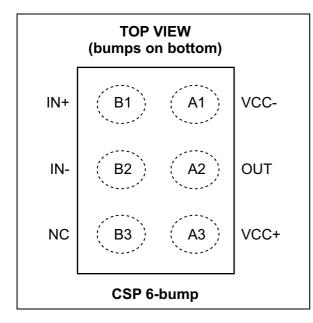


### Micropower low-voltage, 1.2 x 0.8 mm CSP comparator

Datasheet - production data



#### **Features**

- Supply operation from 1.8 to 5 V
- Low current consumption: 14 μA
- Rail to rail inputs, push-pull outputs
- Low propagation delay: 300 ns
- 60 μA supply current at 1 MHz switching frequency
- Low output saturation voltage
- Internal hysteresis
- Wide temperature range: -40 ° to 85 °C
- ESD tolerance: 2 kV HBM
- 6-bump CSP, 1.2 x 0.8 mm, 400 μm pitch

#### **Applications**

- Mobiles phones
- Battery supplied electronics
- General purpose portable devices
- General purpose low voltage applications

#### **Description**

The TS985 is a single micropower and low voltage comparator. It can operate with a supply voltage ranging from 1.8 V to 5 V with a typical current consumption as low as 14  $\mu$ A while achieving a 300 ns propagation delay. In addition, rail-to-rail inputs make it a perfect choice for low voltage applications.

The 6-bump chip scale package (CSP) is a real advantage for overcoming space constraints.

TS985 is specified for temperature between -40 °C to 85 °C, making it ideal for a wide range of applications.

Contents TS985

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2	Electrical characteristics4
3	Electrical characteristic curves
4	Package information
	4.1 CSP 6-bump package information
5	Ordering information
6	Revision history



# 1 Absolute maximum ratings

Table 1. Absolute maximum ratings (AMR)

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply voltage <sup>(1)</sup>	5.5	
V <sub>id</sub>	Differential input voltage (2)	±5.5	V
V <sub>in</sub>	Input voltage (3)	$(V_{CC}^{-})$ - 0.3 to $(V_{CC}^{+})$ + 0.3	V
V <sub>out</sub>	Output voltage	5.5	
I <sub>F</sub>	Forward current in ESD protection diodes on inputs <sup>(4)</sup>	10	mA
T <sub>j</sub>	Maximum junction temperature	150	°C
T <sub>stg</sub>	Storage temperature range	-65 to 150	C
R <sub>thja</sub>	Thermal resistance junction to ambient <sup>(5)</sup>	TBA	°C/W
ESD	HBM: human body model <sup>(6)</sup>	2000	V
ESD	CDM: charged device model <sup>(7)</sup>	1500	V
	Latch-up immunity	200	mA

- 1. All voltage values, except differential voltage, are with respect to network ground terminal.
- 2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- Excursions of input voltages may exceed the power supply level. As long as the common mode voltage [V<sub>icm</sub>=(V<sub>in</sub><sup>+</sup> + V<sub>in</sub><sup>-</sup>)/2] remains within the specified range, the comparator will provide a stable output state. However, the maximum current through the ESD diodes (IF) of the input stage must strictly be observed.
- 4. Guaranteed by design.
- 5. Short-circuits can cause excessive heating and destructive dissipation. Values are typical
- 6. According to JEDEC standard JESD22-A114F.
- 7. According to ANSI/ESD STM5.3.1.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V <sub>CC</sub> <sup>+</sup>	Supply voltage	1.8 to 5.0	
V	Common mode input voltage range, T <sub>amb</sub> = 25 °C	$(V_{CC}^{-})$ - 0.25 to $(V_{CC}^{+})$ + 0.25	V
V <sub>icm</sub>	Common mode input voltage range, $T_{min} \le T_{amb} \le T_{max}$	$(V_{CC}^-)$ to $(V_{CC}^+)$	
T <sub>oper</sub>	Operating free-air temperature range	-40 to 85	°C



