



# CD8601 CD8602 CD8604

Precision CMOS, Single-Supply, Rail-to-Rail, Input/Output Wideband  
Operational Amplifiers

Version: Rev 1.0.0 Date: 2025-8-4

## Features ■■

- Low offset voltage: 80  $\mu$ V (typ)
- Low supply current: 750  $\mu$ A/Amplifier
- Single-supply operation: 2.7 V to 5.5 V
- Wide bandwidth: 8.5 MHz
- Slew rate: 5 V/ $\mu$ s
- Unity gain stable
- Low input currents
- Low offset voltage: 80  $\mu$ V (typ)
- Low supply current: 750  $\mu$ A/Amplifier

## Application ■■

- Barcode scanners
- Multipole filters
- Battery-powered instrumentation
- Current sensing
- Sensors
- PA controls
- Audio
- Barcode scanners
- Multipole filters

## Description ■■

The CD8601, CD8602, and CD8604 are single, dual, and quad rail-to-rail, input and output, single-supply amplifiers featuring very low offset voltage and Gain bandwidth product characteristics up to 8.5MHz. These amplifiers use a new, patented trimming technique that achieves superior performance without laser trimming. All are fully specified to operate on a 2.7 V to 5.5 V single supply.

The combination of low offsets, very low input bias currents, and high speed make these amplifiers useful in a wide variety of applications. Filters, integrators, diode amplifiers, shunt current sensors, and high impedance sensors all benefit from the combination of performance features. Audio and other ac applications benefit from the wide bandwidth and low distortion. Applications for these amplifiers include audio amplification for portable devices, portable phone headsets, bar code scanners, portable instruments, cellular PA controls, and multipole filters.

The ability to swing rail-to-rail at both the input and output enables designers to buffer CMOS ADCs, DACs, ASICs, and other wide output swing devices in single-supply systems.

The CD8601, CD8602, and CD8604 are specified over the extended industrial ( $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ) temperature range. The CD8601, single, is available in a tiny, 5-lead SOT-23 package. The CD8602, dual, is available in 8-lead MSOP and 8-lead, narrow SOIC surface-mount packages. The CD8604, quad, is available in 14-lead TSSOP, 14-lead SOIC, and 16-lead QSOP packages.

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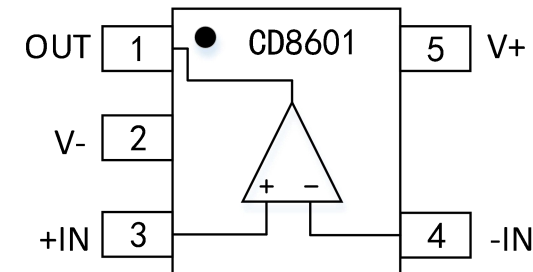
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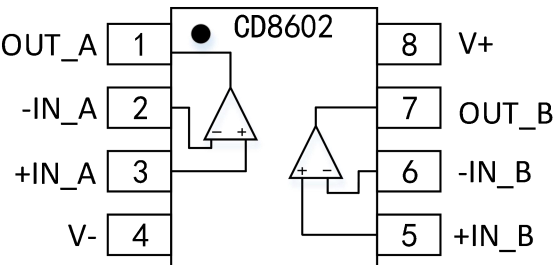
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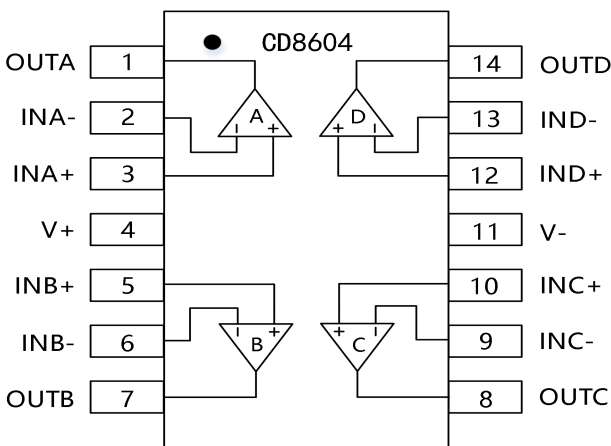
Pin Configurations



