Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

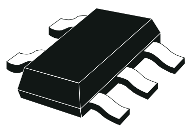
Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

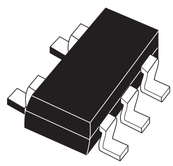
TS881

Rail-to-rail 0.9 V nanopower comparator

Datasheet - production data



SC70-5 (top view)



SOT23-5 (top view)

Features

- Ultra low current consumption: 210 nA typ.
- Propagation delay: 2 µs typ.
- Rail-to-rail inputs
- Push-pull output
- Supply operation from 0.85 V to 5.5 V
- Wide temperature range: -40 to +125 °C
- ESD tolerance: 8 kV HBM / 300 V MM
- SMD package

Applications

- Portable systems
- Signal conditioning
- Medical

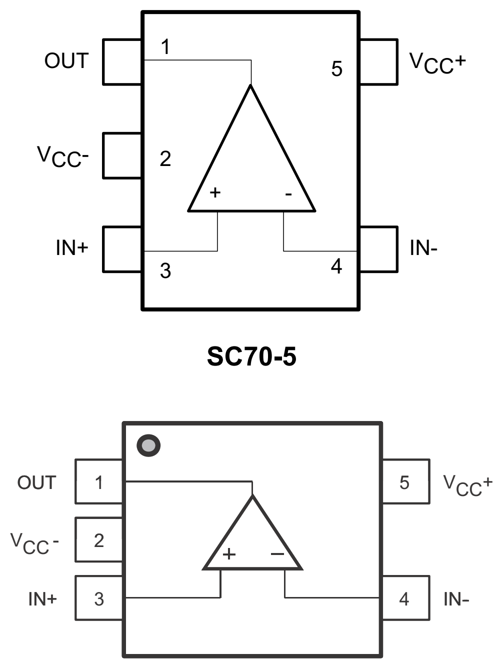
Description

The TS881 device is a single comparator featuring ultra low supply current (210 nA typical with output high, V_{CC} = 1.2 V, no load) with rail-to-rail input and output capability. The performance of this comparator allows it to be used in a wide range of portable applications. The TS881 device minimizes battery supply leakage and therefore enhances battery lifetime.

Operating from 0.85 V to 5.5 V supply voltage, this comparator can be used over a wide temperature range (-40 to +125 °C) keeping the current consumption at an ultra low level.

The TS881 device is available in the SC70-5 and the SOT23-5 package, allowing great space saving on the PCB.

Figure 1. Pin connections (top view)



SOT23-5

This is information on a product in full production. www.st.com

Contents

List of figures

1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage(1)	6	V
V_{ID}	Differential input voltage(2)	±6	V
V_{IN}	Input voltage range	$(V_{CC}-)$ - 0.3 to $(V_{CC}+)$ + 0.3	V
R_{THJA}	Thermal resistance junction-to-ambient(3) SC70-5 SOT23-5	 205 250	°C/W
T_{STG}	Storage temperature	-65 to +150	°C
T_J	Junction temperature	150	°C
T_{LEAD}	Lead temperature (soldering 10 seconds)	260	°C
ESD	Human body model (HBM)(4)	8000	kV
	Machine model (MM)(5)	300	V
	Charged device model (CDM)(6)	1300	
	Latch-up immunity	200	mA

1. All voltage values, except differential voltages, are referenced to $V_{CC}-$. V_{CC} is defined as the difference between $V_{CC}+$ and $V_{CC}-$.
2. The magnitude of input and output voltages must never exceed the supply rail ±0.3 V.
3. Short-circuits can cause excessive heating. These values are typical.
4. According to JEDEC standard JESD22-A114F.
5. According to JEDEC standard JESD22-A115A.
6. According to ANSI/ESD STM5.3.1.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
T_{oper}	Operating temperature range 0.85 V < V_{CC} < 5.5 V 1.1 V < V_{CC} < 5.5 V	 -40 to +85 -40 to +125	°C
V_{CC}	Supply voltage -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C	 0.85 to 5.5 1.1 to 5.5	V
V_{ICM}	Common mode input voltage range 0.85 V < V_{CC} < 5.5 V -40 °C < T_{amb} < +85 °C 1.1 V < V_{CC} < 5.5 V -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C	- 0.2 to + 0.2 and V_{CC+} - 0.2 to V_{CC+} + 0.2 V_{CC-} - 0.2 to V_{CC+} + 0.2 V_{CC-} to V_{CC+} + 0.2	V

2 Electrical characteristics

Table 3. V_{CC} = +0.9 V, T_{amb} = +25 °C, V_{ICM} = 0 V (unless otherwise specified)[1]

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage [2]	 -40 °C < T_{amb} < +85 °C	-10 -12	1	10 12	mV
ΔV_{IO}	Input offset voltage drift	-40 °C < T_{amb} < +85 °C		4.6		µV/°C
V_{HYST}	Input hysteresis voltage[3]	 -40 °C < T_{amb} < +85 °C	 1.0	2.4	 4.2	mV
I_{IO}	Input offset current[4]	 -40 °C < T_{amb} < +85 °C	-10 -100		10 100	pA
I_{IB}	Input bias current[4]	 -40 °C < T_{amb} < +85 °C	-10 -100		10 100	pA
I_{CC}	Supply current per operator	No load, output low, V_{ID} = -0.1 V -40 °C < T_{amb} < +85 °C No load, output high, V_{ID} = +0.1 V -40 °C < T_{amb} < +85 °C		300 260	400 450 350 400	nA
I_{SC}	Short-circuit current	Source Sink		0.2 0.4		mA
V_{OH}	Output voltage high	I_{source} = 50 µA -40 °C < T_{amb} < +85 °C	0.85 0.83	0.87		V
V_{OL}	Output voltage low	I_{sink} = 50 µA -40 °C < T_{amb} < +85 °C		20	50 70	mV
T_{PLH}	Propagation delay (low to high)	f = 1 kHz, C_L = 30 pF, R_L = 1 MΩ Overdrive = 10 mV -40 °C < T_{amb} < +85 °C Overdrive = 100 mV -40 °C < T_{amb} < +85 °C		7.2 3.3	14 16 5.0 5.5	µs
T_{PHL}	Propagation delay (high to low)	f = 1 kHz, C_L = 30 pF, R_L = 1 MΩ Overdrive = 10 mV -40 °C < T_{amb} < +85 °C Overdrive = 100 mV -40 °C < T_{amb} < +85 °C		6.0 2.5	11 12 4.5 5.0	µs
T_R	Rise time (10% to 90%)	C_L = 30 pF, R_L = 1 MΩ		160		ns
T_F	Fall time (90% to 10%)	C_L = 30 pF, R_L = 1 MΩ		140		ns
T_{ON}	Power-up time			1.1	1.7	ms

1. All values over the temperature range are guaranteed through correlation and simulation. No production test is performed at the temperature range limits.
2. The offset is defined as the average value of positive and negative trip points (input voltage differences requested to change the output state in each direction).
3. The hysteresis is a built-in feature of the TS881 device. It is defined as the voltage difference between the trip points.
4. Maximum values are guaranteed by design.

Table 4. V_{CC} = +1.2 V, T_{amb} = +25 °C, V_{ICM} = V_{CC}/2 (unless otherwise specified)(1)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage(2)	-40 °C < T_{amb} < +125 °C	-6	1	6	mV
ΔV_{IO}	Input offset voltage drift	-40 °C < T_{amb} < +125 °C		3		µV/°C
V_{HYST}	Input hysteresis voltage(3)	-40 °C < T_{amb} < +125 °C	1.6	2.4	4.2	mV
I_{IO}	Input offset current(4)	 -40 °C < T_{amb} < +125 °C	-10 -100		10 100	pA
I_{IB}	Input bias current(4)	 -40 °C < T_{amb} < +125 °C	-10 -100	1	10 100	pA
I_{CC}	Supply current per operator	No load, output low, V_{ID} = -0.1 V -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C No load, output high, V_{ID} = +0.1 V -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C		300 210	450 500 1050 350 400 950	nA
I_{SC}	Short-circuit current	Source Sink		1.4 1.0		mA
V_{OH}	Output voltage high	I_{source} = 0.2 mA -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C	1.13 1.10 1.00	1.15		V
V_{OL}	Output voltage low	I_{sink} = 0.2 mA -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C		40	50 60 70	mV
CMRR	Common mode rejection ratio	0 < V_{ICM} < V_{CC} -40 °C < T_{amb} < +125 °C	 50	68		dB
T_{PLH}	Propagation delay (low to high)	f = 1 kHz, C_L = 30 pF, R_L = 1 MΩ Overdrive = 10 mV -40 °C < T_{amb} < +125 °C Overdrive = 100 mV -40 °C < T_{amb} < +125 °C		 6 2.2	 11 13 3.1 3.4	µs
T_{PHL}	Propagation delay (high to low)	f = 1 kHz, C_L = 30 pF, R_L = 1 MΩ Overdrive = 10 mV -40 °C < T_{amb} < +125 °C Overdrive = 100 mV -40 °C < T_{amb} < +125 °C		 5.1 2.0	 8 10 2.6 3.1	µs
T_R	Rise time (10% to 90%)	C_L = 30 pF, R_L = 1 MΩ		100		ns
T_F	Fall time (90% to 10%)	C_L = 30 pF, R_L = 1 MΩ		110		ns
T_{ON}	Power-up time			1.0	1.5	ms

