# SGM8776-1
# High Voltage Differential Comparator

## GENERAL DESCRIPTION

The SGM8776-1 is a single, high-speed, differential voltage comparator, which features a fast response time of 180ns. The device is optimized for high voltage operation from 3.4V to 30V single supply or ±1.7V to ±15V dual power supplies.

The SGM8776-1 has an N-MOSFET with open-drain output structure, which allows the device to change the electric potential difference to a maximum of 50V at a current of 50mA. It has the ability to drive loads, such as relays or lamps, with respect to $+V_S$, $-V_S$ or ground. The device can separate any input or output from the common ground. It can support most CMOS or TTL logic. Since the open-drain configuration of the outputs is used, several outputs can be connected together to achieve wired-OR logic. In some special applications, the SGM8776-1 can also be configured as a source output according to user needs.

The SGM8776-1 is available in a Green SOIC-8 package. It is rated over the -40℃ to +125℃ operating temperature range.

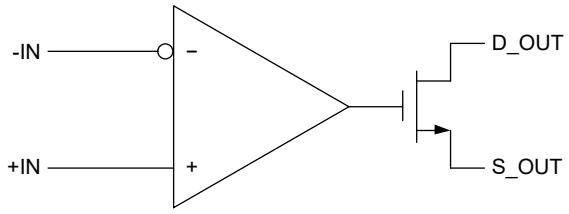
## FEATURES

- **High Speed: 180ns Propagation Delay**
- **Support Open-Drain Output and Source Output**
- **Wide Supply Ranges:**
  **Single Supply: 3.4V to 30V**
  **Dual Supplies: ±1.7V to ±15V**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in a Green SOIC-8 Package**

## APPLICATIONS

Industrial Equipment
Telecom Equipment
Zero-Crossing Detectors

## SIMPLIFIED SCHEMATIC

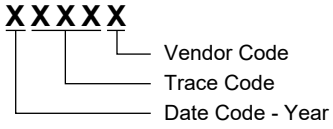


# PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---|---|---|---|---|---|
| SGM8776-1 | SOIC-8 | -40℃ to +125℃ | SGM8776-1XS8G/TR | 09YXS8<br>XXXXX | Tape and Reel, 4000 |

## MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code.




Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage
- $+V_S$ (1) ..... 18V
- $-V_S$ (1) ..... -18V
- $+V_S$ - ($-V_S$) ..... 36V

Differential Input Voltage, $V_{ID}$ (2) (3) ..... ±30V
Input Voltage (Either Input), $V_{IN}$ (1) (3) ..... ±15V
Voltage from S_OUT to $-V_S$ ..... ($+V_S$) + 0.3V
Voltage from D_OUT to $-V_S$ ..... 60V
Output Short-Circuit Duration to GND ..... 10s
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM ..... 2000V
CDM ..... 1000V

NOTES:
1. The reference point for measuring any voltage is the center point of $+V_S$ and $-V_S$, except when specified differently.
2. The differential input voltage is the voltage difference between +IN and -IN.
3. The absolute input voltage range should always not exceed the smaller of the absolute supply voltage range and ±15V.

## RECOMMENDED OPERATING CONDITIONS

Supply Voltage Range, $+V_S$ - ($-V_S$) ..... 3.4V to 30V
Input Voltage Range, $V_{IN}$ ..... ($-V_S$) to ($+V_S$) - 2V
Operating Temperature Range ..... -40℃ to +125℃

## OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

## ESD SENSITIVITY CAUTION

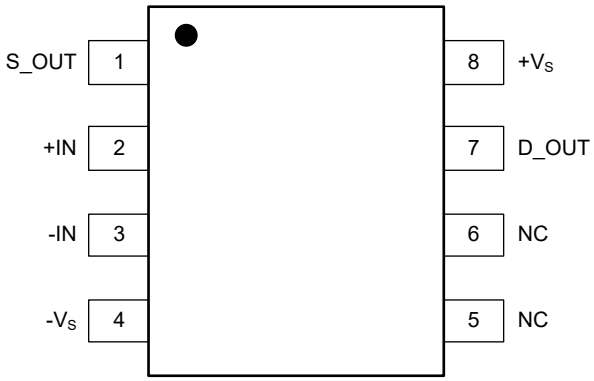
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

## DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

## PIN CONFIGURATION

(TOP VIEW)




SOIC-8

## PIN DESCRIPTION

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | S_OUT | Source of Output N-Type MOSFET. |
| 2 | +IN | Non-Inverting Input of Comparator. |
| 3 | -IN | Inverting Input of Comparator. |
| 4 | $-V_S$ | Negative Power Supply. |
| 5 | NC | No Connection. |
| 6 | NC | No Connection. |
| 7 | D_OUT | Drain of Output N-Type MOSFET. |
| 8 | $+V_S$ | Positive Power Supply. |

## ELECTRICAL CHARACTERISTICS

($V_S$ = ±15V, Full = -40℃ to +125℃, typical values are at $T_A$ = +25℃, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | TEMP | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{OS}$ | $V_{CM}$ = 0V | +25℃ | | 1 | 3 | mV |
| | | | Full | | | 4 | |
| Input Offset Current | $I_{OS}$ | $V_{CM}$ = 0V | +25℃ | | 0.1 | 3.5 | nA |
| | | | Full | | | 5 | |
| Input Bias Current | $I_B$ | $V_{CM}$ = 0V | +25℃ | | 0.1 | 3.5 | nA |
| | | | Full | | | 20 | |
| Input Common Mode Voltage Range | $V_{CM}$ | | Full | $-V_S$ | | $(+V_S)-2$ | V |
| Common Mode Rejection Ratio | CMRR | $V_{CM}$ = -15V to 13V | +25℃ | 88 | 110 | | dB |
| | | | Full | 85 | | | |
| Large-Signal Different-Voltage Amplification | $A_{VD}$ | $V_{OUT}$ = 5V to 35V, $R_L$ = 1kΩ | +25℃ | | 105 | | dB |
| High-Level Output Leakage Current | $I_{OH}$ | $V_{ID}$ = 200mV, $V_{OH}$ = 35V | +25℃ | | 2 | 15 | nA |
| | | | Full | | | 100 | |
| Low-Level Output Voltage | $V_{OL}$ | $I_{SINK}$ = 50mA, $V_{ID}$ = -200mV | +25℃ | | 0.6 | 0.8 | V |
| | | | Full | | | 1 | |
| | | $+V_S$ = 4.5V, $-V_S$ = 0V, $I_{SINK}$ = 8mA, $V_{ID}$ = -200mV | +25℃ | | 0.1 | 0.15 | |
| | | | Full | | | 0.3 | |
| Supply Current from $+V_S$ Output Low | $I_{+VS}$ | $V_{ID}$ = -300mV, no load | +25℃ | | 3.3 | 4.2 | mA |
| | | | Full | | | 4.8 | |
| Supply Current from $-V_S$ Output High | $I_{-VS}$ | $V_{ID}$ = 300mV, no load | +25℃ | -2.2 | -1.8 | | mA |
| | | | Full | -2.6 | | | |

NOTE: 1. Unless otherwise noted, all characteristics are measured with the source pin tied to ground.

