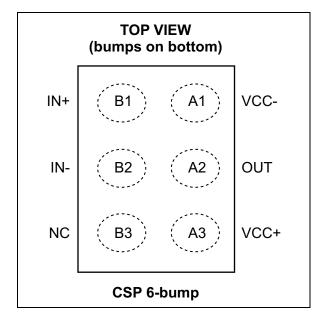


## Micropower low-voltage, 1.2 x 0.8 mm CSP comparator

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

## **Contents**

6	Revision history
5	Ordering information16
	4.1 CSP 6-bump package information
4	Package information
3	Electrical characteristic curves
2	Electrical characteristics4
1	Absolute maximum ratings

## 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)	2) ±5.5			
V <sub>in</sub>	Input voltage (3)	oltage $^{(3)}$ $(V_{CC}^{-}) - 0.3 \text{ to } (V_{CC}^{+}) + 0.3$			
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	n temperature 150			
T <sub>stg</sub>	Storage temperature range	-65 to 150	°C		
R <sub>thja</sub>	Thermal resistance junction to ambient (5)	al resistance junction to ambient <sup>(5)</sup> TBA			
ESD	HBM: human body model <sup>(6)</sup>	2000	V		
LSD	CDM: charged device model (7)	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.
- 3. 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
- 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>		(V <sub>CC</sub> <sup>-</sup> ) to (V <sub>CC</sub> <sup>+</sup> )	
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	Min.	Тур.	Max.	Unit	
M	Input offset voltage, full V <sub>icm</sub> range		0.5	8	m\/	
$V_{io}$	Input offset voltage, $T_{min} \le T_{amb} \le T_{max}$			9	mV	
$\Delta V_{io}/\Delta T$	Input offset voltage drift vs. temperature		4.5		uV/°C	
V <sub>Hyst</sub>	Input hysteresis voltage		3		mV	
	Input bias current (1), 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	٦,	
	Input offset current, full V <sub>icm</sub> range		1	10	nA	
I <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	
ı	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	μΑ	
\ /	High-level output voltage, I <sub>Source</sub> = 1 mA	1.69	1.71		V	
V <sub>OH</sub>	High-level output voltage, $T_{min} \le T_{amb} \le T_{max}$	1.67				
V.	Low-level output voltage, I <sub>Sink</sub> = 1 mA		65	80	m\/	
$V_{OL}$	Low-level output voltage, $T_{min} \le T_{amb} \le T_{max}$			95	— mV	
l	V <sub>OUT</sub> = 0 V	6	8			
I <sub>Sink</sub>	$T_{min} \le T_{amb} \le T_{max}$	5			mA	
1_	$V_{OUT} = V_{CC}$	4.5	7.3			
Source	$T_{min} \le T_{amb} \le T_{max}$	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			
	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.

4/18 DocID029328 Rev 2

<sup>2.</sup>  $TP_{HL}$  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  $V_{ICM}$  + 100mV to  $V_{ICM}$  - 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.

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	m\/	
$V_{io}$	Input offset voltage, $T_{min} \le T_{amb} \le T_{max}$			9	mV	
$\Delta V_{io}/\Delta T$	Input offset voltage drift vs. temperature		4.5		uV/°C	
V <sub>Hyst</sub>	Input hysteresis voltage		3		mV	
1	Input bias current (1), full V <sub>icm</sub> range		15	40		
I <sub>ib</sub>	Input bias current <sup>(1)</sup> , T <sub>min</sub> ≤ T <sub>amb</sub> ≤ T <sub>max</sub>			100	n 1	
ſ	Input offset current, full V <sub>icm</sub> range		1	10	- nA	
I <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	μΑ	
V	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				
\/	Low-level output voltage, I <sub>Sink</sub> = 1 mA		43	55	mV	
$V_{OL}$	Low-level output voltage, $T_{min} \le T_{amb} \le T_{max}$			65		
1.	V <sub>OUT</sub> = 0 V	14	18			
I <sub>Sink</sub>	$T_{min} \le T_{amb} \le T_{max}$	12			mA	
1.	V <sub>OUT</sub> = V <sub>CC</sub>	14	18			
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 $^{(2)}$ , $V_{icm} = 0$ V, $C_L = 15$ 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 $^{(3)}$ , $V_{icm} = 0$ V, $C_L = 15$ pF, overdrive = 100 mV		330			

