# MIC7221YM5-TR Datasheet


https://www.DiGi-Electronics.com

| | |
|---|---|
| DiGi Electronics Part Number | MIC7221YM5-TR-DG |
| Manufacturer | Microchip Technology |
| Manufacturer Product Number | MIC7221YM5-TR |
| Description | IC COMPARATOR 1 GEN PUR SOT23-5 |
| Detailed Description | Comparator General Purpose Open-Drain SOT-23-5 |

## Purchase and inquiry

| | |
|---|---|
| Manufacturer Product Number: | Manufacturer: |
| MIC7221YM5-TR | Microchip Technology |
| Series: | Product Status: |
| IttyBitty® | Active |
| Type: | Number of Elements: |
| General Purpose | 1 |
| Output Type: | Voltage - Supply, Single/Dual (±): |
| Open-Drain | 2.2V ~ 10V |
| Voltage - Input Offset (Max): | Current - Input Bias (Max): |
| 10mV @ 5V | 0.5pA @ 5V |
| Current - Output (Typ): | Current - Quiescent (Max): |
| - | 25µA |
| CMRR, PSRR (Typ): | Propagation Delay (Max): |
| 70dB CMRR, 90dB PSRR | 5µs |
| Hysteresis: | Operating Temperature: |
| - | -40°C ~ 85°C |
| Package / Case: | Mounting Type: |
| SC-74A, SOT-753 | Surface Mount |
| Supplier Device Package: | Base Product Number: |
| SOT-23-5 | MIC7221 |

## Environmental & Export classification

| | |
|---|---|
| RoHS Status: | Moisture Sensitivity Level (MSL): |
| ROHS3 Compliant | 1 (Unlimited) |
| REACH Status: | ECCN: |
| REACH Unaffected | EAR99 |
| HTSUS: | |
| 8542.39.0001 | |

MICROCHIP

# MIC7211/MIC7221

## Rail-to-Rail Input Comparator

## Features

- Small Footprint SOT-23-5 Package
- Guaranteed Performance at 2.2V, 2.7V, 5V, and 10V
- 7 µA Typical Supply Current at 5V
- <5 µs Response Time at 5V
- Push-Pull Output (MIC7211)
- Open-Drain Output (MIC7221)
- Input Voltage Range May Exceed Supply Voltage by 0.3V
- >100 mA Typical Sink or Source

## Applications

- Battery-Powered Products
- Notebook Computers and PDAs
- PCMCIA Cards
- Cellular and Other Wireless Communication Devices
- Alarm and Security Circuits
- Direct Sensor Interface

## General Description

The MIC7211 and MIC7221 are micropower comparators that feature rail-to-rail input performance in an SOT-23-5 package. The comparators are ideal for systems where small size is a critical consideration.

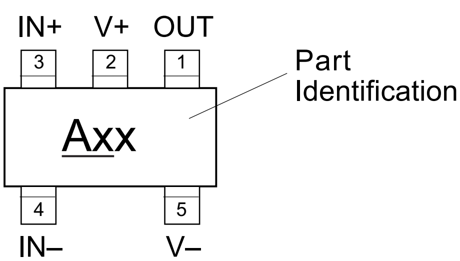
The MIC7211/MIC7221 are optimized for single supply operation from 2.2V to 10V power supplies.

The MIC7211 features a conventional push-pull output while the MIC7221 has an open-drain output for mixed-voltage applications with an external pull-up resistor.

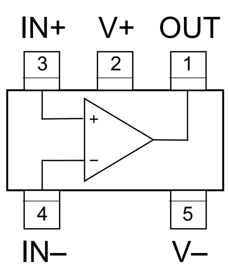
The MIC7211/MIC7221 benefits small battery-operated portable electronic devices where small size and the ability to place the comparator close to the signal source are primary design concerns.

