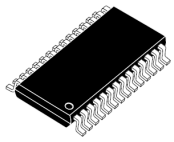
ST10G32245

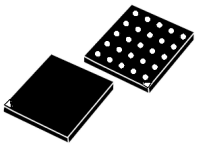
10-bit dual supply bus transceiver level translator with A side series resistor

Features

- High speed: t_{PD} = 4.4ns (Max.) at T_A = 85°C
  - V_{CCA} = 3.0V
  - V_{CCB} = 2.3V
- Low power dissipation:
  $I_{CCA} = I_{CCB}$ = 5µA(Max.) at T_A = 85°C
- Symmetrical output impedance:
  - $|I_{OHA}| = I_{OLA}$ = 8mA Min at
    V_{CCA} = 3.0V; V_{CCB} = 1.65V or 2.3V
  - $|I_{OHB}| = I_{OLB}$ = 6mA Min at
    V_{CCA} = 3.0V or 2.3V; V_{CCB} = 1.65V
- Balanced propagation delays:
  $t_{PLH} \cong t_{PHL}$
- Power down protection on inputs and outputs
- 26Ω series resistor on A side outputs
- Operating voltage range:
  - V_{CCA}(Opr) = 1.8V to 3.6V
    (1.2V data retent)
  - V_{CCB}(Opr) = 1.4V to 2.7V
    (1.2V data retent)
- Function compatible with 74 series 8245
- Latch-up performance exceeds 500mA (JESD 17)
- ESD performance:
  - HBM > 2000V (MIL STD 883 method 3015);
  - MM > 200V
- RoHS Compliant for µTFBGA25 package



TSSOP28



µTFBGA25

Description

The ST10G32245 is a dual supply low voltage CMOS 10-bit bus transceiver level translator fabricated with sub-micron silicon gate and five-layer metal wiring C^2MOS 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 two-way asynchronous communication between data buses and the direction of data transmission is determined by nDIR inputs. The enable inputs $n\overline{G}$ can be used to disable the device so that the buses are effectively isolated. The A-port interfaces with the 3V/1.8V bus, the B-port with the 2.5V, 1.8V and 1.4V bus.

All inputs are equipped with protection circuits against static discharge, giving them ESD immunity and transient excess voltage. All floating bus terminals during High Z State must be held HIGH or LOW.

Table 1. Device summary

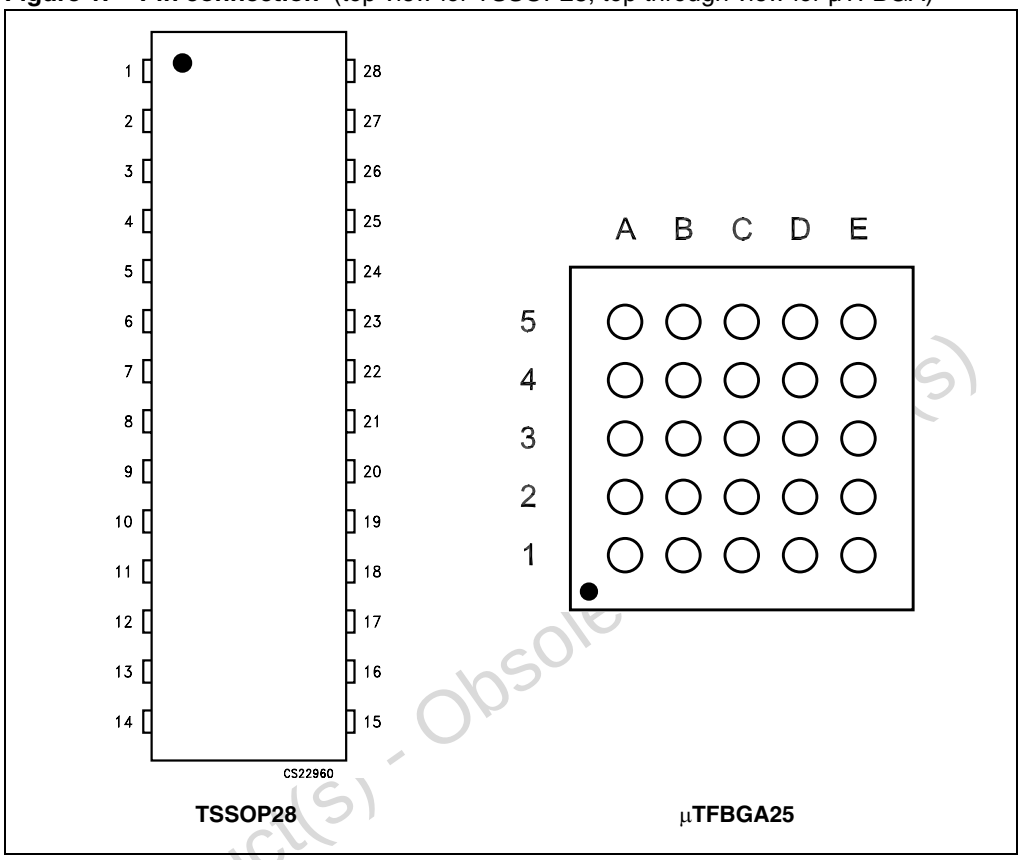
Part number	Package	Packaging
ST10G32245TTR	TSSOP28	Tape and reel
ST10G32245TBR	µTFBGA25	Tape and reel (3000 parts per reel)

