

MC33201, MC33202, MC33204, NCV33202, NCV33204

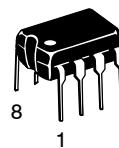


ON Semiconductor®

Low Voltage, Rail-to-Rail Operational Amplifiers

The MC33201/2/4 family of operational amplifiers provide rail-to-rail operation on both the input and output. The inputs can be driven as high as 200 mV beyond the supply rails without phase reversal on the outputs, and the output can swing within 50 mV of each rail. This rail-to-rail operation enables the user to make full use of the supply voltage range available. It is designed to work at very low supply voltages (± 0.9 V) yet can operate with a supply of up to +12 V and ground. Output current boosting techniques provide a high output current capability while keeping the drain current of the amplifier to a minimum. Also, the combination of low noise and distortion with a high slew rate and drive capability make this an ideal amplifier for audio applications.

- Low Voltage, Single Supply Operation (+1.8 V and Ground to +12 V and Ground)
- Input Voltage Range Includes both Supply Rails
- Output Voltage Swings within 50 mV of both Rails
- No Phase Reversal on the Output for Over-driven Input Signals
- High Output Current ($I_{SC} = 80$ mA, Typ)
- Low Supply Current ($I_D = 0.9$ mA, Typ)
- $600\ \Omega$ Output Drive Capability
- Extended Operating Temperature Ranges (-40° to +105°C and -55° to +125°C)
- Typical Gain Bandwidth Product = 2.2 MHz
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes
- Pb-Free Packages are Available



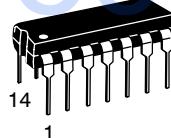
PDIP-8
P, VP SUFFIX
CASE 626



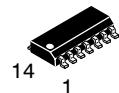
SOIC-8
D, VD SUFFIX
CASE 751



Micro8™
DM SUFFIX
CASE 846A



PDIP-14
P, VP SUFFIX
CASE 646



SOIC-14
D, VD SUFFIX
CASE 751A



TSSOP-14
DTB SUFFIX
CASE 948G

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 12 of this data sheet.

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MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage (V_{CC} to V_{EE})	V_S	+13	V
Input Differential Voltage Range	V_{IDR}	Note 1	V
Common Mode Input Voltage Range (Note 2)	V_{CM}	$V_{CC} + 0.5$ V to $V_{EE} - 0.5$ V	V
Output Short Circuit Duration	t_s	Note 3	sec
Maximum Junction Temperature	T_J	+150	°C
Storage Temperature	T_{stg}	-65 to +150	°C
Maximum Power Dissipation	P_D	Note 3	mW

DC ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$)

Characteristic	$V_{CC} = 2.0$ V	$V_{CC} = 3.3$ V	$V_{CC} = 5.0$ V	Unit
Input Offset Voltage V_{IO} (max) MC33201 MC33202, NCV33202 MC33204, NCV33204	± 8.0 ± 10 ± 12	± 8.0 ± 10 ± 12	± 6.0 ± 8.0 ± 10	mV
Output Voltage Swing V_{OH} ($R_L = 10$ kΩ) V_{OL} ($R_L = 10$ kΩ)	1.9 0.10	3.15 0.15	4.85 0.15	V_{min} V_{max}
Power Supply Current per Amplifier (I_D)	1.125	1.125	1.125	mA

Specifications at $V_{CC} = 3.3$ V are guaranteed by the 2.0 V and 5.0 V tests. $V_{EE} = \text{GND}$.

DC ELECTRICAL CHARACTERISTICS ($V_{CC} = +5.0$ V, $V_{EE} = \text{Ground}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

Characteristic	Figure	Symbol	Min	Typ	Max	Unit
Input Offset Voltage ($V_{CM} = 0$ V to 0.5 V, $V_{CM} = 1.0$ V to 5.0 V) MC33201: $T_A = +25^\circ\text{C}$ MC33201: $T_A = -40^\circ$ to $+105^\circ\text{C}$ MC33201V: $T_A = -55^\circ$ to $+125^\circ\text{C}$ MC33202: $T_A = +25^\circ\text{C}$ MC33202: $T_A = -40^\circ$ to $+105^\circ\text{C}$ MC33202V: $T_A = -55^\circ$ to $+125^\circ\text{C}$ NCV33202V: $T_A = -55^\circ$ to $+125^\circ\text{C}$ (Note 4) MC33204: $T_A = +25^\circ\text{C}$ MC33204: $T_A = -40^\circ$ to $+105^\circ\text{C}$ MC33204V: $T_A = -55^\circ$ to $+125^\circ\text{C}$ NCV33204: $T_A = -55^\circ$ to $+125^\circ\text{C}$	3	$ V_{IO} $	-	-	6.0 9.0 13 8.0 11 14 14 10 13 17 17	mV
Input Offset Voltage Temperature Coefficient ($R_S = 50$ Ω) $T_A = -40^\circ$ to $+105^\circ\text{C}$ $T_A = -55^\circ$ to $+125^\circ\text{C}$	4	$\Delta V_{IO}/\Delta T$	-	2.0 2.0	-	$\mu\text{V}/^\circ\text{C}$
Input Bias Current ($V_{CM} = 0$ V to 0.5 V, $V_{CM} = 1.0$ V to 5.0 V) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+105^\circ\text{C}$ $T_A = -55^\circ$ to $+125^\circ\text{C}$	5, 6	$ I_{IB} $	-	80 100	200 250 500	nA

