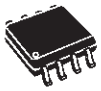
TS321

LOW POWER SINGLE OPERATIONAL AMPLIFIER

- LARGE OUTPUT VOLTAGE SWING :
- 0 to 3.5V min. (@V_{CC} = 5V)
- LOW SUPPLY CURRENT : 500µA
- LOW INPUT BIAS CURRENT : 20nA
- LOW INPUT OFFSET VOLTAGE : 2mV max.
- WIDE POWER SUPPLY RANGE :
- SINGLE SUPPLY : +3V TO +30V
- DUAL SUPPLIES : ±1.5V TO ±15V
- STABLE WITH HIGH CAPACITIVE LOADS



D
SO8
(Plastic Micropackage)

L
SOT23-5
(Plastic Package)

DESCRIPTION

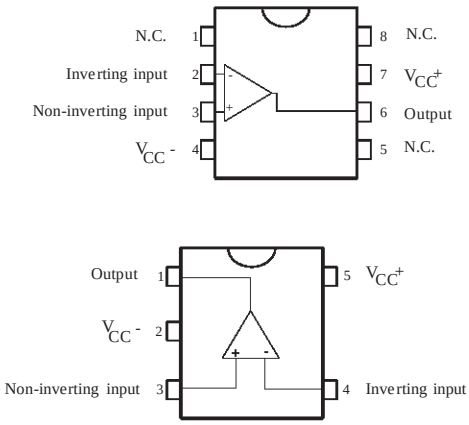
The TS321 is intended for cost sensitive applications where space saving is of great importance. This bipolar Op-Amp offers the benefits of a reduced component size (SOT23-5 package), with specifications that match (or better) industry standard devices (like the popular LM358A, LM324, etc.). The TS321 has an input common mode range (Vicm) that includes ground, therefore can be employed in single supply applications.

ORDER CODE

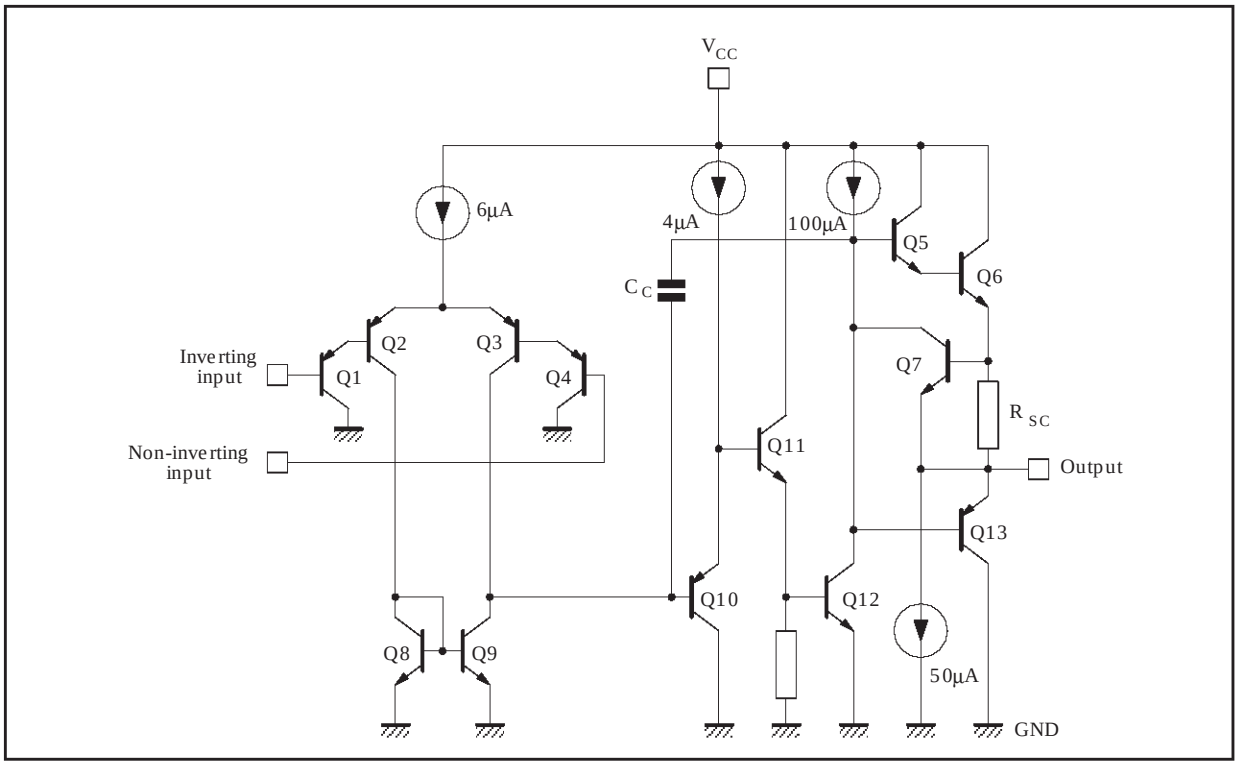
Part Number	Temperature Range	Package		SOT23 Marking
		D	L	
TS321I	-40°C, +125°C	•	•	K401
TS321AI		•	•	K402

