



# SGM7222

## High Speed USB 2.0 (480Mbps) DPDT Analog Switch

### GENERAL DESCRIPTION

The SGM7222 is a DPDT (double-pole/double-throw) analog switch. It operates from a 1.8V to 4.3V single power supply. Each switch of the SGM7222 is bidirectional, which can ensure that the high speed signals have little or no attenuation at the outputs.

The SGM7222 features high speed, low bit-to-bit skew and wide bandwidth. The high performances make it very suitable for multiple applications, such as cellular phones and computer peripherals, etc.

The SGM7222 has a power-off protection. It can prevent accidental signal leakage and ensure system reliability under power-down and over-voltage conditions. In addition, the device is capable of withstanding a  $V_{BUS}$  short to D+ or D- when the device is either powered on or powered off because of the special circuitry on the D+/D- pins.

The SGM7222 is available in Green TQFN-1.8×1.4-10L, MSOP-10 and UTQFN-1.8 × 1.4-10L packages. It operates over an ambient temperature range of -40°C to +85°C.

### APPLICATIONS

Cellular Phones  
Digital Cameras  
Portable Equipment  
Computer Peripherals  
Battery-Powered Systems  
Routes Signals for USB 2.0 Full-Speed

### FEATURES

- **Supply Voltage Range:** 1.8V to 4.3V
- **On-Resistance:** 4.5Ω (TYP) at 3V
- **High Off-Isolation:** -35dB ( $R_L = 50\Omega$ ,  $f = 250\text{MHz}$ )
- **Low Crosstalk:** -41dB ( $R_L = 50\Omega$ ,  $f = 250\text{MHz}$ )
- **Low Bit-to-Bit Skew:** 50ps (TYP)
- **-3dB Bandwidth:** 550MHz
- **Fast Switching Times:**
  - $t_{ON}$ : 10ns (TYP)
  - $t_{OFF}$ : 22ns (TYP)
- **Break-Before-Make Switching**
- **Rail-to-Rail Input and Output Operation**
- **Power-Off and Power-On Protections**
- **-40°C to +85°C Operating Temperature Range**
- **Available in Green MSOP-10, TQFN-1.8×1.4-10L and UTQFN-1.8×1.4-10L Packages**

## PACKAGE/ORDERING INFORMATION

| MODEL   | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER  | PACKAGE MARKING           | PACKING OPTION      |
|---------|---------------------|-----------------------------|------------------|---------------------------|---------------------|
| SGM7222 | MSOP-10             | -40°C to +85°C              | SGM7222YMS10/TR  | SGM7222<br>YMS10<br>XXXXX | Tape and Reel, 3000 |
|         | TQFN-1.8×1.4-10L    | -40°C to +85°C              | SGM7222YWQ10/TR  | 7222                      | Tape and Reel, 3000 |
|         | UTQFN-1.8×1.4-10L   | -40°C to +85°C              | SGM7222YUWQ10/TR | CAA<br>XXX                | Tape and Reel, 3000 |

## MARKING INFORMATION

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

## MSOP-10

XXXXX

Vendor Code  
Date Code - Week  
Date Code - Year

## UTQFN-1.8×1.4-10L

YYY  
XXX

Serial Number  
Trace Code  
Date Code - Year

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

V<sub>+</sub> to GND .....0V to 4.6V  
 Analog, Digital Voltage Range ..... -0.3V to (V<sub>+</sub>) + 0.3V  
 Continuous Current HSDn or Dn ..... ±100mA  
 Peak Current HSDn or Dn ..... ±150mA  
 Junction Temperature ..... +150°C  
 Storage Temperature Range ..... -65°C to +150°C  
 Lead Temperature (Soldering, 10s) ..... +260°C  
 ESD Susceptibility  
 HBM.....8000V  
 MM.....400V

## RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range ..... -40°C to +85°C

## 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.

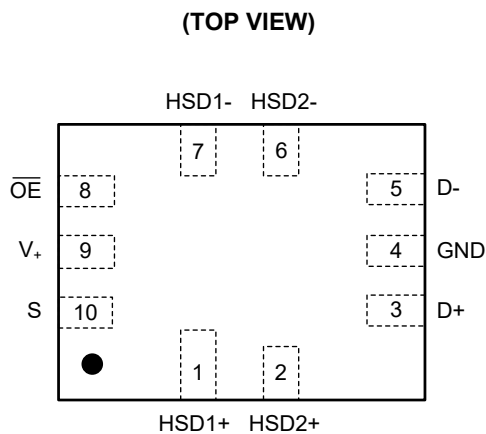
## ESD SENSITIVITY CAUTION

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.

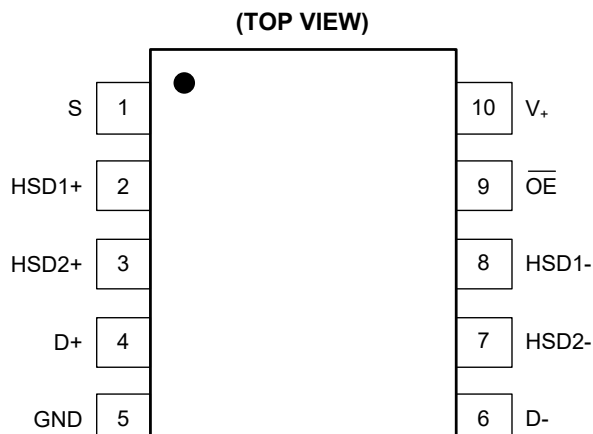
## DISCLAIMER

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

## PIN CONFIGURATIONS



TQFN-1.8×1.4-10L/UTQFN-1.8×1.4-10L



MSOP-10

## PIN DESCRIPTION

| PIN                                    |         | NAME                   | FUNCTION               |
|----------------------------------------|---------|------------------------|------------------------|
| TQFN-1.8×1.4-10L/<br>UTQFN-1.8×1.4-10L | MSOP-10 |                        |                        |
| 1, 2                                   | 2, 3    | HSD1+, HSD2+           | Data Ports.            |
| 3, 5                                   | 4, 6    | D+, D-                 |                        |
| 7, 6                                   | 8, 7    | HSD1-, HSD2-           |                        |
| 4                                      | 5       | GND                    | Ground.                |
| 8                                      | 9       | $\overline{\text{OE}}$ | Enable Control Pin.    |
| 9                                      | 10      | V+                     | Positive Power Supply. |
| 10                                     | 1       | S                      | Select Input Pin.      |

