

## Low noise dual operational amplifier

### Features

- Low voltage noise: **4.5 nV/√Hz**
- High gain bandwidth product: **15 MHz**
- High slew rate: **7 V/μs**
- Low distortion: 0.002%
- Large output voltage swing: +14.3 V / -14.6 V
- Low input offset voltage
- Excellent frequency stability
- ESD protection 2 kV
- Macromodel included in this specification

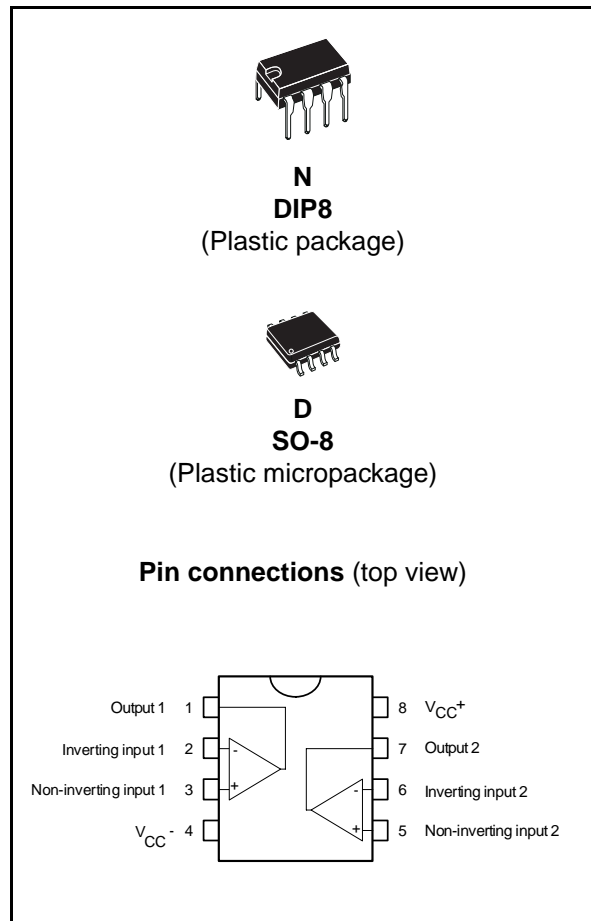
### Description

The MC33078 is a monolithic dual operational amplifier particularly well suited for audio applications.

It offers low voltage noise (4.5 nV/√Hz) and high frequency performance (15 MHz gain bandwidth product, 7 V/μs slew rate).

In addition, the MC33078 has a very low distortion (0.002%) and excellent phase/gain margins.

The output stage allows a large output voltage swing and symmetrical source and sink currents.



# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings (AMR)**

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply voltage	±18 or +36	V
V <sub>id</sub>	Differential input voltage - note <sup>(1)</sup>	±30	V
V <sub>i</sub>	Input voltage - see note 1	±15	V
	Output short circuit duration	Infinite	s
T <sub>j</sub>	Junction temperature	+150	°C
T <sub>stg</sub>	Storage temperature	-65 to +150	°C
R <sub>thja</sub>	Thermal resistance junction to ambient <sup>(2) (3)</sup>		°C/W
	SO-8 DIP8	125 85	
R <sub>thjc</sub>	Thermal resistance junction to case <sup>(2) (3)</sup>		°C/W
	SO-8 DIP8	40 41	
ESD	HBM: human body model <sup>(4)</sup>	2	kV
	MM: machine model <sup>(5)</sup>	200	V
	CDM: charged device model <sup>(6)</sup>	1.5	kV

