

## 1.8V to 11V, 15 $\mu$ A, 25 kHz GBW, Rail-to-Rail Input and Output Operational Amplifier

### Features

- 1.8V to 11V Single Supply Operation
- $\pm 0.9$ V to  $\pm 5.5$ V Dual Supply Operation
- Low 15  $\mu$ A Supply Current at 1.8V
- 25 kHz Gain Bandwidth
- 1 mV Input Offset Voltage (Typical)
- 1 pA Input Bias Current (Typical)
- 0.01 pA Input Offset Current (Typical)
- Input-Referred Noise is 110 nV/ $\sqrt{\text{Hz}}$  at 1 kHz
- Output Swing to within 1 mV of Rails with 1.8V Supply And 100 k $\Omega$  Load
- Suitable for Driving Capacitive Loads
- Cost Effective SOT23-5 Package

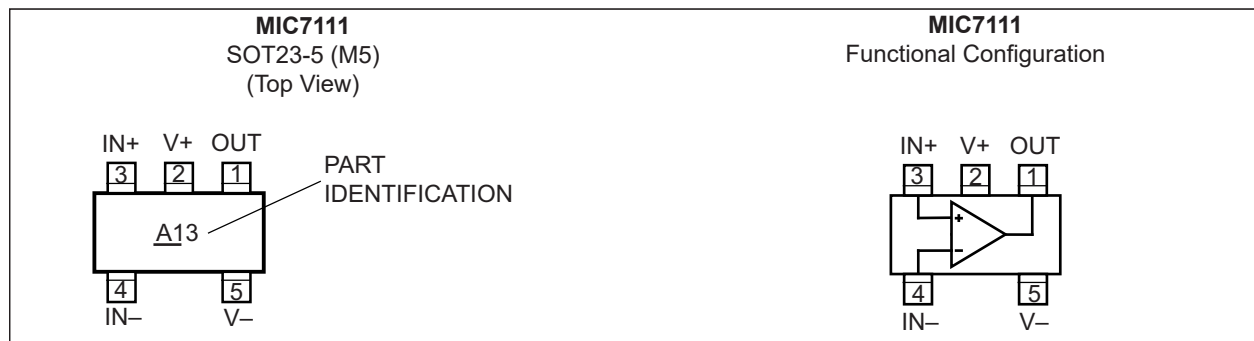
### Applications

- Wireless and Cellular Communications
- Gaas RF Bias Amplifier
- Current Sensing for Battery Chargers
- Transducer Linearization and Interface
- Portable Computing

### General Description

The MIC7111 is a low-power operational amplifier with rail-to-rail inputs and outputs. The device operates from a 1.8V to 11V single supply or an  $\pm 0.9$ V to  $\pm 5.5$ V dual supply. The device consumes a low 15  $\mu$ A of current from a 1.8V supply and 25  $\mu$ A from a 10V supply. The device features a unity gain bandwidth of 25 kHz and swings within 1 mV of either the supply rail with a 100 k $\Omega$  load. The device is capable of sinking and sourcing 25 mA of current from a 1.8V supply and up to 200 mA from a 10V supply. The device is available in the cost effective SOT23-5 package.

### Package Type



# MIC7111

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

Supply Voltage, ( $V_{V+}$ – $V_{V-}$ ) .....	+12V
Differential Input Voltage, ( $V_{IN+}$ – $V_{IN-}$ ) .....	$\pm(V_{V+}$ – $V_{V-})$
I/O Pin Voltage, ( $V_{IN}$ , $V_{OUT}$ ), (Note 1) .....	$V_{V+} + 0.3V$ to $V_{V-} - 0.3V$
ESD Protection On All Pins, (Note 2) .....	$\pm 2$ kV

### Operating Ratings ††

Supply Voltage, ( $V_{V+}$ – $V_{V-}$ ) .....	+1.8V to +11V
Maximum Power Dissipation .....	Note 3

† **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.

†† **Notice:** The device is not guaranteed to function outside its operating ratings.

