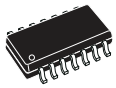
TS514

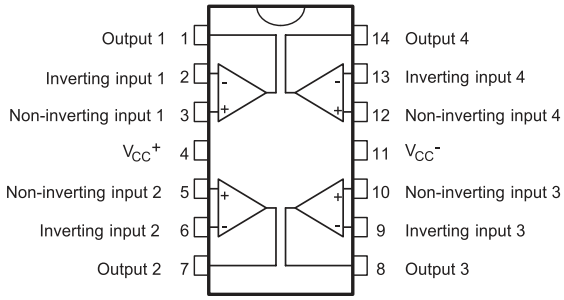
Precision quad operational amplifier

Datasheet - production data



D
SO-14
(plastic micropackage)

Pin connections
(top view)



Description

The TS514 device is a high-performance quad operational amplifier with frequency and phase compensation built into the chip. The internal phase compensation allows stable operation as a voltage follower in spite of its high gain bandwidth.

The circuit presents very stable electrical characteristics over the entire supply voltage range, and is particularly intended for professional and telecom applications (such as active filters, for example).

Features

- Low input offset voltage: 500 µV max.
- Low power consumption
- Short-circuit protection
- Low distortion, low noise
- High gain bandwidth product
- High channel separation
- ESD protection 2 kV

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

Contents

1 Absolute maximum ratings and operating conditions 3

2 Schematic diagram 4

3 Electrical characteristics 5

4 Package information 12

4.1 SO-14 package information 13

5 Ordering information 14

6 Revision history 15

1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	±18	V
V_i	Input voltage	V_{DD}-0.2 to V_{CC}+0.2	V
V_{id}(1)	Differential input voltage	$\pm V_{CC}$	V
T_{stg}	Storage temperature range	-65 to +150	°C
R_{thja}	Thermal resistance junction-to-ambient SO-14	103	°C/W
R_{thjc}	Thermal resistance junction-to-case SO-14	31	°C/W
ESD	HBM: human body model(2)	2	kV
	MM: machine model(3)	200	V
	CDM: charged device model(4)	1.5	kV

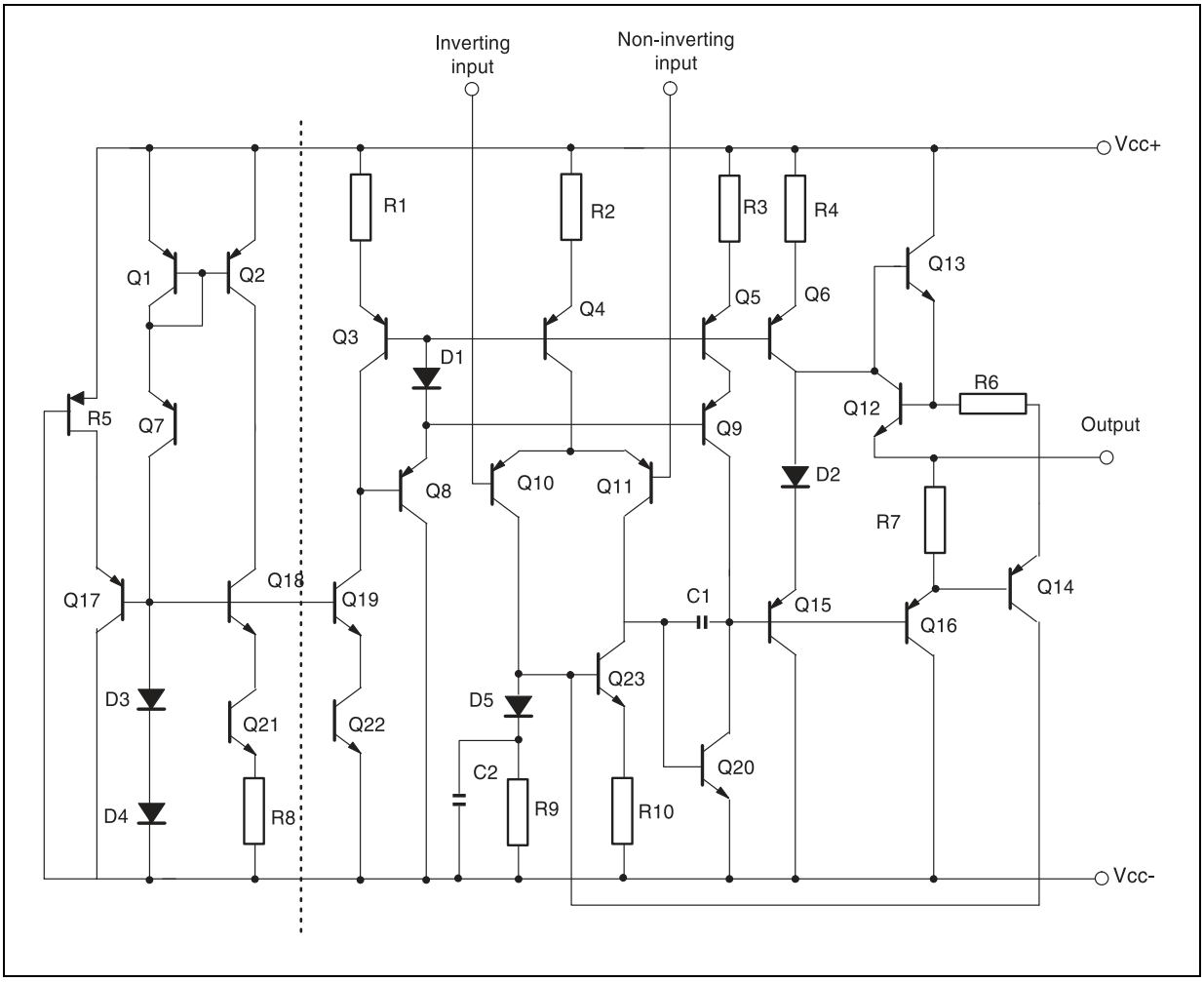
1. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
2. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
3. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.
4. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to ground through only one pin. This is done for all pins.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	6 to 30	V
V_{icm}	Common mode input voltage range	V_{DD} +0.8 to V_{CC} -1.5	V
T_{oper}	Operating free air temperature range	-40 to +125	°C