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

<sup>2.</sup>  $TP_{HL}$  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  $V_{ICM}$  + 100mV to  $V_{ICM}$  - 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	
W	Input offset voltage, full V <sub>icm</sub> range		0.5	8	m\/	
$V_{io}$	Input offset voltage, $T_{min} \le T_{amb} \le T_{max}$			9	mV	
$\Delta V_{io}/\Delta T$	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		
l <sub>ib</sub>	Input bias current <sup>(1)</sup> , T <sub>min</sub> ≤ T <sub>amb</sub> ≤ T <sub>max</sub>			100	۰,۸	
	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	
	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	μΑ	
.,	High-level output voltage, I <sub>Source</sub> = 1 mA	4.85	4.9		V	
$V_{OH}$	High-level output voltage, $T_{min} \le T_{amb} \le T_{max}$	4.8			7 v	
V	Low-level output voltage, I <sub>Sink</sub> = 1 mA		31	45	mV	
$V_{OL}$	Low-level output voltage, $T_{min} \le T_{amb} \le T_{max}$			55		
	V <sub>OUT</sub> = 0 V	35	42			
$I_{Sink}$	$T_{min} \le T_{amb} \le T_{max}$	30			]	
1	V <sub>OUT</sub> = V <sub>CC</sub>	45	52		→ mA	
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			
t <sub>PLH</sub>	Response time low to high $^{(3)}$ , $V_{icm} = 0$ V, $C_L = 15$ pF, overdrive = 10 mV		1100		– ns	
	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.

DocID029328 Rev 2

<sup>2.</sup>  $TP_{HL}$  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  $V_{ICM}$  + 100mV to  $V_{ICM}$  - 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

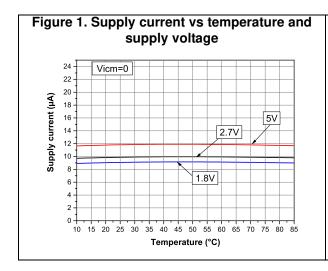


Figure 2. Supply current vs supply voltage,

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

Vicm=0
Output Low

Vicm=0
Output Low

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

85°C
25°C
40°C

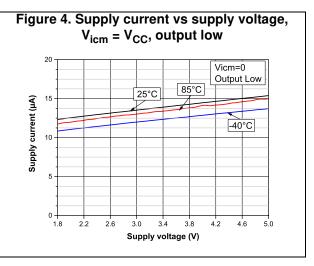
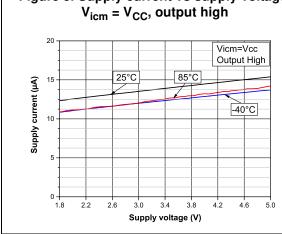
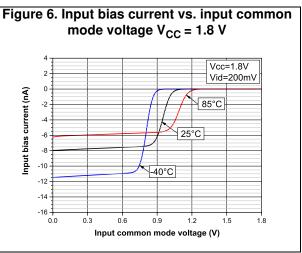


Figure 5. Supply current vs supply voltage,  $V_{icm} = V_{CC}, output high$ 







-10

-14

Figure 7. Input bias current vs. input common mode voltage  $V_{CC} = 2.7 \text{ V}$ Vcc=2.7V Vid=200mV Input bias current (nA) 85°C

25°C

-40°C

Figure 8. Input bias current vs. input common mode voltage V<sub>CC</sub> = 5 V Vcc=5V 2 Vid=200mV Input bias current (nA) -2 85°C 25°C -6 -8 -40°C -12 -16 1.5 2.0 2.5 Input common mode voltage (V)

Figure 9. Input offset voltage vs. input common mode voltage V<sub>CC</sub> = 1.8 V

Input common mode voltage (V)

0.6 0.9 1.2 1.5 1.8

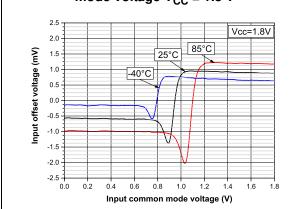


Figure 10. Input offset voltage vs. input common mode voltage  $V_{CC} = 2.7 \text{ V}$ 

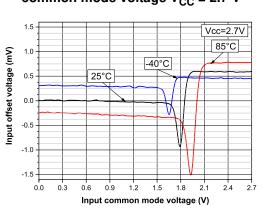


Figure 11. Input offset voltage vs. input common mode voltage V<sub>CC</sub> = 5 V

