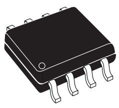
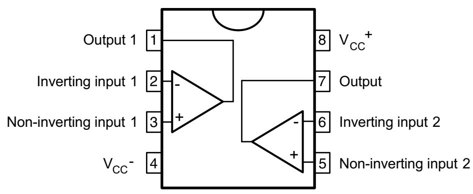
RobuST, rail-to-rail, high output current dual operational amplifier

Datasheet - production data



D
SO8
(plastic micropackage)

Pin connections (top view)



Features

- Rail-to-rail input and output
- Low noise: 9 nV/√Hz
- Low distortion
- High output current: 80 mA (able to drive 32 Ω loads)
- High-speed: 4 MHz, 1 V/µs
- Operating from 2.7 to 12 V
- Low input offset voltage
- ESD internal protection: 2 kV
- Latch-up immunity
- Macromodel included in this specification
- Dual version available in flip-chip package
- Intended for use in Aerospace and Defense applications:
  - Dedicated traceability and part marking
  - Approval documents available for production parts
  - Adapted extended life time and obsolescence management
  - Extended product change notification process
  - Designed and manufactured to meet sub ppm quality goals
  - Advanced mold and frame designs for superior resilience to harsh environments (acceleration, EMI, thermal, humidity)
  - Extended screening capability on request
  - Single fabrication, assembly, and test site
  - Temperature range (-40 °C to 125 °C)

Applications

- Aerospace and defense
- Harsh environments

Description

The RT922 device is a rail-to-rail dual BiCMOS operational amplifier optimized and fully specified for 3 V and 5 V operation. The device has high output currents which allow low-load impedances to be driven.

Very low noise, low distortion, low offset, and a high output current capability make this device an excellent choice for aerospace and defense applications.

The device is stable for capacitive loads up to 500 pF.

Contents

1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings (AMR)

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage(1)	14	V
V_{id}	Differential input voltage(2)	±1	
V_{in}	Input voltage(3)	(V_{CC-}) - 0.3 to (V_{CC+}) + 0.3	
T_{stg}	Storage temperature	-65 to +150	°C
R_{thja}	Thermal resistance junction to ambient(4)	125	°C/W
R_{thjc}	Thermal resistance junction to case(4)	40	
T_j	Maximum junction temperature	150	°C
ESD	HBM: human body model(5) MM: machine model(6) CDM: charged device model(7)	2000 120 1500	V
	Output short-circuit duration	See note(8)	
	Latch-up immunity	200	mA
	Soldering temperature (10 s), leaded version Soldering temperature (10 s), unleaded version	250 260	°C

1. All voltage values, except the differential voltage are with respect to the network ground terminal.
2. The differential voltage is the non-inverting input terminal with respect to the inverting input terminal. If V_{id} > ±1 V, the maximum input current must not exceed ±1 mA. In this case (V_{id} > ±1 V), an input series resistor must be added to limit the input current.
3. Do not exceed 14 V.
4. Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers. These values are typical.
5. Human body model: 100 pF discharged through a 1.5 kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
6. 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 pin combinations with other pins floating.
7. Charged device model: all pins and plus package are charged together to the specified voltage and then discharged directly to ground.
8. There is no short-circuit protection inside the device: short-circuits from the output to V_{CC} can cause excessive heating. The maximum output current is approximately 80 mA, independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2.7 to 12	V
V_{icm}	Common mode input voltage range	(V_{CC-}) - 0.2 to (V_{CC+}) + 0.2	
T_{oper}	Operating free air temperature range	-40 to 125	°C