D = Small Outline Package (SO) - also available in Tape & Reel (DT)
L = Tiny Package (SOT23-5) - only available in Tape & Reel (LT)

PIN CONNECTIONS (top view)



SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	±16 to 32	V
V_i	Input Voltage	-0.3 to +32	V
V_{id}	Differential Input Voltage	+32	V
-	Output Short-circuit Duration - note 1)	Infinite	
I_{in}	Input Current - note 2)	50	mA
T_{oper}	Operating Free-air Temperature Range	-40 to +125	°C
T_{stg}	Storage Temperature Range	-65 to +150	°C

1. Short-circuits from the output to V_{CC} can cause excessive heating if V_{CC} > 15V. The maximum output current is approximately 40mA independent of the magnitude of V_{CC}.
2. This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as input diodes clamps.
In addition to this diode action, there is also NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the Op-amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time duration than an input is driven negative. This is not destructive and normal output will set up again for input voltage higher than -0.3V.

ELECTRICAL CHARACTERISTICS

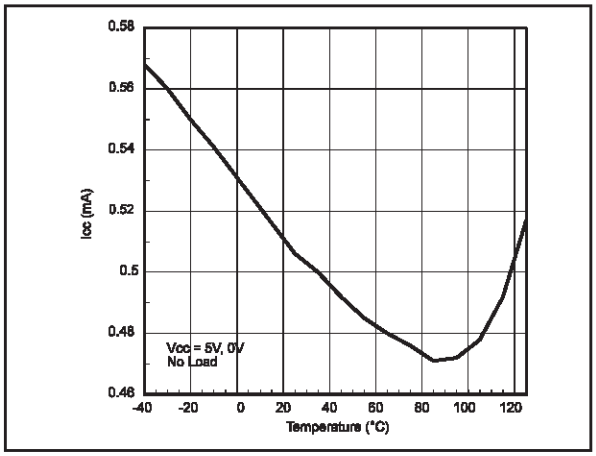
V_{cc}^+ = +5V, V_{cc}^- = Ground, V_o = 1.4V, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter		Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage - note 1) T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$	 TS321A TS321A		0.5	4 2 5 3	mV
I_{io}	Input Offset Current T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$			2	30 50	nA
I_{ib}	Input Bias Current - note 2) T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$			20	150 200	nA
A_{vd}	Large Signal Voltage Gain V_{CC}^+ = +15V, R_L = 2kΩ, Vo = 1.4V to 11.4V T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$		 50 25	100		V/mV
SVR	Supply Voltage Rejection Ratio ($R_s \le$ 10kΩ) V_{CC}^+ = 5 to 30V T_{amb} = +25°C		 65	110		dB
I_{CC}	Supply Current, no load T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$	 V_{CC} = +5V V_{CC} = +30V V_{CC} = +5V V_{CC} = +30		 500 600 600	 800 900 900 1000	µA
V_{icm}	Common Mode Input Voltage Range (V_{CC} = +30V) - note3) T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$		 0 0		 V_{CC} -1.5 V_{CC} -2	V
CMR	Common Mode Rejection Ratio ($R_s \le$ 10kΩ) T_{amb} = +25°C		 65	85		dB
I_{source}	Output Current Source (V_{id} = +1V) V_{CC} = +15V, V_o = +2V		 20	40		mA
I_{sink}	Output Sink Current (V_{id} = -1V) V_{CC} = +15V, V_o = +2V V_{CC} = +15V, V_o = +0.2V		 10 12	 20 50		 mA µA
I_o	Short Circuit to Ground (V_{CC} = +15V)			40	60	mA
V_{OH}	High Level Output Voltage V_{CC} = +30V T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$ T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$ V_{CC} = +5V, R_L = 2kΩ T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$	 R_L = 2kΩ R_L = 10kΩ 	 26 25.5 27 26.5 3.5 3	 27 28 	 	V
V_{OL}	Low Level Output Voltage R_L = 10kΩ T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$			5	15 20	mV
SR	Slew Rate V_{CC} = +15V, V_i = 0.5 to 3V, R_L = 2kΩ, C_L = 100pF, T_{amb} = +25°C, unity gain			0.4		V/µs
GBP	Gain Bandwith Product V_{CC} = 30V, f = 100kHz, T_{amb} = +25°C, V_{in} = 10mV, R_L = 2kΩ, C_L = 100pF			0.8		MHz
ϕm	Phase Margin			60		Degrees

