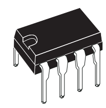
MC33078

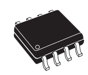
Low noise dual operational amplifier

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

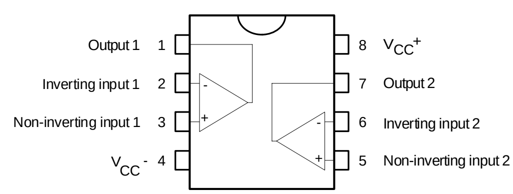


N
DIP8
(Plastic package)



D
SO-8
(Plastic micropackage)

Pin connections (top view)



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_{CC}	Supply voltage	±18 or +36	V
V_{id}	Differential input voltage - note (1)	±30	V
V_i	Input voltage - see note 1	±15	V
	Output short circuit duration	Infinite	s
T_j	Junction temperature	+150	°C
T_{stg}	Storage temperature	-65 to +150	°C
R_{thja}	Thermal resistance junction to ambient(2) (3) SO-8 DIP8	 125 85	°C/W
R_{thjc}	Thermal resistance junction to case(2) (3) SO-8 DIP8	 40 41	°C/W
ESD	HBM: human body model(4)	2	kV
	MM: machine model(5)	200	V
	CDM: charged device model(6)	1.5	kV

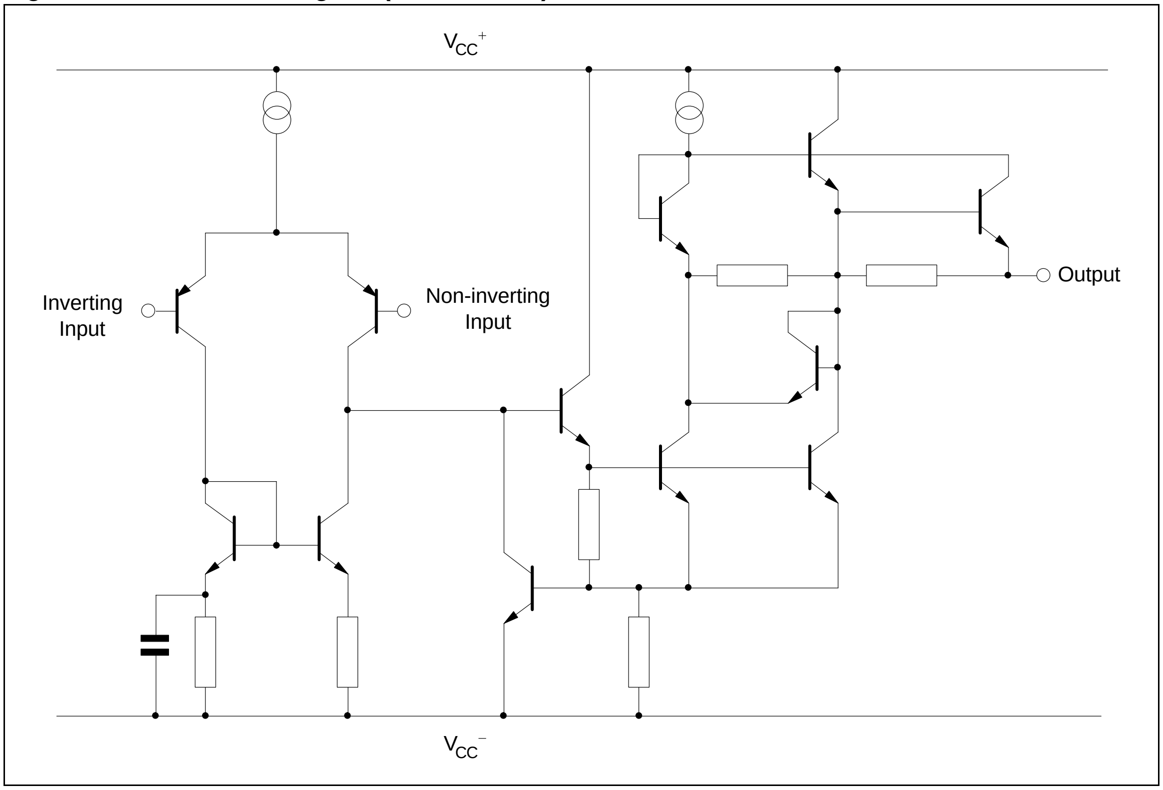
1. Either or both input voltages must not exceed the magnitude of V_{CC}^+ or V_{CC}^-.
2. Short-circuits can cause excessive heating and destructive dissipation.
3. R_{th} are typical values.
4. Human body model: A 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ 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_{CC}	Supply voltage	±2.5 to ±15	V
T_{oper}	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°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage (V_o = 0V, V_{ic} = 0V) $T_{min} \le T_{amb} \le T_{max}$		0.15	2 3	mV
