National Semiconductor

PRELIMINARY
September 2005

LMP7701
Precision, CMOS Input, RRIO, Wide Supply Range Amplifier

General Description

The LMP7701 is a single, low offset voltage, rail-to-rail input and output precision amplifier with a CMOS input stage and a wide supply voltage range. The LMP7701 is part of the LMP™ precision amplifier family and is ideal for sensor interface and other instrumentation applications.

The guaranteed low offset voltage of less than ±200 µV along with the guaranteed low input bias current of less than ±10 pA make the LMP7701 ideal for precision applications. The LMP7701 is built utilizing VIP50 technology, which allows the combination of a CMOS input stage and a 12V common mode and supply voltage range. This makes the LMP7701 a great choice in many applications where conventional CMOS parts cannot operate under the desired voltage conditions.

The LMP7701 has a rail-to-rail input stage that significantly reduces the CMRR glitch commonly associated with rail-to-rail input amplifiers. This is achieved by trimming both sides of the complimentary input stage, thereby reducing the difference between the NMOS and PMOS offsets. The output of the LMP7701 swings within 40 mV of either rail to maximize the signal dynamic range in applications requiring low supply voltage.

The LMP7701 is offered in space saving SOT23-5. This small package is an ideal solution for area constrained PC boards and portable electronics.

Features

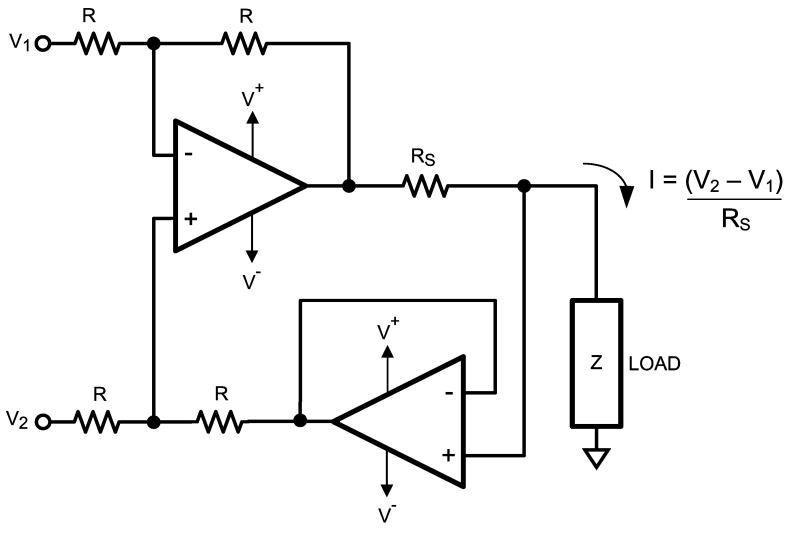
Unless otherwise noted, typical values at V_S = 5V

- Input offset voltage ±200 µV (max)
- Input bias current 300 fA
- Input voltage noise 12 nV/$\sqrt{\text{Hz}}$
- CMRR 100 dB
- Open loop gain 130 dB
- Temperature range –40˚C to 125˚C
- Unity gain bandwidth 2.5 MHz
- Supply current 715 µA
- Supply Voltage Range 2.7V to 12V
- Rail-to-rail input and output

Applications

- High impedance sensor interface
- Battery powered instrumentation
- High gain amplifiers
- DAC buffer
- Instrumentation amplifier
- Active filters

Typical Application



Precision Current Source

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Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

ESD Tolerance (Note 2)	
Human Body Model	2 kV
Machine Model	200V
V_{IN} Differential	±300 mV
Supply Voltage ($V_S = V^+ - V^-$)	13.2V
Voltage at Input/Output Pins	V^++ 0.3V, V^- − 0.3V
Input Current	10 mA
Storage Temperature Range	−65˚C to +150˚C
Junction Temperature (Note 3)	+150˚C
Soldering Information	
Infrared or Convection (20 sec)	235˚C
Wave Soldering Lead Temp. (10 sec)	260˚C

