SGM8780-1
High Voltage Differential Comparator

GENERAL DESCRIPTION

The SGM8780-1 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.

The SGM8780-1 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. 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. The open-drain output is controlled by external $\overline{EN}$ Pin. When $\overline{EN}$ is high, the open-drain output is in the off state, unaffected by the differential input. When $\overline{EN}$ is low or floating, the open-drain output transistor is controlled by the differential input. The $\overline{EN}$ pin has a 200kΩ pull-down resistor.

The SGM8780-1 is available in a Green SOIC-8 package. It is rated over the -40℃ to +125℃ operating temperature range.

FEATURES

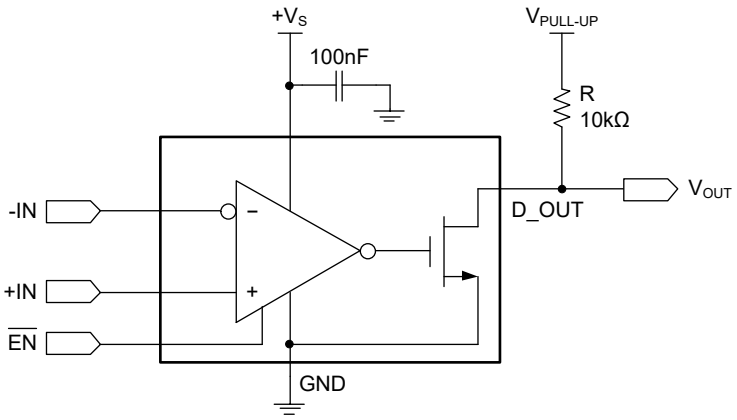
- **High Speed: 180ns Propagation Delay**
- **Open-Drain Output**
- **1.8V Logic $\overline{EN}$ Control**
- **$\overline{EN}$ has a 200kΩ Pull-Down Resistor**
- **Wide Supply Voltage Range: 3.4V to 30V**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in a Green SOIC-8 Package**

APPLICATIONS

Industrial Equipment

Telecom Equipment

APPLICATION SCHEMATIC

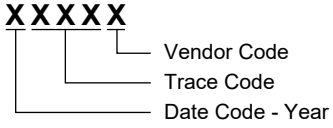


PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8780-1	SOIC-8	-40℃ to +125℃	SGM8780-1XS8G/TR	SGM 87801XS8 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) 36V
Differential Input Voltage, V_{ID} (2) (3) ..... ±30V
Input Voltage of +IN, -IN (1) (3) ..... -0.3V to 30V
Voltage of $\overline{EN}$ 6V
Voltage of D_OUT 60V
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 GND, except when specified differently.
2. The differential input voltage is the voltage difference between +IN and -IN.
3. The absolute input voltage range at +IN and -IN pins should always not exceed the absolute supply voltage range.

RECOMMENDED OPERATING CONDITIONS

Supply Voltage Range, $+V_S$ ..... 3.4V to 30V
Input Voltage of +IN and -IN ..... -0.3V to $+V_S$
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

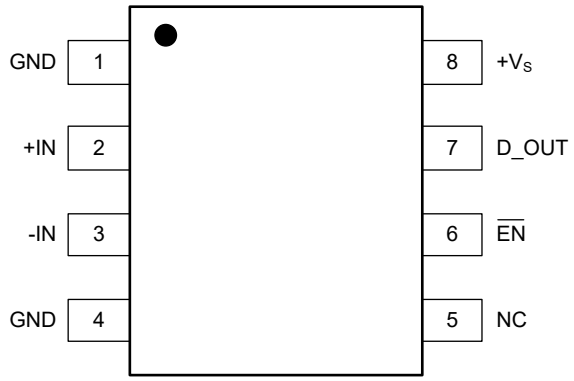
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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, 4	GND	Ground.
2	+IN	Non-Inverting Input of Comparator.
3	-IN	Inverting Input of Comparator.
5	NC	No Connection.
6	$\overline{EN}$	Control of Open-Drain Output. It has an internal 200kΩ pull-down resistor. When $\overline{EN}$ = "High", the open-drain output is in the off state, unaffected by the differential input. When $\overline{EN}$ = "Low" or floating, the open-drain output transistor is controlled by the differential input.
7	D_OUT	Drain of Output N-Type MOSFET. D_OUT supports 50V/50mA, it can be used as a low-side driver to drive external loading in high-speed protection, such as relay, etc.
8	$+V_S$	Positive Power Supply.

ELECTRICAL CHARACTERISTICS

(+V_S = 30V, 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} = 15V	+25℃		1	3	mV
			Full			4	
Input Offset Current	I_{OS}	V_{CM} = 15V	+25℃		0.1	3.5	nA
			Full			5	
Input Bias Current	I_B	V_{CM} = 15V	+25℃		0.1	3.5	nA
			Full			20	
Input Common Mode Voltage Range	V_{CM}		Full	0		(+V_S) - 2	V
Common Mode Rejection Ratio	CMRR	V_{CM} = 0V to 28V	+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, I_{SINK} = 8mA, V_{ID} = -200mV	+25℃		0.1	0.15	
			Full			0.3	
Supply Current from +V_S Output Low	I_S	V_{ID} = -300mV, no load	+25℃		3.3	4.2	mA
			Full			4.8	
Logic of $\overline{EN}$	V_{IH}	+V_S = 3.4V to 30V	Full	1.4		5.5	V
	V_{IL}	+V_S = 3.4V to 30V	Full	0		0.4	
$\overline{EN}$ Pin Pull-Down Resistance	R_{EN}		Full	120	200	280	kΩ

SWITCHING CHARACTERISTICS

(At T_A = +25℃, +V_S = 30V, unless otherwise noted.)

