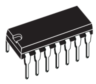
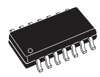
TS514 / TS514A

Precision Quad Operational Amplifier

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



N
DIP14
(Plastic Package)



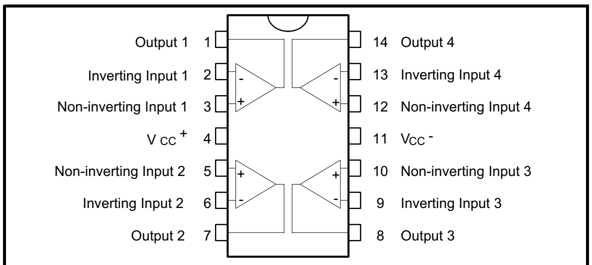
D
SO-14
(Plastic Micropackage)

Description

The TS514 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 product.

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

Pin Connections (top view)



Order Codes

Part Number	Temperature Range	Package	Packing	Marking
TS514IN	-40, + 125°C	DIP14	Tube	514IN
TS514AIN				514AIN
TS514ID/IDT		SO-14	Tube or Tape & Reel	514I
TS514AID/AIDT				514AI
TS514IYD/IYDT		SO14 (automotive grade level)		514IY
TS514AIYD/AIYDT				514AIY

1 Absolute Maximum Ratings

Table 1. Key parameters and their absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	±18	V
V_i	Input Voltage Positive Negative	 $+V_{CC}$ -Vcc - 0.5	V
V_{id}(1)	Differential Input Voltage	$\pm(V_{CC} - 1)$	V
p_{tot}	Power Dissipation at T_{amb} = 70°C (2)	400	mW
T_{stg}	Storage Temperature Range	-65 to +150	°C
R_{thja}	Thermal Resistance Junction to Ambient SO14 DIP14	 103 66	°C/W
ESD	HBM: Human Body Model(3)	2	kV
	MM: Machine Model(4)	<200	V
	CDM: Charged Device Model	1.5	kV

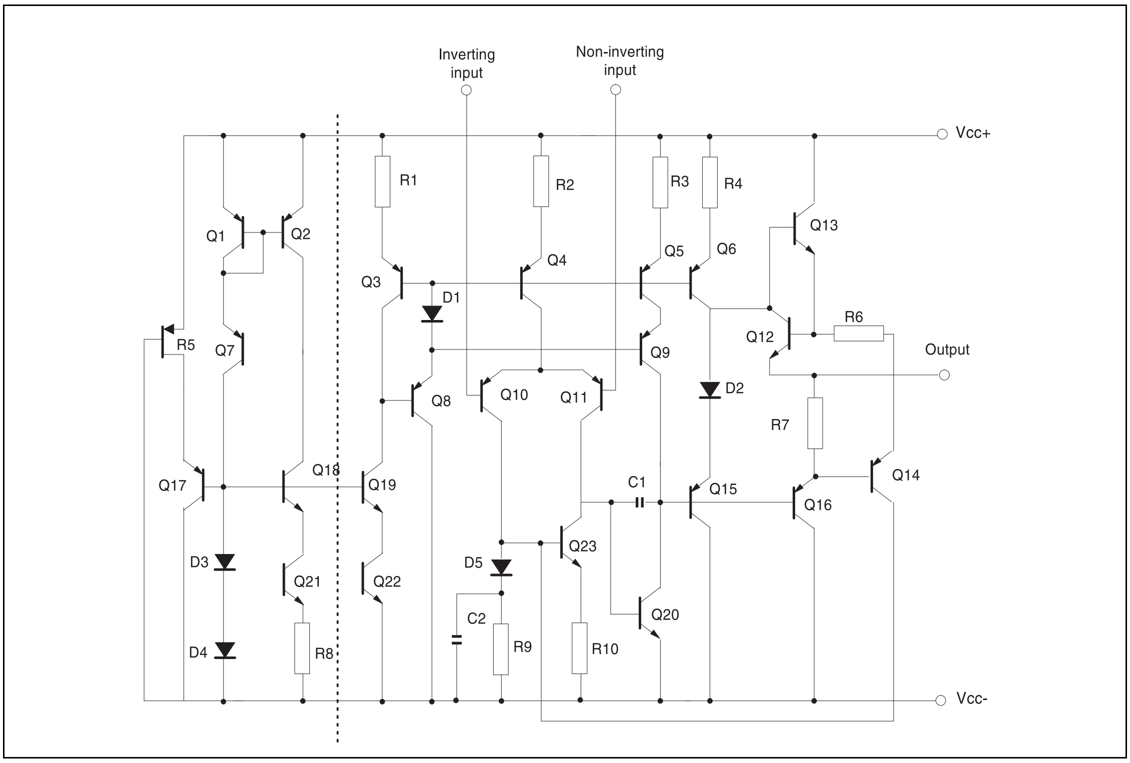
1. Differential voltages are with respect to the midpoint between Vcc+ and Vcc-.
2. Power dissipation must be considered to ensure maximum junction temperature (Tj) is not exceeded.
3. Human body model, 100pF discharged through a 1.5kΩ resistor into pin of device.
4. Machine model ESD, a 200pF cap is charged to the specified voltage, then discharged directly into the IC with no external series resistor (internal resistor < 5Ω), into pin to pin of device.