DV_{io}	Input offset voltage drift V_o = 0V, V_{ic} = 0V, $T_{min} \le T_{amb} \le T_{max}$		2		µV/°C
I_{io}	Input offset current (V_o = 0V, V_{ic} = 0V) $T_{min} \le T_{amb} \le T_{max}$		10	150 175	nA
I_{ib}	Input bias current (V_o = 0V, V_{ic} = 0V) $T_{min} \le T_{amb} \le T_{max}$		250	750 800	nA
V_{icm}	Input common mode voltage range (ΔV_{io} = 5mV, V_o = 0V)	±13	±14		V
A_{vd}	Large signal voltage gain (R_L = 2kΩ, V_o = ±10V) $T_{min} \le T_{amb} \le T_{max}$	90 85	100		dB
$\pm V_{opp}$	Output voltage swing (V_{id} = ±1V) R_L = 600Ω R_L = 600Ω R_L = 2.0kΩ R_L = 2.0kΩ R_L = 10kΩ R_L = 10kΩ	 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} = ±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} = ±1V, output to ground) Source Sink	 15 20	 29 37		mA
I_{CC}	Supply current (V_o = 0V, all amplifiers) $T_{min} \le T_{amb} \le T_{max}$		4	5 5.5	mA
SR	Slew rate V_i = -10V to +10V, R_L = 2kΩ, C_L = 100pF, A_V = +1	5	7		V/µs
GBP	Gain bandwidth product R_L = 2kΩ, C_L = 100pF, f = 100kHz	10	15		MHz
B	Unity gain bandwidth (Open loop)		9		MHz
A_m	Gain margin (R_L = 2kΩ), C_L = 0pF C_L = 100pF		-11 -6		dB
ϕm	Phase margin (R_L = 2kΩ), C_L = 0pF C_L = 100pF		55 30		Degrees
e_n	Equivalent input noise voltage R_S = 100Ω, f = 1kHz		4.5		nV/√Hz
i_n	Equivalent input noise current (f = 1kHz)		0.5		pA/√Hz