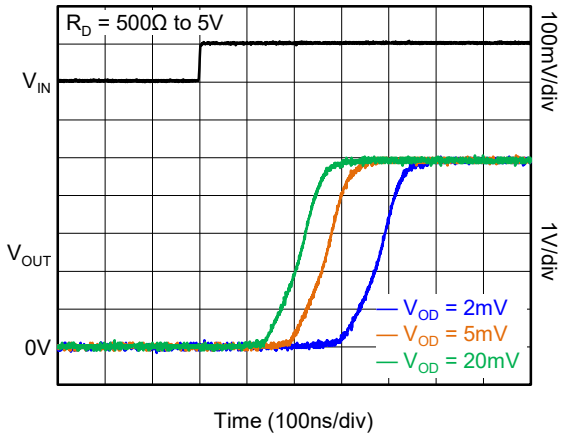
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Propagation Delay (Low to High) (1)	t_{PLH}	R_D = 500Ω to 5V, C_L = 5pF, see Figure 2	+25℃		240		ns
Propagation Delay (High to Low) (1)	t_{PHL}		+25℃		180		ns

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.

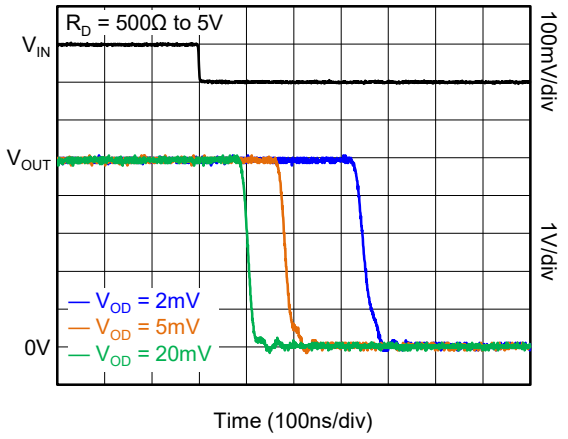
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, $+V_S$ = 30V, unless otherwise noted.

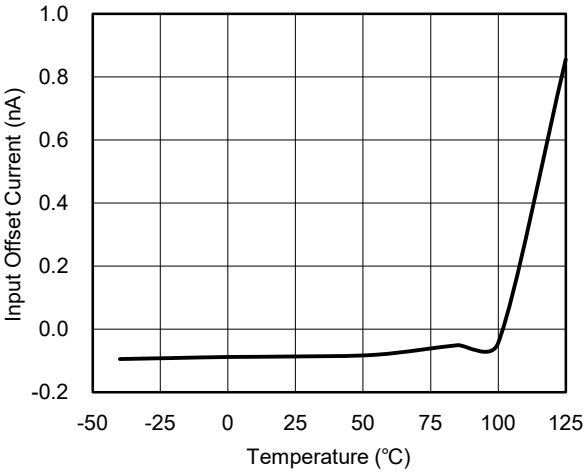
Propagation Delay (L-H) for Various Input Overdrives



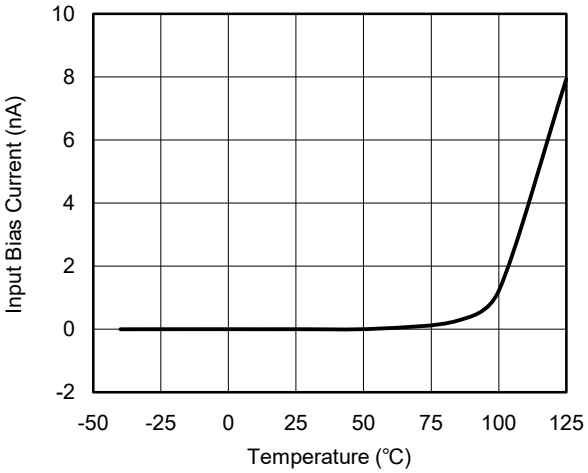
Propagation Delay (H-L) for Various Input Overdrives