2 Electrical characteristics

Table 3. Electrical characteristics measured at V_{CC} = +3 V, V_{CC}- = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25 °C, and R_L connected to V_{CC}/2 (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage				3	mV
		$T_{min} \leq T_{amb} \leq T_{max}$			5	
$\Delta V_{io}/\Delta T$	Input offset voltage drift			2		µV/°C
I_{io}	Input offset current	$V_{out} = V_{CC}/2$ $T_{min} \leq T_{amb} \leq T_{max}$		1	30 30	nA
I_{ib}	Input bias current	$V_{out} = V_{CC}/2$ $T_{min} \leq T_{amb} \leq T_{max}$		15	100 100	
V_{OH}	High level output voltage	R_L= 10 kΩ $T_{min} \leq T_{amb} \leq T_{max}$	2.90 2.90			V
		R_L = 600 Ω $T_{min} \leq T_{amb} \leq T_{max}$	2.87 2.87			
		R_L = 32 Ω		2.63		
V_{OL}	Low level output voltage	R_L= 10 kΩ $T_{min} \leq T_{amb} \leq T_{max}$			50 50	mV
		R_L = 600 Ω $T_{min} \leq T_{amb} \leq T_{max}$			100 100	
		R_L = 32 Ω		180		
A_{vd}	Large signal voltage gain	R_L= 10 kΩ, V_{out} = 2 V_{p-p} $T_{min} \leq T_{amb} \leq T_{max}$	 70	200		V/mV
		R_L = 600 Ω, V_{out} = 2 V_{p-p} $T_{min} \leq T_{amb} \leq T_{max}$	 15	35		
		R_L = 32 Ω, V_{out} = 2 V_{p-p}		16		
I_{CC}	Total supply current	No load, $V_{out} = V_{CC}/2$ $T_{min} \leq T_{amb} \leq T_{max}$		2	3 3.2	mA
GBP	Gain bandwidth product	R_L = 600 Ω		4		MHz
CMR	Common mode rejection ratio	V_{icm} = 0 to 3 V $T_{min} \leq T_{amb} \leq T_{max}$	60 56	80		dB
SVR	Supply voltage rejection ratio	V_{CC} = 2.7 to 3.3 V $T_{min} \leq T_{amb} \leq T_{max}$	60 60	85		
I_o	Output short-circuit current		50	80		mA
SR	Slew rate		0.7	1.3		V/µs
ϕm	Phase margin at unit gain	R_L = 600 Ω, C_L = 100 pF		68		Degrees
G_m	Gain margin			12		dB
e_n	Equivalent input noise voltage	f = 1 kHz		9		$\frac{nV}{\sqrt{Hz}}$

Table 3. Electrical characteristics measured at V_{CC} = +3 V, V_{CC}- = 0 V, V_{icm} = $V_{CC}/2$, T_{amb} = 25 °C, and R_L connected to $V_{CC}/2$ (unless otherwise specified) (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
THD	Total harmonic distortion	V_{out} = 2 V_{p-p}, f = 1 kHz, A_v = 1, R_L = 600 Ω		0.005		%
C_s	Channel separation			120		dB

Table 4. Electrical characteristics measured at V_{CC} = 5 V, V_{CC^-} = 0 V, V_{icm} = $V_{CC}/2$, T_{amb} = 25 °C, and R_L connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage				3	mV
		$T_{min} \leq T_{amb} \leq T_{max}$			5	
$\Delta V_{io}/\Delta T$	Input offset voltage drift			2		µV/°C
I_{io}	Input offset current	$V_{out} = V_{CC}/2$ $T_{min} \leq T_{amb} \leq T_{max}$		1	30 30	nA
I_{ib}	Input bias current	$V_{out} = V_{CC}/2$ $T_{min} \leq T_{amb} \leq T_{max}$		15	100 100	nA
V_{OH}	High level output voltage	R_L = 10 kΩ $T_{min} \leq T_{amb} \leq T_{max}$	4.9 4.9			V
		R_L = 600 Ω $T_{min} \leq T_{amb} \leq T_{max}$	4.85 4.85			
		R_L = 32 Ω		4.4		
V_{OL}	Low level output voltage	R_L = 10 kΩ $T_{min} \leq T_{amb} \leq T_{max}$			50 50	mV
		R_L = 600 Ω $T_{min} \leq T_{amb} \leq T_{max}$			120 120	
		R_L = 32 Ω		300		
A_{vd}	Large signal voltage gain	R_L = 10 kΩ, V_{out} = 2 V_{p-p} $T_{min} \leq T_{amb} \leq T_{max}$	 70	200		V/mV
		R_L = 600 Ω, V_{out} = 2 V_{p-p} $T_{min} \leq T_{amb} \leq T_{max}$	 20	35		
		R_L = 32 Ω, V_{out} = 2 V_{p-p}		16		
I_{cc}	Total supply current	No load, $V_{out} = V_{CC}/2$ $T_{min} \leq T_{amb} \leq T_{max}$		2	3 3.2	mA
GBP	Gain bandwidth product	R_L = 600 Ω		4		MHz
CMR	Common mode rejection ratio	V_{icm} = 0 to 5 V $T_{min} \leq T_{amb} \leq T_{max}$	60 56	80		dB
SVR	Supply voltage rejection ratio	V_{CC} = 4.5 to 5.5 V $T_{min} \leq T_{amb} \leq T_{max}$	60 60	85		dB
I_o	Output short-circuit current		50	80		mA
SR	Slew rate		0.7	1.3		V/µs
ϕm	Phase margin at unit gain	R_L = 600 Ω, C_L =100 pF		68		Degrees
G_m	Gain margin	R_L = 600 Ω, C_L =100 pF		12		dB
e_n	Equivalent input noise voltage	f = 1 kHz		9		$\frac{nV}{\sqrt{Hz}}$
THD	Total harmonic distortion	V_{out} = 2 V_{p-p}, f = 1 kHz, A_v = 1, R_L = 600 Ω		0.005		%
C_s	Channel separation			120		dB