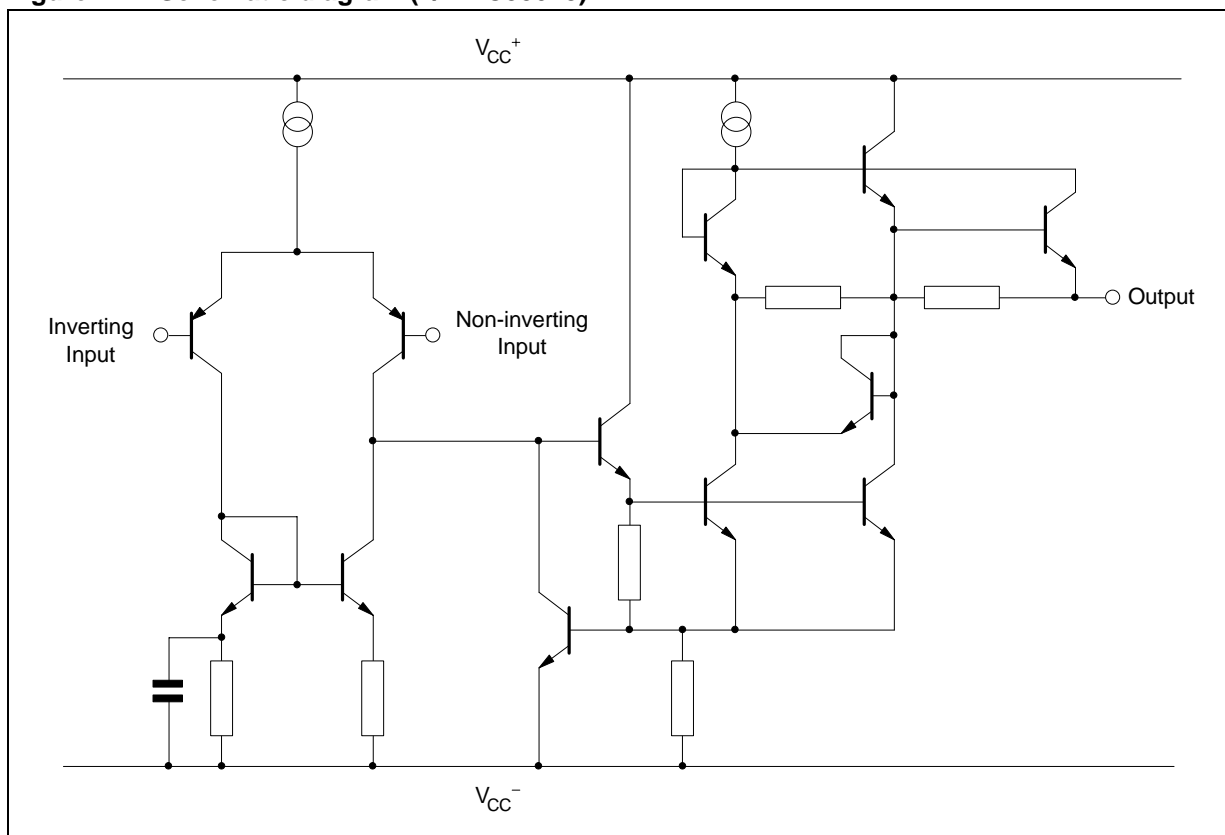
1. Either or both input voltages must not exceed the magnitude of V<sub>CC</sub><sup>+</sup> or V<sub>CC</sub><sup>-</sup>.
2. Short-circuits can cause excessive heating and destructive dissipation.
3. R<sub>th</sub> are typical values.
4. Human body model: A 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
5. 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.
6. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.

