LMC7101

Low-Power Operational Amplifier

Features

- Small Footprint SOT-23-5 Package
- Guaranteed 2.7V, 3V, 5V, and 12V Performance
- 500 kHz Gain-Bandwidth
- 0.01% Total Harmonic Distortion at 10 kHz (5V, 2 kΩ)
- 0.5 mA Typical Supply Current at 5V

Applications

- Mobile Communications, Cellular Phones, Pagers
- Battery-Powered Instrumentation
- PCMCIA, USB
- Portable Computers and PDAs

General Description

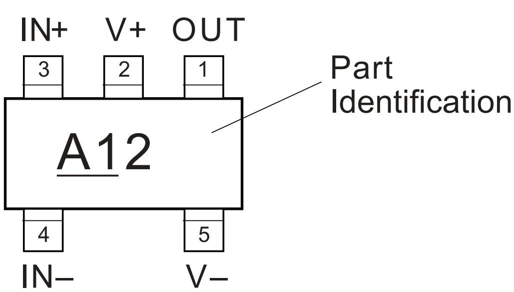
The LMC7101 is a high-performance, low-power, operational amplifier that is pin-for-pin compatible with the National Semiconductor LMC7101. It features rail-to-rail input and output performance in the IttyBitty SOT-23-5 package.

The LMC7101 is a 500 kHz gain–bandwidth amplifier designed to operate from 2.7V to 12V single-ended power supplies with guaranteed performance at supply voltages of 2.7V, 3V, 5V, and 12V.

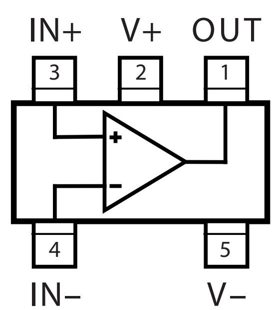
This op amp's input common-mode range includes ground and extends 300 mV beyond the supply rails. For example, the common-mode range is –0.3V to +5.3V with a 5V supply.

Package Type

LMC7101 Pin Configuration
SOT-23-5



LMC7101 Functional Pinout
SOT-23-5



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings † ††

Supply Voltage, ($V_{V+} – V_{V–}$) .... +15V
Differential Input Voltage, ($V_{IN+} – V_{IN–}$) .... ±($V_{V+} – V_{V–}$)
I/O Pin Voltage, (V_{IN}, V_{OUT}) (Note 1) .... V_{V+} + 0.3V to $V_{V–}$ – 0.3V
ESD Protection, (Note 2) .... ±2 kV HBM

Operating Ratings††

Supply Voltage, $V_{IN} – V_{V–}$ .... 2.7V to 12V
Max. Power Dissipation .... (Note 3)

† Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

†† Notice: Absolute maximum ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside its recommended operating ratings.

Note 1: I/O pin voltage is any external voltage to which an input or output is referenced.

2: Human body model, 1.5 kΩ in series with 100 pF.

3: The maximum allowable power dissipation is a function of the maximum junction temperature, $T_{J(max)}$; the junction-to-ambient thermal resistance, θ_{JA}; and the ambient temperature, T_A. The maximum allowable power dissipation at any ambient temperature is calculated using: $P_D = (T_{J(max)} – T_A) \div \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature.

LM7101A 2.7V DC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +2.7V, V– = 0V, V_{CM} = V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	V_{OS}	—	0.11	6	mV	—
Input Offset Voltage Average Drift	TCV_{OS}	—	1.0	—	µV/°C	—
Input Bias Current	I_B	—	1.0	64	pA	–40°C ≤ T_J ≤ +85°C
Input Offset Current	I_{OS}	—	0.5	32		–40°C ≤ T_J ≤ +85°C
Input Resistance	R_{IN}	—	>1	—	TΩ	—
Common-Mode Rejection Ratio	CMRR	50	70	—	dB	0V ≤ V_{CM} ≤ 2.7V, Note 1
Input Common Mode Voltage	V_{CM}	—	–0.3	0.0	V	Input LOW, CMRR ≥ 50 dB
		2.7	3.0	—	V	Input HIGH, CMRR ≥ 50 dB
Power Supply Rejection Ratio	PSRR	50	60	—	dB	V+ = 1.35V to 1.65 V, V– = –1.35 V to –1.65V, V_{CM} = 0V
Common-Mode Input Capacitance	C_{IN}	—	3	—	pF	—
Output Swing	V_O	2.64	2.699	—	V	Output HIGH, R_L = 10 kΩ
		—	0.001	0.06	V	Output LOW, R_L = 10 kΩ
		2.6	2.692	—	V	Output HIGH, R_L = 2 kΩ
		—	0.008	0.1	V	Output LOW, R_L = 2 kΩ
Supply Current	I_S	—	0.5	0.81	mA	—
		—	—	0.95	mA	–40°C ≤ T_J ≤ +85°C
Slew Rate	SR	—	0.4	—	V/µs	—
Gain–Bandwidth Product	GBW	—	0.5	—	MHz	—

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

LM7101B 2.7V DC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +2.7V, V– = 0V, V_{CM} = V_{OUT} = V+/2; R_L = 1MΩ; T_J = +25°C. **Bold** values indicate –40°C ≤ T_J ≤ +85°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	V_{OS}	—	0.11	9	mV	—
Input Offset Voltage Average Drift	TCV_{OS}	—	1.0	—	µV/°C	—
Input Bias Current	I_B	—	1.0	64	pA	–40°C ≤ T_J ≤ +85°C
Input Offset Current	I_{OS}	—	0.5	32	pA	–40°C ≤ T_J ≤ +85°C
Input Resistance	R_{IN}	—	>1	—	TΩ	—
Common-Mode Rejection Ratio	CMRR	50	70	—	dB	0V ≤ V_{CM} ≤ 2.7V, Note 1
Input Common Mode Voltage	V_{CM}	—	–0.3	0.0	V	Input LOW, CMRR ≥ 50dB
		2.7	3.0	—	V	Input HIGH, CMRR ≥ 50dB
Power Supply Rejection Ratio	PSRR	45	60	—	dB	V+ = 1.35V to 1.65V, V– = –1.35V to –1.65V, V_{CM} = 0V
Common-Mode Input Capacitance	C_{IN}	—	3	—	pF	—
Output Swing	V_O	2.64	2.699	—	V	Output HIGH, R_L = 10 kΩ
		—	0.001	0.06	V	Output LOW, R_L = 10 kΩ
		2.6	2.692	—	V	Output HIGH, R_L = 2 kΩ
		—	0.008	0.1	V	Output LOW, R_L = 2 kΩ
Supply Current	I_S	—	0.5	0.81	mA	—
		—	—	0.95	mA	–40°C ≤ T_J ≤ +85°C
Slew Rate	SR	—	0.4	—	V/µs	—
Gain–Bandwidth Product	GBW	—	0.5	—	MHz	—

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

LM7101A 3.0V DC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +3.0V, V– = 0V, V_{CM} = V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	V_{OS}	—	0.11	4	mV	—
		—	0.11	6	mV	–40°C ≤ T_J ≤ +85°C
Input Offset Voltage Average Drift	TCV_{OS}	—	1.0	—	μV/°C	—
Input Bias Current	I_B	—	1.0	64	pA	–40°C ≤ T_J ≤ +85°C
Input Offset Current	I_{OS}	—	0.5	32	pA	–40°C ≤ T_J ≤ +85°C
Input Resistance	R_{IN}	—	>1	—	TΩ	—
Common-Mode Rejection Ratio	CMRR	60	74	—	dB	0V ≤ V_{CM} ≤ 3.0V, Note 1
Input Common Mode Voltage	V_{CM}	—	–0.3	0.0	V	Input LOW, CMRR ≥ 50 dB
		3.0	3.3	—	V	Input HIGH, CMRR ≥ 50 dB
Power Supply Rejection Ratio	PSRR	68	80	—	dB	V+ = 1.5V to 6.0V, V– = –1.5V to –6.0V, V_{CM} = 0V
Common-Mode Input Capacitance	C_{IN}	—	3	—	pF	—
Output Swing	V_{OUT}	2.9	2.992	—	V	Output HIGH, R_L = 2 kΩ
			0.008	0.1	V	Output LOW, R_L = 2 kΩ
		2.85	2.973	—	V	Output HIGH, R_L = 600Ω
		—	0.027	0.15	V	Output LOW, R_L = 600Ω
Supply Current	I_S	—	0.5	0.81	mA	—
		—	—	0.95	mA	–40°C ≤ T_J ≤ +85°C

