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TSC200

Datasheet

High voltage, current sense amplifier with open drain comparator and ref



MiniSO8



SO8

Maturity status link
TSC200

Features

- Wide common mode voltage: -16 to 80 V
- 2.7 to 18 V supply voltage
- Amplification gain: 20 V/V
- 0.6 V internal reference
- Internal open-drain comparator
- Latching capability on comparator
- High accuracy: 3.5 % max. error overtemperature
- Bandwidth: 1 MHz
- Quiescent current: 1.8 mA maximum
- SO8 and MiniSO8 package

Applications

- High-side current sensing
- Low-side current sensing
- Overcurrent protection
- Telecom equipment
- Test and measurement equipment
- Industrial process control

Description

The TSC200 is a high-side current sense amplifier which delivers an analog voltage output. It can sense current via a shunt resistor over a wide range of common mode voltages, from -16 to +80 V, whatever the supply voltage is. It is available with an amplification gain of 20 V/V.

The TSC200 integrates an open-drain comparator with output latch function and an internal 0.6 V voltage reference connected to its input. External resistor divider can then set the switching threshold.

This device fully operates over the broad supply voltage range of 2.7 to 18 V and over the industrial temperature range of -40 to +125 °C.

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1 Block diagram and pin description

Figure 1. **Block diagram**

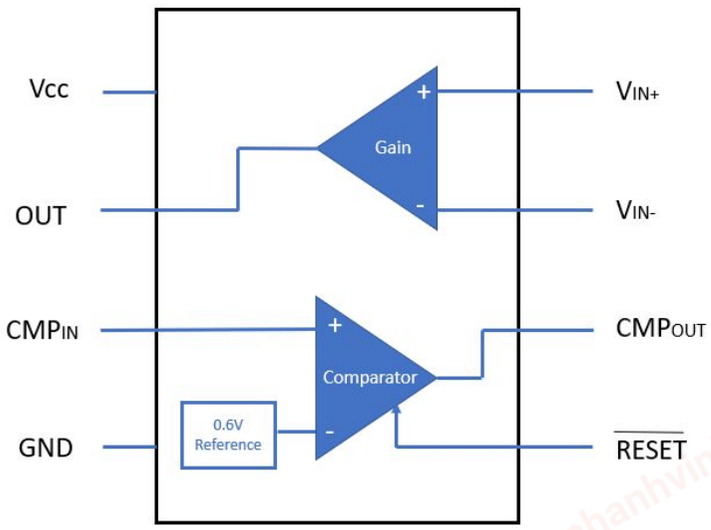


Figure 2. **Pin connections (top view)**

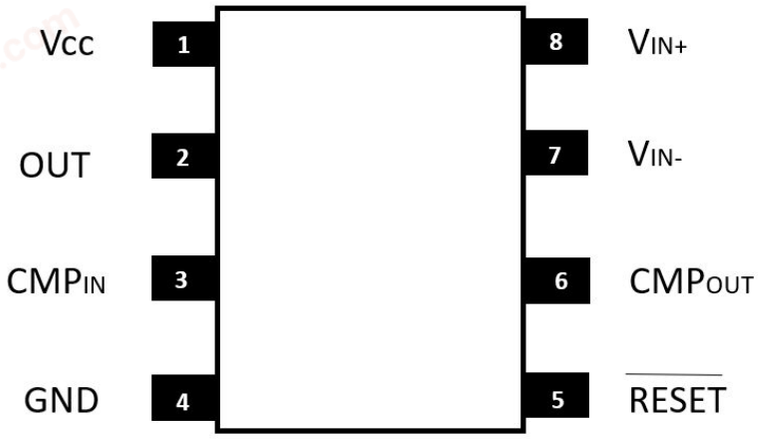


Table 1. **Pin description**

Pin	Pin name	Description
1	V_{CC}	Supply voltage
2	OUT	Current sense amplifier, output
3	CMP_{IN}	Comparator input
4	GND	Ground
5	RESET	Comparator reset pin, active low
6	CMP_{OUT}	Comparator output
7	V_{IN-}	Current sense amplifier, negative input
8	V_{IN+}	Current sense amplifier, positive input

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2 Absolute maximum ratings and operating conditions

Table 2. Absolute maximum ratings

Symbol	Parameter		Value	Unit
V_{CC}	Supply voltage		-0.3 to 18.3	V
V_{IN} +, V_{IN-}	Differential voltage (V_{IN+}) – (V_{IN-})		25% V_{CC} (1)	
	Common mode voltage on input pins		-18 to +82	
CMP_{IN}, RESET	Voltage present on pins V_{IN+}, V_{IN-}, CMP_{IN}, RESET		Gnd -0.3 to Vcc +0.3	V
OUT	Analog output		Gnd -0.3 to Vcc +0.3	
CMP_{OUT}	Voltage present on pin CMP_{OUT}		Gnd -0.3 to 18.3	
I_{IN}	Input current on V_{IN+}, V_{IN-}		5	mA
T_J	Junction temperature		150	°C
T_{STG}	Storage temperature		-65 to 150	°C
ESD	Human Body Model (HBM)		4000	V
	Charged Device Model (CDM)		1000	
R_{THJA}	Thermal resistance junction to ambient	SO8	125	°C/W
		MiniSO8	190	