Contents

1 Pin settings

1.1 Pin connection

Figure 1. Pin connection (top view for TSSOP28, top through view for µTFBGA)



1.2 Pin description

Table 2. Pin description

µTFBGA25 Pin N°	TSSOP28 Pin N°	Symbol	Name and function
D3	13	G	Output enable (V_{CCB} referred)
E3	16	DIR	Dir. control input (V_{CCB} referred)
A1, A2	2, 3	B0, B1	Data Inputs/Outputs
B1, B2	4, 5	B2, B3	Data Inputs/Outputs
C1, C2	6, 8	B4, B5	Data Inputs/Outputs
D1, D2	9, 10	B6, B7	Data Inputs/Outputs
E1, E2	11, 12	B8, B9	Data Inputs/Outputs
A4, A5	27, 26	A0, A1	Data Inputs/Outputs
B4, B5	25, 24	A2, A3	Data Inputs/Outputs
C4, C5	23, 21	A4, A5	Data Inputs/Outputs
D4, D5	20, 19	A6, A7	Data Inputs/Outputs
E4, E5	18, 17	A8, A9	Data Inputs/Outputs
C3	1, 28	GND	Ground (0V)
B3	22	V_{CCA}	Positive supply voltage
A3	7	V_{CCB}	Positive supply voltage
	14, 15	NC	No connect

2 Input equivalent circuit and truth table

Figure 2. Input equivalent circuit

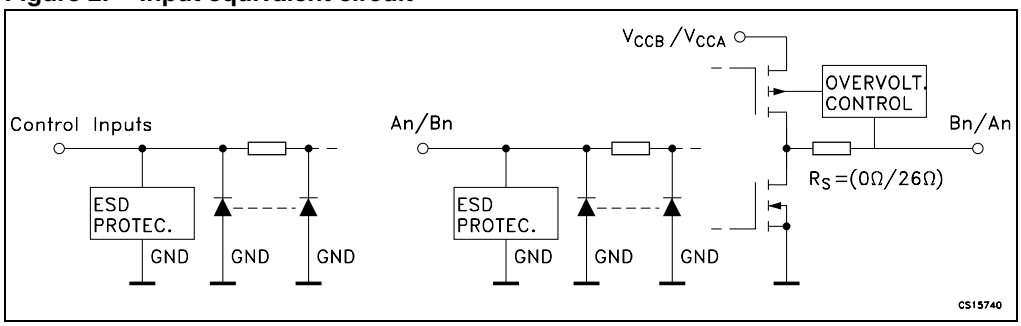
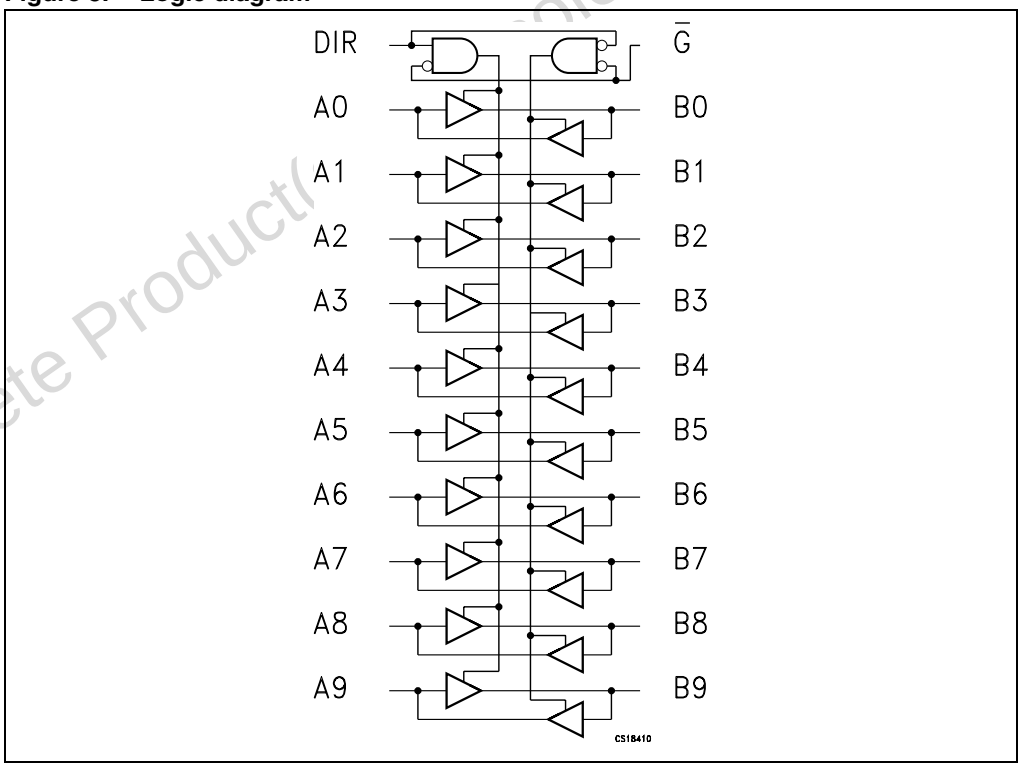


Table 3. Truth table

Inputs		Function		Output
G	DIR	A Bus	B bus	
L	L	Output	Input	A = B
L	H	Input	Output	B = A
H	X	Z	Z	Z

Note: X = Do not care; Z = High impedance

Figure 3. Logic diagram



3 Maximum rating

Stressing the device above the rating listed in the “Absolute Maximum Ratings” table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE Program and other relevant quality documents.