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

LM7101B 3.0V DC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +3.0V, V– = 0V, V_{CM} = V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	V_{OS}	—	0.11	7	mV	—
		—	0.11	9	mV	–40°C ≤ T_J ≤ +85°C
Input Offset Voltage Average Drift	TCV_{OS}	—	1.0	—	µV/°C	—
Input Bias Current	I_B	—	1.0	64	pA	–40°C ≤ T_J ≤ +85°C
Input Offset Current	I_{OS}	—	0.5	32	pA	–40°C ≤ T_J ≤ +85°C
Input Resistance	R_{IN}	—	>1	—	TΩ	—
Common-Mode Rejection Ratio	CMRR	60	74	—	dB	0V ≤ V_{CM} ≤ 3.0V, Note 1
Input Common Mode Voltage	V_{CM}	—	–0.3	0.0	V	Input LOW, CMRR ≥ 50 dB
		3.0	3.3	—	V	Input HIGH, CMRR ≥ 50 dB
Power Supply Rejection Ratio	PSRR	60	80	—	dB	V+ = 1.5V to 6.0V, V– = –1.5V to –6.0V, V_{CM} = 0
Common-Mode Input Capacitance	C_{IN}	—	3	—	pF	—
Output Swing	V_O	2.9	2.992	—	V	Output HIGH, R_L = 2 kΩ
		—	0.008	0.1	V	Output LOW, R_L = 2 kΩ
		2.85	2.973	—	V	Output HIGH, R_L = 600Ω
		—	0.027	0.15	V	Output LOW, R_L = 600Ω
Supply Current	I_S	—	0.5	0.81	mA	—
		—	—	0.95	mA	–40°C ≤ T_J ≤ +85°C

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

LM7101A 5.0V DC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +5.0V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	V_{OS}	—	0.11	3	mV	—
		—	0.11	5	mV	–40°C ≤ T_J ≤ +85°C
Input Offset Voltage Average Drift	TCV_{OS}	—	1.0	—	µV/°C	—
Input Bias Current	I_B	—	1.0	64	pA	–40°C ≤ T_J ≤ +85°C
Input Offset Current	I_{OS}	—	0.5	32	pA	–40°C ≤ T_J ≤ +85°C
Input Resistance	R_{IN}	—	>1	—	TΩ	—
Common-Mode Rejection Ratio	CMRR	60	82	—	dB	0V ≤ V_{CM} ≤ 5V, Note 1
		55	—	—	dB	0V ≤ V_{CM} ≤ 5V, Note 1, –40°C ≤ T_J ≤ +85°C
Input Common Mode Voltage	V_{CM}		–0.3	–0.20	V	Input LOW, CMRR ≥ 50 dB
		—	—	0.00	V	Input LOW, CMRR ≥ 50 dB, –40°C ≤ T_J ≤ +85°C
		5.20	5.3	—	V	Input HIGH, CMRR ≥ 50 dB
		5.0	—	—	V	Input HIGH, CMRR ≥ 50 dB, –40°C ≤ T_J ≤ +85°C
Positive Power Supply Rejection Ratio	+PSRR	70	82	—	dB	V+ = 5V to 12V, V– = 0V, V_{OUT} = 1.5V
		65	—	—	db	V+ = 5V to 12V, V– = 0V, V_{OUT} = 1.5V, –40°C ≤ T_J ≤ +85°C
Negative Power Supply Rejection Ratio	–PSRR	70	82	—	dB	V+ = 0V, V– = –5V to –12V, V_{OUT} = –1.5V
		65	—	—	dB	V+ = 0V, V– = –5V to –12V, V_{OUT} = –1.5V, –40°C ≤ T_J ≤ +85°C
Common-Mode Input Capacitance	C_{IN}	—	3	—	pF	—

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

2: Continuous short circuit may exceed absolute maximum T_J under some conditions.

LM7101A 5.0V DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V+ = +5.0V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Swing	V_{OUT}	4.9	4.989	—	V	Output HIGH, R_L = 2 kΩ
		4.85	—	—	V	Output HIGH, R_L = 2 kΩ, –40°C ≤ T_J ≤ +85°C
		—	0.011	0.1	V	Output LOW, R_L = 2 kΩ
		—	—	0.15	V	Output LOW, R_L = 2 kΩ, –40°C ≤ T_J ≤ +85°C
		4.9	4.963	—	V	Output HIGH, R_L = 600Ω
		4.8	—	—	V	Output HIGH, R_L = 600Ω, –40°C ≤ T_J ≤ +85°C
		—	0.037	0.1	V	Output LOW, R_L = 600Ω
		—	—	0.2	V	Output LOW, R_L = 600Ω, –40°C ≤ T_J ≤ +85°C
Output Short Supply Current Note 2	I_{SC}	120	200	—	mA	Sourcing (V_{OUT} = 0V) or Sinking (V_{OUT} = 5V)
		80	—	—	mA	Sourcing (V_{OUT} = 0V) or Sinking (V_{OUT} = 5V), –40°C ≤ T_J ≤ +85°C
Supply Current	I_S	—	0.5	0.85	mA	—
		—	—	1.0	mA	–40°C ≤ T_J ≤ +85°C

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

2: Continuous short circuit may exceed absolute maximum T_J under some conditions.

LM7101B 5.0V DC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +5.0V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.						
Parameters	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Input Offset Voltage	V_{OS}	—	0.11	7	mV	—
		—	0.11	9	mV	–40°C ≤ T_J ≤ +85°C
Input Offset Voltage Average Drift	TCV_{OS}	—	1.0	—	µV/°C	—
Input Bias Current	I_B	—	1.0	64	pA	–40°C ≤ T_J ≤ +85°C
Input Offset Current	I_{OS}	—	0.5	32	pA	–40°C ≤ T_J ≤ +85°C
Input Resistance	R_{IN}	—	>1	—	TΩ	—
Common-Mode Rejection Ratio	CMRR	60	82	—	dB	0V ≤ V_{CM} ≤ 5V, Note 1
		55	—	—	dB	0V ≤ V_{CM} ≤ 5V, Note 1, –40°C ≤ T_J ≤ +85°C
Input Common Mode Voltage	V_{CM}		–0.3	–0.20	V	Input LOW, CMRR ≥ 50 dB
		—	—	0.00	V	Input LOW, CMRR ≥ 50 dB, –40°C ≤ T_J ≤ +85°C
		5.20	5.3	—	V	Input HIGH, CMRR ≥ 50 dB
		5.0	—	—	V	Input HIGH, CMRR ≥ 50 dB, –40°C ≤ T_J ≤ +85°C
Positive Power Supply Rejection Ratio	+PSRR	65	82	—	dB	V+ = 5V to 12V, V– = 0V, V_{OUT} = 1.5V
		62	—	—	dB	V+ = 5V to 12V, V– = 0V, V_{OUT} = 1.5V, –40°C ≤ T_J ≤ +85°C
Negative Power Supply Rejection Ratio	–PSRR	65	82	—	dB	V+ = 0V, V– = –5V to –12V, V_{OUT} = –1.5V
		62	—	—	dB	V+ = 0V, V– = –5V to –12V, V_{OUT} = –1.5V, –40°C ≤ T_J ≤ +85°C
Common-Mode Input Capacitance	C_{IN}	—	3	—	pF	—

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

2: Continuous short circuit may exceed absolute maximum T_J under some conditions.

