ST16C32245

14 BIT DUAL SUPPLY BUS TRANSCEIVER LEVEL TRANSLATOR, A SIDE SERIES RESISTOR, 2 BIT I^2C LINES

PRELIMINARY DATA

- 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} = 20µA(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_{CCB} = 1.65V V_{CCA} = 3V)
- BALANCED PROPAG. DELAYS: $t_{PLH} \cong t_{PHL}$
- POWER DOWN PROTECTION ON I/O
- 26Ω SERIES RESISTOR ON A SIDE OUTPUTS
- OPERATING VOLTAGE RANGE:
  V_{CCA}(OPR)=2.3V to 3.6V (1.2V Data Retent)
  V_{CCB}(OPR)=1.65V to 2.7V (1.2V Data Retent)
- FAST I^2C LINES 1.8V/2.8V LEVEL TRANSLATOR: 400KHz GUARANTEED DATA RATE AT C_L = 15pF
- BUS HOLD PROVIDED ON DATA INPUT BOTH SIDE
- LATCH-UP PERFORMANCE EXCEEDS 500mA (JESD 17)
- ESD PERFORMANCE:
  HBM > 2000V (MIL STD 883 method 3015);
  MM > 200V

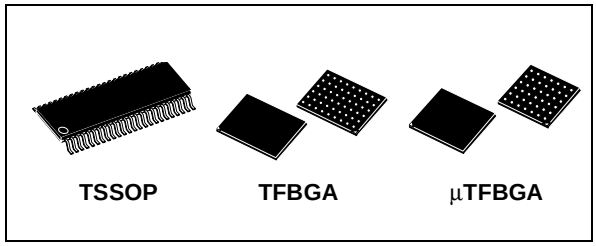
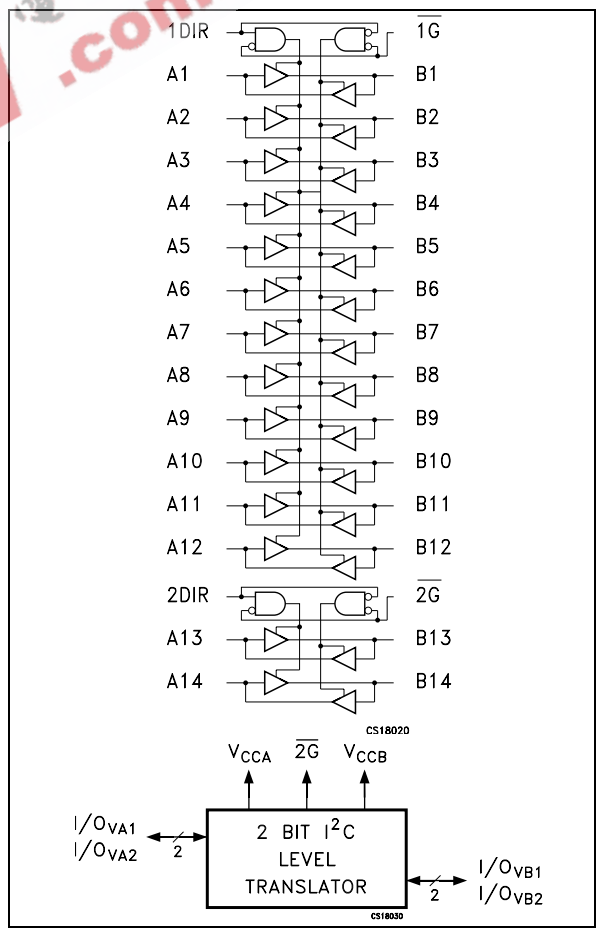


Table 1: Order Codes

PACKAGE	T & R
TSSOP48	ST16C32245TTR
TFBGA54	ST16C32245LBR
µTFBGA42	ST16C32245TBR

Figure 1: Logic Diagram



DESCRIPTION

The ST16C32245 is a dual supply low voltage CMOS 14-BIT BUS TRANSCEIVER 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 and 2.5V/1.8V supply systems, it achieves high speed operation while maintaining the CMOS low power dissipation and it includes 2-bit I^2C level translation. 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 nG can be used to disable the device so that the buses are effectively isolated. The A-port interfaces with the 3V bus, the B-port with the 2.5V and 1.8V bus. All inputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage. All floating bus terminals during High Z State don't need external pull-up or pull-down resistor.