Table 4. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CCA}	Supply voltage	-0.5 to +4.6	V
V_{CCB}	Supply voltage	-0.5 to +4.6	V
V_I	DC input voltage	-0.5 to +4.6	V
$V_{I/OA}$	DC I/O voltage (Output disabled)	-0.5 to +4.6	V
$V_{I/OB}$	DC I/O voltage (Output disabled)	-0.5 to +4.6	V
$V_{I/OA}$	DC I/O voltage	-0.5 to V_{CCA} + 0.5	V
$V_{I/OB}$	DC I/O voltage	-0.5 to V_{CCB} + 0.5	V
I_{IK}	DC input diode current	– 20	mA
I_{OK}	DC output diode current	– 50	mA
I_{OA}	DC output current	± 50	mA
I_{OB}	DC output current	± 50	mA
I_{CCA}	DC V_{CC} or ground current	± 100	mA
I_{CCB}	DC V_{CC} or ground current	± 100	mA
P_d	Power dissipation	400	mW
T_{STG}	Storage temperature	-65 to +150	°C
T_L	Lead temperature (10 sec)	260	°C

3.1 Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Value	Unit
V_{CCA}	Supply voltage	1.8 to 3.6	V
V_{CCB}	Supply voltage	1.4 to 2.7	V
V_I	Input Voltage (Dir, $\overline{G}$)	0 to V_{CCB}	V
$V_{I/OA}$	I/O voltage	0 to V_{CCA}	V
$V_{I/OB}$	I/O voltage	0 to V_{CCB}	V
T_{op}	Operating temperature	-40 to 85	°C
dt/dv	Input rise and fall time (1)	0 to 10	ns/V

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

4 Electrical characteristics

Table 6. DC specification for V_{CCA}

Symbol	Parameter	Test condition			Value					Unit
		V_{CC} (V)(1)	V_{CCA} (V)(1)		T_A = 25 °C			-40 to 85 °C		
					Min	Typ	Max	Min	Max	
V_{IHA}	High level input voltage (An)	1.4	1.8		0.65V_{CCA}			0.65V_{CCA}		V
		1.4	2.5		1.6			1.6		
		1.8	2.5		1.6			1.6		
		1.8	3.3		2.0			2.0		
		2.5	3.3		2.0			2.0		
V_{ILA}	Low level input voltage (An)	1.4	1.8				0.35V_{CCA}		0.35V_{CCA}	V
		1.4	2.5				0.7		0.7	
		1.8	2.5				0.7		0.7	
		1.8	3.3				0.8		0.8	
		2.5	3.3				0.8		0.8	
V_{OHA}	High level output voltage	2.3	3.0	I_O=-100µA	2.8			2.8		V
		2.3	3.0	I_O=-8mA	2.4			2.4		
		1.65	3.0	I_O=-8mA	2.4			2.4		
		1.65	2.3	I_O=-6mA	1.8			1.8		
V_{OLA}	Low level output voltage	2.3	3.0	I_O=100µA			0.2		0.2	V
		2.3	3.0	I_O=8mA			0.55		0.55	
		1.65	3.0	I_O=8mA			0.55		0.55	
		1.65	2.3	I_O=6mA			0.40		0.40	
I_{IA}	Input leakage current	2.7	3.6	V_I = V_{CC} or GND			± 0.5		± 5	µA
I_{OZA}	High impedance output leakage current	2.7	3.6	V_{IA} = GND or 3.6V V_{IB} = V_{IHB} or V_{ILB} $\overline{G}$ = V_{CCB}			± 1.0		± 10	µA

Table 6. DC specification for V_{CCA}

Symbol	Parameter	Test condition			Value					Unit
		V_{CC} (V)(1)	V_{CCA} (V)(1)		T_A = 25 °C			-40 to 85 °C		
					Min	Typ	Max	Min	Max	
I_{OFF}	Power off leakage current	0	0	V_{IA} = GND to 3.6V V_{IB} = GND to 3.6V $\overline{G}$, Dir = GND to 3.6V			± 1.0		± 10	µA
I_{CCtA}	Quiescent supply current	1.95	3.6	V_{IA} =V_{CCA} or GND V_{IB} =V_{CCB} or GND Dir or $\overline{G}$=V_{CCB} or GND			0.5		5	µA
		1.95	2.7							
		2.7	3.6							
ΔI_{CCtA}	Maximum quiescent supply current / input (An)	2.7	3.6	V_{IA} =V_{CCA} - 0.6V V_{IB} =V_{CCB} or GND					0.75	mA
		1.95	3.6							
		1.95	2.7							