1. All values over the temperature range are guaranteed through correlation and simulation. No production test is performed at the temperature range limits.
2. The offset is defined as the average value of positive and negative trip points (input voltage differences requested to change the output state in each direction).
3. The hysteresis is a built-in feature of the TS881 device. It is defined as the voltage difference between the trip points.
4. Maximum values are guaranteed by design.

Table 5. V_{CC} = +2.7 V, T_{amb} = +25 °C, V_{ICM} = V_{CC}/2 (unless otherwise specified)(1)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage(2)	 -40 °C < T_{amb} < +125 °C	 -6	1	 6	mV
ΔV_{IO}	Input offset voltage drift	-40 °C < T_{amb} < +125 °C		3		µV/°C
V_{HYST}	Input hysteresis voltage(3)	 -40 °C < T_{amb} < +125 °C	 1.6	2.7	 4.2	mV
I_{IO}	Input offset current(4)	 -40 °C < T_{amb} < +125 °C	-10 -100		10 100	pA
I_{IB}	Input bias current(4)	 -40 °C < T_{amb} < +125 °C	-10 -100	1	10 100	pA
I_{CC}	Supply current per operator	No load, output low, V_{ID} = -0.1 V -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C No load, output high, V_{ID} = +0.1 V -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C		310 220	450 500 1150 350 400 1050	nA
I_{SC}	Short-circuit current	Source Sink		12 10		mA
V_{OH}	Output voltage high	I_{source} = 2 mA -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C	2.48 2.40 2.10	2.51		V
V_{OL}	Output voltage low	I_{sink} = 2 mA -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C		140	210 230 310	mV
CMRR	Common mode rejection ratio	0 < V_{ICM} < V_{CC} -40 °C < T_{amb} < +125 °C	 55	74		dB
T_{PLH}	Propagation delay (low to high)	f = 1 kHz, C_L = 30 pF, R_L = 1 MΩ Overdrive = 10 mV -40 °C < T_{amb} < +125 °C Overdrive = 100 mV -40 °C < T_{amb} < +125 °C		 6.3 2.4	 12 13 3.0 3.7	µs
T_{PHL}	Propagation delay (high to low)	f = 1 kHz, C_L = 30 pF, R_L = 1 MΩ Overdrive = 10 mV -40 °C < T_{amb} < +125 °C Overdrive = 100 mV -40 °C < T_{amb} < +125 °C		 6.4 2.3	 12 14 3.0 3.7	µs
T_R	Rise time (10% to 90%)	C_L = 30 pF, R_L = 1 MΩ		120		ns
T_F	Fall time (90% to 10%)	C_L = 30 pF, R_L = 1 MΩ		130		ns
T_{ON}	Power-up time			0.9	1.5	ms

1. All values over the temperature range are guaranteed through correlation and simulation. No production test is performed at the temperature range limits.
2. The offset is defined as the average value of positive and negative trip points (input voltage differences requested to change the output state in each direction).
3. The hysteresis is a built-in feature of the TS881. It is defined as the voltage difference between the trip points.
4. Maximum values are guaranteed by design.

Table 6. V_{CC} = +5 V, T_{amb} = +25 °C, V_{ICM} = V_{CC}/2 (unless otherwise specified)[1]

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IO}	Input offset voltage[2]	-40 °C < T_{amb} < +125 °C	-6	1	6	mV
ΔV_{IO}	Input offset voltage drift	-40 °C < T_{amb} < +125 °C		3		µV/°C
V_{HYST}	Input hysteresis voltage[3]	-40 °C < T_{amb} < +125 °C	1.6	3.1	4.2	mV
I_{IO}	Input offset current[4]	 -40 °C < T_{amb} < +125 °C	-10 -100		10 100	pA
I_{IB}	Input bias current[4]	 -40 °C < T_{amb} < +125 °C	-10 -100	1	10 100	pA
I_{CC}	Supply current per operator	No load, output low, V_{ID} = -0.1 V -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C No load, output high, V_{ID} = +0.1 V -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C		350 250	500 750 1350 400 650 1250	nA
I_{SC}	Short-circuit current	Source Sink		32 36		mA
V_{OH}	Output voltage high	I_{source} = 2 mA -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C	4.86 4.75 4.60	4.90		V
V_{OL}	Output voltage low	I_{sink} = 2 mA -40 °C < T_{amb} < +85 °C -40 °C < T_{amb} < +125 °C		95	130 170 280	mV
CMRR	Common mode rejection ratio	0 < V_{ICM} < V_{CC} -40 °C < T_{amb} < +125 °C	 55	78		dB
SVR	Supply voltage rejection	ΔV_{CC} = 1.2 V to 5 V -40 °C < T_{amb} < +125 °C	 65	80		dB
T_{PLH}	Propagation delay (low to high)	f = 1 kHz, C_L = 30 pF, R_L = 1 MΩ Overdrive = 10 mV -40 °C < T_{amb} < +125 °C Overdrive = 100 mV -40 °C < T_{amb} < +125 °C		 7.8 2.6	 13 22 3.4 4.1	µs
T_{PHL}	Propagation delay (high to low)	f = 1 kHz, C_L = 30 pF, R_L = 1 MΩ Overdrive = 10 mV -40 °C < T_{amb} < +125 °C Overdrive = 100 mV -40 °C < T_{amb} < +125 °C		 8.9 2.7	 16 19 3.5 4.2	µs
T_R	Rise time (10% to 90%)	C_L = 30 pF, R_L = 1 MΩ		160		ns
T_F	Fall time (90% to 10%)	C_L = 30 pF, R_L = 1 MΩ		150		ns
T_{ON}	Power-up time			1.1	1.5	ms

1. All values over the temperature range are guaranteed through correlation and simulation. No production test is performed at the temperature range limits.
2. The offset is defined as the average value of positive and negative trip points (input voltage differences requested to change the output state in each direction).
3. The hysteresis is a built-in feature of the TS881 device. It is defined as the voltage difference between the trip points.
4. Maximum values are guaranteed by design.