Electrical characteristics TS985

### 2 Electrical characteristics

Table 3.  $V_{CC}^+$  = 1.8 V,  $V_{CC}^-$  = 0 V,  $T_{amb}$  = 25 °C (unless otherwise specified)

Symbol	Parameter Parameter	Min.	Тур.	Max.	Unit	
V	Input offset voltage, full V <sub>icm</sub> range		0.5	8	mV	
V <sub>io</sub>	Input offset voltage, T <sub>min</sub> ≤T <sub>amb</sub> ≤T <sub>max</sub>			9	1110	
$\Delta V_{io}/\Delta T$	Input offset voltage drift vs. temperature		4.5		uV/°C	
V <sub>Hyst</sub>	Input hysteresis voltage		3		mV	
	Input bias current <sup>(1)</sup> , full V <sub>icm</sub> range		14	40		
l <sub>ib</sub>	Input bias current $^{(1)}$ , $T_{min} \le T_{amb} \le T_{max}$			100	- n A	
	Input offset current, full V <sub>icm</sub> range		1	10	nA	
l <sub>io</sub>	Input offset current, $T_{min} \le T_{amb} \le T_{max}$			100		
CMR	Common-mode rejection ratio, V <sub>icm</sub> = 0 to 1.8 V	43			dB	
	Supply current per comparator, no load - V <sub>icm</sub> = 0 V		13	19		
I <sub>CC</sub>	Supply current per comparator, $T_{min} \le T_{amb} \le T_{max}$			20	μA	
V	High-level output voltage, I <sub>Source</sub> = 1 mA	1.69	1.71		V	
V <sub>OH</sub>	High-level output voltage, $T_{min} \le T_{amb} \le T_{max}$	output voltage, $T_{min} \le T_{amb} \le T_{max}$ 1.67			7	
\/	Low-level output voltage, I <sub>Sink</sub> = 1 mA		65	80	mV	
V <sub>OL</sub>	Low-level output voltage, $T_{min} \le T_{amb} \le T_{max}$			95	1110	
1.	V <sub>OUT</sub> = 0 V	6	8			
I <sub>Sink</sub>	$T_{min} \le T_{amb} \le T_{max}$	5			mA	
1.	V <sub>OUT</sub> = V <sub>CC</sub>	4.5	7.3			
I <sub>Source</sub>	$T_{min} \le T_{amb} \le T_{max}$	3.5				
	Response time high to low $^{(2)}$ , $V_{icm}$ = 0 V, $C_L$ = 15 pF, overdrive = 10 mV		730			
t <sub>PHL</sub>	Response time high to low $^{(2)}$ , $V_{icm} = 0$ V, $C_L = 15$ pF, overdrive = 100 mV		300		Ī	
4	Response time low to high $^{(3)}$ , $V_{icm}$ = 0 V, $C_L$ = 15 pF, overdrive = 10 mV		730		– ns	
t <sub>PLH</sub>	Response time low to high $^{(3)}$ , $V_{icm}$ = 0 V, $C_L$ = 15 pF, overdrive = 100 mV		300			

<sup>1.</sup> Maximum values include unavoidable inaccuracies of the industrial tests.

TP<sub>HL</sub> is measured when the output signal crosses a voltage level at 50% of V<sub>CC</sub> with the following conditions: inverting input voltage (IN-) = V<sub>ICM</sub> and non-inverting input (IN+), moving from V<sub>ICM</sub> + 100mV to V<sub>ICM</sub> - overdrive.

<sup>3.</sup> TP<sub>LH</sub> is measured when the output signal crosses a voltage level at 50 % of  $V_{CC}$  with the following conditions: inverting input voltage (IN-) =  $V_{ICM}$  and non-inverting input (IN+), moving from  $V_{ICM}$  - 100 mV to  $V_{ICM}$  + overdrive.

