# SGM3705
# 0.2Ω, Low THD+N, Wide Positive and Negative Signal Passing, Dual SPST Analog Switch

## GENERAL DESCRIPTION

The SGM3705 is a dual SPST (single-pole/single-throw) analog switch with low distortion. It operates from a 2.7V to 5.5V single power supply. The SGM3705 allows a -18V to +18V wide range positive and negative signal passing for 2.7V to 5.5V power supply range.

Other features include ultra-low on-resistance, low voltage and fast switching times. The high performances make it very suitable for multiple applications, such as portable equipment, battery-powered systems, etc. In addition, the SGM3705 can be used as a dual 2-to-1 multiplexer, two single signals or one differential signal switch and power switches.

The SGM3705 is available in Green TQFN-4×4-16L and WLCSP-2.11×2.2-12B packages. It operates over an operating temperature range of -40℃ to +85℃.

## FEATURES

- **Single Supply Voltage Range: 2.7V to 5.5V**
- **On-Resistance:**
  **0.2Ω (TYP) in WLCSP-2.11×2.2-12B Package**
- **-18V to +18V Low Distortion, Analog Signal Passing**
- **Fast Switching Times**
- **High Off-Isolation**
- **Very Low Crosstalk**
- **Low Input Leakage Current**
- **1.2V, 1.8V Logic Compatible Control Pin**
- **Break-Before-Make Switching**
- **-40℃ to +85℃ Operating Temperature Range**
- **Available in Green TQFN-4×4-16L and WLCSP-2.11×2.2-12B Packages**

## APPLICATIONS

Portable Equipment
Sample-and-Hold Circuits
Battery-Powered Systems
HiFi Audio Switch

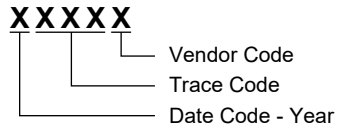
# PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---|---|---|---|---|---|
| SGM3705 | TQFN-4×4-16L | -40℃ to +85℃ | SGM3705YTQE16G/TR | SGM3705<br>YTQE16<br>XXXXX | Tape and Reel, 3000 |
| | WLCSP-2.11×2.2-12B | -40℃ to +85℃ | SGM3705YG/TR | 3705<br>XXXXX<br>XX#XX | Tape and Reel, 3000 |

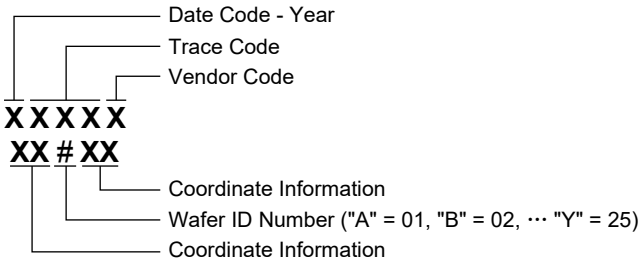
## MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code. XX#XX = Coordinate Information and Wafer ID Number.

**TQFN-4×4-16L**




**WLCSP-2.11×2.2-12B**




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

$V_{CC}$ to GND ..... 0V to 6V
IN1, IN2, EN to GND ..... 0V to 6V
Analog Voltage Range ..... -19V to +19V
Continuous Current from Sx to Dx ..... ±800mA
Peak Current from Sx to Dx ..... ±2000mA
I/O Clamp Current ($V_I$ < 0) ..... -30mA
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM ..... 3000V
CDM ..... 1000V

## RECOMMENDED OPERATING CONDITIONS

Supply Voltage Range ..... 2.7V to 5.5V
Operating Temperature Range ..... -40℃ to +85℃

## 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

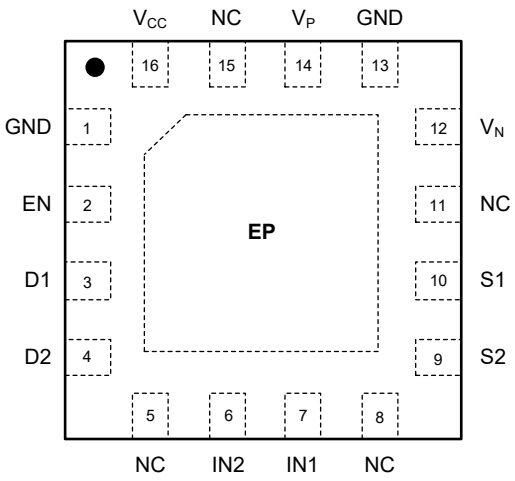
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

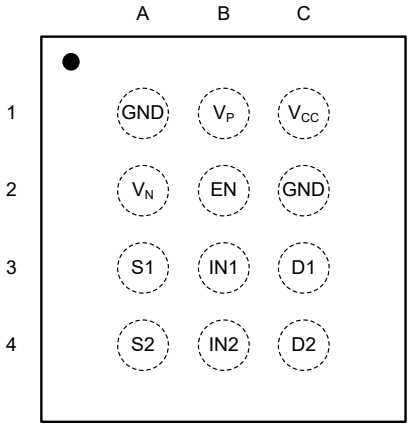
## PIN CONFIGURATIONS

(TOP VIEW)