Figure 2. Current consumption vs. supply voltage - output low

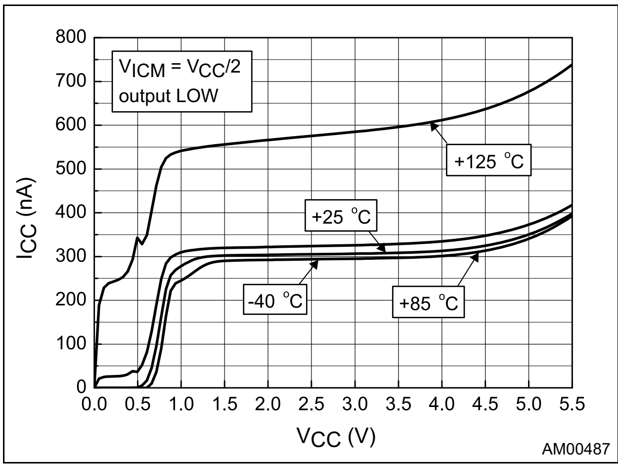


Figure 3. Current consumption vs. supply voltage - output high

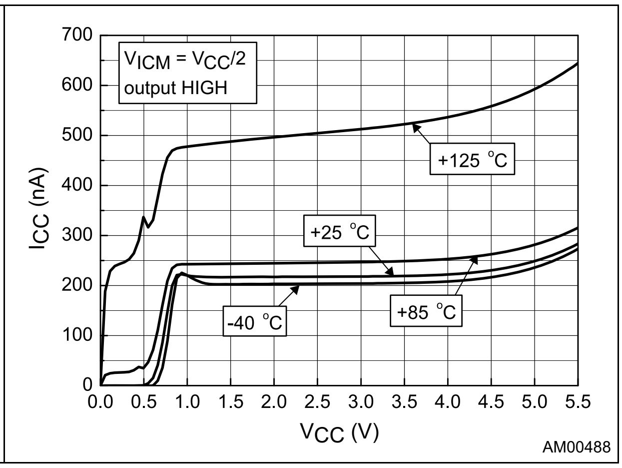


Figure 4. Current consumption vs. input common mode voltage at V_{CC} = 1.2 V

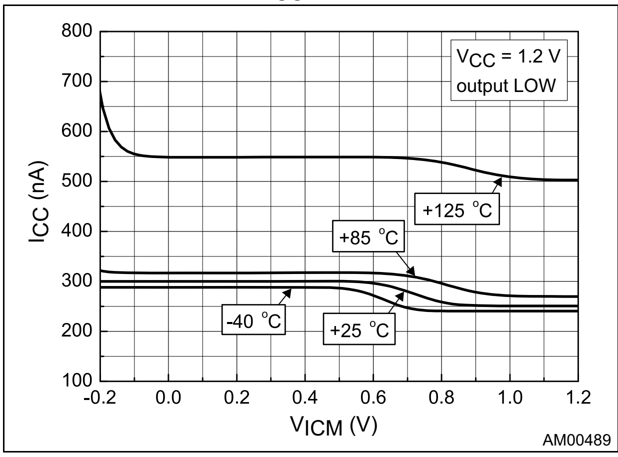


Figure 5. Current consumption vs. input common mode voltage at V_{CC} = 5 V

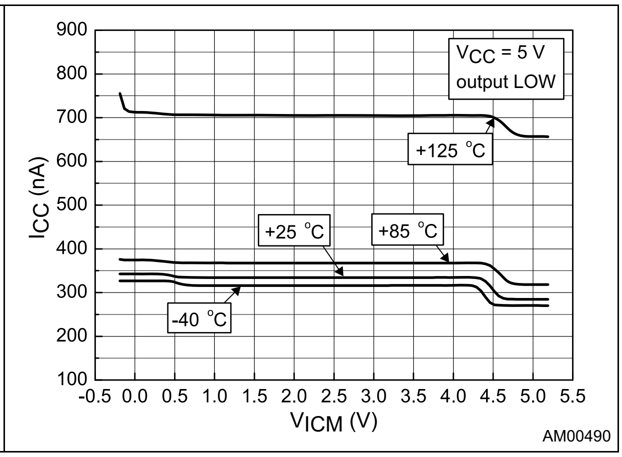


Figure 6. Current consumption vs. temperature

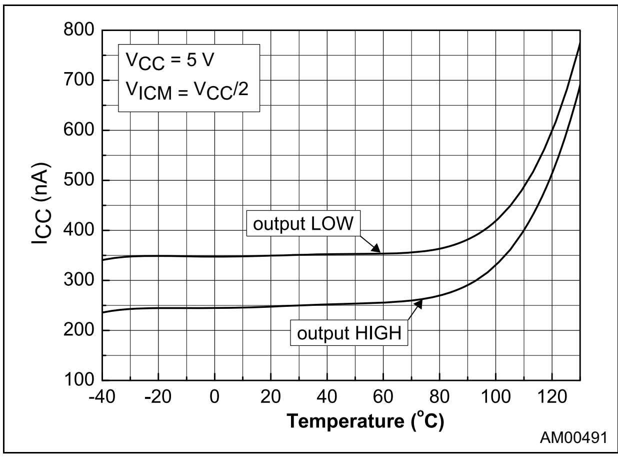


Figure 7. Current consumption vs. toggle frequency

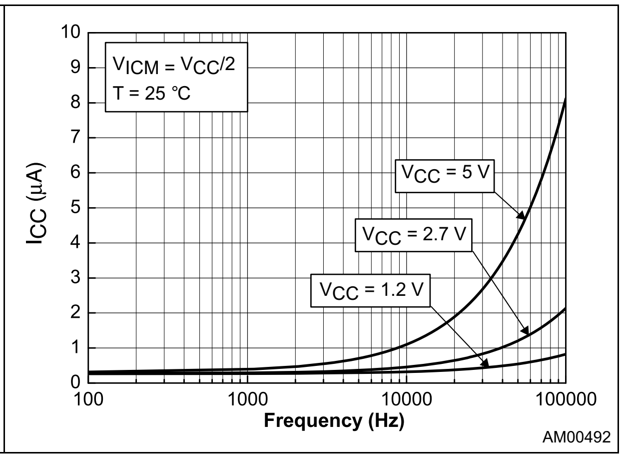


Figure 8. Input offset voltage vs. input common mode voltage at V_{CC} = 1.2 V

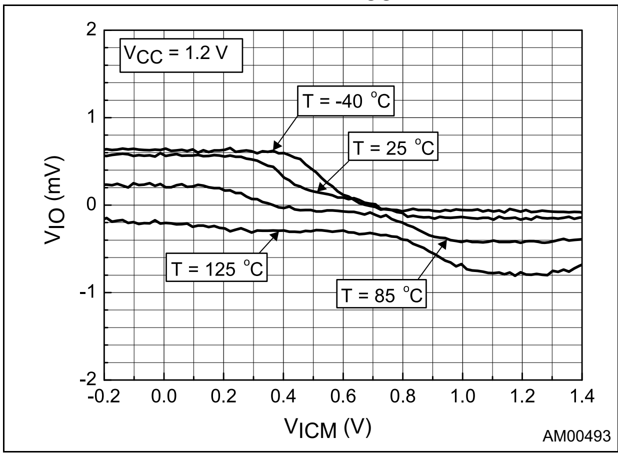


Figure 9. Input hysteresis voltage vs. input common mode voltage at V_{CC} = 1.2 V

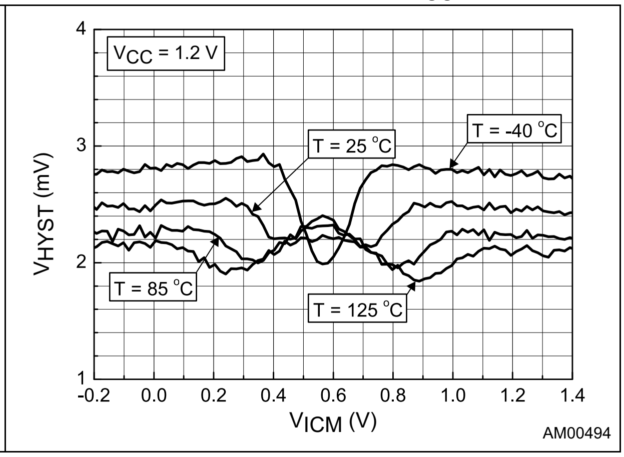


Figure 10. Input offset voltage vs. input common mode voltage at V_{CC} = 5 V

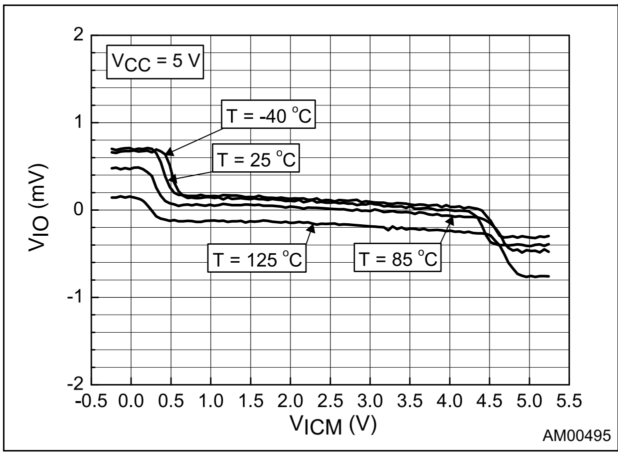


Figure 11. Input hysteresis voltage vs. input common mode voltage at V_{CC} = 5 V