Symbol	Parameter	Min.	Typ.	Max.	Unit
THD	Total Harmonic Distortion f = 1kHz, A_V = 20dB, R_L = 2kΩ, V_o = 2Vpp, C_L = 100pF, T_{amb} = +25°C, V_{CC} = 30V		0.015		%
en	Equivalent Input Noise Voltage f = 1kHz, R_S = 100Ω, V_{CC} = 30V		40		$\frac{nV}{\sqrt{Hz}}$

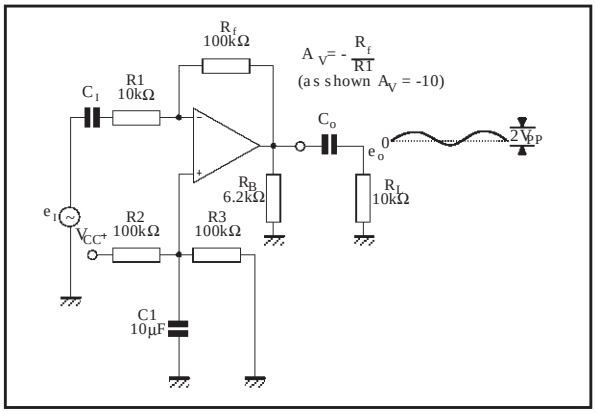
1. Vo = 1.4V, Rs = 0W, 5V < Vcc+ < 30V, 0 < Vic < Vcc+ - 1.5V
2. The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
3. The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is Vcc+ - 1.5V, but either or both inputs can go to +32V without damage.

ICC = f(t)