1. V_{CC} range = 3.3 ± 0.3; 2.5 ± 0.2; 1.8 ± 0.15

Table 7. DC specification for V_{CCB}

Symbol	Parameter	Test condition			Value					Unit
		V_{CCB} (V)(1)	V_{CCA} (V)(1)		T_A = 25 °C			-40 to 85 °C		
					Min	Typ	Max	Min	Max	
V_{IHB}	High level input voltage (Bn, Dir, $\overline{G}$)	1.4	1.8		0.65V_{CCB}			0.65V_{CCB}		V
		1.4	2.5		0.65V_{CCB}			0.65V_{CCB}		
		1.8	2.5		0.65V_{CCB}			0.65V_{CCB}		
		1.8	3.3		0.65V_{CCB}			0.65V_{CCB}		
		2.5	3.3		1.6			1.6		
V_{ILB}	Low level input voltage (Bn, Dir, $\overline{G}$)	1.4	1.8				0.35V_{CCB}		0.35V_{CCB}	V
		1.4	2.5				0.35V_{CCB}		0.35V_{CCB}	
		1.8	2.5				0.35V_{CCB}		0.35V_{CCB}	
		1.8	3.3				0.35V_{CCB}		0.35V_{CCB}	
		2.5	3.3				0.7		0.7	
V_{OHB}	High level output voltage	2.3	3.0	I_O=-100µA	2.1			2.1		V
		2.3	3.0	I_O=-18mA	1.7			1.7		
		1.65	3.0	I_O=-6mA	1.25			1.25		
		1.65	2.3	I_O=-6mA	1.25			1.25		
V_{OLB}	Low level output voltage	2.3	3.0	I_O=100µA			0.2		0.2	V
		2.3	3.0	I_O=18mA			0.60		0.60	
		1.65	3.0	I_O=6mA			0.30		0.30	
		1.65	2.3	I_O=6mA			0.30		0.30	
I_{IB}	Input leakage current	2.7	3.6	V_I = V_{CC} or GND			± 0.5		± 5	µA
I_{OZB}	High impedance output leakage current	2.7	3.6	V_{IA} = V_{IHA} or V_{ILA} V_{IB} = GND or 2.7V $\overline{G}$ = V_{CCB}			± 1.0		± 10	µA
I_{CCtB}	Quiescent supply current	1.95	3.6	V_{IA} =V_{CCA} or GND V_{IB} =V_{CCB} or GND Dir or $\overline{G}$=V_{CCB} or GND			0.5		5	µA
		1.95	2.7							
		2.7	3.6							
ΔI_{CCtB}	Maximum quiescent supply current / input (Bn, DIR, $\overline{G}$)	2.7	3.6	V_{IB} =V_{CCB} - 0.6V V_{IA} =V_{CCA} or GND					0.75	mA
		1.95	3.6							
		1.95	2.7							

1. V_{CC} range = 3.3±0.3V; 2.5±0.2V; 1.8±0.15V

Table 8. Dynamic switching characteristics

Symbol	Parameter	Test condition			Value					Unit
		V_{CCB} (V)	V_{CCA} (V)		T_A = 25 °C			-40 to 85 °C		
					Min	Typ	Max	Min	Max	
V_{OLPA}	Dynamic low level quiet An Output	1.4	1.8	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		0.2				V
		1.4	2.5			0.2				
		1.8	2.5			0.25				
		1.8	3.3			0.35				
		2.5	3.3			0.35				
V_{OLPB}	Dynamic low level quiet Bn Output	1.4	1.8	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		0.2				V
		1.4	2.5			0.2				
		1.8	2.5			0.25				
		1.8	3.3			0.25				
		2.5	3.3			0.6				
V_{OLVA}	Dynamic low level quiet An Output	1.4	1.8	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		-0.2				V
		1.4	2.5			-0.2				
		1.8	2.5			-0.25				
		1.8	3.3			-0.35				
		2.5	3.3			-0.35				
V_{OLVB}	Dynamic low level quiet Bn Output	1.4	1.8	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		-0.2				V
		1.4	2.5			-0.2				
		1.8	2.5			-0.25				
		1.8	3.3			-0.25				
		2.5	3.3			-0.6				
V_{OHVA}	Dynamic low level quiet An Output	1.4	1.8	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		1.6				V
		1.4	2.5			2.1				
		1.8	2.5			2.1				
		1.8	3.3			2.6				
		2.5	3.3			2.6				
V_{OHVB}	Dynamic low level quiet Bn Output	1.4	1.8	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		1.2				V
		1.4	2.5			1.2				
		1.8	2.5			1.6				
		1.8	3.3			1.6				
		2.5	3.3			2.0				

