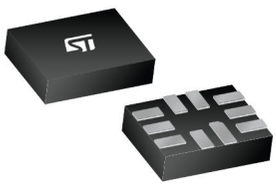
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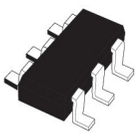
TSC199

Datasheet

High / low side, bidirectional, zero-drift current sense amplifiers



QFN10L 1.8 x 1.4 mm



SC70-6L

Maturity status link
TSC199

Features

- Wide common-mode voltage: -0.3 V to 26 V
- Offset voltage: ±150 µV max.
- Gain error: 1.5% max.
- Offset drift: 0.5 µV/°C max.
- Different gain available
  - TSC199A1 50 V/V
  - TSC199A2 100 V/V
  - TSC199A3 200 V/V
- Quiescent current: 100 µA max.
- SC70-6 and QFN10L (1.8 x 1.4 mm)

Applications

- Notebook computers
- Telecom equipment
- Industrial application
- Power management
- Battery chargers

Description

TSC199 is a series of zero-drift current sense amplifiers that can sense current via a shunt resistor over a wide range of common-mode voltages from -0.3 V to +26 V, whatever the supply voltage is. It is available in three different versions, each of them having a different gain: 50 V/V, 100 V/V, and 200 V/V. TSC199 is designed with a specific zero-drift architecture, which can achieve high precision. TSC199 is able to sense very low drop voltages, as low as 10 mV full scale, minimizing measurement error.

TSC199 are current sense amplifiers that may be used in various functions like precision current measurement, overcurrent protection, current monitoring, and feedback loops.

This device fully operates over the broad supply voltage range of 2.7 V to 26 V and over the industrial temperature range of -40 °C to 125 °C.

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1 Pin connections and block diagram