Figure 2: Input And Output Equivalent Circuit

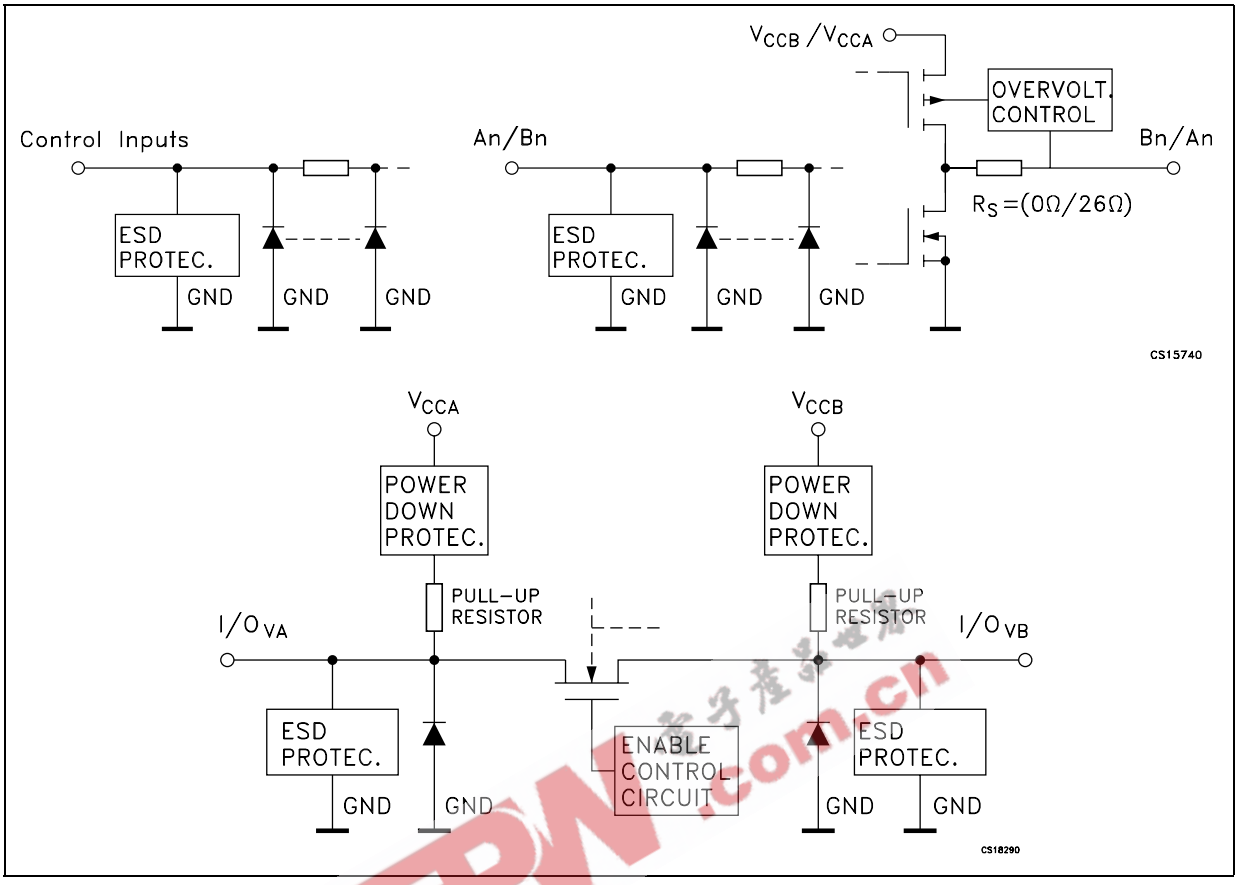


Table 2: Pin Description

TFBGA54 PIN N°	µTFBGA42 PIN N°	TSSOP PIN N°	SYMBOL	NAME AND FUNCTION
A3	B3	1	1DIR	Directional Controls
J3	F3	24	2DIR	Directional Controls
A6, B5, B6, C5, C6, D5, D6, E5	A4, A5, A6, B5, B6, C5, C6, D5	47, 46, 44, 43, 41, 40, 38, 37	1A1, 1A2, 1A3, 1A4, 1A5, 1A6, 1A7, 1A8	Data Inputs/Outputs
E6, F5, F6, G5, G6, H5	D6, E5, E6, F5, F6, G6	36, 35, 33, 32, 30, 29	1A9, 1A10, 1A11, 1A12, 2A13, 2A14	Data Inputs/Outputs
A1, B2, B1, C2, C1, D2, D1, E2	A3, A2, A1, B2, B1, C2, C1, D2	2, 3, 5, 6, 8, 9, 11, 12	1B1, 1B2, 1B3, 1B4, 1B5, 1B6, 1B7, 1B8	Data Inputs/Outputs
E1, F2, F1, G2, G1, H2	D1, E2, E1, F2, F1, G1	13, 14, 16, 17, 19, 20	1B9, 1B10, 1B11, 1B12, 2B13, 2B14	Data Inputs/Outputs
J4	F4	25	$\overline{2G}$	Output Enable Inputs
A4	B4	48	$\overline{1G}$	Output Enable Inputs
D3, D4, E3, E4, F3, F4	C3, C4, E3, E4	4, 10, 15, 21, 28, 34, 39, 45	GND	Ground (0V)
A2, A5, B3, B4, H3, H4, J2, J5	-	-	NC	No Connected
C4, G4	D4	42, 31	V_{CCA}	Positive Supply Voltage
C3, G3	D3	7, 18	V_{CCB}	Positive Supply Voltage
H6, J6	G5, G4	27, 26	I/O_{VA1}, I/O_{VA2}	I^2C Line (V_{CCA} Referred)
H1, J1	G2, G3	22, 23	I/O_{VB1}, I/O_{VB2}	I^2C Line (V_{CCB} Referred)

Figure 3: Pin Connection (top view for TSSOP, top through view for BGA)

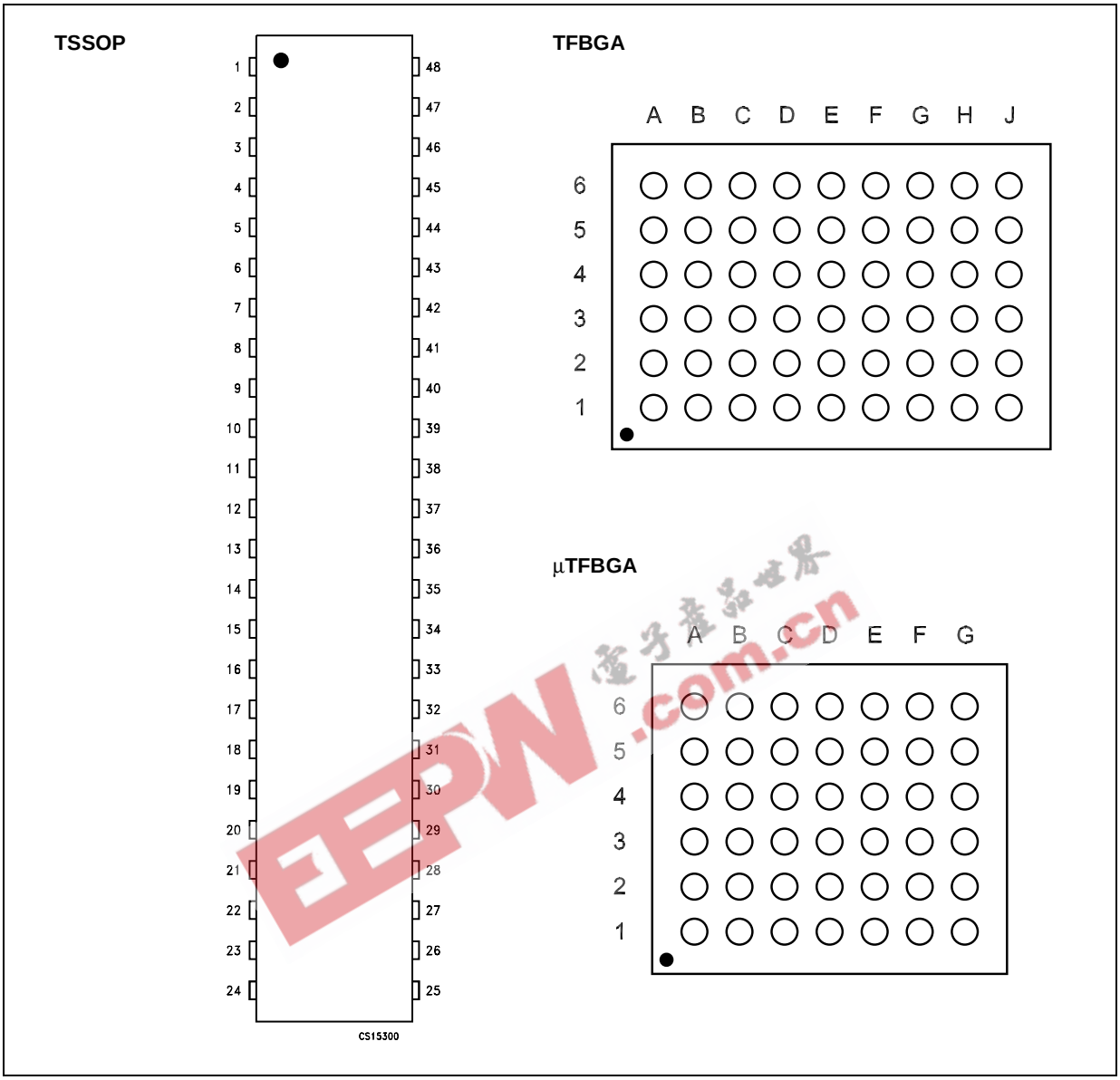


Table 3: Truth Table

INPUTS		FUNCTION		OUTPUT
$\overline{G}$	DIR	A BUS	B BUS	
L	L	OUTPUT	INPUT	A = B
L	H	INPUT	OUTPUT	B = A
H	X	Z	Z	Z

X=Don't care; Z=High Impedance

Table 4: I²C Bus Function Table

$\overline{2G}$	$\overline{1G}$, 1DIR, 2DIR	I/O INPUT		FUNCTION
		I/O_{VA}	I/O_{VB}	
H	X	Z	Z	I^2C Disabled
L	X	L	L	I^2C Comm.
L	X	V_{CCA}	V_{CCB}	I^2C Comm.
L	X	Open	V_{CCB}	I^2C Comm.
L	X	V_{CCA}	Open	I^2C Comm.