TQFN-4×4-16L

(TOP VIEW)




WLCSP-2.11×2.2-12B

## PIN DESCRIPTION

| PIN | | NAME | FUNCTION |
|---|---|---|---|
| TQFN-4×4-16L | WLCSP-2.11×2.2-12B | | |
| 1, 13 | A1, C2 | GND | Ground. |
| 2 | B2 | EN | Enable Control Pin. When EN = "Low", both Sx and Dx will be disconnected, charge pump doesn't work and the SGM3705 will be in shutdown state. When EN = "High", charge pump will work, the SGM3705 will be in working state, and Sx or Dx will be connected or disconnected depending on the logical state of INx. |
| 3 | C3 | D1 | Drain Terminal 1. This pin can be an input or an output of switch 1. |
| 4 | C4 | D2 | Drain Terminal 2. This pin can be an input or an output of switch 2. |
| 5, 8, 11, 15 | — | NC | No Connection. |
| 6 | B4 | IN2 | Digital Control Pin of Switch 2. When IN2 = "Low", switch 2 is turned off, and S2 and D2 are disconnected. When IN2 = "High", switch 2 is turned on, and S2 and D2 are connected. |
| 7 | B3 | IN1 | Digital Control Pin of Switch 1. When IN1 = "Low", switch 1 is turned off, and S1 and D1 are disconnected. When IN1 = "High", switch 1 is turned on, and S1 and D1 are connected. |
| 9 | A4 | S2 | Source Terminal 2. This pin can be an input or an output of switch 2. |
| 10 | A3 | S1 | Source Terminal 1. This pin can be an input or an output of switch 1. |
| 12 | A2 | $V_N$ | Negative Supply Voltage Output Pin. Connect a 10nF ceramic capacitor from $V_N$ pin to GND. |
| 14 | B1 | $V_P$ | Positive Supply Voltage Output Pin. Connect a 10nF ceramic capacitor from $V_P$ pin to GND. |
| 16 | C1 | $V_{CC}$ | Positive Power Supply Pin. It is recommended to use a 100nF or larger ceramic capacitor from $V_{CC}$ pin to ground to get good power supply decoupling. |
| Exposed Pad | — | EP | Exposed Pad. No Connection. This pad is not an electrical connection point. |

## FUNCTION TABLE

**Table 1. Function Table of Switch 1:**

| EN | IN1 | S1 and D1 | Negative Charge Pump |
|---|---|---|---|
| 0 | X | Disconnected | Turn Off |
| 1 | 0 | Disconnected | Turn On |
| 1 | 1 | Connected (S1 = D1) | Turn On |

**Table 2. Function Table of Switch 2:**

| EN | IN2 | S2 and D2 | Negative Charge Pump |
|---|---|---|---|
| 0 | X | Disconnected | Turn Off |
| 1 | 0 | Disconnected | Turn On |
| 1 | 1 | Connected (S2 = D2) | Turn On |