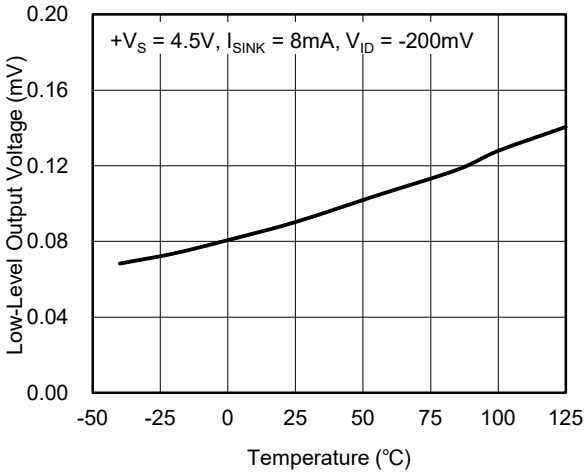
Input Offset Current vs. Temperature



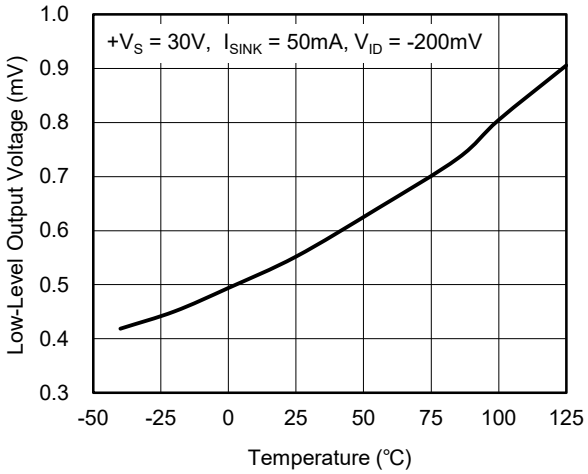
Input Bias Current vs. Temperature



Low-Level Output Voltage vs. Temperature



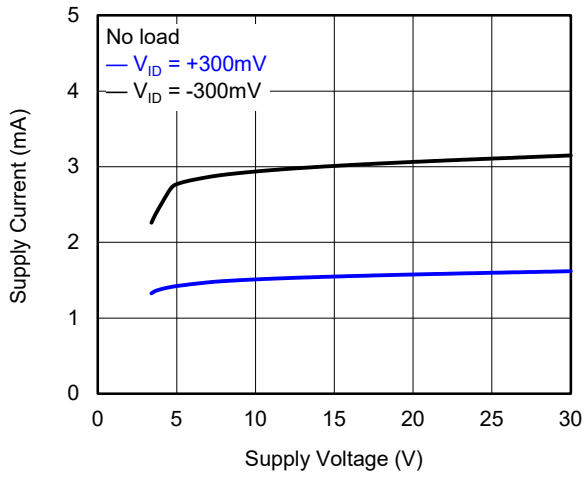
Low-Level Output Voltage vs. Temperature



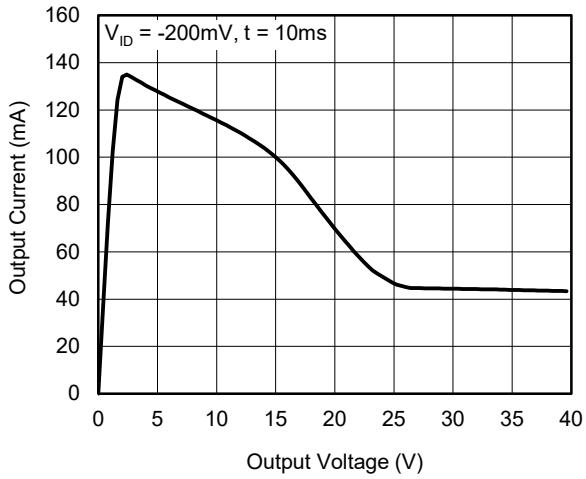
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, $+V_S$ = 30V, unless otherwise noted.