Open: If I/O_{VA} is not driven then the I/O_{VB} will go in high level V_{CCB} by embedded 10kΩ pull-up resistor; If I/O_{VB} is not driven then the I/O_{VA} will go in high level V_{CCB} by embedded 10kΩ pull-up resistor.

Table 5: 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
$V_{I/OVA}$	Level Input Voltage (I/O_{VA})	-0.5 to V_{CCA} + 0.5	V
$V_{I/OVB}$	Level Input Voltage (I/O_{VB})	-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

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

Table 6: Recommended Operating Conditions

Symbol	Parameter	Value	Unit
V_{CCA}	Supply Voltage	2.3 to 3.6	V
V_{CCB}	Supply Voltage	1.65 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
$V_{I/OVA}$	Level Input Voltage (I/O_{VA})	0 to V_{CCA}	V
$V_{I/OVB}$	Level Input Voltage (I/O_{VB})	0 to V_{CCB}	V
T_{op}	Operating Temperature	-40 to 85	°C
dt/dv	Input Rise and Fall Time (note 1)	0 to 10	ns/V

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

Table 7: DC Specification For V_{CCA}

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_{IHA}	High Level Input Voltage (An) (*)	1.8	2.5		1.6			1.6		V
		1.8	3.3		2.0			2.0		
		2.5	3.3		2.0			2.0		
V_{ILA}	Low Level Input Voltage (An) (*)	1.8	2.5				0.7		0.7	V
		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
$I_{IA(HOLD)}$	Input Hold Current	1.65	2.3	V_I = 0.7 V	45			45		µA
		1.65	2.3	V_I = 1.6 V	-45			-45		
		1.65	3.0	V_I = 0.8 V	75			75		
		1.65	3.0	V_I = 2.0 V	-75			-75		
		2.3	3.0	V_I = 0.8 V	75			75		
		2.3	3.0	V_I = 2.0 V	-75			-75		
		2.7	3.6	V_I = 0 to 3.6 V					± 500	
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
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_{OFFI2C}	Power Off I^2C Line Leakage Current	1.65 to 2.7	0	$I/O_{VA1,2}$ = GND or V_{CCA}; $I/O_{VB1,2}$ = GND or V_{CCB}; $\overline{2G}$ = V_{CCB}			1.0		5	µA
I_{CCtA}	Quiescent Supply Current	1.95	3.6	V_{IA} =V_{CCA} or GND V_{IB} =V_{CCB} or GND $I/O_{VA1,2}$=V_{CCA} or Open; Dir, $\overline{G}$ = GND or V_{CCB}			2		20	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							

(*): V_{CC} range = 3.3±0.3; 2.5±0.2V and 2.8±0.1V; 1.8±0.15V

Table 8: DC Specification For V_{CCB}

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_{IHB}	High Level Input Voltage (Bn, Dir, $\overline{G}$) (*)	1.8	2.5		$0.65V_{CCB}$			$0.65V_{CCB}$		V
		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, $\overline{G}$) (*)	1.8	2.5				$0.35V_{CCB}$		$0.35V_{CCB}$	V
		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
$I_{IB(HOLD)}$	Input Hold Current	1.65	2.3	V_I = 0.57 V	25			25		µA
		1.65	2.3	V_I = 1.07 V	-25			-25		
		1.65	3.0	V_I = 0.57 V	25			25		
		1.65	3.0	V_I = 1.07 V	-25			-25		
		2.3	3.0	V_I = 0.7 V	45			45		
		2.3	3.0	V_I = 1.6 V	-45			-45		
		2.7	3.6	V_I = 0 to 2.7 V					± 500	
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 $I/O_{VA1,2}$=V_{CCA} or Open			2		20	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							

(*) V_{CC} range = 3.3±0.3; 2.5±0.2V and 2.8±0.1V ; 1.8±0.15V

Table 9: DC Specification I^2C Lines

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_{IH2}	High Level Input Voltage (I/O_{VB1}, I/O_{VB2})	1.8	2.65 to 3.6		0.7xV_{CCB}		V_{CCB}	0.7xV_{CCB}	V_{CCB}	V
		1.8	2.65 to 3.6		0.7xV_{CCB}		V_{CCB}	0.7xV_{CCB}	V_{CCB}	
	High Level Input Voltage (I/O_{VA1}, I/O_{VA2})	1.8	2.65 to 3.6		0.7xV_{CCA}		V_{CCA}	0.7xV_{CCA}	V_{CCA}	
		1.8	2.65 to 3.6		0.7xV_{CCA}		V_{CCA}	0.7xV_{CCA}	V_{CCA}	
V_{IL2}	Low Level Input Voltage (I/O_{VB1}, I/O_{VB2})	1.8	2.65 to 3.6		0		0.25	0	0.25	V
		1.8	2.65 to 3.6		0		0.25	0	0.25	
	Low Level Input Voltage (I/O_{VA1}, I/O_{VA2})	1.8	2.65 to 3.6		0		0.25	0	0.25	
		1.8	2.65 to 3.6		0		0.25	0	0.25	
V_{OH2}	High Level Output Voltage (I/O_{VB1}, I/O_{VB2})	1.65	2.3	I_{OH} = -20 µA; $V_{I/OVA}$=V_{CCA}	V_{CCB}-0.4			V_{CCB}-0.4		V
	High Level Output Voltage (I/O_{VA1}, I/O_{VA2})	1.65	2.3	I_{OH} = -20 µA; $V_{I/OVB}$=V_{CCB}	V_{CCA}-0.4			V_{CCA}-0.4		
V_{OL2}	Low Level Output Voltage (I/O_{VB1}, I/O_{VB2}), (I/O_{VA1}, I/O_{VA2})	1.65	2.3	I_{OL} = 1 mA; $V_{I/OVB}$ or $V_{I/OVA}$=GND			0.35		0.35	V

