

Rail-to-Rail CMOS Dual Operational Amplifier

- Rail-to-rail input and output voltage ranges
- Single (or dual) supply operation from 2.7V to 16V
- Extremely low input bias current: 1pA typ.
- Low input offset voltage: 2mV max.
- Specified for 600Ω and 100Ω loads
- Low supply current: 200μA/ampli ($V_{CC} = 3V$)
- Latch-up immunity
- ESD tolerance: 3kV
- Spice macromodel included in this specification

Description

The TS912 is a rail-to-rail CMOS dual operational amplifier designed to operate with a single or dual supply voltage.

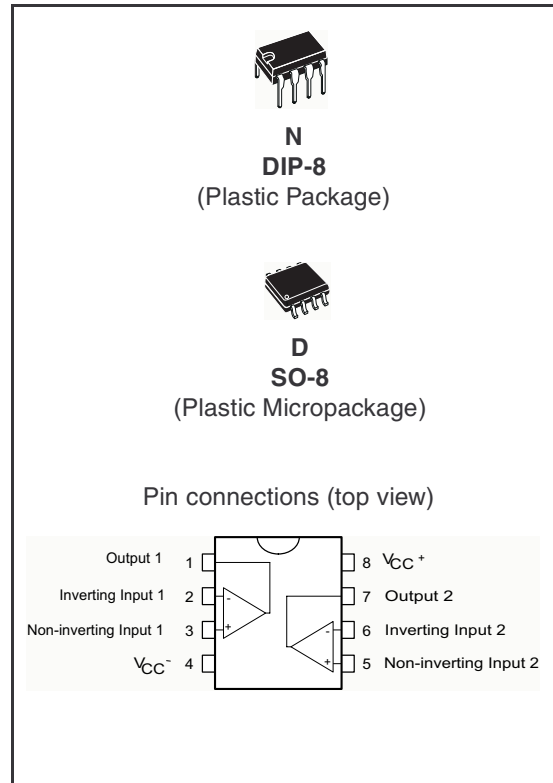
The input voltage range V_{ICM} includes the two supply rails V_{CC}^+ and V_{CC}^- .

The output reaches:

- $V_{CC}^- + 30mV$, $V_{CC}^+ - 40mV$, with $R_L = 10k\Omega$
- $V_{CC}^- + 300mV$, $V_{CC}^+ - 400mV$, with $R_L = 600\Omega$

This product offers a broad supply voltage operating range from 2.7V to 16V and a supply current of only 200μA/amp ($V_{CC} = 3V$).

Source and sink output current capability is typically 40mA (at $V_{CC} = 3V$), fixed by an internal limitation circuit.



1 Order Codes

| Part Number | Temperature Range | Package | Packing | Marking |
|-----------------|-------------------|-------------------------------|---------------------|----------|
| TS912IN | -40, +125°C | DIP8 | Tube | TS912IN |
| TS912ID/IDT | | SO-8 | Tube or Tape & Reel | 912I |
| TS912AIN | | DIP8 | Tube | TS912AIN |
| TS912AID/AIDT | | SO-8 | Tube or Tape & Reel | 912AI |
| TS912BID/BIDT | | SO-8 | | 912BI |
| TS912IYD/IYDT | | SO-8 (automotive grade level) | | 912IY |
| TS912AIYD/AIYDT | | | | 912AIY |

2 Absolute Maximum Ratings and Operating Conditions

Table 1. Key parameters and their absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|------------|---|--------------|---------------|
| V_{CC} | Supply voltage ⁽¹⁾ | 18 | V_{CC} |
| V_{id} | Differential Input Voltage ⁽²⁾ | ± 18 | V_{id} |
| V_i | Input Voltage ⁽³⁾ | -0.3 to 18 | V_i |
| I_{in} | Current on Inputs | ± 50 | I_{in} |
| I_o | Current on Outputs | ± 130 | I_o |
| T_{oper} | Operating Free Air Temperature Range TS912I/AI/BI | -40 to + 125 | T_{oper} |
| T_{stg} | Storage Temperature | -65 to +150 | T_{stg} |
| T_j | Maximum Junction Temperature | 150 | T_j |
| R_{thja} | Thermal Resistance Junction to Ambient ⁽⁴⁾ DIP8 SO-8 | 85 | $^{\circ}C/W$ |
| | | 125 | |
| R_{thjc} | Thermal Resistance Junction to Case DIP8 SO-8 | 41 | $^{\circ}C/W$ |
| | | 40 | |
| ESD | HBM: Human Body Model ⁽⁵⁾ | 3 | kV |
| | MM: Machine Model ⁽⁶⁾ | 200 | V |
| | CDM: Charged Device Model | 1500 | kV |