1. *For V_{CC} ≥ 12 V, Vdiff must not exceed 3 V.*

Table 3. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2.7 to 18	V
V_{ICM}	Common mode voltage on input pins	-16 to +80	V
T	Operating free-air temperature range	-40 to 125	°C

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3 Electrical characteristics

Table 4. Electrical characteristics of the Current sense amplifier at V_{CC} = 12 V, V_{ICM} = 12 V, V_{Sense} = 100 mV, R_L = 10 kΩ to GND, $R_{pull-up}$ = 5.1 kΩ connected from CMP_{OUT} to V_{CC}, CMP_{IN} = GND, T = 25 °C (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Input						
V_{Sense}	Full scale sense input voltage			0.15	$\frac{V_{CC}-0.25}{Gain}$	V
V_{ICM}	Common mode input range	Tmin < T < Tmax	-16		80	V
CMR	Common mode rejection	V_{IN}+ = -16 to 80 V,	80	110		dB
		V_{IN}+ = 12 to 80 V, Tmin < T < Tmax	100	120		
Vos	Offset voltage, RTI (1) (2)	T = 25 °C	-2.5	±0.1	+2.5	mV
		25 °C < T < Tmax	-3		+3	
		Tmin < T < 25 °C	-3.5		+3.5	
|ΔVos/ΔT|	Offset drift (RTI) vs. temperature	Tmin < T < Tmax		0.5		µV/°C
SVR	Supply voltage rejection, RTI	V_{OUT} = 2 V, V_{IN}+ = 18 V, V_{CC} = 2.7 to 18 V, Tmin < T < Tmax		3	100	µV/V
I_{IB}	Input bias current, V_{IN-} pin	Tmin < T < Tmax		±0.5	±16	µA
Output (V_{Sense} ≥ 20 mV)						
G	Gain	TSC200		20		V/V
E_G	Gain error	V_{Sense} = 20 to 100 mV		±0.05	±1	%
		Tmin < T < Tmax			±2	
TE_G	Total output error (3)	V_{Sense} = 120 mV, V_{CC} = 16 V		±0.1	±2.2	%
		Tmin < T < Tmax			±3.5	
NLE	Non linearity error	V_{Sense} = 20 to 100 mV		±0.002		%
R_O	Output impedance			1.5		Ω
C_{Load}	Maximum capacitive load	No sustained oscillation		10		nF
Output (V_{Sense} < 20 mV)						
Output	TSC200	-16 ≤ V_{ICM} < 0 V		300		mV
		0 ≤ V_{ICM} ≤ Vcc, V_{CC} = 5 V			400	
		Vcc < V_{ICM} ≤ 80 V		300		
Voltage output						
V_{OH}	Output swing to the positive rail	V_{IN-} = 11 V, V_{IN}+ = 12 V, Tmin < T < Tmax		V_{CC} - 0.15	V_{CC} - 0.25	mV
V_{OL}	Output swing to GND	V_{IN-} = 0 V, V_{IN}+ = -50 mV, Tmin < T < Tmax		4	50	mV

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Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Dynamic performances						
BW	C_{Load} = 5 pF	TSC200		1		MHz
SR	Slew rate			7		V/µs
Ts	Settling time	V_{Sense} = 10 to 100 mVpp Up to 1 % final value, C_{Load} = 5 pF		2		µs
Noise, RTI						
E_N	Voltage noise density	f = 100 kHz		55		nV/√Hz
Power supply						
I_{CC}	Current consumption	V_{OUT} = 2 V		0.84	1.8	mA
		V_{Sense} = 0 mV, Tmin < T < Tmax			1.85	
C_POR	Comparator POR threshold (4)			1.5		V

1. *RTI stands for “Related to input”.*
2. *Offset is extrapolated from measurements of the output at V_{Sense} of 20 mV and 100 mV.*
3. *Total output error considers effects of gain error and V_{OS} inaccuracy.*
4. *The TSC200 is designed to power up with the comparator in a defined reset state as long as RESET is open or grounded. The comparator is in reset as long as the power supply is below the voltage shown here. The comparator assumes a state based on the comparator input above this supply voltage. If RESET is high at power-up, the comparator output comes up high and requires a reset to assume a low state, if appropriate.*