## FUNCTION TABLE

| $\overline{\text{OE}}$ | S | HSD1+<br>HSD1- | HSD2+<br>HSD2- |
|------------------------|---|----------------|----------------|
| 0                      | 0 | ON             | OFF            |
| 0                      | 1 | OFF            | ON             |
| 1                      | x | OFF            | OFF            |

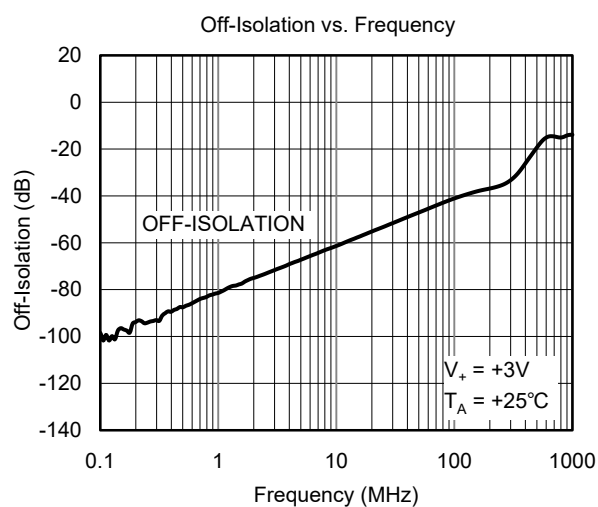
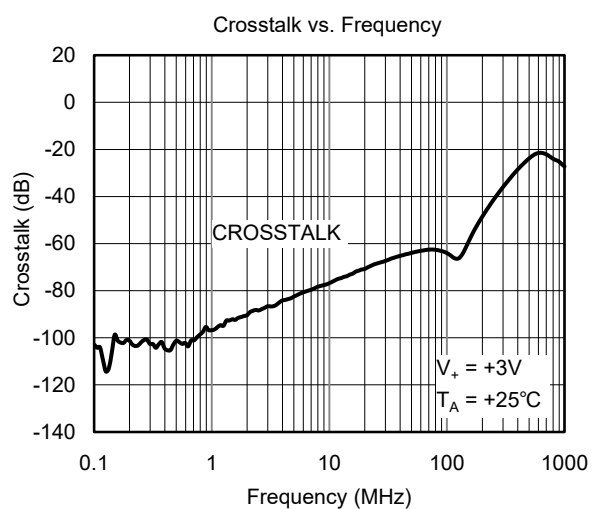
NOTE: Switches shown for logic "0" input.

## ELECTRICAL CHARACTERISTICS

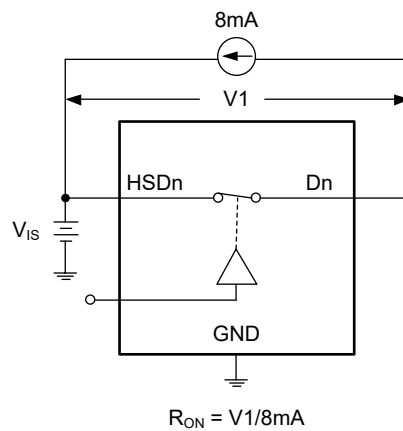
( $V_+ = 1.8\text{V}$  to  $4.3\text{V}$ ,  $\text{GND} = 0\text{V}$ ,  $V_{\text{IH}} = 1.6\text{V}$ ,  $V_{\text{IL}} = 0.5\text{V}$ , Full =  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$ . Typical values are at  $V_+ = 3.3\text{V}$ ,  $T_A = +25^\circ\text{C}$ , unless otherwise noted.)