## Package Type

**MIC7211/MIC7221**
SOT-23-5 (M5)
(Top View)




**Functional Configuration**



# 1.0 ELECTRICAL CHARACTERISTICS

## Absolute Maximum Ratings †

Supply Voltage, ($V_{V+} – V_{V–}$) ........ +12V
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 Ratings ........ (Note 2)

## Operating Ratings ††

Supply Voltage, ($V_{V+} – V_{V–}$) ........ +2.2V to +10V
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 sensitive. Handling precautions recommended.

**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.

## DC CHARACTERISTICS (2.2V)

**Electrical Characteristics:** Unless otherwise indicated, $V_{V+}$ = +2.2V; $V_{V–}$ = 0V; $V_{CM} = V_{OUT} = V_{V+}/2$; $T_J$ = +25°C. (Note 1).

| Parameters | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{OS}$ | — | 2 | 10 | mV | — |
| Input Offset Voltage Temperature Drift | $TCV_{OS}$ | — | 1 | — | µV/°C | — |
| Input Offset Voltage Drift Over Time | $TCV_{OS}$ | — | 3.3 | — | µV/ Month | — |
| Input Bias Current | $I_B$ | — | 0.5 | — | pA | — |
| Input Offset Current | $I_{OS}$ | — | 0.25 | — | pA | — |
| Common Mode Rejection Ratio | CMRR | — | 60 | — | dB | 0V ≤ $V_{CM}$ ≤ 2.2V |
| Positive Power Supply Rejection Ratio | PSRR | — | 90 | — | dB | $V_{V+}$ = 2.2V to 5V |
| Gain | $A_{VOL}$ | — | 125 | — | dB | — |
| Output Voltage (High) | $V_{OH}$ | 2.1 | 2.18 | — | V | MIC7211, $I_{LOAD}$ = 2.5 mA |
| Output Voltage (Low) | $V_{OL}$ | — | 0.02 | 0.1 | V | $I_{LOAD}$ = 2.5 mA |
| Supply Current | $I_S$ | — | 5 | 12 | µA | $V_{OUT}$ = low |

**Note 1:** All limits guaranteed by testing on statistical analysis.

## DC CHARACTERISTICS (2.7V)

**Electrical Characteristics:** Unless otherwise indicated, $V_{V+}$ = +2.7V; $V_{V-}$ = 0V; $V_{CM}$ = $V_{OUT}$ = $V_{V+}/2$; $T_J$ = +25°C. (Note 1).

| Parameters | Sym. | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{OS}$ | — | 2 | 10 | mV | — |
| Input Offset Voltage Temperature Drift | $TCV_{OS}$ | — | 1 | — | µV/°C | — |
| Input Offset Voltage Drift Over Time | $TCV_{OS}$ | — | 3.3 | — | µV/ Month | — |
| Input Bias Current | $I_B$ | — | 0.5 | — | pA | — |
| Input Offset Current | $I_{OS}$ | — | 0.25 | — | pA | — |
| Common Mode Rejection Ratio | CMRR | — | 65 | — | dB | 0V ≤ $V_{CM}$ ≤ 2.7V |
| Positive Power Supply Rejection Ratio | PSRR | — | 90 | — | dB | $V_{V+}$ = 2.7V to 5V |
| Gain | $A_{VOL}$ | — | 125 | — | dB | — |
| Output Voltage (High) | $V_{OH}$ | 2.6 | 2.68 | — | V | MIC7211, $I_{LOAD}$ = 2.5 mA |
| Output Voltage (Low) | $V_{OL}$ | — | 0.02 | 0.1 | V | $I_{LOAD}$ = 2.5 mA |
| Supply Current | $I_S$ | — | 5 | 12 | µA | $V_{OUT}$ = low |

**Note 1:** All limits guaranteed by testing on statistical analysis.

## DC ELECTRICAL CHARACTERISTICS (5V)

**Electrical Characteristics:** Unless otherwise indicated, $V_{V+}$ = +5.0V; $V_{V-}$ = 0V; $V_{CM}$ = $V_{OUT}$ = $V_{V+}/2$; $T_J$ = +25°C. (Note 1).