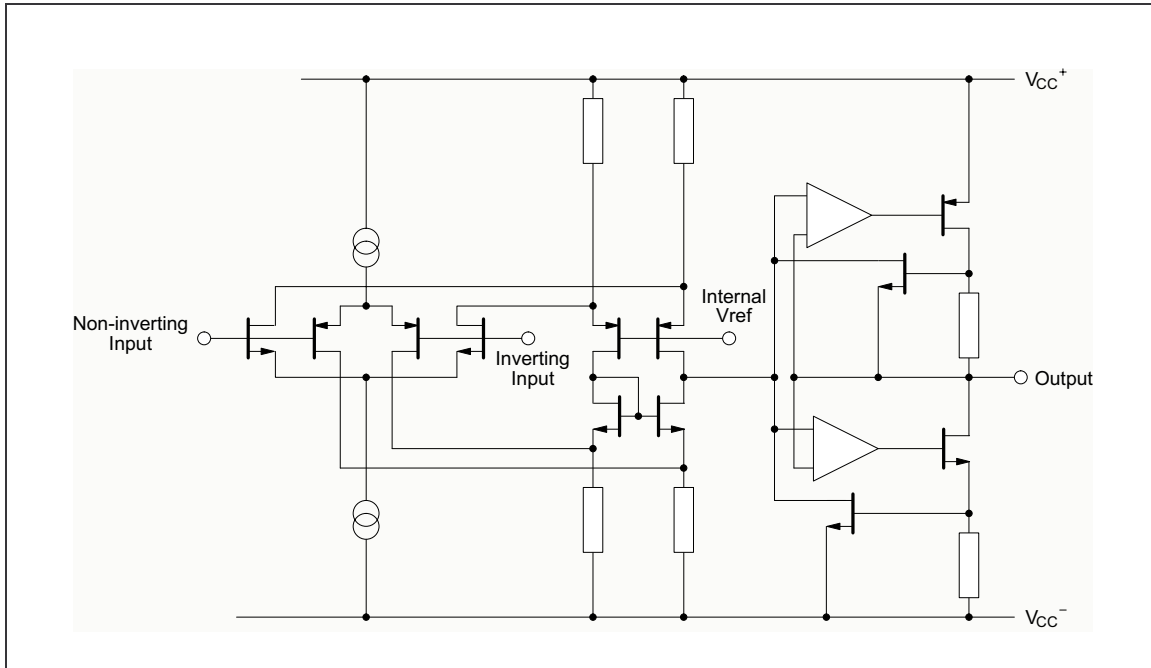
- All voltages values, except differential voltage are with respect to network ground terminal.
- Differential voltages are non-inverting input terminal with respect to the inverting input terminal.
- The magnitude of input and output voltages must never exceed $V_{CC}^{+} + 0.3V$.
- Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuit on all amplifiers. These values are typical.
- Human body model, 100pF discharged through a 1.5k Ω resistor into pin of device.
- 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 < 5 Ω), into pin to pin of device.

Table 2. Operating conditions

| Symbol | Parameter | Value | Unit |
|-----------|---------------------------------|--|------|
| V_{CC} | Supply voltage | 2.7 to 16 | V |
| V_{icm} | Common Mode Input Voltage Range | $V_{CC}^{-} - 0.2$ to $V_{CC}^{+} + 0.2$ | V |

3 Typical Application Information

Figure 1. Schematic diagram (1/2 TS912)



4 Electrical Characteristics

Table 3. $V_{CC}^+ = 3V, V_{CC}^- = 0V, R_L, C_L$ connected to $V_{CC}/2, T_{amb} = 25^\circ C$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|--|---|------|------|------|------------------|
| V_{io} | Input Offset Voltage ($V_{ic} = V_o = V_{CC}/2$)TS912 | | | 10 | mV |
| | TS912A | | | 5 | |
| | TS912B | | | 2 | |
| | $T_{min.} \leq T_{amb} \leq T_{max.}$ TS912 | | | 12 | |
| | TS912A | | | 7 | |
| | TS912B | | | 3 | |
| ΔV_{io} | Input Offset Voltage Drift | | 5 | | $\mu V/^\circ C$ |
| I_{io} | Input Offset Current ⁽¹⁾ | | 1 | 100 | pA |
| | $T_{min.} \leq T_{amb} \leq T_{max.}$ | | | 200 | |
| I_{ib} | Input Bias Current ⁽¹⁾ | | 1 | 150 | pA |
| | $T_{min.} \leq T_{amb} \leq T_{max.}$ | | | 300 | |
| I_{CC} | Supply Current (per amplifier, $A_{VCL} = 1$, no load) | | 200 | 300 | μA |
| | $T_{min.} \leq T_{amb} \leq T_{max.}$ | | | 400 | |
| CMR | Common Mode Rejection Ratio $V_{ic} = 0$ to 3V, $V_o = 1.5V$ | | 70 | | dB |
| SVR | Supply Voltage Rejection Ratio ($V_{CC}^+ = 2.7$ to 3.3V, $V_o = V_{CC}/2$) | 50 | 80 | | dB |
| A_{vd} | Large Signal Voltage Gain ($R_L = 10k\Omega, V_o = 1.2V$ to 1.8V) | 3 | 10 | | V/mV |
| | $T_{min.} \leq T_{amb} \leq T_{max.}$ | 2 | | | |
| V_{OH} | High Level Output Voltage ($V_{id} = 1V$) | | | | V |
| | $R_L = 100k\Omega$ | 2.95 | 2.96 | | |
| | $R_L = 10k\Omega$ | 2.9 | | | |
| | $R_L = 600\Omega$ | 2.3 | | 2.6 | |
| | $R_L = 100\Omega$ | | | 2 | |
| $T_{min.} \leq T_{amb} \leq T_{max.}, R_L = 10k\Omega$ | 2.8 | | | | |
| | $R_L = 600\Omega$ | 2.1 | | | |
| V_{OL} | Low Level Output Voltage ($V_{id} = -1V$) | | | 50 | mV |
| | $R_L = 100k\Omega$ | | 30 | 70 | |
| | $R_L = 10k\Omega$ | | 300 | 400 | |
| | $R_L = 600\Omega$ | | 900 | | |
| | $R_L = 100\Omega$ | | | | |
| | $T_{min.} \leq T_{amb} \leq T_{max.}, R_L = 10k\Omega$ | | | 100 | |
| | $R_L = 600\Omega$ | | | 600 | |
| I_o | Output Short Circuit Current ($V_{id} = \pm 1V$) | | | | mA |
| | Source ($V_o = V_{CC}^-$) | 20 | 40 | | |
| | Sink ($V_o = V_{CC}^+$) | 20 | 40 | | |
| GBP | Gain Bandwidth Product ($A_{VCL} = 100, R_L = 10k\Omega, C_L = 100pF, f = 100kHz$) | | 0.8 | | MHz |
| SR ⁺ | Slew Rate ($A_{VCL} = 1, R_L = 10k\Omega, C_L = 100pF, V_i = 1.3V$ to 1.7V) | | 0.4 | | V/ μs |
| SR ⁻ | Slew Rate ($A_{VCL} = 1, R_L = 10k\Omega, C_L = 100pF, V_i = 1.3V$ to 1.7V) | | 0.3 | | V/ μs |