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
THD	Total harmonic distortion R_L = 2kΩ, 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 = 2kΩ, THD ≤ 1%		120		kHz
Z_o	Output impedance V_o = 0V, f = 9MHz		37		Ω
R_i	Input resistance V_{ic} = 0V		175		kΩ
C_i	Input capacitance V_{ic} = 0V		12		pF

Figure 2. Total supply current vs. supply voltage

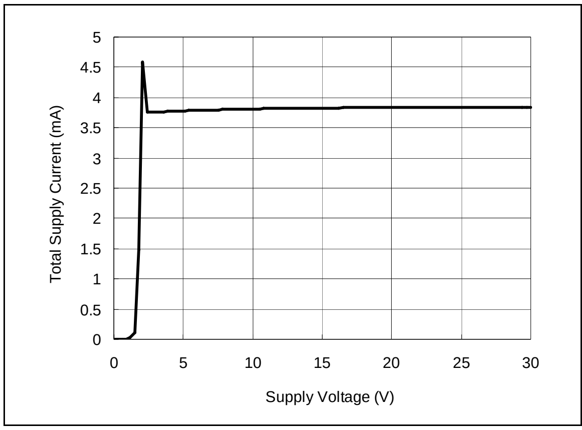


Figure 3. Output voltage vs. supply voltage

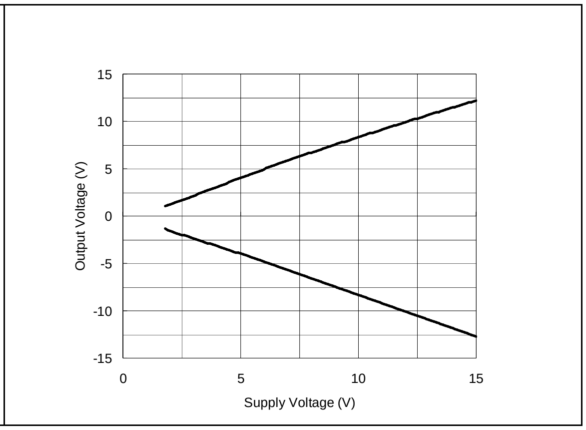


Figure 4. Equivalent input noise voltage vs. frequency

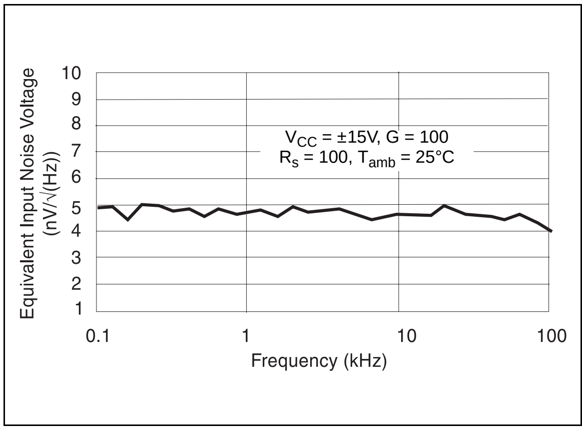


Figure 5. Output short circuit current vs. output voltage

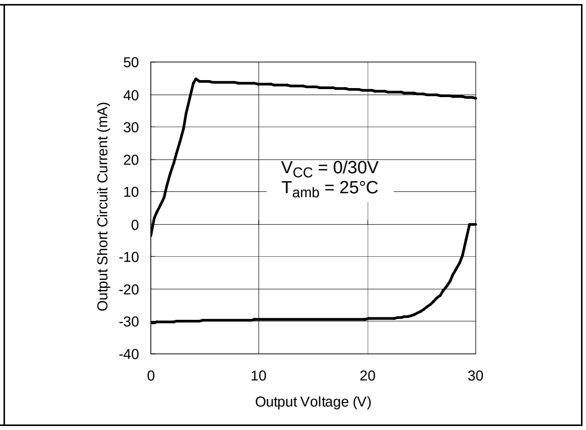


Figure 6. Output voltage vs. supply voltage

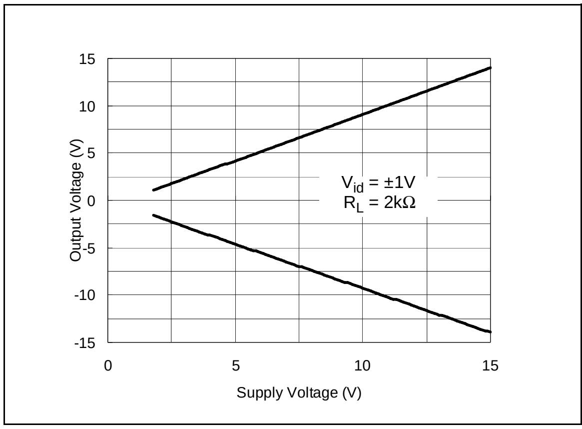


Figure 7. THD + noise vs. frequency

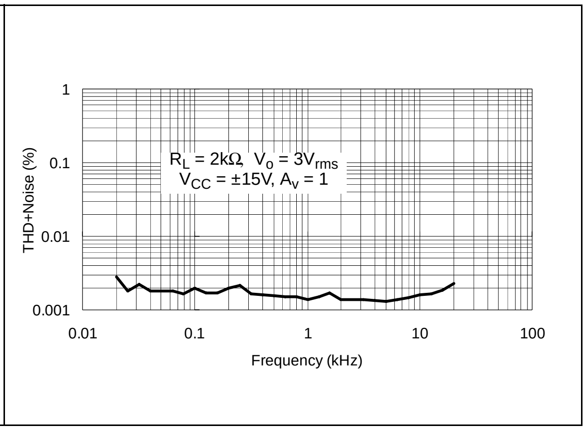


Figure 8. Voltage gain and phase vs. frequency