| Parameters | Sym. | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{OS}$ | — | 2 | 10 | mV | — |
| Input Offset Voltage Temperature Drift | $TCV_{OS}$ | — | 1 | — | µV/°C | — |
| Input Offset Voltage Drift Over Time | $TCV_{OS}$ | — | 3.3 | — | µV/ Month | — |
| Input Bias Current | $I_B$ | — | 0.5 | — | pA | — |
| Input Offset Current | $I_{OS}$ | — | 0.25 | — | pA | — |
| Common Mode Rejection Ratio | CMRR | — | 70 | — | dB | 0V ≤ $V_{CM}$ ≤ 5V |
| Positive Power Supply Rejection Ratio | PSRR | — | 90 | — | dB | $V_{V+}$ = 5.0V to 10V |
| Gain | $A_{VOL}$ | — | 125 | — | dB | — |
| Output Voltage (High) | $V_{OH}$ | 4.9 | 4.95 | — | V | MIC7211, $I_{LOAD}$ = 5 mA |
| Output Voltage (Low) | $V_{OL}$ | — | 0.05 | 0.1 | V | $I_{LOAD}$ = 5 mA |
| Supply Current | $I_S$ | — | 7 | 14 | µA | $V_{OUT}$ = low |
| Short Circuit Current | $I_{SC}$ | — | 150 | — | mA | MIC7211, Sourcing |
| | | — | 110 | — | mA | Sinking |

**Note 1:** All limits guaranteed by testing on statistical analysis.

## DC ELECTRICAL CHARACTERISTICS (10V)

**Electrical Characteristics:** Unless otherwise indicated, $V_{V+}$ = +10V; $V_{V-}$ = 0V; $V_{CM}$ = $V_{OUT}$ = $V_{V+}/2$; $T_J$ = +25°C. (Note 1).

| Parameters | Sym. | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{OS}$ | — | 2 | 10 | mV | — |
| Input Offset Voltage Temperature Drift | $TCV_{OS}$ | — | 1 | — | µV/°C | — |
| Input Offset Voltage Drift Over Time | $TCV_{OS}$ | — | 3.3 | — | µV/ Month | — |
| Input Bias Current | $I_B$ | — | 0.5 | — | pA | — |
| Input Offset Current | $I_{OS}$ | — | 0.25 | — | pA | — |
| Common Mode Rejection Ratio | CMRR | — | 75 | — | dB | 0V ≤ $V_{CM}$ ≤ 10V |
| Positive Power Supply Rejection Ratio | PSRR | — | 90 | — | dB | $V_{V+}$ = 5.0V to 10V |
| Gain | $A_{VOL}$ | — | 125 | — | dB | — |
| Output Voltage (High) | $V_{OH}$ | 9.9 | 9.95 | — | V | MIC7211, $I_{LOAD}$ = 5 mA |
| Output Voltage (Low) | $V_{OL}$ | — | 0.05 | 0.1 | V | $I_{LOAD}$ = 5 mA |
| Supply Current | $I_S$ | — | 12 | 25 | µA | $V_{OUT}$ = low |
| Short Circuit Current | $I_{SC}$ | — | 165 | — | mA | MIC7211, Sourcing |
| | | — | 125 | — | mA | Sinking |

**Note 1:** All limits guaranteed by testing on statistical analysis.

## AC ELECTRICAL CHARACTERISTICS

**Electrical Characteristics:** Unless otherwise indicated, $V_{V-}$ = 0V; $V_{CM}$ = $V_{OUT}$ = $V_{V+}/2$; $T_J$ = +25°C. (Note 1).

