0 to 3.6		1.0	4.9	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time An to Bn	2.3 to 3.6	1.4	C <sub>L</sub> = 10 pF	2.0	5.5	ns
		1.4 to 1.95	1.4		2.0	6.0	
		2.3 to 3.6	1.65 to 1.95		2.0	5.0	
		1.4 to 1.95	1.65 to 1.95		2.0	5.0	
		1.4 to 1.95	2.3 to 2.7		2.0	4.6	
		1.4 to 1.95	3.0 to 3.6		2.0	3.9	
		2.3 to 2.7	3.0 to 3.6		1.0	3.0	
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time An to Bn	2.3 to 3.6	1.4	C <sub>L</sub> = 30 pF R <sub>L</sub> = 500 Ω	2.0	7.0	ns
		1.4 to 1.95	1.4		2.0	7.5	
		2.3 to 3.6	1.65 to 1.95		2.0	6.0	
		1.4 to 1.95	1.65 to 1.95		2.0	6.0	
		1.4 to 1.95	2.3 to 2.7		2.0	5.6	
		1.4 to 1.95	3.0 to 3.6		2.0	4.6	
		2.3 to 2.7	3.0 to 3.6		1.0	4.0	
t <sub>OSLH</sub> t <sub>OSHL</sub>	Output To Output Skew Time (note1, 2)	1.8 ± 0.15	2.5 ± 0.2	C <sub>L</sub> = 30 pF R <sub>L</sub> = 500 Ω		0.5	ns
		1.8 ± 0.15	3.3 ± 0.3			0.5	
		2.5 ± 0.2	3.3 ± 0.3			0.75	

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>|)

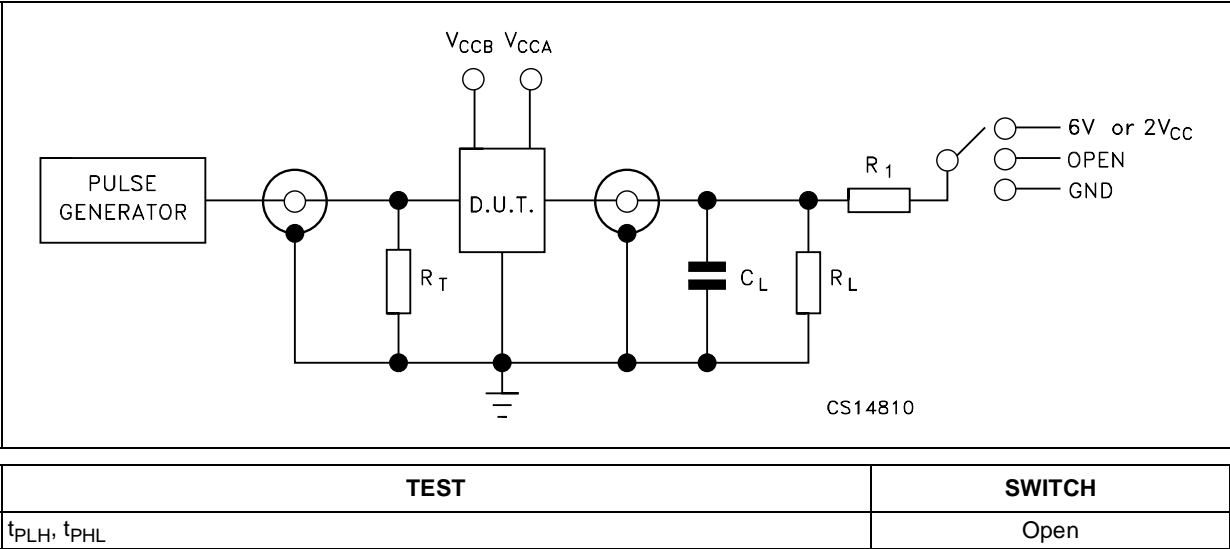
2) Parameter guaranteed by design

Table 10: Capacitance Characteristics

Symbol	Parameter	Test Condition			Value					Unit
		V <sub>CCB</sub> (V)	V <sub>CCA</sub> (V)		T <sub>A</sub> = 25 °C			-40 to 85 °C		
					Min.	Typ.	Max.	Min.	Max.	
C <sub>IN</sub>	Input Capacitance	open	open			6				pF
C <sub>O</sub>	Output Capacitance	1.8-2.5	2.5-3.3			9				pF
C <sub>PD</sub>	Power Dissipation Capacitance	2.5	3.3	f=10MHz		50				pF
		1.8	3.3			28				
		1.4	2.5			22				
		1.4	1.8			15				
		3.3	1.8			28				