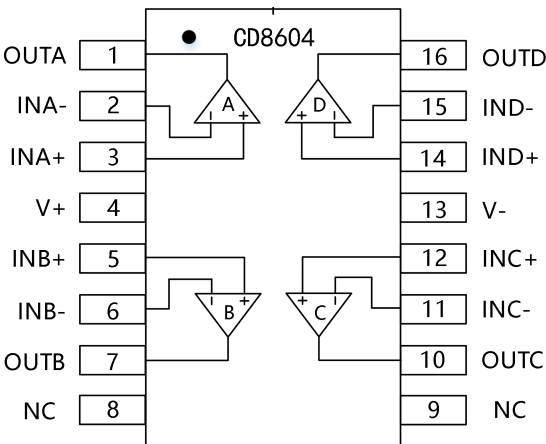
SOT23 Pin Configuration



MSOP/SOP Pin Configuration



TSSOP/SOP Pin Configuration



QSOP Pin Configuration

Pin Description

| Pin_N | Symbol SOT23 (CD8601)     | Input/Output | Function               |
|-------|---------------------------|--------------|------------------------|
| 1     | OUT                       | O            | Output                 |
| 2     | V-                        | --           | Negative power supply  |
| 3     | +IN                       | I            | None Inverting input   |
| 4     | -IN                       | I            | Inverting input        |
| 5     | V+                        | --           | Positive power supply  |
| Pin_N | Symbol MSOP/SOP (CD8602)  | Input/Output | Function               |
| 1     | OUT_A                     | O            | Output A               |
| 2     | -IN_A                     | I            | Inverting input A      |
| 3     | +IN_A                     | I            | None Inverting input A |
| 4     | V-                        | --           | Negative power supply  |
| 5     | +IN_B                     | I            | None Inverting input B |
| 6     | -IN_B                     | I            | Inverting input B      |
| 7     | OUT_B                     | O            | Output B               |
| 8     | V+                        | --           | Positive power supply  |
| Pin_N | Symbol TSSOP/SOP (CD8604) | Input/Output | Function               |
| 1     | OUT_A                     | O            | Output A               |
| 2     | -IN_A                     | I            | Inverting input A      |

| 3     | +IN_A                     | I            | None Inverting input A |
|-------|---------------------------|--------------|------------------------|
| 4     | V+                        | --           | Positive power supply  |
| 5     | +IN_B                     | I            | None Inverting input B |
| 6     | -IN_B                     | I            | Inverting input B      |
| 7     | OUT_B                     | O            | Output B               |
| 8     | OUT_C                     | O            | Output C               |
| 9     | -IN_C                     | I            | Inverting input C      |
| 10    | +IN_C                     | I            | None Inverting input C |
| 11    | V-                        | --           | Negative power supply  |
| 12    | +IN_D                     | I            | None Inverting input D |
| 13    | -IN_D                     | I            | Inverting input D      |
| 14    | OUT_D                     | O            | Output D               |
| Pin_N | Symbol TSSOP/SOP (CD8604) | Input/Output | Function               |
| 1     | OUT_A                     | O            | Output A               |
| 2     | -IN_A                     | I            | Inverting input A      |
| 3     | +IN_A                     | I            | None Inverting input A |
| 4     | V+                        | --           | Positive power supply  |
| 5     | +IN_B                     | I            | None Inverting input B |
| 6     | -IN_B                     | I            | Inverting input B      |
| 7     | OUT_B                     | O            | Output B               |
| 8     | NC                        | --           | No connect             |
| 9     | NC                        | --           | No connect             |
| 10    | OUT_C                     | O            | Output C               |
| 11    | -IN_C                     | I            | Inverting input C      |
| 12    | +IN_C                     | I            | None Inverting input C |
| 13    | V-                        | --           | Negative power supply  |
| 14    | +IN_D                     | I            | None Inverting input D |
| 15    | -IN_D                     | I            | Inverting input D      |
| 16    | OUT_D                     | O            | Output D               |

## Absolute Maximum Ratings

| Parameter                                | Range                    |
|------------------------------------------|--------------------------|
| Supply Voltage                           | 6V                       |
| Input Voltage                            | V- to V+                 |
| Differential Input Voltage               | ±6 V                     |
| Storage Temperature Range All Packages   | -65°C to +150°C          |
| Operating Temperature Range All Packages | -40°C to +125°C          |
| Junction Temperature Range All Packages  | -65°C to +150°C          |
| Lead Temperature                         | (Soldering, 60s) : 300°C |
| ESD(CD8601)                              | 5kV (HBM)                |
| ESD(CD8602)                              | 4.5kV (HBM)              |

## Electrical characteristics

( $V_S = 5\text{ V}$ ,  $V_{CM} = V_S/2$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

Table1.