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

**2:** Devices are ESD protected, however, handling precautions are recommended. All limits guaranteed by testing on statistical analysis. Human body model, 1.5 k $\Omega$  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,  $\theta_{JA}$ ; 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. See [Temperature Specifications](#) section.

## DC ELECTRICAL CHARACTERISTICS (1.8V)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +1.8V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1$  M $\Omega$ ;  $T_J = +25^\circ C$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	$V_{OS}$	—	0.9	7	mV	—
		—	—	9	mV	$-40^\circ C \leq T_J \leq +85^\circ C$
Input Offset Voltage Temperature Drift	$TCV_{OS}$	—	2.0	—	$\mu V/^\circ C$	—
Input Bias Current	$I_B$	—	1	10	pA	—
		—	—	500		$-40^\circ C \leq T_J \leq +85^\circ C$
Input Offset Current	$I_{OS}$	—	0.01	0.5	pA	—
		—	—	75		$-40^\circ C \leq T_J \leq +85^\circ C$
Input Resistance	$R_{IN}$	—	>10	—	T $\Omega$	—
Positive Power Supply Rejection Ratio	+PSRR	60	85	—	dB	$1.8V \leq V_{V+} \leq 5V$ , $V_{V-} = 0V$ , $V_{CM} = V_{OUT} = 0.9V$
Negative Power Supply Rejection Ratio	–PSRR	60	85	—	dB	$-1.8V \leq V_{V-} \leq -5V$ , $V_{V+} = 0V$ , $V_{CM} = V_{OUT} = -0.9V$
Common-Mode Rejection Ratio	CMRR	50	70	—	dB	$V_{CM} = -0.2V$ to $+2.0V$
Common-Mode Input Capacitance	$C_{IN}$	—	3	—	pF	—

## DC ELECTRICAL CHARACTERISTICS (1.8V) (CONTINUED)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +1.8V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\text{ M}\Omega$ ;  $T_J = +25^\circ\text{C}$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Output Voltage Swing	$V_{OUT}$	—	0.14	1	mV	Output HIGH, $R_L = 100\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$
		—	—	1		Output HIGH, $R_L = 100\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	0.14	1		Output LOW, $R_L = 100\text{ k}\Omega$
		—	—	1		Output LOW, $R_L = 100\text{ k}\Omega$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	6.8	23		Output HIGH, $R_L = 2\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$
		—	—	34		Output HIGH, $R_L = 2\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	6.8	23		Output LOW, $R_L = 2\text{ k}\Omega$
		—	—	34		Output LOW, $R_L = 2\text{ k}\Omega$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
Output Short-Circuit Current (Note 1)	$I_{SC}$	15	25	—	mA	Sourcing, $V_{OUT} = 0V$
		15	25	—		Sinking, $V_{OUT} = 1.8V$
Voltage Gain	$A_{VOL}$	—	400	—	V/mV	Sourcing
		—	400	—		Sinking
Supply Current	$I_S$	—	15	35	$\mu\text{A}$	$V_{V+} = 1.8V$ , $V_{OUT} = V_{V+}/2$

**Note 1:** Short circuit may cause device to exceed maximum allowable power dissipation.

## AC ELECTRICAL CHARACTERISTICS (1.8V)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +1.8V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\text{ M}\Omega$ ;  $T_J = +25^\circ\text{C}$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Slew Rate	SR	—	0.015	—	V/ $\mu\text{s}$	Voltage follower, 1V step, $R_L = 100\text{ k}\Omega$ at 0.9V, $V_{OUT} = 1V_{PP}$
Gain Bandwidth Product	GBWP	—	25	—	kHz	—

## DC ELECTRICAL CHARACTERISTICS (2.7V)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +2.7V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\text{ M}\Omega$ ;  $T_J = +25^\circ\text{C}$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	$V_{OS}$	—	0.9	7	mV	—
		—	—	9	mV	$-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
Input Offset Voltage Temperature Drift	$TCV_{OS}$	—	2.0	—	$\mu\text{V}/^\circ\text{C}$	—