| PARAMETER                                       | SYMBOL                                          | CONDITIONS                                                                                                                                       | TEMP                | MIN | TYP  | MAX   | UNITS         |
|-------------------------------------------------|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----|------|-------|---------------|
| <b>Analog Switch</b>                            |                                                 |                                                                                                                                                  |                     |     |      |       |               |
| Analog I/O Voltage (HSD1+, HSD1-, HSD2+, HSD2-) | $V_{\text{IS}}$                                 |                                                                                                                                                  | Full                | 0   |      | $V_+$ | V             |
| On-Resistance                                   | $R_{\text{ON}}$                                 | $V_+ = 3\text{V}$ , $V_{\text{IS}} = 0\text{V}$ to $0.4\text{V}$ , $I_{\text{D}} = 8\text{mA}$ , Test Circuit 1                                  | $+25^\circ\text{C}$ |     | 4.5  | 8.5   | $\Omega$      |
|                                                 |                                                 |                                                                                                                                                  | Full                |     |      | 9     |               |
| On-Resistance Match Between Channels            | $\Delta R_{\text{ON}}$                          | $V_+ = 3\text{V}$ , $V_{\text{IS}} = 0\text{V}$ to $0.4\text{V}$ , $I_{\text{D}} = 8\text{mA}$ , Test Circuit 1                                  | $+25^\circ\text{C}$ |     | 0.15 | 0.6   | $\Omega$      |
|                                                 |                                                 |                                                                                                                                                  | Full                |     |      | 1.6   |               |
| On-Resistance Flatness                          | $R_{\text{FLAT(ON)}}$                           | $V_+ = 3\text{V}$ , $V_{\text{IS}} = 0\text{V}$ to $1\text{V}$ , $I_{\text{D}} = 8\text{mA}$ , Test Circuit 1                                    | $+25^\circ\text{C}$ |     | 1.5  | 2.0   | $\Omega$      |
|                                                 |                                                 |                                                                                                                                                  | Full                |     |      | 2.6   |               |
| Power Off Leakage Current (D+, D-)              | $I_{\text{OFF}}$                                | $V_+ = 0\text{V}$ , $V_{\text{D}} = 0\text{V}$ to $3.6\text{V}$ , $V_{\text{S}}$ , $V_{\text{OE}} = 0\text{V}$ or $3.6\text{V}$                  | Full                |     |      | 1     | $\mu\text{A}$ |
| Increase in $I_+$ per Control Voltage           | $I_{\text{CCT}}$                                | $V_+ = 3.6\text{V}$ , $V_{\text{S}}$ or $V_{\text{OE}} = 2.6\text{V}$                                                                            | Full                |     |      | 5     | $\mu\text{A}$ |
| Source Off Leakage Current                      | $I_{\text{HSD2(OFF)}}$ , $I_{\text{HSD1(OFF)}}$ | $V_+ = 3.6\text{V}$ , $V_{\text{IS}} = 3.3\text{V}/0.3\text{V}$ , $V_{\text{D}} = 0.3\text{V}/3.3\text{V}$                                       | Full                |     |      | 1     | $\mu\text{A}$ |
| Channel On Leakage Current                      | $I_{\text{HSD2(ON)}}$ , $I_{\text{HSD1(ON)}}$   | $V_+ = 3.6\text{V}$ , $V_{\text{IS}} = 3.3\text{V}/0.3\text{V}$ , $V_{\text{D}} = 3.3\text{V}/0.3\text{V}$ or floating                           | Full                |     |      | 1     | $\mu\text{A}$ |
| <b>Digital Inputs</b>                           |                                                 |                                                                                                                                                  |                     |     |      |       |               |
| Input High Voltage                              | $V_{\text{IH}}$                                 |                                                                                                                                                  | Full                | 1.6 |      |       | V             |
| Input Low Voltage                               | $V_{\text{IL}}$                                 |                                                                                                                                                  | Full                |     |      | 0.5   | V             |
| Input Leakage Current                           | $I_{\text{IN}}$                                 | $V_+ = 3\text{V}$ , $V_{\text{S}}$ , $V_{\text{OE}} = 0\text{V}$ or $V_+$                                                                        | Full                |     |      | 1     | $\mu\text{A}$ |
| <b>Dynamic Characteristics</b>                  |                                                 |                                                                                                                                                  |                     |     |      |       |               |
| Turn-On Time                                    | $t_{\text{ON}}$                                 | $V_{\text{IS}} = 0.8\text{V}$ , $R_{\text{L}} = 50\Omega$ , $C_{\text{L}} = 10\text{pF}$ , Test Circuit 2                                        | $+25^\circ\text{C}$ |     | 10   |       | ns            |
| Turn-Off Time                                   | $t_{\text{OFF}}$                                |                                                                                                                                                  | $+25^\circ\text{C}$ |     | 22   |       | ns            |
| Break-Before-Make Time Delay                    | $t_{\text{D}}$                                  | $V_{\text{IS}} = 0.8\text{V}$ , $R_{\text{L}} = 50\Omega$ , $C_{\text{L}} = 10\text{pF}$ , Test Circuit 3                                        | $+25^\circ\text{C}$ |     | 4    |       | ns            |
| Propagation Delay                               | $t_{\text{PD}}$                                 | $R_{\text{L}} = 50\Omega$ , $C_{\text{L}} = 10\text{pF}$                                                                                         | $+25^\circ\text{C}$ |     | 0.3  |       | ns            |
| Off Isolation                                   | $O_{\text{ISO}}$                                | Signal = $0\text{dBm}$ , $R_{\text{L}} = 50\Omega$ , $f = 250\text{MHz}$ , Test Circuit 4                                                        | $+25^\circ\text{C}$ |     | -35  |       | dB            |
| Channel-to-Channel Crosstalk                    | $X_{\text{TALK}}$                               | Signal = $0\text{dBm}$ , $R_{\text{L}} = 50\Omega$ , $f = 250\text{MHz}$ , Test Circuit 5                                                        | $+25^\circ\text{C}$ |     | -41  |       | dB            |
| -3dB Bandwidth                                  | BW                                              | Signal = $0\text{dBm}$ , $R_{\text{L}} = 50\Omega$ , $C_{\text{L}} = 5\text{pF}$ , Test Circuit 6                                                | $+25^\circ\text{C}$ |     | 550  |       | MHz           |
| Channel-to-Channel Skew                         | $t_{\text{SKEW}}$                               | $R_{\text{L}} = 50\Omega$ , $C_{\text{L}} = 10\text{pF}$                                                                                         | $+25^\circ\text{C}$ |     | 0.05 |       | ns            |
| Charge Injection Select Input to Common I/O     | Q                                               | $V_{\text{G}} = \text{GND}$ , $C_{\text{L}} = 1\text{nF}$ , $R_{\text{G}} = 0\Omega$ , $Q = C_{\text{L}} \times V_{\text{OUT}}$ , Test Circuit 7 | $+25^\circ\text{C}$ |     | 11   |       | pC            |
| HSD+, HSD-, D+, D-On Capacitance                | $C_{\text{ON}}$                                 |                                                                                                                                                  | $+25^\circ\text{C}$ |     | 6.5  |       | pF            |
| <b>Power Requirements</b>                       |                                                 |                                                                                                                                                  |                     |     |      |       |               |
| Power Supply Range                              | $V_+$                                           |                                                                                                                                                  | Full                | 1.8 |      | 4.3   | V             |
| Power Supply Current                            | $I_+$                                           | $V_+ = 3\text{V}$ , $V_{\text{S}}$ , $V_{\text{OE}} = 0\text{V}$ or $V_+$                                                                        | Full                |     |      | 1     | $\mu\text{A}$ |