| PARAMETER                                         | CONDITION                                                                       | MIN   | TYP      | MAX  | UNIT                         |
|---------------------------------------------------|---------------------------------------------------------------------------------|-------|----------|------|------------------------------|
| <b>INPUT CHARACTERISTICS</b>                      |                                                                                 |       |          |      |                              |
| Input Offset Voltage ( $V_{OS}$ )                 | $V_{CM} = 0\text{V}\sim 5\text{V}$                                              | --    | 80       | 500  | $\mu\text{V}$                |
| Offset Voltage Drift ( $\Delta V_{OS}/\Delta T$ ) | --                                                                              | --    | 2        | --   | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current ( $I_B$ )                      | --                                                                              | --    | 0.2      | 60   | $\text{pA}$                  |
| Input Offset Current ( $I_{OS}$ )                 | --                                                                              | --    | 0.1      | 30   | $\text{pA}$                  |
| Common-Mode Rejection Ratio (CMRR)                | $V_{CM}=0\text{V}\sim 5\text{V}$                                                | 74    | 89       | --   | $\text{dB}$                  |
| Open-Loop Voltage Gain ( $A_{OL}$ )               | $V_O=0.5\text{V}$ to $4.5\text{V}$ , $R_L=2\text{K}\Omega$ , $V_{CM}=0\text{V}$ | 30    | 80       | --   | $\text{V/mV}$                |
| <b>OUTPUT CHARACTERISTICS</b>                     |                                                                                 |       |          |      |                              |
| Output Voltage High ( $V_{OH}$ )                  | $I_L = 1\text{ mA}$                                                             | 4.925 | 4.978    | --   | $\text{V}$                   |
|                                                   | $I_L = 10\text{mA}$                                                             | 4.7   | 4.78     | --   | $\text{V}$                   |
| Output Voltage Low ( $V_{OL}$ )                   | $I_L = 1\text{ mA}$                                                             | --    | 14       | 30   | $\text{mV}$                  |
|                                                   | $I_L = 10\text{mA}$                                                             | --    | 135      | 175  | $\text{mV}$                  |
| Output Current ( $I_{OUT}$ )                      | --                                                                              | --    | $\pm 50$ | --   | $\text{mA}$                  |
| <b>NOISE PERFORMANCE</b>                          |                                                                                 |       |          |      |                              |
| Voltage Noise Density ( $e_n$ )                   | $f = 1\text{ kHz}$                                                              | --    | 33       | --   | $\text{nV}/\sqrt{\text{Hz}}$ |
|                                                   | $f=10\text{KHz}$                                                                | --    | 18       | --   | $\text{nV}/\sqrt{\text{Hz}}$ |
| Current Noise Density ( $i_n$ )                   | $f=1\text{kHz}$                                                                 | --    | 0.05     | --   | $\text{pA}/\sqrt{\text{Hz}}$ |
| <b>POWER SUPPLY</b>                               |                                                                                 |       |          |      |                              |
| Power Supply Rejection Ratio (PSRR)               | $V_S=2.7\text{V}\sim 5.5\text{V}$                                               | 67    | 85       | --   | $\text{dB}$                  |
| Supply Current/Amplifier ( $I_{SV}$ )             | $V_O = 0\text{V}$                                                               | --    | 550      | 1200 | $\mu\text{A}$                |
| <b>DYNAMIC PERFORMANCE</b>                        |                                                                                 |       |          |      |                              |
| Slew Rate (SR)                                    | $R_L = 2\text{ k}\Omega$                                                        | --    | 5.5      | --   | $\text{V}/\mu\text{s}$       |
| Gain-Bandwidth Product (GBW)                      | --                                                                              | --    | 8.5      | --   | $\text{MHz}$                 |
| Settling Time                                     | To 0.01%                                                                        | --    | <1       | --   | $\mu\text{s}$                |

( $V_S = 3\text{V}$ ,  $V_{CM} = V_S/2$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

Table 2.

| PARAMETER                                         | CONDITION                            | MIN | TYP | MAX | UNIT                         |
|---------------------------------------------------|--------------------------------------|-----|-----|-----|------------------------------|
| <b>INPUT CHARACTERISTICS</b>                      |                                      |     |     |     |                              |
| Input Offset Voltage ( $V_{OS}$ )                 | $V_{CM} = 0\text{V}\sim 1.3\text{V}$ | --  | 80  | 500 | $\mu\text{V}$                |
| Offset Voltage Drift ( $\Delta V_{OS}/\Delta T$ ) | --                                   | --  | 2   | --  | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current ( $I_B$ )                      | --                                   | --  | 0.2 | 60  | $\text{pA}$                  |
| Input Offset Current ( $I_{OS}$ )                 | --                                   | --  | 0.1 | 30  | $\text{pA}$                  |

