



THE DATASHEET OF TS514AIN



Precision quad operational amplifier

Datasheet – production data

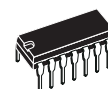
Features

- 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

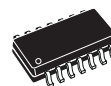
Description

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).

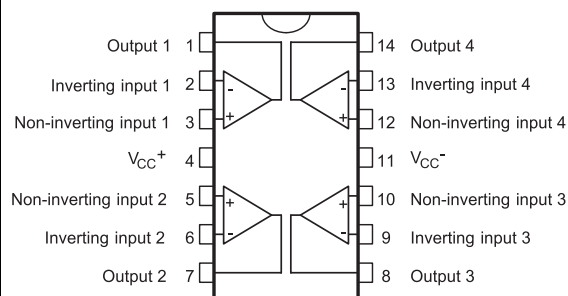


N
DIP14
(plastic package)



D
SO-14
(plastic micropackage)

Pin connections (top view)



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 |
| | DIP14 | 80 | |
| R_{thjc} | Thermal resistance junction-to-case SO-14 | 31 | °C/W |
| | DIP14 | 33 | |
| ESD | HBM: human body model ⁽²⁾ | 2 | kV |
| | MM: machine model ⁽³⁾ | 200 | V |
| | CDM: charged device model ⁽⁴⁾ | 1.5 | kV |

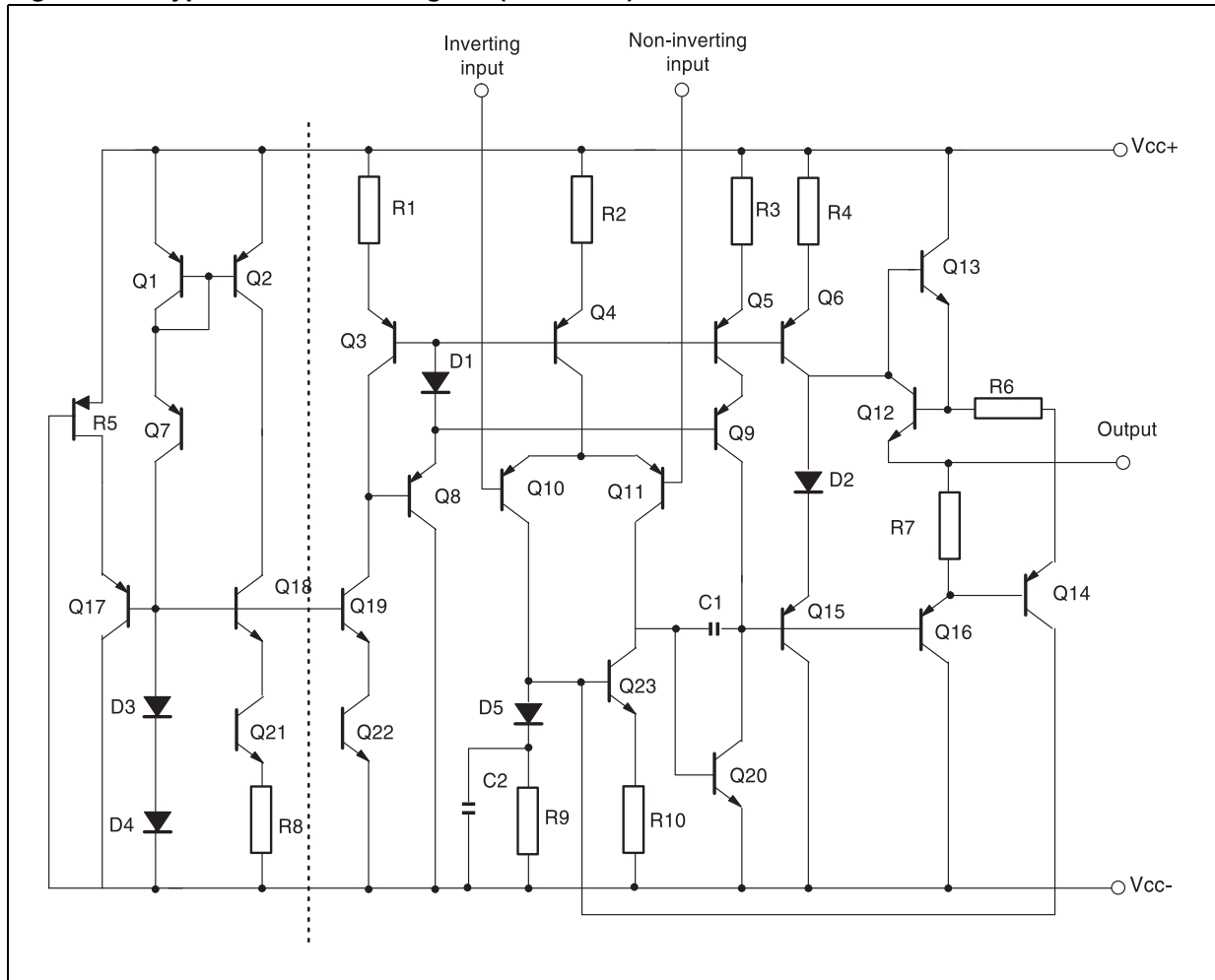
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5k Ω resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- 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.
- 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 $V_{CC} = \pm 15\text{ V}$, $T_{amb} = 25\text{ °C}$
(unless otherwise specified)**

