

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

### Features

- 1.8V to 11V Single Power Supply Operation
- $\pm 0.9$ V to  $\pm 5.5$ V Dual Power 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
- Packaging: 2.9 mm x 1.6 mm, 5-Lead SOT23 (M5)

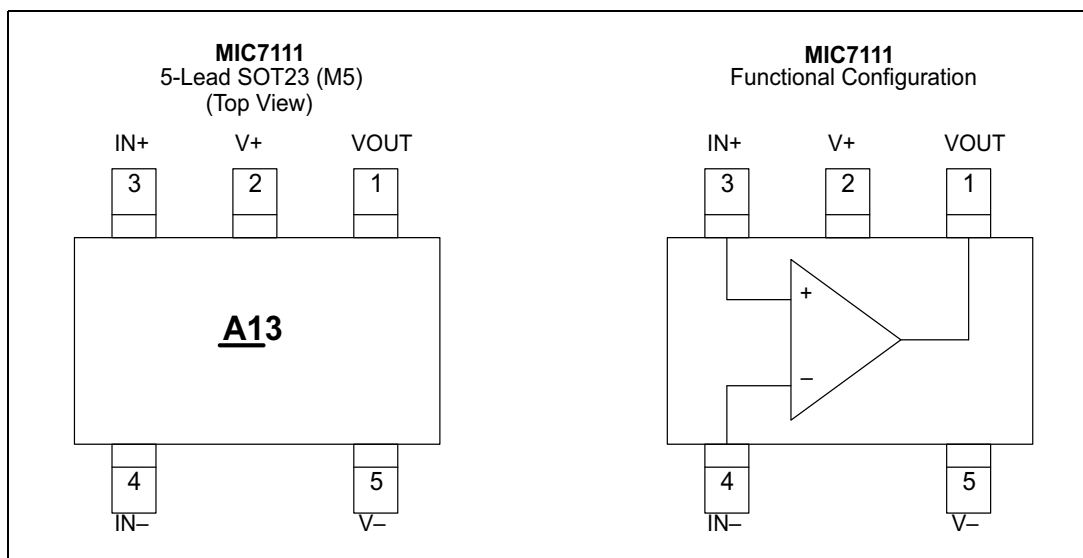
### Applications

- Wireless and Cellular Communications
- Gallium Arsenide (GaAs) Radio-Frequency (RF) Bias Amplifier
- Current Sensing for Battery Chargers
- Transducer Linearization and Interface
- Portable Computing

### Package Type

### General Description

MIC7111 is a low-power operational amplifier with rail-to-rail inputs and outputs. The device operates from a 1.8V to 11V single power supply or an  $\pm 0.9$ V to  $\pm 5.5$ V dual power supply. MIC7111 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 supply rail with a 100 k $\Omega$  load. MIC7111 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 5-Lead SOT23 package.



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings <sup>†</sup>

|                                                             |                                  |
|-------------------------------------------------------------|----------------------------------|
| 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 <sup>††</sup>

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

<sup>†</sup> **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 listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

#### <sup>††</sup> **Notices:**

- 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,  $T_{JMAX}$ , 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  $P_D = (T_{JMAX} - T_A)/\theta_{JA}$ . Exceeding the maximum allowable power dissipation will result in excessive die temperature. See [Temperature Specifications](#).

## DC ELECTRICAL CHARACTERISTICS (1.8V)

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

| Parameters                             | Symbol     | Min. | Typical | 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      | 60   | 85      | —    | dB                           | $1.8\text{V} \leq V_{V+} \leq 5\text{V}$ , $V_{V-} = 0\text{V}$ , $V_{CM} = V_{OUT} = 0.9\text{V}$    |
| Negative Power Supply Rejection Ratio  | -PSRR      | 60   | 85      | —    | dB                           | $-1.8\text{V} \leq V_{V-} \leq -5\text{V}$ , $V_{V+} = 0\text{V}$ , $V_{CM} = V_{OUT} = -0.9\text{V}$ |
| Common-Mode Rejection Ratio            | CMRR       | 50   | 70      | —    | dB                           | $V_{CM} = -0.2\text{V}$ to $+2.0\text{V}$                                                             |
| Common-Mode Input Capacitance          | $C_{IN}$   | —    | 3       | —    | pF                           |                                                                                                       |