## SWITCHING CHARACTERISTICS

(At $T_A$ = +25℃, $V_S$ = ±15V, unless otherwise noted.)

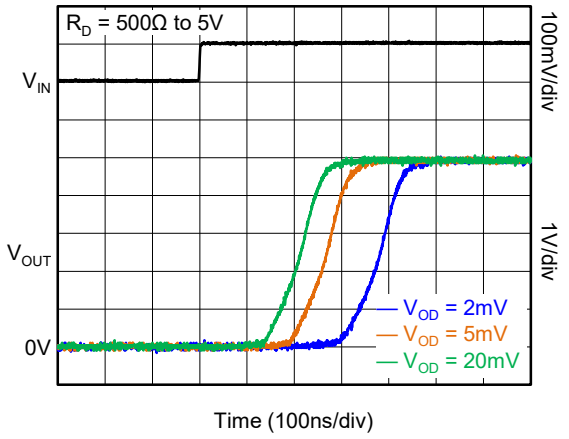
| PARAMETER | SYMBOL | CONDITIONS | TEMP | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Propagation Delay (Low to High) (1) | $t_{PLH}$ | $R_D$ = 500Ω to 5V, $C_L$ = 5pF, see Figure 3, 4 | +25℃ | | 240 | | ns |
| Propagation Delay (High to Low) (1) | $t_{PHL}$ | | +25℃ | | 180 | | ns |

NOTE: 1. When the input changes by 100mV with 5mV overdrive, the output eventually crosses 1.4V at some point. The propagation delay is the duration from the input change to that point.

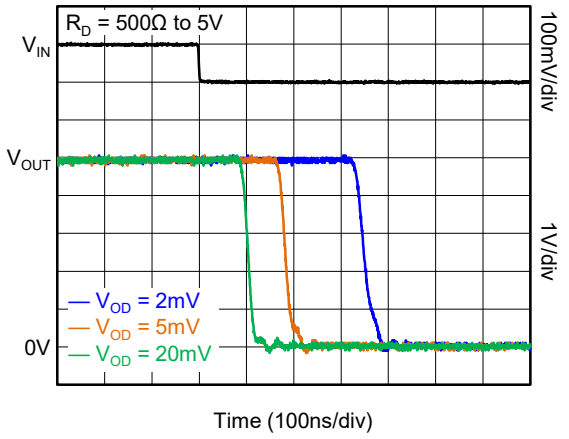
## TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A$ = +25℃, $V_S$ = ±15V, unless otherwise noted.

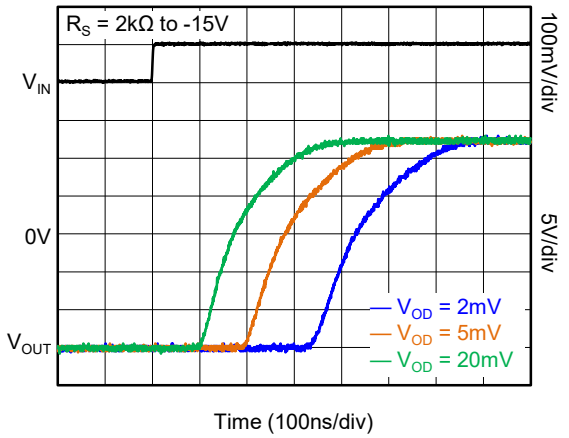
D_OUT Propagation Delay (L-H) for Various Input Overdrives