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 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>/4 (per circuit)

Figure 4: Test Circuit



C<sub>L</sub> = 10/30pF or equivalent (includes jig and probe capacitance)  
R<sub>L</sub> = R<sub>1</sub> = 500Ω or equivalent  
R<sub>T</sub> = Z<sub>OUT</sub> of pulse generator (typically 50Ω)

Table 11: Waveform Symbol Value

Symbol	V <sub>CC</sub>		
	3.0 to 3.6V	2.3 to 2.7V	1.65 to 1.95V
V <sub>IH</sub>	V <sub>CC</sub>	V <sub>CC</sub>	V <sub>CC</sub>
V <sub>M</sub>	1.5V	V <sub>CC</sub> /2	V <sub>CC</sub> /2
V <sub>X</sub>	V <sub>OL</sub> +0.3V	V <sub>OL</sub> +0.15V	V <sub>OL</sub> +0.15V
V <sub>Y</sub>	V <sub>OL</sub> -0.3V	V <sub>OL</sub> -0.15V	V <sub>OL</sub> -0.15V



Figure 5: Waveform - Propagation Delay (f=1MHz; 50% duty cycle)

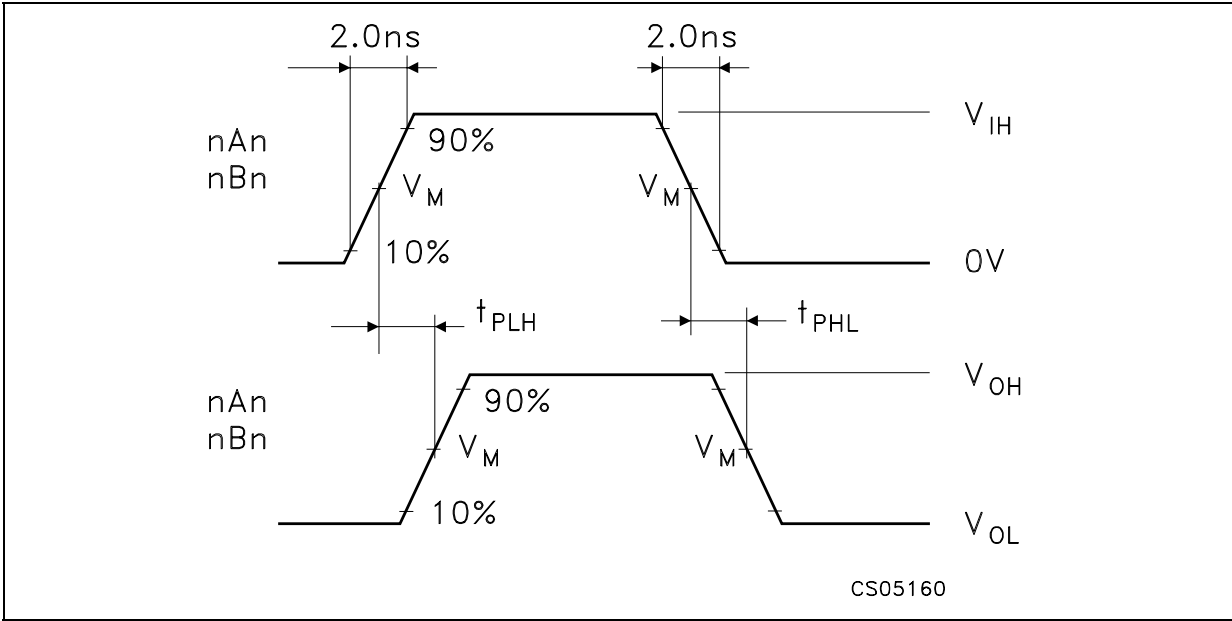
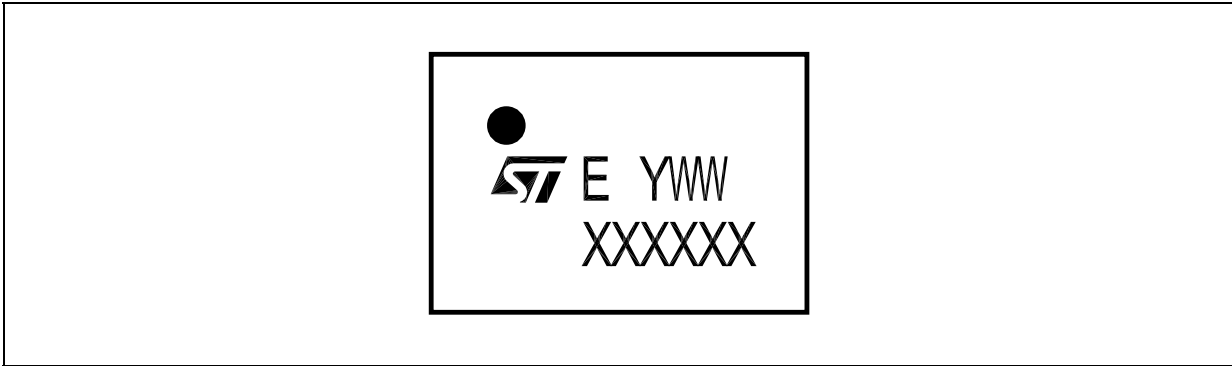