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. The differential input voltage of each amplifier is limited by two internal parallel back-to-back diodes. For additional differential input voltage range, use current limiting resistors in series with the input pins.
2. The input common mode voltage range is limited by internal diodes connected from the inputs to both supply rails. Therefore, the voltage on either input must not exceed either supply rail by more than 500 mV.
3. Power dissipation must be considered to ensure maximum junction temperature (T_J) is not exceeded. (See Figure 2)
4. *NCV33202 and NCV33204 are qualified for automotive use.*

MC33201, MC33202, MC33204, NCV33202, NCV33204

DC ELECTRICAL CHARACTERISTICS (cont.) ($V_{CC} = + 5.0 \text{ V}$, $V_{EE} = \text{Ground}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

Characteristic	Figure	Symbol	Min	Typ	Max	Unit
Input Offset Current ($V_{CM} = 0 \text{ V}$ to 0.5 V , $V_{CM} = 1.0 \text{ V}$ to 5.0 V) $T_A = + 25^\circ\text{C}$ $T_A = - 40^\circ$ to $+105^\circ\text{C}$ $T_A = - 55^\circ$ to $+125^\circ\text{C}$	-	$ I_{IO} $	-	5.0 10 -	50 100 200	nA
Common Mode Input Voltage Range	-	V_{ICR}	V_{EE}	-	V_{CC}	V
Large Signal Voltage Gain ($V_{CC} = + 5.0 \text{ V}$, $V_{EE} = - 5.0 \text{ V}$) $R_L = 10 \text{ k}\Omega$ $R_L = 600 \Omega$	7	A_{VOL}	50 25	300 250	- -	kV/V
Output Voltage Swing ($V_{ID} = \pm 0.2 \text{ V}$) $R_L = 10 \text{ k}\Omega$ $R_L = 10 \text{ k}\Omega$ $R_L = 600 \Omega$ $R_L = 600 \Omega$	8, 9, 10	V_{OH} V_{OL} V_{OH} V_{OL}	4.85 - 4.75 -	4.95 0.05 4.85 0.15	- 0.15 - 0.25	V
Common Mode Rejection ($V_{in} = 0 \text{ V}$ to 5.0 V)	11	CMR	60	90	-	dB
Power Supply Rejection Ratio $V_{CC}/V_{EE} = 5.0 \text{ V}/\text{GND}$ to $3.0 \text{ V}/\text{GND}$	12	PSRR	500	25	-	$\mu\text{V/V}$
Output Short Circuit Current (Source and Sink)	13, 14	I_{SC}	50	80	-	mA
Power Supply Current per Amplifier ($V_O = 0 \text{ V}$) $T_A = - 40^\circ$ to $+105^\circ\text{C}$ $T_A = - 55^\circ$ to $+125^\circ\text{C}$	15	I_D	- -	0.9 0.9	1.125 1.125	mA

AC ELECTRICAL CHARACTERISTICS ($V_{CC} = + 5.0 \text{ V}$, $V_{EE} = \text{Ground}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

Characteristic	Figure	Symbol	Min	Typ	Max	Unit
Slew Rate ($V_S = \pm 2.5 \text{ V}$, $V_O = - 2.0 \text{ V}$ to $+ 2.0 \text{ V}$, $R_L = 2.0 \text{ k}\Omega$, $A_V = +1.0$)	16, 26	SR	0.5	1.0	-	$\text{V}/\mu\text{s}$
Gain Bandwidth Product ($f = 100 \text{ kHz}$)	17	GBW	-	2.2	-	MHz
Gain Margin ($R_L = 600 \Omega$, $C_L = 0 \text{ pF}$)	20, 21, 22	A_M	-	12	-	dB
Phase Margin ($R_L = 600 \Omega$, $C_L = 0 \text{ pF}$)	20, 21, 22	ϕ_M	-	65	-	Deg
Channel Separation ($f = 1.0 \text{ Hz}$ to 20 kHz , $A_V = 100$)	23	CS	-	90	-	dB
Power Bandwidth ($V_O = 4.0 \text{ V}_{pp}$, $R_L = 600 \Omega$, THD $\leq 1 \%$)		BW_P	-	28	-	kHz
Total Harmonic Distortion ($R_L = 600 \Omega$, $V_O = 1.0 \text{ V}_{pp}$, $A_V = 1.0$) $f = 1.0 \text{ kHz}$ $f = 10 \text{ kHz}$	24	THD	- -	0.002 0.008	- -	%
Open Loop Output Impedance ($V_O = 0 \text{ V}$, $f = 2.0 \text{ MHz}$, $A_V = 10$)		$ Z_O $	-	100	-	Ω
Differential Input Resistance ($V_{CM} = 0 \text{ V}$)		R_{in}	-	200	-	$\text{k}\Omega$
Differential Input Capacitance ($V_{CM} = 0 \text{ V}$)		C_{in}	-	8.0	-	pF
Equivalent Input Noise Voltage ($R_S = 100 \Omega$) $f = 10 \text{ Hz}$ $f = 1.0 \text{ kHz}$	25	e_n	- -	25 20	- -	$\text{nV}/\sqrt{\text{Hz}}$
Equivalent Input Noise Current $f = 10 \text{ Hz}$ $f = 1.0 \text{ kHz}$	25	i_n	- -	0.8 0.2	- -	$\text{pA}/\sqrt{\text{Hz}}$