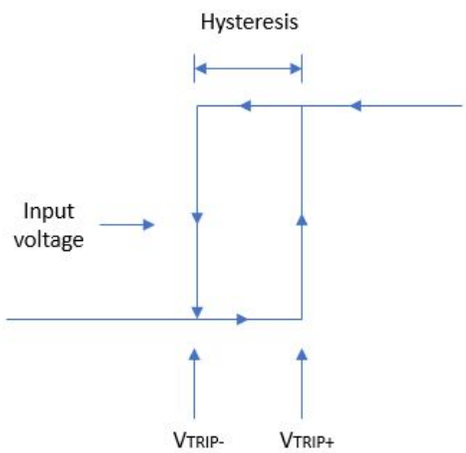
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Table 5. Electrical characteristics of the Comparator at V_{CC} = 12 V, V_{ICM} = 12 V, V_{Sense} = 100 mV, R_L = 10 kΩ to GND, $R_{pull-up}$ = 5.1 kΩ connected from CMP_{OUT} to V_{CC}, T = 25 °C (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Input						
V_{TH}	Threshold	T = 25 °C	590	608	620	mV
		Tmin < T < Tmax	586		625	
Hyst	Hysteresis (1)	Tmin < T < Tmax		-9		
I_{IB}	Input bias current, CMP_{IN} pin (2)	T = 25 °C		0.005	10	nA
		Tmin < T < Tmax			15	
V_{IN}	Input voltage range, CMP_{IN} pin		0		V_{CC} -1.5	V
Output (open-drain)						
Av	Large signal differential voltage gain	CMP_{OUT} from 1 to 4 V R_L ≥ 15 kΩ connected to 5 V		200		V/mV
I_{OH}	High level leakage current (3) (4)	V_{ID} = 0.4 V, V_{OH} = V_{CC}		0.0001	1	µA
V_{OL}	Low level output voltage (3)	V_{ID} = -0.6 V, I_{OL} = 2.35 mA		140	300	mV
Response time						
T_P	Response time (5)	R_L to 5 V, C_{Load} = 15 pF, 100 mV input step with 5 mV overdrive		0.3		µs
$\overline{RESET}$						
V_T	$\overline{Reset}$ threshold (6)			1.1		V
R_I	Input impedance			2		MΩ
T_{DW}	Minimum $\overline{Reset}$ pulse width			0.1		µs
T_D	Propagation delay			0.1		µs

1. *See Figure 3 for details, Hysteresis=V_{TRIP}- - V_{TRIP}+.*
2. *Specified by design.*
3. *V_{ID} is the differential voltage present at the comparator inputs.*
4. *Open-drain output can be pulled up to 2.7~18 V range, regardless of V_{CC}.*
5. *The comparator response time specified is the time interval between the input step and the instant when the output crosses 1.4 V.*
6. *The RESET input has an internal 2 MΩ (typical) pull-down. In case RESET pin is left open, the output shows a LOW state, with transparent comparator operation.*

Figure 3. Typical comparator hysteresis



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4 Typical performance characteristics

T = 25 °C, V_{CC} = 12 V, V_{IN+} = 12 V and V_{Sense} = 100 mV (unless otherwise specified).

Figure 4. Gain vs. frequency (C_L = 1000 pF)

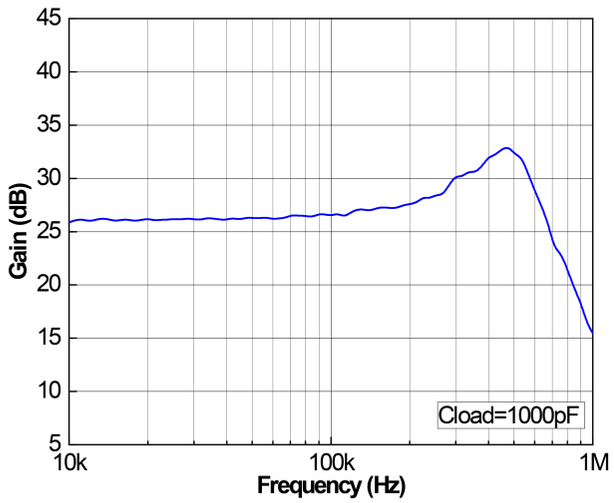


Figure 5. Gain vs. frequency (C_L = 100 pF)