Supply Current vs. Supply Voltage



Output Current vs. Output Voltage



PARAMETER MEASUREMENT INFORMATION

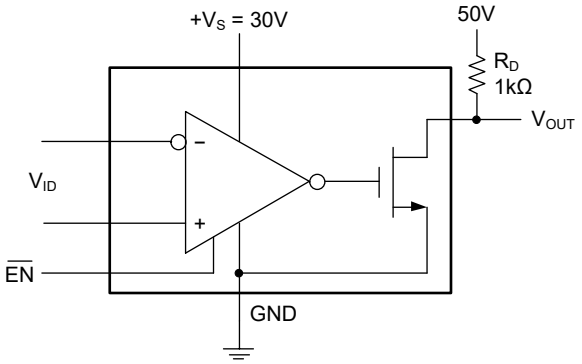


Figure 1. D_OUT Transfer Characteristic Test Circuit

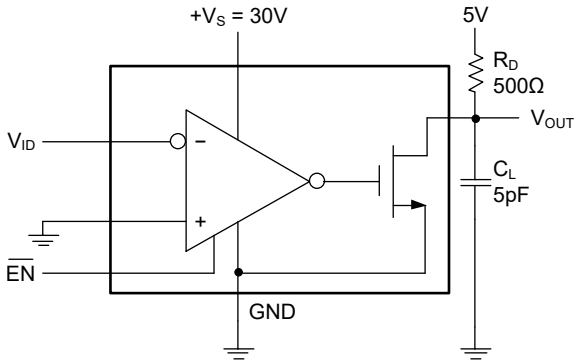


Figure 2. D_OUT Propagation Delay Test Circuit

FUNCTIONAL BLOCK DIAGRAM

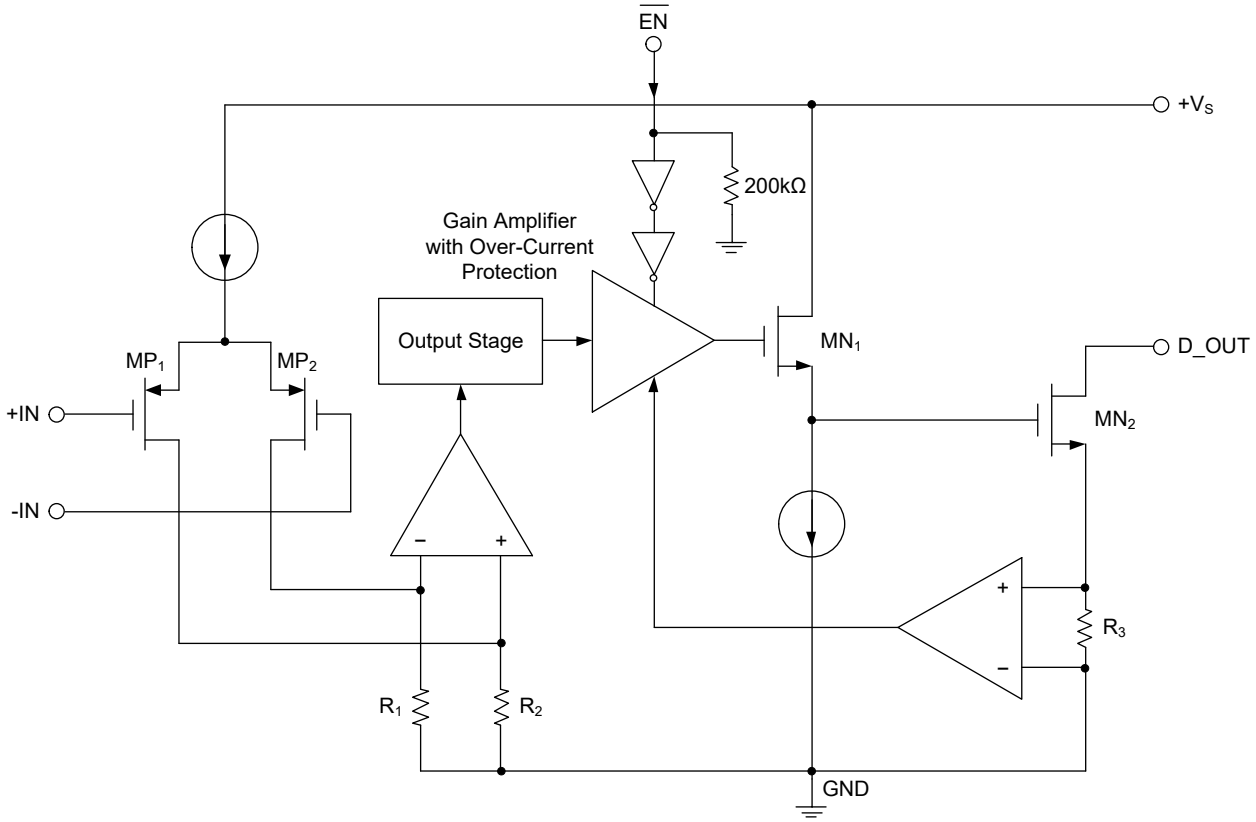


Figure 3. Block Diagram

DETAILED DESCRIPTION

The SGM8780-1 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. The SGM8780-1 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.

When the open-drain configuration of the outputs is used, several outputs can be connected together to achieve wired-OR logic. The output MOSFET can drive load up to 50V/50mA.

Feature Description

The SGM8780-1 is an open-drain output structure comparator. In actual application, 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 SGM8780-1 does not support rail-to-rail input, although it has a P-type input stage as shown in Figure 3. This stage has a very fast response once a differential voltage occurs on the input pins. Besides, the SGM8780-1 has an N-type MOSFET output stage. It can be configured as open-drain output, but it is different from most open-drain comparators. The output (D_OUT) pin can be connected to a maximum voltage of 50V. Most universal comparators outputs do not support high voltage connection exceed power supply.

The SGM8780-1 is designed with a control pin $\overline{EN}$. This pin can enable or disable the output stage. If the $\overline{EN}$ pin is tied to high, the SGM8780-1 will enter shutdown mode and the output will maintain high impedance.

The $\overline{EN}$ pin defaults to low because this pin has an internal 200kΩ pull-down resistor.

APPLICATION INFORMATION

The SGM8780-1 is a high voltage comparator. It has 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 SGM8780-1 is ideal for voltage level shifting due to its wide supply range and ability to handle high voltages.

Typical Application

The Figure 4 shows the SGM8780-1 used as an inverting input comparator. For this application, the key design parameters are listed in Table 1.