(*) V_{CC} range = 1.8±0.15V

Table 10: 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	1.8	2.5	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		0.25				V
		1.8	3.3			0.35				
		2.5	3.3			0.35				
V_{OLPB}	Dynamic Low Level Quiet Bn Output	1.8	2.5	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		0.25				V
		1.8	3.3			0.25				
		2.5	3.3			0.6				
V_{OLVA}	Dynamic Low Level Quiet An Output	1.8	2.5	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		-0.25				V
		1.8	3.3			-0.35				
		2.5	3.3			-0.35				
V_{OLVB}	Dynamic Low Level Quiet Bn Output	1.8	2.5	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		-0.25				V
		1.8	3.3			-0.25				
		2.5	3.3			-0.6				
V_{OHVA}	Dynamic High Level Quiet An Output	1.8	2.5	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		2.1				V
		1.8	3.3			2.6				
		2.5	3.3			2.6				
V_{OHVB}	Dynamic High Level Quiet Bn Output	1.8	2.5	C_L =30pF V_{IL} =0V V_{IH} =V_{CC}		1.7				V
		1.8	3.3			1.7				
		2.5	3.3			2.0				

Table 11: 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 (nota 3)	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 (note1, 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
3) To add 2.5ns at t_{PLH}, t_{PHL} max propagation delay time Bn to An at V_{CCB}=1.8±0.15V; V_{CCA}=2.8±0.1V; R_L=500Ω, when C_L=60 pF

Table 12: AC I²C Electrical Characteristics

Symbol	Parameter	Test Condition			Value		Unit
		V_{CCB} (V)(*)	V_{CCA} (V)(*)		-40 to 85 °C		
					Min.	Max.	
$t_{rI/O}$	Rise Time I²C Input/Output Voltage (20% to 80%) (See fig. 3)	1.8 ± 0.15	2.5 ± 0.2	C_L = 15 pF $t_{rI/O}$ = 15ns		250	ns
		1.8 ± 0.15	3.3 ± 0.3				
		2.5 ± 0.2	3.3 ± 0.3				
$t_{fI/O}$	Fall Time I²C Input/Output Voltage (80% to 20%) (See fig. 3)	1.8 ± 0.15	2.5 ± 0.2	C_L = 15 pF $t_{rI/O}$ = 15ns		250	ns
		1.8 ± 0.15	3.3 ± 0.3				
		2.5 ± 0.2	3.3 ± 0.3				
t_{PLH}	Propagation Delay Time I²C I/O Voltage (20% to 80%) (Low to High) (fig. 3)	1.8 ± 0.15	2.5 ± 0.2	C_L = 15 pF $t_{rI/O}$ = 15ns		100	ns
		1.8 ± 0.15	3.3 ± 0.3				
		2.5 ± 0.2	3.3 ± 0.3				
t_{PHL}	Propagation Delay Time I²C I/O Voltage (20% to 80%) High to Low) (fig. 3)	1.8 ± 0.15	2.5 ± 0.2	C_L = 15 pF $t_{rI/O}$ = 15ns		100	ns
		1.8 ± 0.15	3.3 ± 0.3				
		2.5 ± 0.2	3.3 ± 0.3				
$f_{I/OVA}$, $f_{I/OVB}$	I²C lines data rate	1.8 ± 0.15	2.5 ± 0.2	C_L = 15 pF $t_{rI/O}$ = 15ns	400		KHz
		1.8 ± 0.15	3.3 ± 0.3				
		2.5 ± 0.2	3.3 ± 0.3				

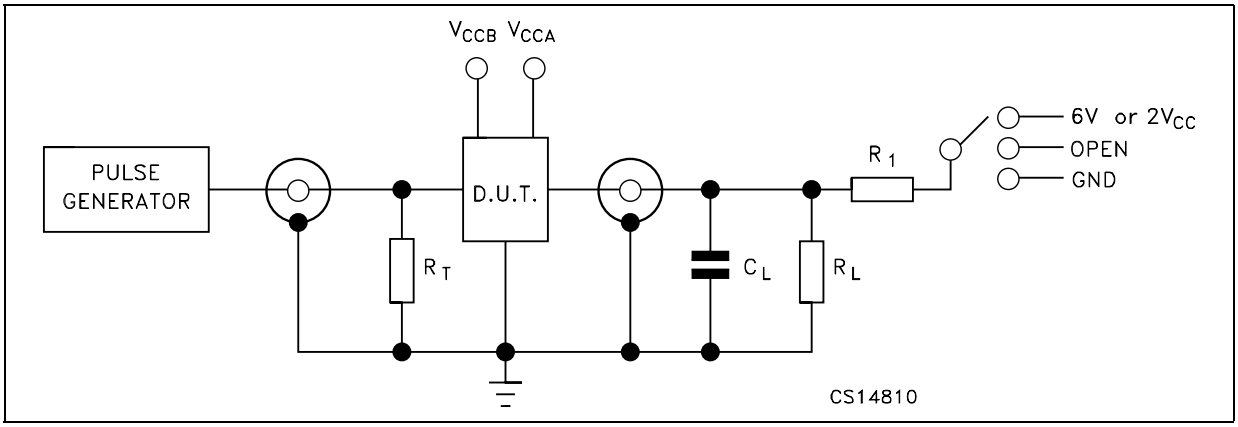
(*) V_{CC} range = 3.3±0.3; 2.5±0.2V and 2.8±0.1V; 1.8±0.15V

Table 13: 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

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 current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/14$ (per circuit)

Figure 4: 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 2.8V or V_{CC} = 1.65 to 1.95V)	$2V_{CC}$
t_{PZH}, t_{PHZ}	GND

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)

Table 14: Waveform Symbol Value

Symbol	V_{CC}		
	3.0 to 3.6V	2.3 to 2.8V	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)

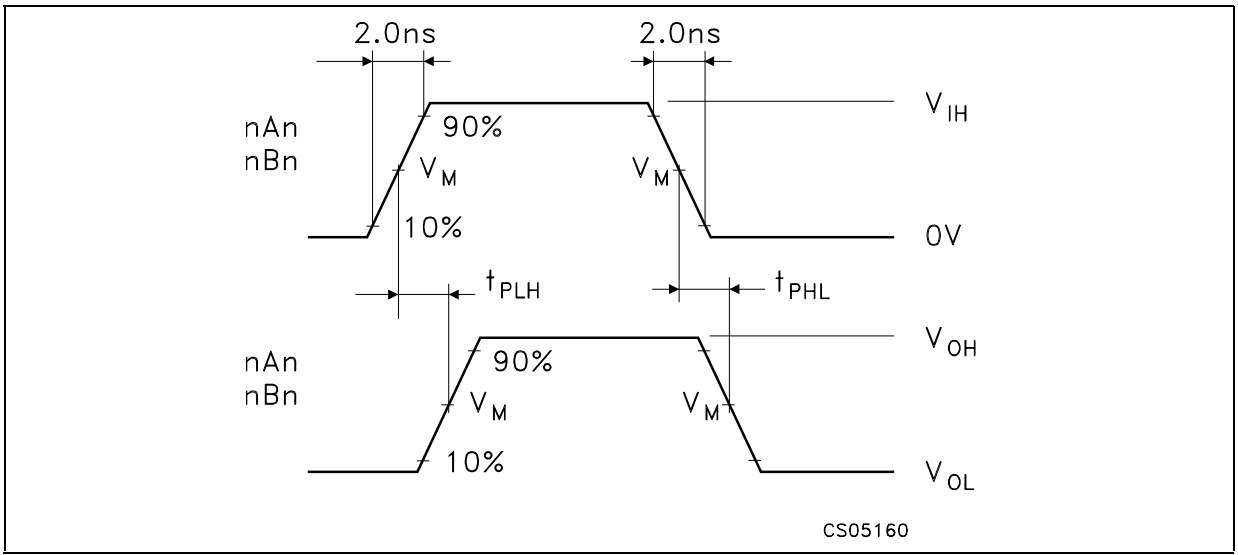


Figure 6: Waveform - Output Enable And Disable Time (f=1MHz; 50% duty cycle)