Operating Ratings (Note 1)

Temperature Range (Note 3)	−40˚C to +125˚C
Supply Voltage ($V_S = V^+ - V^-$)	2.7V to 12V
Package Thermal Resistance (θ_{JA} (Note 3))	
5-Pin SOT23	234˚C/W

3V Electrical Characteristics (Note 4)

Unless otherwise specified, all limits are guaranteed for T_A = 25˚C, V^+ = 3V, V^- = 0V, $V_{CM} = V^+/2$, and R_L > 10 kΩ to $V^+/2$. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
V_{OS}	Input Offset Voltage			±37	±200 **±500**	µV
TCV_{OS}	Input Offset Voltage Drift	(Note 7)		±1	**±5**	µV/˚C
I_B	Input Bias Current	(Notes 7, 8)		0.3	10 **300**	pA
I_{OS}	Input Offset Current			40		fA
CMRR	Common Mode Rejection Ratio	0V ≤ V_{CM} ≤ 3V	86 **80**	98		dB
PSRR	Power Supply Rejection Ratio	2.7V ≤ V^+ ≤ 12V, Vo = $V^+/2$	86 **82**	98		dB
CMVR	Input Common-Mode Voltage Range	CMRR ≥ 80 dB CMRR ≥ 77 dB	−0.2 **−0.2**		3.2 **3.2**	V
A_{VOL}	Large Signal Voltage Gain	R_L = 2 kΩ V_O = 0.3V to 2.7V	100 **96**	114		dB
		R_L = 10 kΩ V_O = 0.2V to 2.8V	100 **96**	124		
V_O	Output Swing High	R_L = 2 kΩ to $V^+/2$	2.92 **2.88**	2.96		V
		R_L = 10 kΩ to $V^+/2$	2.96 **2.94**	2.97		
	Output Swing Low	R_L = 2 kΩ to $V^+/2$		0.04	0.06 **0.08**	V
		R_L = 10 kΩ to $V^+/2$		0.02	0.04 **0.05**	
I_O	Output Short Circuit Current (Notes 3, 9)	Sourcing V_O = 0V V_{IN} = 100 mV	25 **15**	42		mA
		Sinking V_O = 3V V_{IN} = −100 mV	25 **20**	42		
I_S	Supply Current			0.670	1.0 **1.2**	mA
SR	Slew Rate (Note 10)	A_V = +1, V_O = 2 V_{PP} 10% to 90%		0.9		V/µs
GBW	Gain Bandwidth Product			2.5		MHz
THD+N	Total Harmonic Distortion + Noise	f = 1 kHz, Av = 1, R_L = 1 kΩ		0.02		%
e_n	Input-Referred Voltage Noise	f = 1 kHz		12		nV/$\sqrt{Hz}$

3V Electrical Characteristics (Note 4) (Continued)

Unless otherwise specified, all limits are guaranteed for T_A = 25˚C, V^+ = 3V, V^- = 0V, V_{CM} = $V^+/2$, and R_L > 10 kΩ to $V^+/2$. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
i_n	Input-Referred Current Noise	f = 100 kHz		1		fA/$\sqrt{Hz}$

5V Electrical Characteristics (Note 4)