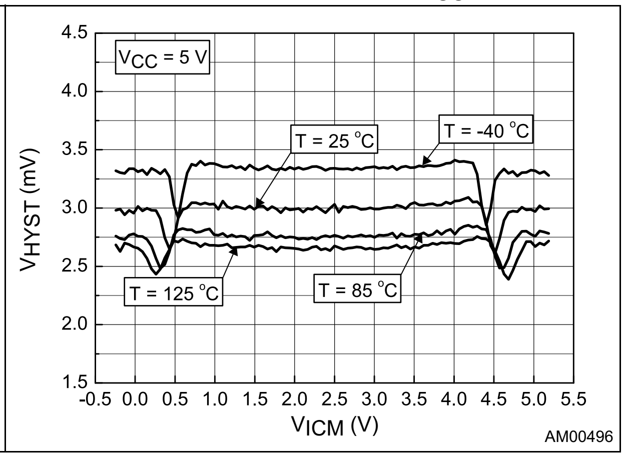


Figure 12. Input offset voltage vs. temperature

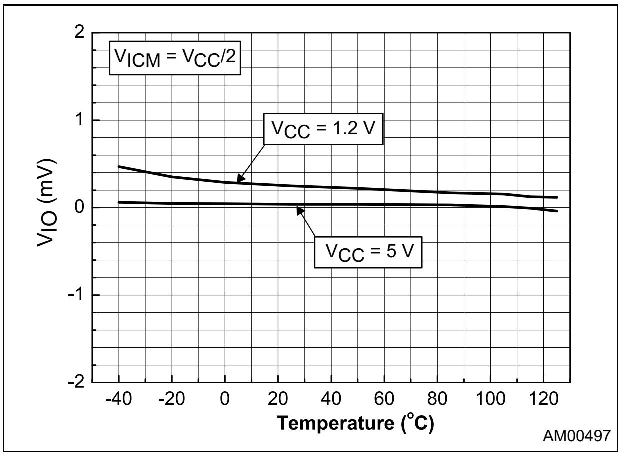


Figure 13. Input hysteresis voltage vs. temperature

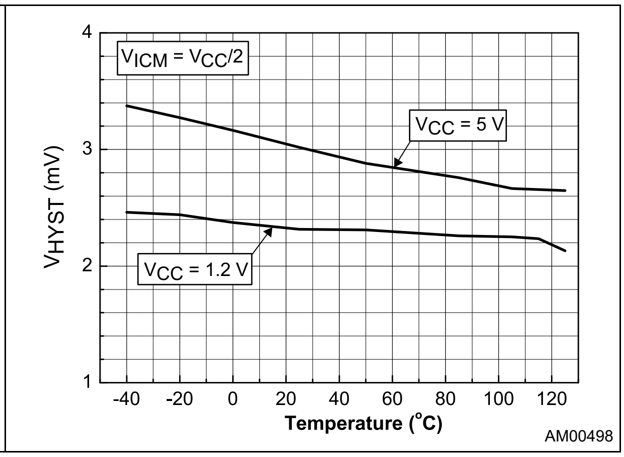


Figure 14. Output voltage drop vs. sink current at V_{CC} = 1.2 V

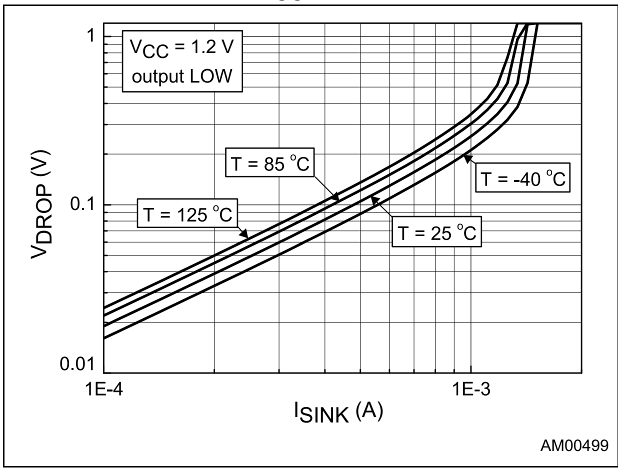


Figure 15. Output voltage drop vs. source current at V_{CC} = 1.2 V

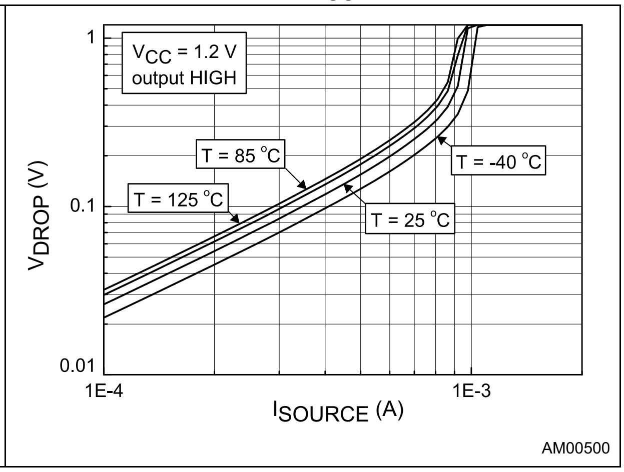


Figure 16. Output voltage drop vs. sink current at V_{CC} = 2.7 V

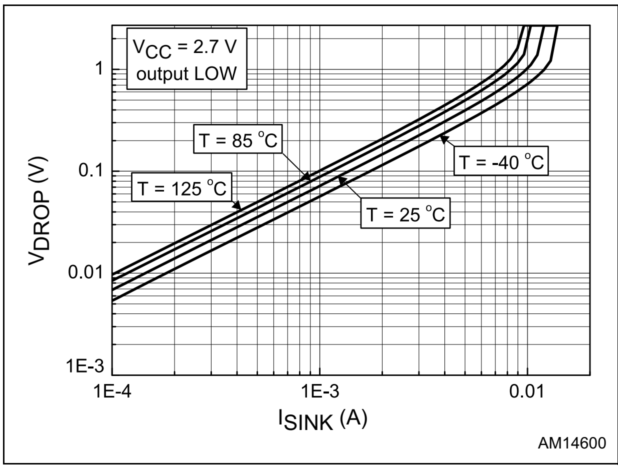


Figure 17. Output voltage drop vs. source current at V_{CC} = 2.7 V

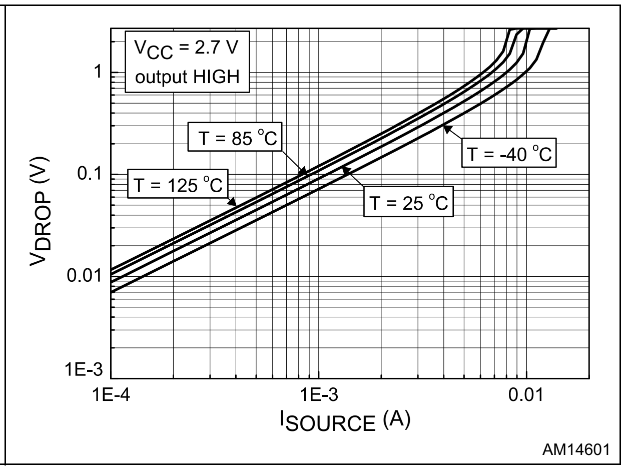


Figure 18. Output voltage drop vs. sink current at V_{CC} = 5 V

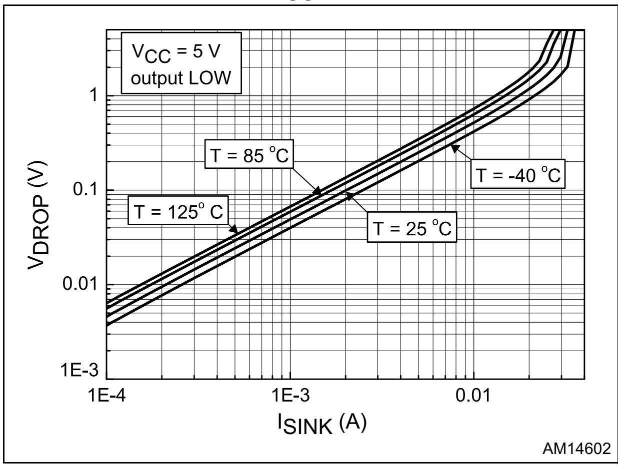


Figure 19. Output voltage drop vs. source current at V_{CC} = 5 V

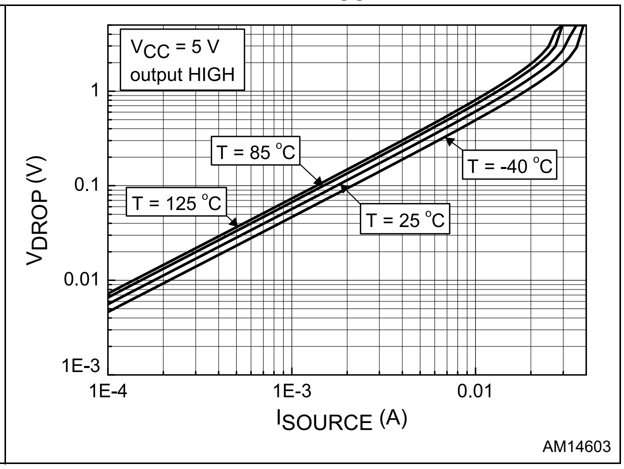


Figure 20. Propagation delay T_{PLH} vs. input common mode voltage at V_{CC} = 1.2 V