2 Schematic diagram

Figure 1. Typical schematic diagram (1/4 TS514)



3 Electrical characteristics

Table 3. Electrical characteristics at V_{CC} = ±15 V, T_{amb} = 25 °C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply current (per operator) at $T_{min} \le T_{op} \le T_{max}$		0.5	0.6 0.75	mA
I_{ib}	Input bias current – at 25 °C – at $T_{min} \le T_{op} \le T_{max}$		50	150 300	nA
R_i	Input resistance, F= 1 kHz		1		MΩ
V_{io}	Input offset voltage – at 25 °C TS514 TS514A – at $T_{min} \le T_{op} \le T_{max}$ TS514 TS514A		0.5	2.5 0.5 4 1.5	mV
ΔV_{io}	Input offset voltage drift at $T_{min} \le T_{op} \le T_{max}$		5		µV/°C
I_{io}	Input offset current at 25 °C at $T_{min} \le T_{op} \le T_{max}$		5	20 40	nA
ΔI_{io}	Input offset current drift $T_{min} \le T_{op} \le T_{max}$		0.08		$\frac{nA}{°C}$
I_{os}	Output short-circuit current		23		mA
A_{vd}	Large signal voltage gain, R_L = 2 kΩ V_{CC} = ±15 V, at $T_{min} \le T_{op} \le T_{max}$ V_{CC} = ± 4 V	90	100 95		dB
GBP	Gain bandwidth product, F = 100 kHz	1.8	3		MHz
e_n	Equivalent input noise voltage, F = 1 kHz Rs = 50 Ω Rs = 1 kΩ Rs = 10 kΩ		8 10 18	15	$\frac{nV}{\sqrt{Hz}}$
THD	Total harmonic distortion Av = 20 dB, R_L = 2 kΩ, V_o = 2 V_{pp}, f = 1 kHz		0.03	0.1	%
$\pm V_{opp}$	Output voltage swing, R_L = 2 kΩ V_{CC} = ±15 V, at $T_{min} \le T_{op} \le T_{max}$ V_{CC} = ± 4 V	±13	 ±3		V
V_{opp}	Large signal voltage swing, R_L = 2 kΩ, F = 10 kHz		28		V_{pp}
SR	Slew rate, unity gain, R_L = 2 kΩ	0.8	1.5		V/µs
CMR	Common mode rejection ratio CMR = 20 log ($\Delta V_{ic}/\Delta V_{io}$) ($V_{ic}$ = -10 V to 10 V, V_{out} = V_{CC}/2, R_L > 1 MΩ)	90			dB

Table 3. Electrical characteristics at V_{CC} = ±15 V, T_{amb} = 25 °C (unless otherwise specified) (continued)

Symbol	Parameter	Min.	Typ.	Max.	Unit
SVR	Supply voltage rejection ratio 20 log ($\Delta V_{CC}/\Delta V_{io}$) ($V_{CC}$ = ±5 V to ±15 V, V_{out} = V_{icm} = V_{CC}/2)	90			dB
V_{o1}/V_{o2}	Channel separation, F = 1 kHz		120		dB