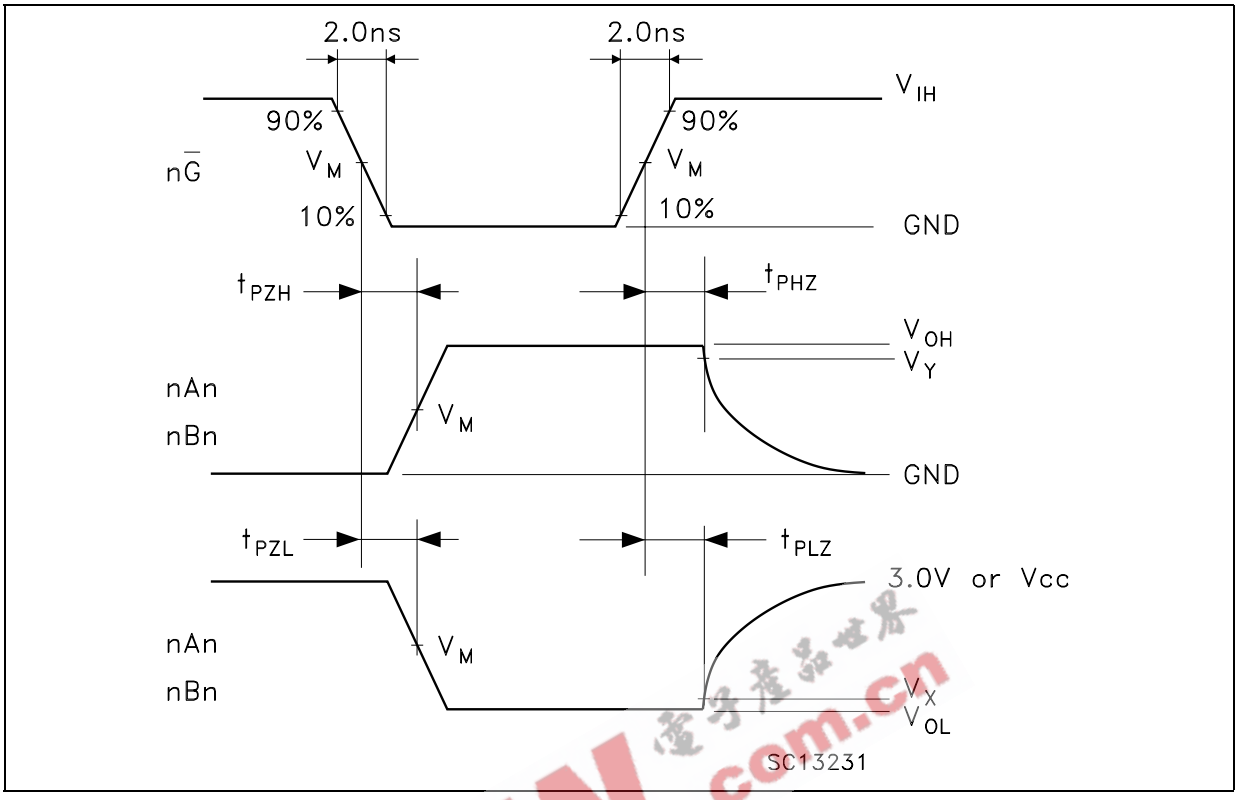
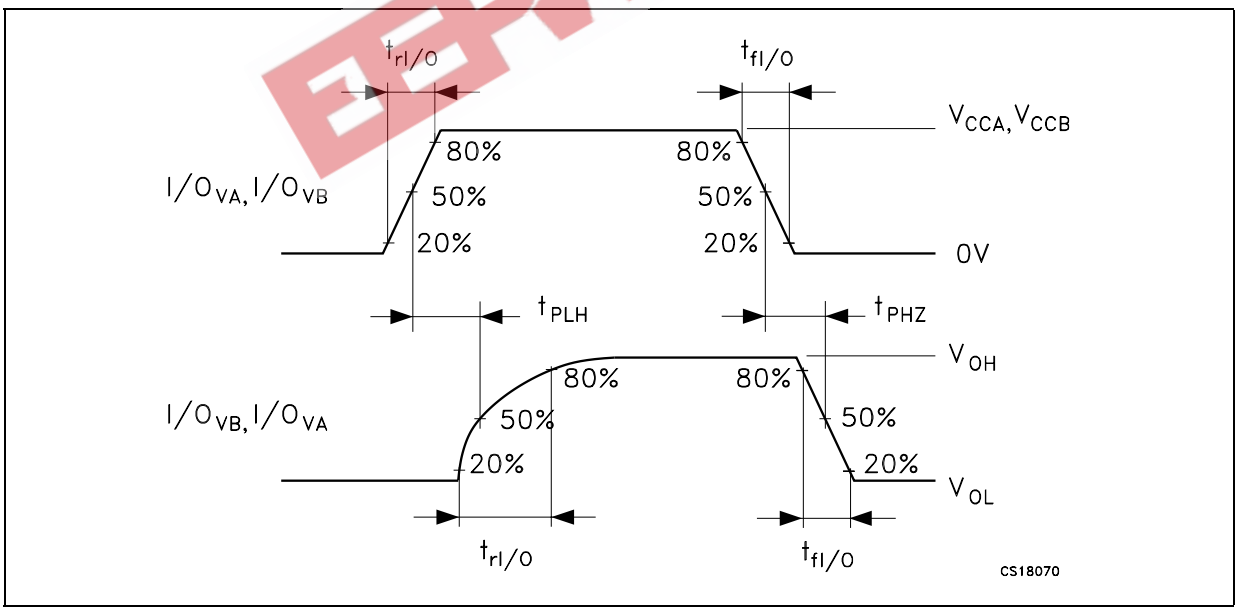
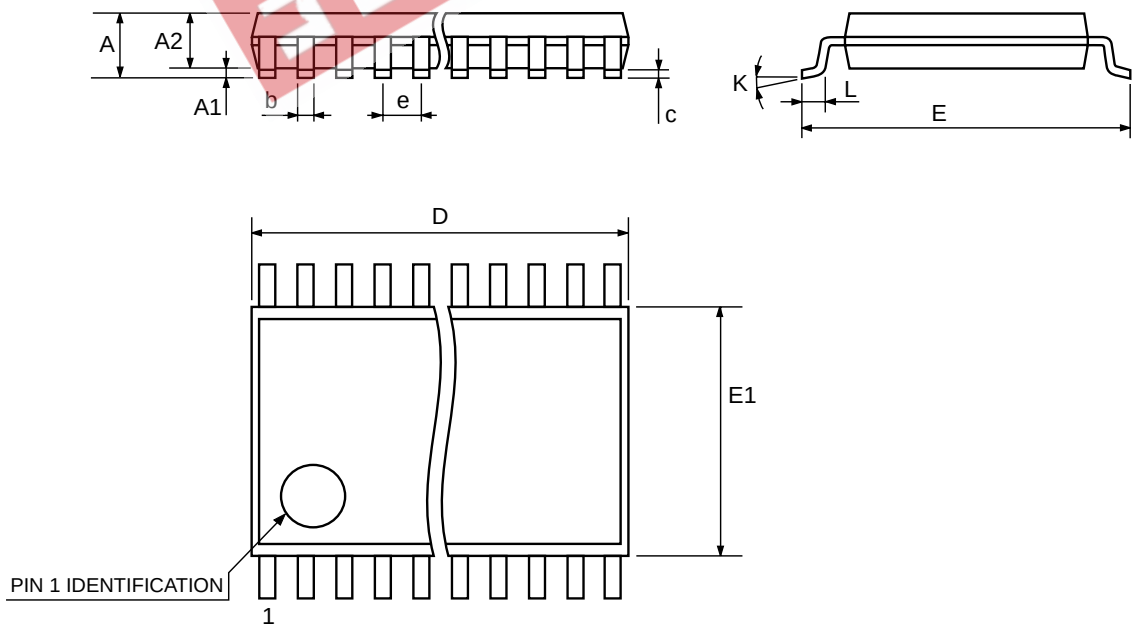