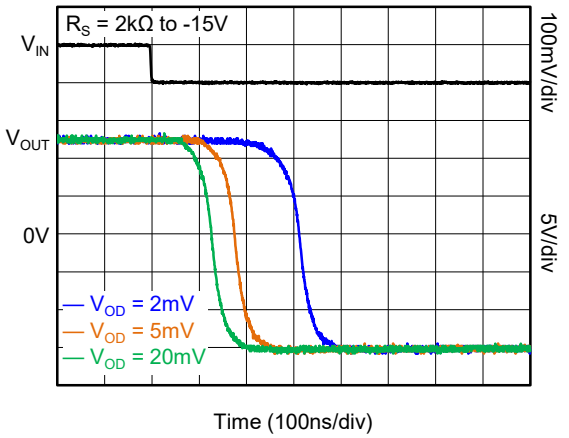

D_OUT Propagation Delay (H-L) for Various Input Overdrives



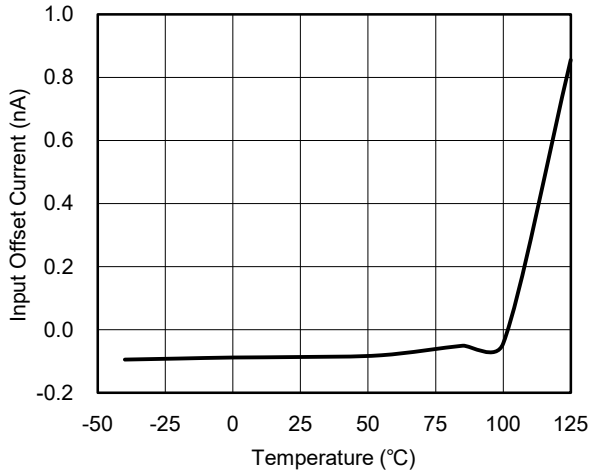

S_OUT Propagation Delay (L-H) for Various Input Overdrives



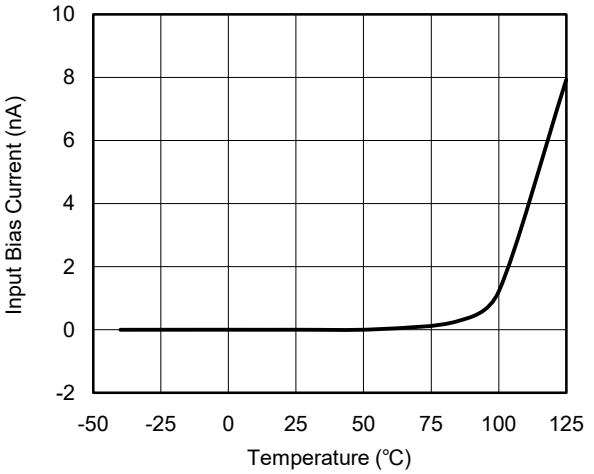

S_OUT Propagation Delay (H-L) for Various Input Overdrives




Input Offset Current vs. Temperature



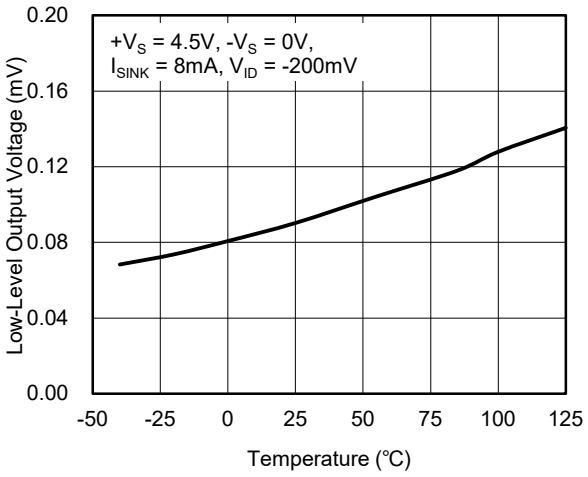

Input Bias Current vs. Temperature



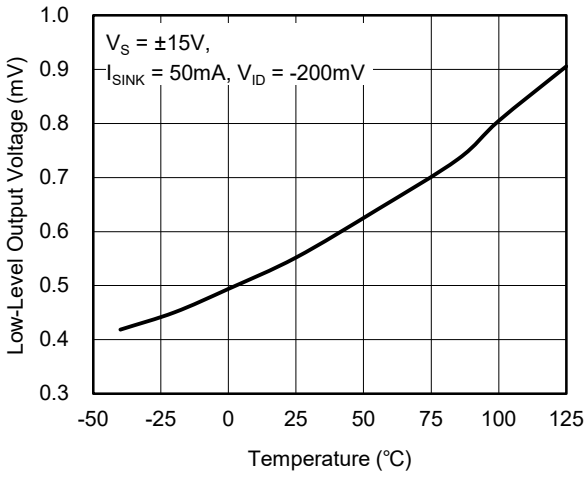
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A$ = +25℃, $V_S$ = ±15V, unless otherwise noted.

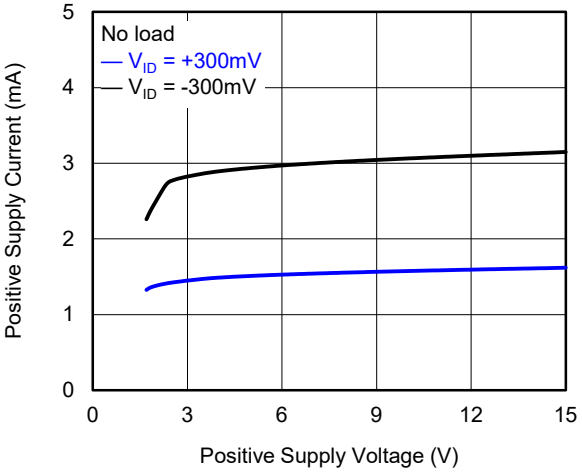
Low-Level Output Voltage vs. Temperature