Figure 2. V_{io} distribution at V_{CC} = ±15 V and T = 25 °C

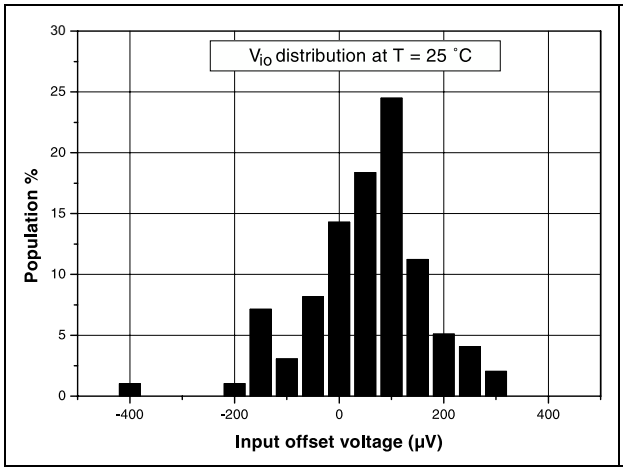


Figure 3. V_{io} distribution at V_{CC} = ±15 V and T = 125 °C

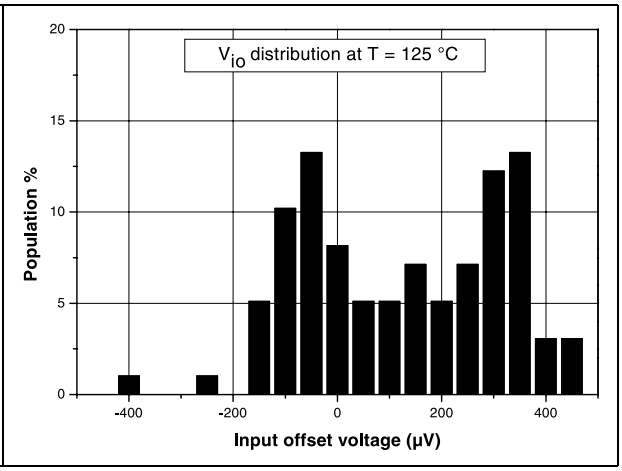


Figure 4. Input offset voltage vs. supply voltage at $V_{icm} = V_{CC}/2$

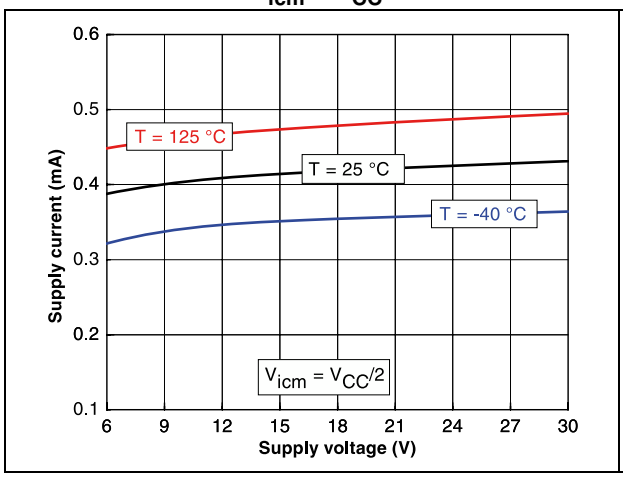


Figure 5. Input offset voltage vs. input common mode voltage at V_{CC} = 6 V

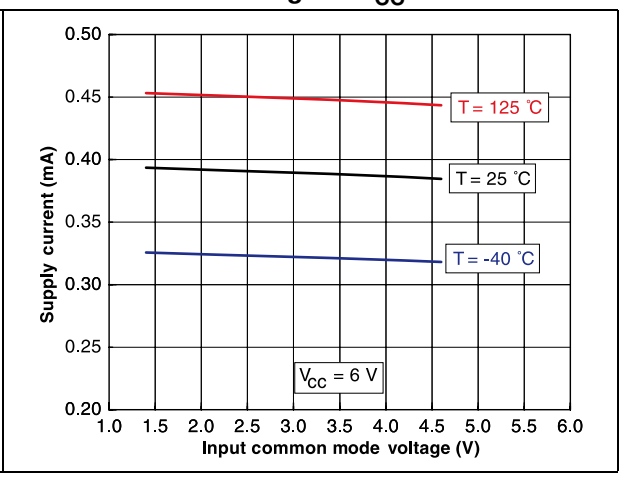


Figure 6. Input offset voltage vs. input common mode voltage at V_{CC} = 10 V

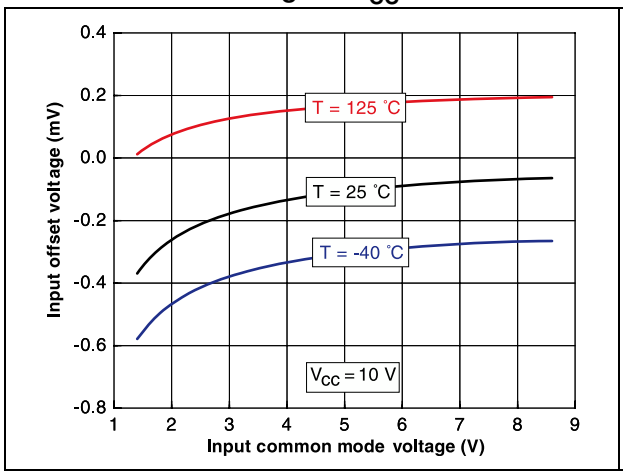


Figure 7. Input offset voltage vs. input common mode voltage at V_{CC} = 30 V

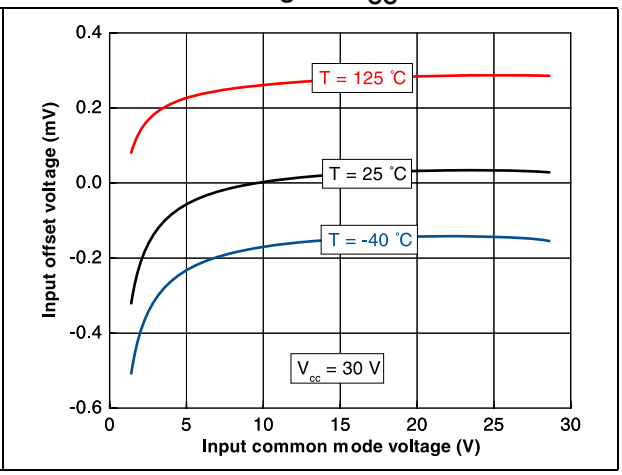


Figure 8. Supply current (per operator) vs. supply voltage at $V_{icm} = V_{CC}/2$