Figure 1. **Pin connections (top view)**

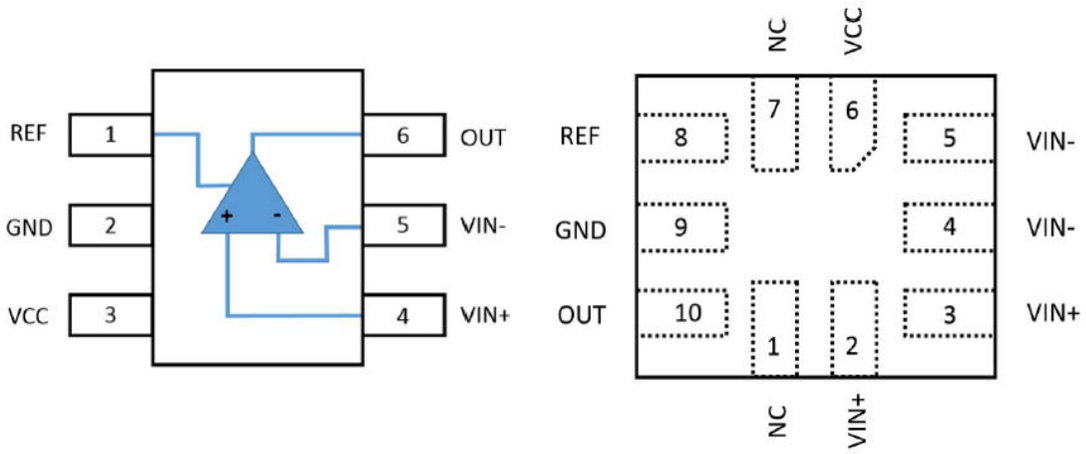


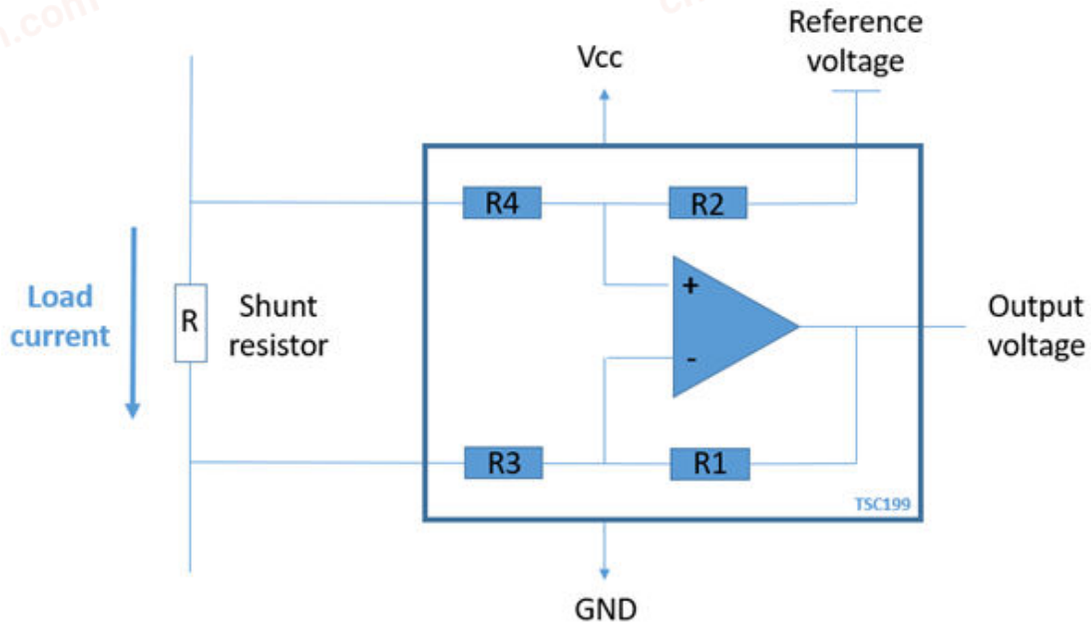
Table 1. **Pin description**

Name	SC70-6	QFN10	Description
REF	1	8	Reference voltage input
GND	2	9	Ground
VCC	3	6	Power supply voltage
VIN+	4	2, 3	Connection to the external sense resistor
VIN-	5	4, 5	Connection to the external sense resistor
OUT	6	10	Output voltage
NC		1, 7	Not connected (1)

1. *Pins can be left floating or connected to VCC or GND.*

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Figure 2. **Block diagram**



Output voltage = (Rshunt x Iload) x Gain + Vref

Table 2. **Resistors and gain values**

Product	R1 and R2	R3 and R4	Gain
TSC199A1	1 MΩ	20 kΩ	50
TSC199A2	1 MΩ	10 kΩ	100
TSC199A3	1 MΩ	5 kΩ	200

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2 Absolute maximum ratings and operation conditions

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage (1)	26	V
V_{in}	Differential voltage between input pins (In+, In-)	-26 to +26	V
	Common-mode voltage on input pins	Gnd -0.3 to 26	
Ref	Reference input voltage	Gnd -0.3 to V_{CC}+0.3	V
I_{in}	Input current to any pin (2)	5	mA
V_{out}	Output voltage	Gnd -0.3 to V_{CC}+0.3	V
T_{Lead}	Lead temperature for 10 s (3)	260	°C
T_{stg}	Storage temperature	-65 to 150	°C
T_j	Junction temperature	150	°C
$R_{th\text{-}ja}$	Thermal resistance junction to ambient (4) (5) QFN10L (1.8 x 1.4 x 0.5 mm) SC70-6	 124 232	°C/W
ESD	HBM: Human Body Model (6)	2000	V
	CDM: Charged Device Model (7)	1000	

1. *All voltage values, except the differential voltage, are with respect to the network ground terminal.*
2. *Input voltage can go beyond supply voltage but input current must be limited. Using a serial resistor with the input is highly recommended in that case.*
3. *Reflow at peak temperature of 260 °C. Time above 255 °C must not exceed 30 s.*
4. *Short-circuits can cause excessive heating and destructive dissipation.*
5. *R_{th} are typical values.*
6. *According to JEDEC standard JESD22-A114F.*
7. *According to ANSI/ESD STM 5.3.1.*

Table 4. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2.7 to 26	V
V_{ICM}	Common-mode voltage on input pins	-0.3 to +26	V
T	Operating free-air temperature range	-40 to 125	°C

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3 Electrical characteristics

Table 5. T = 25 °C, V_{CC} = 5 V, V_{IN+} = 12 V, V_{SENSE} = V_{IN+} - V_{IN-}, and V_{REF} = V_{CC} / 2 (unless otherwise specified).