Table 4.  $V_{CC}^+$  = 2.7 V,  $V_{CC}^-$  = 0 V,  $T_{amb}$  = 25 °C (unless otherwise specified)

Symbol	Parameter	Min.	Тур.	Max.	Unit	
V	Input offset voltage, full V <sub>icm</sub> range		0.5	8	mV	
V <sub>io</sub>	Input offset voltage, T <sub>min</sub> ≤T <sub>amb</sub> ≤T <sub>max</sub>			9	IIIV	
ΔV <sub>io</sub> /ΔΤ	Input offset voltage drift vs. temperature		4.5		uV/°C	
V <sub>Hyst</sub>	Input hysteresis voltage		3		mV	
	Input bias current <sup>(1)</sup> , full V <sub>icm</sub> range		15	40		
l <sub>ib</sub>	Input bias current $^{(1)}$ , $T_{min} \le T_{amb} \le T_{max}$			100	n ^	
	Input offset current, full V <sub>icm</sub> range		1	10	− nA	
l <sub>io</sub>	Input offset current, $T_{min} \le T_{amb} \le T_{max}$			100		
CMR	Common-mode rejection ratio, V <sub>icm</sub> = 0 to 2.7 V	48			dB	
	Supply current per comparator, no load - V <sub>icm</sub> = 0 V		14	20		
I <sub>CC</sub>	Supply current per comparator, $T_{min} \le T_{amb} \le T_{max}$			22	μA	
\/	High-level output voltage, I <sub>Source</sub> = 1 mA	2.6	2.64		V	
V <sub>OH</sub>	High-level output voltage, $T_{min} \le T_{amb} \le T_{max}$	2.5			7 '	
\/	Low-level output voltage, I <sub>Sink</sub> = 1 mA		43	55	m\/	
V <sub>OL</sub>	Low-level output voltage, $T_{min} \le T_{amb} \le T_{max}$			65	mV	
	V <sub>OUT</sub> = 0 V	14	18			
I <sub>Sink</sub>	$T_{min} \le T_{amb} \le T_{max}$	12			m ^	
1.	V <sub>OUT</sub> = V <sub>CC</sub>	14	18		mA	
I <sub>Source</sub>	$T_{min} \le T_{amb} \le T_{max}$	12				
	Response time high to low $^{(2)}$ , $V_{icm} = 0$ V, $C_L = 15$ pF, overdrive = 10 mV		860			
t <sub>PHL</sub>	Response time high to low <sup>(2)</sup> , V <sub>icm</sub> = 0 V, C <sub>L</sub> = 15 pF, overdrive = 100 mV		330			
	Response time low to high $^{(3)}$ , $V_{icm}$ = 0 V, $C_L$ = 15 pF, overdrive = 10 mV		860		– ns	
t <sub>PLH</sub>	Response time low to high <sup>(3)</sup> , V <sub>icm</sub> = 0 V, C <sub>L</sub> = 15 pF, overdrive = 100 mV		330			

<sup>1.</sup> Maximum values include unavoidable inaccuracies of the industrial tests.

TP<sub>HL</sub> is measured when the output signal crosses a voltage level at 50% of V<sub>CC</sub> with the following conditions: inverting input voltage (IN-) = V<sub>ICM</sub> and non-inverting input (IN+), moving from V<sub>ICM</sub> + 100mV to V<sub>ICM</sub> - overdrive.

TP<sub>LH</sub> is measured when the output signal crosses a voltage level at 50 % of V<sub>CC</sub> with the following conditions: inverting input voltage (IN-) = V<sub>ICM</sub> and non-inverting input (IN+), moving from V<sub>ICM</sub> - 100 mV to V<sub>ICM</sub> + overdrive.