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

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

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------------|---|------|------|------|------|
| CMR | Common mode rejection ratio $CMR = 20 \log (\Delta V_{ic} / \Delta V_{io})$ $(V_{ic} = -10\text{ V to } 10\text{ V}, V_{out} = V_{CC}/2, R_L > 1\text{ M}\Omega)$ | 90 | | | dB |
| SVR | Supply voltage rejection ratio $20 \log (\Delta V_{CC} / \Delta V_{io})$ $(V_{CC} = \pm 5\text{ V to } \pm 15\text{ V}, V_{out} = V_{icm} = V_{CC}/2)$ | 90 | | | dB |
| V_{o1}/V_{o2} | Channel separation, $F = 1\text{ kHz}$ | | 120 | | dB |

Figure 2. V_{io} distribution at $V_{CC} = \pm 15\text{ V}$ and $T = 25\text{ }^\circ\text{C}$

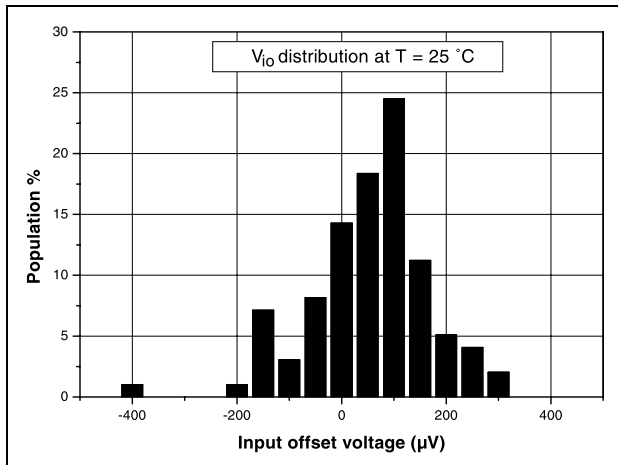


Figure 3. V_{io} distribution at $V_{CC} = \pm 15\text{ V}$ and $T = 125\text{ }^\circ\text{C}$

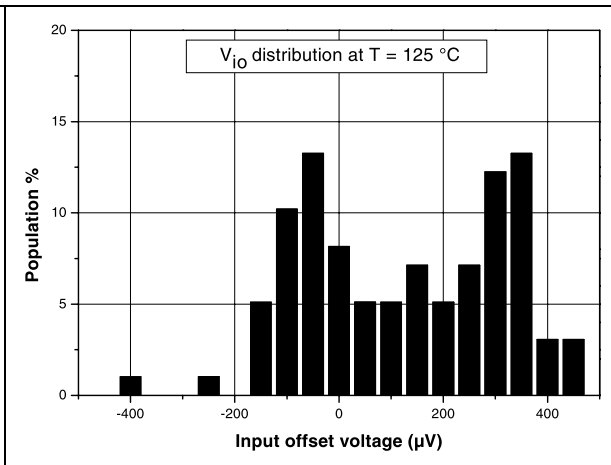


Figure 4. Input offset voltage vs. supply voltage at $V_{icm} = V_{CC}/2$

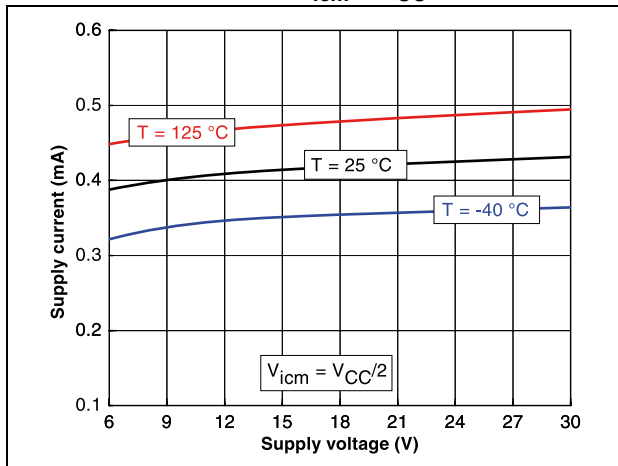


Figure 5. Input offset voltage vs. input common mode voltage at $V_{CC} = 6\text{ V}$

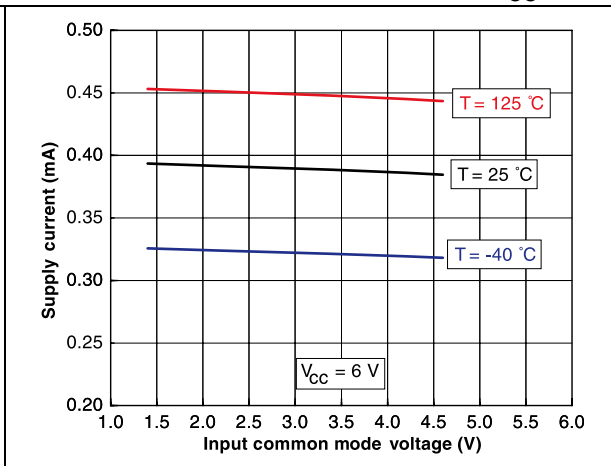


Figure 6. Input offset voltage vs. input common mode voltage at $V_{CC} = 10\text{ V}$