Figure 1. Output short-circuit current vs. output voltage

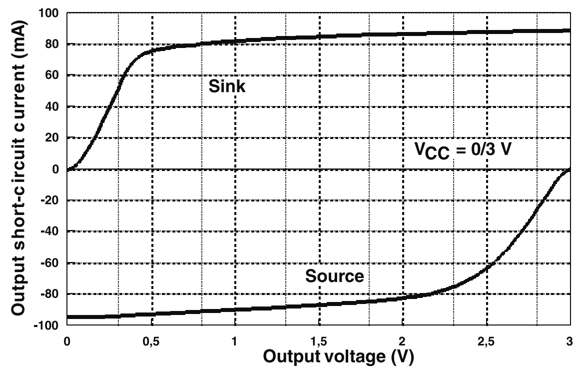


Figure 2. Total supply current vs. supply voltage

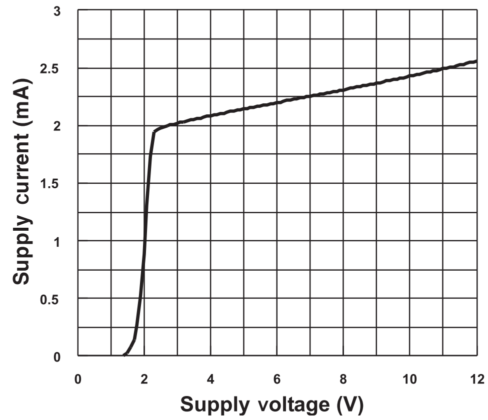


Figure 3. Voltage gain and phase vs. frequency

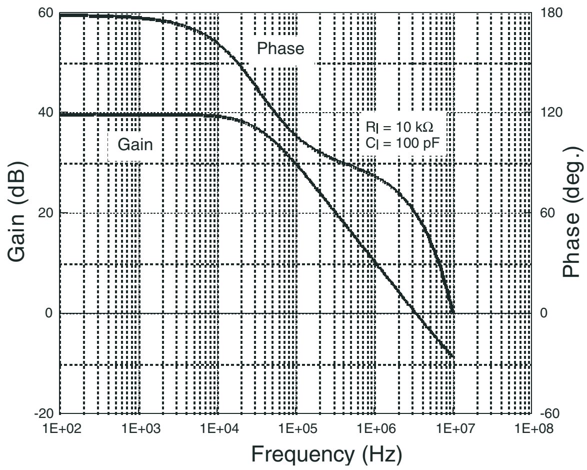


Figure 4. Equivalent input noise voltage vs. frequency

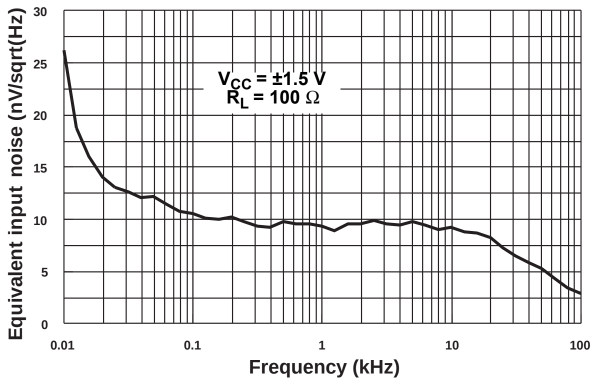


Figure 5. THD + noise vs. frequency (R_L = 2 kΩ, V_o = 10 Vpp, V_{CC} = ± 6 V)