Unless otherwise specified, all limits are guaranteed for T = 25˚C, V^+ = 5V, V^- = 0V, V_{CM} = $V^+/2$, and R_L > 10 kΩ to $V^+/2$. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
V_{OS}	Input Offset Voltage			±37	±200 **±500**	µV
TCV_{OS}	Input Offset Voltage Drift	(Note 7)		±1	**±5**	µV/˚C
I_B	Input Bias Current	(Notes 7, 8)		0.3	10 **300**	pA
I_{OS}	Input Offset Current			40		fA
CMRR	Common Mode Rejection Ratio	0V ≤ V_{CM} ≤ 5V	88 **83**	100		dB
PSRR	Power Supply Rejection Ratio	2.7V ≤ V^+ ≤ 12V, Vo = $V^+/2$	86 **82**	98		dB
CMVR	Input Common-Mode Voltage Range	CMRR ≥ 80 dB CMRR ≥ 78 dB	−0.2 **−0.2**		5.2 **5.2**	V
A_{VOL}	Large Signal Voltage Gain	R_L = 2 kΩ V_O = 0.3V to 4.7V	100 **96**	119		dB
		R_L = 10 kΩ V_O = 0.2V to 4.8V	100 **96**	130		
V_O	Output Swing High	R_L = 2 kΩ to $V^+/2$	4.89 **4.87**	4.94		V
		R_L = 10 kΩ to $V^+/2$	4.95 **4.93**	4.96		
	Output Swing Low	R_L = 2 kΩ to $V^+/2$		0.05	0.08 **0.09**	V
		R_L = 10 kΩ to $V^+/2$		0.03	0.04 **0.05**	
I_O	Output Short Circuit Current (Notes 3, 9)	Sourcing V_O = 0V V_{IN} = 100 mV	40 **28**	66		mA
		Sinking V_O = 5V V_{IN} = −100 mV	40 **28**	76		
I_S	Supply Current			0.715	1.0 **1.2**	mA
SR	Slew Rate (Note 10)	A_V = +1, V_O = 4 V_{PP} 10% to 90%		1.0		V/µs
GBW	Gain Bandwidth Product			2.5		MHz
THD+N	Total Harmonic Distortion + Noise	f = 1 kHz, Av = 1, R_L = 1 kΩ		0.02		%
e_n	Input-Referred Voltage Noise	f = 1 kHz		12		nV/$\sqrt{Hz}$
i_n	Input-Referred Current Noise	f = 100 kHz		1		fA/$\sqrt{Hz}$

±5V Electrical Characteristics (Note 4)

Unless otherwise specified, all limits are guaranteed for T_A = 25˚C, V^+ = 5V, V^- = –5 V, V_{CM} =0, and R_L > 10 kΩ to V_{CM}. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
V_{OS}	Input Offset Voltage			±37	±200 **±500**	µV
TCV_{OS}	Input Offset Voltage Drift	(Note 7)		±1	**±5**	µV/˚C
I_B	Input Bias Current	(Notes 7, 8)		0.3	10 **300**	pA
I_{OS}	Input Offset Current			40		fA
CMRR	Common Mode Rejection Ratio	–5V ≤ V_{CM} ≤ 5V	92 **88**	110		dB
PSRR	Power Supply Rejection Ratio	2.7V ≤ V^+ ≤ 12V, Vo = V_{CM}	86 **82**	98		dB
CMVR	Input Common-Mode Voltage Range	CMRR ≥ 80 dB CMRR ≥ 78dB	–5.2 **–5.2**		5.2 **5.2**	V
A_{VOL}	Large Signal Voltage Gain	R_L = 2 kΩ V_O = –4.7V to 4.7V	100 **98**	121		dB
		R_L = 10 kΩ V_O = –4.8V to 4.8V	100 **98**	134		
V_O	Output Swing High	R_L = 2 kΩ to V_{CM}	4.85 **4.83**	4.91		V
		R_L = 10 kΩ to V_{CM}	4.92 **4.90**	4.96		
	Output Swing Low	R_L = 2 kΩ to V_{CM}		–4.91	–4.87 **-4.85**	V
		R_L = 10 kΩ to V_{CM}		–4.96	–4.95 **-4.94**	
I_O	Output Short Circuit Current (Notes 3, 9)	Sourcing V_O = –5V V_{IN} = 100 mV	50 **35**	86		mA
		Sinking V_O = 5V V_{IN} = –100 mV	50 **35**	84		
I_S	Supply Current			0.790	1.1 **1.3**	mA
SR	Slew Rate (Note 10)	A_V = +1, V_O = 9 V_{PP} 10% to 90%		1.1		V/µs
GBW	Gain Bandwidth Product			2.5		MHz
THD+N	Total Harmonic Distortion + Noise	f = 1 kHz, Av = 1, R_L = 1 kΩ		0.02		%
e_n	Input-Referred Voltage Noise	f = 1 kHz		12		nV/ $\sqrt{Hz}$
i_n	Input-Referred Current Noise	f = 100 kHz		1		fA/ $\sqrt{Hz}$

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics Tables.