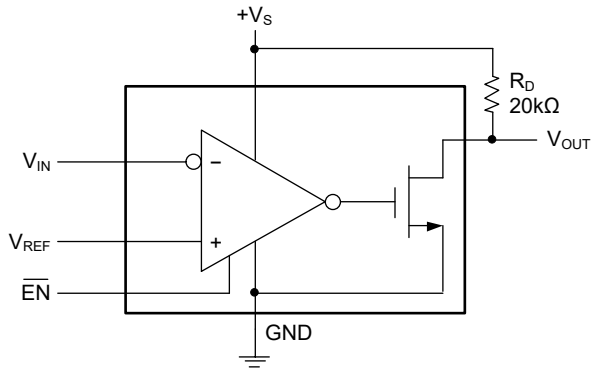


Figure 4. Inverting Input Comparator

Table 1. Key Design Parameters

PARAMETER	MIN	TYP	MAX	UNITS
Positive Supply Voltage (+V_S)			30	V
Input Voltage Range (V_{IN})	0		28	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 SGM8780-1 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 SGM8780-1 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 SGM8780-1 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 SGM8780-1 is configured as an open-drain output, the positive propagation delay time (τ_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 (τ_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

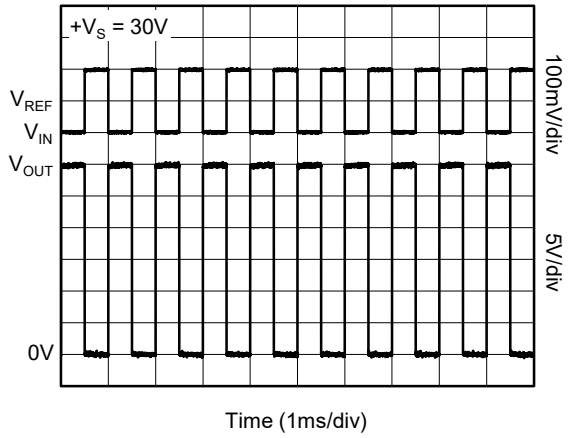


Figure 5. Output Waveform of Inverting Input Comparator

Power Supply Recommendations

The SGM8780-1 has a recommended operating voltage range of 3.4V to 30V single supply. 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