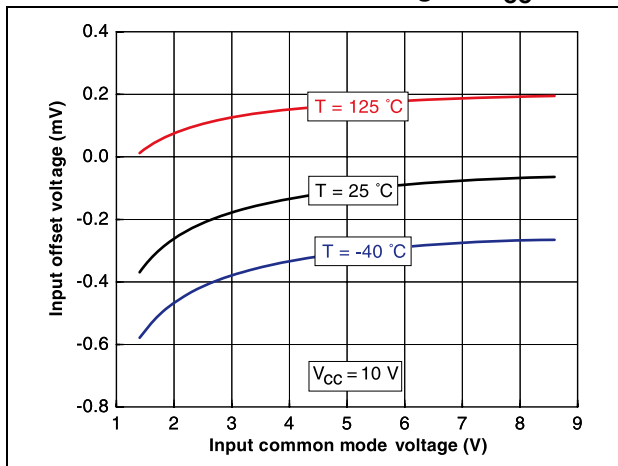


Figure 7. Input offset voltage vs. input common mode voltage at $V_{CC} = 30\text{ V}$

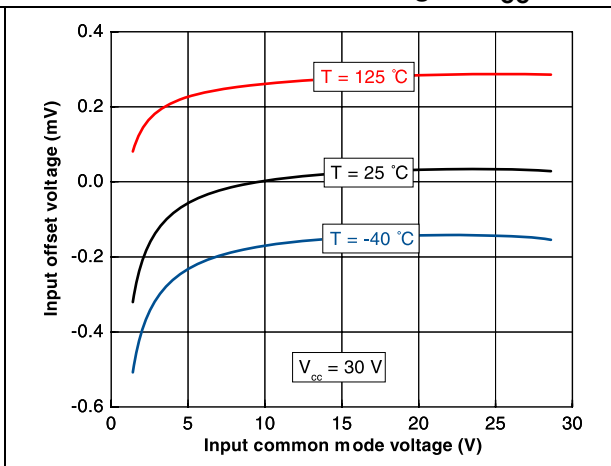


Figure 8. Supply current (per operator) vs. supply voltage at $V_{icm} = V_{CC}/2$

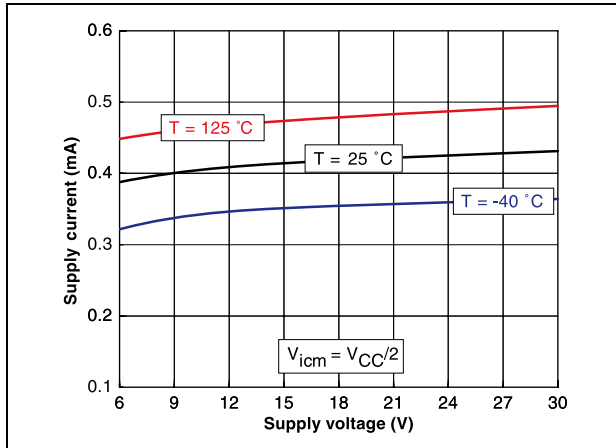


Figure 9. Supply current (per operator) vs. input common mode voltage at $V_{CC} = 6 V$

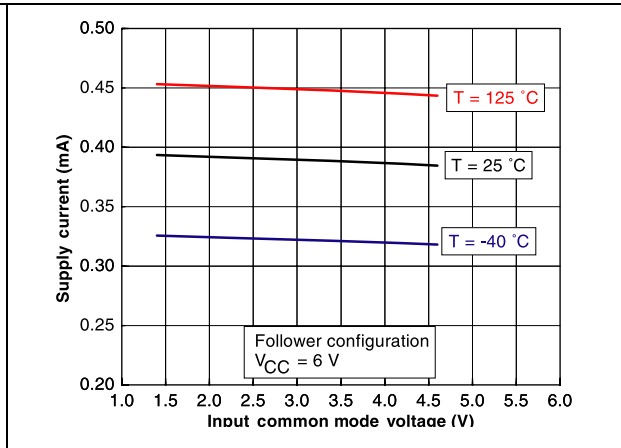


Figure 10. Supply current (per operator) vs. input common mode voltage at $V_{CC} = 10 V$

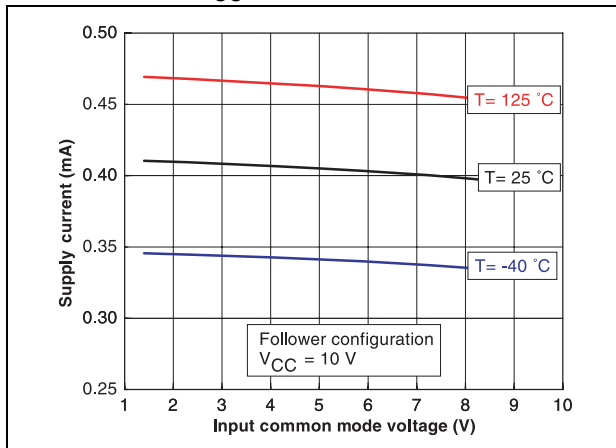


Figure 11. Supply current (per operator) vs. input common mode voltage at $V_{CC} = 30 V$