**Table 2. Operating conditions**

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply voltage	±2.5 to ±15	V
T <sub>oper</sub>	Operating free-air temperature range	-40 to 105	°C

## 2 Schematic diagram

Figure 1. Schematic diagram (1/2 MC33078)



### 3 Electrical characteristics

**Table 3.**  $V_{CC}^+ = +15V$ ,  $V_{CC}^- = -15V$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input offset voltage ( $V_o = 0V$ , $V_{ic} = 0V$ ) $T_{min} \leq T_{amb} \leq T_{max}$		0.15	2 3	mV
$DV_{io}$	Input offset voltage drift $V_o = 0V$ , $V_{ic} = 0V$ , $T_{min} \leq T_{amb} \leq T_{max}$		2		$\mu V/^\circ C$
$I_{io}$	Input offset current ( $V_o = 0V$ , $V_{ic} = 0V$ ) $T_{min} \leq T_{amb} \leq T_{max}$		10	150 175	nA
$I_{ib}$	Input bias current ( $V_o = 0V$ , $V_{ic} = 0V$ ) $T_{min} \leq T_{amb} \leq T_{max}$		250	750 800	nA
$V_{icm}$	Input common mode voltage range ( $\Delta V_{io} = 5mV$ , $V_o = 0V$ )	$\pm 13$	$\pm 14$		V
$A_{vd}$	Large signal voltage gain ( $R_L = 2k\Omega$ , $V_o = \pm 10V$ ) $T_{min} \leq T_{amb} \leq T_{max}$	90 85	100		dB
$\pm V_{opp}$	Output voltage swing ( $V_{id} = \pm 1V$ ) $R_L = 600\Omega$ $R_L = 600\Omega$ $R_L = 2.0k\Omega$ $R_L = 2.0k\Omega$ $R_L = 10k\Omega$ $R_L = 10k\Omega$	13.2 13.5	12.2 -12.7 14 -14.2 14.3 -14.6	-13.2 -14	V
CMR	Common-mode rejection ratio ( $V_{ic} = \pm 13V$ )	80	100		dB
SVR	Supply voltage rejection ratio $V_{CC}^+ / V_{CC}^- = +15V / -15V$ to $+5V / -5V$	80	105		dB
$I_o$	Output short-circuit current ( $V_{id} = \pm 1V$ , output to ground) Source Sink	15 20	29 37		mA
$I_{CC}$	Supply current ( $V_o = 0V$ , all amplifiers) $T_{min} \leq T_{amb} \leq T_{max}$		4	5 5.5	mA
SR	Slew rate $V_i = -10V$ to $+10V$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , $A_V = +1$	5	7		V/ $\mu s$
GBP	Gain bandwidth product $R_L = 2k\Omega$ , $C_L = 100pF$ , $f = 100kHz$	10	15		MHz
B	Unity gain bandwidth (Open loop)		9		MHz
$A_m$	Gain margin ( $R_L = 2k\Omega$ ), $C_L = 0pF$ $C_L = 100pF$		-11 -6		dB
$\phi_m$	Phase margin ( $R_L = 2k\Omega$ ), $C_L = 0pF$ $C_L = 100pF$		55 30		Degrees
$e_n$	Equivalent input noise voltage $R_S = 100\Omega$ , $f = 1kHz$		4.5		nV/ $\sqrt{Hz}$
$i_n$	Equivalent input noise current ( $f = 1kHz$ )		0.5		pA/ $\sqrt{Hz}$

Table 3.  $V_{CC}^+ = +15V$ ,  $V_{CC}^- = -15V$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified) (continued)

Symbol	Parameter	Min.	Typ.	Max.	Unit
THD	Total harmonic distortion $R_L = 2k\Omega$ , $f = 20Hz$ to $20kHz$ , $V_o = 3V_{rms}$ , $A_V = +1$		0.002		%
$V_{O1}/V_{O2}$	Channel separation $f = 20Hz$ to $20kHz$		120		dB
FPB	Full power bandwidth $V_o = 27V_{pp}$ , $R_L = 2k\Omega$ , $THD \leq 1\%$		120		kHz
$Z_o$	Output impedance $V_o = 0V$ , $f = 9MHz$		37		$\Omega$
$R_i$	Input resistance $V_{ic} = 0V$		175		$k\Omega$
$C_i$	Input capacitance $V_{ic} = 0V$		12		pF