|                                       |                                               |      |          |      |                |
|---------------------------------------|-----------------------------------------------|------|----------|------|----------------|
| Common-Mode Rejection Ratio (CMRR)    | $V_{CM}=0V\sim 3V$                            | 68   | 83       | --   | dB             |
| Open-Loop Voltage Gain ( $A_{OL}$ )   | $V_O=0.5V$ to $2.5V, R_L=2K\Omega, V_{CM}=0V$ | 30   | 100      | --   | V/mV           |
| <b>OUTPUT CHARACTERISTICS</b>         |                                               |      |          |      |                |
| Output Voltage High ( $V_{OH}$ )      | $I_L = 1\text{ mA}$                           | 2.92 | 2.95     | --   | V              |
| Output Voltage Low ( $V_{OL}$ )       | $I_L = 1\text{ mA}$                           | --   | 20       | 35   | mV             |
| Output Current ( $I_{OUT}$ )          | --                                            | --   | $\pm 30$ | --   | mA             |
| <b>NOISE PERFORMANCE</b>              |                                               |      |          |      |                |
| Voltage Noise Density ( $e_n$ )       | $f = 1\text{ kHz}$                            | --   | 33       | --   | $nV/\sqrt{Hz}$ |
|                                       | $f=10KHz$                                     | --   | 18       | --   | $nV/\sqrt{Hz}$ |
| Current Noise Density ( $i_n$ )       |                                               | --   | 0.05     | --   | $pA/\sqrt{Hz}$ |
| <b>POWER SUPPLY</b>                   |                                               |      |          |      |                |
| Power Supply Rejection Ratio (PSRR)   | $V_s=2.7V\sim 5.5V$                           | 67   | 80       | --   | dB             |
| Supply Current/Amplifier ( $I_{SV}$ ) | $V_O = 0V$                                    | --   | 450      | 1000 | $\mu A$        |
| <b>DYNAMIC PERFORMANCE</b>            |                                               |      |          |      |                |
| Slew Rate (SR)                        | $R_L = 2\text{ k}\Omega$                      | --   | 5.5      | --   | V/ $\mu s$     |
| Gain-Bandwidth Product (GBW)          | --                                            | --   | 8.5      | --   | MHz            |
| Settling Time                         | To 0.01%                                      | --   | <1       | --   | $\mu s$        |