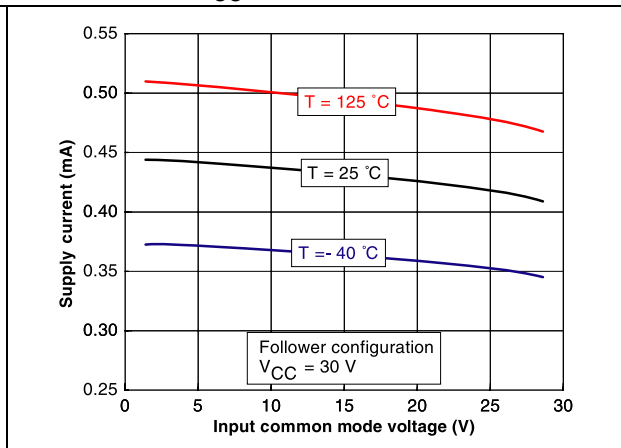


Figure 12. Output current vs. supply voltage at $V_{icm} = V_{CC}/2$

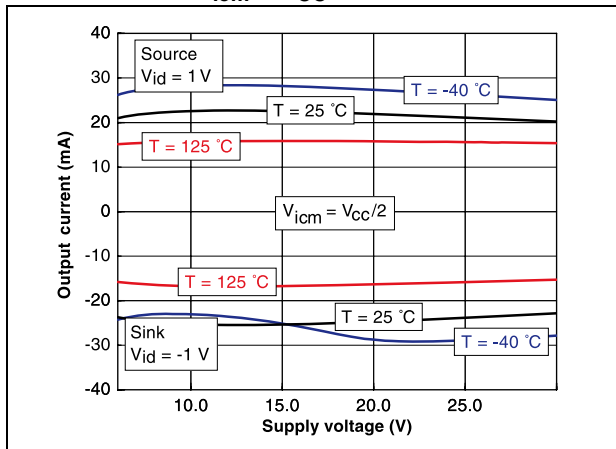


Figure 13. Output current vs. output voltage at $V_{CC} = 6 V$

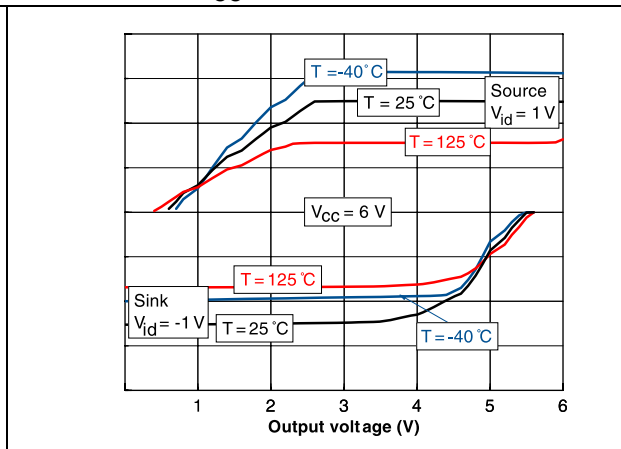


Figure 14. Output current vs. output voltage at $V_{CC} = 10\text{ V}$

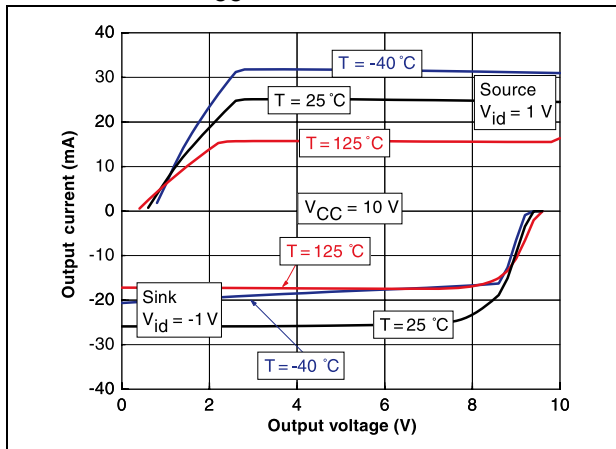


Figure 15. Output current vs. output voltage at $V_{CC} = 30\text{ V}$

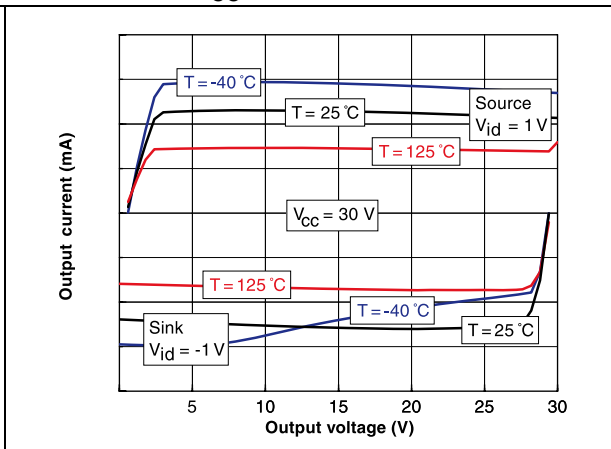


Figure 16. Voltage gain and phase for different capacitive load at $V_{CC} = 6\text{ V}$, $V_{icm} = 3\text{ V}$ and $T = 25\text{ °C}$