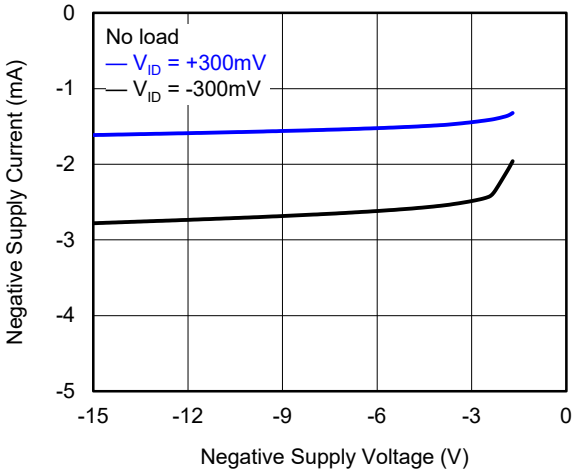

Low-Level Output Voltage vs. Temperature



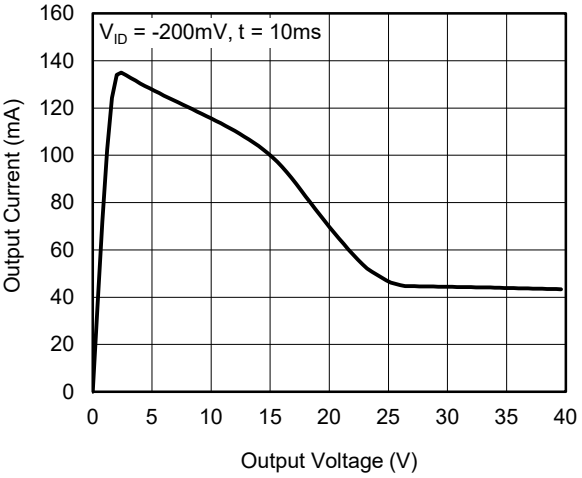

Positive Supply Current vs. Positive Supply Voltage




Negative Supply Current vs. Negative Supply Voltage




Output Current vs. Output Voltage



# PARAMETER MEASUREMENT INFORMATION

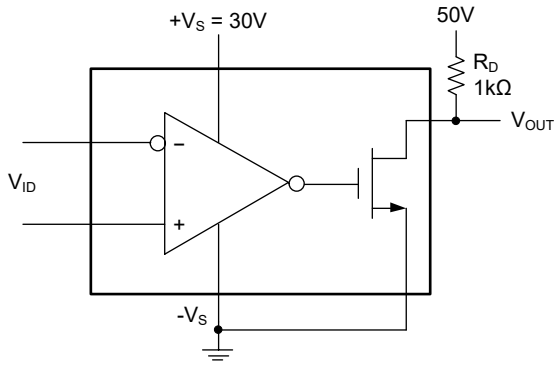



Figure 1. D_OUT Transfer Characteristic Test Circuit

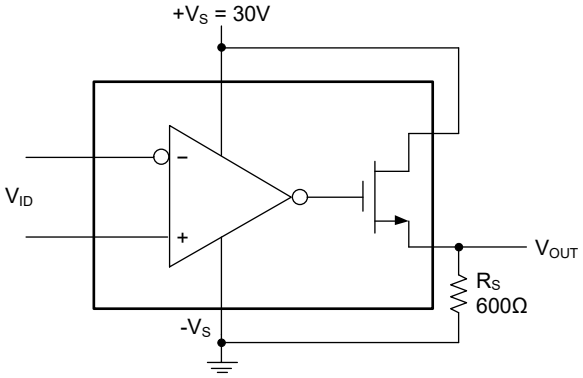



Figure 2. S_OUT Transfer Characteristic Test Circuit

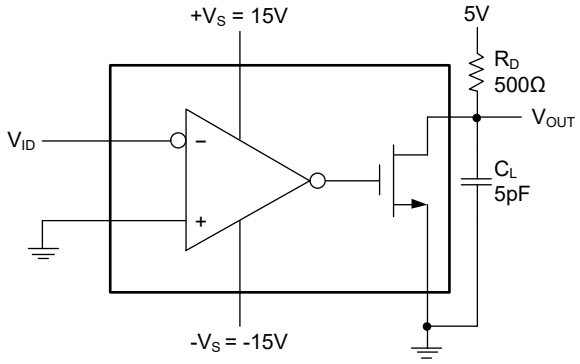



Figure 3. D_OUT Propagation Delay Test Circuit

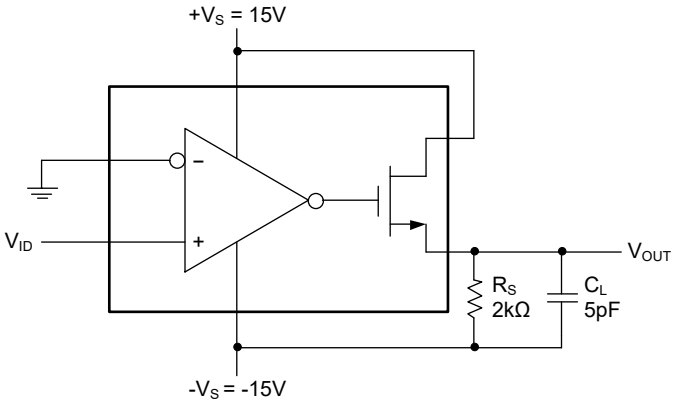



Figure 4. S_OUT Propagation Delay Test Circuit

## FUNCTIONAL BLOCK DIAGRAM

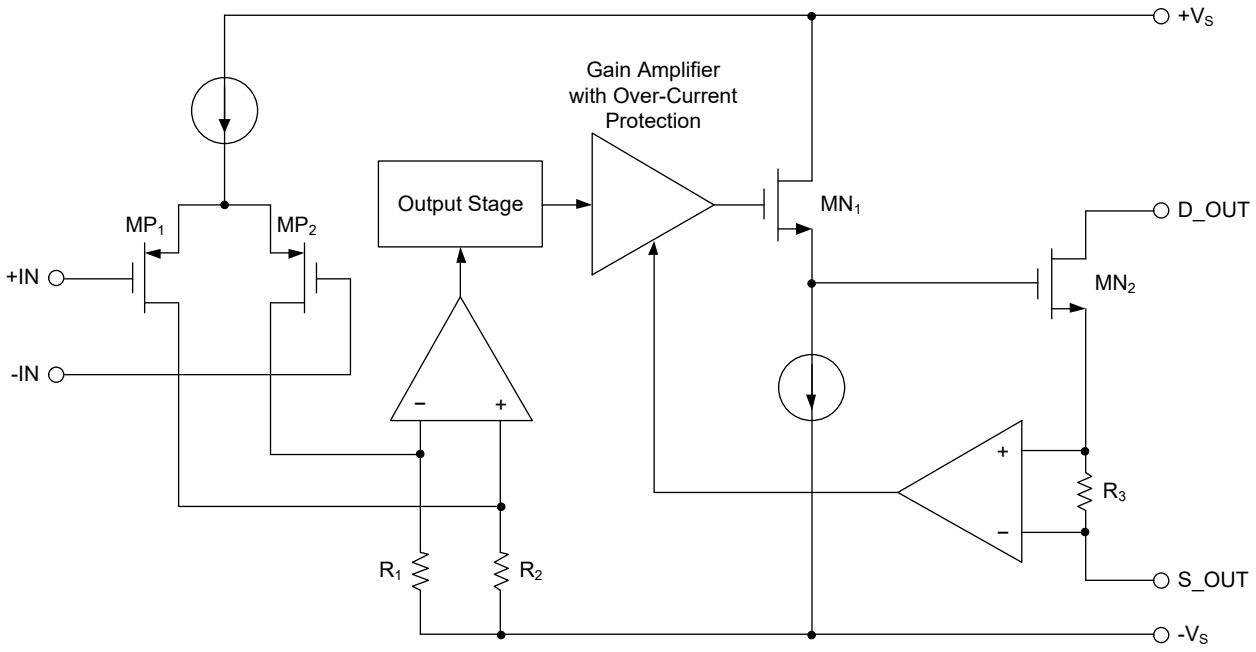



**Figure 5. Block Diagram**

## DETAILED DESCRIPTION

The SGM8776-1 is a single, high-speed, differential voltage comparator, which features very low input bias currents. The device has a wide power supply range from 3.4V to 30V single supply or ±1.7V to ±15V dual power supplies, and this feature makes the SGM8776-1 can be flexibly applied to 5V single-supply or usual ±15V dual-supply applications. The SGM8776-1 has an open-drain output structure, which allows the device to change the electric potential difference to a maximum of 50V at a current of 50mA and control relays or lamps. Also, the device can support CMOS or TTL logic.

The device can separate any input or output from the common ground. The output has the ability to drive loads with respect to $+V_S$, $-V_S$ or ground. Since the open-drain configuration of the outputs is used, several outputs can be connected together to achieve wired-OR logic.

### Feature Description

The SGM8776-1 is a flexibly configurable voltage comparator. It has two output pins: D_OUT and S_OUT.

When the SGM8776-1 is configured as D_OUT pin output, it will output a logic low or high-impedance state based on the differential voltage between the positive and negative pins. If it needs to output a logic high, an external pull-up resistor must be added.

The SGM8776-1 does not support rail-to-rail input, although it has a P-type input stage as shown in Figure 5. This stage has a very fast response once a differential voltage occurs on the input pins. Besides, the SGM8776-1 has an N-type MOSFET output stage. This N-type MOSFET output stage is completely isolated from $+V_S$ or $-V_S$. It can be configured as open-drain output, but it is different from most open-drain comparators. The S_OUT pin configuration is more flexible. In other words, the $V_{OL}$ output value can be defined by users.