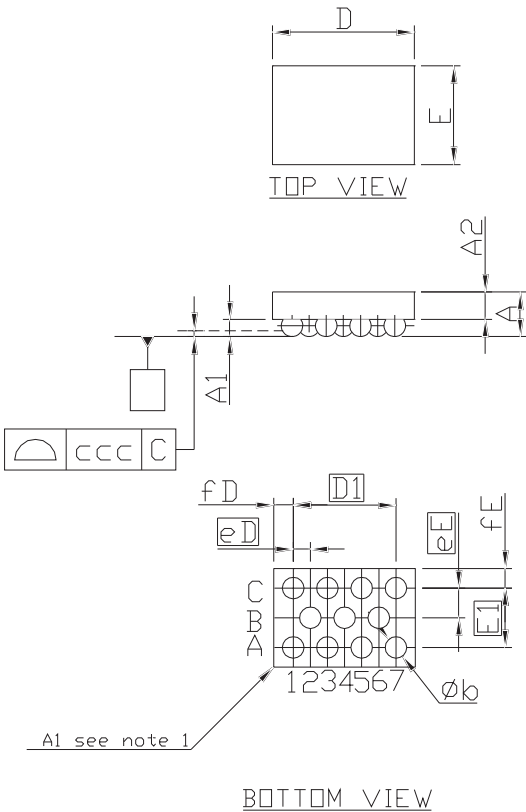
Figure 6: Marking



NOTE: E = Eco Level; Y = Assy Year; WW = Assy Week; X = Marking Area; Marking Code 9521