Typical Characteristics

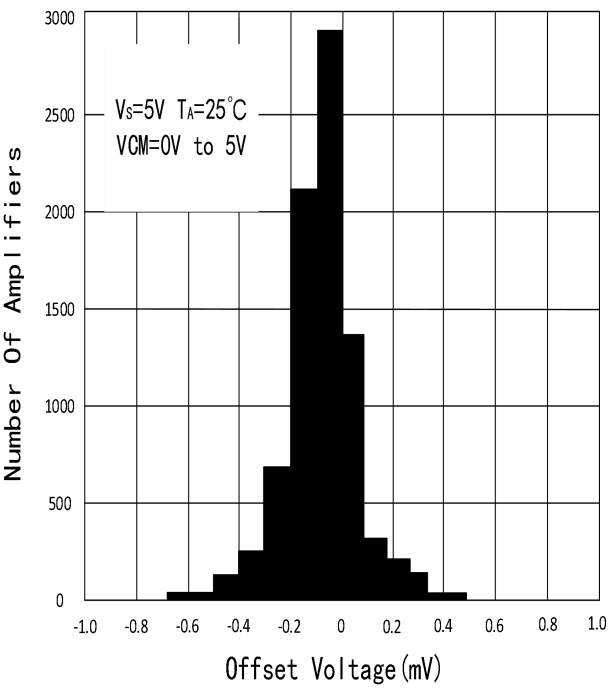


Figure1.Input Offset Voltage Distribution

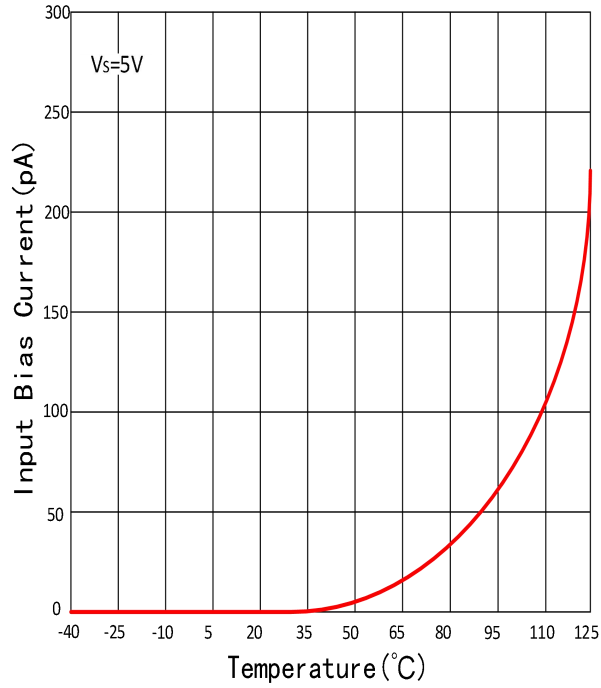


Figure2.Input Bias Current vs. Temperature

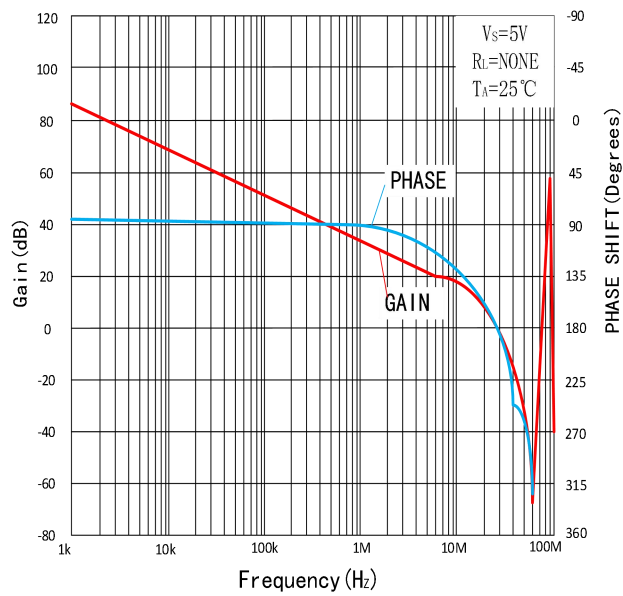


Figure3.Open-Loop Gain and Phase vs. Frequency

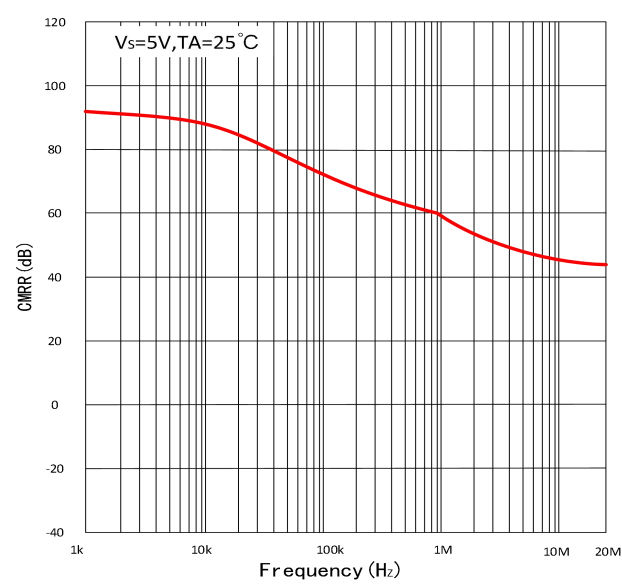
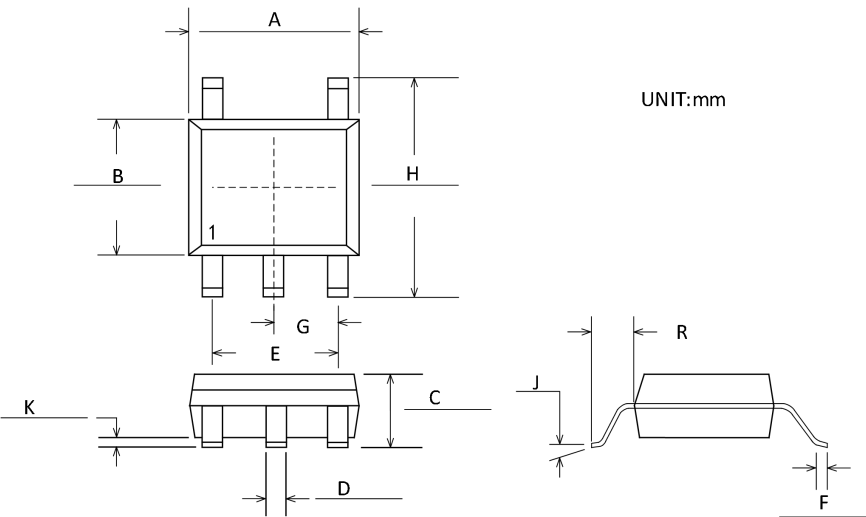


Figure4.Common-Mode Rejection Ratio (CMRR) vs.