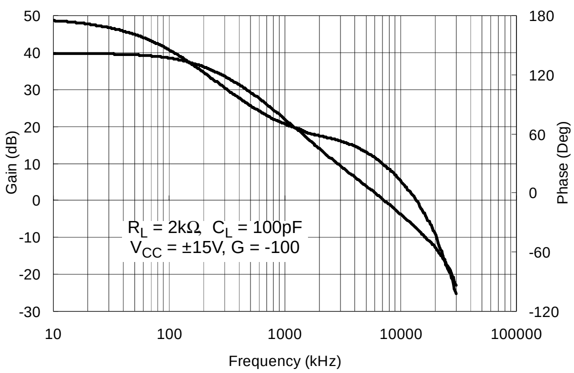
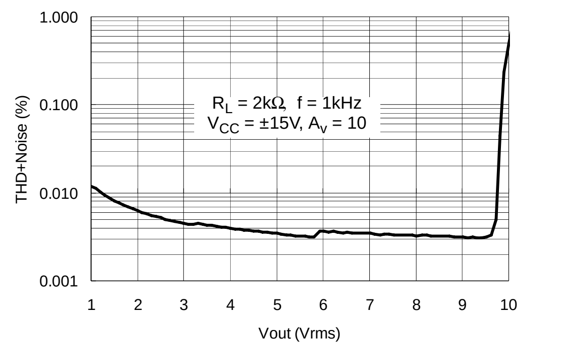


Figure 9. THD noise vs. V_{out}



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°C (unless otherwise specified)

Symbol	Conditions	Value	Unit
V_{io}		0	mV
A_{VD}	R_L = 2kΩ, V_O = ±10V	100	dB
I_{CC}	No load, per operator	2	mA
V_{icm}	ΔV_{io} = 5mV, V_O = 0V	28	V
V_{opp}	R_L = 2kΩ	28.2	V
I_{sink}	V_O = 0V	37	mA
I_{source}	V_O = 0V	29	mA
GBP	R_L = 2kΩ, C_L = 100pF	15	MHz
SR	R_L = 10kΩ, C_L = 100pF, A_V = +1	7	V/μs
ϕm	R_L = 2kΩ, 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 VOFP 1.718182E+01
FCN 5 4 VOFN 1.718182E+01
FIBP 2 5 VOFN 4.545455E-03
FIBN 5 1 VOFP 4.545455E-03
* AMPLIFYING STAGE
FIP 5 19 VOFP 9.545455E+02
FIN 5 19 VOFN 9.545455E+02
CC 19 29 1.500000E-08
HZTP 30 29 VOFP 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® 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 DIP8 package information