Table 3. $V_{CC}^+ = 3V, V_{CC}^- = 0V, R_L, C_L$ connected to $V_{CC/2}, T_{amb} = 25^\circ C$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|----------|--|------|------|------|-----------------|
| ϕ_m | Phase Margin | | 30 | | Degrees |
| en | Equivalent Input Noise Voltage ($R_s = 100\Omega, f = 1kHz$) | | 30 | | nV/ \sqrt{Hz} |

1. Maximum values including unavoidable inaccuracies of the industrial test

Table 4. $V_{CC}^+ = 5V, V_{CC}^- = 0V, R_L, C_L$ connected to $V_{CC/2}, T_{amb} = 25^\circ C$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------------|---|-----------------------------------|---------------------|--------------------------------|------------------|
| V_{io} | Input Offset Voltage ($V_{ic} = V_o = V_{CC/2}$) TS912 TS912A TS912B $T_{min.} \leq T_{amb} \leq T_{max.}$ TS912 TS912A TS912B | | | 10 5 2 12 7 3 | mV |
| ΔV_{io} | Input Offset Voltage Drift | | 5 | | $\mu V/^\circ C$ |
| I_{io} | Input Offset Current ⁽¹⁾ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 100 200 | pA |
| I_{ib} | Input Bias Current ⁽¹⁾ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 150 300 | pA |
| I_{CC} | Supply Current (per amplifier, $A_{VCL} = 1$, no load) $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 230 | 350 450 | μA |
| CMR | Common Mode Rejection Ratio $V_{ic} = 1.5$ to $3.5V, V_o = 2.5V$ | 60 | 85 | | dB |
| SVR | Supply Voltage Rejection Ratio ($V_{CC}^+ = 3$ to $5V, V_o = V_{CC/2}$) | 55 | 80 | | dB |
| A_{vd} | Large Signal Voltage Gain ($R_L = 10k\Omega, V_o = 1.5V$ to $3.5V$) $T_{min.} \leq T_{amb} \leq T_{max.}$ | 10 7 | 40 | | V/mV |
| V_{OH} | High Level Output Voltage ($V_{id} = 1V$) $R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $T_{min.} \leq T_{amb} \leq T_{max.}, R_L = 10k\Omega$ $R_L = 600\Omega$ | 4.95 4.9 4.25 4.8 4.1 | 4.95 4.55 3.7 | | V |
| V_{OL} | Low Level Output Voltage ($V_{id} = -1V$) $R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $T_{min.} \leq T_{amb} \leq T_{max.}, R_L = 10k\Omega$ $R_L = 600\Omega$ | | 40 350 1400 | 50 100 500 150 750 | mV |
| I_o | Output Short Circuit Current ($V_{id} = \pm 1V$) Source ($V_o = V_{CC}^-$) Sink ($V_o = V_{CC}^+$) | 45 45 | 65 65 | | mA |
| GBP | Gain Bandwidth Product ($A_{VCL} = 100, R_L = 10k\Omega, C_L = 100pF, f = 100kHz$) | | 1 | | MHz |

Table 4. $V_{CC}^+ = 5V$, $V_{CC}^- = 0V$, R_L , C_L connected to $V_{CC/2}$, $T_{amb} = 25^\circ C$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------------|--|------|------|------|-----------------|
| SR ⁺ | Slew Rate ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_i = 1V$ to $4V$) | | 0.8 | | |
| SR ⁻ | Slew Rate ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_i = 1V$ to $4V$) | | 0.6 | | V/ μs |
| en | Equivalent Input Noise Voltage ($R_s = 100\Omega$, $f = 1kHz$) | | 30 | | nV/ \sqrt{Hz} |
| V_{O1}/V_{O2} | Channel Separation ($f = 1kHz$) | | 120 | | dB |
| ϕ_m | Phase Margin | | 30 | | Degrees |