Table 9. AC electrical characteristics

Symbol	Parameter	Test condition			Value		Unit
		V_{CCB} (V)	V_{CCA} (V)		-40 to 85 °C		
					Min	Max	
t_{PLH} t_{PHL}	Propagation delay time An to Bn	1.8 ± 0.15	2.5 ± 0.2	C_L = 30 pF R_L = 500 Ω	1.0	5.8	ns
		1.8 ± 0.15	3.3 ± 0.3		1.0	6.2	
		2.5 ± 0.2	3.3 ± 0.3		1.0	4.4	
t_{PLH} t_{PHL}	Propagation delay time Bn to An	1.8 ± 0.15	2.5 ± 0.2	C_L = 30 pF R_L = 500 Ω	1.0	5.5	ns
		1.8 ± 0.15	3.3 ± 0.3		1.0	5.1	
		2.5 ± 0.2	3.3 ± 0.3		1.0	4.0	
t_{PZL} t_{PZH}	Output enable time $\overline{G}$ to An	1.8 ± 0.15	2.5 ± 0.2	C_L = 30 pF R_L = 500 Ω	1.0	5.3	ns
		1.8 ± 0.15	3.3 ± 0.3		1.0	5.1	
		2.5 ± 0.2	3.3 ± 0.3		1.0	4.0	
t_{PZL} t_{PZH}	Output enable time $\overline{G}$ to Bn	1.8 ± 0.15	2.5 ± 0.2	C_L = 30 pF R_L = 500 Ω	1.0	8.3	ns
		1.8 ± 0.15	3.3 ± 0.3		1.0	8.2	
		2.5 ± 0.2	3.3 ± 0.3		1.0	4.6	
t_{PLZ} t_{PHZ}	Output disable time $\overline{G}$ to An	1.8 ± 0.15	2.5 ± 0.2	C_L = 30 pF R_L = 500 Ω	1.0	5.2	ns
		1.8 ± 0.15	3.3 ± 0.3		1.0	5.6	
		2.5 ± 0.2	3.3 ± 0.3		1.0	4.8	
t_{PLZ} t_{PHZ}	Output disable time $\overline{G}$ to Bn	1.8 ± 0.15	2.5 ± 0.2	C_L = 30 pF R_L = 500 Ω	1.0	4.6	ns
		1.8 ± 0.15	3.3 ± 0.3		1.0	4.5	
		2.5 ± 0.2	3.3 ± 0.3		1.0	4.4	
t_{OSLH} t_{OSHL}	Output to output skew time (1) (2)	1.8 ± 0.15	2.5 ± 0.2	C_L = 30 pF R_L = 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 ($t_{OSLH} = | t_{PLHm} - t_{PLHn} |$, $t_{OSHL} = | t_{PHLm} - t_{PHLn} |$
2. Parameter guaranteed by design

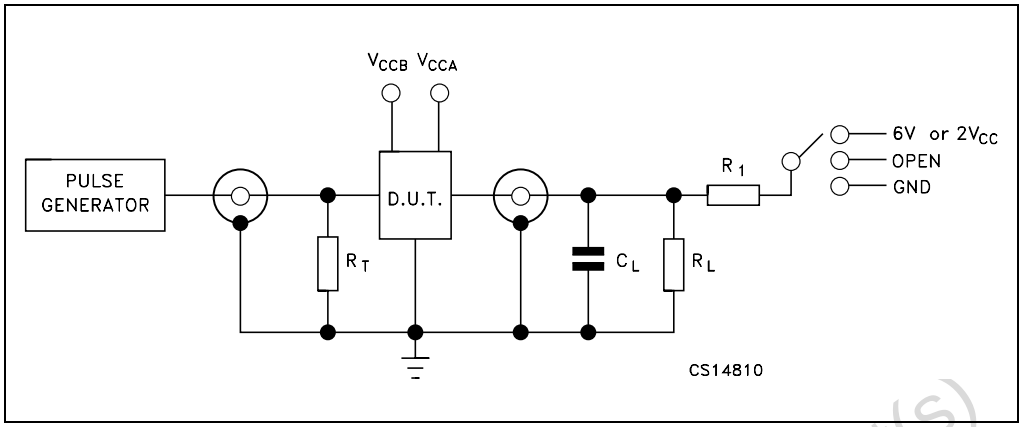
Table 10. Capacitance characteristics

Symbol	Parameter	Test condition			Value					Unit
		V_{CCB} (V)	V_{CCA} (V)		T_A = 25 °C			-40 to 85 °C		
					Min	Typ	Max	Min	Max	
C_{INB}	Input capacitance	open	open			5				pF
$C_{I/O}$	Input/Output capacitance	2.5	3.3			6				pF
C_{PD}	Power dissipation capacitance	2.5	3.3	f = 10MHz		28				pF
		1.8	3.3			28				pF

Note: 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 current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/10$ (per circuit)

5 Test circuit

Figure 4. Test circuit



C_L = 5/35pF or equivalent (includes jig and probe capacitance)

R_L = 50Ω or equivalent

R_T = Z_{OUT} of pulse generator (typically 50Ω)

Table 11. Test circuit

Test	Switch
t_{PLH}, t_{PHL}	Open
t_{PZL}, t_{PLZ} (V_{CC} = 3.0 to 3.6V)	6V
t_{PZL}, t_{PLZ} (V_{CC} = 2.3 to 2.7V or V_{CC} = 1.65 to 1.95V)	$2V_{CC}$
t_{PZH}, t_{PHZ}	GND

Note: C_L = 30pF or equivalent (includes jig and probe capacitance)

R_L = R_1 = 500Ω or equivalent

R_T = Z_{OUT} of pulse generator (typically 50Ω)

6 Waveforms

Table 12. Waveform symbol value

Symbol	V_{CC}		
	3.0 to 3.6V	2.3 to 2.7V	1.65 to 1.95V
V_{IH}	V_{CC}	V_{CC}	V_{CC}
V_M	1.5V	$V_{CC}/2$	$V_{CC}/2$
V_X	V_{OL} +0.3V	V_{OL} +0.15V	V_{OL} +0.15V
V_Y	V_{OL} -0.3V	V_{OL} -0.15V	V_{OL} -0.15V

Figure 5. Waveform - propagation delay (f = 1MHz; 50% duty cycle)