Electrical characteristics TS985

Table 5.  $V_{CC}^+$  = 5 V,  $V_{CC}^-$  = 0 V,  $T_{amb}$  = 25 °C (unless otherwise specified)

Symbol	Parameter	Min.	Тур.	Max.	Unit	
V	Input offset voltage, full V <sub>icm</sub> range		0.5	8	mV	
V <sub>io</sub>	Input offset voltage, T <sub>min</sub> ≤T <sub>amb</sub> ≤T <sub>max</sub>			9	- IIIV	
$\Delta V_{io}/\Delta T$	Input offset voltage drift vs. temperature		4.5		uV/°C	
V <sub>Hyst</sub>	Input hysteresis voltage		3		mV	
	Input bias current <sup>(1)</sup> , full V <sub>icm</sub> range		17	50		
I <sub>ib</sub>	Input bias current $^{(1)}$ , $T_{min} \le T_{amb} \le T_{max}$			100		
1	Input offset current, full V <sub>icm</sub> range		1	10	nA	
l <sub>io</sub>	Input offset current, $T_{min} \le T_{amb} \le T_{max}$			100		
CMR	Common-mode rejection ratio, V <sub>icm</sub> = 0 to 5 V	56			dB	
1	Supply current per comparator, no load - V <sub>icm</sub> = 0 V		16	24		
I <sub>CC</sub>	Supply current per comparator, $T_{min} \le T_{amb} \le T_{max}$			25	μA	
	High-level output voltage, I <sub>Source</sub> = 1 mA	4.85	4.9		V	
V <sub>OH</sub>	High-level output voltage, $T_{min} \le T_{amb} \le T_{max}$	4.8				
V	Low-level output voltage, I <sub>Sink</sub> = 1 mA		31	45	mV	
V <sub>OL</sub>	Low-level output voltage, $T_{min} \le T_{amb} \le T_{max}$			55		
	V <sub>OUT</sub> = 0 V	35	42			
I <sub>Sink</sub>	$T_{min} \le T_{amb} \le T_{max}$	30			mA	
1.	V <sub>OUT</sub> = V <sub>CC</sub>	45	52			
I <sub>Source</sub>	$T_{min} \le T_{amb} \le T_{max}$	40				
+	Response time high to low $^{(2)}$ , $V_{icm}$ = 0 V, $C_L$ = 15 pF, overdrive = 10 mV		1100			
t <sub>PHL</sub>	Response time high to low $^{(2)}$ , $V_{icm}$ = 0 V, $C_L$ = 15 pF, overdrive = 100 mV		420			
	Response time low to high $^{(3)}$ , $V_{icm}$ = 0 V, $C_L$ = 15 pF, overdrive = 10 mV		1100		– ns	
t <sub>PLH</sub>	Response time low to high $^{(3)}$ , $V_{icm}$ = 0 V, $C_L$ = 15 pF, overdrive = 100 mV		420			

<sup>1.</sup> Maximum values include unavoidable inaccuracies of the industrial tests.

TP<sub>HL</sub> is measured when the output signal crosses a voltage level at 50% of V<sub>CC</sub> with the following conditions: inverting input voltage (IN-) = V<sub>ICM</sub> and non-inverting input (IN+), moving from V<sub>ICM</sub> + 100mV to V<sub>ICM</sub> - overdrive.

TP<sub>LH</sub> is measured when the output signal crosses a voltage level at 50 % of V<sub>CC</sub> with the following conditions: inverting input voltage (IN-) = V<sub>ICM</sub> and non-inverting input (IN+), moving from V<sub>ICM</sub> - 100 mV to V<sub>ICM</sub> + overdrive.

### 3 Electrical characteristic curves

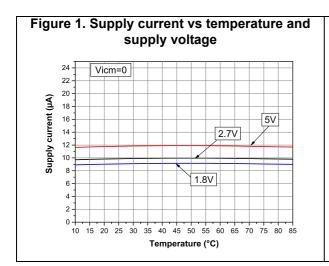


Figure 2. Supply current vs supply voltage,

V<sub>icm</sub> = 0 V, output low

Vicm=0
Output Low

15
0
40°C

1.8 2.2 2.6 3.0 3.4 3.8 4.2 4.6 5.0

Supply voltage (V)

Figure 3. Supply current vs supply voltage,

V<sub>icm</sub> = 0 V, output high

Vicm=0
Output High

15
0
16
0
18
22
25°C
0
18
22
26
3.0
3.4
3.8
4.2
4.6
5.0
Supply voltage (V)