LM7101B 5.0V DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V+ = +5.0V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Swing	V_{OUT}	4.9	4.989	—	V	Output HIGH, R_L = 2 kΩ
		4.85	—	—	V	Output HIGH, R_L = 2 kΩ, –40°C ≤ T_J ≤ +85°C
		—	0.011	0.1	V	Output LOW, R_L = 2 kΩ
		—	—	0.15	V	Output LOW, R_L = 2 kΩ, –40°C ≤ T_J ≤ +85°C
		4.9	4.963	—	V	Output HIGH, R_L = 600Ω
		4.8	—	—	V	Output HIGH, R_L = 600Ω, –40°C ≤ T_J ≤ +85°C
		—	0.037	0.1	V	Output LOW, R_L = 600Ω
		—	—	0.2	V	Output LOW, R_L = 600Ω, –40°C ≤ T_J ≤ +85°C
Output Short Supply Current Note 2	I_{SC}	120	200	—	mA	Sourcing (V_{OUT} = 0V) or Sinking (V_{OUT} = 5V)
		80	—	—	mA	Sourcing (V_{OUT} = 0V) or Sinking (V_{OUT} = 5V), –40°C ≤ T_J ≤ +85°C
Supply Current	I_S	—	0.5	0.85	mA	—
		—	—	1.0	mA	–40°C ≤ T_J ≤ +85°C

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

2: Continuous short circuit may exceed absolute maximum T_J under some conditions.

LM7101A 12.0V DC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +12V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	V_{OS}	—	0.11	6	mV	—
Input Offset Voltage Average Drift	TCV_{OS}	—	1.0	—	µV/°C	—
Input Bias Current	I_B	—	1.0	64	pA	–40°C ≤ T_J ≤ +85°C
Input Offset Current	I_{OS}	—	0.5	32	pA	–40°C ≤ T_J ≤ +85°C
Input Resistance	R_{IN}	—	>1	—	TΩ	—
Common-Mode Rejection Ratio	CMRR	65	82	—	dB	0V ≤ V_{CM} ≤ 12V, Note 1
		60	—	—	dB	0V ≤ V_{CM} ≤ 12V, Note 1, –40°C ≤ T_J ≤ +85°C
Input Common Mode Voltage	V_{CM}	—	—0.3	—0.20	V	Input LOW, V+ = 12V, CMRR ≥ 50 dB
		—	—	0.00	V	Input LOW, V+ = 12V, CMRR ≥ 50 dB, –40°C ≤ T_J ≤ +85°C
		12.2	12.3	—	V	Input HIGH, V+ = 12V, CMRR ≥ 50 dB
		12.0	—	—	V	Input HIGH, V+ = 12V, CMRR ≥ 50 dB, –40°C ≤ T_J ≤ +85°C
Positive Power Supply Rejection Ratio	+PSRR	70	82	—	dB	V+ = 5V to 12V, V– = 0V, V_{OUT} = 1.5V
		65	—	—	dB	V+ = 5V to 12V, V– = 0V, V_{OUT} = 1.5V, –40°C ≤ T_J ≤ +85°C
Negative Power Supply Rejection Ratio	–PSRR	70	82	—	dB	V+ = 0V, V– = –5V to –12V, V_{OUT} = –1.5V
		65	—	—	dB	V+ = 0V, V– = –5V to –12V, V_{OUT} = –1.5V, –40°C ≤ T_J ≤ +85°C
Large Signal Voltage Gain	A_V	80	340	—	V/mV	Sourcing or sinking, R_L = 2kΩ, Note 4
		40	—	—	V/mV	Sourcing or sinking, R_L = 2kΩ, Note 4, –40°C ≤ T_J ≤ +85°C
		15	300	—	V/mV	Sourcing or sinking, R_L = 600Ω, Note 4
		10	—	—	V/mV	Sourcing or sinking, R_L = 600Ω, Note 4, –40°C ≤ T_J ≤ +85°C
Common-Mode Input Capacitance	C_{IN}	—	3	—	pF	—

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

2: Continuous short circuit may exceed absolute maximum T_J under some conditions.

3: Shorting OUT to V+ when V+ > 12V may damage the device.

4: R_L connected to 5.0V. Sourcing: 5V ≤ V_{OUT} ≤ 12V. Sinking: 2.5V ≤ V_{OUT} ≤ 5V.

LM7101A 12.0V DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V+ = +12V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Swing	V_{OUT}	11.9	11.98	—	V	Output HIGH, V+ = 12V, R_L = 2 kΩ
		11.87	—	—	V	Output HIGH, V+ = 12V, R_L = 2 kΩ, –40°C ≤ T_J ≤ +85°C
		—	0.02	0.10	V	Output LOW, V+ = 12V, R_L = 2 kΩ
		—	—	0.13	V	Output LOW, V+ = 12V, R_L = 2 kΩ, –40°C ≤ T_J ≤ +85°C
		11.73	11.93	—	V	Output HIGH, V+ = 12V, R_L = 600Ω
		11.65	—	—	V	Output HIGH, V+ = 12V, R_L = 600Ω, –40°C ≤ T_J ≤ +85°C
		—	0.07	0.27	V	Output LOW, V+ = 12V, R_L = 600Ω
		—	—	0.35	V	Output LOW, V+ = 12V, R_L = 600Ω, –40°C ≤ T_J ≤ +85°C
Output Short Supply Current Note 2	I_{SC}	200	300	—	mA	Sourcing (V_{OUT} = 0V) or Sinking (V_{OUT} = 12V), Note 2, 3
		120	—	—	mA	Sourcing (V_{OUT} = 0V) or Sinking (V_{OUT} = 12V), Note 2, 3, –40°C ≤ T_J ≤ +85°C
Supply Current	I_S	—	0.8	1.5	mA	—
		—	—	1.71	mA	–40°C ≤ T_J ≤ +85°C

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

2: Continuous short circuit may exceed absolute maximum T_J under some conditions.

3: Shorting OUT to V+ when V+ > 12V may damage the device.

4: R_L connected to 5.0V. Sourcing: 5V ≤ V_{OUT} ≤ 12V. Sinking: 2.5V ≤ V_{OUT} ≤ 5V.

LM7101B 12.0V DC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +12V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	V_{OS}	—	0.11	9	mV	—
Input Offset Voltage Average Drift	TCV_{OS}	—	1.0	—	µV/°C	—
Input Bias Current	I_B	—	1.0	64	pA	–40°C ≤ T_J ≤ +85°C
Input Offset Current	I_{OS}	—	0.5	32	pA	–40°C ≤ T_J ≤ +85°C
Input Resistance	R_{IN}	—	>1	—	TΩ	—
Common-Mode Rejection Ratio	CMRR	65	82	—	dB	0V ≤ V_{CM} ≤ 12V, Note 1
		60	—	—	dB	0V ≤ V_{CM} ≤ 12V, Note 1, –40°C ≤ T_J ≤ +85°C
Input Common Mode Voltage	V_{CM}	—	—0.3	—0.20	V	Input LOW, V+ = 12V, CMRR ≥ 50 dB
		—	—	0.00	V	Input LOW, V+ = 12V, CMRR ≥ 50 dB, –40°C ≤ T_J ≤ +85°C
		12.2	12.3	—	V	Input HIGH, V+ = 12V, CMRR ≥ 50 dB
		12.0	—	—	V	Input HIGH, V+ = 12V, CMRR ≥ 50 dB, –40°C ≤ T_J ≤ +85°C
Positive Power Supply Rejection Ratio	+PSRR	65	82	—	dB	V+ = 5V to 12V, V– = 0V, V_{OUT} = 1.5V
		62	—	—	db	V+ = 5V to 12V, V– = 0V, V_{OUT} = 1.5V, –40°C ≤ T_J ≤ +85°C
Negative Power Supply Rejection Ratio	–PSRR	65	82	—	dB	V+ = 0V, V– = –5V to –12V, V_{OUT} = –1.5V
		62	—	—	dB	V+ = 0V, V– = –5V to –12V, V_{OUT} = –1.5V, –40°C ≤ T_J ≤ +85°C
Large Signal Voltage Gain	A_V	80	340	—	V/mV	Sourcing or sinking, R_L = 2kΩ, Note 4
		40	—	—	V/mV	Sourcing or sinking, R_L = 2kΩ, Note 4, –40°C ≤ T_J ≤ +85°C
		15	300	—	V/mV	Sourcing or sinking, R_L = 600Ω, Note 4
		10	—	—	V/mV	Sourcing or sinking, R_L = 600Ω, Note 4, –40°C ≤ T_J ≤ +85°C
Common-Mode Input Capacitance	C_{IN}	—	3	—	pF	—

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

2: Continuous short circuit may exceed absolute maximum T_J under some conditions.