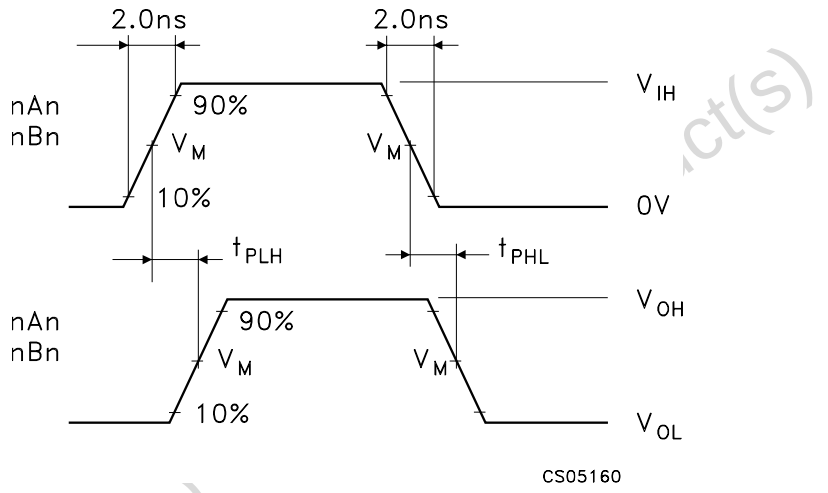
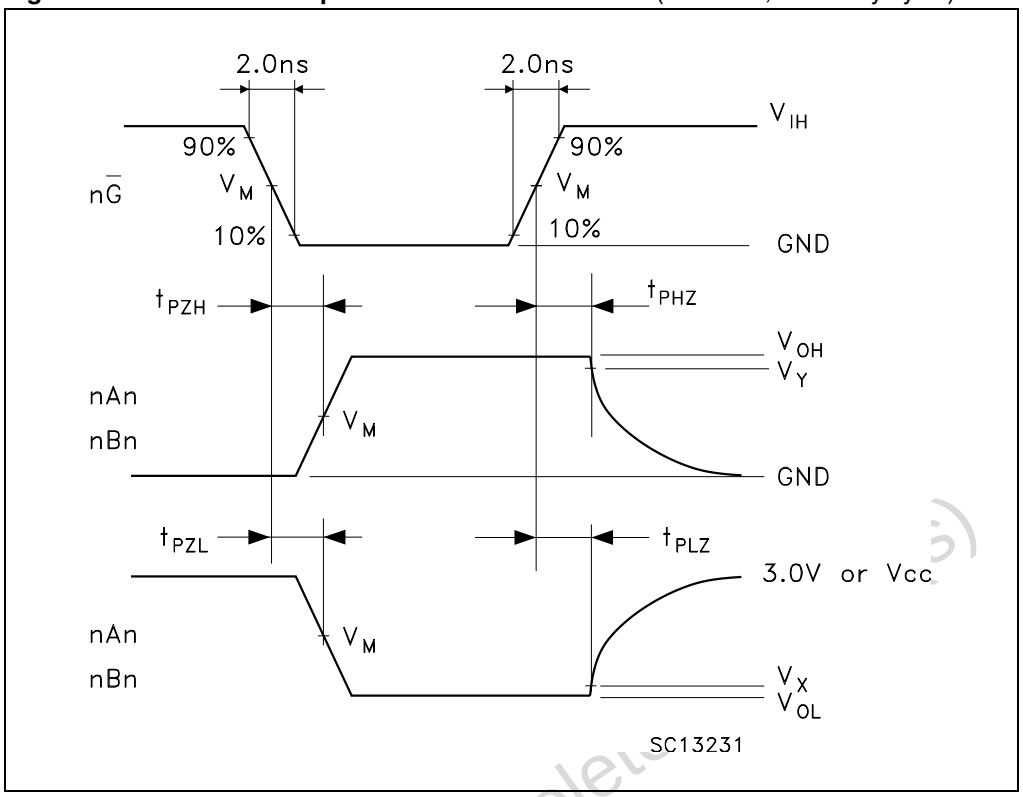


Figure 6. Waveform - output enable and disable time (f = 1MHz; 50% duty cycle)



7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect . The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com

Table 13. µTFBGA25 mechanical data

Dim.	mm.			inch		
	Min	Typ	Max	Min	Typ	Max
A	1.0	1.1	1.16	39.4	43.3	45.7
A1			0.25			9.8
A2	0.78		0.86	30.7		33.9
b	0.25	0.30	0.35	9.8	11.8	13.8
D	2.9	3.0	3.1	114.2	118.1	122.0
D1		2			78.8	
E	2.9	3.0	3.1	114.2	118.1	122.0
E1		2			78.8	
e		0.5			19.7	
SE		0.25			9.8	