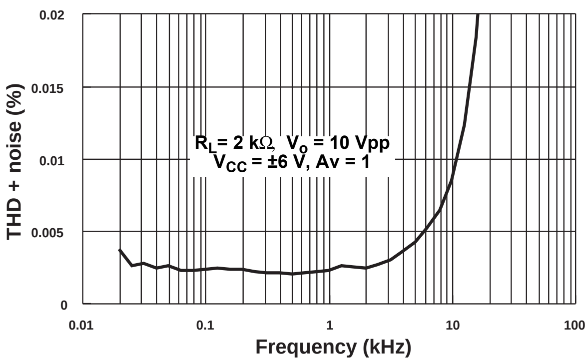


Figure 6. THD + noise vs. frequency (R_L = 32 Ω, V_o = 4 Vpp, V_{CC} = ± 2.5 V)

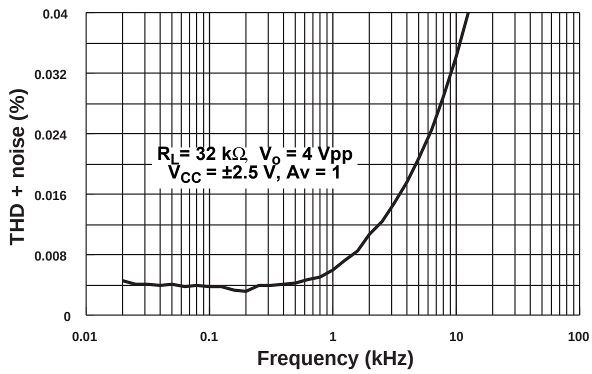


Figure 7. THD + noise vs. frequency (R_L = 32 Ω, V_o = 2 Vpp, V_{CC} = ± 1.5 V)

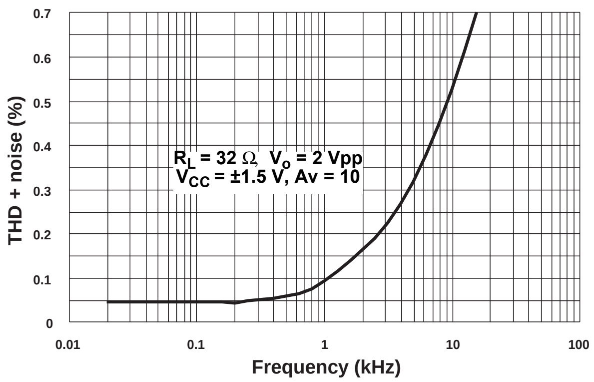


Figure 8. THD + noise vs. output voltage (R_L = 600 Ω, f = 1 kHz, V_{CC} = 0/3 V)

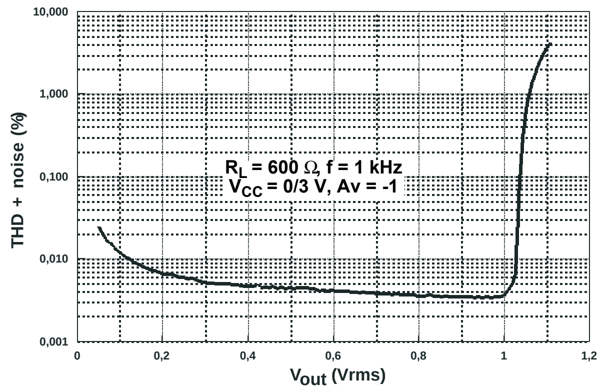


Figure 9. THD + noise vs. output voltage (R_L = 32 Ω, f = 1 kHz, V_{CC} = ± 1.5 V)

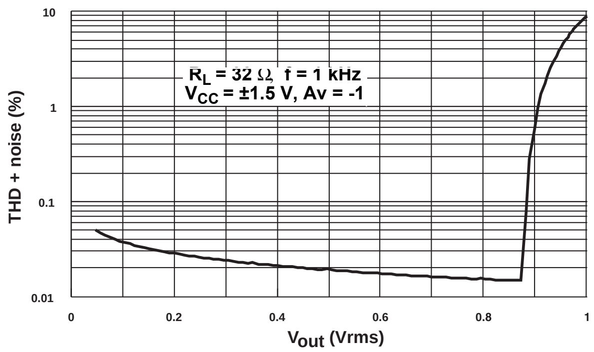


Figure 10. THD + noise vs. output voltage (R_L = 2 kΩ, f = 1 kHz, V_{CC} = ± 1.5 V)