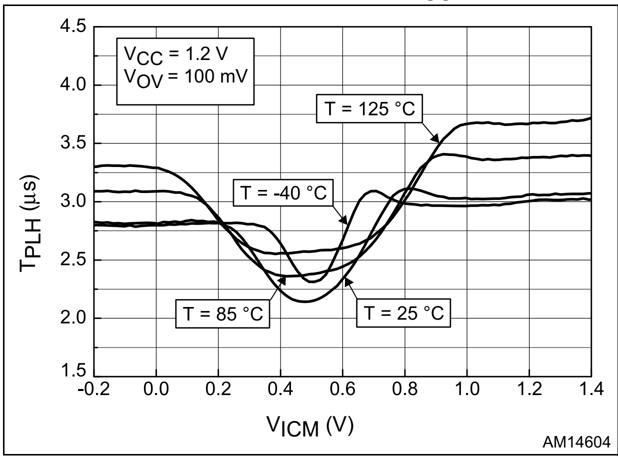


Figure 21. Propagation delay T_{PHL} vs. input common mode voltage at V_{CC} = 1.2 V

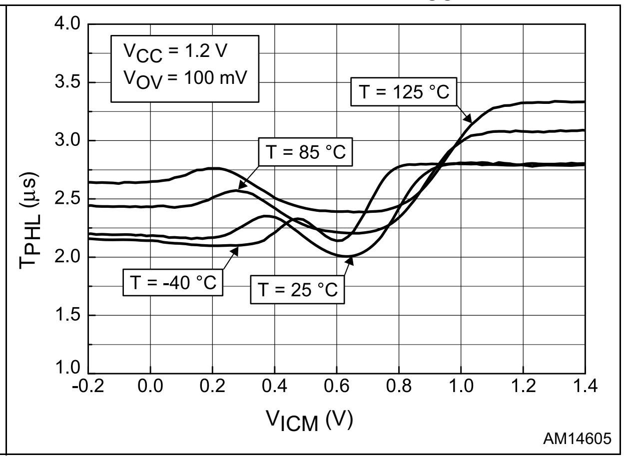


Figure 22. Propagation delay T_{PLH} vs. input common mode voltage at V_{CC} = 5 V

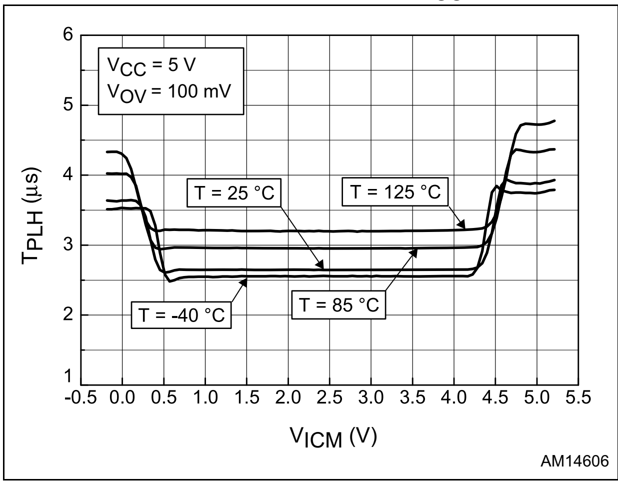


Figure 23. Propagation delay T_{PHL} vs. input common mode voltage at V_{CC} = 5 V

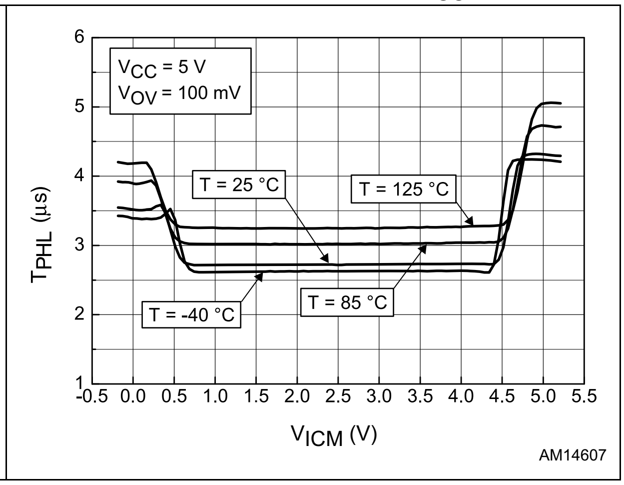


Figure 24. Propagation delay T_{PLH} vs. input signal overdrive at V_{CC} = 1.2 V

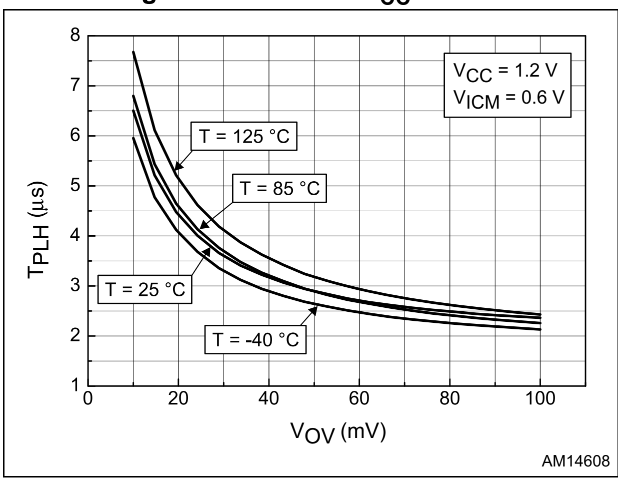


Figure 25. Propagation delay T_{PHL} vs. input signal overdrive at V_{CC} = 1.2 V

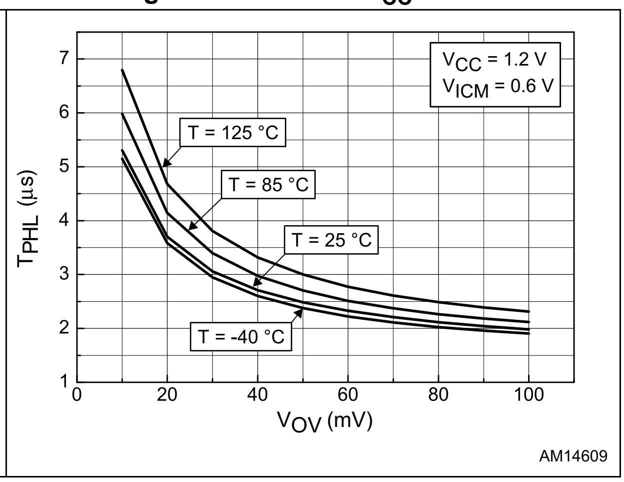


Figure 26. Propagation delay T_{PLH} vs. input signal overdrive at V_{CC} = 5 V

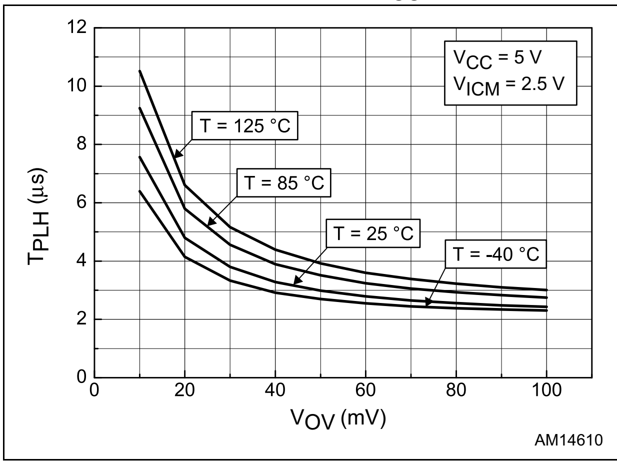


Figure 27. Propagation delay T_{PHL} vs. input signal overdrive at V_{CC} = 5 V

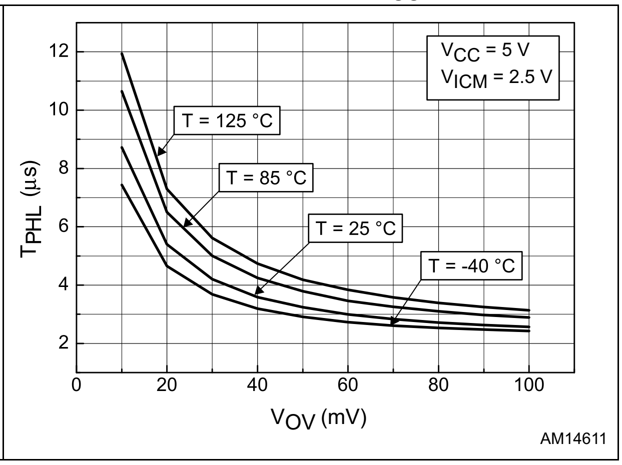


Figure 28. Propagation delay T_{PLH} vs. supply voltage for signal overdrive 10 mV