| Parameters | Sym. | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| Rise Time | $t_{RISE}$ | — | 75 | — | ns | $V_{V+}$ = 5.0V, f = 10 kHz, $C_{LOAD}$ = 50 pF, overdrive = 10 mV (Note 2) |
| Fall Time | $t_{FALL}$ | — | 70 | — | ns | $V_{V+}$ = 5.0V, f = 10 kHz, $C_{LOAD}$ = 50 pF, overdrive = 10 mV (Note 2) |
| Propagation Delay-High to Low | $t_{PHL}$ | — | 10 | — | µs | $V_{V+}$ = 2.2V, f = 10 kHz, $C_{LOAD}$ = 50 pF, overdrive = 10 mV (Note 2) |
| | | — | 6 | — | µs | $V_{V+}$ = 2.2V, f = 10 kHz, $C_{LOAD}$ = 50 pF, overdrive = 100 mV, –40°C ≤ $T_J$ ≤ +85°C (Note 2) |
| | | — | 13 | — | µs | $V_{V+}$ = 5V, f = 10 kHz, $C_{LOAD}$ = 50 pF, overdrive = 10 mV, –40°C ≤ $T_J$ ≤ +85°C (Note 2) |
| | | — | 5 | — | µs | $V_{V+}$ = 5V, f = 10 kHz, $C_{LOAD}$ = 50 pF, overdrive = 100 mV (Note 2) |

| Electrical Characteristics: Unless otherwise indicated, $V_{V-}$ = 0V; $V_{CM}$ = $V_{OUT}$ = $V_{V+}/2$; $T_J$ = +25°C. (Note 1). | | | | | | |
|---|---|---|---|---|---|---|
| **Parameters** | **Sym.** | **Min.** | **Typ.** | **Max.** | **Units** | **Conditions** |
| Propagation Delay-Low to High | $t_{PLH}$ | — | 13.5 | — | µs | $V_{V+}$ = 2.2V, f = 10 kHz, $C_{LOAD}$ = 50 pF, overdrive = 10 mV (Note 2) |
| | | — | 4 | — | µs | $V_{V+}$ = 2.2V, f = 10 kHz, $C_{LOAD}$ = 50 pF, overdrive = 100 mV, –40°C ≤ $T_J$ ≤ +85°C (Note 2) |
| | | — | 11.5 | — | µs | $V_{V+}$ = 5V, f = 10 kHz, $C_{LOAD}$ = 50 pF, overdrive = 10 mV, –40°C ≤ $T_J$ ≤ +85°C (Note 2) |
| | | — | 3 | — | µs | $V_{V+}$ = 5V, f = 10 kHz, $C_{LOAD}$ = 50 pF, overdrive = 100 mV (Note 2) |

**Note 1:** All limits guaranteed by testing on statistical analysis.

**2:** The MIC7221 requires a 5 kΩ pull-up resistor.

## TEMPERATURE SPECIFICATIONS

| Parameters | Sym. | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| **Temperature Ranges** | | | | | | |
| Junction Operating Temperature | $T_J$ | –40 | — | +85 | °C | — |
| Storage Temperature Range | $T_S$ | –65 | — | +150 | °C | — |
| **Package Thermal Resistances** | | | | | | |
| Thermal Resistance, SOT-23-5Ld | $\theta_{JA}$ | — | 235 | — | °C/W | Note 1 |

**Note 1:** Thermal resistance, $\theta_{JA}$, applies to a part soldered on a printed circuit board.

## 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+ | Noninverting Input |
| 4 | IN– | Inverting Input |
| 5 | V– | Negative Supply |

## 3.0 APPLICATION INFORMATION

The small outline and low supply current (typically 7 µA at 5V) of the MIC7211/21 are the primary advantages of these comparators. They have been characterized for 2.2V, 2.7V, 5V, and 10V operation.

Their 2.2V capability is especially useful in low-battery voltage situations. Low-voltage operation allows longer battery life or deeper discharge capability. Even at 2.2V, the output can drive several logic-gate inputs. At 2.5 mA, the output stage voltage drop is guaranteed to not exceed 0.1V.

### 3.1 Output

The MIC7211 has a push-pull output while the MIC7221 has an open-drain output, otherwise both comparators share a common design.