Figure 2. Total supply current vs. supply voltage

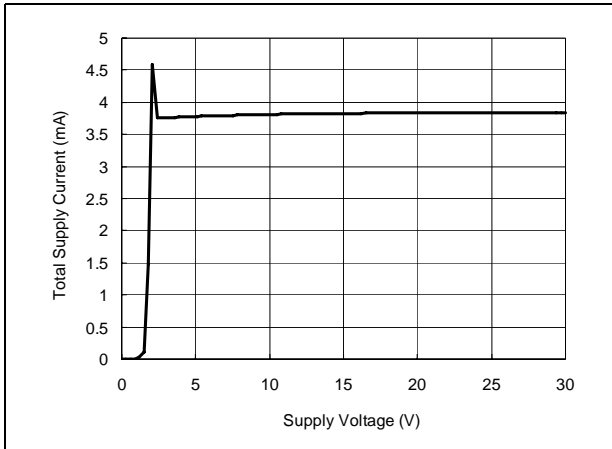


Figure 3. Output voltage vs. supply voltage

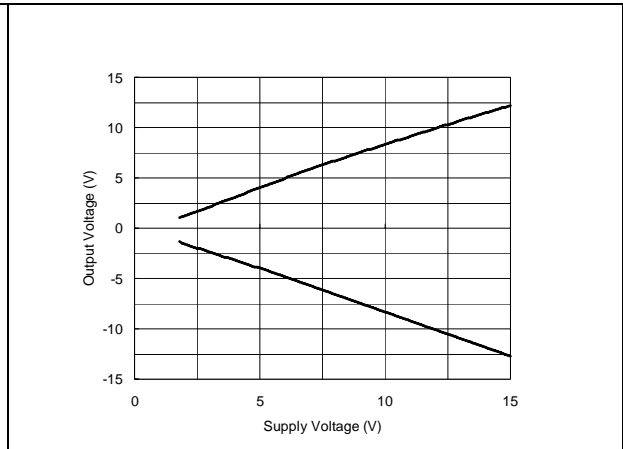


Figure 4. Equivalent input noise voltage vs. frequency

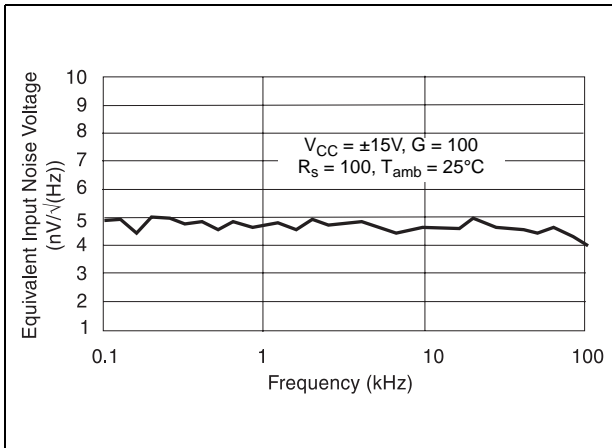


Figure 5. Output short circuit current vs. output voltage

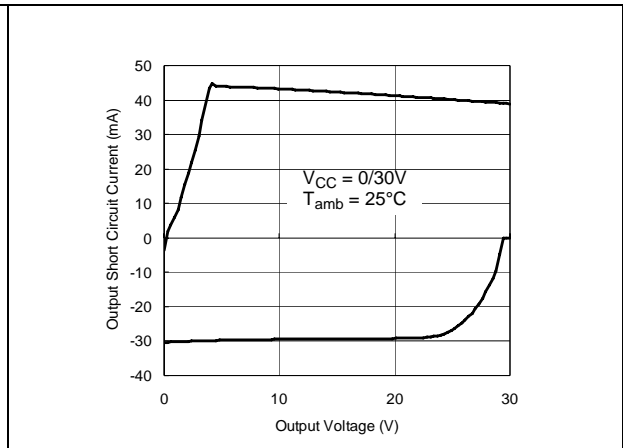


Figure 6. Output voltage vs. supply voltage

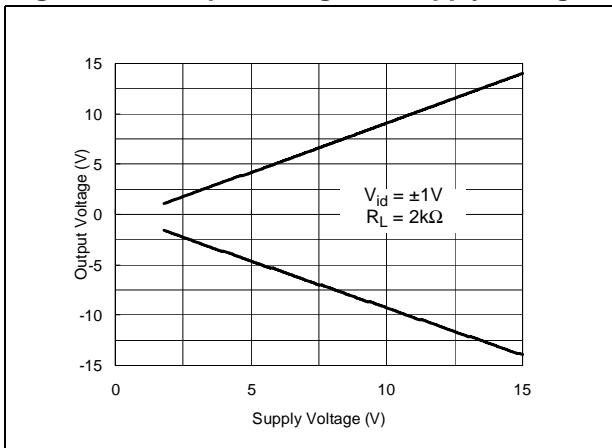


Figure 7. THD + noise vs. frequency

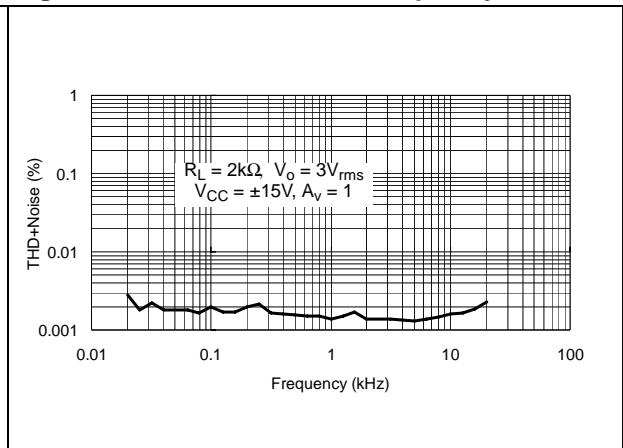