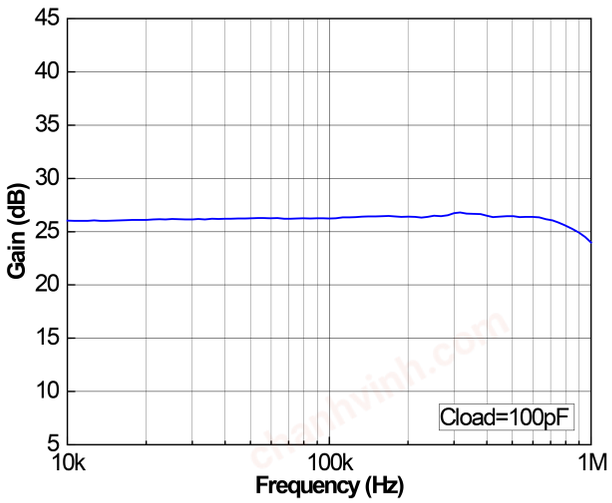


Figure 6. Gain plot

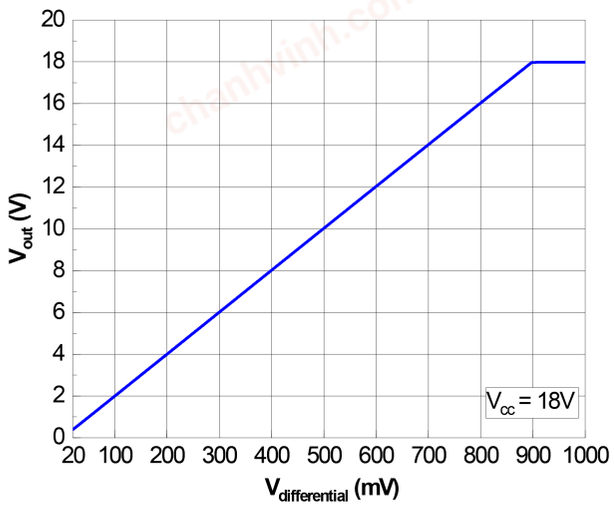
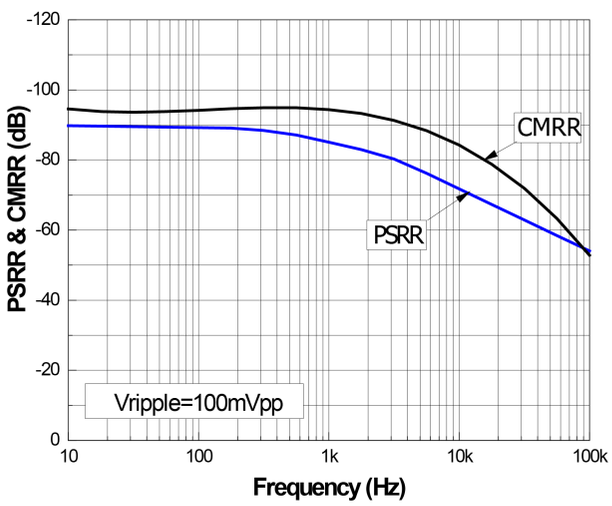


Figure 7. CMRR and PSRR vs. frequency



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Figure 8. Output error vs. V_{sense}