**Note 1:** Short circuit may cause device to exceed maximum allowable power dissipation.

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## DC ELECTRICAL CHARACTERISTICS (2.7V) (CONTINUED)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +2.7V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\text{ M}\Omega$ ;  $T_J = +25^\circ\text{C}$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Input Bias Current	$I_B$	—	1	10	pA	—
		—		500		$-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
Input Offset Current	$I_{OS}$	—	0.01	0.5	pA	—
		—		75		$-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
Input Resistance	$R_{IN}$	—	>10	—	T $\Omega$	—
Positive Power Supply Rejection Ratio	+PSRR	60	90	—	dB	$2.7V \leq V_{V+} \leq 5V$ , $V_{V-} = 0V$ , $V_{CM} = V_{OUT} = 1.35V$
Negative Power Supply Rejection Ratio	-PSRR	60	90	—	dB	$-2.7V \leq V_{V-} \leq -5V$ , $V_{V+} = 0V$ , $V_{CM} = V_{OUT} = -1.35V$
Common-Mode Rejection Ratio	CMRR	52	75	—	dB	$V_{CM} = -0.2V$ to $+2.9V$
Common-Mode Input Capacitance	$C_{IN}$	—	3	—	pF	—
Output Voltage Swing	$V_{OUT}$	—	0.2	1	mV	Output HIGH, $R_L = 100\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$
		—	—	1		Output HIGH, $R_L = 100\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	0.2	1		Output LOW, $R_L = 100\text{ k}\Omega$
		—	—	1		Output LOW, $R_L = 100\text{ k}\Omega$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	10	33		Output HIGH, $R_L = 2\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$
		—	—	50		Output HIGH, $R_L = 2\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	10	33		Output Low, $R_L = 2\text{ k}\Omega$
		—	—	50		Output Low, $R_L = 2\text{ k}\Omega$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
Output Short-Circuit Current (Note 1)	$I_{SC}$	30	50	—	mA	Sourcing, $V_{OUT} = 0V$
		30	50	—		Sinking, $V_{OUT} = 2.7V$
Voltage Gain	$A_{VOL}$	—	400	—	V/mV	Sourcing
		—	400	—		Sinking
Supply Current	$I_S$	—	17	42	$\mu\text{A}$	$V_{V+} = 2.7V$ , $V_{OUT} = V_{V+}/2$

**Note 1:** Short circuit may cause device to exceed maximum allowable power dissipation.

## AC ELECTRICAL CHARACTERISTICS (2.7V)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +2.7V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\text{ M}\Omega$ ;  $T_J = +25^\circ\text{C}$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Slew Rate	SR	—	0.015	—	V/ $\mu\text{s}$	Voltage follower, 1V step, $R_L = 100\text{ k}\Omega$ @ 1.35V, $V_{OUT} = 1V_{PP}$
Gain Bandwidth Product	GBWP	—	25	—	kHz	—

## DC ELECTRICAL CHARACTERISTICS (5.0V)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +5.0V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\text{ M}\Omega$ ;  $T_J = +25^\circ\text{C}$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	$V_{OS}$	—	0.9	7	mV	—
		—	—	9	mV	$-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
Input Offset Voltage Temperature Drift	$TCV_{OS}$	—	2.0	—	$\mu\text{V}/^\circ\text{C}$	—
Input Bias Current	$I_B$	—	1	10	pA	—
		—	—	500		$-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
Input Offset Current	$I_{OS}$	—	0.01	0.5	pA	—
		—	—	75		$-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
Input Resistance	$R_{IN}$	—	>10	—	T $\Omega$	—
Positive Power Supply Rejection Ratio	+PSRR	65	95	—	dB	$5V \leq V_{V+} \leq 10V$ , $V_{V-} = 0V$ , $V_{CM} = V_{OUT} = 2.5V$
Negative Power Supply Rejection Ratio	-PSRR	65	95	—	dB	$-5V \leq V_{V-} \leq -10V$ , $V_{V+} = 0V$ , $V_{CM} = V_{OUT} = -2.5V$
Common-Mode Rejection Ratio	CMRR	57	80	—	dB	$V_{CM} = -0.2V$ to $+5.2V$
Common-Mode Input Capacitance	$C_{IN}$	—	3	—	pF	—
Output Voltage Swing	$V_{OUT}$	—	0.3	1.5	mV	Output HIGH, $R_L = 100\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$
		—	—	1.5		Output HIGH, $R_L = 100\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	0.3	1.5		Output LOW, $R_L = 100\text{ k}\Omega$
		—	—	1.5		Output LOW, $R_L = 100\text{ k}\Omega$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	15	50		Output HIGH, $R_L = 2\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$
		—	—	75		Output HIGH, $R_L = 2\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	15	50		Output LOW, $R_L = 2\text{ k}\Omega$
		—	—	75		Output LOW, $R_L = 2\text{ k}\Omega$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$