Figure 8. Voltage gain and phase vs. frequency

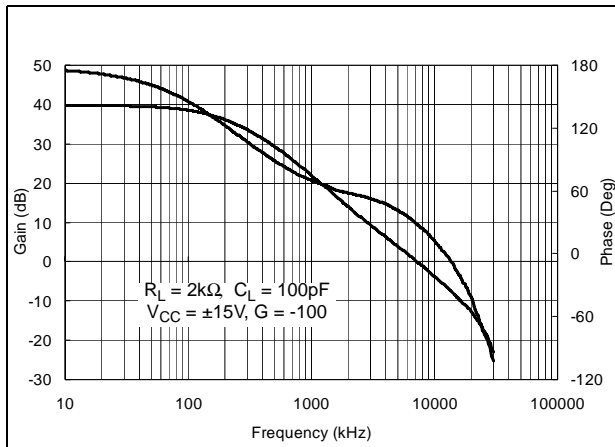
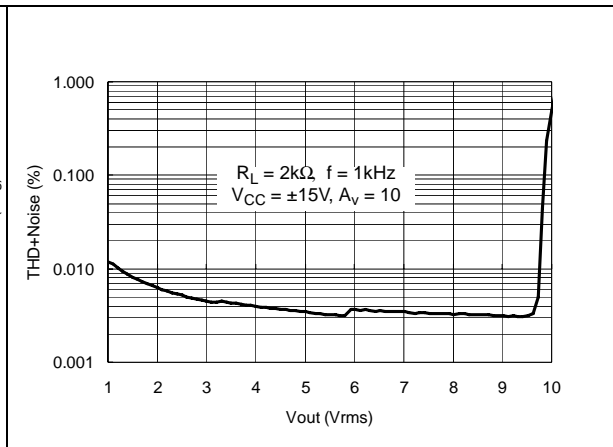


Figure 9. THD+noise vs.  $V_{out}$



## 4 Macromodel

### 4.1 Important note concerning this macromodel

Please consider the 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** (temperature, supply voltage, for example). 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 ( $V_{CC}$ , temperature, for example) or even worse, outside of the device operating conditions ( $V_{CC}$ ,  $V_{icm}$ , for example), is not reliable in any way.