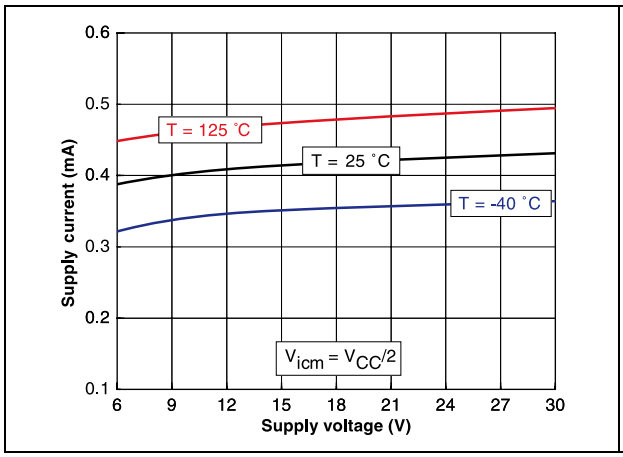


Figure 9. Supply current (per operator) vs. input common mode voltage at $V_{CC} = 6$ V

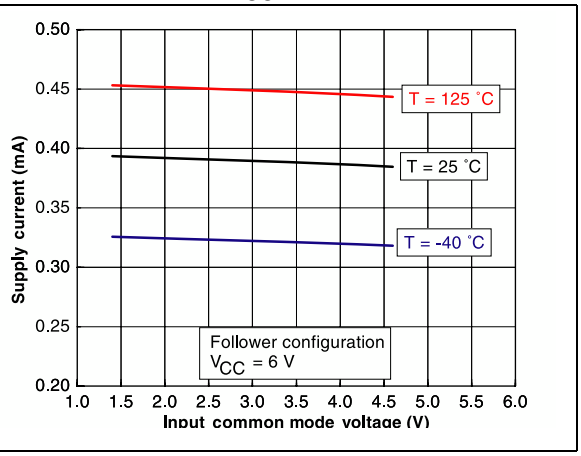


Figure 10. Supply current (per operator) vs. input common mode voltage at $V_{CC} = 10$ V

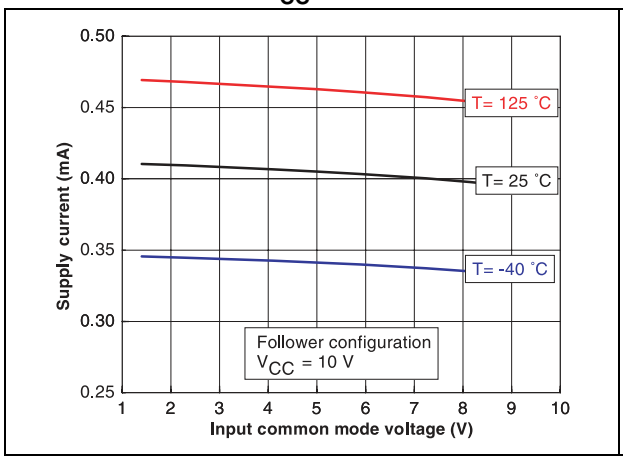


Figure 11. Supply current (per operator) vs. input common mode voltage at $V_{CC} = 30$ V