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

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

| Parameters                            | Symbol    | Min. | Typical | 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, $V_{OUT} = 0\text{V}$                                                                                                 |
|                                       |           | 15   | 25      | —    |               | Sinking, $V_{OUT} = 1.8\text{V}$                                                                                                |
| Voltage Gain                          | $A_{VOL}$ | —    | 400     | —    | V/mV          | Sourcing                                                                                                                        |
|                                       |           | —    | 400     | —    |               | Sinking                                                                                                                         |
| Supply Current                        | $I_S$     | —    | 15      | 35   | $\mu\text{A}$ | $V_{V+} = 1.8\text{V}$ , $V_{OUT} = V_{V+}/2$                                                                                   |

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

## AC ELECTRICAL CHARACTERISTICS (1.8V)

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

| Parameters             | Symbol | Min. | Typical | Max. | Units                  | Conditions                                                                         |
|------------------------|--------|------|---------|------|------------------------|------------------------------------------------------------------------------------|
| Slew Rate              | SR     | —    | 0.015   | —    | $\text{V}/\mu\text{s}$ | 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, all parameters apply at  $T_J = +25^\circ\text{C}$ ;  $V_{V+} = +2.7\text{V}$ ;  $V_{V-} = 0\text{V}$ ;  $V_{CM} = V_{OUT} = V_{V+}/2$ ;  $R_L = 1\text{ M}\Omega$ .

| Parameters                             | Symbol     | Min. | Typical | 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     | —    | $\text{T}\Omega$             |                                                                                                                                 |
| Positive Power Supply Rejection Ratio  | +PSRR      | 60   | 90      | —    | dB                           | $2.7\text{V} \leq V_{V+} \leq 5\text{V}$ , $V_{V-} = 0\text{V}$ , $V_{CM} = V_{OUT} = 1.35\text{V}$                             |
| Negative Power Supply Rejection Ratio  | -PSRR      | 60   | 90      | —    | dB                           | $-2.7\text{V} \leq V_{V-} \leq -5\text{V}$ , $V_{V+} = 0\text{V}$ , $V_{CM} = V_{OUT} = -1.35\text{V}$                          |
| Common-Mode Rejection Ratio            | CMRR       | 52   | 75      | —    | dB                           | $V_{CM} = -0.2\text{V}$ to $+2.9\text{V}$                                                                                       |
| 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, $V_{OUT} = 0\text{V}$                                                                                                 |
|                                        |            | 30   | 50      | —    |                              | Sinking, $V_{OUT} = 2.7\text{V}$                                                                                                |
| Voltage Gain                           | $A_{VOL}$  | —    | 400     | —    | V/mV                         | Sourcing                                                                                                                        |
|                                        |            | —    | 400     | —    |                              | Sinking                                                                                                                         |
| Supply Current                         | $I_S$      | —    | 17      | 42   | $\mu\text{A}$                | $V_{V+} = 2.7\text{V}$ , $V_{OUT} = V_{V+}/2$                                                                                   |

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

## AC ELECTRICAL CHARACTERISTICS (2.7V)

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

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

## DC ELECTRICAL CHARACTERISTICS (5.0V)

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

| Parameters                             | Symbol     | Min. | Typical | 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                           | $5\text{V} \leq V_{V+} \leq 10\text{V}$ , $V_{V-} = 0\text{V}$ , $V_{CM} = V_{OUT} = 2.5\text{V}$                               |
| Negative Power Supply Rejection Ratio  | -PSRR      | 65   | 95      | —    | dB                           | $-5\text{V} \leq V_{V-} \leq -10\text{V}$ , $V_{V+} = 0\text{V}$ , $V_{CM} = V_{OUT} = -2.5\text{V}$                            |
| Common-Mode Rejection Ratio            | CMRR       | 57   | 80      | —    | dB                           | $V_{CM} = -0.2\text{V}$ to $+5.2\text{V}$                                                                                       |
| 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, $R_L = 2\text{ k}\Omega$ , $-40^\circ\text{C} \leq T_J \leq +85^\circ\text{C}$                                      |