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Input						
V_{ICM}	Common-mode input range	-40 °C to 125 °C	-0.3		26	V
CMR	Common-mode rejection	V_{IN+} = 0 V to 26 V, V_{SENSE} = 0 mV, Tmin < T < Tmax	100	120		dB
V_O	Offset voltage (RTI) (1)	V_{SENSE} = 0 mV			±150	µV
$\|\Delta V_O / \Delta T\|$	Offset voltage variation (RTI) vs. temperature	Tmin < T < Tmax		0.1	0.5	µV/°C
PSR	Power supply rejection	V_{CC} = 2.7 V to 18 V V_{IN+} = 18 V, V_{SENSE} = 0 mV		0.1		µV/V
I_{IB}	Input bias current	V_{SENSE} = 0 mV		28		µA
I_{IO}	Input offset current	V_{SENSE} = 0 mV		0.02		
Output						
G	Gain	TSC199A1 TSC199A2 TSC199A3		50 100 200		V/V
E_G	Gain error	V_{SENSE} = -5 mV to +5 mV Tmin < T < Tmax		0.03	±1.5	%
T_G	Gain error vs. temperature	Tmin < T < Tmax		7	20	ppm/°C
NLE	Linearity error	V_{SENSE} = -5 mV to +5 mV		0.01		%
C_L	Maximum capacitive load	No sustained oscillation		470		pF
V_{SW+}	Output swing close to Vcc	R_L = 10 kΩ to Gnd Tmin < T < Tmax	Vcc - 0.2			V
V_{SW-}	Output swing close to Gnd	R_L = 10 kΩ to Gnd, Tmin < T < Tmax			0.05	
Dynamic performances						
BW	Bandwidth	C_L = 100 pF, TSC199A1 C_L = 100 pF, TSC199A2 C_L = 100 pF, TSC199A3		100 40 25		kHz
SR	Slew rate	C_L = 100 pF, TSC199A1 C_L = 100 pF, TSC199A2 C_L = 100 pF, TSC199A3		0.85 0.32 0.2		V/µs
Noise						
EN	Noise (RTI) (1)			40		nV/√Hz
Power supply						
V_{CC}	Supply voltage		2.7		26	V
I_{CC}	Quiescent current	V_{SENSE} = 0 mV		65	100	µA
		Tmin < T < Tmax			115	

1. *RTI stands for "related to input."*

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

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4.1 SC70-6 package information