3: Shorting OUT to V+ when V+ > 12V may damage the device.

4: R_L connected to 5.0V. Sourcing: 5V ≤ V_{OUT} ≤ 12V. Sinking: 2.5V ≤ V_{OUT} ≤ 5V.

LM7101B 12.0V DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: Unless otherwise indicated, V+ = +12V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Swing	V_{OUT}	11.9	11.98	—	V	Output HIGH, V+ = 12V, R_L = 2 kΩ
		11.87	—	—	V	Output HIGH, V+ = 12V, R_L = 2 kΩ, –40°C ≤ T_J ≤ +85°C
		—	0.02	0.10	V	Output LOW, V+ = 12V, R_L = 2 kΩ
		—	—	0.13	V	Output LOW, V+ = 12V, R_L = 2 kΩ, –40°C ≤ T_J ≤ +85°C
		11.73	11.93	—	V	Output HIGH, V+ = 12V, R_L = 600Ω
		11.65	—	—	V	Output HIGH, V+ = 12V, R_L = 600Ω, –40°C ≤ T_J ≤ +85°C
		—	0.07	0.27	V	Output LOW, V+ = 12V, R_L = 600Ω
		—	—	0.35	V	Output LOW, V+ = 12V, R_L = 600Ω, –40°C ≤ T_J ≤ +85°C
Output Short Supply Current Note 2	I_{SC}	200	300	—	mA	Sourcing (V_{OUT} = 0V) or Sinking (V_{OUT} = 12V), Note 2, 3
		120	—	—	mA	Sourcing (V_{OUT} = 0V) or Sinking (V_{OUT} = 12V), Note 2, 3, –40°C ≤ T_J ≤ +85°C
Supply Current	I_S	—	0.8	1.5	mA	—
		—	—	1.71	mA	–40°C ≤ T_J ≤ +85°C

Note 1: Common-mode performance tends to follow the typical value. Minimum value limits reflect performance only near the supply rails.

2: Continuous short circuit may exceed absolute maximum T_J under some conditions.

3: Shorting OUT to V+ when V+ > 12V may damage the device.

4: R_L connected to 5.0V. Sourcing: 5V ≤ V_{OUT} ≤ 12V. Sinking: 2.5V ≤ V_{OUT} ≤ 5V.

LM7101A 5.0V AC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +5V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Total Harmonic Distortion	THD	—	0.01	—	%	f = 10 kHz, A_V= –2, R_L = 2 kΩ, V_{OUT} = 4.0 V_{PP}
Slew Rate	SR	—	0.3	—	V/µs	—
Gain Bandwidth Product	GBW	—	0.5	—	MHz	—

LM7101B 5.0V AC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +5V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1 MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Total Harmonic Distortion	THD	—	0.01	—	%	f = 10 kHz, A_V= –2, R_L = 2 kΩ, V_{OUT} = 4.0 V_{PP}
Slew Rate	SR	—	0.3	—	V/µs	—
Gain Bandwidth Product	GBW	—	0.5	—	MHz	—

LM7101A 12.0V AC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +12V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1MΩ; T_J = +25°C.

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Total Harmonic Distortion	THD	—	0.01	—	%	f = 10 kHz, A_V= –2, R_L = 2 kΩ, V_{OUT} = 8.5 V_{PP}
Slew Rate	SR	0.19	0.3	—	V/µs	V+ = 12V, Note 1
		0.15	—	—	V/µs	V+ = 12V, Note 1, –40°C ≤ T_J ≤ +85°C
Gain–Bandwidth Product	GBW	—	0.5	—	MHz	—
Phase Margin	Φ_m	—	45	—	°	—
Gain Margin	G_m	—	10	—	dB	—
Input-Referred Voltage Noise	e_n	—	37	—	$nV/\sqrt{Hz}$	f = 1 kHz, V_{CM} = 1V
Input-Referred Current Noise	i_n	—	1.5	—	$fA/\sqrt{Hz}$	f = 1 kHz

Note 1: Device connected as a voltage follower with a 12V step input. The value is the positive or negative slew rate, whichever is slower.

LM7101B 12.0V AC ELECTRICAL CHARACTERISTICS

Electrical Characteristics: Unless otherwise indicated, V+ = +12V, V– = 0V, V_{CM} = 1.5V, V_{OUT} = V+/2; R_L = 1MΩ; T_J = +25°C.						
Parameters	**Symbol**	**Min.**	**Typ.**	**Max.**	**Units**	**Conditions**
Total Harmonic Distortion	THD	—	0.01	—	%	f = 10 kHz, A_V= –2, R_L = 2 kΩ, V_{OUT} = 8.5 V_{PP}
Slew Rate	SR	0.19	0.3	—	V/µs	V+ = 12V, Note 1
		0.15	—	—	V/µs	V+ = 12V, Note 1, –40°C ≤ T_J ≤ +85°C
Gain–Bandwidth Product	GBW	—	0.5	—	MHz	—
Phase Margin	Φ_m	—	45	—	°	—
Gain Margin	G_m	—	10	—	dB	—
Input-Referred Voltage Noise	e_n	—	37	—	$nV/\sqrt{Hz}$	f = 1 kHz, V_{CM} = 1V
Input-Referred Current Noise	i_n	—	1.5	—	$fA/\sqrt{Hz}$	f = 1 kHz

Note 1: Device connected as a voltage follower with a 12V step input. The value is the positive or negative slew rate, whichever is slower.

TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Operating Ambient Temperature Range	T_A	–40	—	+85	°C	—
Junction Operating Temperature	T_J	–40	—	+125	°C	—
Max. Junction Operating Temperature	$T_{J(max)}$	—	—	+125	°C	—
Storage Temperature Range	T_A	–65	—	+150	°C	—
Package Thermal Resistances						
Thermal Resistance	θ_{JA}	—	325	—	°C/W	—

Note 1: Absolute maximum ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside its recommended operating ratings.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