Figure 7: Waveform - I²C Propagation Delay Time (f = 400KHz; 50% duty cycle, C_L = 15pF)



TSSOP48 MECHANICAL DATA

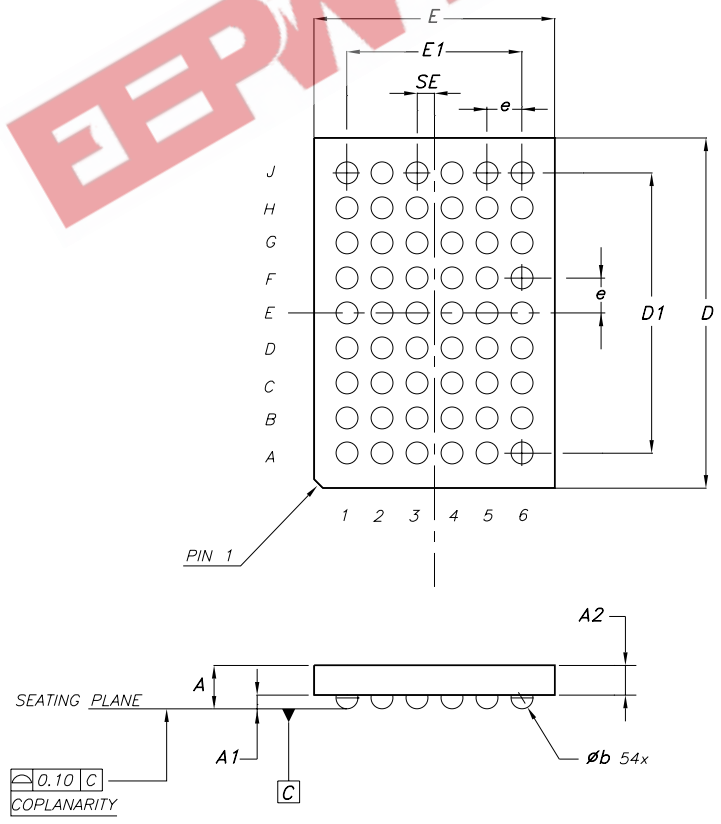
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002		0.006
A2		0.9			0.035	
b	0.17		0.27	0.0067		0.011
c	0.09		0.20	0.0035		0.0079
D	12.4		12.6	0.488		0.496
E		8.1 BSC			0.318 BSC	
E1	6.0		6.2	0.236		0.244
e		0.5 BSC			0.0197 BSC	
K	0°		8°	0°		8°
L	0.45		0.75	0.018		0.030