Figure 10. DIP8 package mechanical drawing

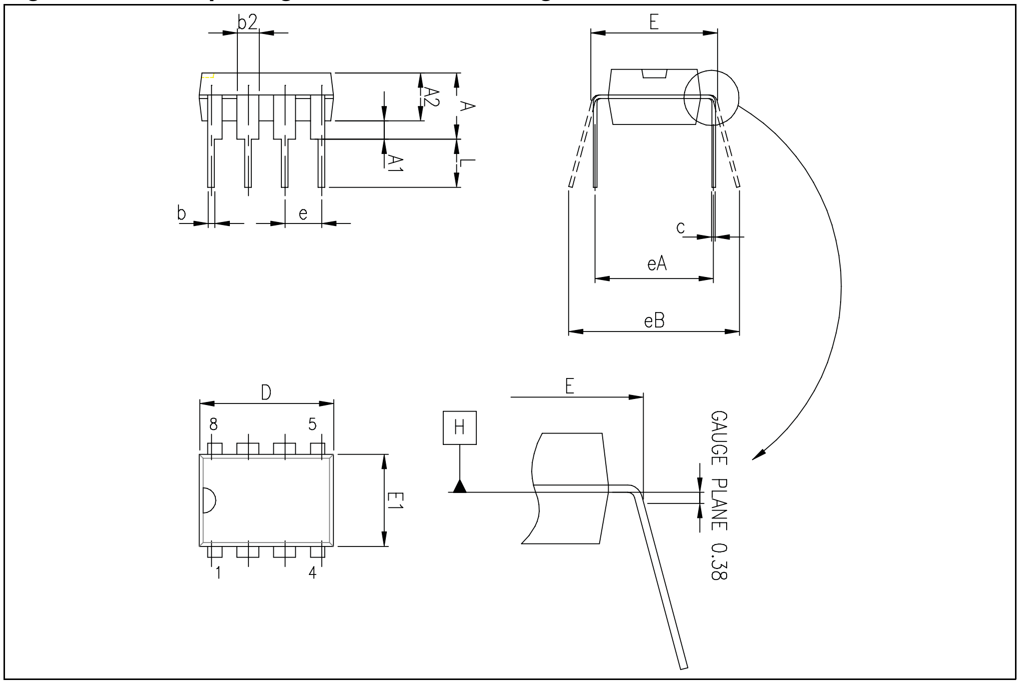


Table 5. DIP8 package mechanical data

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

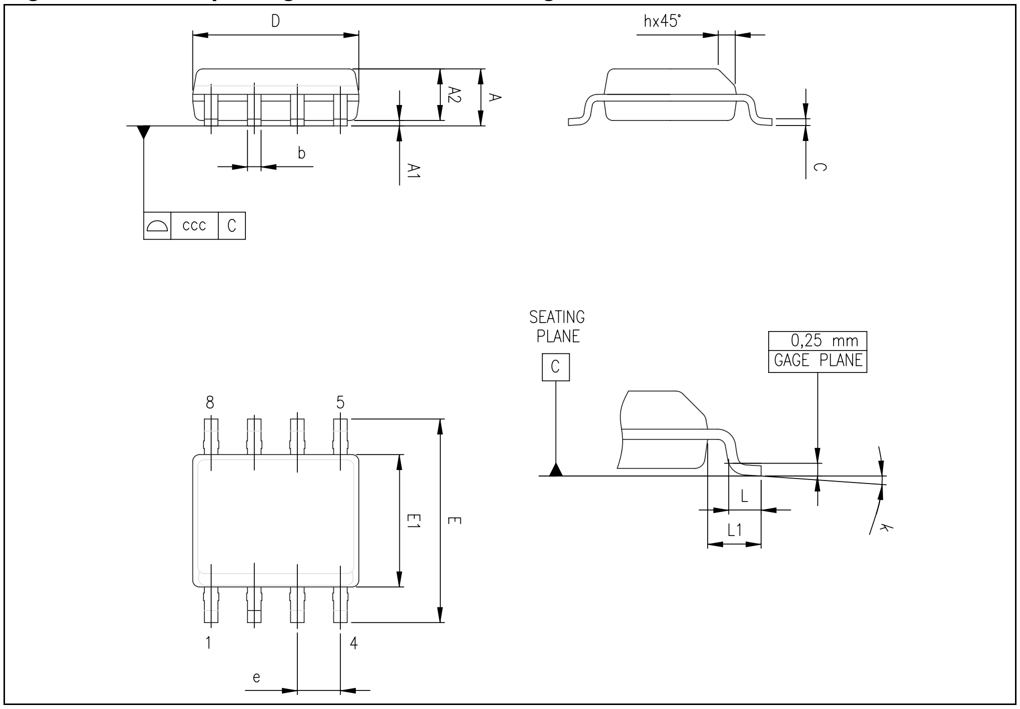


Table 6. SO-8 package mechanical data

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 (1) MC33078YDT (1)		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 *Chapter 4.3: Macromodel code on page 9*.
16-Feb-2006	4	Corrected error in the first page title.
3-Mar-2008	5	Added R_{th} and ESD values in absolute maximum ratings table. Added footnote for automotive grade order codes in order codes table. Re-formatted document.

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