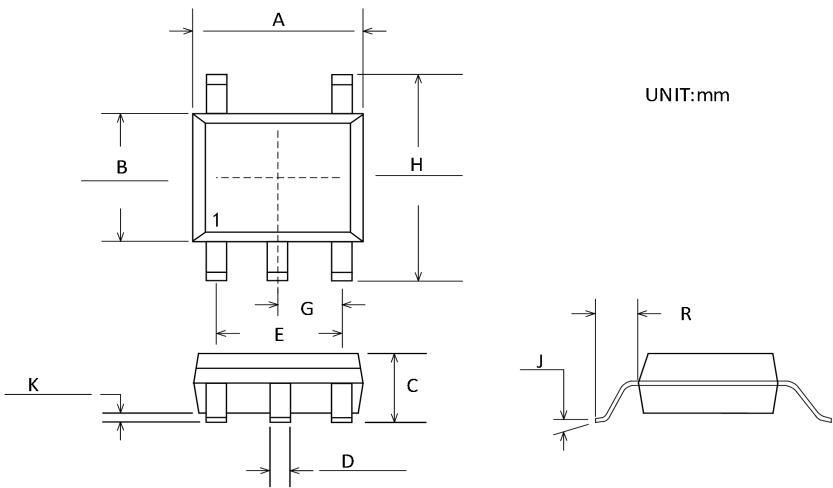
Package Outline Dimensions

SOT23-5



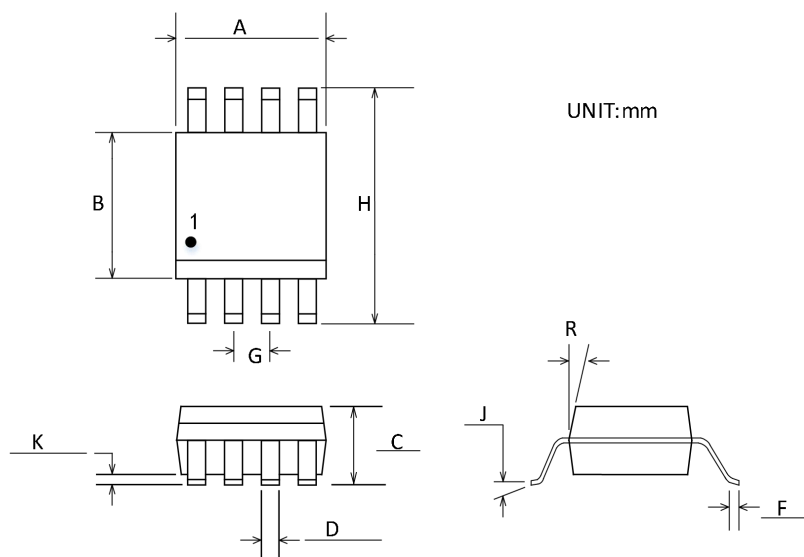
| Symbol | Dimensions In Millimeters |      |
|--------|---------------------------|------|
|        | Min                       | Max  |
| A      | 2.80                      | 3.00 |
| B      | 1.50                      | 1.70 |
| C      | 0.95                      | 1.45 |
| D      | 0.35                      | 0.50 |
| E      | 1.90BSC                   |      |
| F      | 0.35                      | 0.55 |
| G      | 0.95BSC                   |      |
| H      | 2.60                      | 3.00 |
| J      | 0°                        | 10°  |
| K      | 0.05                      | 0.15 |
| R      | 0.60BSC                   |      |

TSOT23-5



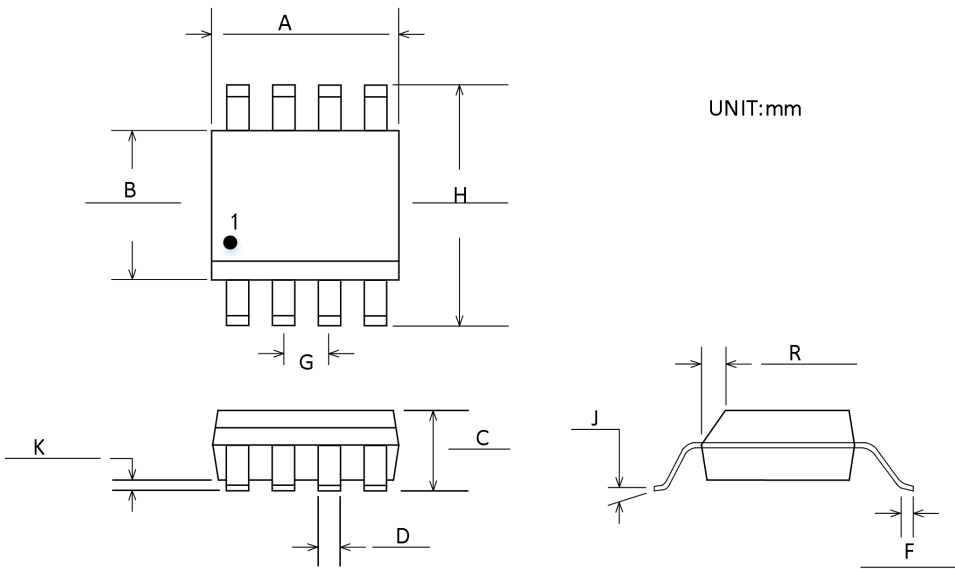
| 符号 | 尺寸 (毫米) |      |
|----|---------|------|
|    | 最小值     | 最大值  |
| A  | 2.80    | 3.00 |
| B  | 1.60    | 1.70 |
| C  | --      | 0.90 |
| D  | 0.35    | 0.50 |
| E  | 1.90BSC |      |
| G  | 0.95BSC |      |
| H  | 2.65    | 2.95 |
| J  | 0°      | 8°   |
| K  | 0.02    | 0.09 |
| R  | 0.30    | 0.60 |