7065588D

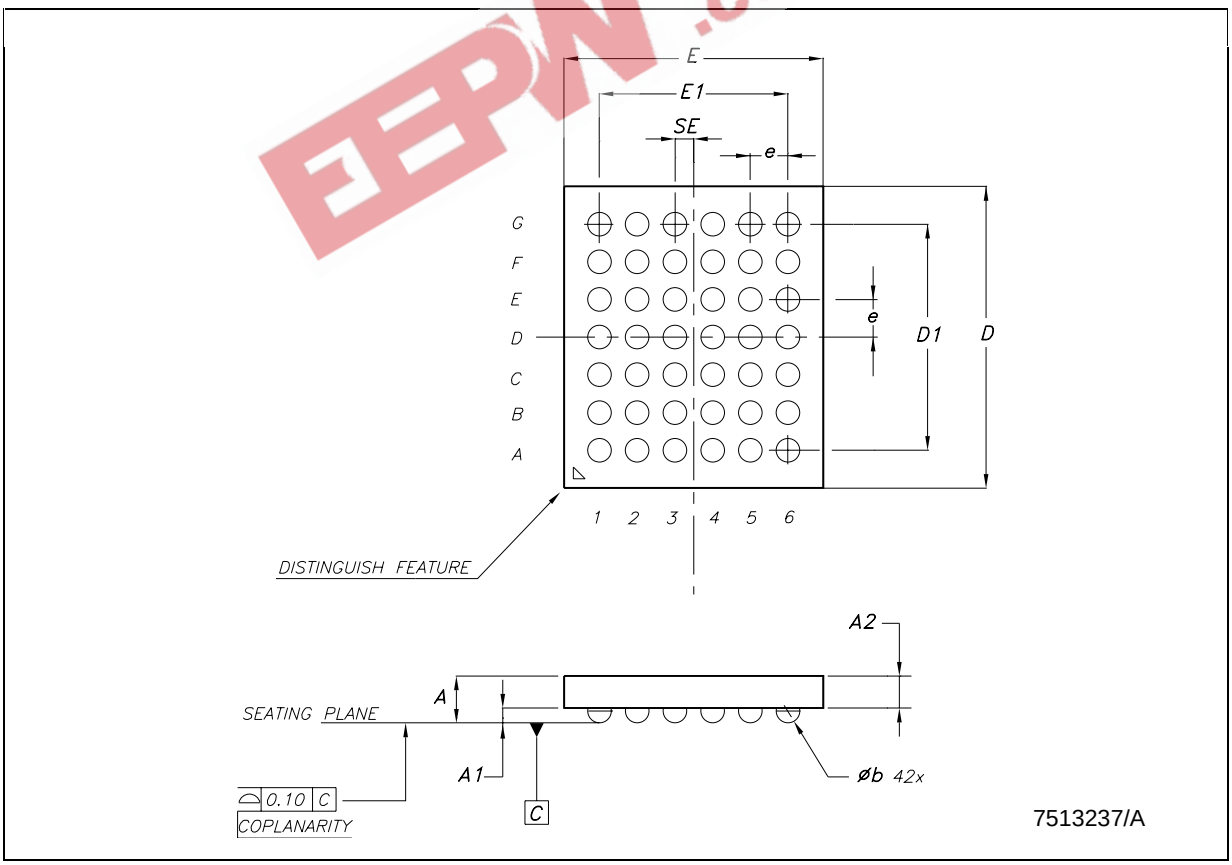
TFBGA54 MECHANICAL DATA

DIM.	mm.			mils		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			47.2
A1	0.25			9.8		
A2	0.78		0.86	30.7		33.8
B	0.35	0.4	0.45	13.7	15.7	17.7
D	7.9		8.1	311.0		318.9
D1		6.4			252.0	
E	5.4	5.5	5.6	212.6	216.5	220.5
E1		4			157.5	
e		0.8			31.5	
SE		0.4			15.7	



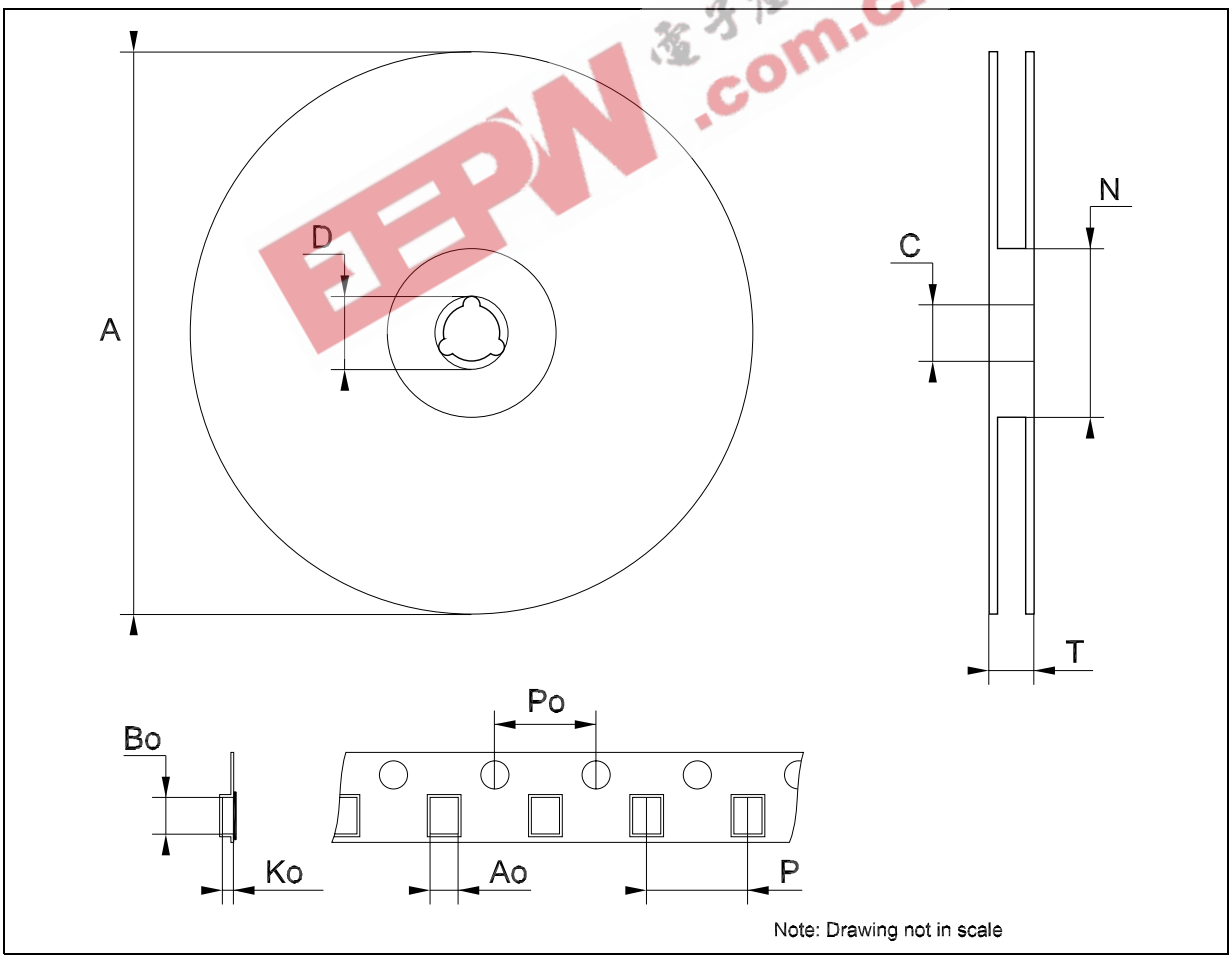
µTFBGA42 MECHANICAL DATA

DIM.	mm.			mils		
	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	3.9	4.0	4.1	153.5	157.5	161.4
D1		3			118.1	
E	3.4	3.5	3.6	133.9	137.8	141.7
E1		2.5			98.4	
e		0.5			19.7	
SE		0.25			9.8	