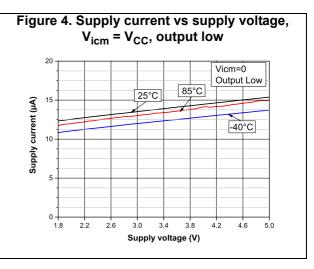
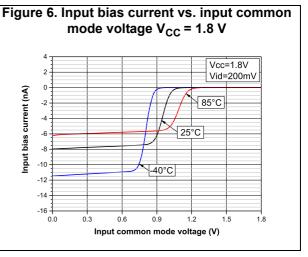


Figure 5. Supply current vs supply voltage,

V<sub>icm</sub> = V<sub>CC</sub>, output high

Vicm=Vcc
Output High

15
25°C
85°C
Output High
Outpu



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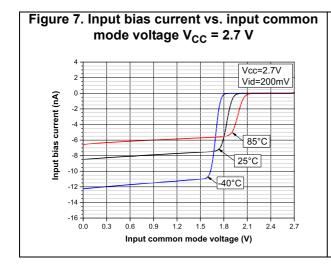


Figure 8. Input bias current vs. input common mode voltage V<sub>CC</sub> = 5 V

Figure 9. Input offset voltage vs. input common mode voltage V<sub>CC</sub> = 1.8 V 2.5 Vcc=1.8V 2.0 85°C Input offset voltage (mV) 1.5 25°C 1.0 -40°C 0.5 0.0 -0.5 -1.0 -1.5

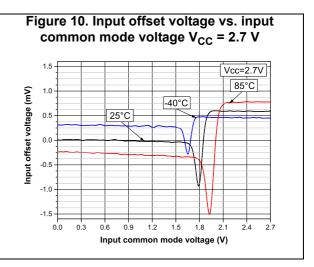
0.8 1.0 1.2

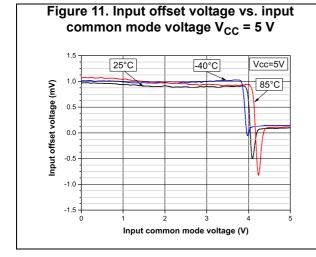
Input common mode voltage (V)

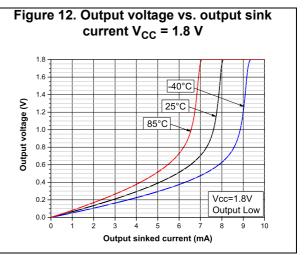
-2.0

0.0 0.2

0.4 0.6







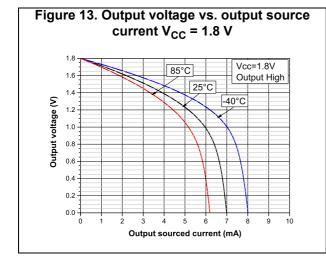


Figure 14. Output voltage vs. output sink current  $V_{CC} = 2.7 \text{ V}$ 0.9 Vcc=2.7V 0.8 Output Low 0.7 Output voltage (V) 0.6 85°C 0.5 25°C 0.4 -40°C 0.3 0.2 0.1 0.0 Output sinked current (mA)

Figure 15. Output voltage vs. output source current V<sub>CC</sub> = 2.7 V

Output sourced current (mA)

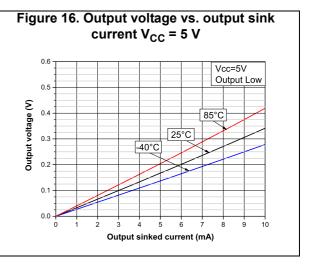
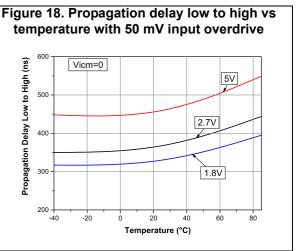