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

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

| Parameters                            | Symbol    | Min. | Typical | Max. | Units         | Conditions                                  |
|---------------------------------------|-----------|------|---------|------|---------------|---------------------------------------------|
| Output Short-Circuit Current (Note 1) | $I_{SC}$  | 60   | 100     | —    | mA            | Sourcing, $V_{OUT} = 0\text{V}$             |
|                                       |           | 60   | 100     | —    |               | Sinking, $V_{OUT} = 5\text{V}$              |
| Voltage Gain                          | $A_{VOL}$ | —    | 500     | —    | V/mV          | Sourcing                                    |
|                                       |           | —    | 500     | —    |               | Sinking                                     |
| Supply Current                        | $I_S$     | —    | 20      | 50   | $\mu\text{A}$ | $V_{V+} = 5\text{V}$ , $V_{OUT} = V_{V+}/2$ |

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

## AC ELECTRICAL CHARACTERISTICS (5.0V)

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

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

## DC ELECTRICAL CHARACTERISTICS (10.0V)

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

| Parameters                             | Symbol     | Min. | Typical | 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     | —    | $\text{T}\Omega$             |                                                                                                      |
| Positive Power Supply Rejection Ratio  | +PSRR      | 65   | 95      | —    | dB                           | $5\text{V} \leq V_{V+} \leq 10\text{V}$ , $V_{V-} = 0\text{V}$ , $V_{CM} = V_{OUT} = 2.5\text{V}$    |
| Negative Power Supply Rejection Ratio  | -PSRR      | 65   | 95      | —    | dB                           | $-5\text{V} \leq V_{V-} \leq -10\text{V}$ , $V_{V+} = 0\text{V}$ , $V_{CM} = V_{OUT} = -2.5\text{V}$ |
| Common-Mode Rejection Ratio            | CMRR       | 60   | 85      | —    | dB                           | $V_{CM} = -0.2\text{V}$ to $+10.2\text{V}$                                                           |
| Common-Mode Input Capacitance          | $C_{IN}$   | —    | 3       | —    | pF                           |                                                                                                      |

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

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

| Parameters                            | Symbol    | Min. | Typical | 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, $V_{OUT} = 0\text{V}$                                                                                                 |
|                                       |           | 100  | 200     | —    |               | Sinking, $V_{OUT} = 10\text{V}$                                                                                                 |
| Voltage Gain                          | $A_{VOL}$ | —    | 500     | —    | V/mV          | Sourcing                                                                                                                        |
|                                       |           | —    | 500     | —    |               | Sinking                                                                                                                         |
| Supply Current                        | $I_S$     | —    | 25      | 65   | $\mu\text{A}$ | $V_{V+} = 10\text{V}$ , $V_{OUT} = V_{V+}/2$                                                                                    |

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

**AC ELECTRICAL CHARACTERISTICS (10.0V)**

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

| Parameters                   | Sym.     | Min. | Typ. | Max. | Units                        | Conditions                                                                          |
|------------------------------|----------|------|------|------|------------------------------|-------------------------------------------------------------------------------------|
| Slew Rate                    | SR       | —    | 0.02 | —    | $\text{V}/\mu\text{s}$       | Voltage follower, 1V step, $R_L = 100\text{ k}\Omega$ at 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  | —    | $\text{nV}/\sqrt{\text{Hz}}$ | $f = 1\text{ kHz}$ , $V_{CM} = 1.0\text{V}$                                         |
| Input-Referred Current Noise | $i_N$    | —    | 0.03 | —    | $\text{pA}/\sqrt{\text{Hz}}$ | $f = 1\text{ kHz}$                                                                  |

## TEMPERATURE SPECIFICATIONS

| Parameters                         | Symbol        | Min. | Typical | 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, 5-Lead SOT23   | $\theta_{JA}$ | —    | 252     | —    | °C/W  |                |

2.0 PIN DESCRIPTIONS

The descriptions of the MIC7111 pins are listed in [Table 2-1](#).

TABLE 2-1: PIN FUNCTION TABLE

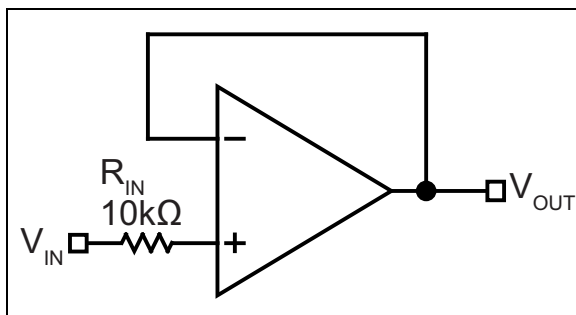
| Pin Number | Pin Name | Description        |
|------------|----------|--------------------|
| 1          | OUT      | Amplifier Output   |
| 2          | V+       | Positive Supply    |
| 3          | IN+      | Noninverting Input |
| 4          | IN-      | Inverting Input    |
| 5          | V- 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