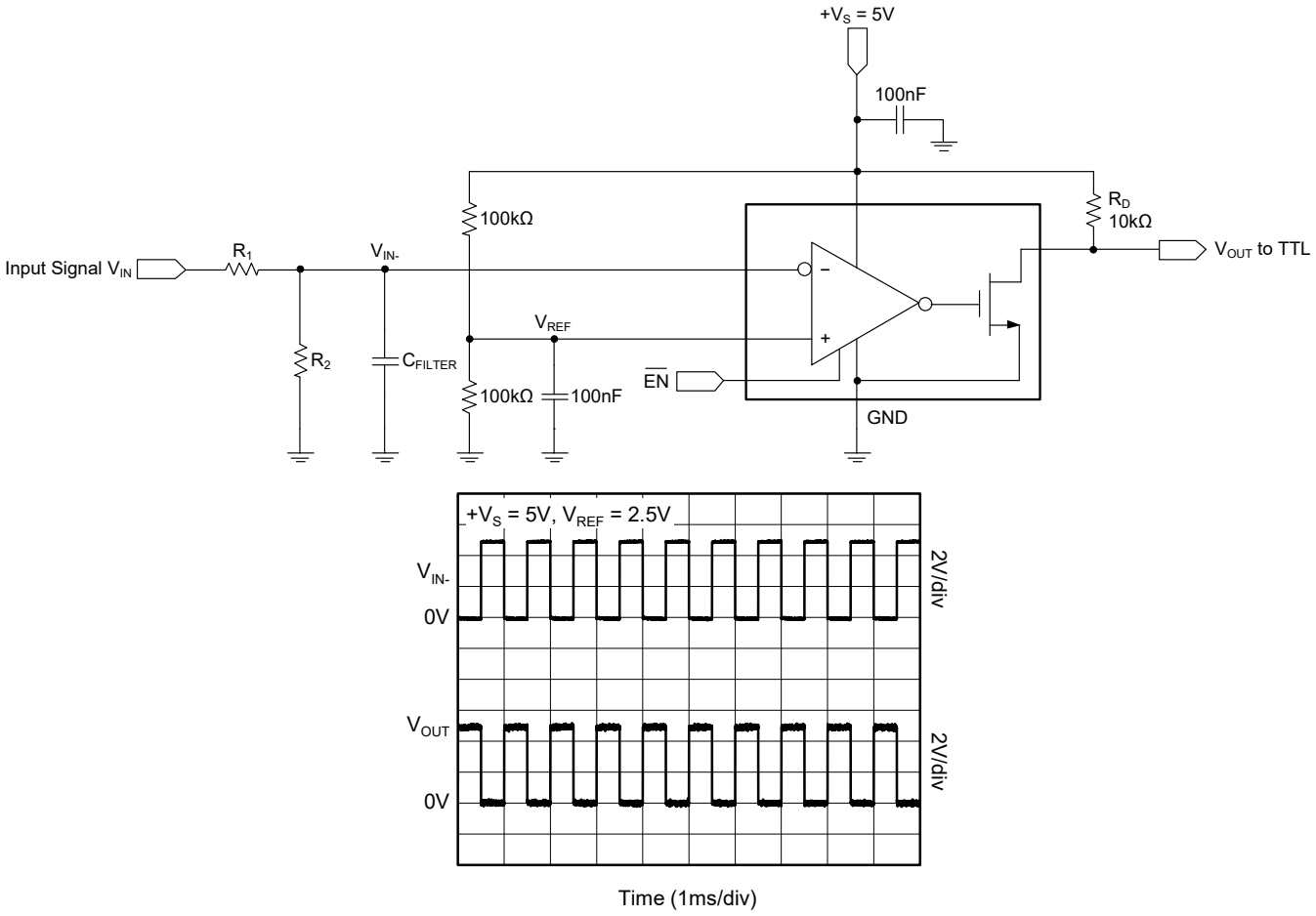


Figure 6. TTL Interface with High Voltage Input

TYPICAL APPLICATION CIRCUITS (continued)

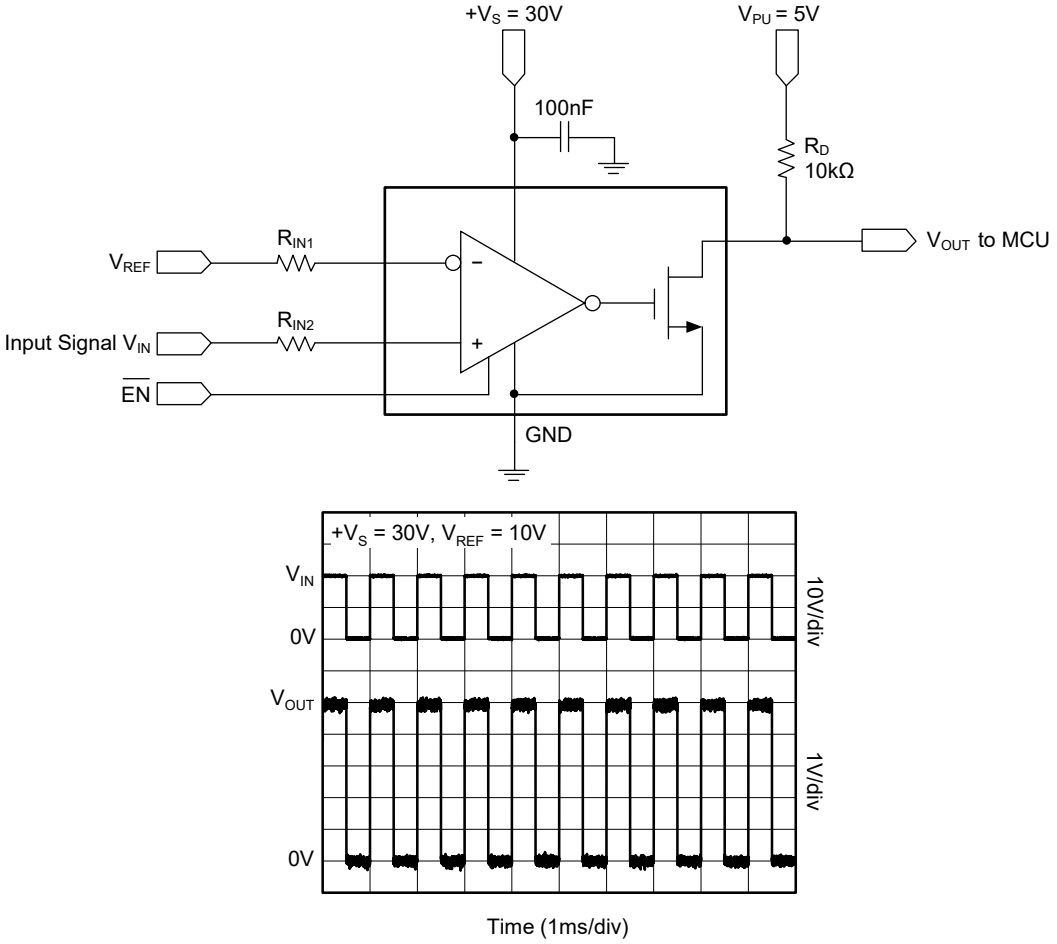


Figure 7. The Application of Low Voltage Output

TYPICAL APPLICATION CIRCUITS (continued)