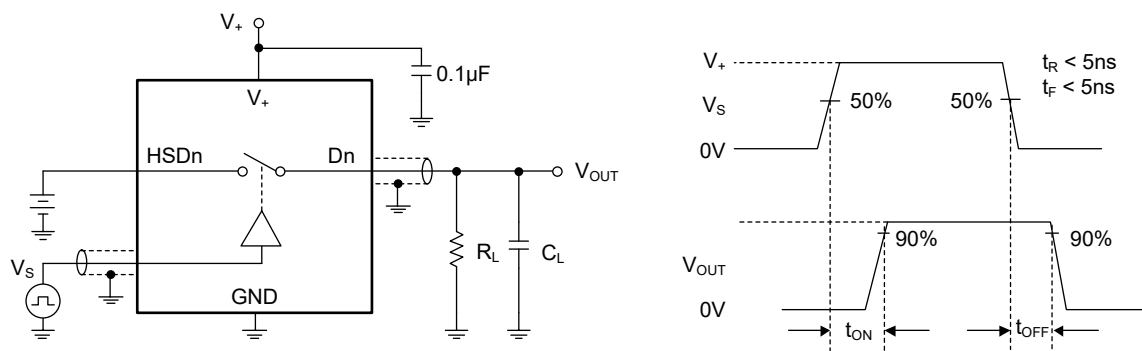
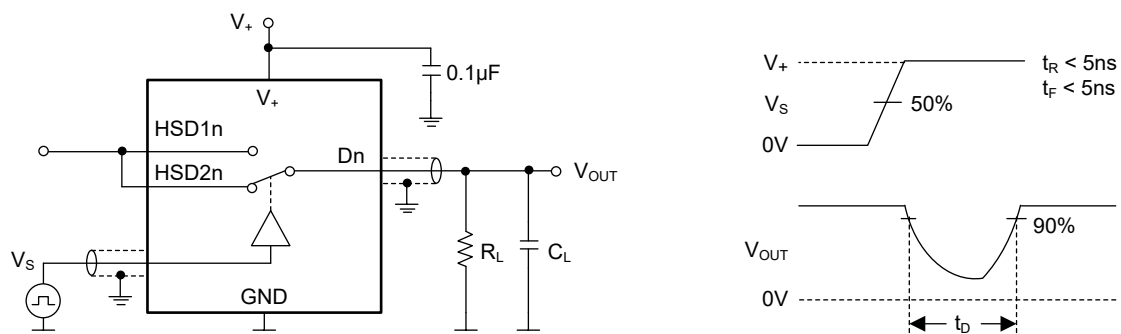
## TYPICAL PERFORMANCE CHARACTERISTICS



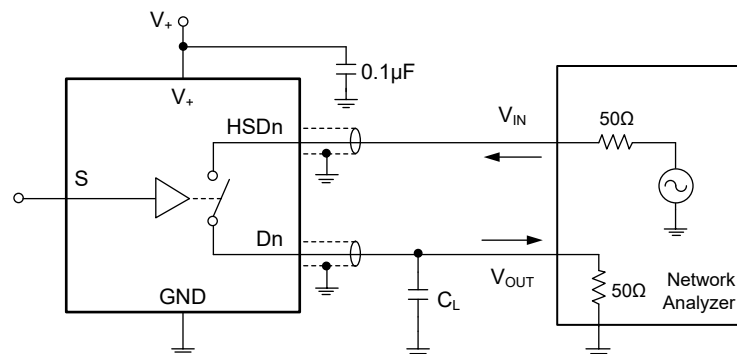
## TEST CIRCUITS



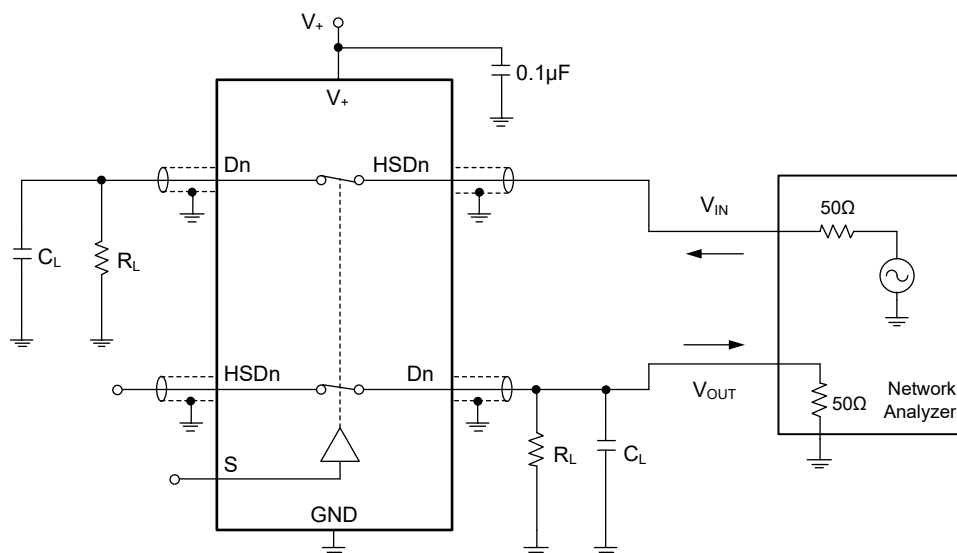
Test Circuit 1. On-Resistance

Test Circuit 2. Switching Times ( $t_{ON}$ ,  $t_{OFF}$ )Test Circuit 3. Break-Before-Make Time ( $t_D$ )