1. Maximum values including unavoidable inaccuracies of the industrial test

Table 5. $V_{CC}^+ = 10V$, $V_{CC}^- = 0V$, R_L , C_L connected to $V_{CC/2}$, $T_{amb} = 25^\circ C$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------------|--|---------------------------------|---------------------|------------------------------|------------------|
| V_{io} | Input Offset Voltage ($V_{ic} = V_o = V_{CC/2}$) TS912 TS912A TS912B $T_{min.} \leq T_{amb} \leq T_{max.}$ TS912 TS912A TS912B | | | 10 5 2 12 7 3 | mV |
| ΔV_{io} | Input Offset Voltage Drift | | 5 | | $\mu V/^\circ C$ |
| I_{io} | Input Offset Current ⁽¹⁾ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 100 200 | pA |
| I_{ib} | Input Bias Current ⁽¹⁾ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 150 300 | pA |
| I_{CC} | Supply Current (per amplifier, $A_{VCL} = 1$, no load) $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 400 | 600 700 | μA |
| CMR | Common Mode Rejection Ratio $V_{ic} = 3$ to $7V$, $V_o = 5V$ $V_{ic} = 0$ to $10V$, $V_o = 5V$ | 60 50 | 90 75 | | dB |
| SVR | Supply Voltage Rejection Ratio ($V_{CC}^+ = 5$ to $10V$, $V_o = V_{CC/2}$) | 60 | 90 | | dB |
| A_{vd} | Large Signal Voltage Gain ($R_L = 10k\Omega$, $V_o = 2.5V$ to $7.5V$) $T_{min.} \leq T_{amb} \leq T_{max.}$ | 15 10 | 50 | | V/mV |
| V_{OH} | High Level Output Voltage ($V_{id} = 1V$) $R_L = 100k\Omega$ $R_L = 10k\Omega$ $R_L = 600\Omega$ $R_L = 100\Omega$ $T_{min.} \leq T_{amb} \leq T_{max.}$, $R_L = 10k\Omega$ $R_L = 600\Omega$ | 9.95 9.85 9 9.8 8.8 | 9.95 9.35 7.8 | | V |

Table 5. $V_{CC}^+ = 10V$, $V_{CC}^- = 0V$, R_L , C_L connected to $V_{CC}/2$, $T_{amb} = 25^\circ C$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------------|--|----------|----------|------|-----------------|
| V_{OL} | Low Level Output Voltage ($V_{id} = -1V$) | | | | |
| | $R_L = 100k\Omega$ | | | 50 | |
| | $R_L = 10k\Omega$ | | 50 | 150 | |
| | $R_L = 600\Omega$ | | 650 | 800 | mV |
| | $R_L = 100\Omega$ | | 2300 | | |
| | $T_{min.} \leq T_{amb} \leq T_{max.}$, $R_L = 10k\Omega$ | | | 150 | |
| | $R_L = 600\Omega$ | | | 900 | |
| I_o | Output Short Circuit Current ($V_{id} = \pm 1V$) Source ($V_o = V_{CC}^-$) Sink ($V_o = V_{CC}^+$) | 45 50 | 65 75 | | mA |
| GBP | Gain Bandwidth Product ($A_{VCL} = 100$, $R_L = 10k\Omega$, $C_L = 100pF$, $f = 100kHz$) | | 1.4 | | MHz |
| SR ⁺ | Slew Rate ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_i = 2.5V$ to $7.5V$) | | 1.3 | | V/ μ s |
| SR ⁻ | Slew Rate ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_i = 2.5V$ to $7.5V$) | | 0.8 | | |
| ϕ_m | Phase Margin | | 40 | | Degrees |
| e_n | Equivalent Input Noise Voltage ($R_s = 100\Omega$, $f = 1kHz$) | | 30 | | nV/ \sqrt{Hz} |
| THD | Total Harmonic Distortion ($A_{VCL} = 1$, $R_L = 10k\Omega$, $C_L = 100pF$, $V_o = 4.75V$ to $5.25V$, $f = 1kHz$) | | 0.02 | | % |
| C_{in} | Input Capacitance | | 1.5 | | pF |