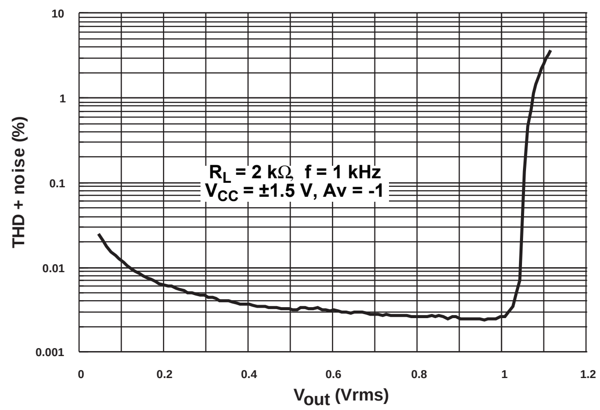
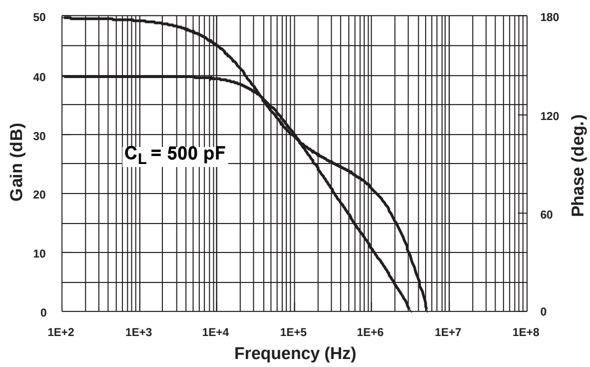


Figure 11. Open loop gain and phase vs. frequency



3 RT922 macromodel

3.1 Important note concerning this macromodel

- All models are a trade-off between accuracy and complexity (i.e. simulation time).
- Macromodels are not a substitute for 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** (for example, temperature, supply voltage). Thus the macromodel is often not as exhaustive as the datasheet, its purpose is to illustrate the main parameters of the product.

Data derived from macromodels used outside of the specified conditions (for example, V_{CC}, temperature) or worse, outside of the device operating conditions (for example, V_{CC}, V_{icm}), are not reliable in any way.

Section 3.2 provides the electrical characteristics resulting from the use of the RT922, macromodel.

3.2 Electrical characteristics from macromodelization

Table 5. Electrical characteristics resulting from macromodel simulation at V_{CC} = 3 V, V_{CC}- = 0 V, R_L, C_L connected to V_{CC}/2, T_{amb} = 25 °C (unless otherwise specified)

<table>
<tr><th>Symbol</th><th>Conditions</th><th>Value</th><th>Unit</th></tr>
<tr><td>V_{io}</td><td></td><td>0</td><td>mV</td></tr>
<tr><td>A_{vd}</td><td>R_L = 10 kΩ</td><td>200</td><td>V/mV</td></tr>
<tr><td>I_{CC}</td><td>No load, per operator</td><td>1.2</td><td>mA</td></tr>
<tr><td>V_{icm}</td><td></td><td>-0.2 to 3.2</td><td rowspan="2">V</td></tr>
<tr><td>V_{OH}</td><td rowspan="2">R_L = 10 kΩ</td><td>2.95</td></tr>
<tr><td>V_{OL}</td><td>25</td><td>mV</td></tr>
<tr><td>I_{sink}</td><td>V_O = 3 V</td><td rowspan="2">80</td><td rowspan="2">mA</td></tr>
<tr><td>I_{source}</td><td>V_O = 0 V</td></tr>
<tr><td>GBP</td><td>R_L = 600 kΩ</td><td>4</td><td>MHz</td></tr>
<tr><td>SR</td><td>R_L = 10 kΩ, C_L = 100 pF</td><td>1.3</td><td>V/µs</td></tr>
<tr><td>ϕm</td><td>R_L = 600 kΩ</td><td>68</td><td>Degrees</td></tr>
</table>