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ORDERING INFORMATION

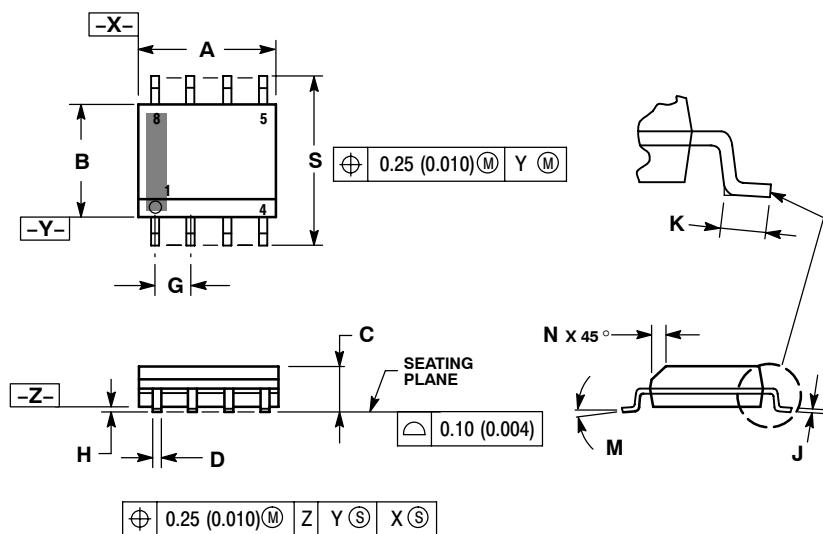
Operational Amplifier Function	Device	Operating Temperature Range	Package	Shipping [†]
Single	MC33201D	$T_A = -40^\circ \text{ to } +105^\circ\text{C}$	SOIC-8	98 Units / Rail
	MC33201DG		SOIC-8 (Pb-Free)	
	MC33201DR2		SOIC-8	2500 / Tape & Reel
	MC33201DR2G		SOIC-8 (Pb-Free)	
	MC33201P	$T_A = -55^\circ \text{ to } 125^\circ\text{C}$	PDIP-8	50 Units / Rail
	MC33201PG		PDIP-8 (Pb-Free)	
	MC33201VD		SOIC-8	98 Units / Rail
	MC33201VDG		SOIC-8 (Pb-Free)	
Dual	MC33202D	$T_A = -40^\circ \text{ to } +105^\circ\text{C}$	SOIC-8	98 Units / Rail
	MC33202DG		SOIC-8 (Pb-Free)	
	MC33202DR2		SOIC-8	2500 / Tape & Reel
	MC33202DR2G		SOIC-8 (Pb-Free)	
	MC33202DMR2		Micro-8	4000 / Tape & Reel
	MC33202DMR2G		Micro-8 (Pb-Free)	
	MC33202P		PDIP-8	50 Units / Rail
	MC33202PG		PDIP-8 (Pb-Free)	
	MC33202VD	$T_A = -55^\circ \text{ to } 125^\circ\text{C}$	SOIC-8	98 Units / Rail
	MC33202VDG		SOIC-8 (Pb-Free)	
	MC33202VDR2		SOIC-8	2500 / Tape & Reel
	MC33202VDR2G		SOIC-8 (Pb-Free)	
	NCV33202VDR2*		SOIC-8	50 Units / Rail
	NCV33202VDR2G*		SOIC-8 (Pb-Free)	
	MC33202VP		PDIP-8	
	MC33202VPG		PDIP-8 (Pb-Free)	

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

*NCV33202 and NCV33204 are qualified for automotive use.

PACKAGE DIMENSIONS

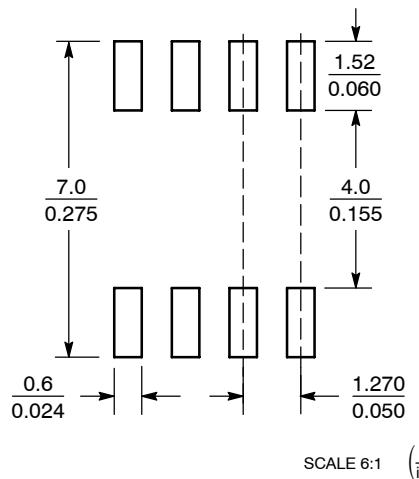
SOIC-8 NB
CASE 751-07
ISSUE AH



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: MILLIMETER.
 3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
 4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
 5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION, ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
 6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0 °	8 °	0 °	8 °
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT*



SCALE 6:1 (mm/inches)

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.