Note 2: Human Body Model: 1.5 kΩ in series with 100 pF. Machine Model: 0Ω in series with 200 pF.

Note 3: The maximum power dissipation is a function of $T_{J(MAX)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A)/ \theta_{JA}$. All numbers apply for packages soldered directly onto a PC board.

Note 4: Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.

Note 5: Typical values represent the parametric norm at the time of characterization.

Note 6: Limits are 100% production tested at 25˚C. Limits over the operating temperature range are guaranteed through correlations using the Statistical Quality Control (SQC) method.

Note 7: Guaranteed by design.

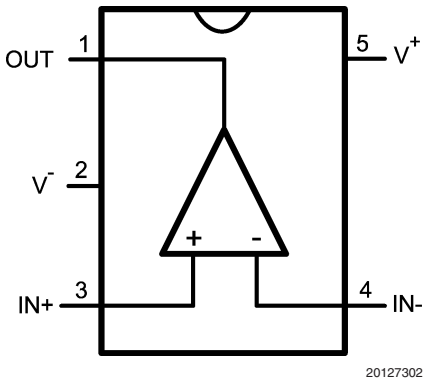
Note 8: Positive current corresponds to current flowing into the device.

Note 9: The short circuit test is a momentary test.

Note 10: The number specified is the slower of positive and negative slew rates.

Connection Diagram

5-Pin SOT23

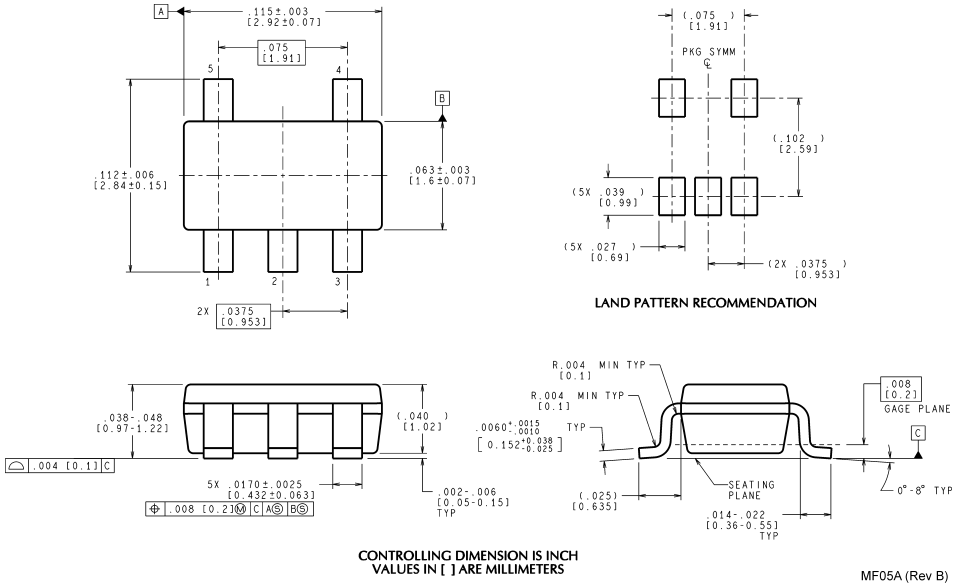


Top View

Ordering Information

Package	Part Number	Package Marking	Transport Media	NSC Drawing
5-Pin SOT-23	LMP7701MF	AC2A	1k Units Tape and Reel	MF05A
	LMP7701MFX		3k Units Tape and Reel	

Physical Dimensions inches (millimeters) unless otherwise noted



5-Pin SOT23
NS Package Number MF05A

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