MSOP-8



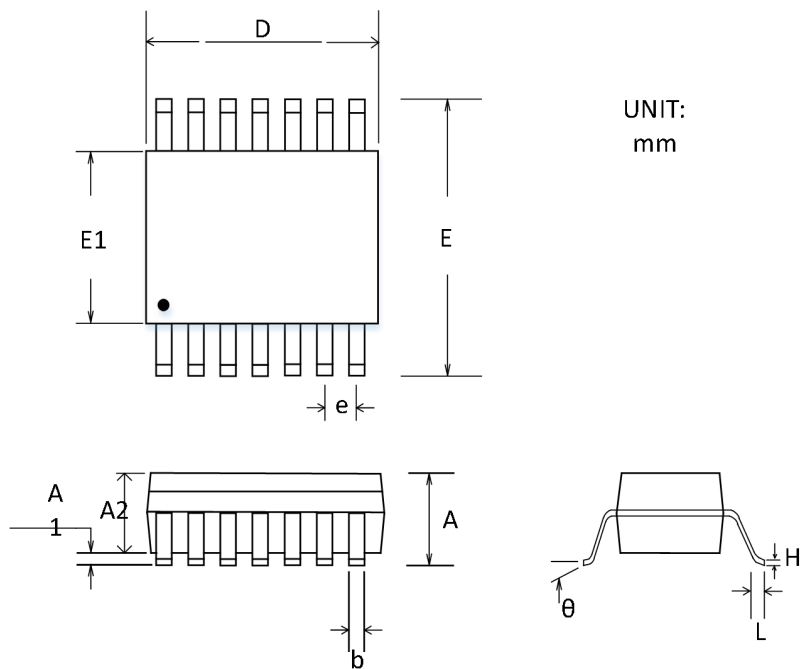
| Symbol | Dimensions In Millimeters |      |
|--------|---------------------------|------|
|        | Min                       | Max  |
| A      | 2.80                      | 3.20 |
| B      | 2.80                      | 3.20 |
| C      | 1.10MAX                   |      |
| D      | 0.25                      | 0.40 |
| F      | 0.40                      | 0.80 |
| G      | 0.65BSC                   |      |
| H      | 4.65                      | 5.15 |
| J      | 0°                        | 6°   |
| K      | 0.05                      | 0.15 |
| R      | 15°MAX                    |      |