1. Maximum values including unavoidable inaccuracies of the industrial test

Figure 2. Supply current (each amplifier) vs. supply voltage

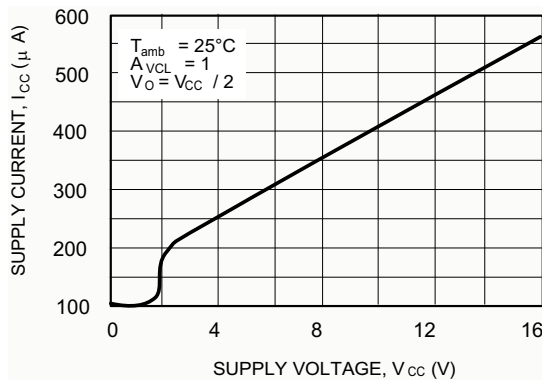


Figure 3. High level output voltage vs. high level output current

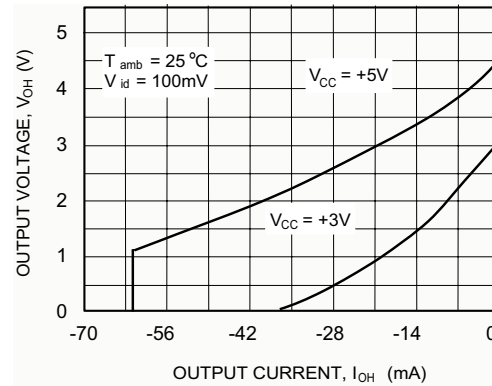


Figure 4. Low level output voltage vs. low level output current

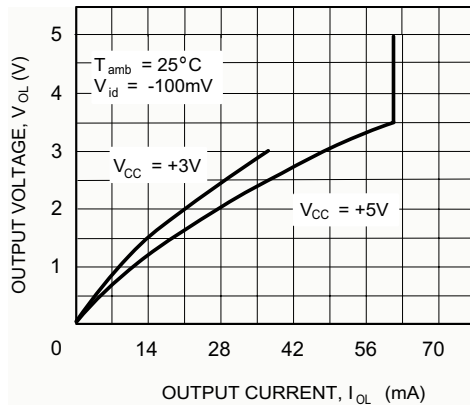


Figure 5. Input bias current vs. temperature

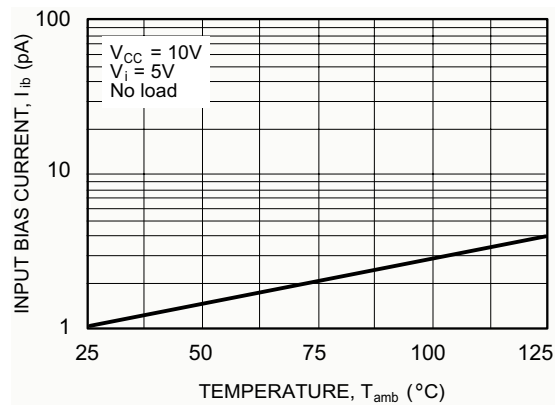


Figure 6. High level output voltage vs. high level output current

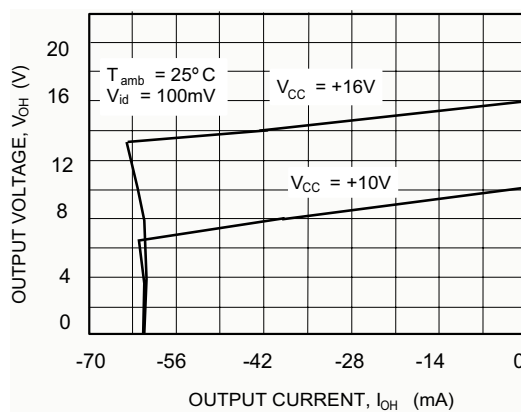


Figure 7. Low level output voltage vs. low level output current

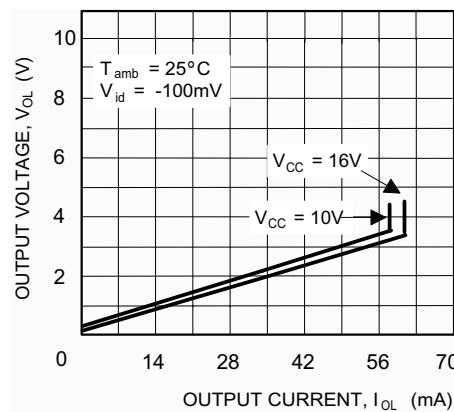


Figure 8. Gain and phase vs. frequency

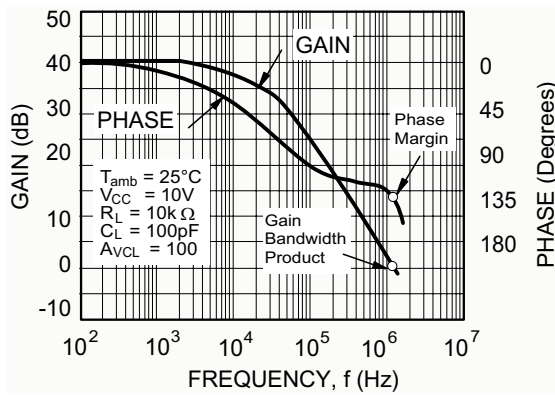


Figure 9. Gain bandwidth product vs. supply voltage

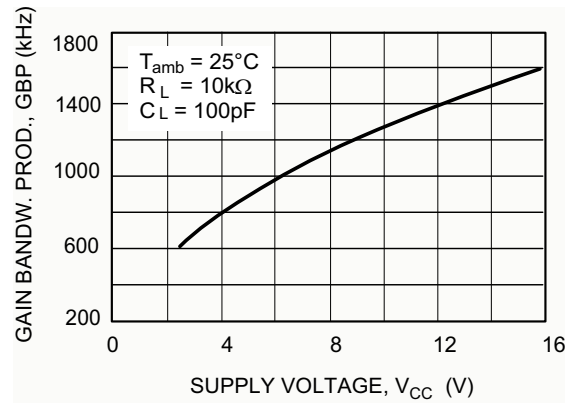


Figure 10. Phase margin vs. supply voltage

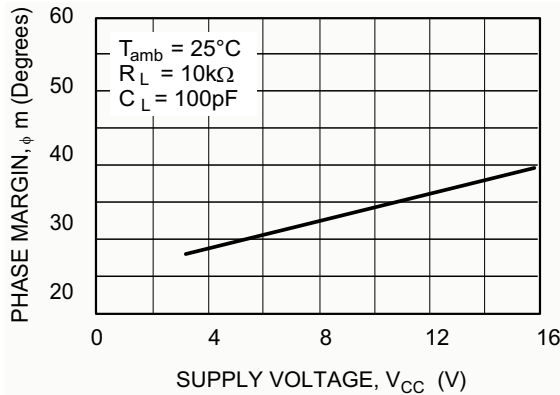


Figure 11. Gain and phase vs. frequency

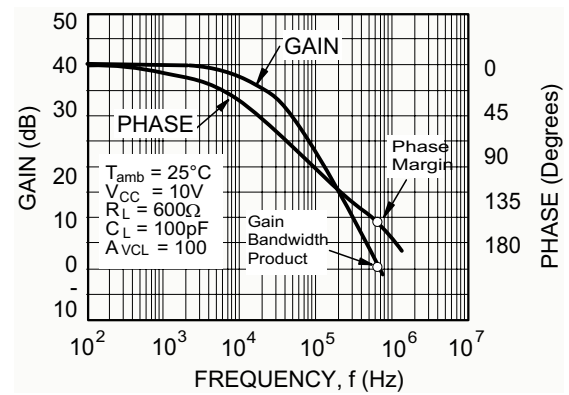


Figure 12. Gain bandwidth product vs. supply voltage

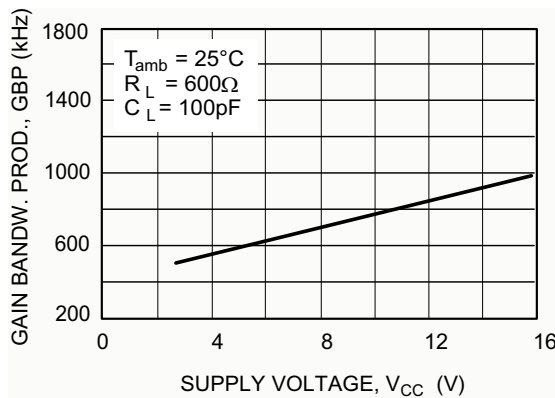


Figure 13. Phase margin vs. supply voltage

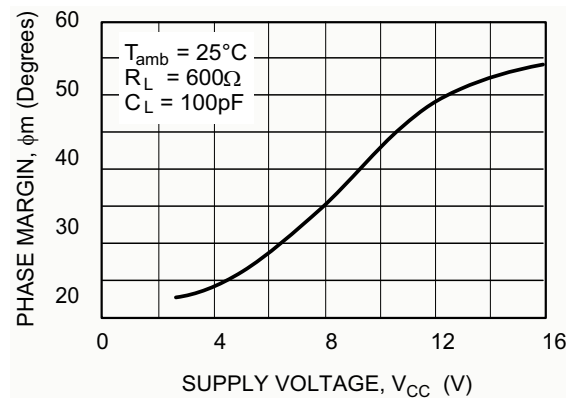
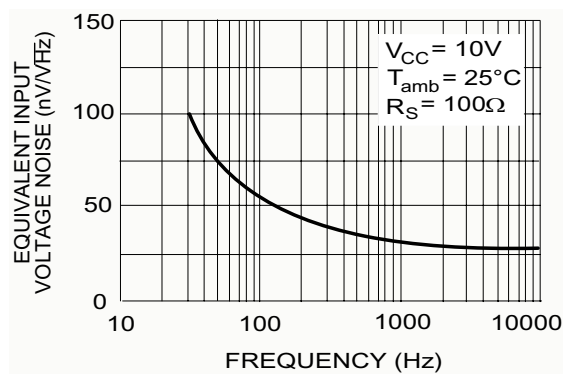


Figure 14. Input voltage noise vs. frequency



5 Macromodels

5.1 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 (V_{CC} , Temperature, etc.) or even worse: outside of the device operating conditions (V_{CC} , V_{icm} , etc.) are not reliable in any way.

In *Section 5.2* and *Section 5.4*, the electrical characteristics resulting from the use of these macromodels are presented.

5.2 Electrical characteristics from macromodelization

Table 6. Electrical characteristics resulting from macromodel simulation at $V_{CC}^+ = 3V$, $V_{CC}^- = 0V$, R_L , C_L connected to $V_{CC}/2$, $T_{amb} = 25^\circ C$ (unless otherwise specified)

| Symbol | Conditions | Value | Unit |