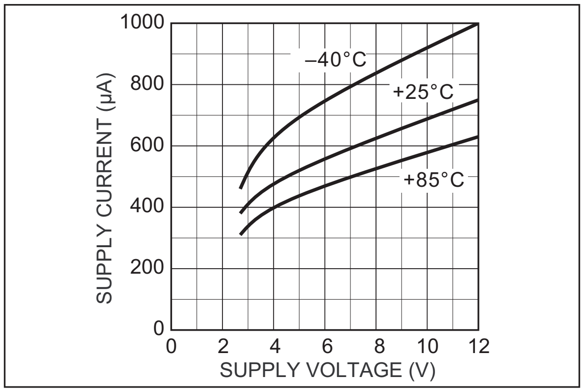


FIGURE 2-1: *Supply Current vs. Supply Voltage.*

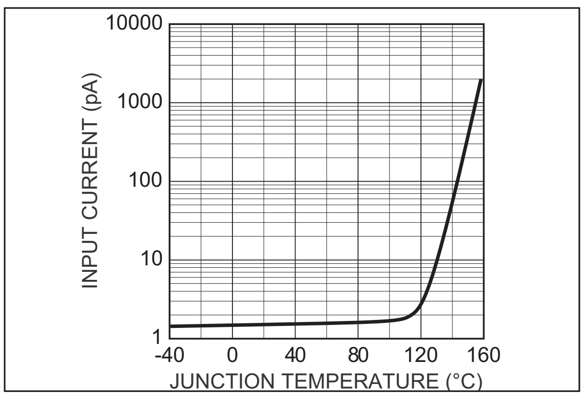


FIGURE 2-2: *Input Current vs. Junction Temperature.*

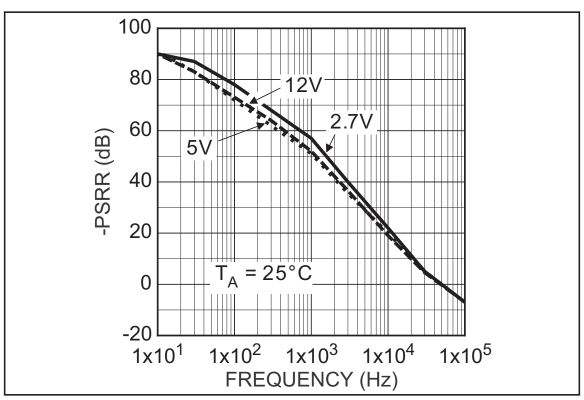


FIGURE 2-3: *–PSRR vs. Frequency.*

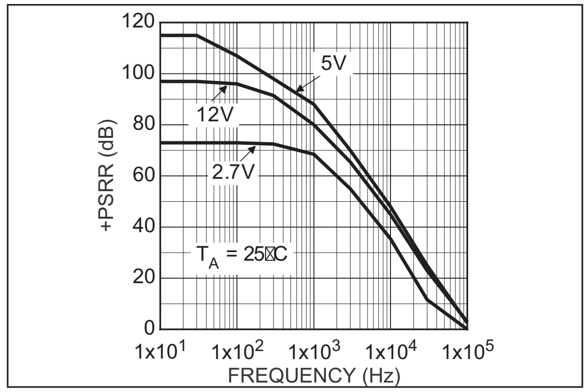


FIGURE 2-4: *+PSRR vs. Frequency.*

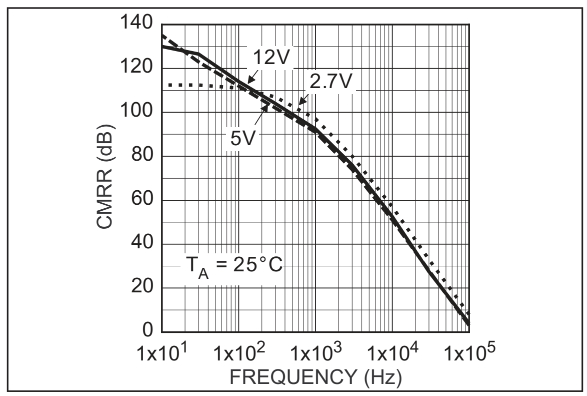


FIGURE 2-5: *CMRR vs. Frequency.*

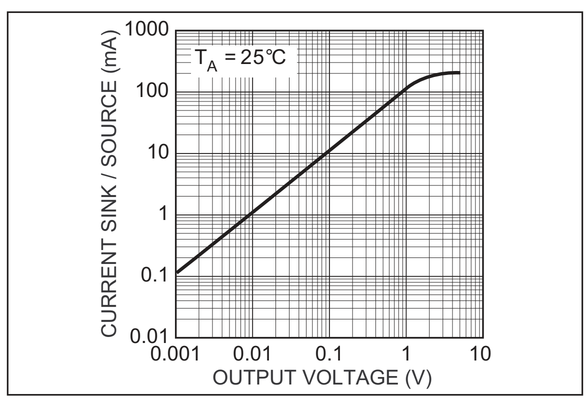


FIGURE 2-6: *Sink/Source Current vs. Output Voltage.*

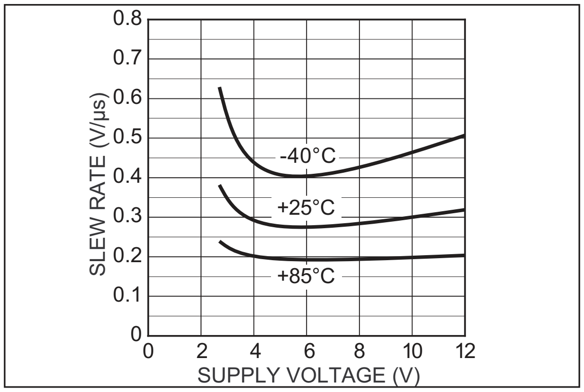


FIGURE 2-7: *Falling Slew Rate vs. Supply Voltage.*

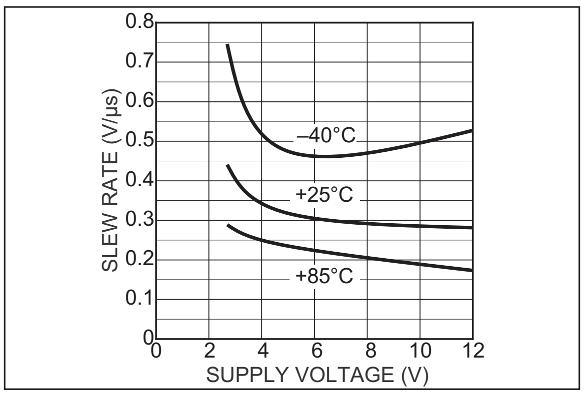


FIGURE 2-8: *Rising Slew Rate vs. Supply Voltage.*

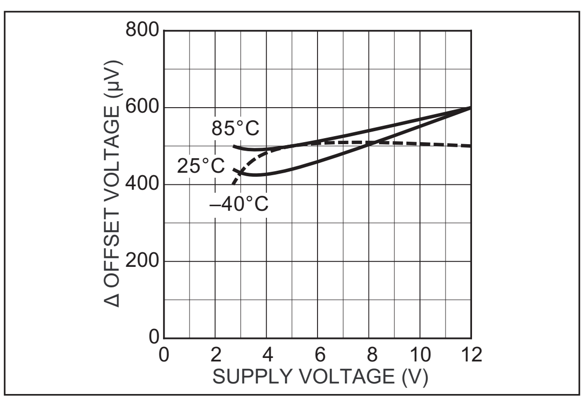


FIGURE 2-9: *Offset Voltage vs. Supply Voltage.*

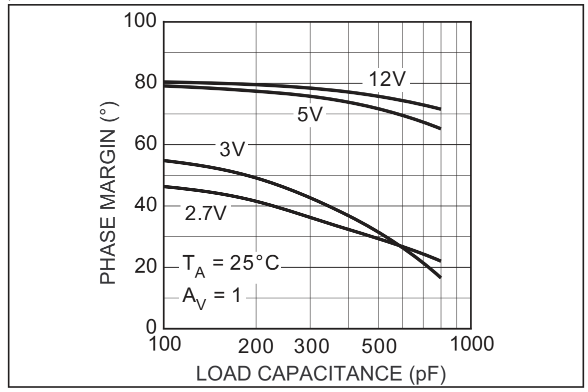


FIGURE 2-10: *Phase Margin vs. Capacitance Load.*

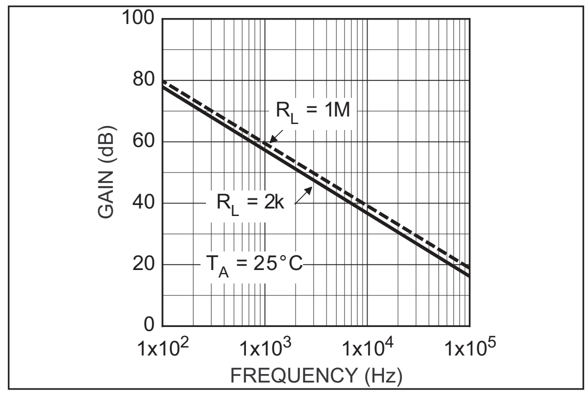


FIGURE 2-11: *2.7V Open-Loop Frequency Response.*

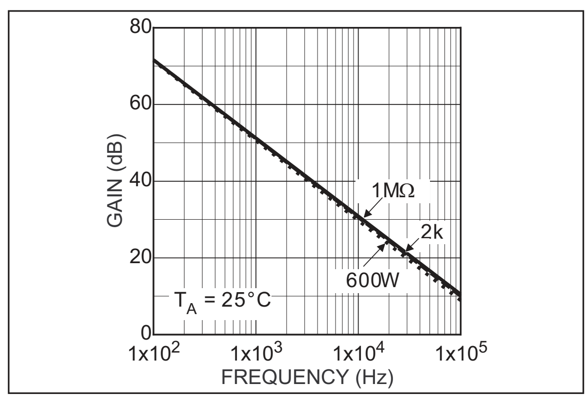


FIGURE 2-12: *5V Open-Loop Frequency Response.*