[Section 4.2](#) provides the electrical characteristics resulting from the use of this macromodel.

### 4.2 Electrical characteristics from macromodelization

**Table 4. Electrical characteristics resulting from macromodel simulation at  $V_{CC}^+ = +15V$ ,  $V_{CC}^- = -15V$ ,  $T_{amb} = 25^{\circ}C$  (unless otherwise specified)**

Symbol	Conditions	Value	Unit
$V_{io}$		0	mV
$A_{VD}$	$R_L = 2k\Omega$ , $V_O = \pm 10V$	100	dB
$I_{CC}$	No load, per operator	2	mA
$V_{icm}$	$\Delta V_{io} = 5mV$ , $V_O = 0V$	28	V
$V_{opp}$	$R_L = 2k\Omega$	28.2	V
$I_{sink}$	$V_O = 0V$	37	mA
$I_{source}$	$V_O = 0V$	29	mA
GBP	$R_L = 2k\Omega$ , $C_L = 100pF$	15	MHz
SR	$R_L = 10k\Omega$ , $C_L = 100pF$ , $A_V = +1$	7	V/ $\mu s$
$\phi_m$	$R_L = 2k\Omega$ , $C_L = 0pF$	55	Degrees



### 4.3 Macromodel code

```

** Standard Linear Ics Macromodels, 1993.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY
.SUBCKT MC33078 1 3 2 4 5
*****
.MODEL MDTH D IS=1E-8 KF=2.286238E-16 CJO=10F
* INPUT STAGE
CIP 2 5 1.200000E-11
CIN 1 5 1.200000E-11
EIP 10 5 2 5 1
EIN 16 5 1 5 1
RIP 10 11 2.363636E+00
RIN 15 16 2.363636E+00
RIS 11 15 1.224040E+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 1.100000E-04
CPS 11 15 2.35E-09
DINN 17 13 MDTH 400E-12
VIN 17 5 1.000000E+00
DINR 15 18 MDTH 400E-12
VIP 4 18 1.000000E+00
FCP 4 5 VOFN 1.718182E+01
FCN 5 4 VOFN 1.718182E+01
FIBP 2 5 VOFN 4.545455E-03
FIBN 5 1 VOFN 4.545455E-03
* AMPLIFYING STAGE
FIP 5 19 VOFN 9.545455E+02
FIN 5 19 VOFN 9.545455E+02
CC 19 29 1.500000E-08
HZTP 30 29 VOFN 1.523529E+02
HZTN 5 30 VOFN 1.523529E+02
DOPM 51 22 MDTH 400E-12
DONM 21 52 MDTH 400E-12
HOPM 22 28 VOUT 5.172414E+03
VIPM 28 4 1.500000E+02
HONM 21 27 VOUT 4.054054E+03
VINM 5 27 1.500000E+02
DBIDON1 19 53 MDTH 400E-12
V1 51 53 0.68
DBIDON2 54 19 MDTH 400E-12
V2 54 52 0.68
RG11 51 5 3.04E+05
RG12 51 4 3.04E+05

```

```
RG21 52 5 0.6072E+05
RG22 52 4 0.6072E+05
E1 50 40 51 0 1 E2 40 39 52 0 1
EDEC1 38 39 4 0 0.5
EDEC2 0 38 5 0 0.5
DOP 51 25 MDTH 400E-12
VOP 4 25 1.474575E+00
DON 24 52 MDTH 400E-12
VON 24 5 1.474575E+00
RAJUS 50 5 1E12
GCOMP 5 4 4 5 8.1566068E-04
RPM1 5 80 1E+06
RPM2 4 80 1E+06
GAVPH 5 82 50 80 3.26E-03
RAVPHGH 82 4 613
RAVPHGB 82 5 613
RAVPHDH 82 83 1000
RAVPHDB 82 84 1000
CAVPHH 4 83 0.159E-09
CAVPHB 5 84 0.159E-09
EOUT 26 23 82 5 1
VOUT 23 5 0
ROUT 26 3 4.780354E+01
COUT 3 5 1.000000E-12
.ENDS
```

## 5 Package information

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> 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](http://www.st.com).