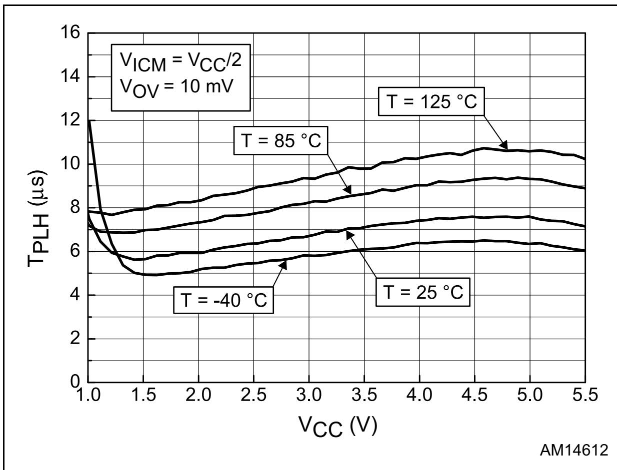


Figure 29. Propagation delay T_{PHL} vs. supply voltage for signal overdrive 10 mV

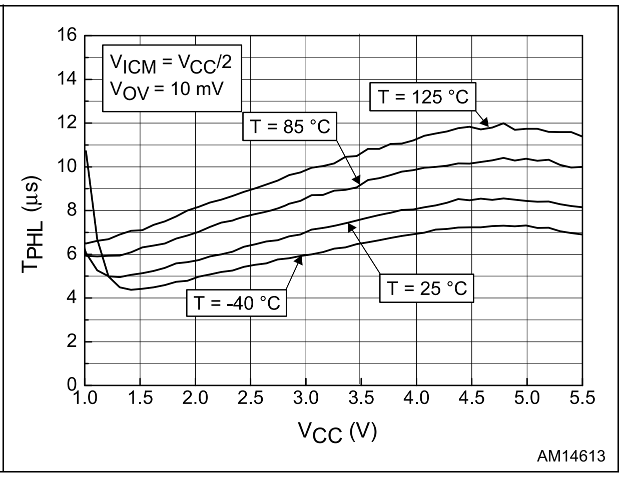


Figure 30. Propagation delay T_{PLH} vs. supply voltage for signal overdrive 100 mV

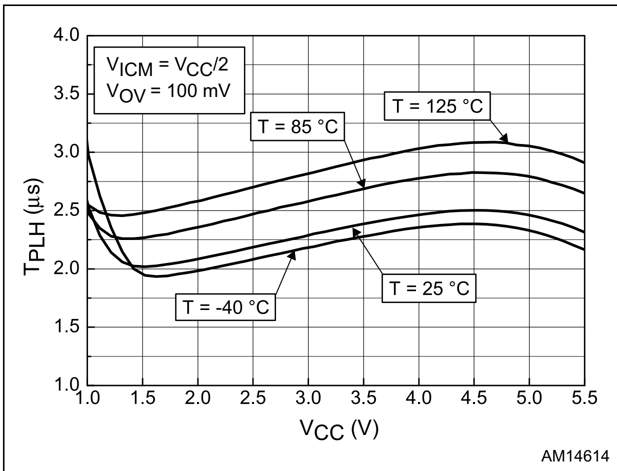


Figure 31. Propagation delay T_{PHL} vs. supply voltage for signal overdrive 100 mV

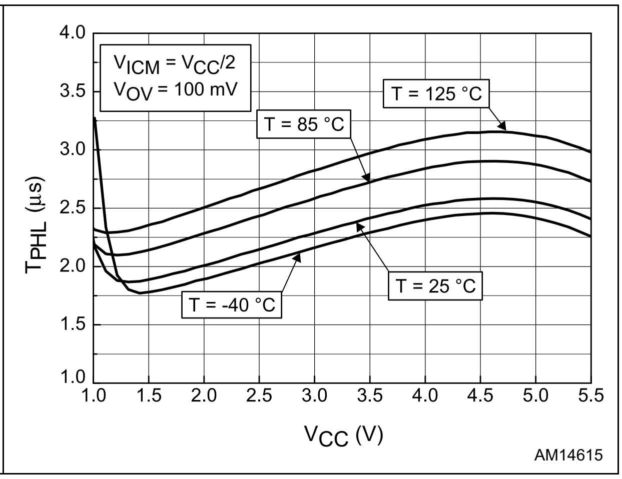


Figure 32. Propagation delay vs. temperature for signal overdrive 10 mV

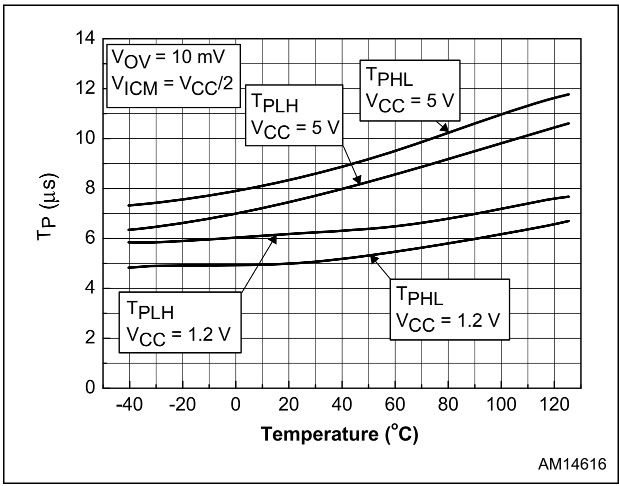


Figure 33. Propagation delay vs. temperature for signal overdrive 100 mV

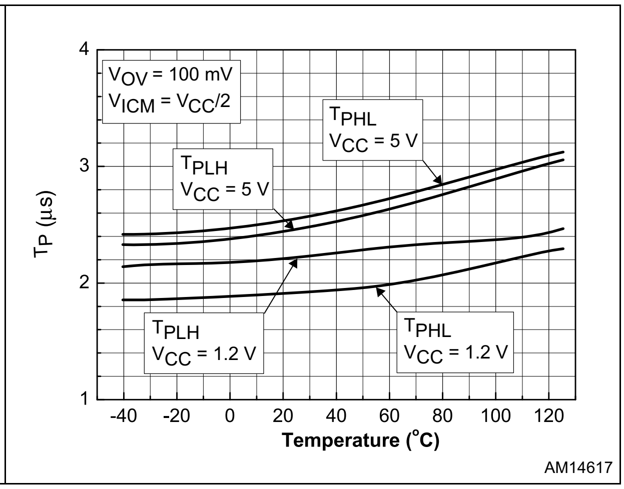


Figure 34. Input offset voltage vs. input common mode voltage at V_{CC} = 0.9 V

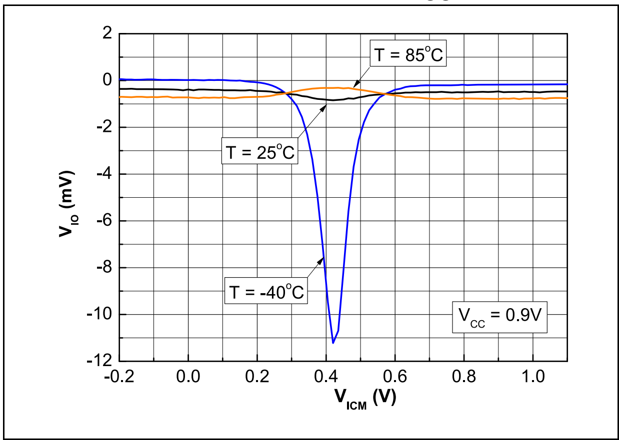


Figure 35. Input voltage hysteresis vs. input common mode voltage at V_{CC} = 0.9 V