Figure 17. Output voltage vs. output source current V<sub>CC</sub> = 5 V



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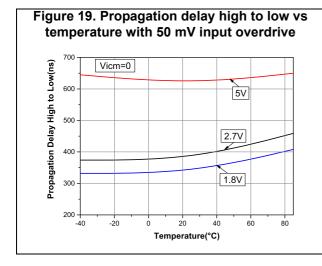
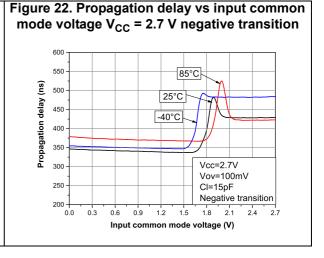
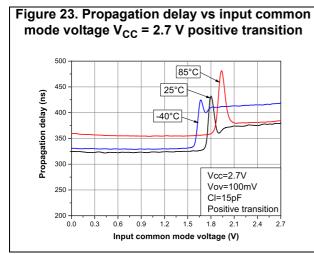
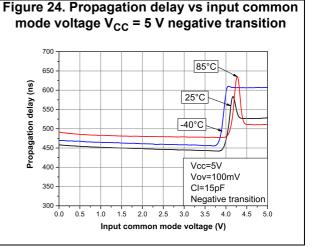


Figure 20. Propagation delay vs input common mode voltage  $V_{CC}$  = 1.8 V negative transition 450 Propagation delay (ns) 400 85°C 350 25°C 300 -40°C Vcc=1.8V Vov=100mV CI=15pF Negative transition 0.0 0.2 0.4 0.6 0.8 1.2 1.4 1.6 1.0 Input common mode voltage (V)

Figure 21. Propagation delay vs input common mode voltage V<sub>CC</sub> = 1.8 V positive transition Vcc=1.8V Vov=100mV 450 CI=15pF Propagation delay (ns) Positive transition 400 350 85°C 300 25°C -40°C 250 200 0.2 0.4 0.6 0.8 1.0 1.2 1.4 Input common mode voltage (V)





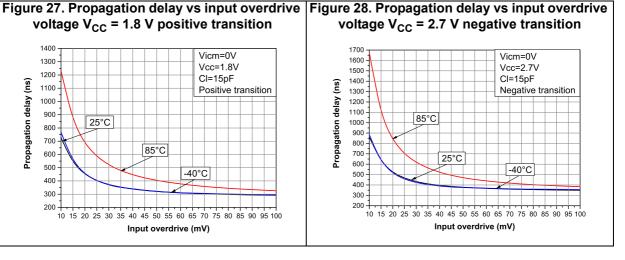


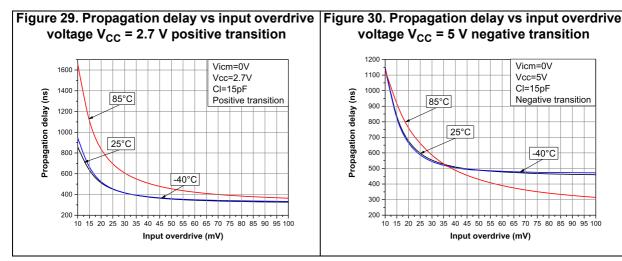
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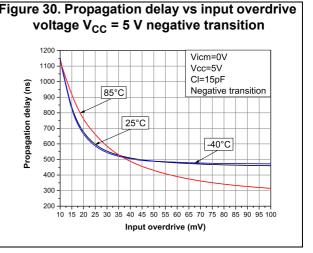
Figure 25. Propagation delay vs input common | Figure 26. Propagation delay vs input overdrive mode voltage  $V_{CC}$  = 5 V positive transition 85°C 550 (ns) 25°C Propagation delay 500 -40°C 450 400 Vcc=5V Vov=100mV 350 CI=15pF Positive transition 300 0.0 0.5 1.0 2.0 2.5 3.0 3.5 4.0 4.5 5.0 Input common mode voltage (V)