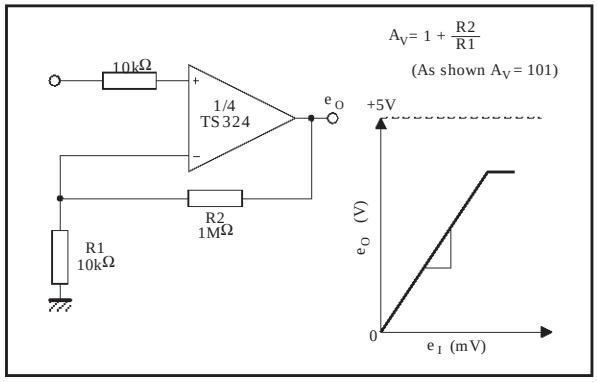


TYPICAL SINGLE - SUPPLY APPLICATIONS

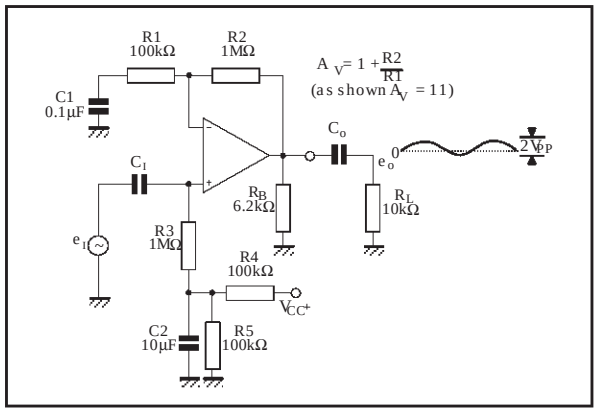
AC COUPLED INVERTING AMPLIFIER



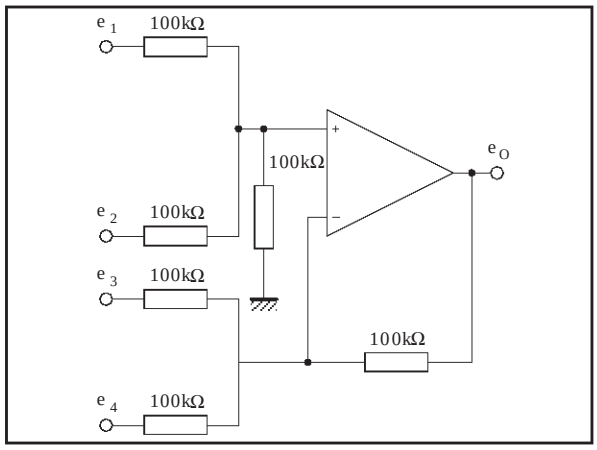
NON-INVERTING DC GAIN



AC COUPLED NON-INVERTING AMPLIFIER



DC SUMMING AMPLIFIER



MACROMODEL

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** Standard Linear Ics Macromodels, 1998.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY
.SUBCKT TS321 1 3 2 4 5 (analog)
*********************************************************
.MODEL MDTH D IS=1E-8 KF=3.104131E-15 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 2.600000E+01
RIN 15 16 2.600000E+01
RIS 11 15 2.003862E+02
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 1.000000E-05
CPS 11 15 3.783376E-09
DINN 17 13 MDTH 400E-12
VIN 17 5 0.000000e+00
DINR 15 18 MDTH 400E-12
VIP 4 18 2.000000E+00
FCP 4 5 VOFP 3.400000E+01
FCN 5 4 VOFN 3.400000E+01
FIBP 2 5 VOFN 2.000000E-03
FIBN 5 1 VOFP 2.000000E-03
* AMPLIFYING STAGE
FIP 5 19 VOFP 3.600000E+02
FIN 5 19 VOFN 3.600000E+02
RG1 19 5 3.652997E+06
RG2 19 4 3.652997E+06
CC 19 5 6.000000E-09
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 7.500000E+03
VIPM 28 4 1.500000E+02
HONM 21 27 VOUT 7.500000E+03
VINM 5 27 1.500000E+02
EOUT 26 23 19 5 1
VOUT 23 5 0
ROUT 26 3 20
COUT 3 5 1.000000E-12
DOP 19 25 MDTH 400E-12
VOP 4 25 2.242230E+00
DON 24 19 MDTH 400E-12
VON 24 5 7.922301E-01
.ENDS
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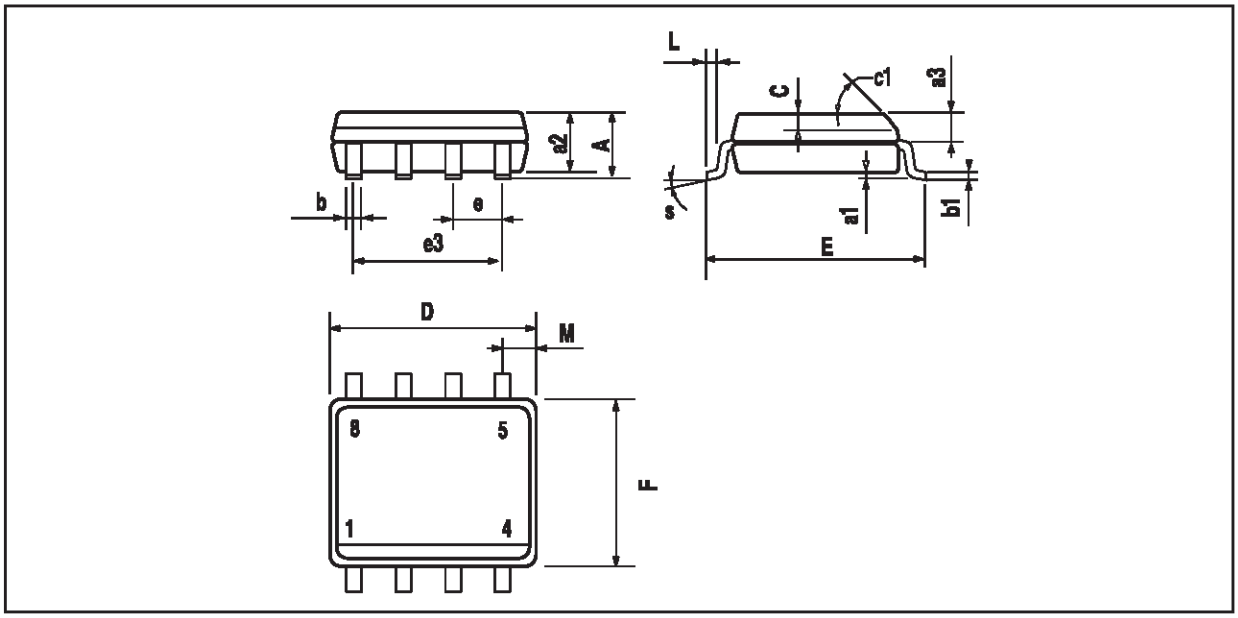
ELECTRICAL CHARACTERISTICS