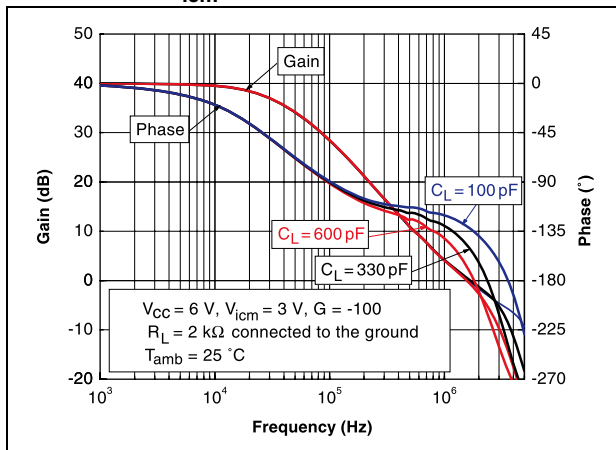


Figure 17. Voltage gain and phase for different capacitive load at $V_{CC} = 10\text{ V}$, $V_{icm} = 5\text{ V}$ and $T = 25\text{ °C}$

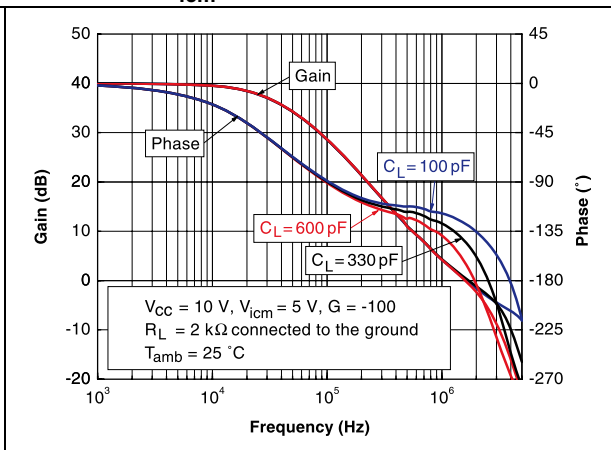


Figure 18. Voltage gain and phase for different capacitive load at $V_{CC} = 30\text{ V}$, $V_{icm} = 15\text{ V}$ and $T = 25\text{ °C}$

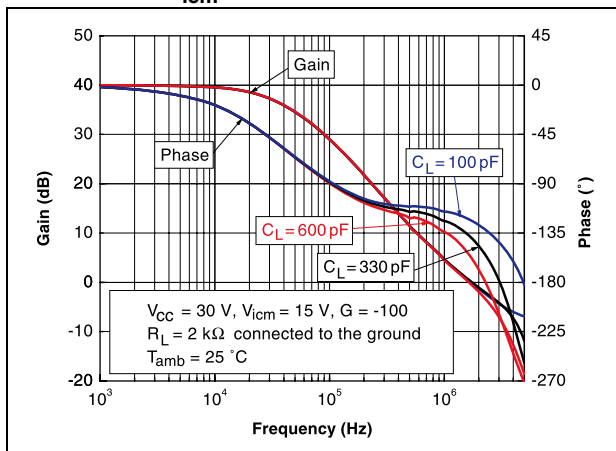


Figure 19. Frequency response for different capacitive load at $V_{CC} = 6\text{ V}$, $V_{icm} = 3\text{ V}$ and $T = 25\text{ °C}$

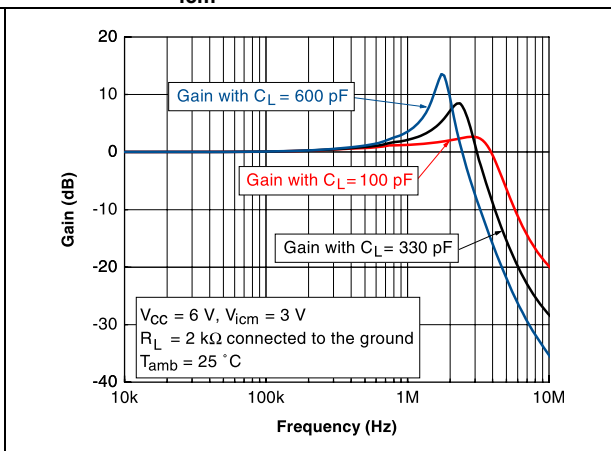


Figure 20. Frequency response for different capacitive load at $V_{CC} = 10\text{ V}$, $V_{icm} = 5\text{ V}$ and $T = 25\text{ }^\circ\text{C}$