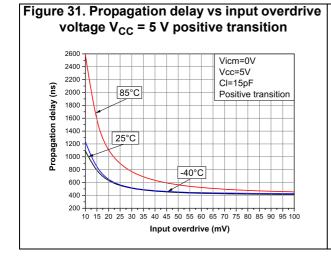
voltage V<sub>CC</sub> = 1.8 V negative transition Vicm=0V 1300 Vcc=1.8V 1200 CI=15pF (ns) 1100 Negative transition 1000 Propagation delay 900 25°C 800 700 85°C 600 500 -40°C 400 300 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 Input overdrive (mV)

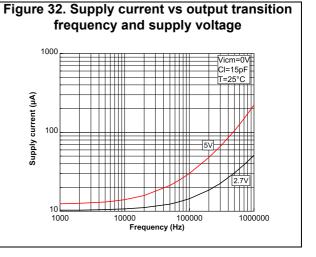
voltage V<sub>CC</sub> = 1.8 V positive transition Vicm=0V 1300 Vcc=1.8V 1200 CI=15pF (ns) 1100 Positive transition 1000 Propagation delay 900 25°C 800 700 85°C 600 500 -40°C 400 300 200 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 Input overdrive (mV)











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TS985 Package information

# 4 Package information

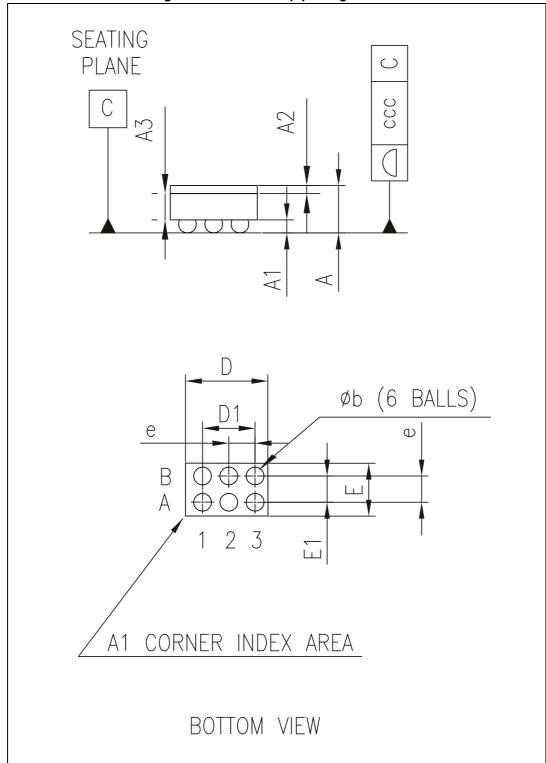
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: <a href="https://www.st.com">www.st.com</a>. ECOPACK<sup>®</sup> is an ST trademark.



Package information TS985

### 4.1 CSP 6-bump package information

Figure 33. CSP 6-bump package outline



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TS985 Package information

Table 6. CSP 6-bump mechanical data

			Dimer	nsions		
Ref.		Millimeters			Inches	
	Min.	Тур.	Max.	Min.	Тур.	Max.
А	0.485	0.525	0.57	0.019	0.021	0.022
A1	0.17		0.23	0.007		0.009
A2		0.025	0.03		0.001	0.001
A3	0.275	0.3	0.325	0.011	0.012	0.013
b	0.23	0.26	0.29	0.009	0.01	0.011
D	1.18	1.2	1.22	0.046	0.047	0.048
D1		0.8			0.031	
E	0.78	0.8	0.82	0.031	0.031	0.032
E1		0.4			0.016	
е		0.4			0.016	
ccc			0.075			0.003



Ordering information TS985

# 5 Ordering information

Table 7. Order codes

Order code	Temperature range	Package	Packing	Marking
TS985IJT	-40 °C to 85 °C	CSP 6-bump	Tape and reel	TBA

TS985 Revision history

# 6 Revision history

**Table 8. Document revision history** 

Date	Revision	Changes
23-Jun-2016	1	Initial release



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