The open-drain MIC7221 output can be pulled up to 10V, even when the supply voltage is as low as 2.2V. Conversely, the output also can be pulled up to voltages that are lower than the positive supply. Logic-level translation is readily facilitated by the ability to pull the open-drain output to voltages above or below the power supply.

Although specified short-circuit output current specified for these parts typically exceeds 100 mA, their output is not intended to sink or source anywhere near 100 mA. The short-circuit rating is only presented as additional information regarding output impedance and may be useful for determining the voltage drop one may experience when driving a given load.

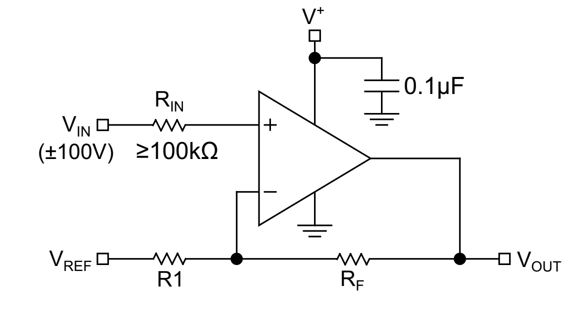
### 3.2 Input Bias Current

The low input-bias current (typically 0.5 pA) requirement of the MIC7211/21 provides flexibility in the kinds of circuitry and devices that can be directly interfaced.

Designs using an amplifier for transducer-to-comparator impedance transformation may be simplified by using the MIC7211/21's low input current requirement to eliminate the amplifier.

### 3.3 Input Signal Levels

Input signals may exceed either supply rail by up to 0.2V without phase inversion or other adverse effects. The inputs have internal clamp diodes to the supply pins.



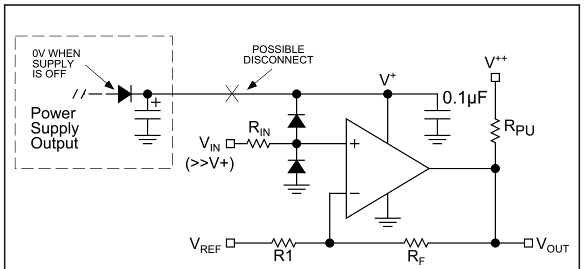

Note: $R_F$ and R1 control hysteresis (typically, $R_F$ >> R1).

***FIGURE 3-1:*** *Driving the Input Beyond the Supply Rails.*

Larger input swings can be accommodated if the input current is limited to 1 mA or less. Using a 100 kΩ input resistor will allow an input to swing up to 100V beyond either supply rail. Because of the low input bias current of the device, even larger input resistors are practical. See Figure 3-1. The ability to swing the input beyond either rail facilitates some otherwise difficult circuits, such as a single-supply zero-crossing detector or a circuit that senses its own supply voltage.

The comparator must be powered if an input is pulled above the rail, even with current limiting in effect. Figure 3-2 shows a hypothetical situation where an input is pulled higher than the rail when the power supply is off or not present. Figure 3-2 also shows external clamp diodes for additional input circuit protection. Discrete clamp diodes can be arbitrarily more robust than the internal clamp diodes.

The power supply has been simplified (real power supplies do not have a series output diode); however, this illustrates a common characteristic of most positive-voltage power supplies: they are designed to source, but not sink, current. If the supply is off, or disconnected, there is no limiting voltage for the clamp diode to reference. The input signal can charge the bypass capacitor, and possibly the filter capacitor, up to the applied input ($V_{IN}$). This may be high enough to cause a thin-oxide rupture in a CMOS integrated circuit.




Note: 1V ≤ $V^{++}$ ≤ 10V

***FIGURE 3-2:*** *Avoid this Condition.*

Ideally, the supply for the comparator and the input-producing circuitry should the same or be switched simultaneously.