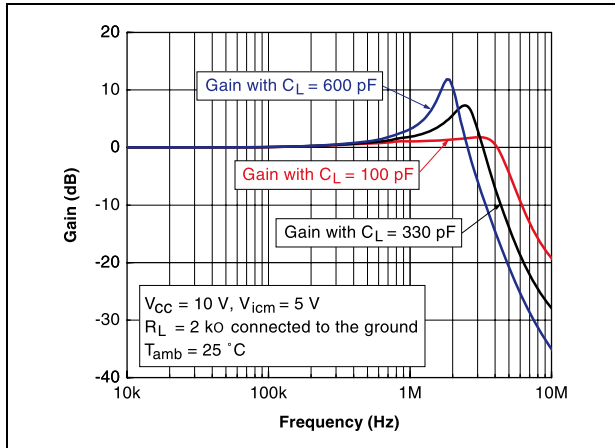


Figure 21. Frequency response for different capacitive load at $V_{CC} = 30\text{ V}$, $V_{icm} = 15\text{ V}$ and $T = 25\text{ }^\circ\text{C}$

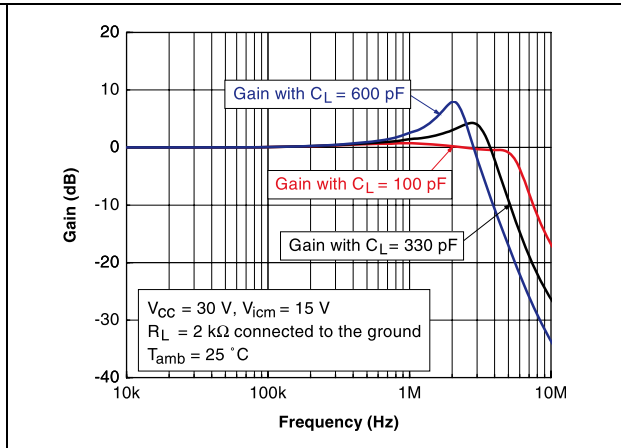


Figure 22. Gain margin vs. output current, at $V_{CC} = 6\text{ V}$, $V_{icm} = 3\text{ V}$ and $T = 25\text{ }^\circ\text{C}$

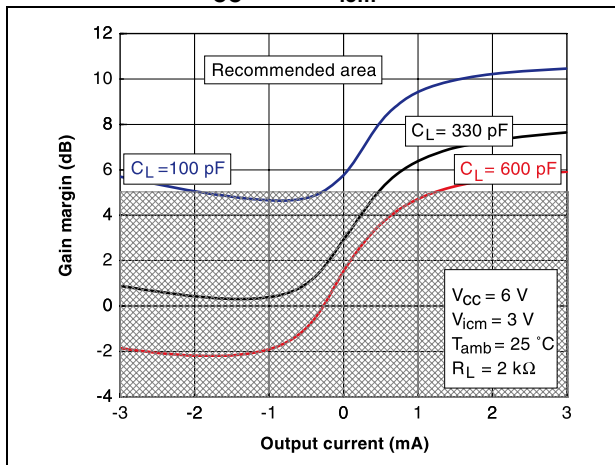


Figure 23. Gain margin vs. output current, at $V_{CC} = 10\text{ V}$, $V_{icm} = 5\text{ V}$ and $T = 25\text{ }^\circ\text{C}$

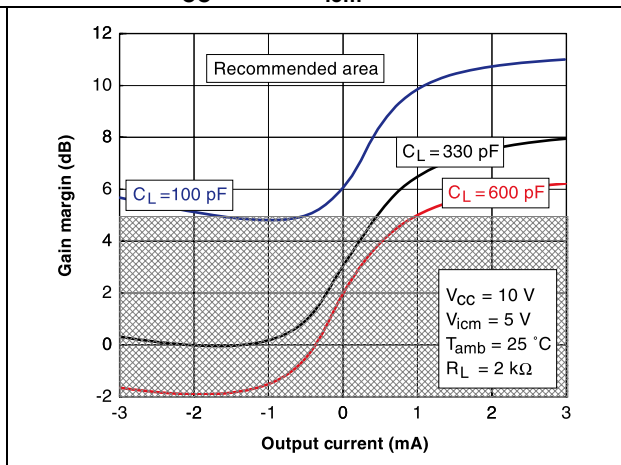


Figure 24. Gain margin vs. output current, at $V_{CC} = 30\text{ V}$, $V_{icm} = 15\text{ V}$ and $T = 25\text{ }^\circ\text{C}$

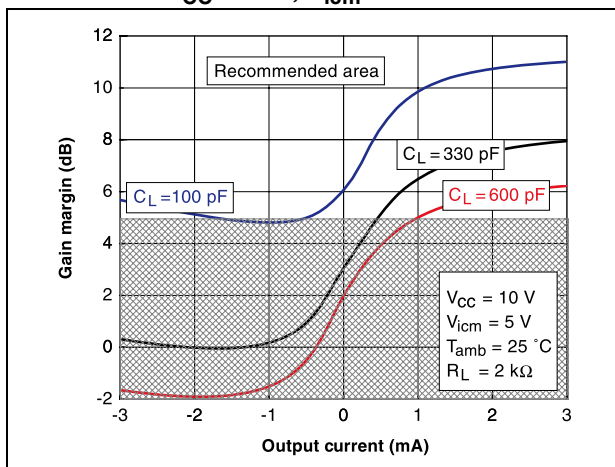


Figure 25. Phase margin vs. output current, at $V_{CC} = 6\text{ V}$, $V_{icm} = 3\text{ V}$ and $T = 25\text{ }^\circ\text{C}$