|--------------|-----------------------------------|-------------|------------|
| V_{io} | | 0 | mV |
| A_{vd} | $R_L = 10k\Omega$ | 10 | V/mV |
| I_{CC} | No load, per operator | 200 | μA |
| V_{icm} | | -0.2 to 3.2 | V |
| V_{OH} | $R_L = 10k\Omega$ | 2.96 | V |
| V_{OL} | $R_L = 10k\Omega$ | 30 | mV |
| I_{sink} | $V_O = 3V$ | 40 | mA |
| I_{source} | $V_O = 0V$ | 40 | mA |
| GBP | $R_L = 10k\Omega$, $C_L = 100pF$ | 0.8 | MHz |
| SR | $R_L = 10k\Omega$, $C_L = 100pF$ | 0.3 | V/ μs |

5.3 Macromodel code

Applies to: TS912 ($V_{CC} = 3V$)

```

** Standard Linear Ics Macromodels, 1993.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT

```

```

* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY
.SUBCKT TS912_3 1 3 2 4 5 (analog)
*****
*****
.MODEL MDTH D IS=1E-8 KF=6.564344E-14 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 6.500000E+00
RIN 15 16 6.500000E+00
RIS 11 15 1.271505E+01
DIP 11 12 MDTH 400E-12
DIN 15 14 MDTH 400E-12
VOFP 12 13 DC 0.000000E+00
VOFN 13 14 DC 0
IPOL 13 5 4.000000E-05
CPS 11 15 2.125860E-08
DINN 17 13 MDTH 400E-12
VIN 17 5 0.000000E+00
DINR 15 18 MDTH 400E-12
VIP 4 18 0.000000E+00
FCP 4 5 VOFP 5.000000E+00
FCN 5 4 VOFN 5.000000E+00
* AMPLIFYING STAGE
FIP 5 19 VOFP 2.750000E+02
FIN 5 19 VOFN 2.750000E+02
RG1 19 5 1.916825E+05
RG2 19 4 1.916825E+05
CC 19 29 2.200000E-08
HZTP 30 29 VOFP 1.3E+03
HZTN 5 30 VOFN 1.3E+03
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 3800
VIPM 28 4 150
HONM 21 27 VOUT 3800
VINM 5 27 150
EOUT 26 23 19 5 1
VOUT 23 5 0
ROUT 26 3 75
COUT 3 5 1.000000E-12
DOP 19 68 MDTH 400E-12
VOP 4 25 1.724
HSCP 68 25 VSCP1 0.8E8
DON 69 19 MDTH 400E-12
VON 24 5 1.7419107
HSCN 24 69 VSCN1 0.8E+08
VSCTHP 60 61 0.0875
** VSCTHP = le seuil au dessus de vio * 500
** c.a.d 275U-000U dus a l'offset
DSCP1 61 63 MDTH 400E-12
VSCP1 63 64 0
ISCP 64 0 1.000000E-8
DSCP2 0 64 MDTH 400E-12
DSCN2 0 74 MDTH 400E-12
ISCN 74 0 1.000000E-8
VSCN1 73 74 0
DSCN1 71 73 MDTH 400E-12
VSCTHN 71 70 -0.55
** VSCTHN = le seuil au dessous de vio * 2000