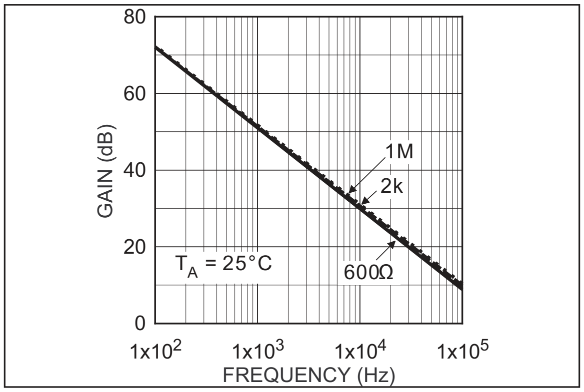


FIGURE 2-13: *12V Open-Loop Frequency Response.*

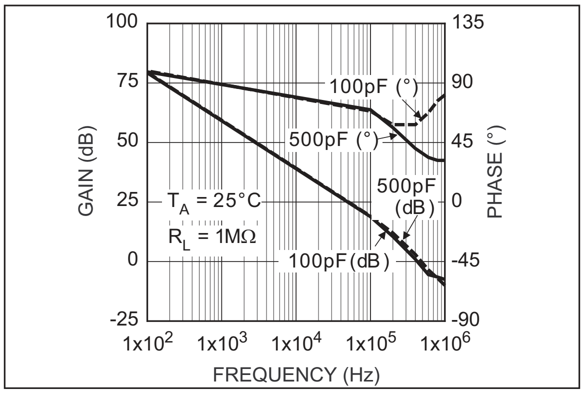


FIGURE 2-14: *2.7V Open-Loop Gain and Phase.*

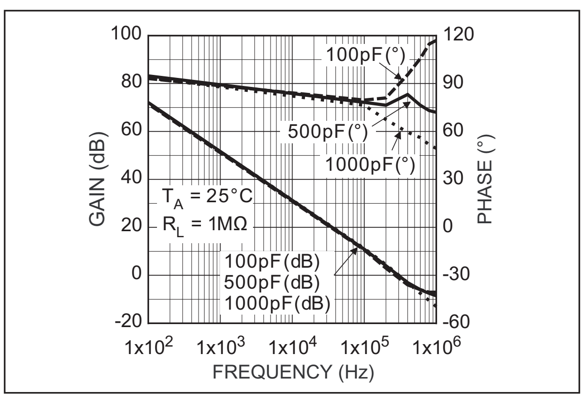


FIGURE 2-15: *5V Open-Loop Gain and Phase.*

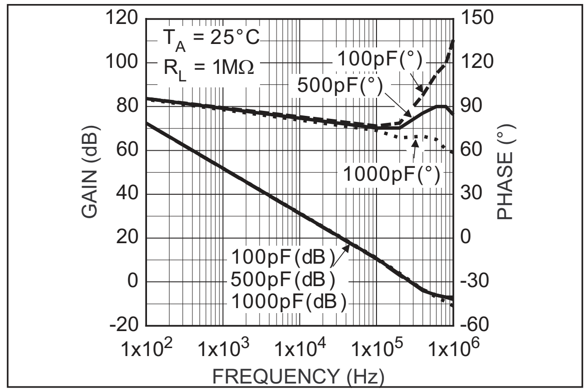


FIGURE 2-16: *12V Open-Loop Gain and Phase.*

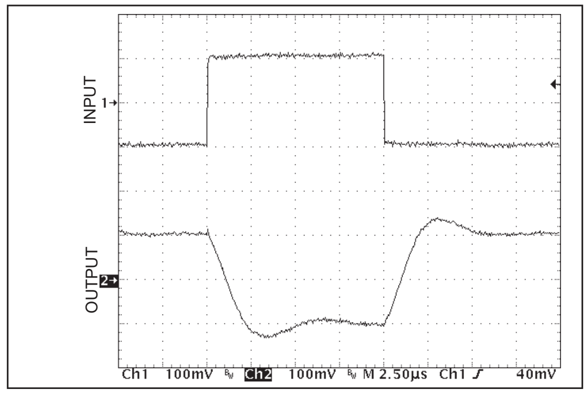


FIGURE 2-17: *Inverting Small-Signal Pulse Response.*

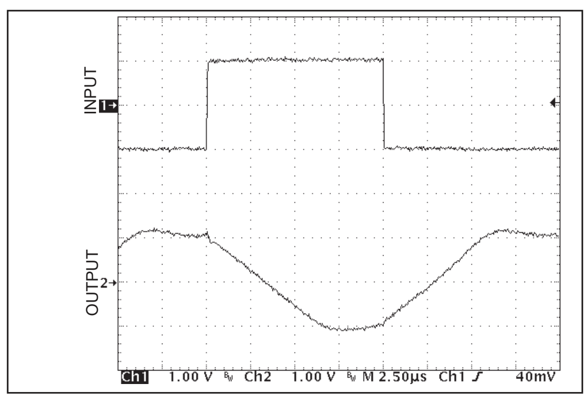


FIGURE 2-18: *Inverting Large-Signal Pulse Response.*

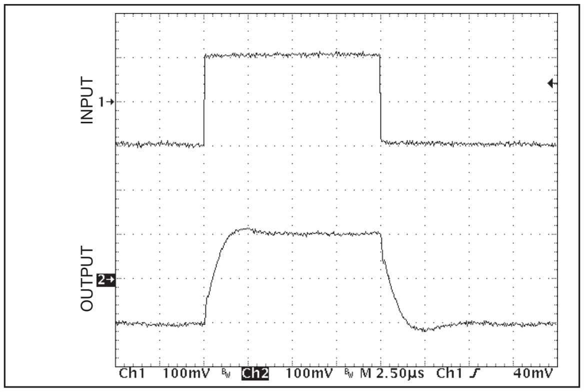


FIGURE 2-19: *Non-Inverting Small-Signal Pulse Response.*

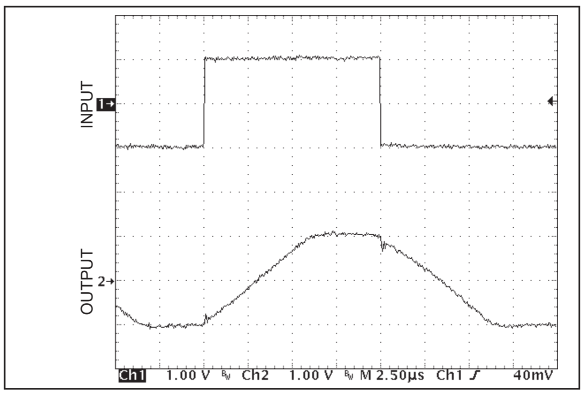


FIGURE 2-20: *Non-Inverting Large-Signal Pulse Response.*

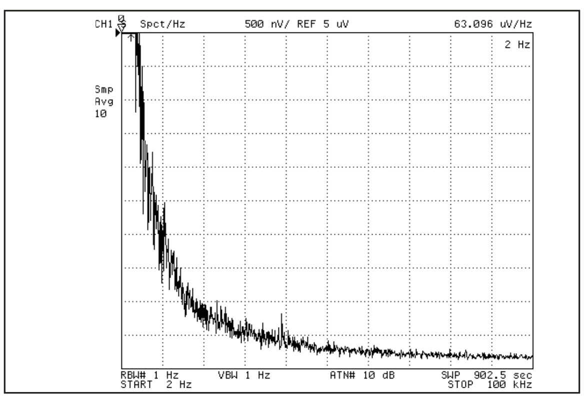


FIGURE 2-21: *Input Voltage Noise vs. Frequency.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number	Symbol	Description
1	OUT	Amplifier Output
2	V+	Positive Supply
3	IN+	Non-Inverting Input
4	IN–	Inverting Input
5	V–	Negative Supply: Negative supply for split–supply application or ground for single–supply application.