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## DC ELECTRICAL CHARACTERISTICS (5.0V) (CONTINUED)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +5.0V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\ M\Omega$ ;  $T_J = +25^\circ C$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Output Short-Circuit Current (Note 1)	$I_{SC}$	80	100	—	mA	Sourcing, $V_{OUT} = 0V$
		80	100	—		Sinking, $V_{OUT} = 5V$
Voltage Gain	$A_{VOL}$	—	500	—	V/mV	Sourcing
		—	500	—		Sinking
Supply Current	$I_S$	—	20	50	$\mu A$	$V_{V+} = 5V, V_{OUT} = V_{V+}/2$

**Note 1:** Short circuit may cause device to exceed maximum allowable power dissipation.

## AC ELECTRICAL CHARACTERISTICS (5.0V)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +5.0V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\ M\Omega$ ;  $T_J = +25^\circ C$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Slew Rate	SR	—	0.02	—	V/ $\mu s$	Voltage follower, 1V step, $R_L = 100\ k\Omega @ 1.5V$ , $V_{OUT} = 1V_{PP}$
Gain Bandwidth Product	GBWP	—	25	—	kHz	Sourcing

## DC ELECTRICAL CHARACTERISTICS (10.0V)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +10.0V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\ M\Omega$ ;  $T_J = +25^\circ C$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Input Offset Voltage	$V_{OS}$	—	0.9	7	mV	—
		—	—	9	mV	$-40^\circ C \leq T_J \leq +85^\circ C$
Input Offset Voltage Temperature Drift	$TCV_{OS}$	—	2.0	—	$\mu V/^\circ C$	—
Input Bias Current	$I_B$	—	1	10	pA	—
		—	—	500		$-40^\circ C \leq T_J \leq +85^\circ C$
Input Offset Current	$I_{OS}$	—	0.01	0.5	pA	—
		—	—	75		$-40^\circ C \leq T_J \leq +85^\circ C$
Input Resistance	$R_{IN}$	—	>10	—	T $\Omega$	—
Positive Power Supply Rejection Ratio	+PSRR	65	95	—	dB	$5V \leq V_{V+} \leq 10V, V_{V-} = 0V, V_{CM} = V_{OUT} = 2.5V$
Negative Power Supply Rejection Ratio	-PSRR	65	95	—	dB	$-5V \leq V_{V-} \leq -10V, V_{V+} = 0V, V_{CM} = V_{OUT} = -2.5V$
Common-Mode Rejection Ratio	CMRR	60	85	—	dB	$V_{CM} = -0.2V$ to $+10.2V$
Common-Mode Input Capacitance	$C_{IN}$	—	3	—	pF	—