## 3.4 Bypass Capacitors

CMOS circuits, especially logic gates with their totem-pole (push-pull) output stages, generate power supply current spikes (noise) on the supply and/or ground lines. These spikes occur because, for a finite time during switching, both output transistors are partially on allowing “shoot-through current.” Bypass capacitors reduce this noise.

Adequate bypassing for the MIC7211 comparator is 0.01 µF; in low-noise systems, where this noise may interfere with the functioning or accuracy of nearby circuitry, 0.1 µF is recommended. Because the MIC7221 does not have a totem-pole output stage, this spiking is not evident; however, switching a capacitive load can present a similar situation.

## 3.5 Thermal Behavior

The thermal impedance of a SOT-23-5 package is 235˚C/W. The DC Electrical Characteristics (5V) table shows a maximum voltage drop of 0.1V for a 5 mA output current, making the output resistance about 20Ω (R = 0.1/0.005 = 20Ω). Attempting to draw the typical specified output short-circuit current of 150 mA (sourcing) can be expected to cause a die temperature rise of 106°C. (Operating die temperature for ICs should generally not exceed 125°C.) Using a series resistance is the simplest form of protecting against damage by excessive output current.

# 4.0 PACKAGING INFORMATION

## 4.1 Package Marking Information

| 5-Lead SOT-23* (Front) | Example |
|---|---|
| XXX | A14 |

| 5-Lead SOT-23* (Back) | Example |
|---|---|
| NNN | 464 |

**Note:** Package marking code for MIC7211 is A14. Package marking code for MIC7221 is A15.

| | | |
|---|---|---|
| **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). |

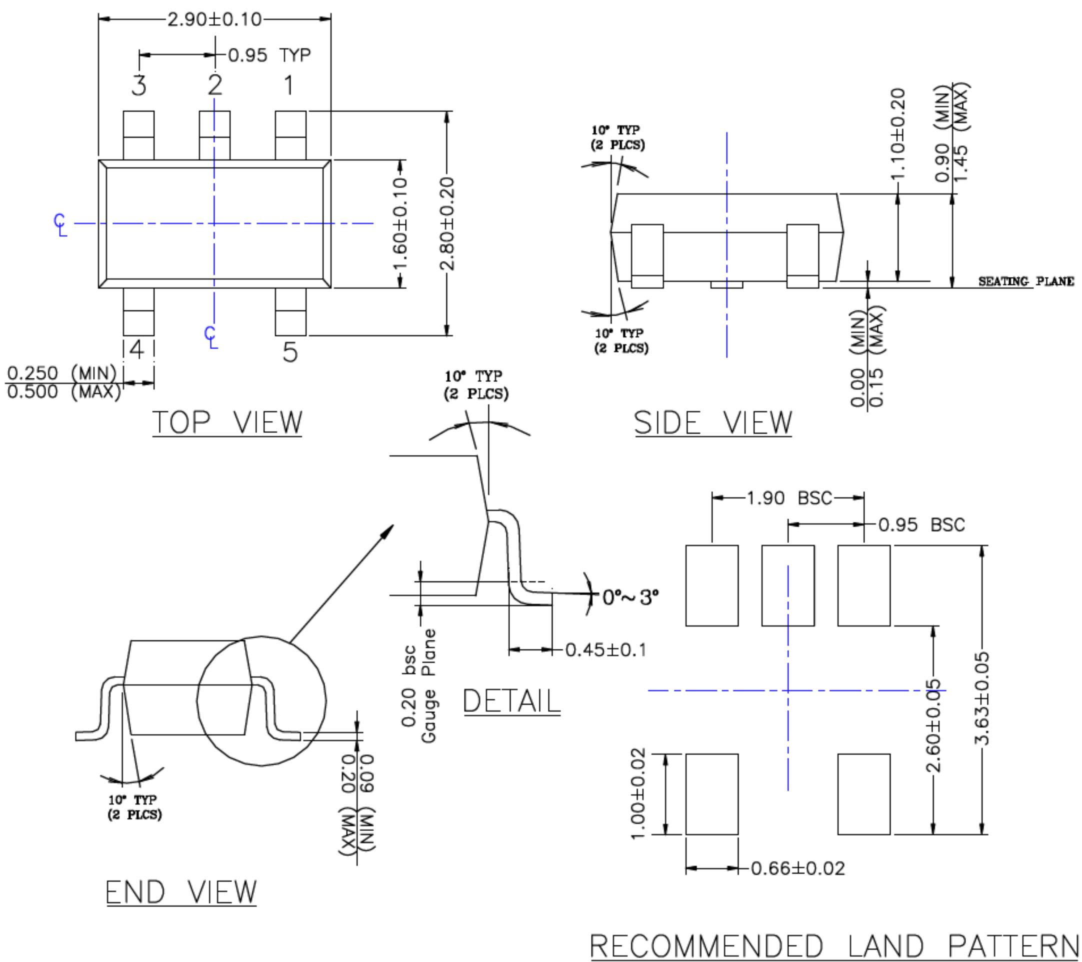
**Note**: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