# APPLICATION INFORMATION

The SGM8776-1 is a high voltage comparator. It is most commonly configured as an open-drain output to compare an individual input signal to a reference or two different input signals. The logic output is usually used as an input signal for other logic devices or MCU. The SGM8776-1 is ideal for voltage level shifting due to its wide supply range and ability to handle high voltages.

## Typical Application

The Figure 6 shows the SGM8776-1 used as a zero-crossing comparator. For this application, the key design parameters are listed in Table 1.

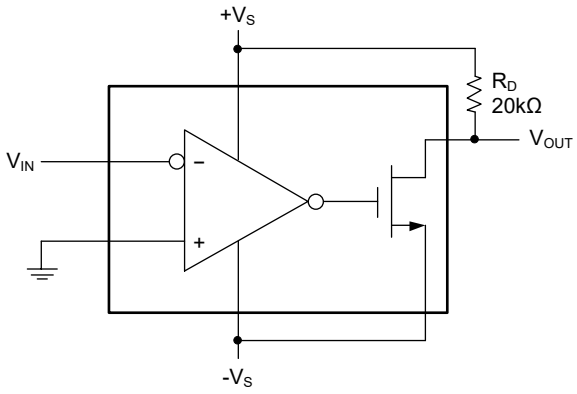



**Figure 6. Zero-Crossing Comparator**

**Table 1. Key Design Parameters**

| PARAMETER | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|
| Positive Supply Voltage (+$V_S$) | | | 15 | V |
| Negative Supply Voltage (-$V_S$) | -15 | | | V |
| Input Voltage Range ($V_{IN}$) | -15 | | 13 | V |
| Output Sink Current ($I_{OUT}$) | | | 50 | mA |

## Input Voltage Range

Users must consider the input common mode voltage range ($V_{CM}$) when using the SGM8776-1 as a comparator. If the input signal exceeds the input common mode voltage range during operation, the output may be incorrect. The detailed explanation is shown in Table 2.

**Table 2. Input Voltage Range**

| Input Signal | The Output Status | The Output Transistor |
|---|---|---|
| **Both Inputs within the $V_{CM}$ Range** | | |
| -IN is higher than +IN and the offset voltage | Low | Sink Current |
| -IN is lower than +IN and the offset voltage | Hi-Z | Not Conducting |
| **Only One Input within the $V_{CM}$ Range** | | |
| -IN is higher than the $V_{CM}$ range and +IN is within the $V_{CM}$ range | Low | Sink Current |
| +IN is higher than the $V_{CM}$ range and -IN is within the $V_{CM}$ range | Hi-Z | Not Conducting |
| **Both Inputs without the $V_{CM}$ Range** | | |
| -IN and +IN are both higher than the $V_{CM}$ range | Undefined | Undefined |
| -IN and +IN are both lower than the $V_{CM}$ range | Undefined | Undefined |

NOTE: The above characteristics are based on the input signal being within the Absolute Maximum Ratings.

## Minimum Overdrive Voltage

The overdrive voltage ($V_{OD}$) is defined as the differential voltage between the positive and negative inputs of the comparator over the offset voltage ($V_{OS}$). In application, the overdrive voltage ($V_{OD}$) must be greater than the input offset voltage ($V_{OS}$) to ensure accurate comparison. The overdrive voltage is one of main factors that affects the propagation delay time. In general, as the overdrive voltage increases, the propagation delay time decreases. The Typical Performance Characteristics section illustrates the relationship between positive and negative propagation delay and overdrive voltage.

## Output and Drive Current

When the SGM8776-1 is configured as an open-drain output and the output is equivalent to the pull-up voltage, the output current is determined by the pull-up resistance ($R_D$) and pull-up voltage. When the SGM8776-1 output is low, the output current capability depends on the drain-source resistance ($R_{DS}$) of the comparator and the output low voltage ($V_{OL}$) from the comparator. The variation of $V_{OL}$ with temperature can be found in the Typical Performance Characteristics section.

# APPLICATION INFORMATION (continued)

### Propagation Delay Time

When the SGM8776-1 is configured as an open-drain output, the positive propagation delay time ( $\tau_P$ ) is determined by the pull-up resistance ($R_D$) and the load capacitance ($C_L$). Equation 1 approximates the positive propagation delay. The negative propagation delay time ( $\tau_N$ ) is determined by drain-source resistance ($R_{DS}$). The Equation 2 approximates negative propagation delay time, and $R_{DS}$ can be calculated by the Equation 3.

$$\tau_P \cong R_D \times C_L \quad (1)$$

$$\tau_N \cong R_{DS} \times C_L \quad (2)$$

$$R_{DS} = \frac{V_{OL}}{I_{OUT}} \quad (3)$$

where:

$V_{OL}$ is the low-level output voltage. The variation of $V_{OL}$ with temperature can be found in the Typical Performance Characteristics section.

$I_{OUT}$ is the output current.

### Application Curves

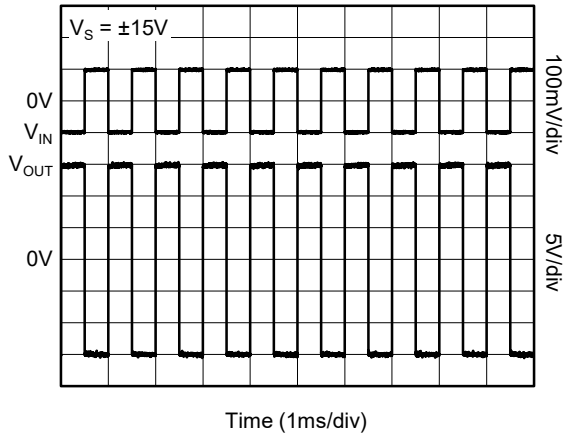



**Figure 7. Output Waveform of Zero-Crossing Detector**

## Power Supply Recommendations

The SGM8776-1 has a recommended operating voltage range of 3.4V to 30V and can be powered from a single or dual power supplies. In application, sudden changes in power supply may cause abnormal output, so one or more bypass capacitors must be connected to the supply pin to ensure a stable power supply. When the comparator is working and the output voltage is switching, the suitable bypass capacitor can not only reject transient changes in the power supply but also reduce high-frequency noise.