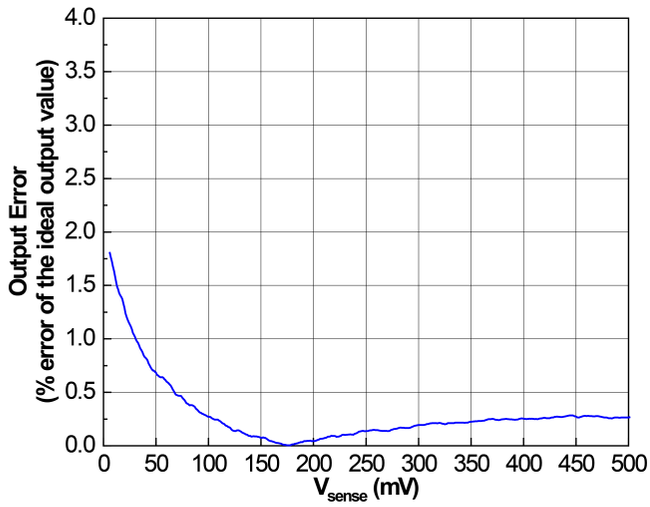


Figure 9. Output error vs. common mode voltage

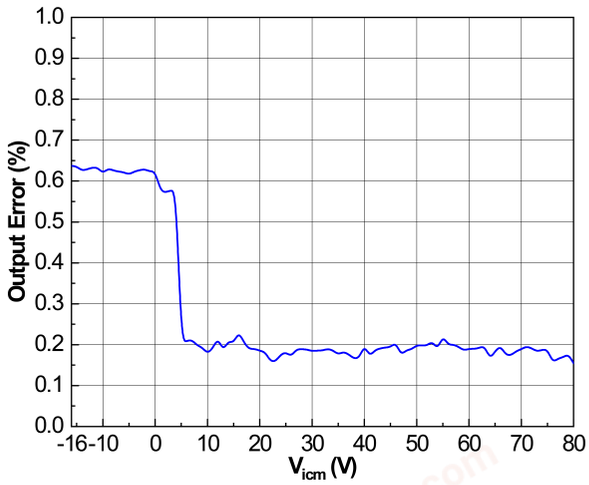


Figure 10. Output current vs. output voltage at V_{CC} = 2.7 V

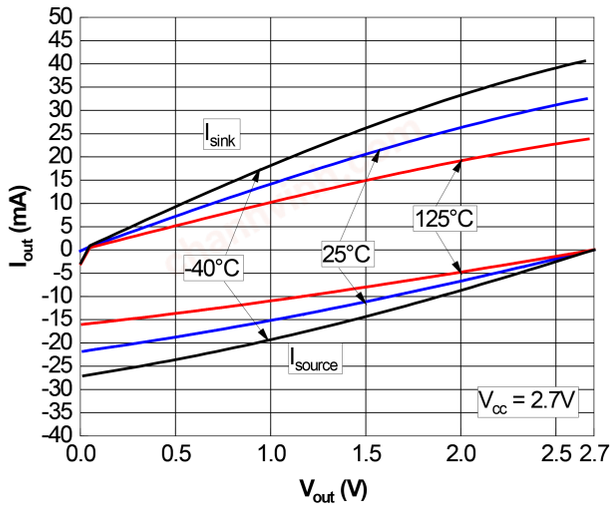


Figure 11. Output current vs. output voltage at V_{CC} = 12 V

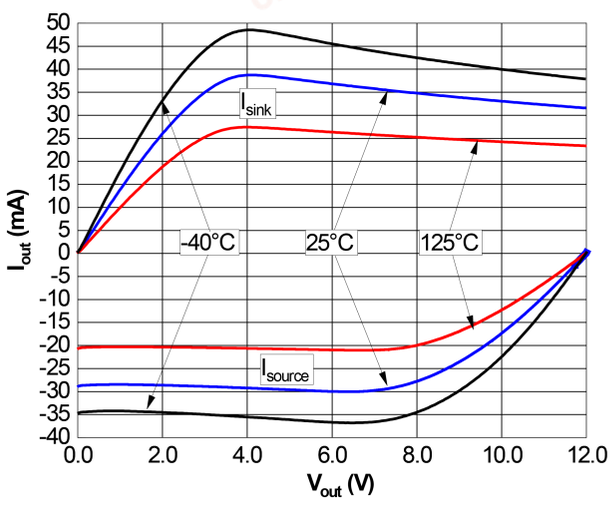


Figure 12. Quiescent current vs. output voltage

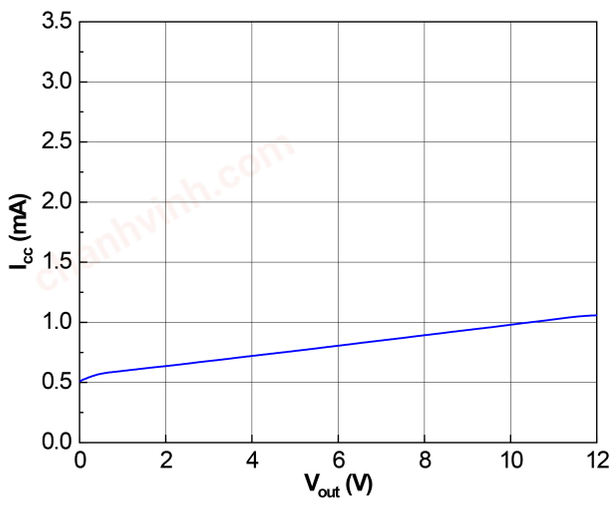
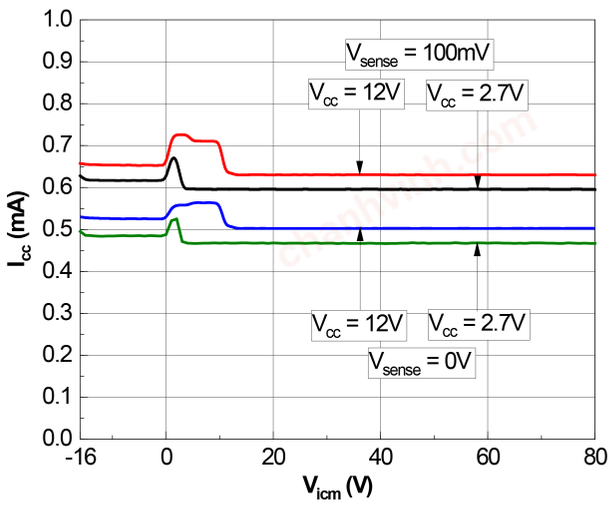


Figure 13. Quiescent current vs. common mode voltage



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Figure 14. Output short-circuit current vs. supply voltage