### 5.1 DIP8 package information

Figure 10. DIP8 package mechanical drawing

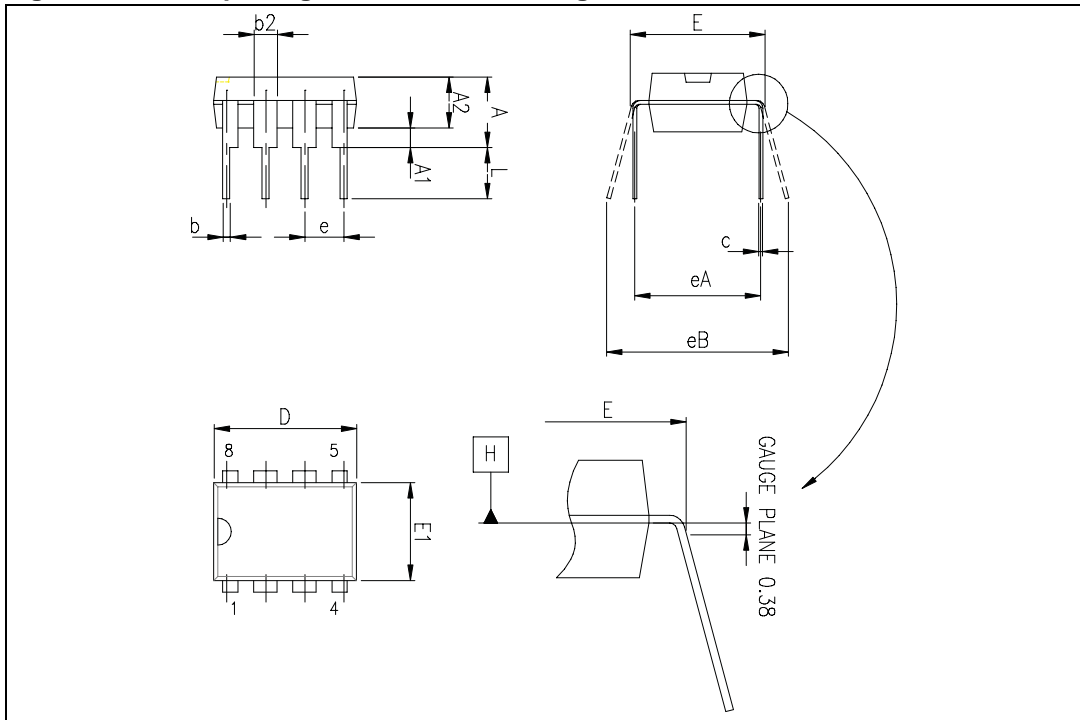


Table 5. DIP8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.210
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.115	0.130	0.195
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.045	0.060	0.070
c	0.20	0.25	0.36	0.008	0.010	0.014
D	9.02	9.27	10.16	0.355	0.365	0.400
E	7.62	7.87	8.26	0.300	0.310	0.325
E1	6.10	6.35	7.11	0.240	0.250	0.280
e		2.54			0.100	
eA		7.62			0.300	
eB			10.92			0.430
L	2.92	3.30	3.81	0.115	0.130	0.150