## DC ELECTRICAL CHARACTERISTICS (10.0V) (CONTINUED)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +10.0V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\text{ M}\Omega$ ;  $T_J = +25^\circ\text{C}$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Output Voltage Swing	$V_{OUT}$	—	0.45	2.5	mV	Output HIGH, $R_L = 100\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$
		—	—	2.5		Output HIGH, $R_L = 100\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	0.45	2.5		Output LOW, $R_L = 100\text{ k}\Omega$
		—	—	2.5		Output LOW, $R_L = 100\text{ k}\Omega$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	24	80		Output HIGH, $R_L = 2\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$
		—	—	120		Output HIGH, $R_L = 2\text{ k}\Omega$ , Specified as $V_{V+} - V_{OUT}$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
		—	24	80		Output LOW, $R_L = 2\text{ k}\Omega$
		—	—	120		Output LOW, $R_L = 2\text{ k}\Omega$ $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$
Output Short-Circuit Current (Note 1)	$I_{SC}$	100	200	—	mA	Sourcing, $V_{OUT} = 0V$
		100	200	—		Sinking, $V_{OUT} = 10V$
Voltage Gain	$A_{VOL}$	—	500	—	V/mV	Sourcing
		—	500	—		Sinking
Supply Current	$I_S$	—	25	65	$\mu\text{A}$	$V_{V+} = 10V$ , $V_{OUT} = V_{V+}/2$

**Note 1:** Short circuit may cause device to exceed maximum allowable power dissipation.

## AC ELECTRICAL CHARACTERISTICS (10.0V)

**Electrical Characteristics:** Unless otherwise indicated,  $V_{V+} = +10.0V$ ;  $V_{V-} = 0V$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\text{ M}\Omega$ ;  $T_J = +25^\circ\text{C}$ .

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Slew Rate	SR	—	0.02	—	V/ $\mu\text{s}$	Voltage follower, 1V step, $R_L = 100\text{ k}\Omega$ @ 1.35V, $V_{OUT} = 1V_{PP}$
Gain Bandwidth Product	GBWP	—	25	—	kHz	—
Phase Margin	$\phi_M$	—	50	—	$^\circ$	—
Gain Margin	$G_M$	—	15	—	dB	—
Input-Referred Voltage Noise	$e_N$	—	110	—	nV/ $\sqrt{\text{Hz}}$	$f = 1\text{ kHz}$ , $V_{CM} = 1.0V$
Input-Referred Current Noise	$i_N$	—	0.03	—	pA/ $\sqrt{\text{Hz}}$	$f = 1\text{ kHz}$

# MIC7111

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## TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
<b>Temperature Ranges</b>						
Junction Operating Temperature	$T_J$	-40	—	+85	°C	—
Storage Temperature Range	$T_A$	-65	—	+150	°C	—
Lead Temperature	$T_S$	—	+260	—	°C	Soldering, 10s
<b>Package Thermal Resistances</b>						
Thermal Resistance, SOT-23-5Ld	$\theta_{JA}$	—	252	—	°C/W	—



## 2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 2-1](#).

**TABLE 2-1: PIN FUNCTION TABLE**

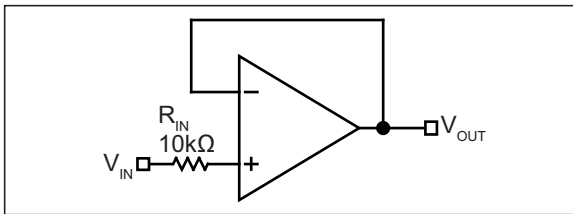
Pin Number	Pin Name	Description
1	OUT	Amplifier Output.
2	V+	Positive Supply.
3	IN+	Non-inverting Input.
4	IN-	Inverting Input.
5	V-	Negative Supply.

## 3.0 APPLICATION INFORMATION

### 3.1 Input Common Mode Voltage

The MIC7111 tolerates input overdrive by at least 300 mV beyond either rail without producing phase inversion.

If the absolute maximum input voltage is exceeded, the input current should be limited to  $\pm 5$  mA maximum to prevent reducing reliability. A 10 k $\Omega$  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 3-1.