## TEST CIRCUITS (continued)



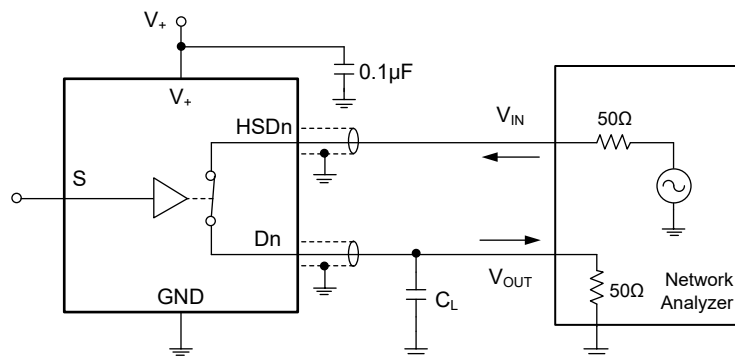
Test Circuit 4. Off Isolation



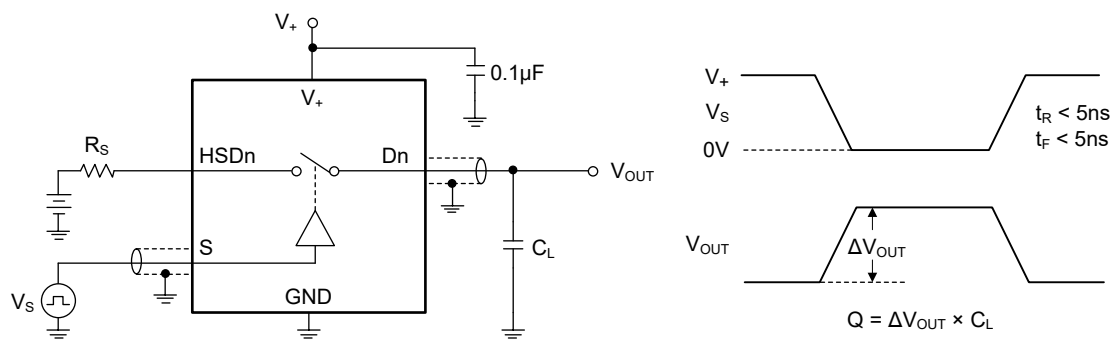
$$\text{Channel-to-Channel Crosstalk} = -20 \log (V_{\text{HSDn}}/V_{\text{OUT}})$$

Test Circuit 5. Channel-to-Channel Crosstalk

## TEST CIRCUITS (continued)



Test Circuit 6. -3dB Bandwidth



Test Circuit 7. Charge Injection (Q)

## APPLICATION INFORMATION

## Meet the Short Requirements of USB 2.0

 $V_{BUS}$ 

According to Section 7.1.1 of the USB 2.0 specification, USB devices must be able to withstand a  $V_{BUS}$  short to D+ or D- when powered on or off. The SGM7222 can fully meet these two requirements

## Power-Off Protection

When D+ or D- is shorted to  $V_{BUS}$ , there is a special protection circuit inside the SGM7222, so that the device will not be damaged within 24 hours. In case of power-down or over-voltage event, the protection circuit can prevent the leakage signal on D+/D- pins to ensure the reliability of the system.

## Power-On Protection

The USB 2.0 specification requires USB device to ensure that the device will not be damaged even if  $V_{BUS}$  short-circuit occurs during data transmission. Therefore, under over-voltage conditions, the SGM7222 will limit the current flowing back to the  $V_+$  track, and the current will not exceed the safe operating range.

## USB2.0 Signal Quality Compliance Test Results

The results of USB eye map test are shown in Figure 1 and Figure 2. Table 1 gives a summary of the USB tests.

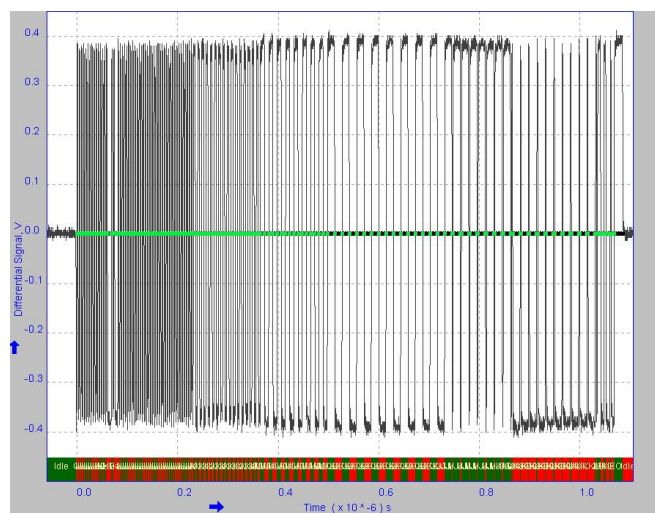


Figure 1. Waveform Plot

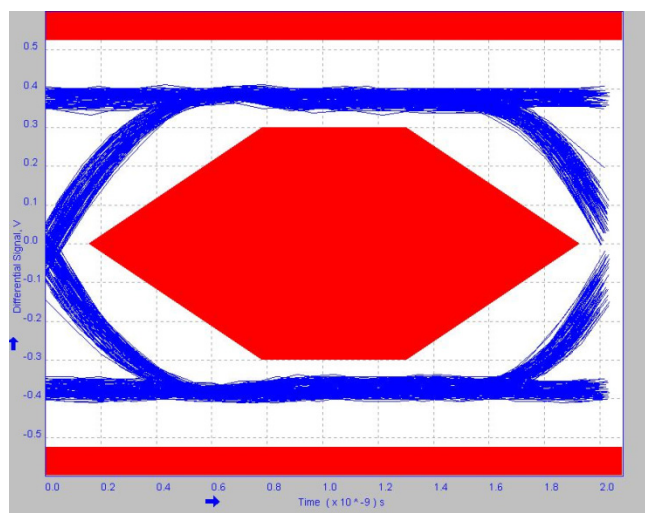
Figure 2. High Speed Signal Quality Eye Diagram Test  
( $V_+ = 3.3V$ )

Table 1. Summary of the USB 2.0 Signal Quality Tests Results

| Measurement Name  | MIN            | MAX            | Mean           | pk-pk         | Standard Deviation | RMS            | Population | Status |
|-------------------|----------------|----------------|----------------|---------------|--------------------|----------------|------------|--------|
| Eye Diagram Test  | -              | -              | -              | -             | -                  | -              | -          | Pass   |
| Signal Rate       | 469.9358 Mbps  | 493.4413 Mbps  | 479.9700 Mbps  | 0.0000 bps    | 5.586580 Mbps      | 480.4200 Mbps  | 512        | Pass   |
| EOP Width         | -              | -              | 16.58804ns     | -             | -                  | -              | 1          | Pass   |
| EOP Width (Bits)  | -              | -              | 7.961762       | -             | -                  | -              | 1          | Pass   |
| Falling Edge Rate | 1.064231 kV/μs | 1.228955 kV/μs | 1.143136 kV/μs | 164.7235 V/μs | 35.43800 V/μs      | 1.143680 kV/μs | 107        | Pass   |
| Rising Edge Rate  | 1.063269 kV/μs | 1.227966 kV/μs | 1.136558 kV/μs | 164.6970 V/μs | 31.49494 V/μs      | 1.136990 kV/μs | 108        | Pass   |