```

```

** c.a.d -375U-000U dus a l'offset
ESCP 60 0 2 1 500
ESCN 70 0 2 1 -2000
.ENDS

```

5.4 Electrical characteristics from macromodelization

Table 7. Electrical characteristics resulting from macromodel simulation at $V_{CC}^+ = 5V$, $V_{CC}^- = 0V$, R_L , C_L connected to $V_{CC}/2$, $T_{amb} = 25^\circ C$ (unless otherwise specified)

| Symbol | Conditions | Value | Unit |
|--------------|-----------------------------------|-------------|------------|
| V_{io} | | 0 | mV |
| A_{vd} | $R_L = 10k\Omega$ | 50 | V/mV |
| I_{CC} | No load, per operator | 230 | μA |
| V_{icm} | | -0.2 to 5.2 | V |
| V_{OH} | $R_L = 10k\Omega$ | 4.95 | V |
| V_{OL} | $R_L = 10k\Omega$ | 40 | mV |
| I_{sink} | $V_O = 5V$ | 65 | mA |
| I_{source} | $V_O = 0V$ | 65 | mA |
| GBP | $R_L = 10k\Omega$, $C_L = 100pF$ | 1 | MHz |
| SR | $R_L = 10k\Omega$, $C_L = 100pF$ | 0.8 | V/ μs |

5.5 Macromodel code

Applies to: TS912 ($V_{CC} = 5V$)

```

** Standard Linear Ics Macromodels, 1993.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY
* 6 STANDBY
.SUBCKT TS912_5 1 3 2 4 5 (analog)
*****
.MODEL MDTH D IS=1E-8 KF=6.564344E-14 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 6.500000E+00
RIN 15 16 6.500000E+00
RIS 11 15 7.322092E+00
DIP 11 12 MDTH 400E-12
DIN 15 14 MDTH 400E-12
VOFP 12 13 DC 0.000000E+00
VOFN 13 14 DC 0
IPOL 13 5 4.000000E-05
CPS 11 15 2.498970E-08
DINN 17 13 MDTH 400E-12

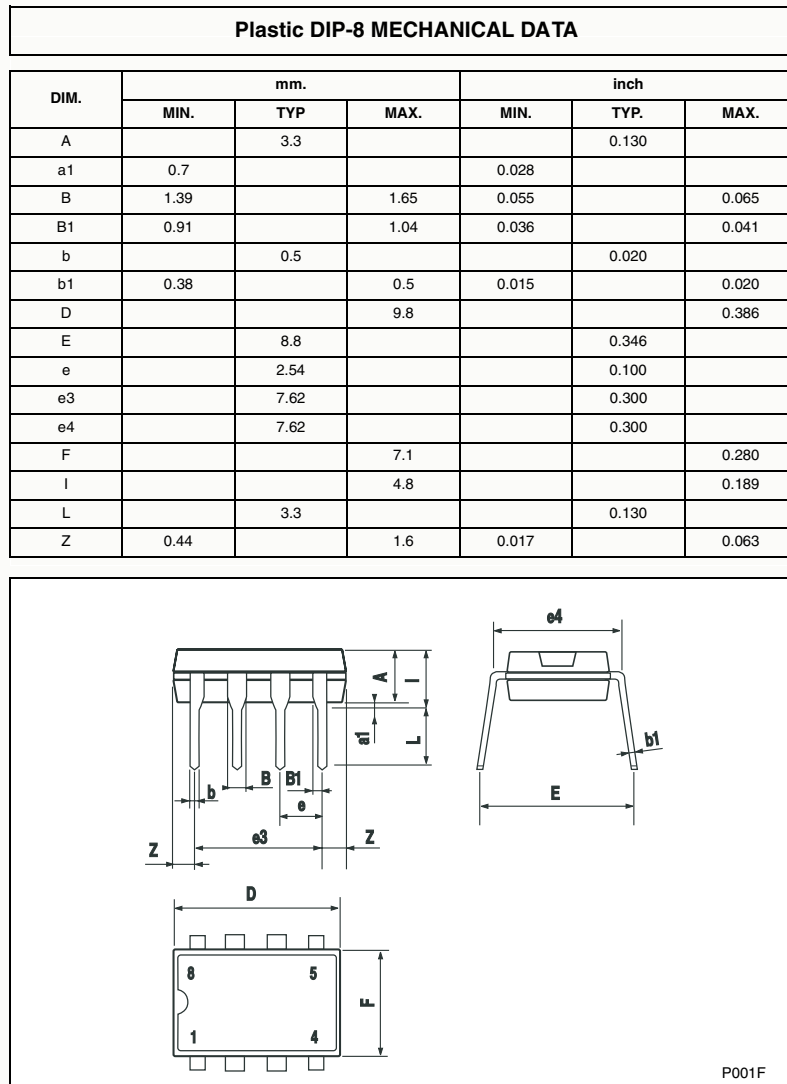
```

```
VIN 17 5 0.000000e+00
DINR 15 18 MDTH 400E-12
VIP 4 18 0.000000E+00
FCP 4 5 VOFP 5.750000E+00
FCN 5 4 VOFN 5.750000E+00
ISTB0 5 4 500N
* AMPLIFYING STAGE
FIP 5 19 VOFP 4.400000E+02
FIN 5 19 VOFN 4.400000E+02
RG1 19 5 4.904961E+05
RG2 19 4 4.904961E+05
CC 19 29 2.200000E-08
HZTP 30 29 VOFP 1.8E+03
HZTN 5 30 VOFN 1.8E+03
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 3800
VIPM 28 4 230
HONM 21 27 VOUT 3800
VINM 5 27 230
EOUT 26 23 19 5 1
VOUT 23 5 0
ROUT 26 3 82
COUT 3 5 1.000000E-12
DOP 19 68 MDTH 400E-12
VOP 4 25 1.724
HSCP 68 25 VSCP1 0.8E+08
DON 69 19 MDTH 400E-12
VON 24 5 1.7419107
HSCN 24 69 VSCN1 0.8E+08
VSCTHP 60 61 0.0875
** VSCTHP = le seuil au dessus de vio * 500
** c.a.d 275U-000U dus a l'offset
DSCP1 61 63 MDTH 400E-12
VSCP1 63 64 0
ISCP 64 0 1.000000E-8
DSCP2 0 64 MDTH 400E-12
DSCN2 0 74 MDTH 400E-12
ISCN 74 0 1.000000E-8
VSCN1 73 74 0
DSCN1 71 73 MDTH 400E-12
VSCTHN 71 70 -0.55
** VSCTHN = le seuil au dessous de vio * 2000
** c.a.d -375U-000U dus a l'offset
ESCP 60 0 2 1 500
ESCN 70 0 2 1 -2000
.ENDS
```