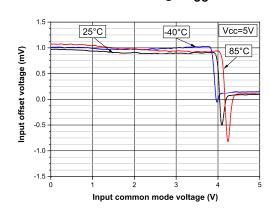
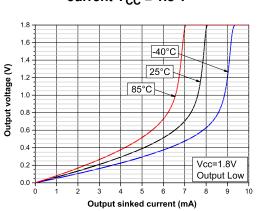


Figure 12. Output voltage vs. output sink current V<sub>CC</sub> = 1.8 V



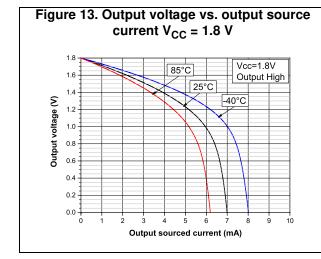
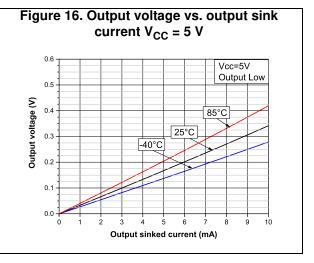
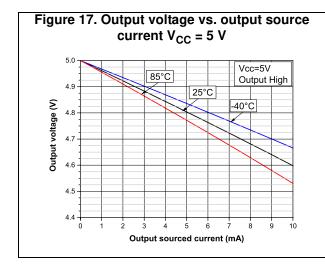


Figure 14. Output voltage vs. output sink current  $V_{CC} = 2.7 \text{ V}$ 0.9 Vcc=2.7V 0.8 Output Low 0.7 Output voltage (V) 0.6 85°C 0.5 25°C 0.4 -40°C 0.3 0.2 0.1 0.0 Output sinked current (mA)

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





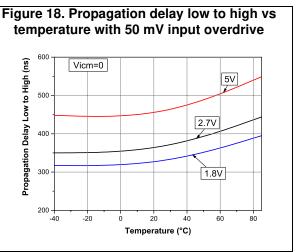


Figure 19. Propagation delay high to low vs temperature with 50 mV input overdrive

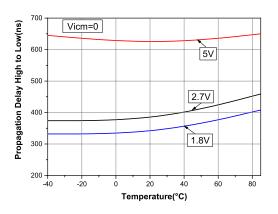


Figure 20. Propagation delay vs input common mode voltage V<sub>CC</sub> = 1.8 V negative transition

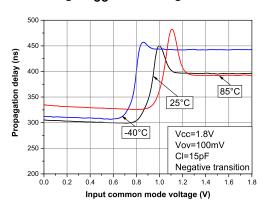


Figure 21. Propagation delay vs input common mode voltage V<sub>CC</sub> = 1.8 V positive transition

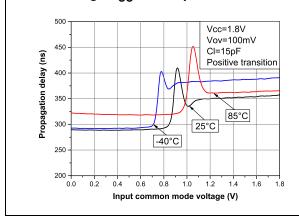


Figure 22. Propagation delay vs input common mode voltage V<sub>CC</sub> = 2.7 V negative transition

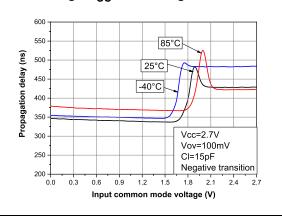


Figure 23. Propagation delay vs input common mode voltage V<sub>CC</sub> = 2.7 V positive transition

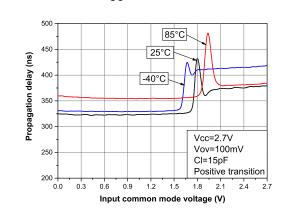
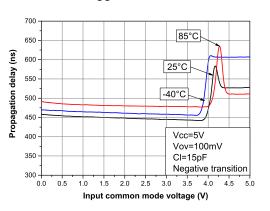


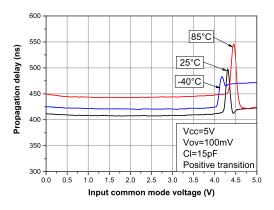
Figure 24. Propagation delay vs input common mode voltage V<sub>CC</sub> = 5 V negative transition