## Additional Information:

Consecutive Jitter range: -82.97ps to 72.87ps RMS Jitter 35.08ps

KJ Paired Jitter range: -25.05ps to 23.05ps RMS Jitter 9.259ps

JK Paired Jitter range: -20.96ps to 30.12ps RMS Jitter 9.734ps

- Rising Edge Rate: 1.136558kV/μs (Equivalent Rise Time = 563.10ps)
- Falling Edge Rate: 1.143136kV/μs (Equivalent Fall Time = 559.86ps)

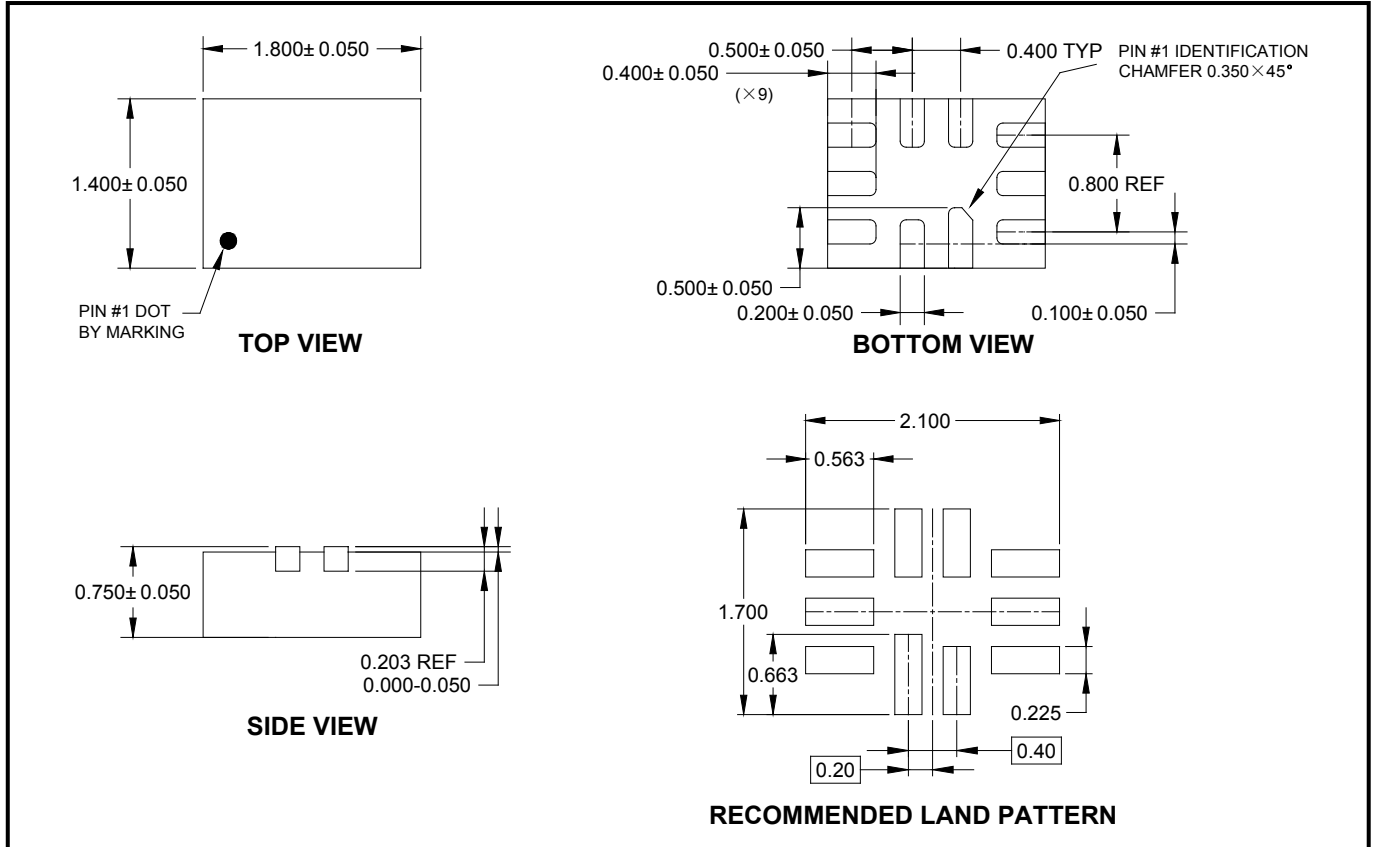
**REVISION HISTORY**

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

| <b>JUNE 2021 – REV.B.3 to REV.B.4</b>                 | <b>Page</b> |
|-------------------------------------------------------|-------------|
| Updated Package Outline Dimensions section .....      | 13          |
| <b>APRIL 2019 – REV.B.2 to REV.B.3</b>                | <b>Page</b> |
| Updated Package/Ordering Information section .....    | 2           |
| <b>MAY 2014 – REV.B.1 to REV.B.2</b>                  | <b>Page</b> |
| Updated Absolute Maximum Ratings section .....        | 2           |
| <b>JANUARY 2013 – REV.B to REV.B.1</b>                | <b>Page</b> |
| Added Recommended Land Pattern section .....          | 12, 13, 14  |
| Added Tape and Reel Information section .....         | 15, 16      |
| <b>MAY 2011 – REV.A.3 to REV.B</b>                    | <b>Page</b> |
| Updated package option .....                          | All         |
| <b>MARCH 2011 – REV.A.2 to REV.A.3</b>                | <b>Page</b> |
| Updated Package Outline Dimensions section .....      | 12, 13, 14  |
| <b>FEBRUARY 2010 – REV.A.1 to REV.A.2</b>             | <b>Page</b> |
| Updated Test Circuits section .....                   | 6, 8        |
| <b>SEPTEMBER 2009– REV.A to REV.A.1</b>               | <b>Page</b> |
| Added new package.....                                | All         |
| Updated Absolute Maximum Ratings section .....        | 2           |
| <b>Changes from Original (DECEMBER 2008) to REV.A</b> | <b>Page</b> |
| Changed from product preview to production data ..... | All         |