4.0 APPLICATION INFORMATION

4.1 Input Common-Mode Voltage

Some amplifiers exhibit undesirable or unpredictable performance when the inputs are driven beyond the common-mode voltage range; for example, phase inversion of the output signal. The LMC7101 tolerates input overdrive by at least 200 mV beyond either rail without producing phase inversion.

If the absolute maximum input voltage (700 mV beyond either rail) is exceeded, the input current should be limited to ±5 mA maximum to prevent reducing reliability. A 10 kΩ series input resistor, used as a current limiter, will protect the input structure from voltages as large as 50V above the supply or below ground. See Figure 4-1.

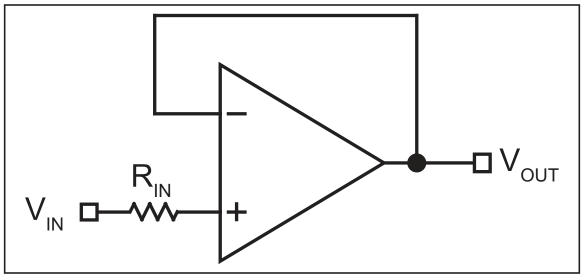


FIGURE 4-1: *Input Current-Limit Protection.*

4.2 Output Voltage Swing

Sink and source output resistances of the LMC7101 are equal. Maximum output voltage swing is determined by the load and the approximate output resistance. To calculate the output resistance, use Equation 4-1:

EQUATION 4-1:

$$R_{OUT} = \frac{V_{DROP}}{I_{LOAD}}$$

V_{DROP} is the voltage dropped within the amplifier output stage. V_{DROP} and I_{LOAD} can be determined from the V_O (output swing) portion of the appropriate Electrical Characteristics table. I_{LOAD} is equal to the typical output high voltage minus V+/2 and divided by R_{LOAD}. For example, using the LM7101A 5.0V DC Electrical Characteristics table, the typical output high voltage using a 2 kΩ load (connected to V+/2) is 4.989V, which produces an I_{LOAD} of:

EQUATION 4-2:

$$1.245mA \times \left(\frac{4.989V - 2.5V}{2k\Omega}\right) = 1.245mA$$

Voltage drop in the amplifier output stage is:

V_{DROP} = 5.0V – 4.989V

V_{DROP} = 0.011V

Because of output stage symmetry, the corresponding typical output low voltage (0.011V) also equals V_{DROP}.

EQUATION 4-3:

$$R_{OUT} = \frac{0.011V}{0.001245A} = 8.8 \approx 9\Omega$$

4.3 Driving Capacitive Loads

Driving a capacitive load introduces phase-lag into the output signal, and this in turn reduces op-amp system phase margin. The application that is least forgiving of reduced phase margin is a unity gain amplifier. The LMC7101 can typically drive a 100 pF capacitive load connected directly to the output when configured as a unity-gain amplifier.

4.4 Using Large-Value Feedback Resistors

A large-value feedback resistor (> 500 kΩ) can reduce the phase margin of a system. This occurs when the feedback resistor acts in conjunction with input capacitance to create phase lag in the feedback signal. Input capacitance is usually a combination of input circuit components and other parasitic capacitance, such as amplifier input capacitance and stray printed circuit board capacitance.

Figure 4-2 illustrates a method of compensating phase lag caused by using a large-value feedback resistor. Feedback capacitor C_{FB} introduces sufficient phase lead to overcome the phase lag caused by feedback resistor R_{FB} and input capacitance C_{IN}. The value of C_{FB} is determined by first estimating C_{IN} and then applying the following formula from Equation 4-4:

EQUATION 4-4:

$$R_{IN} \times C_{IN} \le R_{FB} \times C_{FB}$$

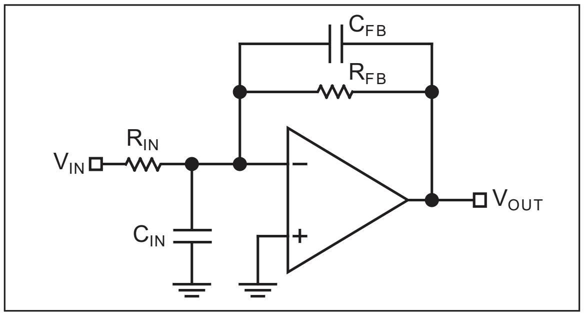


FIGURE 4-2: *Canceling Feedback Phase Lag.*

Since a significant percentage of C_{IN} may be caused by board layout, it is important to note that the correct value of C_{FB} may change when changing from a breadboard to the final circuit layout.

4.5 Typical Circuits

Some suitable LMC7101 single-supply, rail-to-rail applications are shown in the following circuit diagrams.