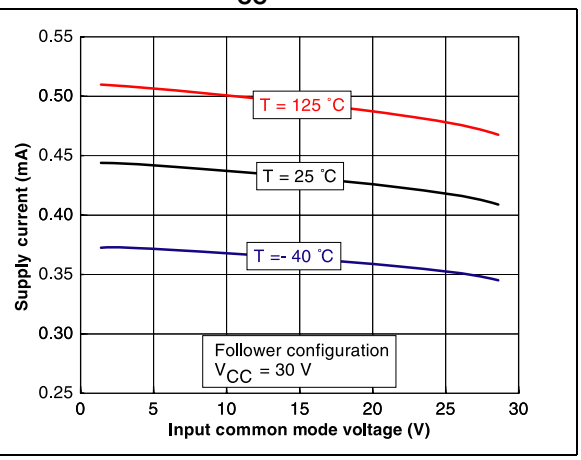


Figure 12. Output current vs. supply voltage at $V_{icm} = V_{CC}/2$

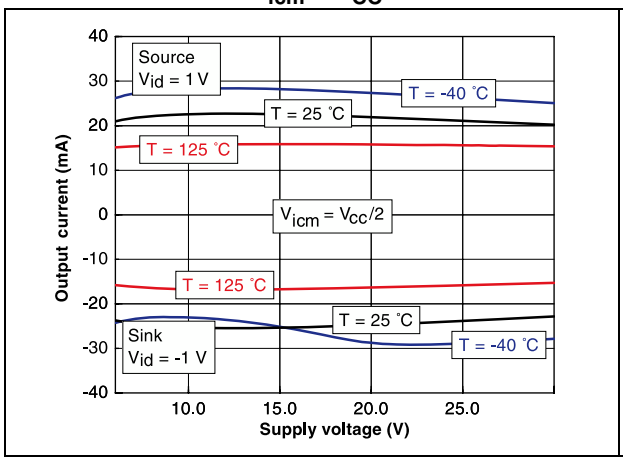


Figure 13. Output current vs. output voltage at $V_{CC} = 6$ V

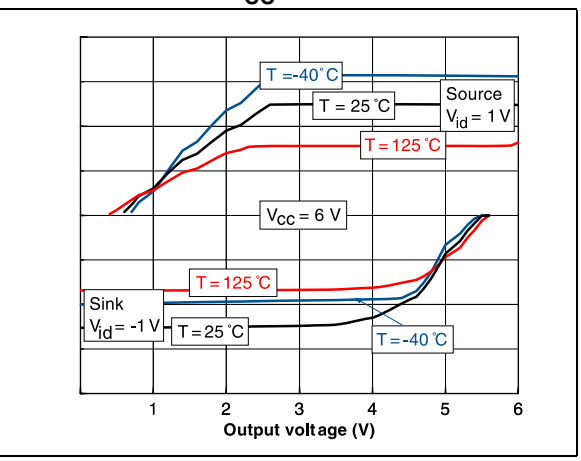


Figure 14. Output current vs. output voltage at V_{CC} = 10 V

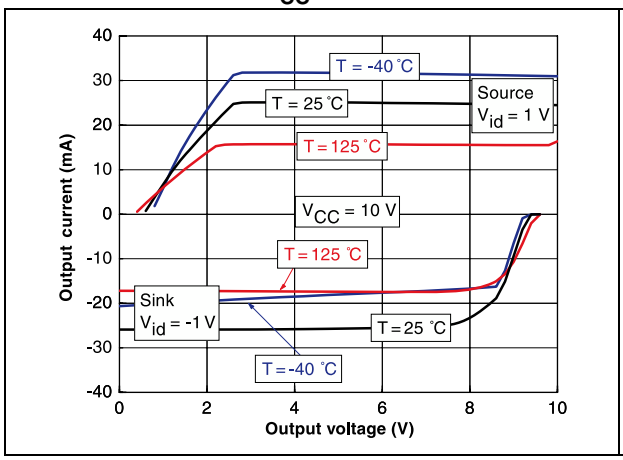


Figure 15. Output current vs. output voltage at V_{CC} = 30 V

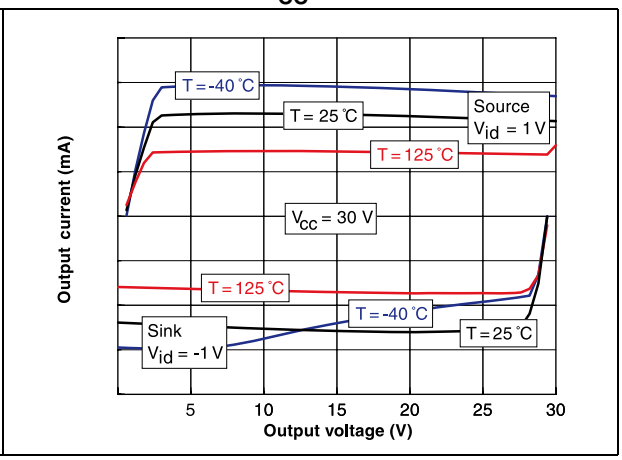


Figure 16. Voltage gain and phase for different capacitive load at V_{CC} = 6 V, V_{icm} = 3 V and T = 25 °C

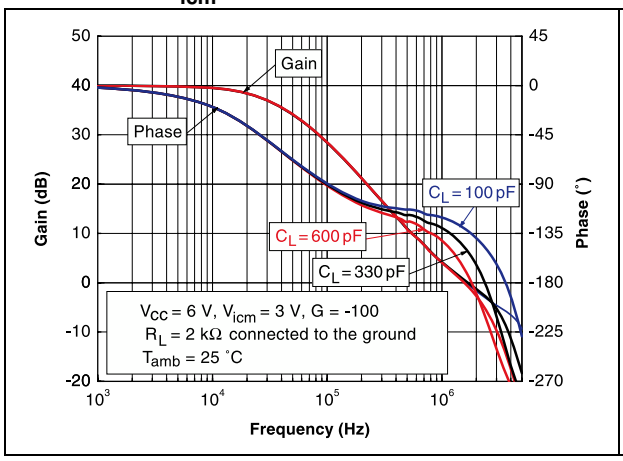


Figure 17. Voltage gain and phase for different capacitive load at V_{CC} = 10 V, V_{icm} = 5 V and T = 25 °C

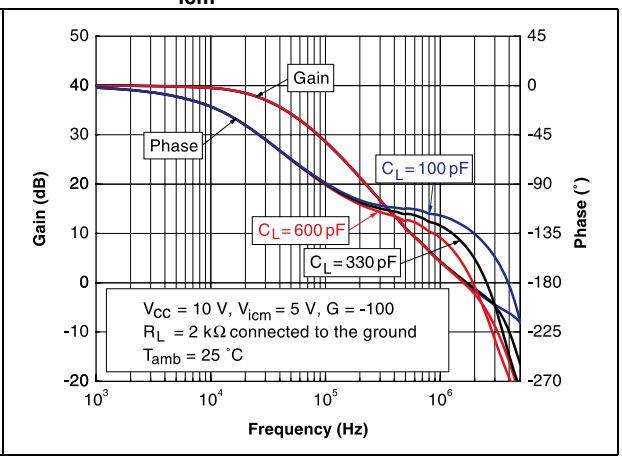


Figure 18. Voltage gain and phase for different capacitive load at V_{CC} = 30 V, V_{icm} = 15 V and T = 25 °C