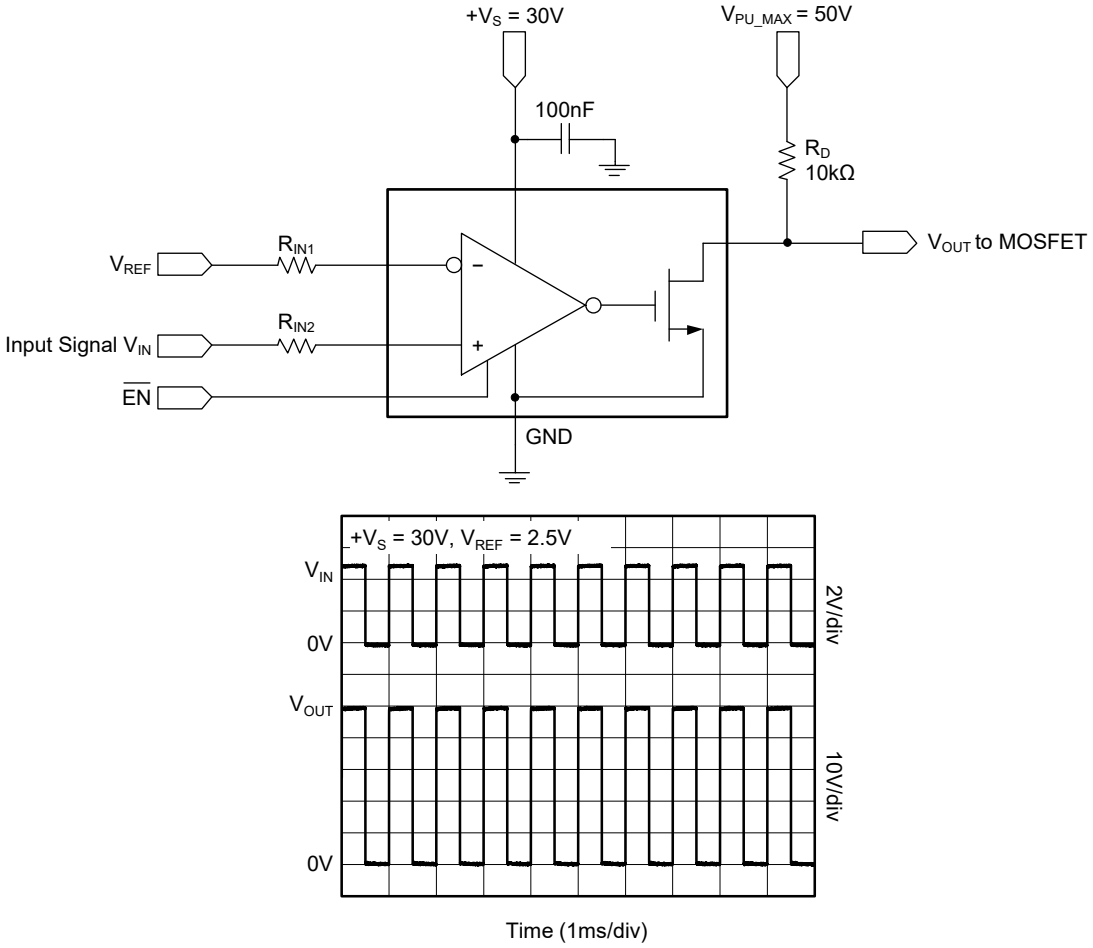


Figure 8. The Application of High Voltage Output

TYPICAL APPLICATION CIRCUITS (continued)