577

10/18

Figure 25. Propagation delay vs input common | Figure 26. Propagation delay vs input overdrive mode voltage  $V_{CC} = 5 V$  positive transition



voltage V<sub>CC</sub> = 1.8 V negative transition

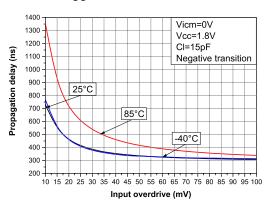
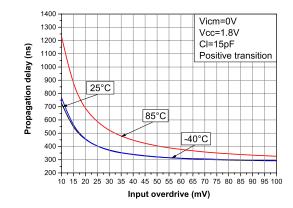
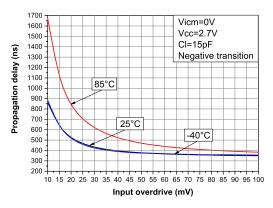


Figure 27. Propagation delay vs input overdrive | Figure 28. Propagation delay vs input overdrive voltage V<sub>CC</sub> = 1.8 V positive transition



voltage V<sub>CC</sub> = 2.7 V negative transition



voltage V<sub>CC</sub> = 2.7 V positive transition

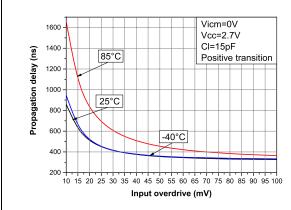


Figure 29. Propagation delay vs input overdrive | Figure 30. Propagation delay vs input overdrive voltage V<sub>CC</sub> = 5 V negative transition

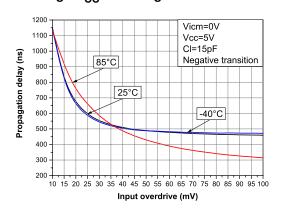




Figure 31. Propagation delay vs input overdrive voltage V<sub>CC</sub> = 5 V positive transition

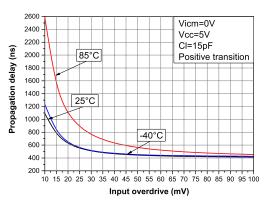
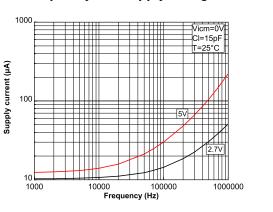


Figure 32. Supply current vs output transition frequency and supply voltage



12/18 DocID029328 Rev 2

## 4 Package information

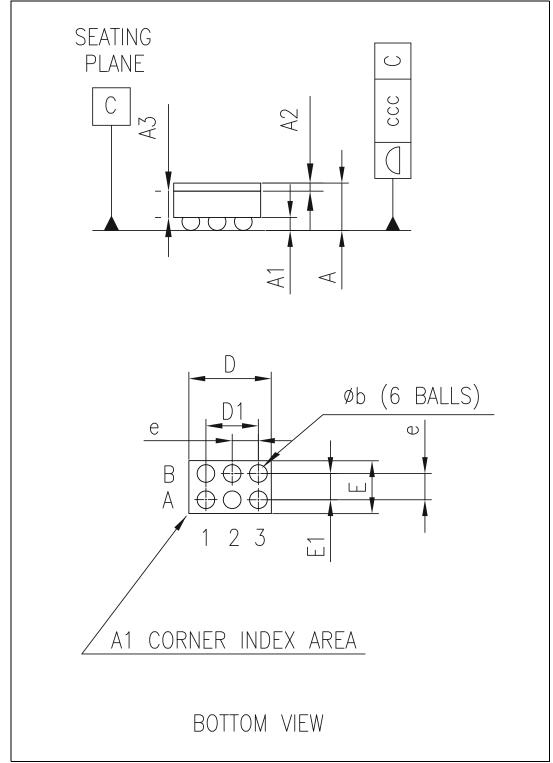
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: <a href="https://www.st.com">www.st.com</a>. ECOPACK is an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



Package information TS985

## 4.1 CSP 6-bump package information

Figure 33. CSP 6-bump package outline



47/

TS985 Package information

Table 6. CSP 6-bump mechanical data

			Dimer	nsions		
Ref.		Millimeters			Inches	
	Min.	Тур.	Max.	Min.	Тур.	Max.
Α	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	WA9

TS985 Revision history

# 6 Revision history

Table 8. Document revision history

Date	Revision	Changes
23-Jun-2016	1	Initial release
04-Apr-2024	2	Updated Marking in <i>Table 7</i>

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577