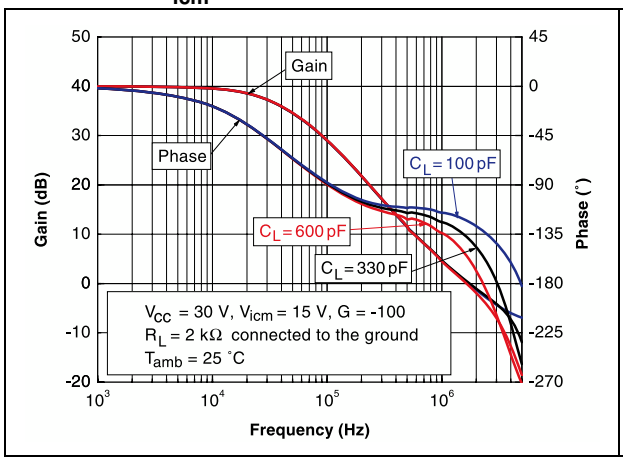


Figure 19. Frequency response for different capacitive load at V_{CC} = 6 V, V_{icm} = 3 V and T = 25 °C

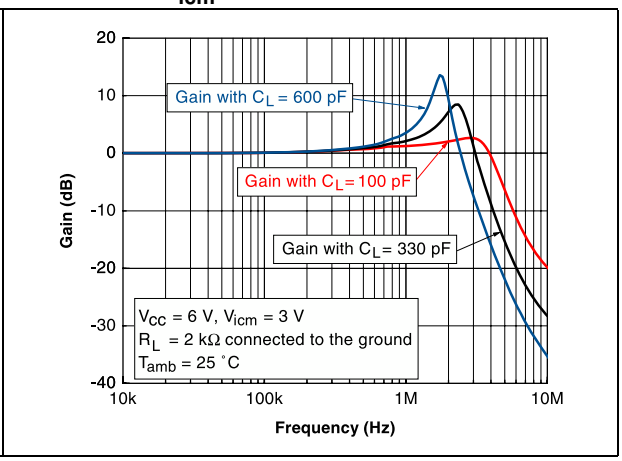


Figure 20. Frequency response for different capacitive load at V_{CC}= 10 V, V_{icm} = 5 V and T = 25 °C

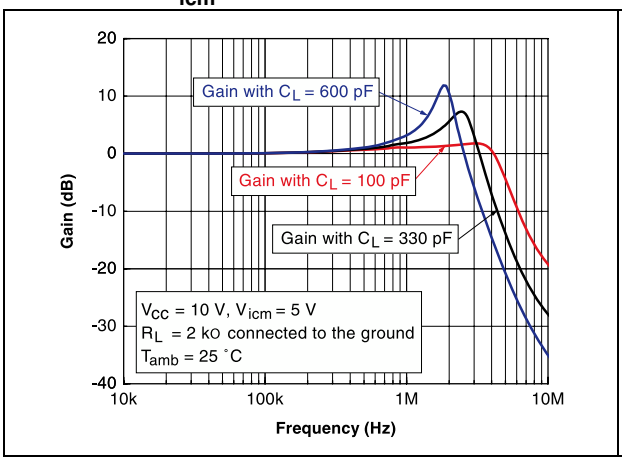


Figure 21. Frequency response for different capacitive load at V_{CC} = 30 V, V_{icm} = 15 V and T = 25 °C

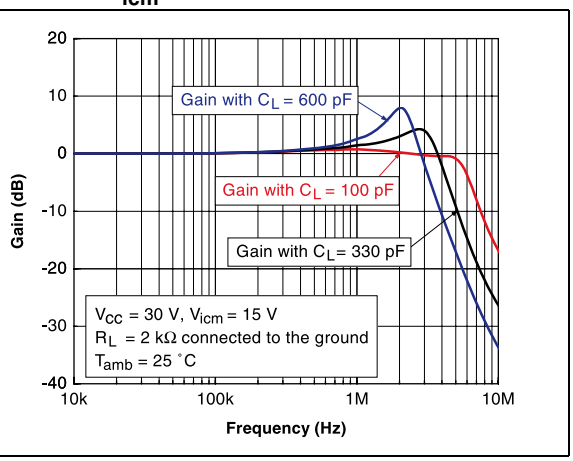


Figure 22. Gain margin vs. output current, at V_{CC} = 6 V, V_{icm} = 3 V and T = 25 °C

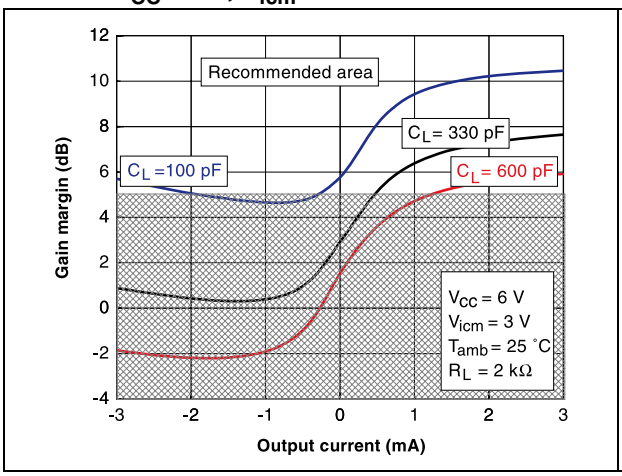


Figure 23. Gain margin vs. output current, at V_{CC} = 10 V, V_{icm} = 5 V and T = 25 °C