## TYPICAL APPLICATION CIRCUITS

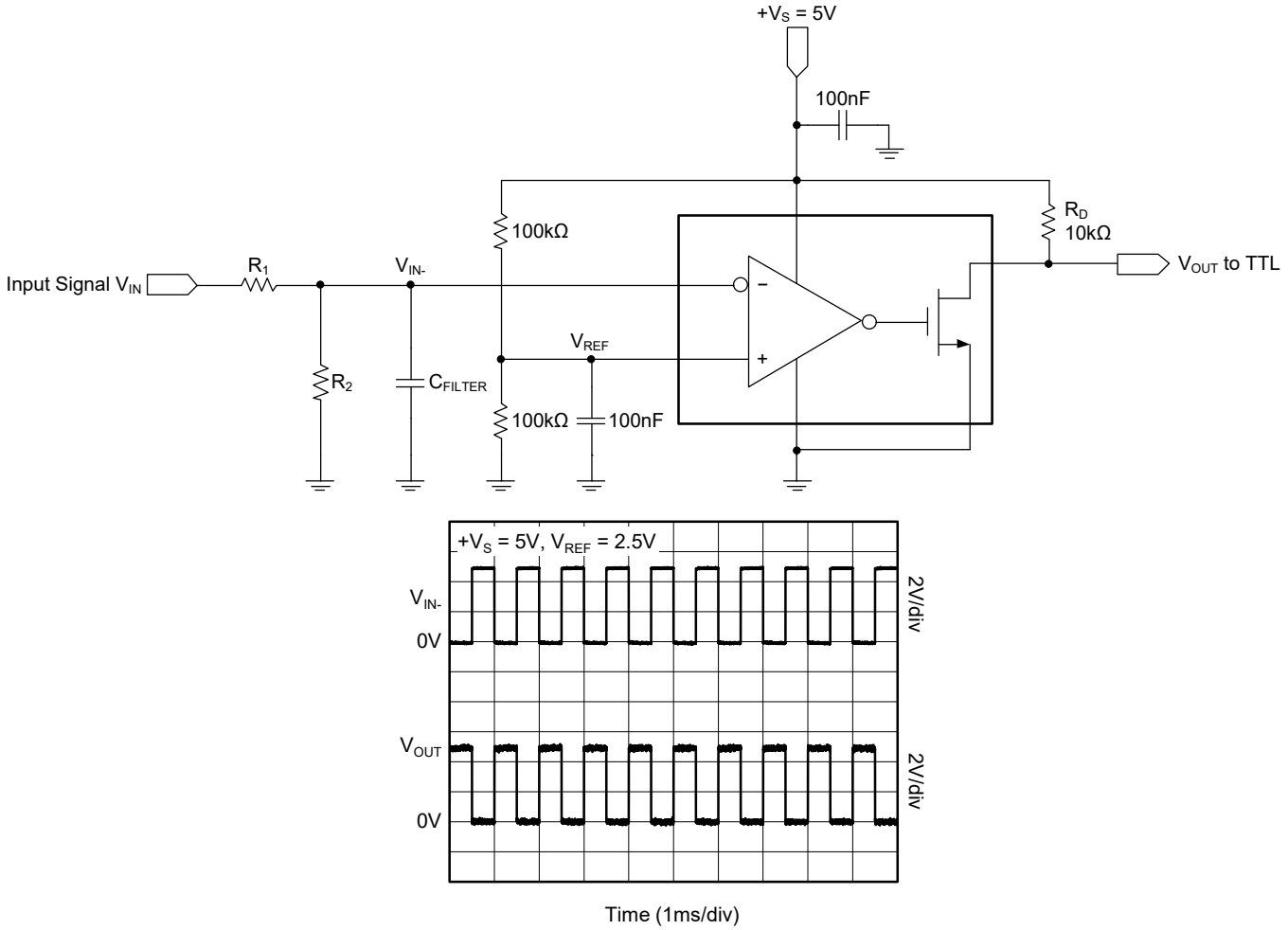



**Figure 8. TTL Interface with High Voltage Input**

## TYPICAL APPLICATION CIRCUITS (continued)

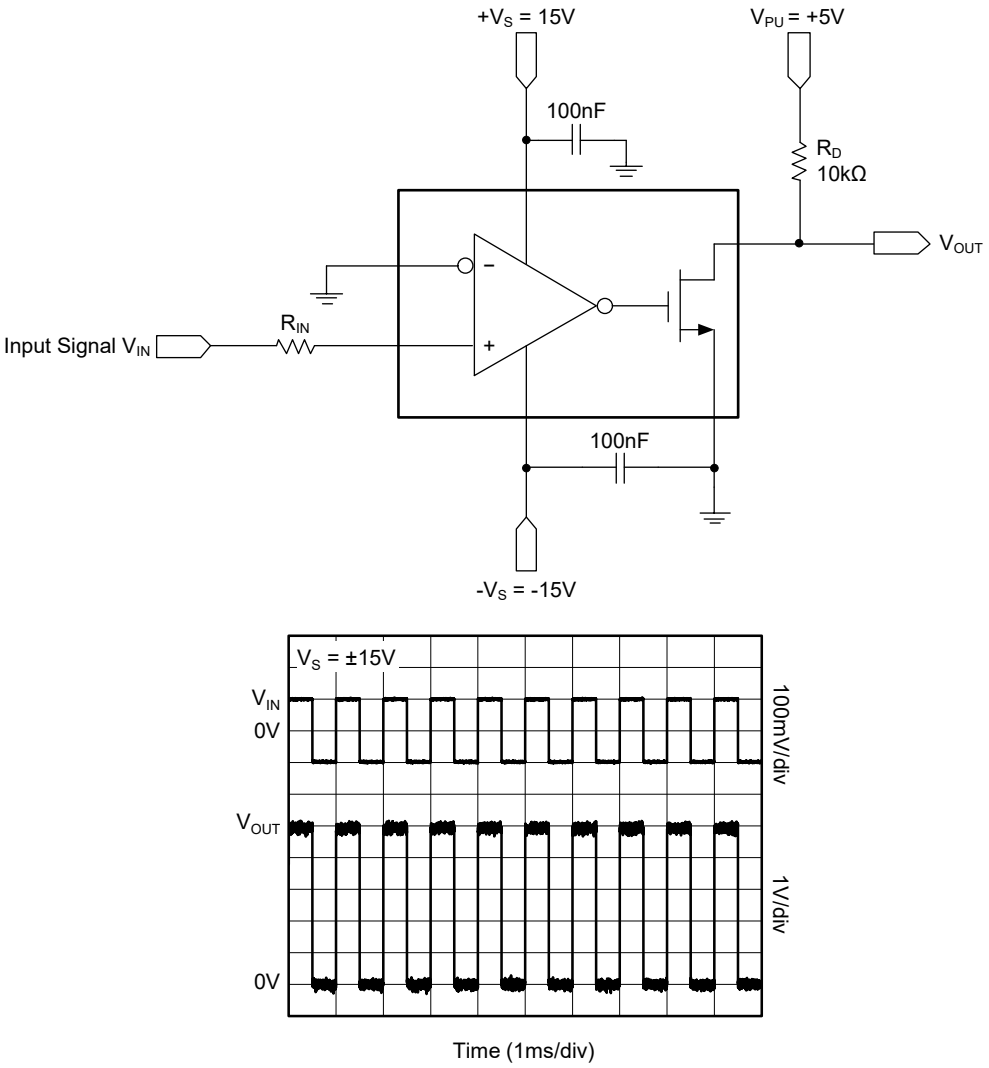



**Figure 9. Zero-Crossing Detector**

## TYPICAL APPLICATION CIRCUITS (continued)

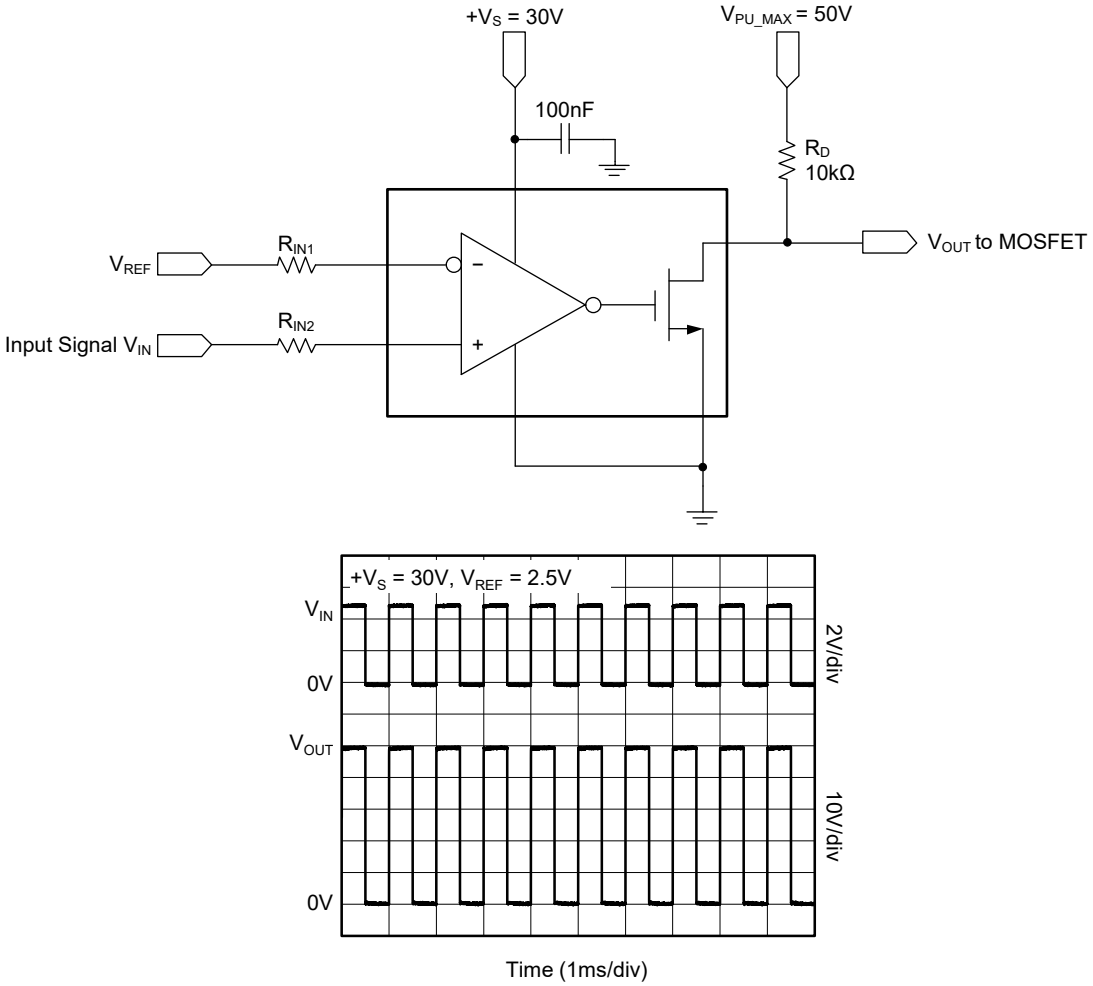



**Figure 10. The Application of High Voltage Output**

## TYPICAL APPLICATION CIRCUITS (continued)

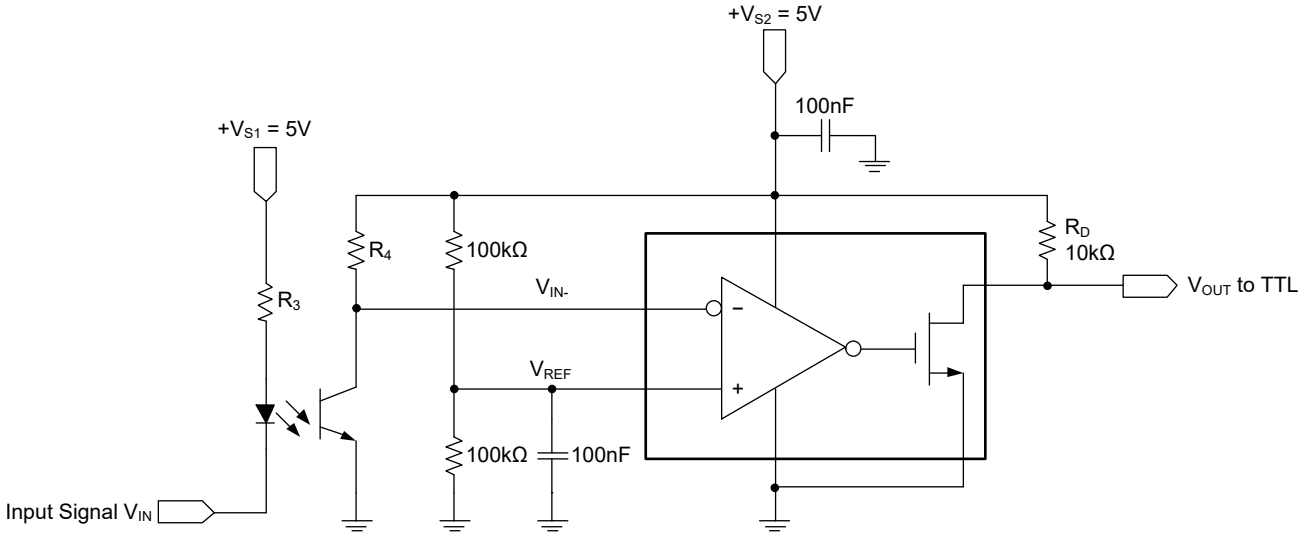



**Figure 11. Digital Transmission Isolator**

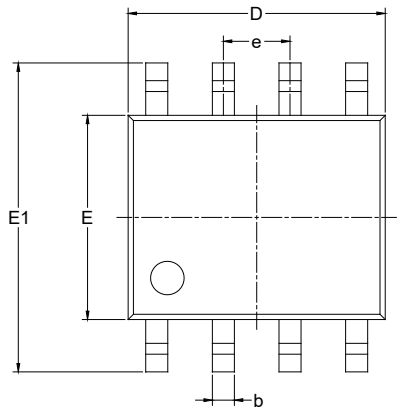
# REVISION HISTORY

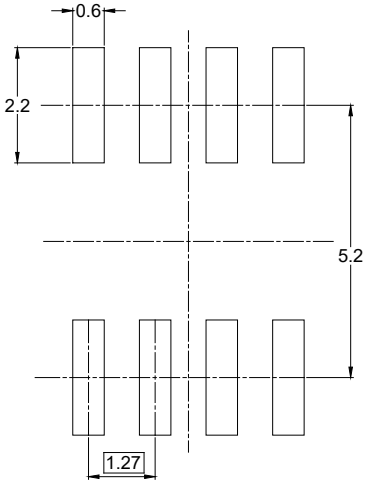
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Original (AUGUST 2024) to REV.A | Page |