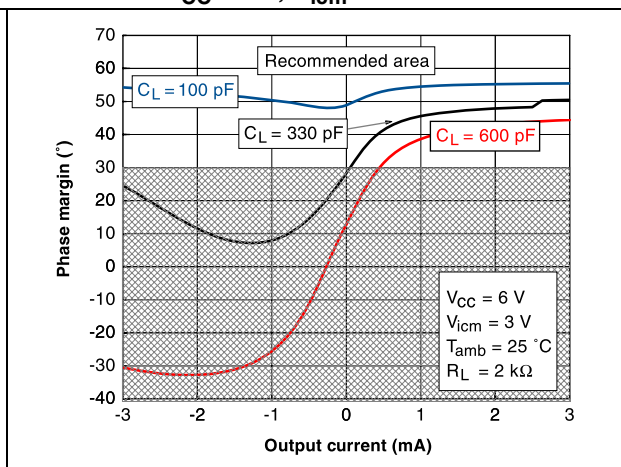


Figure 26. Phase margin vs. output current, at $V_{CC} = 10\text{ V}$, $V_{icm} = 5\text{ V}$ and $T = 25\text{ }^{\circ}\text{C}$

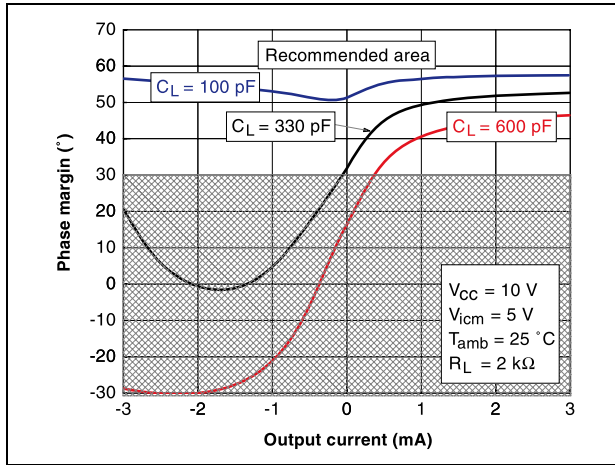
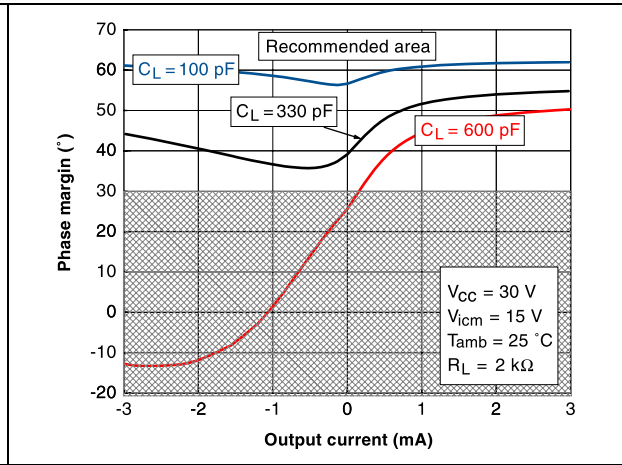


Figure 27. Phase margin vs. output current, at $V_{CC} = 30\text{ V}$, $V_{icm} = 15\text{ V}$ and $T = 25\text{ }^{\circ}\text{C}$