**FIGURE 3-1:** Input Current-Limit Protection.

### 3.2 Output Voltage Swing

Sink and source output resistances of the MIC7111 are equal. Maximum output voltage swing is determined by the load and the approximate output resistance. The output resistance is presented in Equation 3-1:

**EQUATION 3-1:**

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

$V_{DROP}$  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 DC Electrical Characteristics (5.0V) table, the typical output voltage drop using a 2 k $\Omega$  load (connected to  $V+/2$ ) is 0.015V, which produces an  $I_{LOAD}$  of:

**EQUATION 3-2:**

$$\frac{2.5V - 0.015V}{2k\Omega} = 1.243mA$$

Then:

**EQUATION 3-3:**

$$R_{OUT} = \frac{15mV}{1.243mA} = 12.1 = 12\Omega$$

### 3.3 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 MIC7111 can typically drive a 500 pF capacitive load connected directly to the output when configured as a unity-gain amplifier.

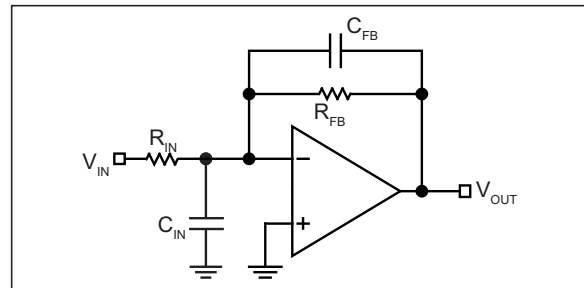
### 3.4 Using Large-Value Feedback Resistors

A large-value feedback resistor (>500 k $\Omega$ ) 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 3-2 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:

**EQUATION 3-4:**

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

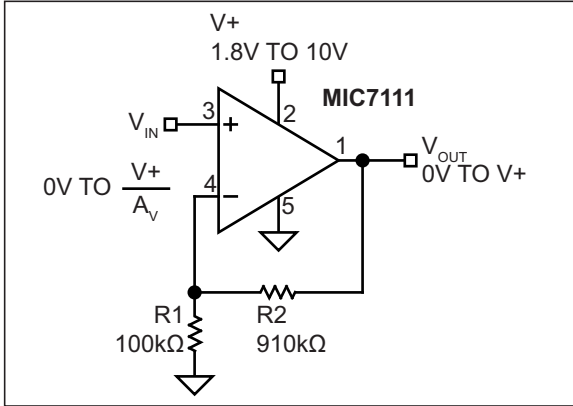


**FIGURE 3-2:** Canceling Feedback Phase Lag.

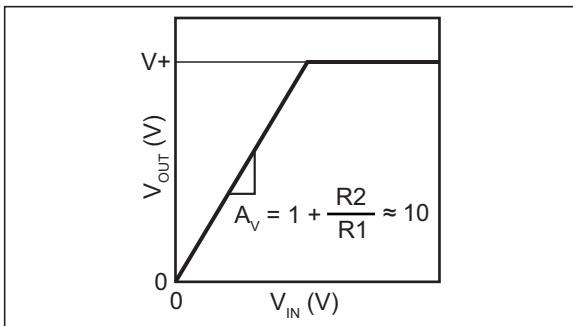
Because a significant percentage of  $C_{IN}$  may be caused by board layout, it is important to note that the correct value of  $C_{FB}$  may change when changing from a breadboard to the final circuit layout.

### 3.5 Typical Circuits

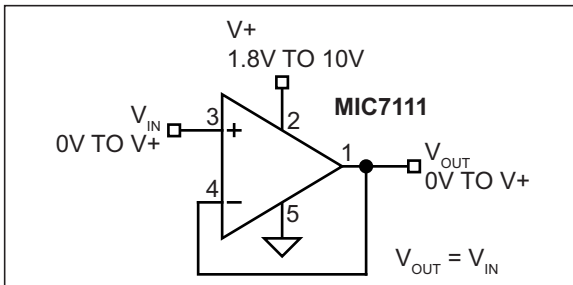
Some single-supply, rail-to-rail applications for which the MIC7111 is well suited are shown in the circuit diagrams of Figure 3-3 through Figure 3-8.