|---|---|
| Changed from product preview to production data | All |

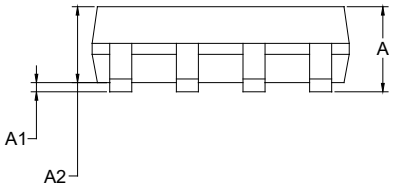
# PACKAGE OUTLINE DIMENSIONS

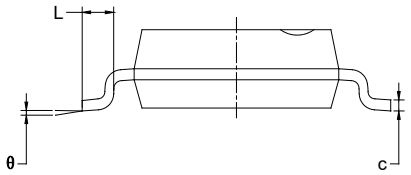
## SOIC-8




**RECOMMENDED LAND PATTERN** (Unit: mm)



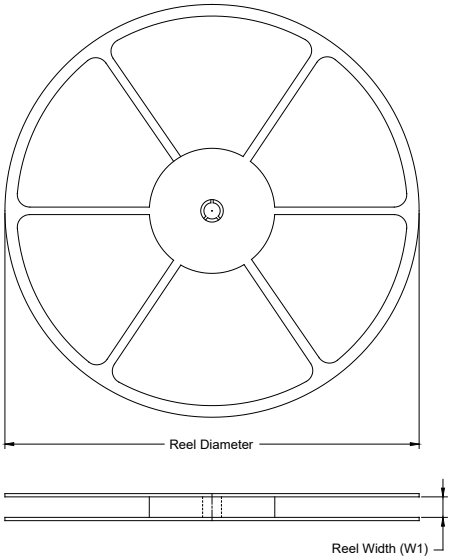




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.006 | 0.010 |
| D | 4.700 | 5.100 | 0.185 | 0.200 |
| E | 3.800 | 4.000 | 0.150 | 0.157 |
| E1 | 5.800 | 6.200 | 0.228 | 0.244 |
| e | 1.27 BSC | | 0.050 BSC | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

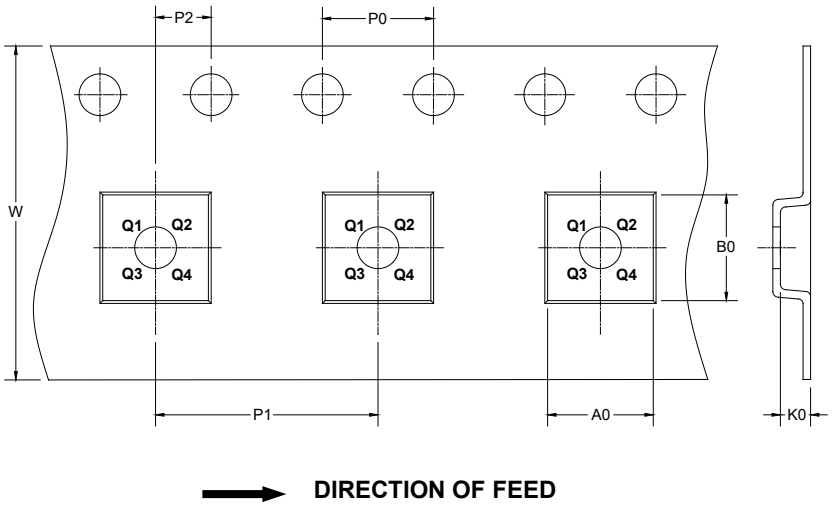
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