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 DIP14 package information

Figure 28. DIP14 package outline

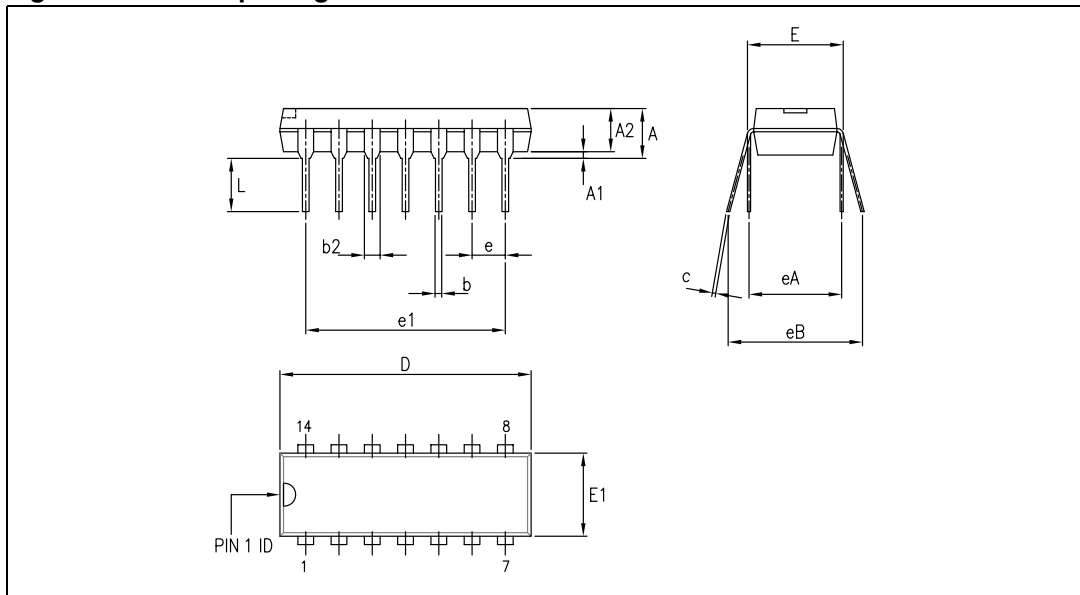


Table 4. DIP14 package mechanical data

| Symbol | Dimensions | | | | | |
|--------|-------------|-------|-------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 5.33 | | | 0.21 |
| A1 | 0.38 | | | 0.015 | | |
| A2 | 2.92 | 3.30 | 4.95 | 0.11 | 0.13 | 0.19 |
| b | 0.36 | 0.46 | 0.56 | 0.014 | 0.018 | 0.022 |
| b2 | 1.14 | 1.52 | 1.78 | 0.04 | 0.06 | 0.07 |
| c | 0.20 | 0.25 | 0.36 | 0.007 | 0.009 | 0.01 |
| D | 18.67 | 19.05 | 19.69 | 0.73 | 0.75 | 0.77 |
| E | 7.62 | 7.87 | 8.26 | 0.30 | 0.31 | 0.32 |
| E1 | 6.10 | 6.35 | 7.11 | 0.24 | 0.25 | 0.28 |
| e | | 2.54 | | | 0.10 | |
| e1 | | 15.24 | | | 0.60 | |
| eA | | 7.62 | | | 0.30 | |
| eB | | | 10.92 | | | 0.43 |
| L | 2.92 | 3.30 | 3.81 | 0.11 | 0.13 | 0.15 |

Note: D and E1 dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.25 mm.

4.2 SO-14 package information

Figure 29. SO-14 package outline

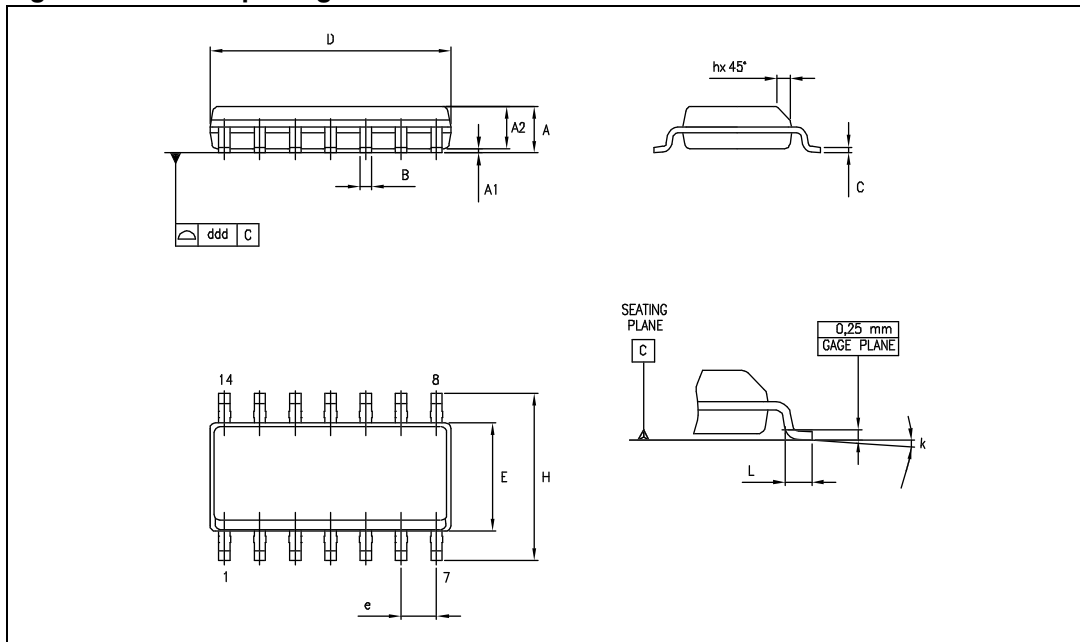


Table 5. SO-14 package mechanical data

| 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 6. Order codes

| Order code | Temperature range | Package | Packaging | Marking |
|-----------------------|-------------------|---------|-----------------------------|----------|
| TS514IN | -40, + 125 °C | DIP14 | Tube | TS514IN |
| TS514AIN | | | | TS514AIN |
| TS514ID TS514IDT | | SO-14 | Tube or tape and reel | 514I |
| TS514AID TS514AIDT | | | | 514AI |

6 Revision history

Table 7. 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. <ul style="list-style-type: none"> – 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 $V_{CC}=6\text{ V}$, $V_{CC}=10\text{ V}$ and $V_{CC}=30\text{ V}$ in Chapter 3: Electrical characteristics . Modified I_{CC} typ, added parameters over temperature in Table 3 . Deleted old macromodel. Added R_{thjc} , R_{thja} in Table 1 . Corrected V_i and V_{id} AMR values in Table 1 . Added input common mode range V_{icm} 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. |

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