V_{cc} = ±15V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Conditions	Value	Unit
V_{io}		0	mV
A_{vd}	R_L = 2kΩ	100	V/mV
I_{cc}	No load, per operator	300	µA
V_{icm}		0 to +3.5	V
V_{OH}	R_L = 2kΩ	+3.5	V
V_{OL}	R_L = 2kΩ	5	mV
I_{os}	V_o = 0V	40	mA
GBP	R_L = 2kΩ, C_L = 100pF	0.8	MHz
SR	R_L = 2kΩ, C_L = 100pF	0.4	V/µs
∅m	R_L = 2kΩ, C_L = 100pF	60	Degrees

PACKAGE MECHANICAL DATA

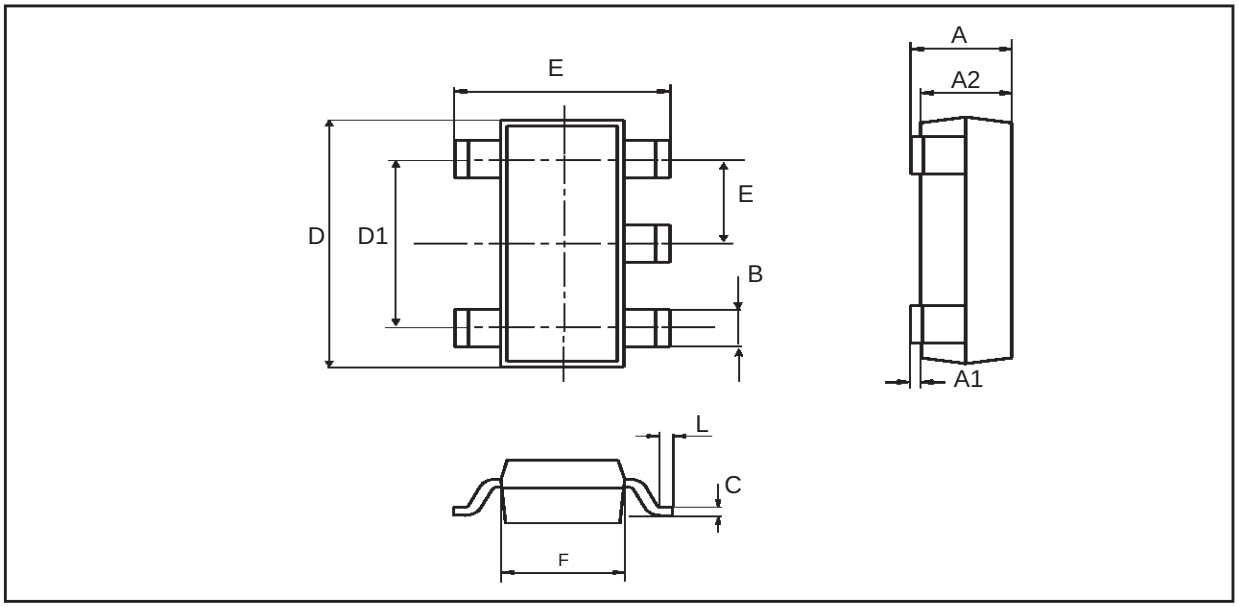
8 PINS - PLASTIC MICROPACKAGE (SO)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

PACKAGE MECHANICAL DATA

5 PINS - TINY PACKAGE (SOT23)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1	0		0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	2.60	2.80	3.00	0.102	0.110	0.118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.10	0.5	0.60	0.004	0.014	0.024
K	0d		10d	0d		10d