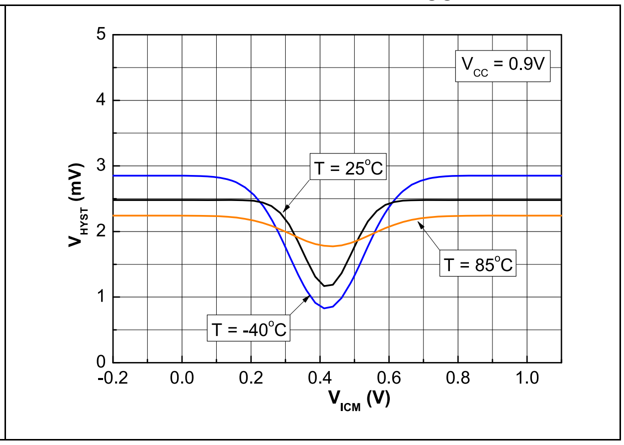


Figure 36. Output voltage drop vs. sink current at V_{CC} = 0.9 V

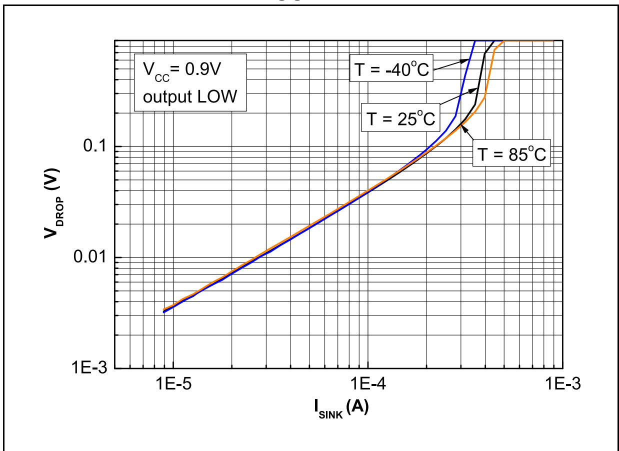


Figure 37. Output voltage drop vs. source current at V_{CC} = 0.9 V

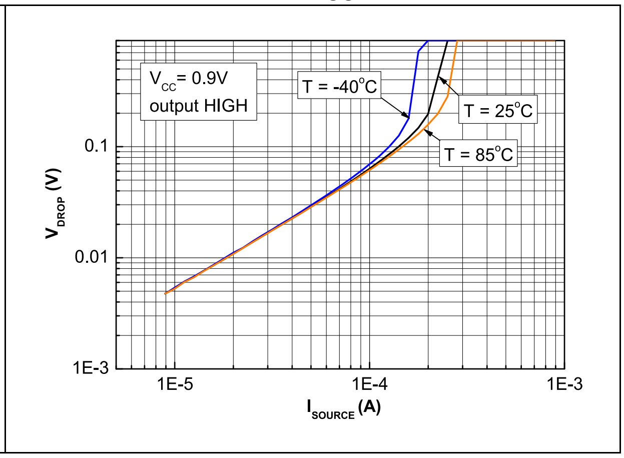


Figure 38. Propagation delay T_{PLH} vs. input common mode voltage at V_{CC} = 0.9 V and 10 mV signal overdrive

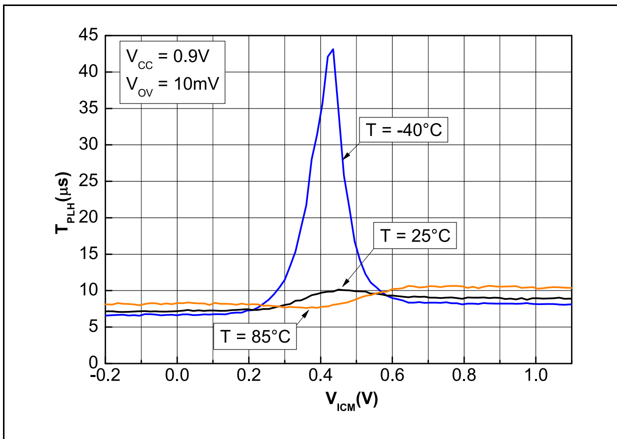


Figure 39. Propagation delay T_{PHL} vs. input common mode voltage at V_{CC} = 0.9 V and 10 mV signal overdrive

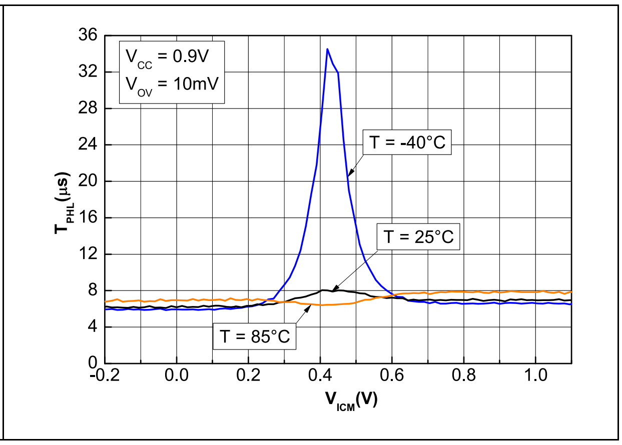


Figure 40. Propagation delay T_{PLH} vs. input common mode voltage at V_{CC} = 0.9 V and 100 mV signal overdrive

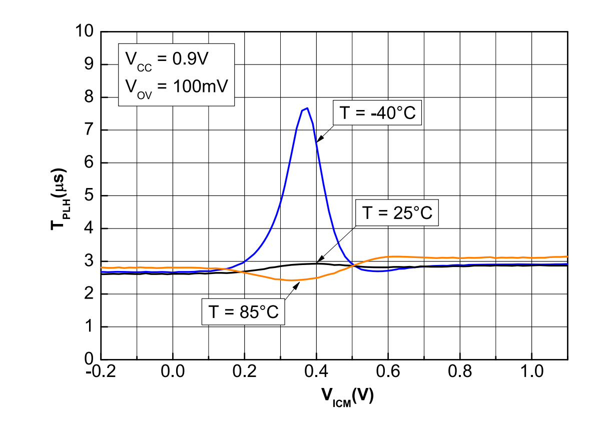


Figure 41. Propagation delay T_{PHL} vs. input common mode voltage at V_{CC} = 0.9 V and 100 mV signal overdrive

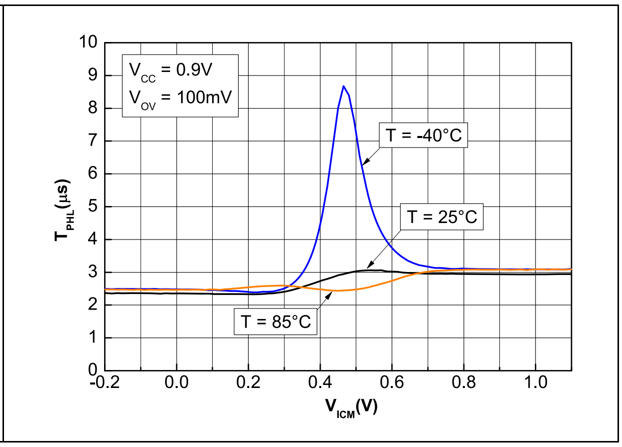


Figure 42. Propagation delay T_{PLH} vs. input signal overdrive at V_{CC} = 0.9 V

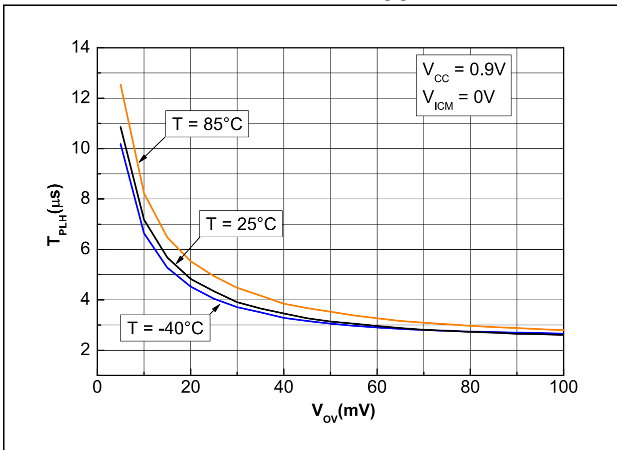
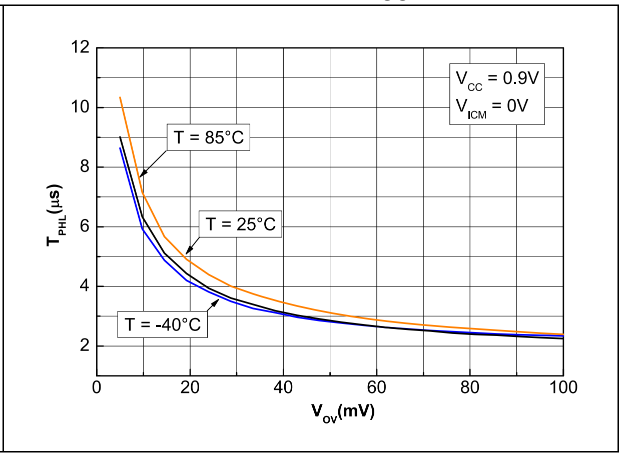


Figure 43. Propagation delay T_{PHL} vs. input signal overdrive at V_{CC} = 0.9 V



3 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: *www.st.com*. ECOPACK is an ST trademark.