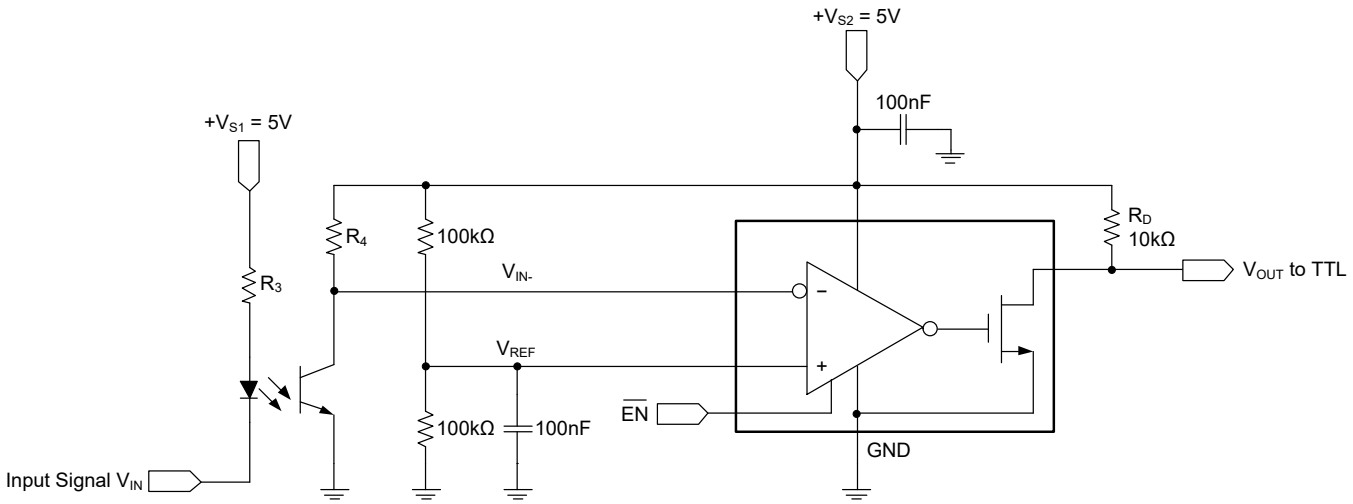


Figure 9. Digital Transmission Isolator

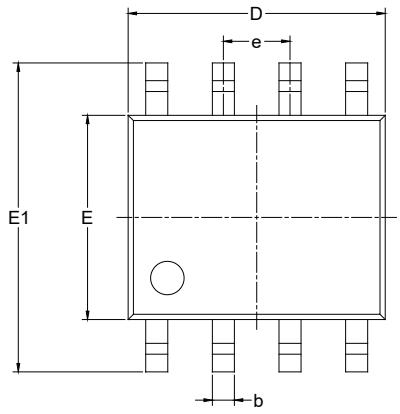
REVISION HISTORY

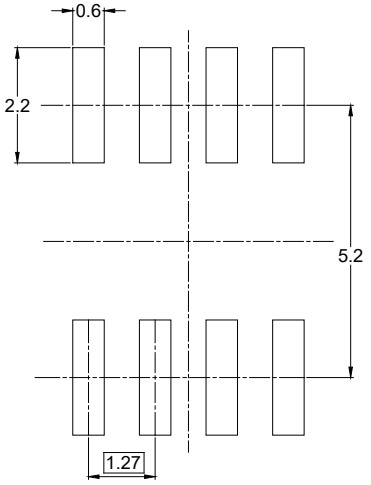
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

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

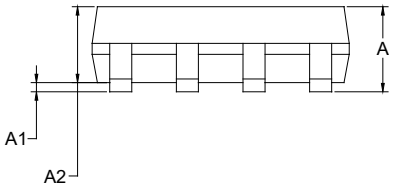
PACKAGE OUTLINE DIMENSIONS

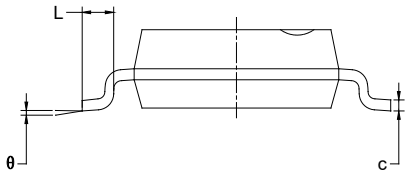
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)



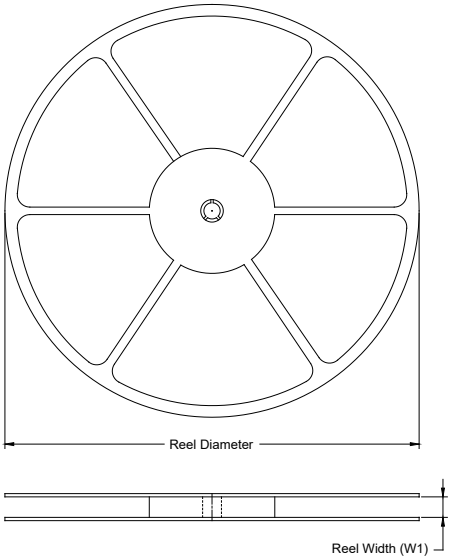


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

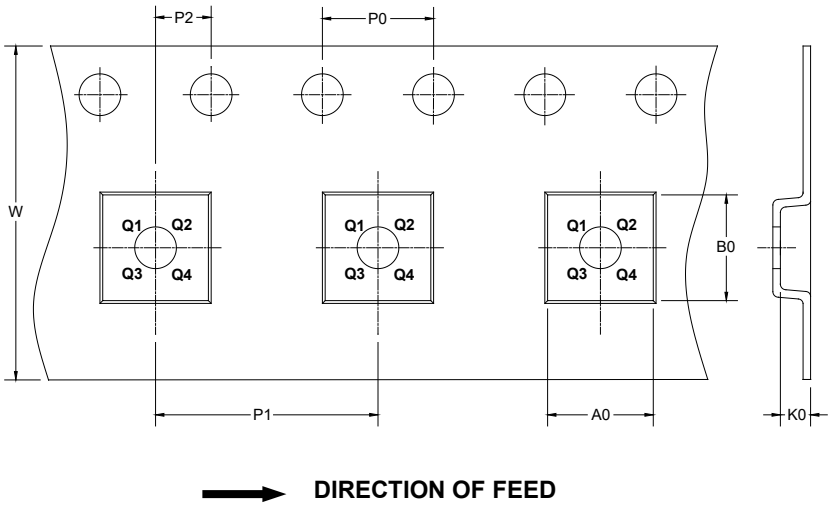
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



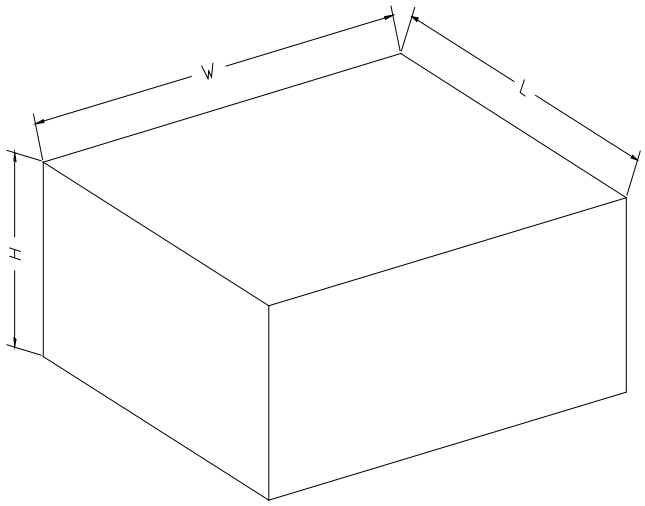
NOTE: The picture is only for reference. Please make the object as the standard.

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