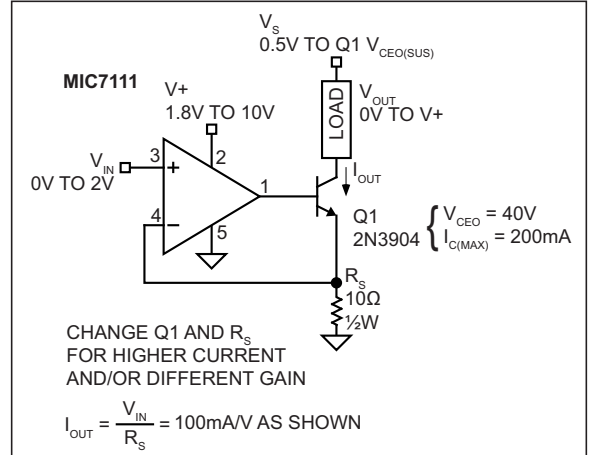
**FIGURE 3-3:** Noninverting Amplifier.



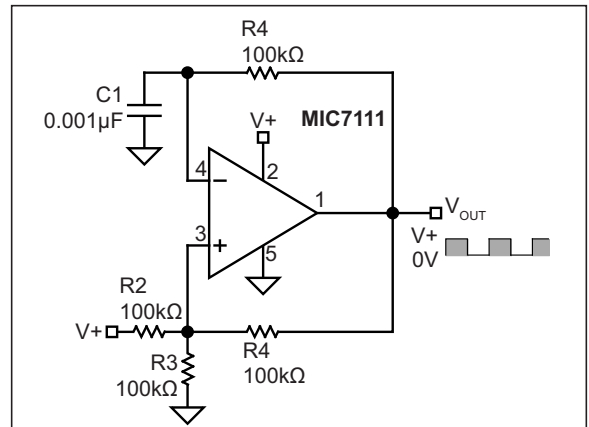
**FIGURE 3-4:** Noninverting Amplifier Behavior.



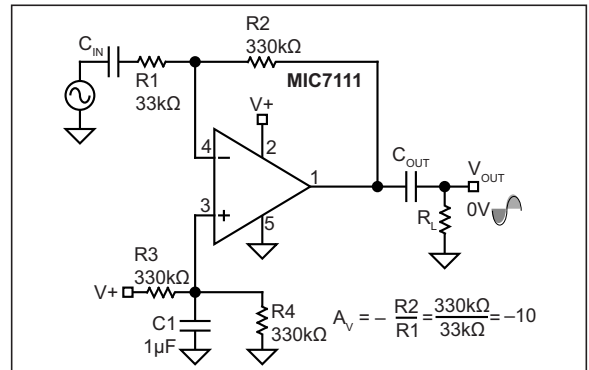
**FIGURE 3-5:** Voltage Follower/Buffer.



**FIGURE 3-6:** Voltage-Controlled Current Sink.



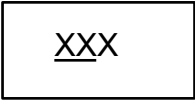
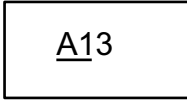

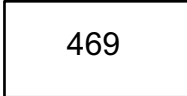
**FIGURE 3-7:** Square Wave Oscillator.