## 3.0 APPLICATION INFORMATION

### 3.1 Input Common Mode Voltage

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

If the absolute maximum input voltage is exceeded, limit the input current to  $\pm 5$  mA maximum to prevent reducing reliability. A 10 k $\Omega$  series input resistor, used as a current limiter, protects 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

The sink and source output resistances of 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:

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

Where:

- $R_{OUT}$  = Output Resistance (k $\Omega$ )
- $V_{DROP}$  = Voltage Dropped within the Amplifier Output Stage (V)
- $I_{LOAD}$  = Load Current (mA)

$V_{DROP}$  and  $I_{LOAD}$  can be determined from the  $V_{OUT}$  (output voltage swing) portion of the appropriate electrical characteristics table. For the conditions of this table, calculate  $I_{LOAD}$  using [Equation 3-2](#).

#### EQUATION 3-2:

$$I_{LOAD} = \frac{\frac{V_{V+}}{2} - V_{DROP}}{R_{LOAD}}$$

Where:

- $I_{LOAD}$  = Load Current (mA)
- $V_{V+}$  = Power Supply Voltage (V)
- $V_{DROP}$  = Voltage Dropped within the Amplifier Output Stage (V)
- $R_{LOAD}$  = Load Resistance (k $\Omega$ )

For example, using [DC Electrical Characteristics \(5.0V\)](#), the typical output voltage drop using a 2 k $\Omega$  load resistance connected to output high voltage is 0.015V. This produces an  $I_{LOAD}$  of 1.243 mA, as calculated in [Equation 3-3](#).

#### EQUATION 3-3:

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

After determining  $I_{LOAD}$  using [Equation 3-2](#), calculate  $R_{OUT}$  using [Equation 3-1](#). This results in a value of 12 $\Omega$ , as shown in [Equation 3-4](#).

#### EQUATION 3-4:

$$R_{OUT} = \frac{15mV}{1.243mA} = 12.067\Omega \approx 12\Omega$$

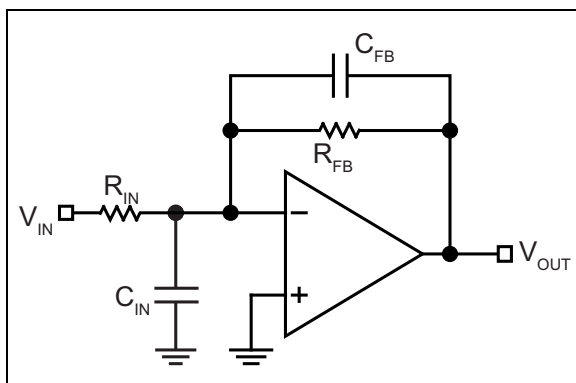
### 3.3 Driving Capacitive Loads

Driving a capacitive load introduces phase lag into the output signal. This reduces the phase margin of the operational amplifier system. The application that is least forgiving of reduced phase margin is a unity gain amplifier. MIC7111 typically drives 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 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 capacitances, such as amplifier input capacitance and stray printed circuit board (PCB) capacitance.

Figure 3-2 illustrates a method of compensating phase lag caused by using a large-value feedback resistor.



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

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 using Equation 3-5.

### EQUATION 3-5:

$$C_{FB} \geq \frac{R_{IN} \times C_{IN}}{R_{FB}}$$

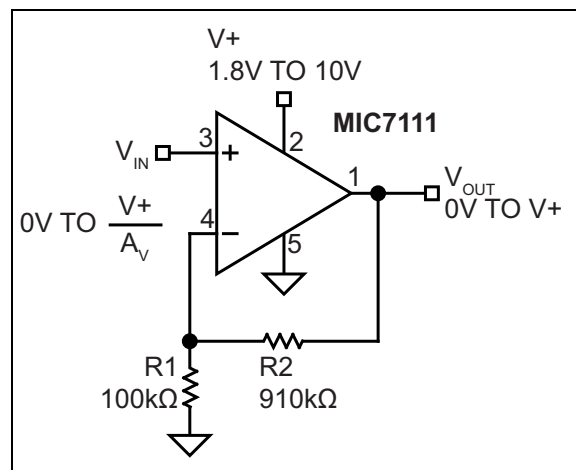
Where:

- $R_{IN}$  = Input Resistance (kΩ)
- $C_{IN}$  = Input Capacitor (pF)
- $R_{FB}$  = Feedback Resistor (kΩ)
- $C_{FB}$  = Feedback Capacitor (pF)

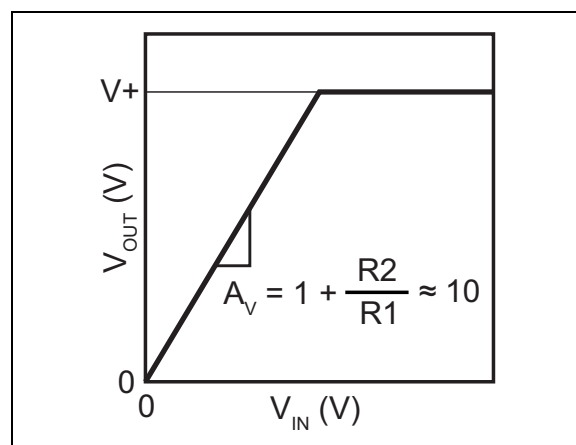
Because a significant percentage of  $C_{IN}$  may be caused by the board layout, it is important to note that the correct value of  $C_{FB}$  may change when changing from a breadboard to the final circuit layout.

## 3.5 Typical Circuits

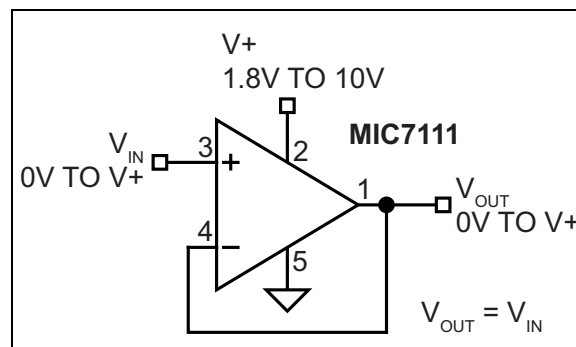
Some single-supply, rail-to-rail applications for which MIC7111 is well suited are shown in the circuit diagrams of Figure 3-3 through Figure 3-8.



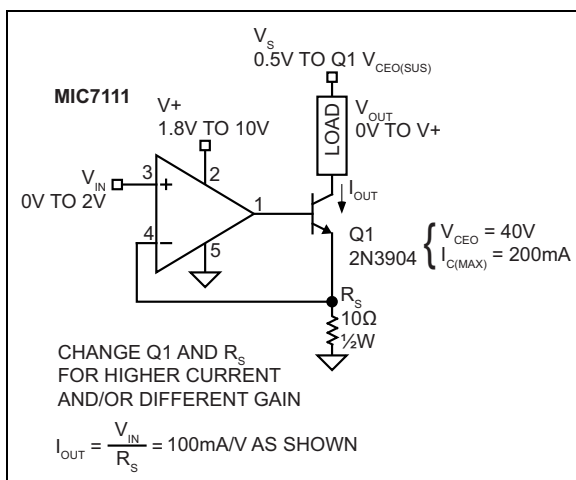
**FIGURE 3-3:** Noninverting Amplifier.



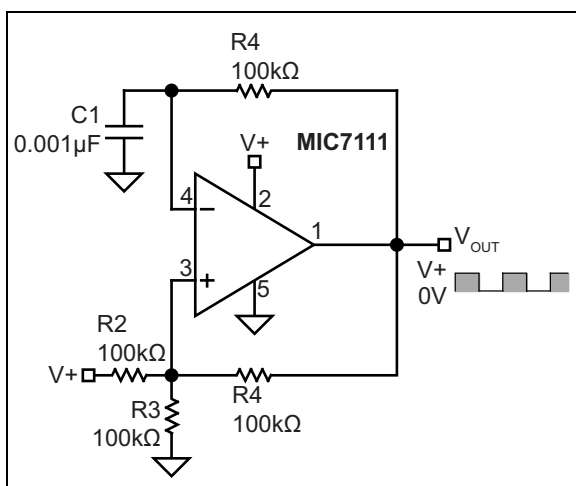
**FIGURE 3-4:** Noninverting Amplifier Behavior.