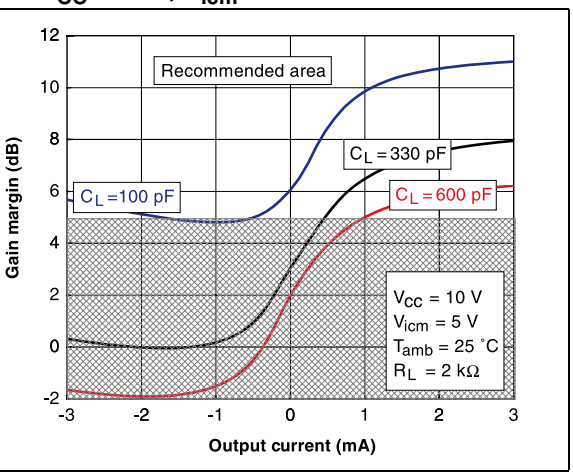


Figure 24. Gain margin vs. output current, at V_{CC} = 30 V, V_{icm} = 15 V and T = 25 °C

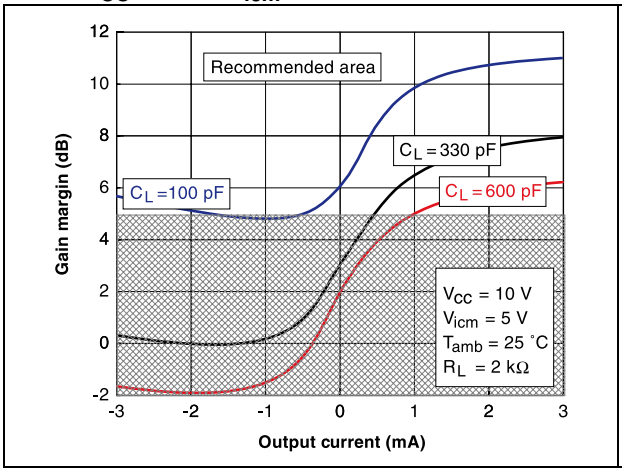


Figure 25. Phase margin vs. output current, at V_{CC} = 6 V, V_{icm} = 3 V and T = 25 °C

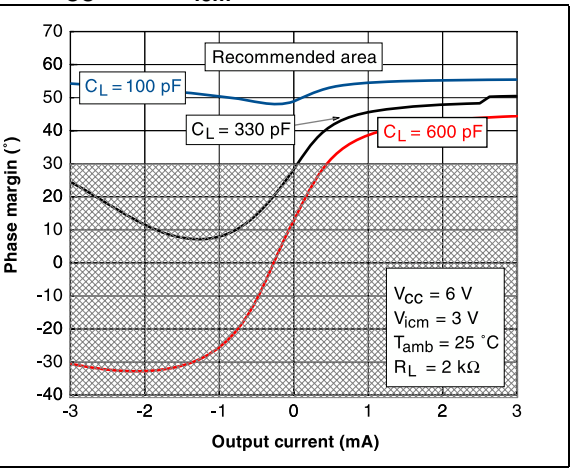


Figure 26. Phase margin vs. output current, at V_{CC} = 10 V, V_{icm} = 5 V and T = 25 °C

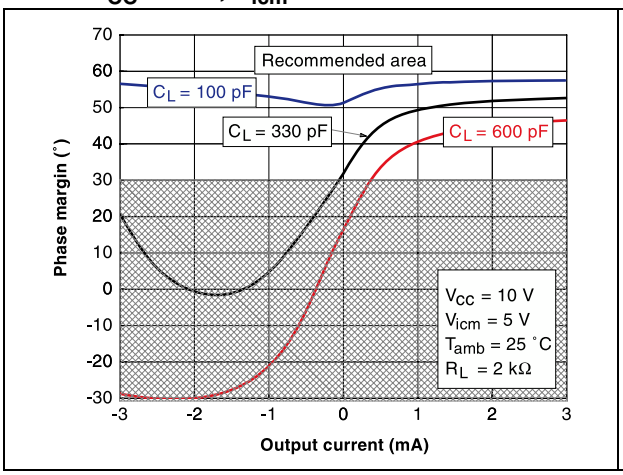
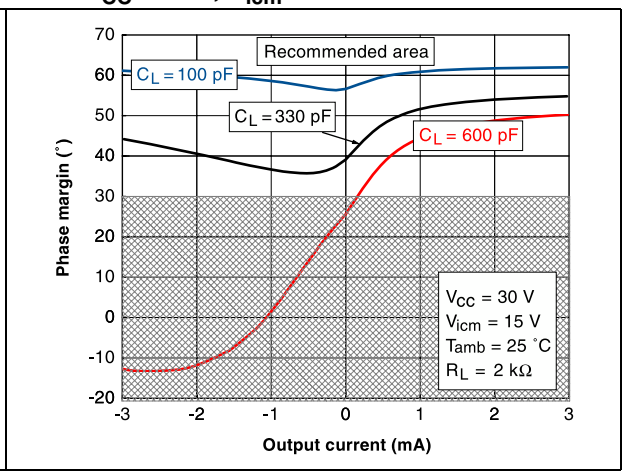


Figure 27. Phase margin vs. output current, at V_{CC} = 30 V, V_{icm} = 15 V and T = 25 °C



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.