Figure 7. Package dimension

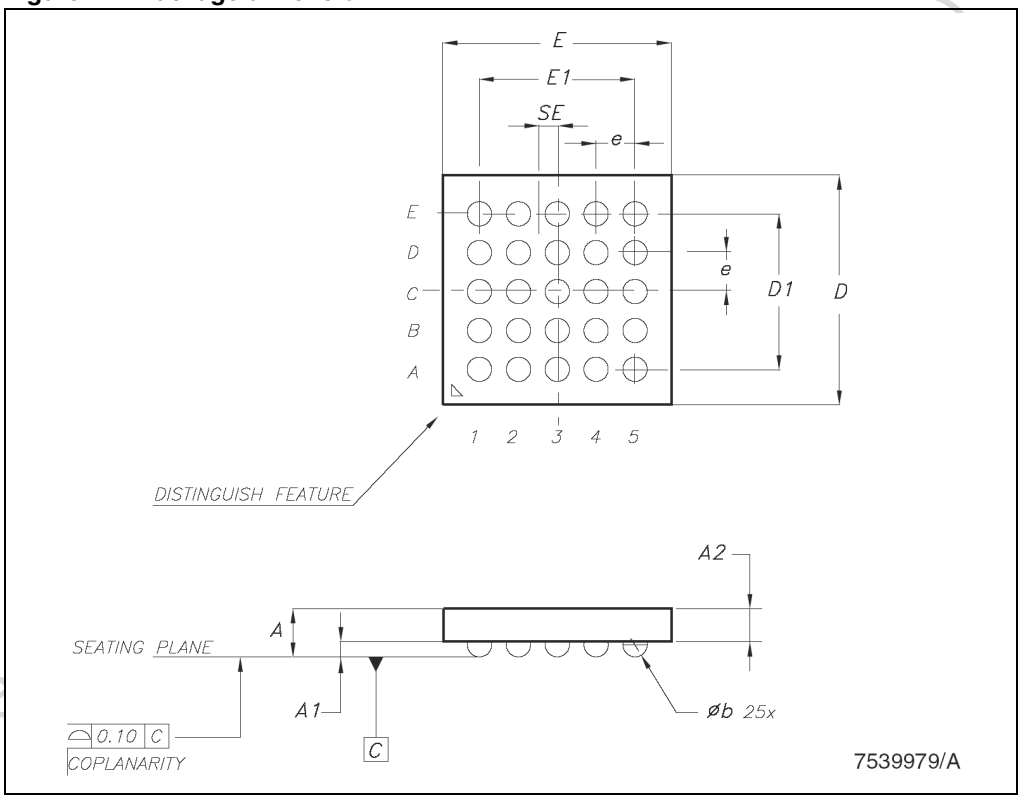


Table 14. TSSOP28 mechanical data

Dim.	mm.			inch		
	Min	Typ	Max	Min	Typ	Max
A			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0079
D	9.6	9.7	9.8	0.378	0.382	0.386
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
e		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030

Figure 8. Package dimension

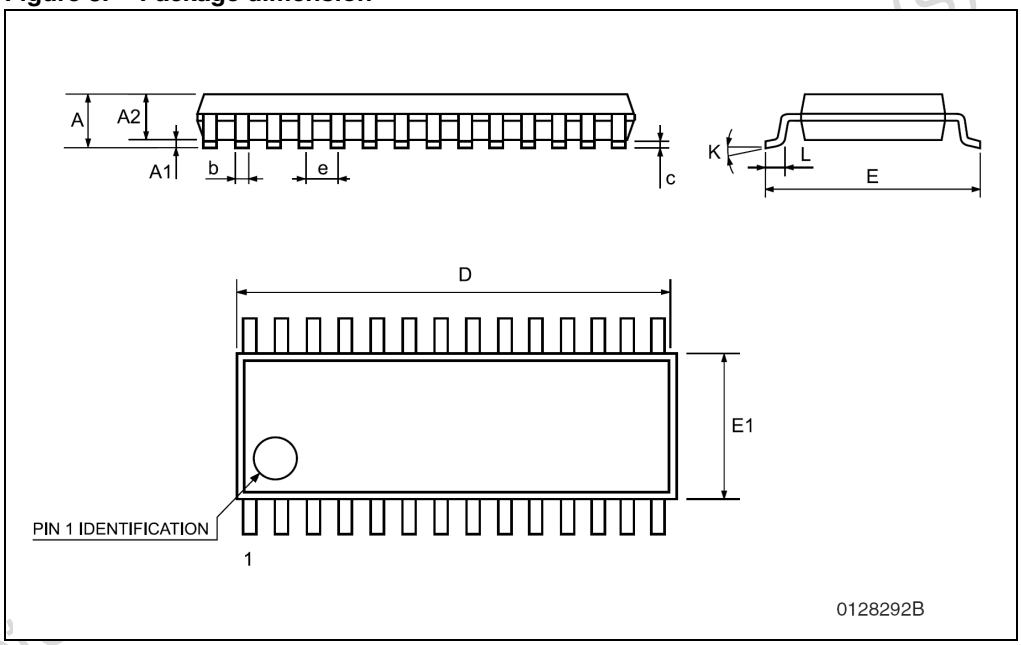


Table 15. Tape and reel μTFBGA25 mechanical data

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			14.4			0.567
Ao		3.3			0.130	
Bo		3.3			0.130	
Ko		1.60			0.063	
Po	3.9		4.1	0.153		0.161
P	7.9		8.1	0.311		0.319