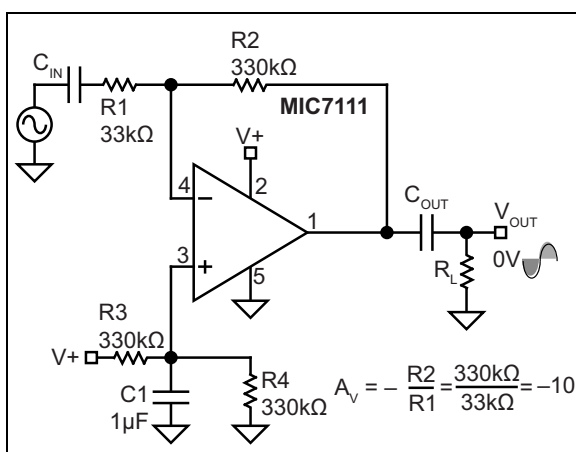
**FIGURE 3-5:** Voltage Follower/Buffer.



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



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

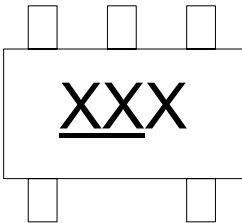


**FIGURE 3-8:** AC-Coupled Inverting Amplifier.

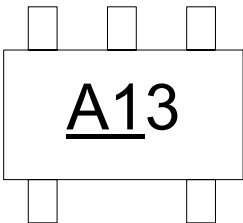
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

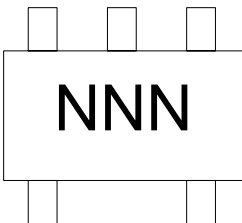
5-Lead SOT23\* (Front)



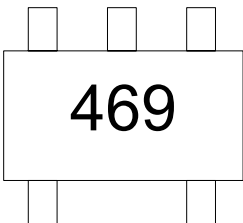
Example:



5-Lead SOT23\* (Back)



Example:



**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).                                    |

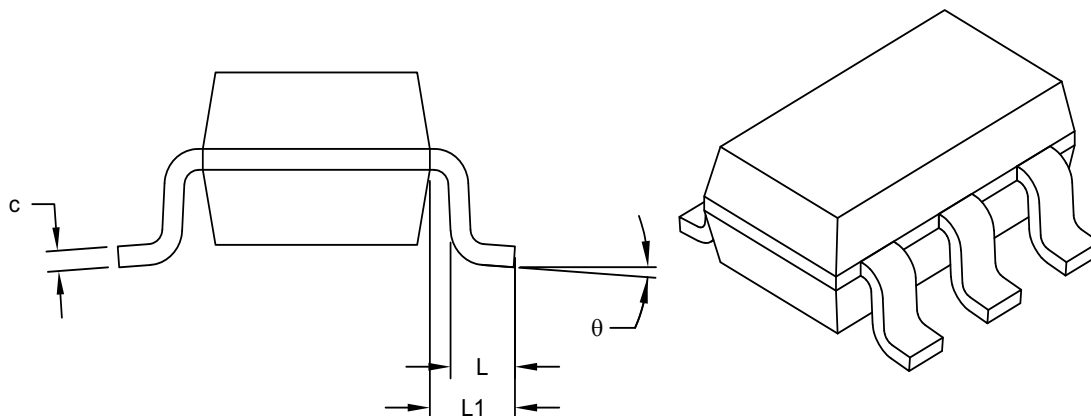
**Note:** In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar ( \_ ) and/or Overbar ( ^ ) symbols may not be to scale.



## 5-Lead Plastic Small Outline Transistor (OT) [SOT-23]

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



VIEW A-A  
SHEET 1

| Units                    |    | MILLIMETERS |     |      |
|--------------------------|----|-------------|-----|------|
| Dimension Limits         |    | MIN         | NOM | MAX  |
| Number of Pins           | N  | 5           |     |      |
| Pitch                    | e  | 0.95 BSC    |     |      |
| Outside lead pitch       | e1 | 1.90 BSC    |     |      |
| Overall Height           | A  | 0.90        | -   | 1.45 |
| Molded Package Thickness | A2 | 0.89        | -   | 1.30 |
| Standoff                 | A1 | -           | -   | 0.15 |
| Overall Width            | E  | 2.80 BSC    |     |      |
| Molded Package Width     | E1 | 1.60 BSC    |     |      |
| Overall Length           | D  | 2.90 BSC    |     |      |
| Foot Length              | L  | 0.30        | -   | 0.60 |
| Footprint                | L1 | 0.60 REF    |     |      |
| Foot Angle               | θ  | 0°          | -   | 10°  |
| Lead Thickness           | c  | 0.08        | -   | 0.26 |
| Lead Width               | b  | 0.20        | -   | 0.51 |