4.1 SO-14 package information

Figure 28. SO-14 package outline

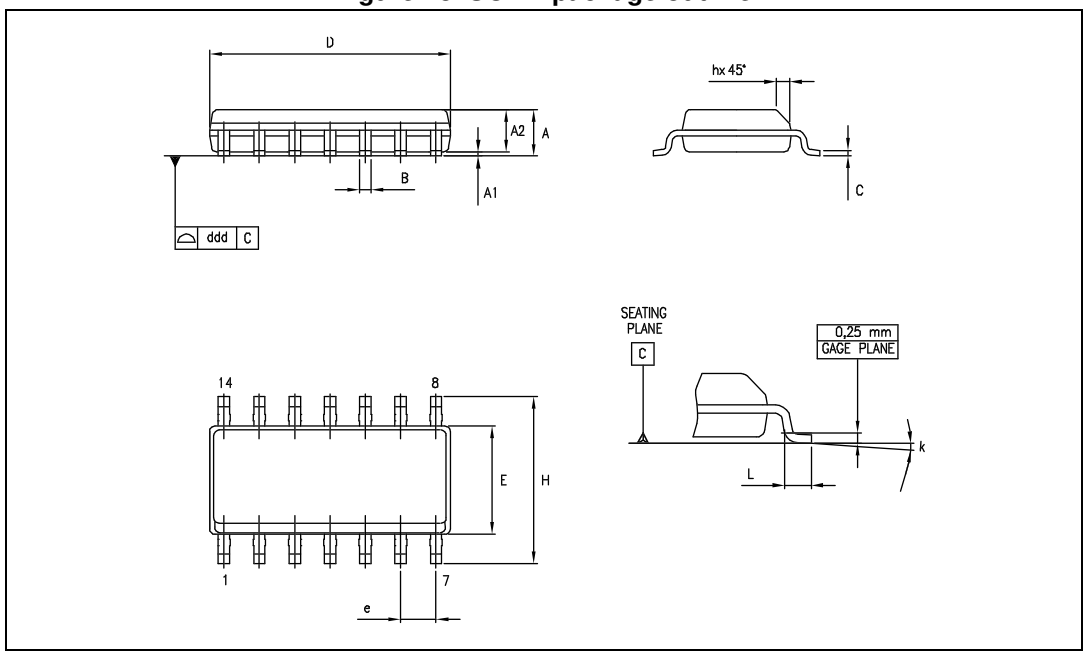


Table 4. SO-14 package mechanical data

Symbol	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.35		1.75	0.05		0.068
A1	0.10		0.25	0.004		0.009
A2	1.10		1.65	0.04		0.06
B	0.33		0.51	0.01		0.02
C	0.19		0.25	0.007		0.009
D	8.55		8.75	0.33		0.34
E	3.80		4.0	0.15		0.15
e		1.27			0.05	
H	5.80		6.20	0.22		0.24
h	0.25		0.50	0.009		0.02
L	0.40		1.27	0.015		0.05
k	8° (max.)					
ddd			0.10			0.004

Note: D and F dimensions do not include mold flash or protrusions. Mold flash or protrusions must not exceed 0.15 mm.

5 Ordering information

Table 5. Order codes

Order code	Temperature range	Package	Packaging	Marking
TS514ID TS514IDT	-40, + 125 °C	SO-14	Tube or tape and reel	514I
TS514AID TS514AIDT				514AI

6 Revision history

Table 6. Document revision history

Date	Revision	Changes
09-Mar-2001	1	Initial release.
23-Jun-2005	2	Automotive grade part references inserted in the datasheet (see Chapter 5: Ordering information on page 14).
30-Sep-2005	3	– The following changes were made in this revision. – – An error in the device description was corrected on page 1. – – Chapter 5: Ordering information on page 14 updated with complete list of markings. – – Addition of supplementary data in Table 1: Absolute maximum ratings on page 2. – – Addition of Table 2: Operating conditions on page 2. – – Reorganization of Chapter 4: Package information on page 11. – – Minor grammatical and formatting changes throughout.
24-Oct-2008	4	Added performance AC and DC characteristic curves for VCC=6 V, VCC=10 V and VCC=30 V in Chapter 3: Electrical characteristics. Modified ICC typ, added parameters over temperature in Table 3. Deleted old macromodel. Added Rthjc, Rthja in Table 1. Corrected Vi and Vid AMR values in Table 1. Added input common mode range Vicm in Table 2: Operating conditions. Updated Section 4.1: DIP14 package information and Section 4.2: SO-14 package information
12-Sep-2012	5	Updated Features (removed “macromodel”). Updated CMR and SVR test conditions in Table 3. Updated ECOPACK text in Section 4. Removed TS514IYD, TS514IYDT, TS514AIYD, and TS514AIYDT order code from Table 6. Minor corrections throughout document.
07-Nov-2024	6	Removed obsolete part numbers. Updated *Table 5*.

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