**FIGURE 3-8:** AC-Coupled Inverting Amplifier.

## 4.0 PACKAGING INFORMATION

### 4.1 Package Marking Information

5-Lead SOT-23* (Front)	Example
	
5-Lead SOT-23* (Back)	Example
	

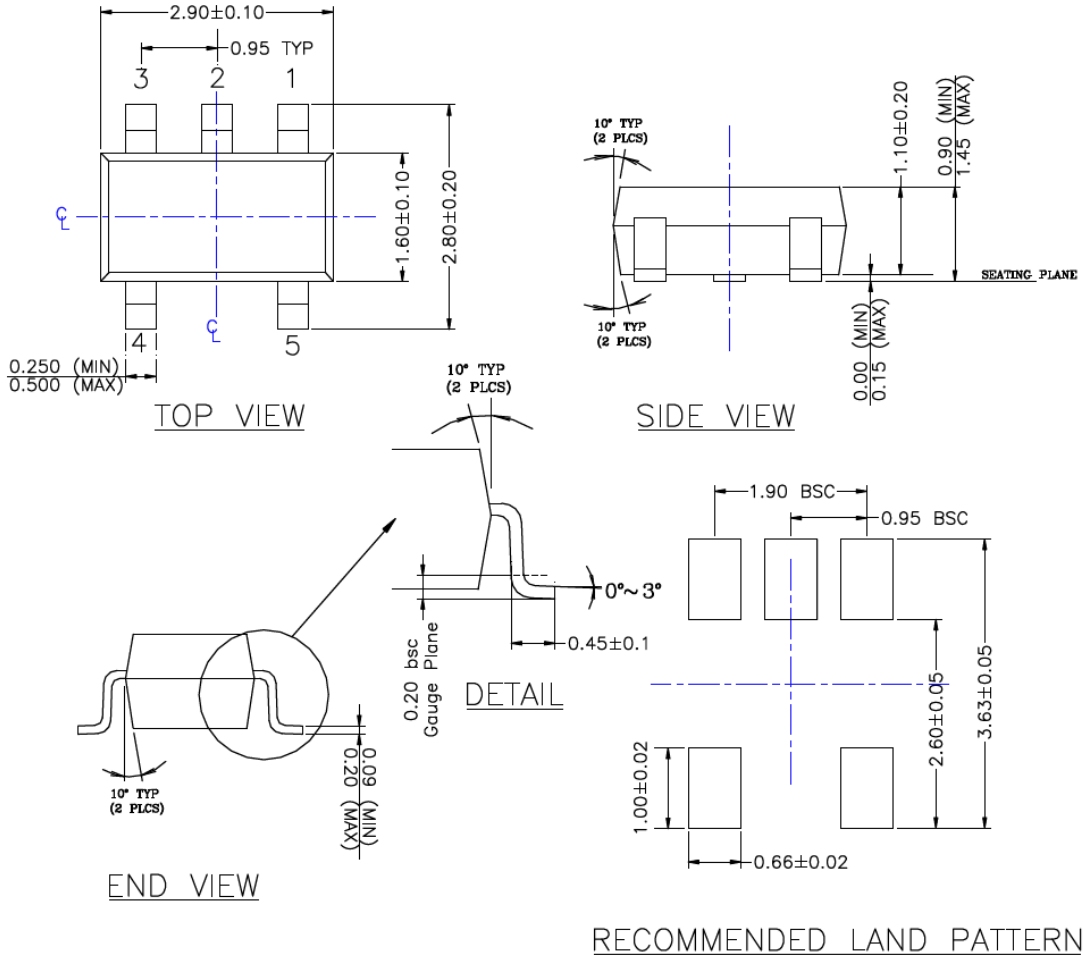
<b>Legend:</b>	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package 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).
<b>Note:</b>	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 SOT23-5 Package Outline & Recommended Land Pattern

**TITLE**

5 LEAD SOT23 PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

<b>DRAWING #</b>	SOT23-5LD-PL-1	<b>UNIT</b>	MM
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**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>.

# MIC7111

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NOTES:

## APPENDIX A: REVISION HISTORY

### Revision A (March 2020)

- Converted Micrel document MIC7111 to Microchip data sheet template DS20006316A.
- Minor grammatical text changes throughout.

# MIC7111

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NOTES:



## PRODUCT IDENTIFICATION SYSTEM

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

<u>PART NO.</u>	<u>X</u>	<u>XX</u>	<u>-XX</u>	<b>Examples:</b>
Device	Temperature Range	Package	Media Type	a) MIC7111YM5-TR: MIC7111, -40°C to +85°C Temperature Range, 5-Lead SOT-23, 3,000/Reel
<b>Device:</b>	MIC7111:	1.8V to 11V, 15 $\mu$ A, 25 kHz GBW, Rail-to-Rail Input and Output Operational Amplifier		<b>Note 1:</b> 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.
<b>Temperature Range:</b>	Y =	-40°C to +85°C (Industrial)		
<b>Packages:</b>	M5 =	5-Lead SOT-23		
<b>Media Type:</b>	TR =	3,000/Reel		

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NOTES:

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