Flip-Chip11 MECHANICAL DATA

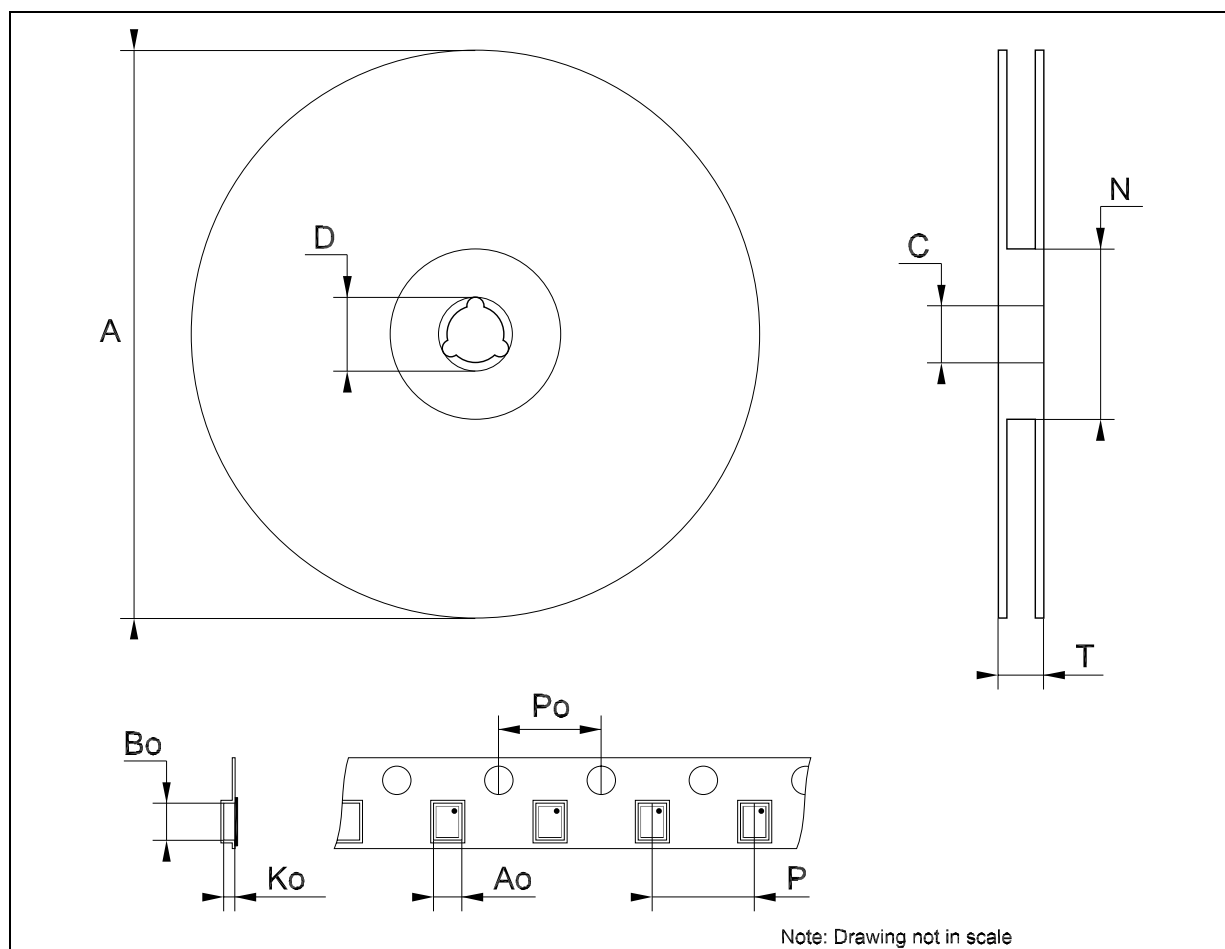
DIM.	mm.			mils		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	0.585	0.65	0.715	23.0	25.6	28.1
A1	0.21	0.25	0.29	8.3	9.8	11.4
A2		0.40			15.7	
b	0.265	0.315	0.365	10.4	12.4	14.4
D	1.99	2.04	2.09	78.3	80.3	82.3
D1		1.5			59.1	
E	1.36	1.41	1.46	53.5	55.5	57.5
E1		0.866			34.1	
eD	0.2	0.25	0.30	7.9	9.8	11.8
eE	0.383	0.433	0.483	15.1	17.0	19.0
fD		0.270			10.6	
fE		0.272			10.7	
ccc		0.080			3.1	



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# Tape & Reel Flip-Chip 11 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			178			6.926
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	49	50	51	1.929	1.969	2.008
T			12.4			0.488
Ao	2.29	2.34	2.39	0.090	0.092	0.094
Bo	1.65	1.70	1.75	0.065	0.067	0.069
Ko	0.76	0.81	0.86	0.030	0.032	0.034
Po	3.9	4	4.1	0.153	0.157	0.161
P	3.9	4	4.1	0.153	0.157	0.161



**Table 12: Revision History**

Date	Revision	Description of Changes
14-Oct-2004	1	First Release.
26-Oct-2004	2	Mechanical Data has been updated.
11-Feb-2005	3	Add Tape & Reel and Figure 6.
18-Feb-2005	4	Table 1 has been updated from 4000 to 5000 parts per Reel.
30-Mar-2005	5	Add Features ==> Max Data Rates.
09-May-2005	6	Table 9 and Table 10 have been updated.

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