# TAPE AND REEL INFORMATION

### REEL DIMENSIONS




### TAPE DIMENSIONS



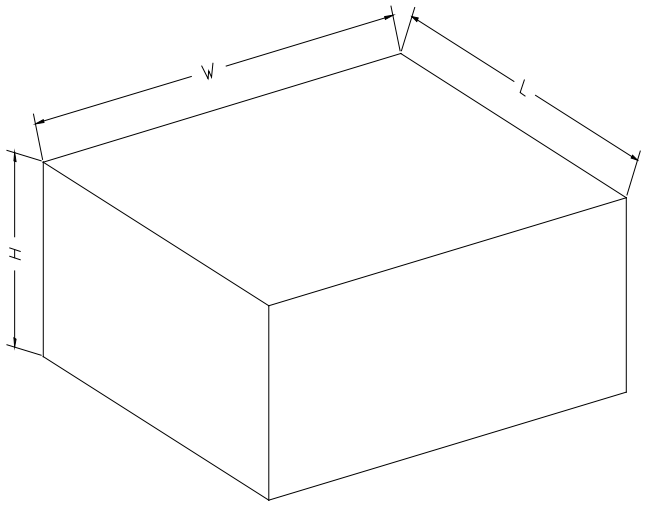

NOTE: The picture is only for reference. Please make the object as the standard.

## KEY PARAMETER LIST OF TAPE AND REEL

| Package Type | Reel Diameter | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|
| SOIC-8 | 13″ | 12.4 | 6.40 | 5.40 | 2.10 | 4.0 | 8.0 | 2.0 | 12.0 | Q1 |

DD0001

## CARTON BOX DIMENSIONS




NOTE: The picture is only for reference. Please make the object as the standard.

## KEY PARAMETER LIST OF CARTON BOX

| Reel Type | Length (mm) | Width (mm) | Height (mm) | Pizza/Carton |
|---|---|---|---|---|
| 13″ | 386 | 280 | 370 | 5 |

DD0002