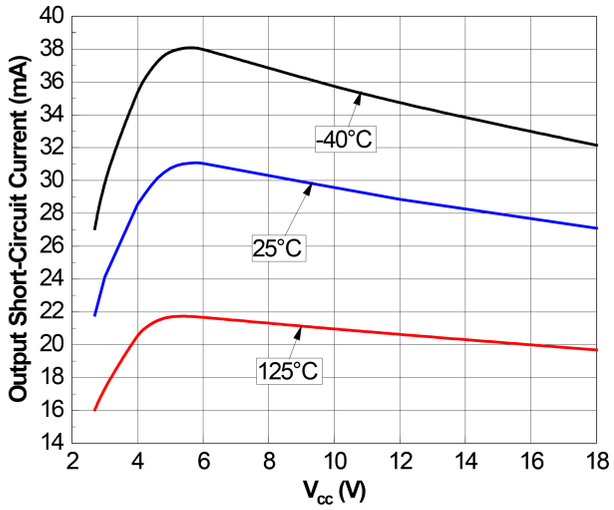


Figure 15. Step response for 20 to 30 mV V_{sense}

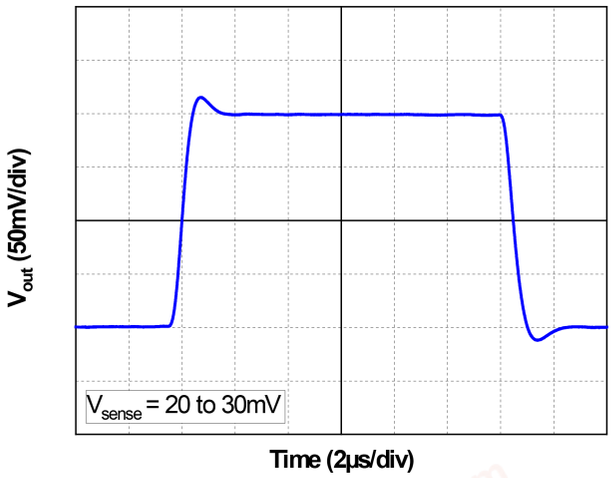


Figure 16. Step response for 20 to 110 mV V_{sense}

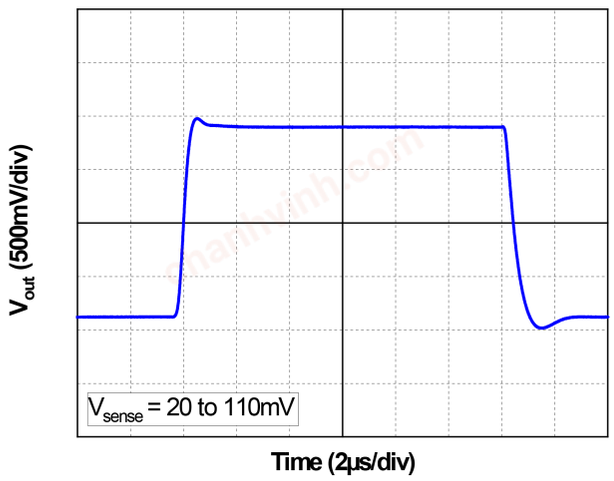


Figure 17. Step response for 90 to 100 mV V_{sense}

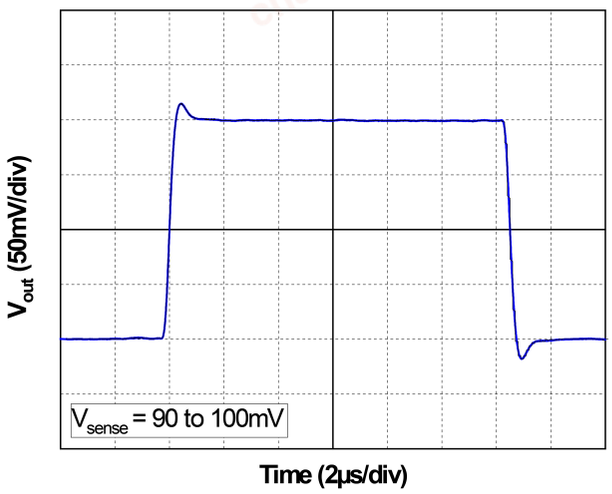


Figure 18. Comparator V_{OL} vs. I_{SINK}

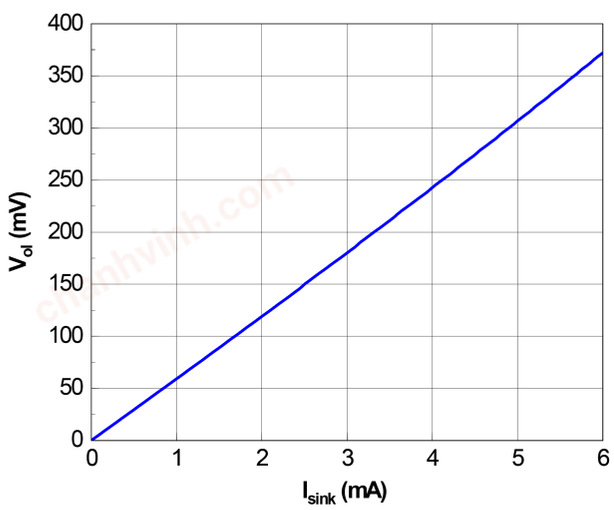
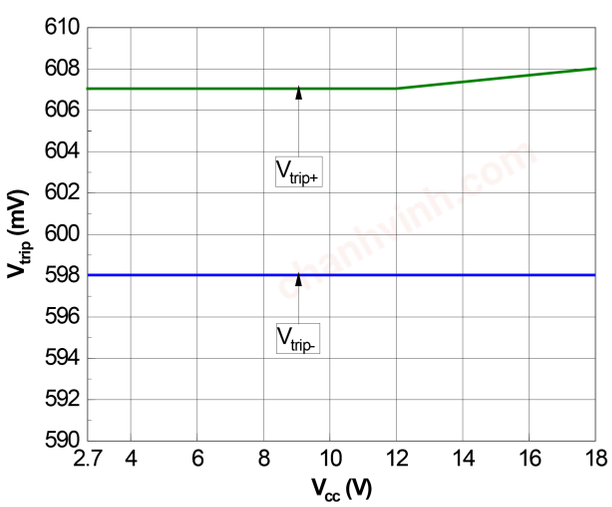


Figure 19. Comparator trip points vs. V_{CC}



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Figure 20. Comparator trip points vs. temperature