## PACKAGE OUTLINE DIMENSIONS

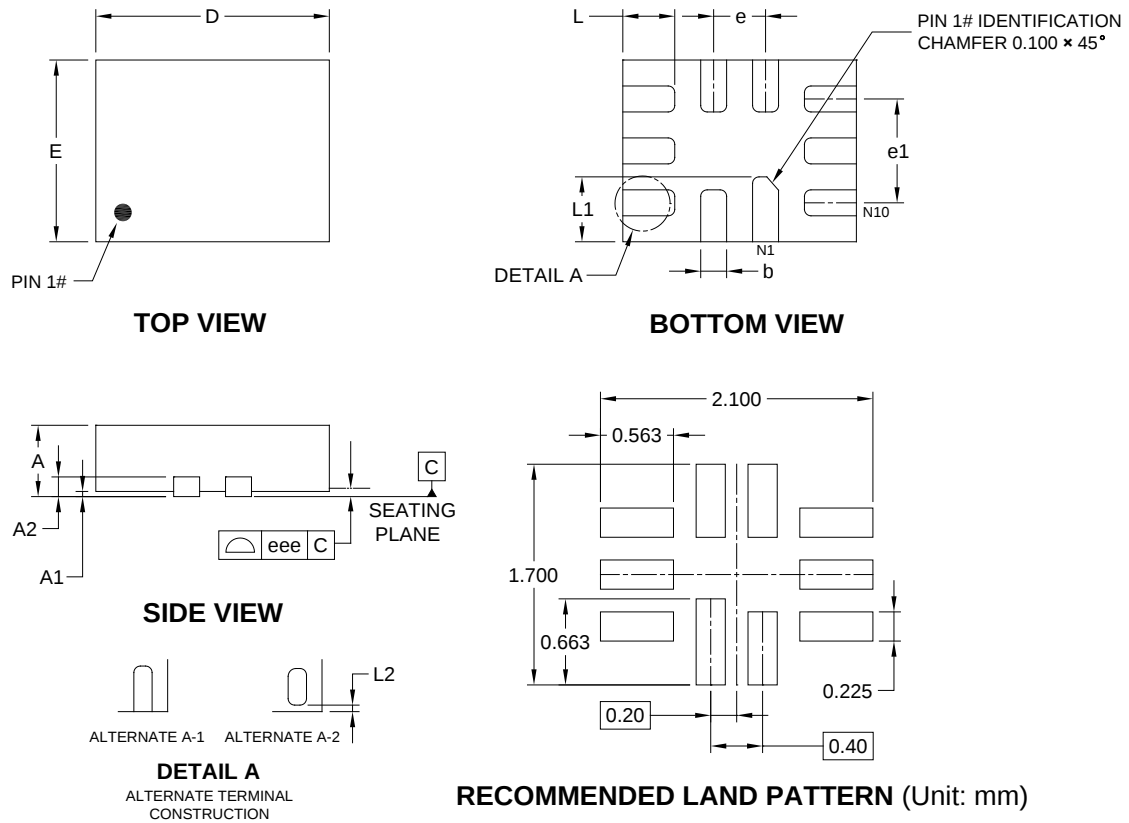
### TQFN-1.8×1.4-10L



NOTE: All linear dimensions are in millimeters.

## PACKAGE OUTLINE DIMENSIONS

### UTQFN-1.8×1.4-10L

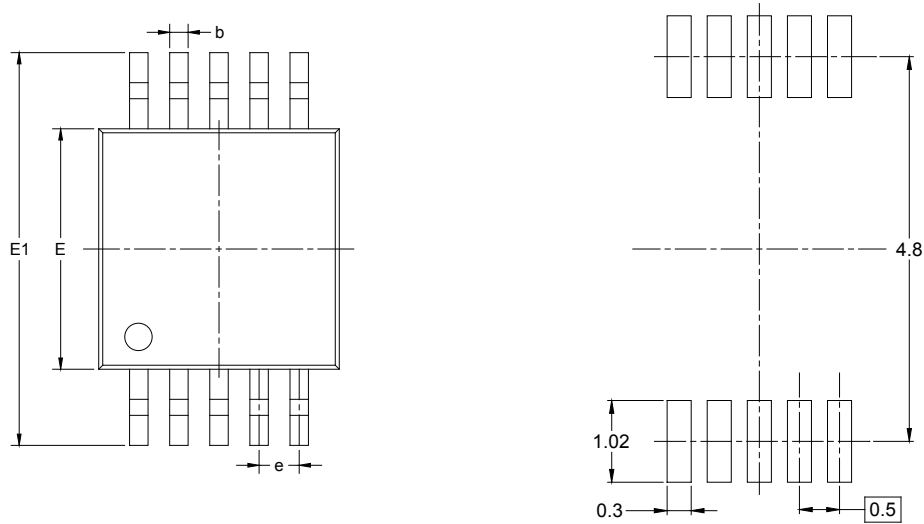


| Symbol | Dimensions In Millimeters |       |       |
|--------|---------------------------|-------|-------|
|        | MIN                       | MOD   | MAX   |
| A      | 0.450                     | -     | 0.600 |
| A1     | 0.000                     | -     | 0.050 |
| A2     | 0.152 REF                 |       |       |
| b      | 0.150                     | 0.200 | 0.250 |
| D      | 1.750                     | 1.800 | 1.850 |
| E      | 1.350                     | 1.400 | 1.450 |
| e      | 0.400 TYP                 |       |       |
| e1     | 0.800 REF                 |       |       |
| L      | 0.350                     | 0.400 | 0.450 |
| L1     | 0.450                     | 0.500 | 0.550 |
| L2     | 0.000                     | -     | 0.100 |
| eee    | -                         | 0.080 | -     |

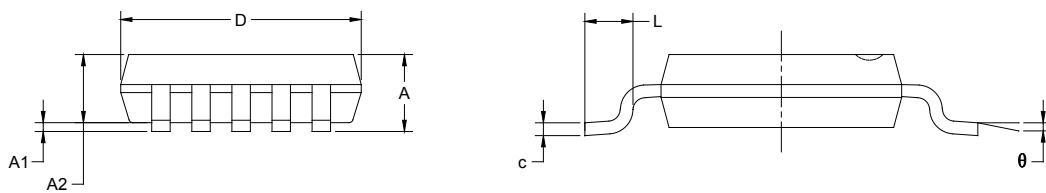
NOTE: This drawing is subject to change without notice.