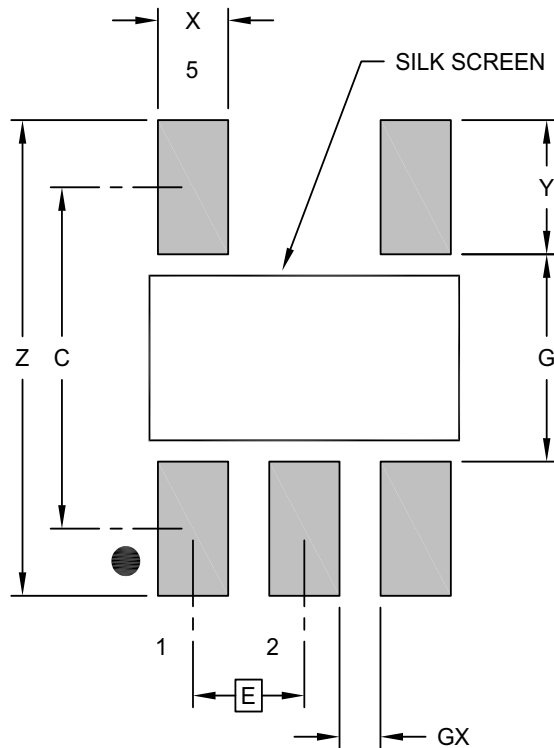
**Notes:**

- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.25mm per side.
- Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.  
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-091-OT Rev H Sheet 2 of 2

## 5-Lead Plastic Small Outline Transistor (OT) [SOT-23]

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



RECOMMENDED LAND PATTERN

| Units                   |    | MILLIMETERS |      |      |
|-------------------------|----|-------------|------|------|
| Dimension Limits        |    | MIN         | NOM  | MAX  |
| Contact Pitch           | E  | 0.95 BSC    |      |      |
| Contact Pad Spacing     | C  |             | 2.80 |      |
| Contact Pad Width (X5)  | X  |             |      | 0.60 |
| Contact Pad Length (X5) | Y  |             |      | 1.10 |
| Distance Between Pads   | G  | 1.70        |      |      |
| Distance Between Pads   | GX | 0.35        |      |      |
| Overall Width           | Z  |             |      | 3.90 |

**Notes:**

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2091-OT Rev H

## APPENDIX A: REVISION HISTORY

### Revision B (January 2024)

- Updated [Package Type](#).
- Updated [DC Electrical Characteristics \(5.0V\)](#), *Output Short-Circuit Current* parameter, **Min.** column.
- Updated [Section 3.2 “Output Voltage Swing”](#). Updated [Equation 3-1](#) and added [Equation 3-2](#).
- Updated [Section 3.4 “Using Large-Value Feedback Resistors”](#). Updated [Equation 3-5](#).
- Updated [Section 4.1 “Package Marking Information”](#).
- Minor grammatical text changes throughout the Data Sheet.

### Revision A (March 2020)

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

**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>           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|-----------|----------------------|
| Device                                                                                                                                                                                                                                                                              | Temperature Range                              | Package   | Tape and Reel Option |
| Device: MIC7111                                                                                                                                                                                                                                                                     |                                                |           |                      |
| Temperature Range:                                                                                                                                                                                                                                                                  | Y = -40°C to +85°C (Industrial)                |           |                      |
| Package:                                                                                                                                                                                                                                                                            | M5 = 5-Lead SOT23                              |           |                      |
| Tape and Reel Option:                                                                                                                                                                                                                                                               | TR = Tape and Reel <sup>(1)</sup> , 3,000/Reel |           |                      |
| <b>Examples:</b><br>a) MIC7111YM5-TR = Industrial Temperature, 5-Lead SOT23, Tape and Reel                                                                                                                                                                                          |                                                |           |                      |
| <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. |                                                |           |                      |

# MIC7111

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NOTES:

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