3.3 Macromodel code

```
** Standard Linear Ics Macromodels, 1996.
** CONNECTIONS:
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY
*
.SUBCKT TS92X 1 2 3 4 5
*
.MODEL MDTH D IS=1E-8 KF=2.664234E-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 8.125000E+00
RIN 15 16 8.125000E+00
RIS 11 15 2.238465E+02
DIP 11 12 MDTH 400E-12
DIN 15 14 MDTH 400E-12
VOFP 12 13 DC 153.5u
VOFN 13 14 DC 0
IPOL 13 5 3.200000E-05
CPS 11 15 1e-9
DINN 17 13 MDTH 400E-12
VIN 17 5 -0.100000e+00
DINR 15 18 MDTH 400E-12
VIP 4 18 0.400000E+00
FCP 4 5 VOFP 1.865000E+02
FCN 5 4 VOFN 1.865000E+02
FIBP 2 5 VOFP 6.250000E-03
FIBN 5 1 VOFN 6.250000E-03
* GM1 STAGE ***************
FGM1P 119 5 VOFP 1.1
FGM1N 119 5 VOFN 1.1
RAP 119 4 2.6E+06
RAN 119 5 2.6E+06
* GM2 STAGE ***************
G2P 19 5 119 5 1.92E-02
G2N 19 5 119 4 1.92E-02
R2P 19 4 1E+07
```

```
R2N 19 5 1E+07
**************************
VINT1 500 0 5
GCONVP 500 501 119 4 19.38
VP 501 0 0
GCONVN 500 502 119 5 19.38
VN 502 0 0
********* orientation isink isource *******
VINT2 503 0 5
FCOPY 503 504 VOUT 1
DCOPYP 504 505 MDTH 400E-9
VCOPYP 505 0 0
DCOPYN 506 504 MDTH 400E-9
VCOPYN 0 506 0
***************************
F2PP 19 5 poly(2) VCOPYP VP 0 0 0 0 0.5
F2PN 19 5 poly(2) VCOPYP VN 0 0 0 0 0.5
F2NP 19 5 poly(2) VCOPYN VP 0 0 0 0 1.75
F2NN 19 5 poly(2) VCOPYN VN 0 0 0 0 1.75
* COMPENSATION ************
CC 19 119 25p
* OUTPUT ***********
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 6.250000E+02
VIPM 28 4 5.000000E+01
HONM 21 27 VOUT 6.250000E+02
VINM 5 27 5.000000E+01
VOUT 3 23 0
ROUT 23 19 6
COUT 3 5 1.300000E-10
DOP 19 25 MDTH 400E-12
VOP 4 25 1.052
DON 24 19 MDTH 400E-12
VON 24 5 1.052
.ENDS;TS92X
```

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 SO8 package information

Figure 12. SO8 package mechanical drawing

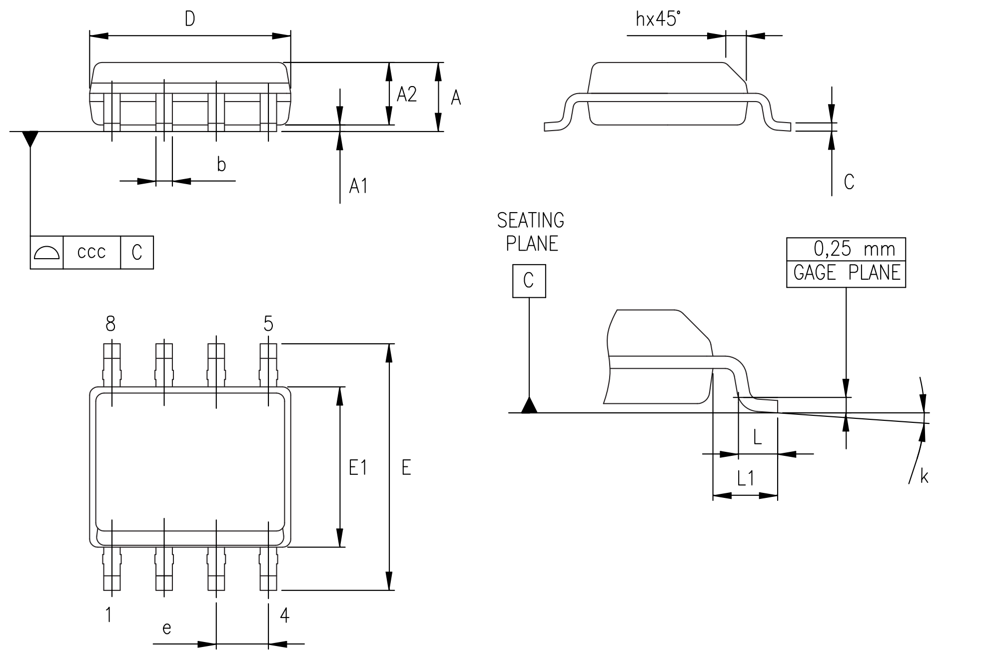


Table 6. SO8 package mechanical data

Symbol	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
L1		1.04			0.040	
k	0		8°	1°		8°
ccc			0.10			0.004

5 Ordering information

Table 7. Order codes

Order codes	Temperature range	Package	Packaging	Marking
RT922IYDT	-40 °C to 125 °C	SO8	Tape and reel	R922IY

6 Revision history

Table 8. Document revision history

Date	Revision	Changes
08-Oct-2014	1	Initial release