Figure 9. Tape and reel dimension

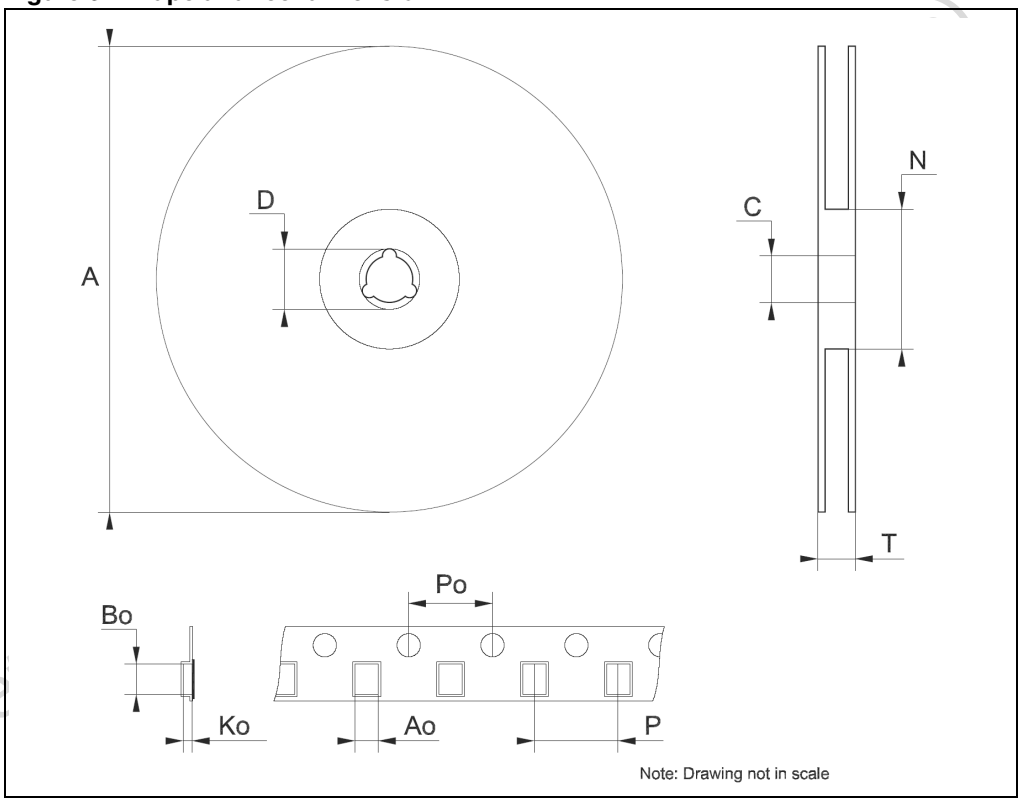
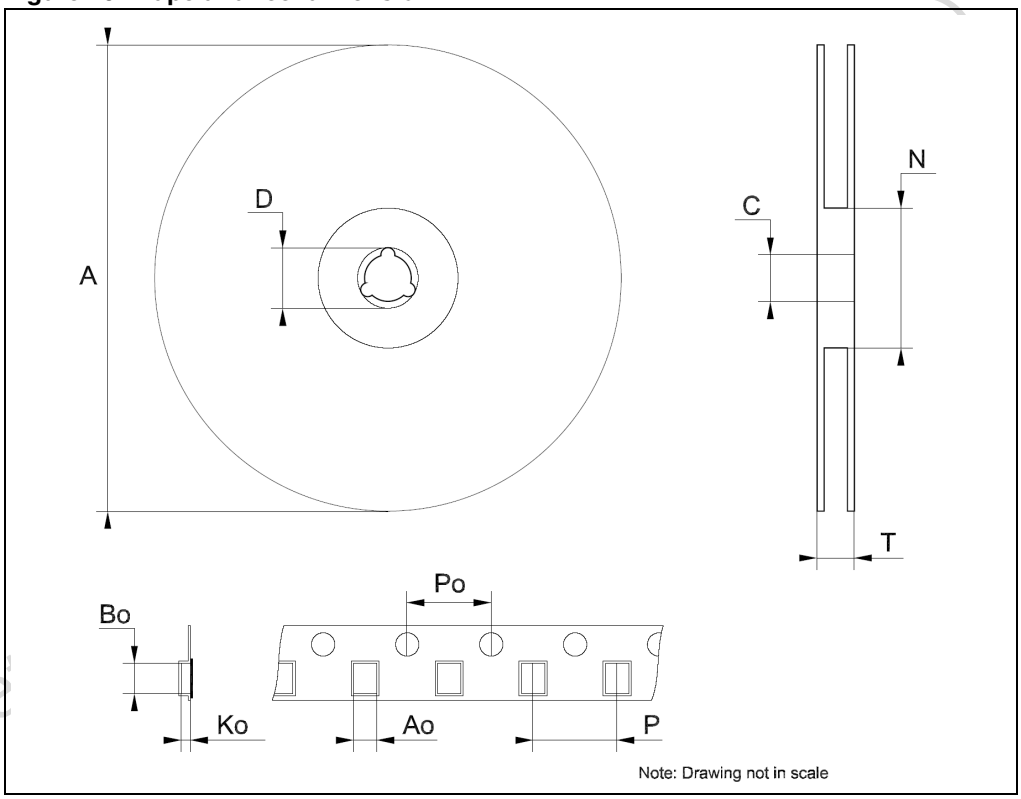


Table 16. Tape and reel TSSOP28 mechanical data

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	10.1		10.3	0.398		0.406
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

Figure 10. Tape and reel dimension



8 Revision history

Table 17. Revision history

Date	Revision	Changes
15-May-2007	1	First release

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries (“ST”) reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST’s terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST’S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER’S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com