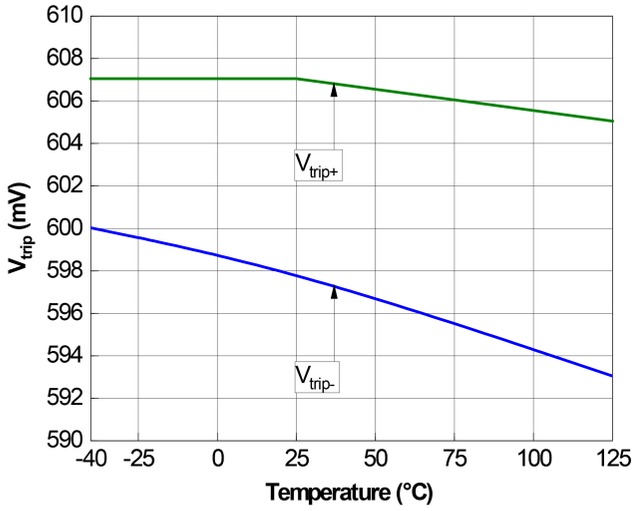


Figure 21. Comparator reset voltage vs. V_{CC}

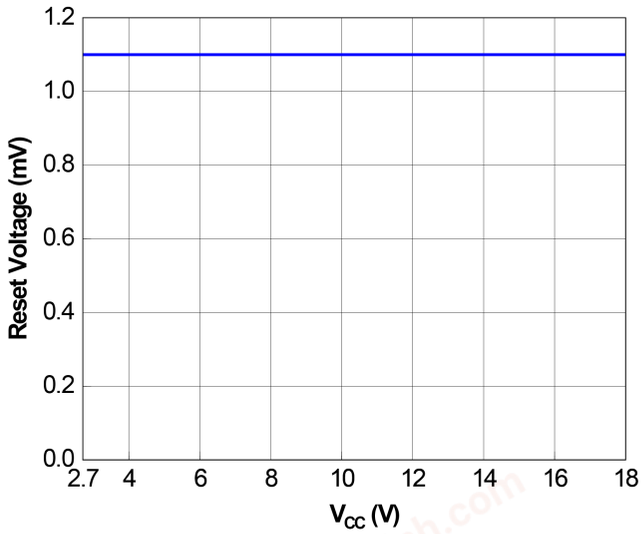


Figure 22. Comparator propagation delay vs. overdrive voltage

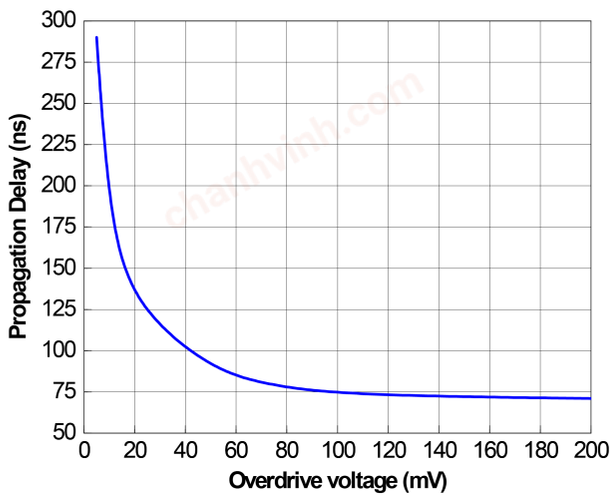


Figure 23. Comparator propagation delay vs. temperature

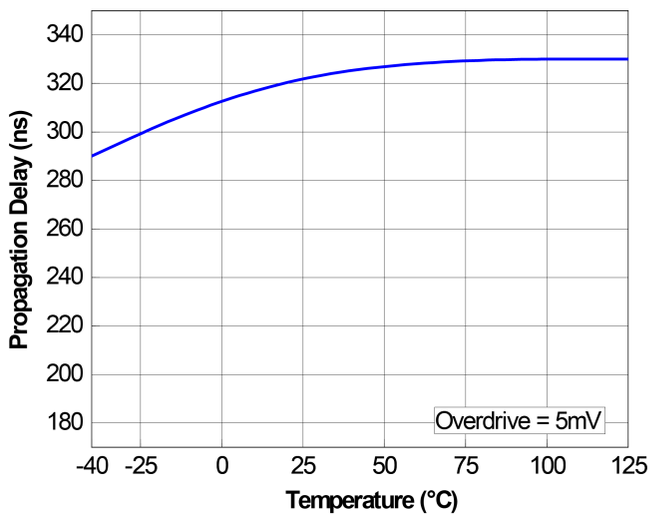
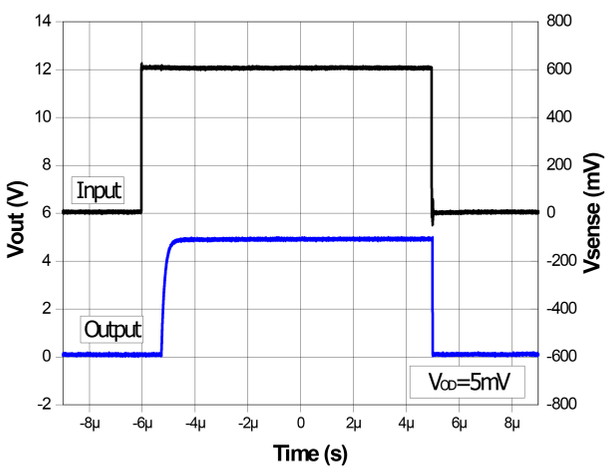


Figure 24. Comparator propagation delay



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5 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.