SOP-8



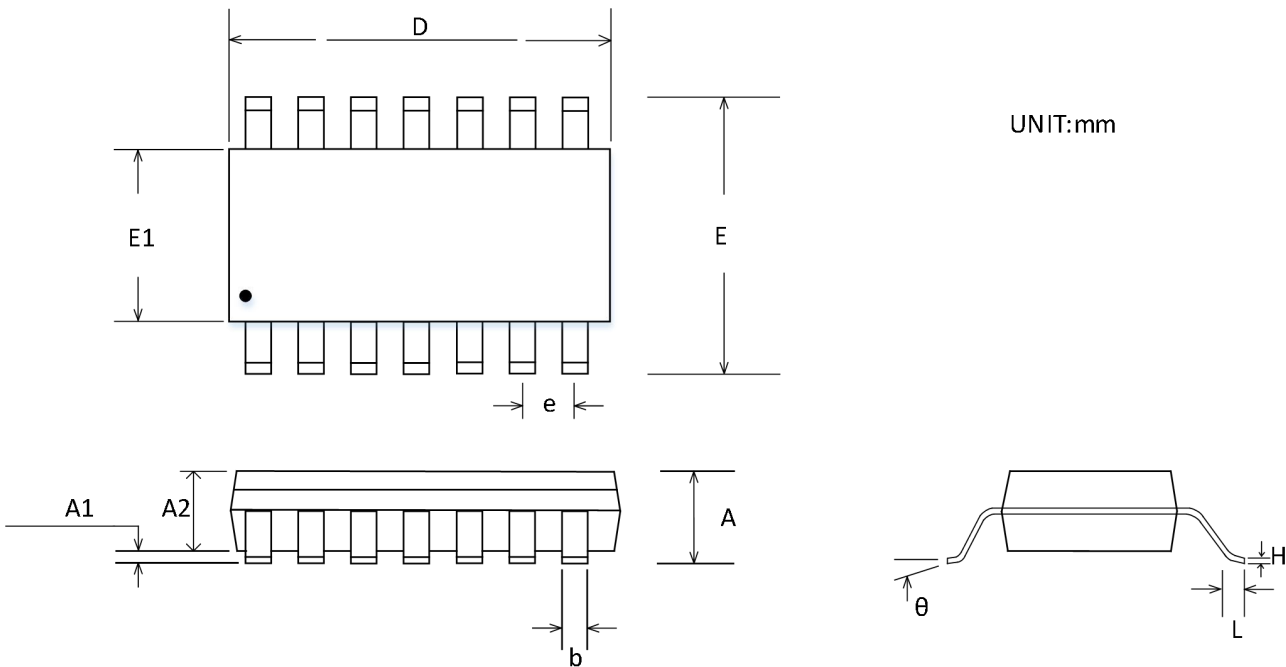
| Symbol | Dimensions In Millimeters |      |
|--------|---------------------------|------|
|        | Min                       | Max  |
| A      | 4.80                      | 5.00 |
| B      | 3.80                      | 4.00 |
| C      | 1.35                      | 1.75 |
| D      | 0.31                      | 0.51 |
| F      | 0.40                      | 1.27 |
| G      | 1.27BSC                   |      |
| H      | 5.80                      | 6.20 |
| J      | 0°                        | 8°   |
| K      | 0.10                      | 0.25 |
| R      | 0.25                      | 0.50 |

TSSOP-14



| Symbol | Dimensions In Millimeters |      |
|--------|---------------------------|------|
|        | Min                       | Max  |
| A      | 1.20MAX                   |      |
| A1     | 0.05                      | 0.15 |
| A2     | 0.80                      | 1.05 |
| b      | 0.19                      | 0.30 |
| D      | 4.90                      | 5.10 |
| E      | 6.40BSC                   |      |
| E1     | 4.30                      | 4.50 |
| e      | 0.65BSC                   |      |
| H      | 0.09                      | 0.20 |
| L      | 0.45                      | 0.75 |
| θ      | 0°                        | 8°   |

SOP-14



| Symbol | Dimensions In Millimeters |      |
|--------|---------------------------|------|
|        | Min                       | Max  |
| A      | 1.35                      | 1.75 |
| A1     | 0.10                      | 0.25 |
| A2     | 1.25                      | 1.50 |
| b      | 0.31                      | 0.51 |
| D      | 8.55                      | 8.75 |
| E      | 5.80                      | 6.20 |
| E1     | 3.80                      | 4.00 |
| e      | 1.27BSC                   |      |
| H      | 0.17                      | 0.25 |
| L      | 0.40                      | 1.27 |
| θ      | 0°                        | 8°   |

Package/Ordering Information

| MODEL            | TEMPERATURE | PACKAGE DESCRIPTION | PACKAGE OPTION |
|------------------|-------------|---------------------|----------------|
| CD8601AST5       | -40°C~125°C | SOT23-5             | S601           |
| CD8602AMS8       | -40°C~125°C | MSOP-8              | M02            |
| CD8602AS8        | -40°C~125°C | SOP-8               | CD8602A        |
| CD8602AS8-RL     | -40°C~125°C | SOP-8               | CD8602A        |
| CD8602AS8-REEL   | -40°C~125°C | SOP-8               | CD8602A        |
| CD8604ATS14      | -40°C~125°C | TSSOP-14            | CD8604AT       |
| CD8604ATS14-RL   | -40°C~125°C | TSSOP-14            | CD8604AT       |
| CD8604ATS14-REEL | -40°C~125°C | TSSOP-14            | CD8604AT       |
| CD8604AS14       | -40°C~125°C | SOP-14              | CD8604AS       |
| CD8604AS14-RL    | -40°C~125°C | SOP-14              | CD8604AS       |
| CD8604AS14-REEL  | -40°C~125°C | SOP-14              | CD8604AS       |
| CD8604AQS16      | -40°C~125°C | QSOP-16             | CD8604AQ       |

Revision Log

| Version | Revision date | Change content  | Reason for Change | Modified by | Reviewed By | Note |
|---------|---------------|-----------------|-------------------|-------------|-------------|------|
| V1.0    | 2025.8.4      | Initial version | Regular update    | WW          | LYL         |      |