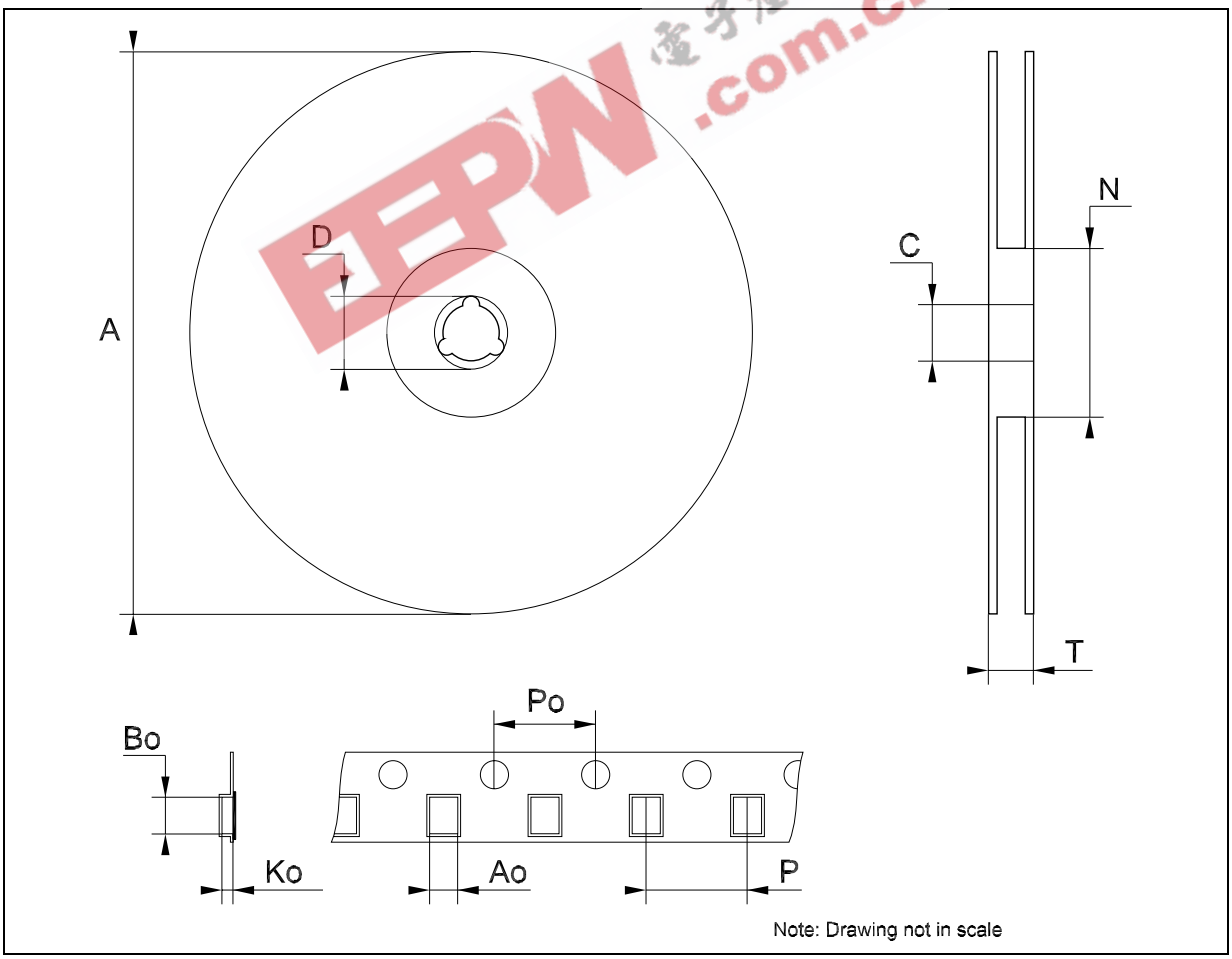
Tape & Reel TSSOP48 MECHANICAL DATA

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	8.7		8.9	0.343		0.350
Bo	13.1		13.3	0.516		0.524
Ko	1.5		1.7	0.059		0.067
Po	3.9		4.1	0.153		0.161
P	11.9		12.1	0.468		0.476



Tape & Reel TFBGA42 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		3.8			0.149	
Bo		4.3			0.169	
Ko		1.05			0.041	
Po	3.9		4.1	0.153		0.161
P	7.9		8.1	0.311		0.319



Note: Drawing not in scale

Tape & Reel TFBGA54 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		6.1			0.240	
Bo		8.6			0.339	
Ko		1.8			0.071	
Po	3.9		4.1	0.153		0.161
P	7.9		8.1	0.311		0.319

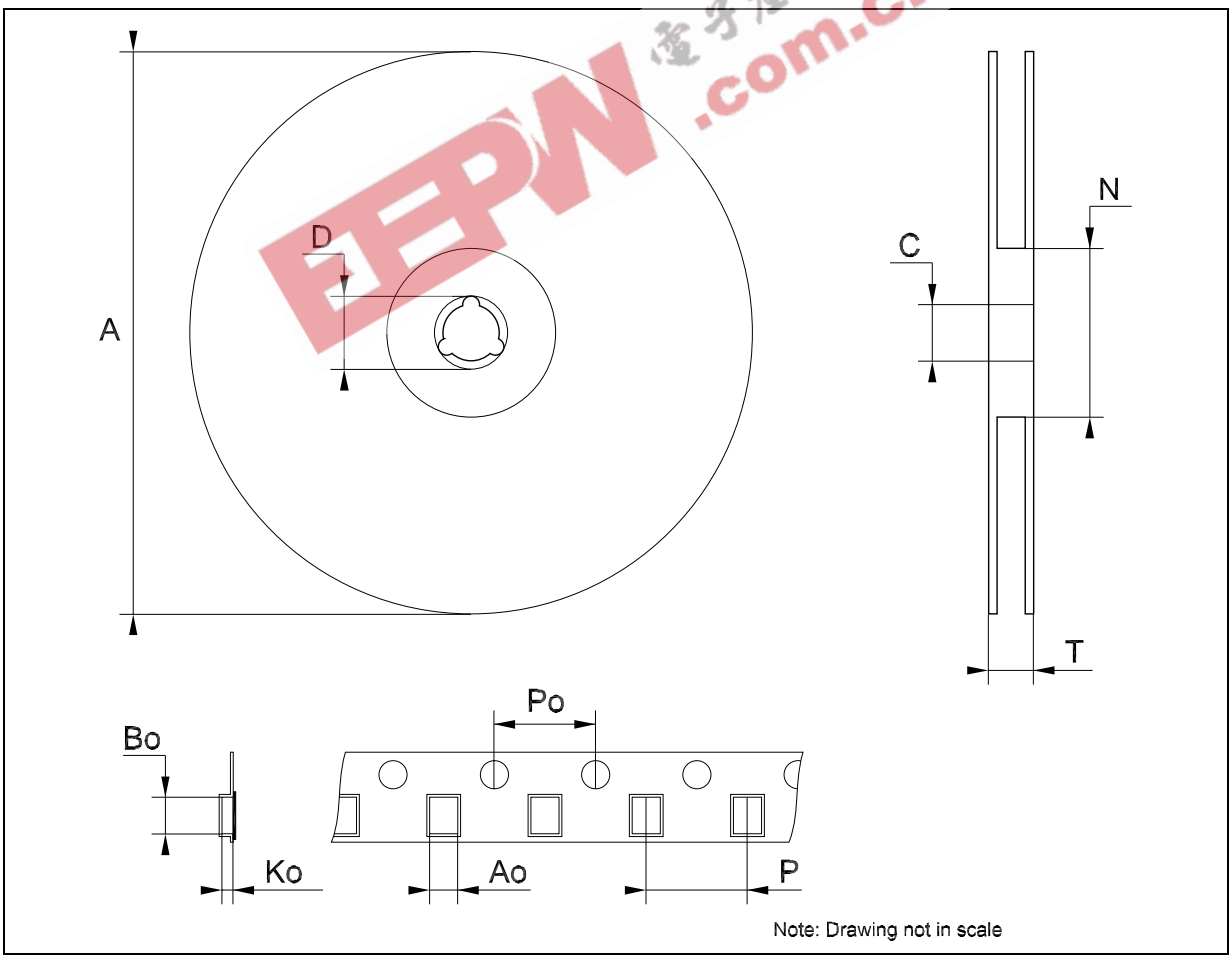


Table 15: Revision History

Date	Revision	Description of Changes
01-Oct-2004	1	First Release.