Figure 3. **SC70-6 package outline**

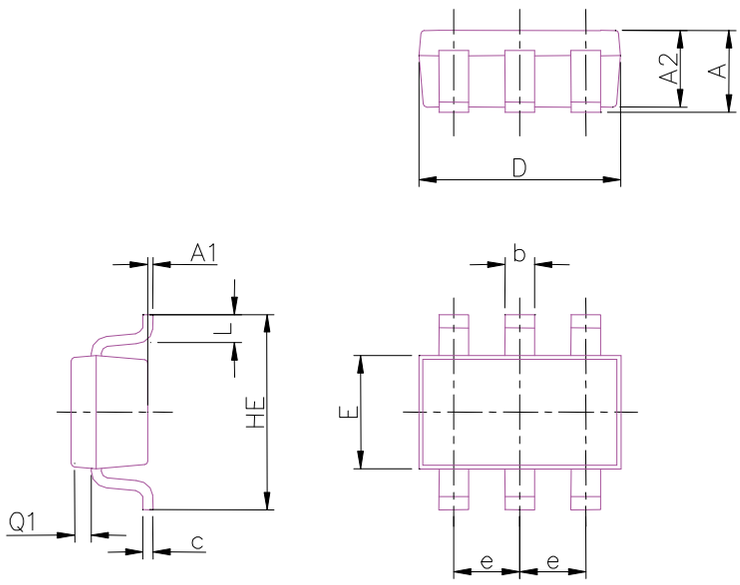


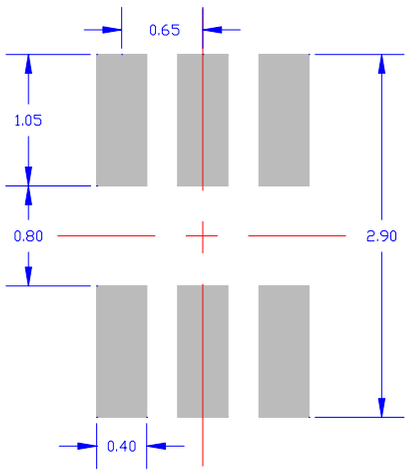
Table 6. **SC70-6 mechanical data**

Symbol	Millimeters			Inches[1]		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.80		1.10	0.037		0.041
A1	0		0.10	0.000		0.004
A2	0.80		1.00	0.035		0.039
b	0.15		0.30	0.008		0.010
c	0.10		0.18	0.004		0.004
D	1.80		2.20	0.078		0.086
E	1.15		1.35	0.050		0.052
e		0.65		0.025		0.026
HE	1.8		2.4	0.083		0.090
L	0.10		0.40	0.013		0.015
Q1	0.10		0.40	0.011		0.013

1. *Values in inches are converted from mm and rounded to 4 decimal digits.*

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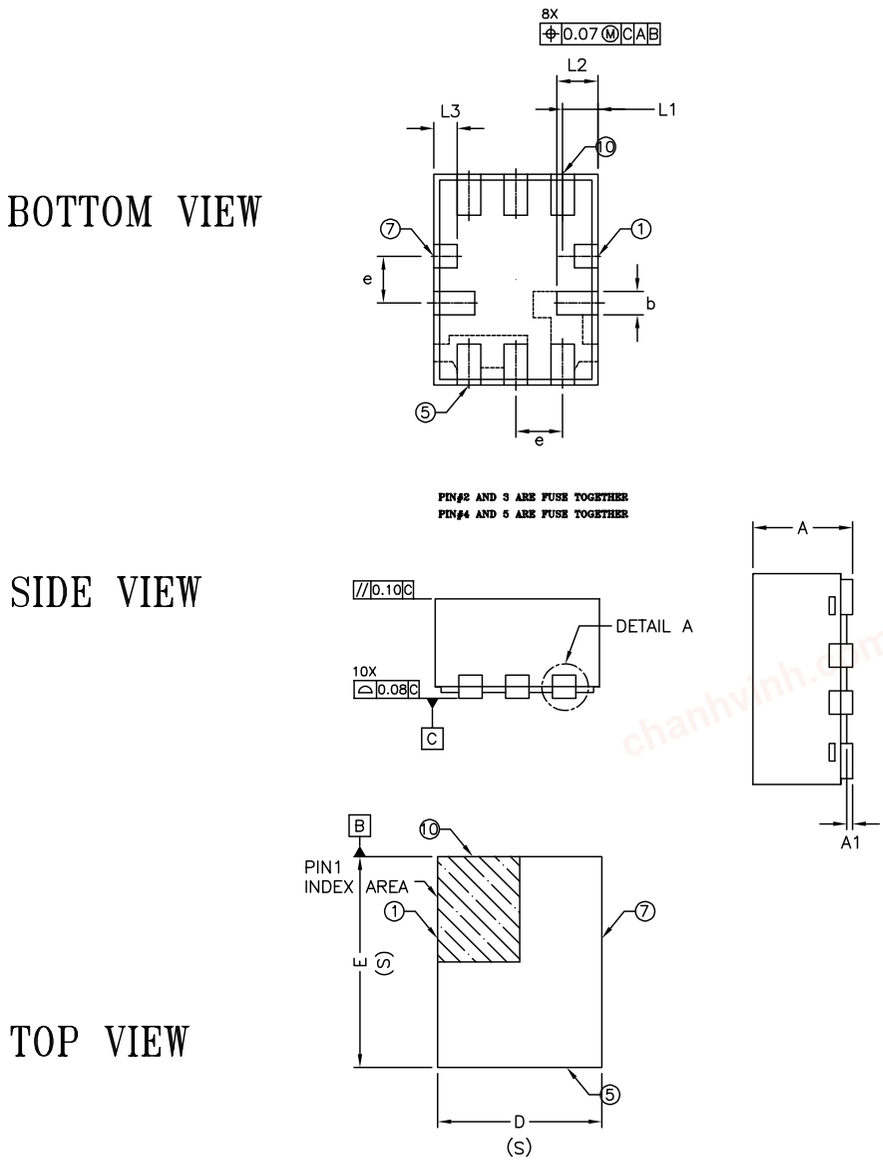
Figure 4. **SC70-6 recommended footprint**