Table 2. Operating conditions

Symbol	Parameter	Min	Max	Unit
V_{CC}^+	Supply voltage	+3	+15	V
V_{CC}^-		-3	-15	
T_{oper}	Operating Free Air Temperature Range	-40	+125	°C

2 Schematic Diagram

Figure 1. Typical application schematic for 1/4 of the TS514



3 Electrical Characteristics

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{cc}	Supply Current		1.4	2.4	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 = 1kHz		1		MΩ
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		µV/°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		$\frac{nA}{°C}$
I_{os}	Output Short Circuit Current		23		mA
A_{vd}	Large Signal Voltage Gain, $R_L = 2k\Omega$ $V_{cc} = \pm 15V$ $V_{cc} = \pm 4V$	90	100 95		dB
GBP	Gain-bandwidth Product, f = 100kHz	1.8	3		MHz
e_n	Equivalent Input Noise Voltage, f = 1kHz Rs = 50Ω Rs = 1kΩ Rs = 10kΩ		8 10 18	15	$\frac{nV}{\sqrt{Hz}}$
THD	Total Harmonic Distortion $A_v = 20dB$, $R_L = 2k\Omega$, $V_o = 2V_{pp}$, f = 1kHz		0.03	0.1	%
$\pm V_{opp}$	Output Voltage Swing, $R_L = 2k\Omega$ $V_{cc} = \pm 15V$ $V_{cc} = \pm 4V$	±13	±3		V
V_{opp}	Large Signal Voltage Swing, $R_L = 10k\Omega$, f = 10kHz		28		V_{pp}
SR	Slew Rate, unity gain, $R_L = 2k\Omega$	0.8	1.5		V/µs
CMR	Common Mode Rejection Ratio, $V_{ic} = 10V$	90			dB
SVR	Supply Voltage Rejection Ratio, $dV_{ic} = 10V$, f = 100Hz	90			dB
V_{o1}/V_{o2}	Channel Separation, f = 1kHz		120		dB

4 Macromodels

4.1 Important note concerning this macromodel

Please consider following remarks before using this macromodel.

- All models are a trade-off between accuracy and complexity (i.e. simulation time).
- Macromodels are not a substitute to breadboarding; rather, they confirm the validity of a design approach and help to select surrounding component values.
- A macromodel emulates the NOMINAL performance of a TYPICAL device within SPECIFIED OPERATING CONDITIONS (i.e. temperature, supply voltage, etc.). Thus the macromodel is often not as exhaustive as the datasheet, its goal is to illustrate the main parameters of the product.
- Data issued from macromodels used outside of its specified conditions (Vcc, Temperature, etc.) or even worse: outside of the device operating conditions (Vcc, Vicm, etc.) are not reliable in any way.

In *Section 4.2*, the electrical characteristics resulting from the use of this macromodel are presented.

4.2 Electrical characteristics from macromodelization

Table 4. Electrical characteristics resulting from macromodel simulation at $V_{cc} = \pm 15V$, $T_{amb} = 25°C$ (unless otherwise specified)

Symbol	Conditions	Value	Unit
V_{io}		0	mV
A_{vd}	$R_L = 2k\Omega$	94	V/mV
I_{cc}	No load, per operator	325	µA
V_{icm}		-13.5 to 13.5	V
V_{OH}	$R_L = 2k\Omega$	+13	V
V_{OL}	$R_L = 2k\Omega$	-13	V
I_{sink}	$V_o = 0V$	24	mA
I_{source}	$V_o = 0V$	24	mA
GBP	$R_L = 2k\Omega$, $C_L = 100pF$	3	MHz
SR	$R_L = 2k\Omega$, $C_L = 100pF$	1.4	V/µs
∅m	$R_L = 2k\Omega$, $C_L = 100pF$	55	Degrees

4.3 Macromodel code

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** Standard Linear Ics Macromodels, 1993.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY