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

## 5-Lead SOT-23 Package Outline & 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.

## APPENDIX A: REVISION HISTORY

### Revision A (April 2020)

- Converted Micrel document MIC7211/MIC7221 to Microchip data sheet template DS20006325A.
- 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:** | MIC7211: | | Rail-to-Rail Input Comparator |
| | MIC7221: | | Rail-to-Rail Input Comparator |
| **Temperature Range:** | Y | = | –40°C to +85°C (RoHS Compliant) |
| **Package:** | M5 | = | 5-Lead SOT-23-5 |
| **Media Type:** | TR | = | 3,000//Reel |

**Examples:**

a) MIC7211YM5-TR: MIC7211, –40°C to +85°C (RoHS Compliant), 5LD SOT-23, 3,000/Reel

b) MIC7221YM5-TR: MIC7221, –40°C to +85°C (RoHS Compliant), 5LD 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.
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**Trademarks**



ISBN: 978-1-5224-5909-5

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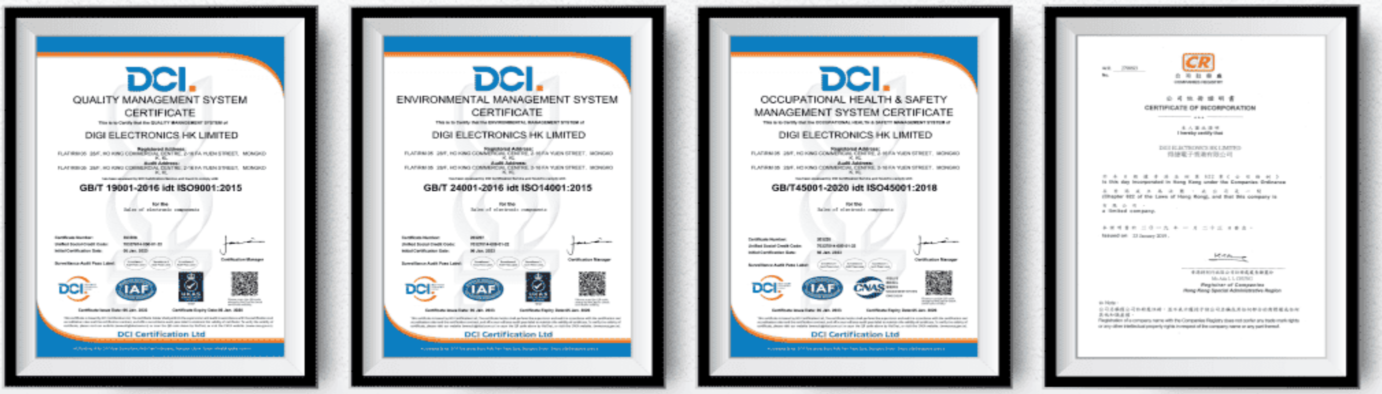



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