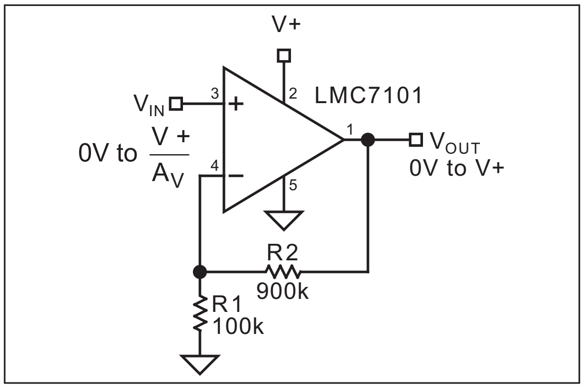


FIGURE 4-3: *Non-Inverting Amplifier.*

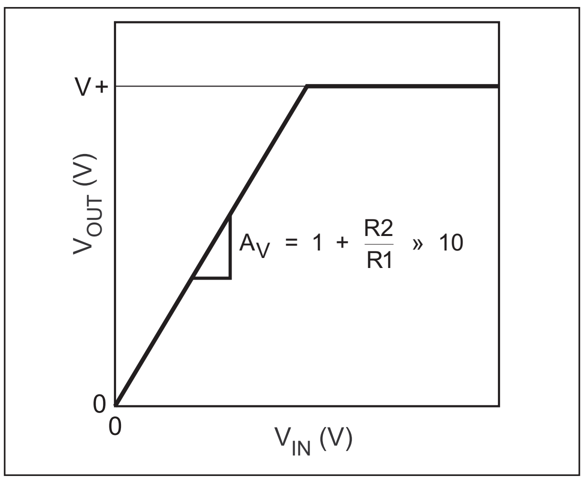


FIGURE 4-4: *Non-Inverting Amplifier Behavior.*

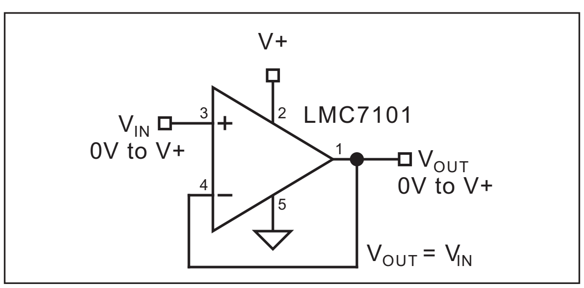


FIGURE 4-5: *Voltage Follower.*

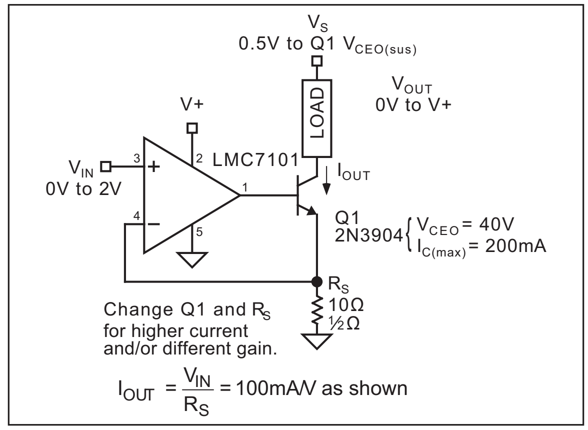


FIGURE 4-6: *Voltage-Controlled Current Sink.*

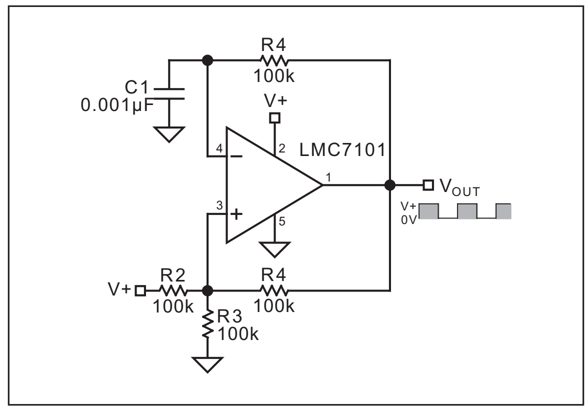


FIGURE 4-7: *Square Wave Oscillator.*

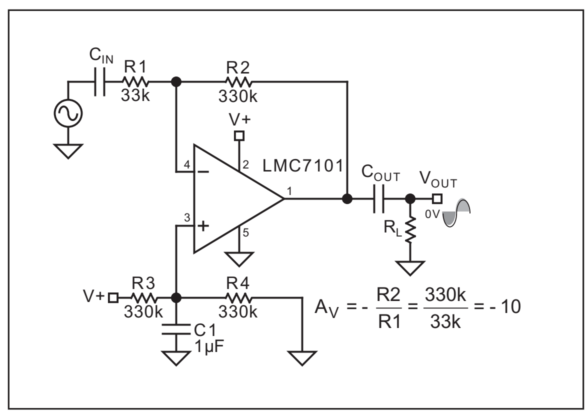


FIGURE 4-8: *AC-Coupled Inverting Amplifier.*

5.0 PACKAGING INFORMATION

5.1 Package Marking Information

5-Lead SOT-23*	Example
XXXX NNN	A12A 971

TABLE 5-1: MARKING CODES

Device	Marking Code
LMC7101A	A12A
LMC7101B	A12

Legend:

XX...X	Product code or customer-specific information
Y	Year code (last digit of calendar year)
YY	Year code (last 2 digits of calendar year)
WW	Week code (week of January 1 is week '01')
NNN	Alphanumeric traceability code
(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

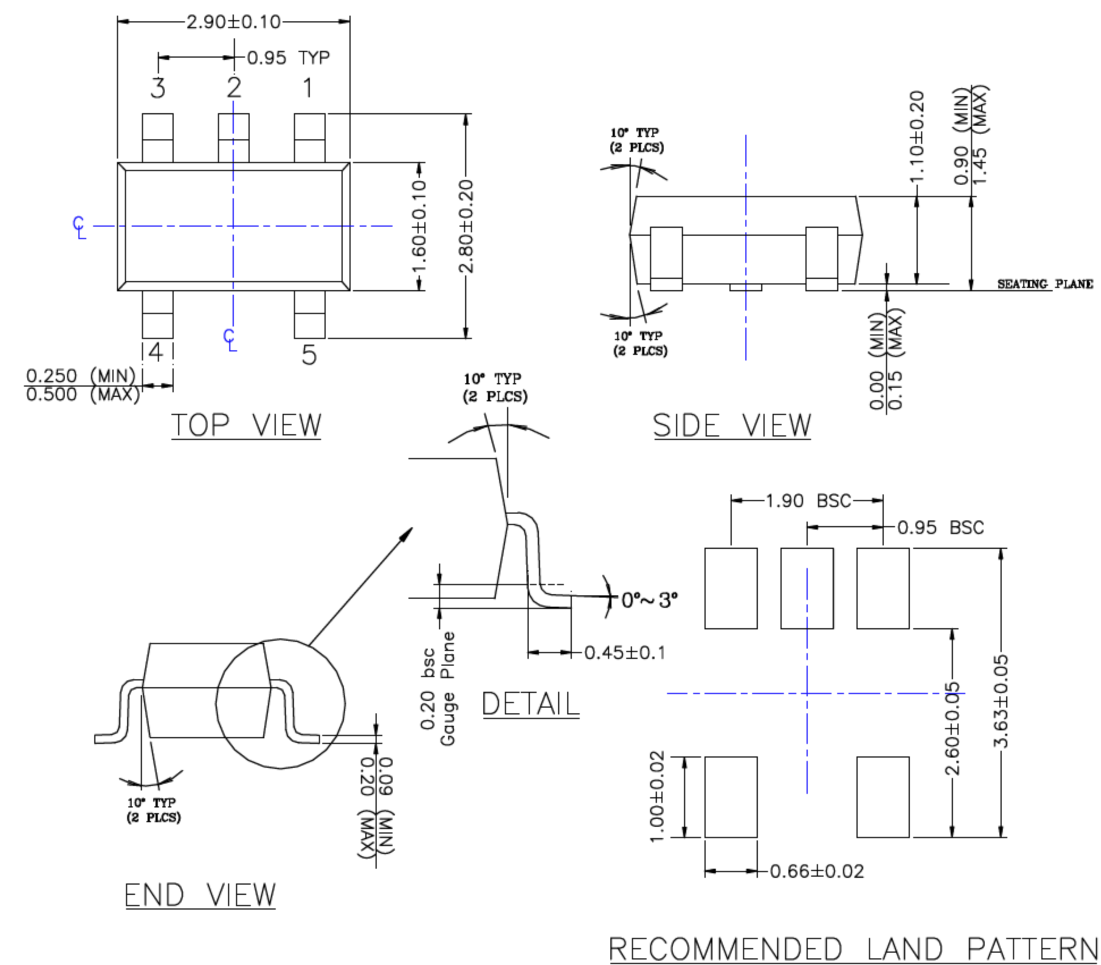
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

5-Lead SOT-23 Package Outline and Recommended Land Pattern

TITLE
5 LEAD SOT23 PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	SOT23-5LD-PL-1	UNIT	MM



NOTE:
1. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & BURR.
2. PACKAGE OUTLINE INCLUSIVE OF SOLER PLATING.
3. DIMENSION AND TOLERANCE PER ANSI Y14.5M, 1982.
4. FOOT LENGTH MEASUREMENT BASED ON GAUGE PLANE METHOD.
5. DIE FACES UP FOR MOLD, AND FACES DOWN FOR TRIM/FORM.
6. ALL DIMENSIONS ARE IN MILLIMETERS.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (December 2019)

- Converted Micrel document LMC7101 to Microchip data sheet template DS20006282A.
- Minor grammatical text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	X	XX	-XX
Device	Temperature Range	Package	Media Type

Device:	LMC7101A:	Low-Power Operational Amplifier, A Grade
	LMC7101B:	Low-Power Operational Amplifier, B Grade
Temperature Range:	Y =	–40°C to +85°C
Packages:	M5 =	5-Lead SOT-23
Media Type:	TR =	3,000/Reel

Examples:

a) LMC7101AYM5-TR: Low–Power Operational Amplifier, A Grade, –40°C to +85°C Temperature Range, 5-Lead SOT-23, 3,000/Reel

b) LMC7101BYM5-TR: Low–Power Operational Amplifier, B Grade, –40°C to +85°C Temperature Range, 5-Lead SOT-23, 3,000/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

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