5.1 SO8 package information

Figure 25. SO8 package outline

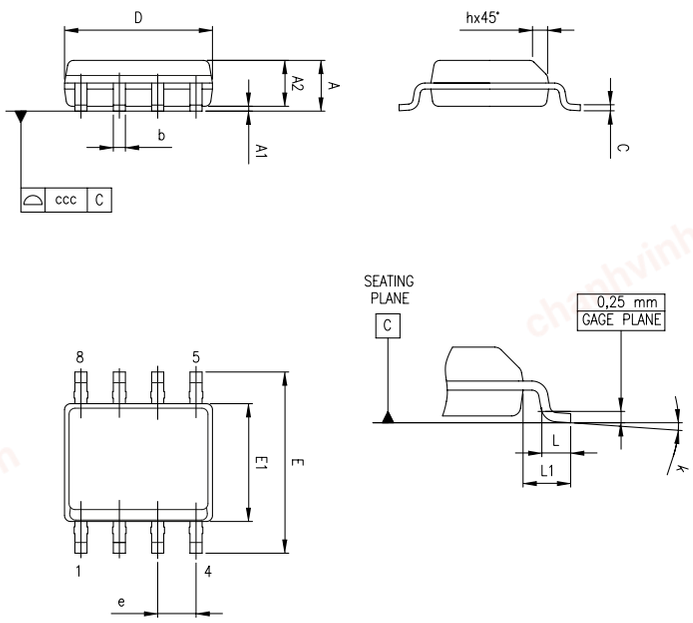


Table 6. SO8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.04		0.010
A2	1.25			0.049		
b	0.28	0.40	0.48	0.011	0.016	0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40	0.635	1.27	0.016		0.050
L1		1.04			0.040	
k	1°		8°	1°		8°
ccc			0.10			0.004

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5.2 MiniSO8 package information

Figure 26. **MiniSO8 package outline**

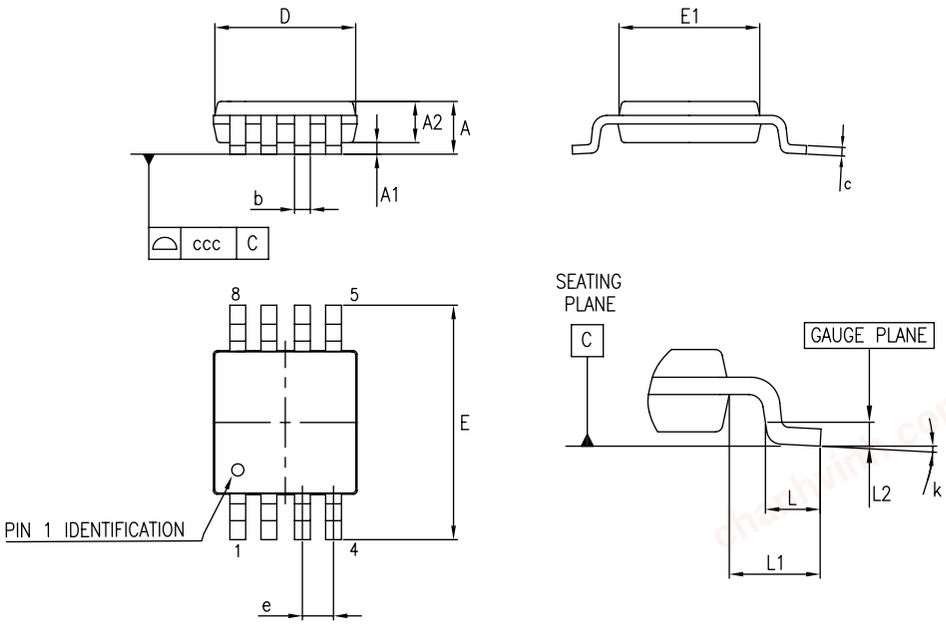


Table 7. **MiniSO8 mechanical data**

Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.006
A2	0.75	0.85	0.95	0.03	0.033	0.037
b	0.22		0.4	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.8	3	3.2	0.11	0.118	0.126
E	4.65	4.9	5.15	0.183	0.193	0.203
E1	2.8	3	3.1	0.11	0.118	0.122
e		0.65			0.026	
L	0.4	0.6	0.8	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.01	
k	0°		8°	0°		8°
ccc			0.1			0.004

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6 Ordering information

Table 8. **Ordering information**

Order code	Gain (V/V)	Package	Packing	Marking
TSC200IDT	20	SO8	Tape and reel	TSC200I
TSC200IST	20	MiniSO8		O123

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Revision history

Table 9. **Document revision history**

Date	Version	Changes
24-Jan-2022	1	First release.

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