6 Package Mechanical Data

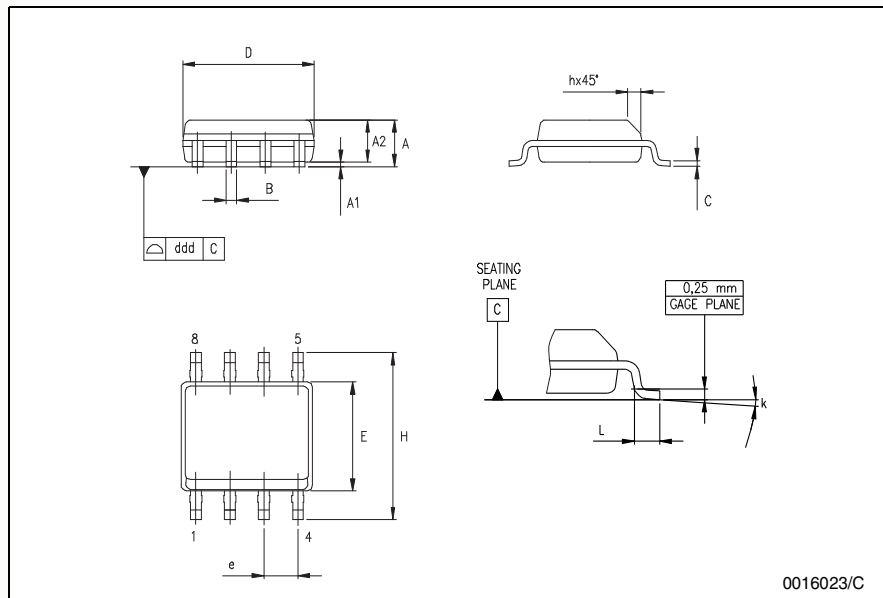
In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings 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.

6.1 DIP-8 Package



6.2 SO-8 Package

| SO-8 MECHANICAL DATA | | | | | | |
|----------------------|------------------|------|------|-------|-------|-------|
| DIM. | mm. | | | inch | | |
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 1.35 | | 1.75 | 0.053 | | 0.069 |
| A1 | 0.10 | | 0.25 | 0.04 | | 0.010 |
| A2 | 1.10 | | 1.65 | 0.043 | | 0.065 |
| B | 0.33 | | 0.51 | 0.013 | | 0.020 |
| C | 0.19 | | 0.25 | 0.007 | | 0.010 |
| D | 4.80 | | 5.00 | 0.189 | | 0.197 |
| E | 3.80 | | 4.00 | 0.150 | | 0.157 |
| e | | 1.27 | | | 0.050 | |
| H | 5.80 | | 6.20 | 0.228 | | 0.244 |
| h | 0.25 | | 0.50 | 0.010 | | 0.020 |
| L | 0.40 | | 1.27 | 0.016 | | 0.050 |
| k | 8° (max.) | | | | | |
| ddd | | | 0.1 | | | 0.04 |



7 Revision History

Table 8. Document revision history

| Date | Revision | Changes |
|-----------|----------|--|
| Dec. 2001 | 1 | First Release |
| July 2005 | 2 | 1 - PPAP references inserted in the datasheet see <i>Table : on page 1</i> 2 - ESD protection inserted in <i>Table I: Key parameters and their absolute maximum ratings on page 2</i> |
| Oct. 2005 | 3 | The following changes were made in this revision: – Some errors in the Order Codes table was corrected <i>on page 1</i> . – Reorganization of <i>Chapter 5: Macromodels on page 12</i> . |
| Feb. 2006 | 4 | – Parameters added in <i>Table 1. on page 3</i> (T_j , ESD, R_{thja} , R_{thjc}). |

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED REPRESENTATIVE OF ST, ST PRODUCTS ARE NOT DESIGNED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS, WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2006 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com