.SUBCKT TS514 1 3 2 4 5 (analog)
*********************************************************
.MODEL MDTH D IS=1E-8 KF=6.647807E-16 CJO=10F
* INPUT STAGE
CIP 2 5 1.000000E-12
CIN 1 5 1.000000E-12
EIP 10 5 2 5 1
EIN 16 5 1 5 1
RIP 10 11 1.300000E+01
RIN 15 16 1.300000E+01
RIS 11 15 6.437882E+01
DIP 11 12 MDTH 400E-12
DIN 15 14 MDTH 400E-12
VOFP 12 13 DC 0
VOFN 13 14 DC 0
IPOL 13 5 2.000000E-05
CPS 11 15 9.75E-10
DINN 17 13 MDTH 400E-12
VIN 17 5 0.000000e+00
DINR 15 18 MDTH 400E-12
VIP 4 18 1.500000E+00
FCP 4 5 VOFP 1.525000E+01
FCN 5 4 VOFN 1.525000E+01
FIBP 2 5 VOFN 5.000000E-03
FIBN 5 1 VOFP 5.000000E-03
* AMPLIFYING STAGE
FIP 5 19 VOFP 1.125000E+03
FIN 5 19 VOFN 1.125000E+03
RG1 19 5 6.512062E+05
RG2 19 4 6.512062E+05
CC 19 29 1.500000E-08
HZTP 30 29 VOFP 8.944787E+02
HZTN  5 30 VOFN 8.944787E+02
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 6.521739E+03
VIPM 28 4 1.500000E+02
HONM 21 27 VOUT 6.521739E+03
VINM 5 27 1.500000E+02
GCOMP 5 4 4 5 7.485029E-04
RPM1 5 80 1E+09
RPM2 4 80 1E+09
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GAVPH 5 82 19 80 2.99E-03
RAVPHGH 82 4 668
RAVPHGB 82 5 668
RAVPHDH 82 83 1000
RAVPHDB 82 84 1000
CAVPHH 4 83 0.352E-09
CAVPHB 5 84 0.352E-09
EOUT 26 23 82 5 1
VOUT 23 5 0
ROUT 26 3 150
COUT 3 5 1.000000E-12
DOP 19 25 MDTH 400E-12
VOP 4 25 1.785252E+00
DON 24 19 MDTH 400E-12
VON 24 5 1.785252E+00
.ENDS
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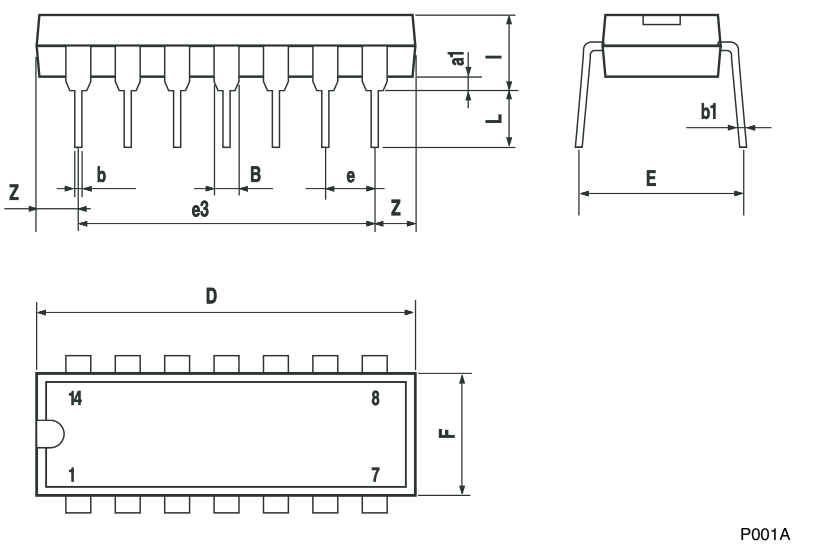
5 Package Mechanical Data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

5.1 DIP14 Package

Plastic DIP-14 MECHANICAL DATA

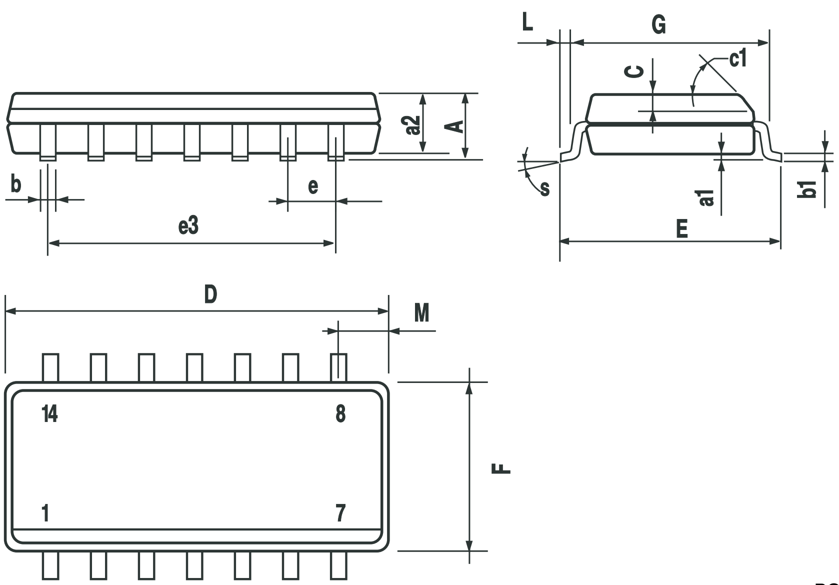
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100



5.2 SO-14 Package

SO-14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.68			0.026
S	8° (max.)					



PO13G

6 Revision History

Date	Revision	Changes
March 2001	1	Initial release
June 2005	2	Automotive grade part references inserted in the datasheet (see *Order Codes on page 1*).
Sept. 2005	3	The following changes were made in this revision: – An error in the device description was corrected on page 1. – *Order Codes on page 1* updated with complete list of markings. – Addition of supplementary data in *Table 1: Key parameters and their absolute maximum ratings on page 2*. – Addition of *Table 2: Operating conditions on page 2*. – Reorganization of *Chapter 4: Macromodels on page 5*. – Minor grammatical and formatting changes throughout.