## PACKAGE OUTLINE DIMENSIONS

### MSOP-10



RECOMMENDED LAND PATTERN (Unit: mm)

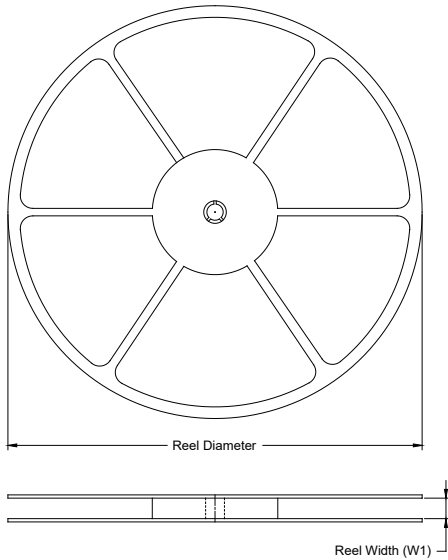


| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 0.820                        | 1.100 | 0.032                   | 0.043 |
| A1     | 0.020                        | 0.150 | 0.001                   | 0.006 |
| A2     | 0.750                        | 0.950 | 0.030                   | 0.037 |
| b      | 0.180                        | 0.280 | 0.007                   | 0.011 |
| c      | 0.090                        | 0.230 | 0.004                   | 0.009 |
| D      | 2.900                        | 3.100 | 0.114                   | 0.122 |
| E      | 2.900                        | 3.100 | 0.114                   | 0.122 |
| E1     | 4.750                        | 5.050 | 0.187                   | 0.199 |
| e      | 0.500 BSC                    |       | 0.020 BSC               |       |
| L      | 0.400                        | 0.800 | 0.016                   | 0.031 |
| θ      | 0°                           | 6°    | 0°                      | 6°    |

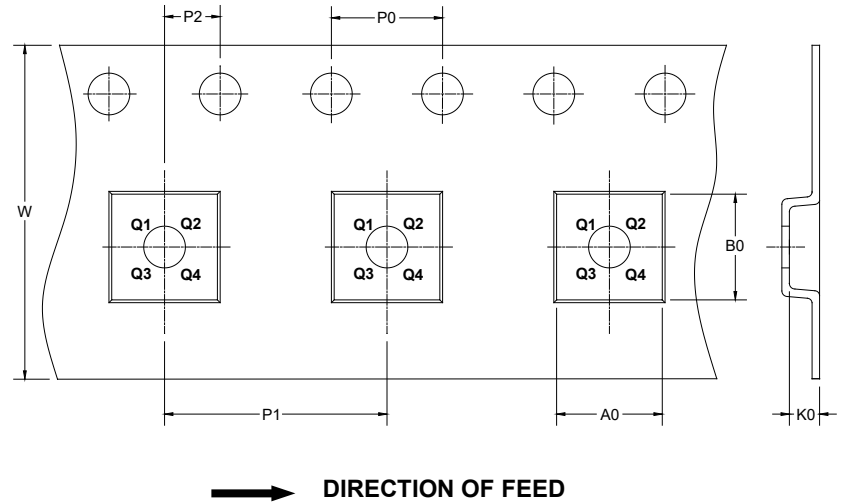
# PACKAGE INFORMATION

## TAPE AND REEL INFORMATION

### REEL DIMENSIONS



### TAPE DIMENSIONS



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

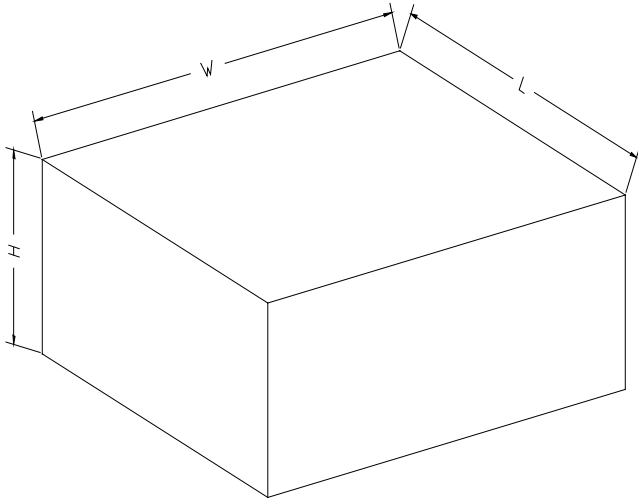
### KEY PARAMETER LIST OF TAPE AND REEL

| Package Type      | Reel Diameter | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|-------------------|---------------|--------------------|---------|---------|---------|---------|---------|---------|--------|---------------|
| TQFN-1.8×1.4-10L  | 7"            | 9.0                | 1.75    | 2.10    | 1.00    | 4.0     | 4.0     | 2.0     | 8.0    | Q1            |
| UTQFN-1.8×1.4-10L | 7"            | 9.0                | 1.75    | 2.10    | 0.70    | 4.0     | 4.0     | 2.0     | 8.0    | Q1            |
| MSOP-10           | 13"           | 12.4               | 5.20    | 3.30    | 1.20    | 4.0     | 8.0     | 2.0     | 12.0   | Q1            |

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## PACKAGE INFORMATION

### 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 |
|-------------|-------------|------------|-------------|--------------|
| 7" (Option) | 368         | 227        | 224         | 8            |
| 7"          | 442         | 410        | 224         | 18           |
| 13"         | 386         | 280        | 370         | 5            |

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