Figure 44. SC70-5 (SOT323-5) package outline

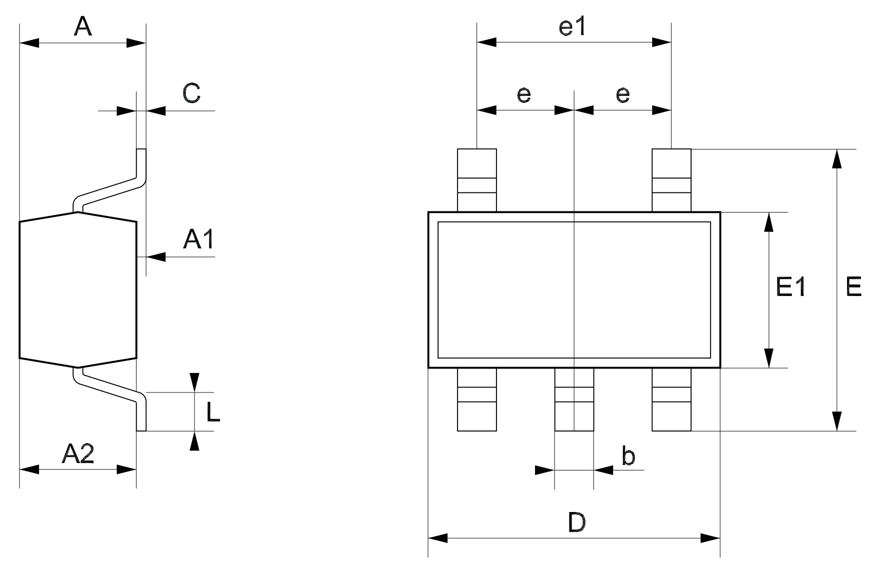


Table 7. SC70-5 (SOT323-5) package mechanical data

Symbol	Dimensions					
	Millimeters			Mils		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.80		1.10	31.5		43.3
A1	0.00		0.10	0.0		3.9
A2	0.80	0.9	1.00	31.5	35.4	39.4
b	0.15		0.30	5.9		11.8
C	0.10		0.22	3.9		8.7
D	1.80		2.20	70.9		86.6
E	1.80		2.40	70.9		94.5
E1	1.15	1.25	1.35	45.3	49.2	53.1
e		0.65			25.6	
e1		1.3			51.2	
L	0.26	0.36	0.46	10.2	14.2	18.1

Figure 45. SOT23-5 - lead small outline transistor package outline

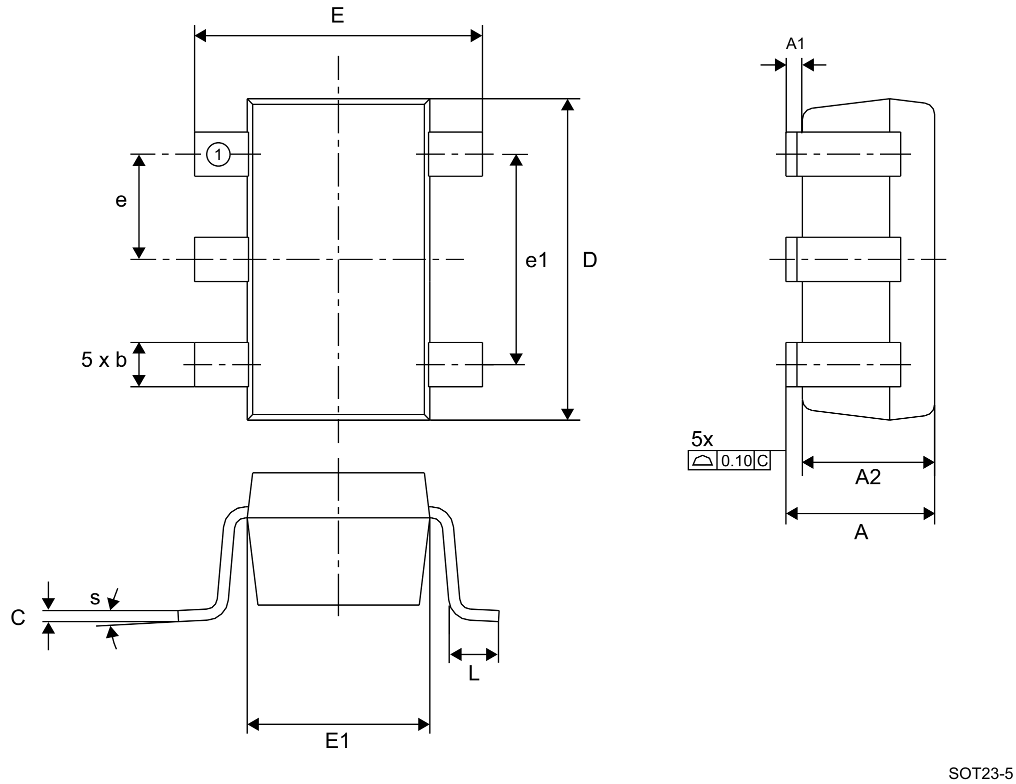


Table 8. SOT23-5 - lead small outline transistor package mechanical data

Symbol	Dimensions					
	Millimeters			Inches		
	Typ.	Min.	Max.	Typ.	Min.	Max.
A			1.45			0.057
A1		0.00	0.15		0.000	0.006
A2	1.15	0.90	1.30	0.045	0.035	0.051
b		0.30	0.50		0.012	0.020
c		0.08	0.22		0.003	0.009
D	2.90			0.114		
E	2.80			0.110		
E1	1.60			0.063		
e	0.95			0.037		
e1	1.90			0.075		
L	0.45	0.30	0.60	0.018	0.012	0.024
q	4	0	8	4	0	8
N	5			5		

4 Ordering information

Table 9. Order codes

Order code	Temperature range	Package	Packaging	Marking
TS881ICT	-40 to +125 °C	SC70-5	Tape and reel	K56
TS881ILT	-40 to +125 °C	SOT23-5	Tape and reel	K524

5 Revision history

Table 10. Document revision history

Date	Revision	Changes
18-Jul-2012	1	Initial release.
16-Dec-2013	2	Updated title *on page 1* (replaced 1.1 V by 0.9 V). Added package SOT23-5 and package information: *on page 1*, in *Section : Description on page 1*, *Figure 1: Pin connections (top view) on page 1*, *Table 1*, *Section 3: Package information*, *Section 4: Ordering information*. Updated *Section : Features on page 1* (replaced “Supply operation” from “1.1 V to 5.5 V” to “0.85 V to 5.5 V”, HBM changed from 4 kV to 8 kV). Updated *Section : Description on page 1* (replaced 1.1 by 0.85 V). Updated *Table 1* (changed ESD HBM to 8000 V). Updated *Table 2* (updated and added parameters and values). Updated *Section 2: Electrical characteristics*: – Added *Table 3*. – Updated *Table 4*, *Table 5*, *Table 6* (added min. values for I_{IO} and I_{IB} symbols). – Note *4.* below *Table 4*., note *4.* below *Table 5*., and note *4.* below *Table 6* (replaced “Maximum values include unavoidable inaccuracies of the industrial tests.” by “Maximum values are guaranteed by design.”). – Added *Figure 34* to *Figure 43*. Minor modifications throughout document.