## 5.2 SO-8 package information

Figure 11. SO-8 package mechanical drawing

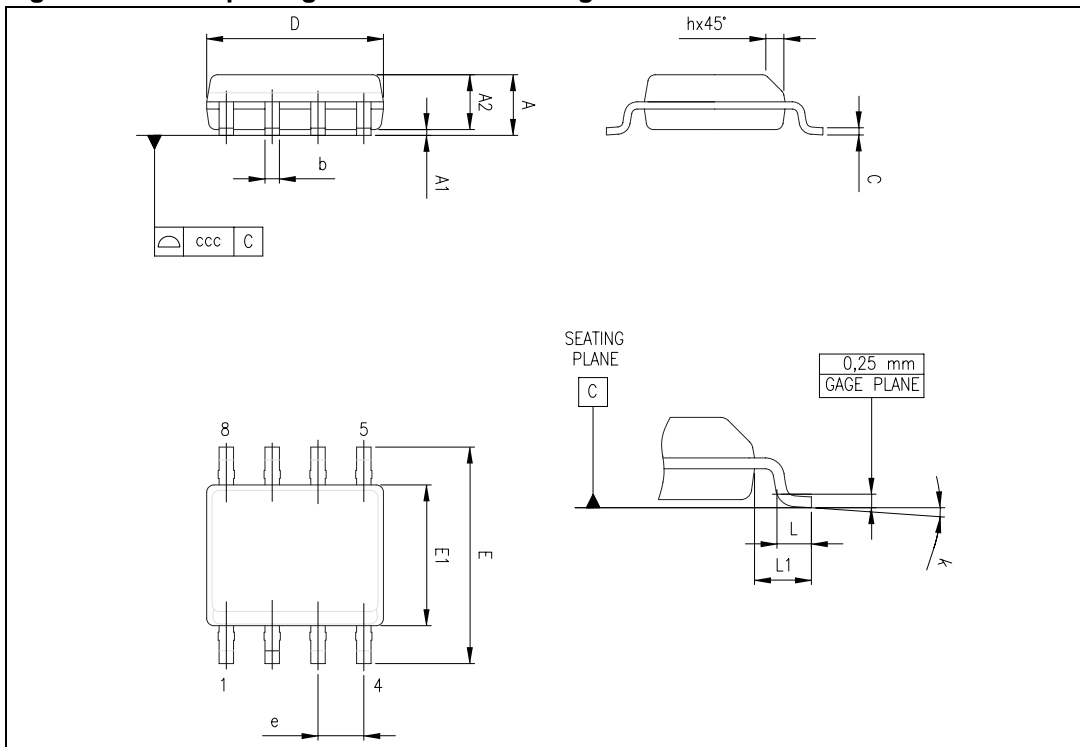


Table 6. SO-8 package mechanical data

Ref.	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
k	1°		8°	1°		8°
ccc			0.10			0.004

## 6 Ordering information

**Table 7. Order codes**

Order code	Temperature range	Package	Packing	Marking
MC33078N	-40, +105°C	DIP8	Tube	MC33078N
MC33078D MC33078DT		SO-8	Tube or Tape & reel	33078
MC33078YD <sup>(1)</sup> MC33078YDT <sup>(1)</sup>		SO-8 (Automotive grade)	Tube or Tape & reel	33078Y

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are on-going.

## 7 Revision history

**Table 8. Document revision history**

Date	Revision	Changes
10-Nov-2001	1	Initial release.
10-Jun-2005	2	PPAP references inserted in the datasheet, see order codes table.
30-Sep- 2005	3	The following changes were made in this revision: – Order codes table updated with complete list of markings and packages. – Reorganization of <a href="#">Chapter 4.3: Macromodel code on page 9</a> .
16-Feb-2006	4	Corrected error in the first page title.
3-Mar-2008	5	Added R <sub>th</sub> and ESD values in absolute maximum ratings table. Added footnote for automotive grade order codes in order codes table. Re-formatted document.

**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 ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, 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. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

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.

© 2008 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](http://www.st.com)