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4.2 QFN10 package information

Figure 5. **QFN10 package outline**



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Figure 6. **QFN10 detail A package outline**

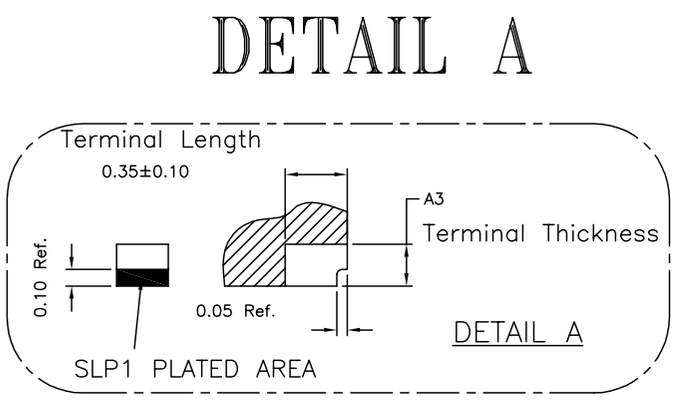
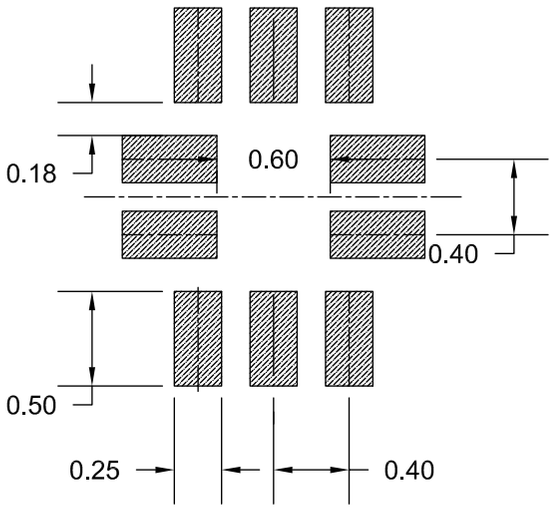


Table 7. **QFN10 mechanical data**

Symbol	mm		
	Min.	Typ.	Max.
A	0.70	0.75	0.80
A1	0.0		0.05
A3		0.203REF	
b	0.15	0.20	0.25
D	1.35	1.40	1.45
e		0.40 BSC	
E	1.75	1.80	1.85
L1	0.10	0.20	0.30
L2	0.25	0.35	0.45
L3	0.10	0.20	0.30

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Figure 7. **QFN10 recommended footprint**



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5 Ordering information

Table 8. **Order codes**

Order code	Gain (V/V)	Package	Packaging	Marking
TSC199A1ICT	50	SC70-6	Tape & reel	O1C
TSC199A1IQT		QFN10 1.8 x 1.4 mm		O1C
TSC199A2ICT	100	SC70-6		O1D
TSC199A2IQT		QFN10 1.8 x 1.4 mm		O1D
TSC199A3ICT	200	SC70-6		O1E
TSC199A3IQT		QFN10 1.8 x 1.4 mm		O1E

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Revision history

Table 9. **Document revision history**

Date	Revision	Changes
04-Sep-2023	1	Initial release.

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