## ELECTRICAL CHARACTERISTICS

($V_{CC}$ = 3V, $C_P$ = $C_N$ = 10nF, Full = -40℃ to +85℃, typical values are at $T_A$ = +25℃, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | TEMP | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| **Analog Switch** | | | | | | | | |
| Analog Signal Range | $V_{ANALOG}$ | | | Full | -15V | | +15V | V |
| On-Resistance | $R_{ON}$ | $V_S$ = -15V, 0V, 15V, $I_S$ = -200mA | TQFN-4×4-16L | Full | | 0.23 | 0.33 | Ω |
| | | | WLCSP-2.11×2.2-12B | Full | | 0.2 | 0.27 | |
| On-Resistance Match between Channels | $\Delta R_{ON}$ | $V_S$ = -15V, 0V, 15V, $I_S$ = -200mA | TQFN-4×4-16L | Full | | 0.002 | 0.012 | Ω |
| | | | WLCSP-2.11×2.2-12B | Full | | 0.0006 | 0.01 | |
| On-Resistance Flatness | $R_{FLAT(ON)}$ | $V_S$ = -15V, 0V, 15V, $I_S$ = -200mA | TQFN-4×4-16L | Full | | 0.0003 | 0.0035 | Ω |
| | | | WLCSP-2.11×2.2-12B | Full | | 0.0002 | 0.0035 | |
| Source OFF Leakage Current | $I_{S(OFF)}$ | $V_S$ = -15V, 15V, $V_D$ = 15V, -15V | | Full | | | 1 | μA |
| Channel ON Leakage Current | $I_{S(ON)}$, $I_{D(ON)}$ | $V_S$ = -15V, 15V, $V_D$ = floating, or $V_S$ = floating, $V_D$ = -15V, 15V | | Full | | | 1 | μA |
| **Digital Inputs** | | | | | | | | |
| Logic High | $V_{INH}$ | $V_{CC}$ = 2.7V to 5.5V | | Full | 0.78 | | | V |
| Logic Low | $V_{INL}$ | $V_{CC}$ = 2.7V to 5.5V | | Full | | | 0.42 | V |
| Pull-Down Resistor | $R_{PULL-DOWN}$ | | | +25℃ | | 550 | | kΩ |
| **Dynamic Characteristics** | | | | | | | | |
| Turn-On Time | $t_{ON}$ | $V_S$ = 1V, $V_{IH}$ = 1.6V, $V_{IL}$ = 0V, $R_L$ = 50Ω, $C_L$ = 35pF, Test Circuit 1 | | +25℃ | | 290 | | ns |
| Turn-Off Time | $t_{OFF}$ | $V_S$ = 1V, $V_{IH}$ = 1.6V, $V_{IL}$ = 0V, $R_L$ = 50Ω, $C_L$ = 35pF, Test Circuit 1 | | +25℃ | | 1300 | | ns |
| Off-Isolation | $O_{ISO}$ | f = 1kHz, $R_L$ = 32Ω, Signal = 0dBm, Test Circuit 2 | | +25℃ | | -133 | | dB |
| | | f = 1MHz, $R_L$ = 50Ω, Signal = 0dBm, $C_L$ = 5pF, Test Circuit 2 | | +25℃ | | -60 | | |
| Channel-to-Channel Crosstalk | $X_{TALK}$ | f = 1kHz, $R_L$ = 32Ω, Signal = 0dBm, Test Circuit 3 | | +25℃ | | -119 | | dB |
| | | f = 1MHz, $R_L$ = 50Ω, Signal = 0dBm, $C_L$ = 5pF, Test Circuit 3 | | +25℃ | | -71 | | |
| -3dB Bandwidth | BW | Signal = 0dBm, $R_L$ = 50Ω, $C_L$ = 5pF, Test Circuit 4 | | +25℃ | | 140 | | MHz |
| Channel On Capacitance | $C_{ON}$ | f = 1MHz | | +25℃ | | 38 | | pF |
| Channel Off Capacitance | $C_{OFF}$ | f = 1MHz | | +25℃ | | 98 | | pF |
| Injection Select Input to Common I/O | Q | $V_G$ = GND, $R_G$ = 0Ω, $C_L$ = 1nF, Test Circuit 5 | | +25℃ | | 2550 | | pC |
| Total Harmonic Distortion + Noise | THD+N | A-Weighting, Test Circuit 6 | $V_S$ = $2V_{RMS}$, $R_L$ = 600Ω | +25℃ | | -118 | | dB |
| | | | $V_S$ = $2V_{PP}$, $R_L$ = 600Ω | +25℃ | | -115 | | |
| | | | $V_S$ = $2V_{PP}$, $R_L$ = 32Ω | +25℃ | | -114 | | |
| | | | $V_S$ = $1V_{PP}$, $R_L$ = 600Ω | +25℃ | | -112 | | |
| | | | $V_S$ = $1V_{PP}$, $R_L$ = 32Ω | +25℃ | | -110 | | |
| Start-Up Time | $t_{START}$ | Switch $V_{EN}$ = 0V to $V_{EN}$ = 1.6V, $C_P$ = $C_N$ = 10nF | | +25℃ | | 4.2 | | ms |
| **Power Requirements** | | | | | | | | |
| Power Supply Current | $I_{CC}$ | $V_{IN}$ = 0V, $V_{EN}$ = 1.6V | | Full | | 1070 | 1550 | μA |
| | | $V_{IN}$ = 1.6V, $V_{EN}$ = 1.6V | | Full | | 1200 | 1550 | |
| Power Supply Current in Shutdown State | $I_{CC}$ | $V_{IN}$ = 0V, $V_{EN}$ = 0V | | Full | | 0.75 | 1.7 | μA |
| | | $V_{IN}$ = 1.6V, $V_{EN}$ = 0V | | Full | | 2.3 | 4 | |

## ELECTRICAL CHARACTERISTICS (continued)

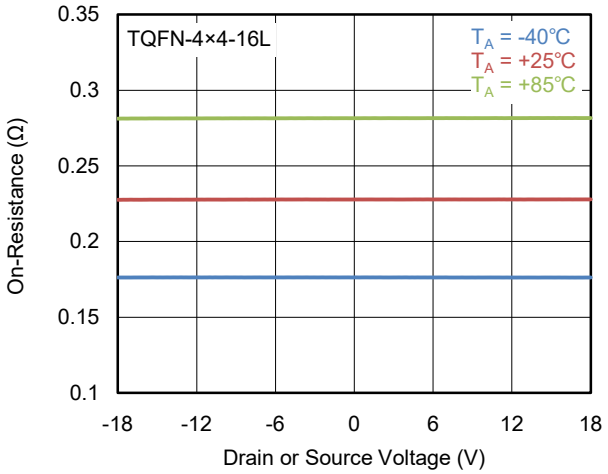
($V_{CC}$ = 5V, $C_P$ = $C_N$ = 10nF, Full = -40℃ to +85℃, typical values are at $T_A$ = +25℃, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | TEMP | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|---|
| **Analog Switch** | | | | | | | | |
| Analog Signal Range | $V_{ANALOG}$ | | | Full | -18V | | +18V | V |
| On-Resistance | $R_{ON}$ | $V_S$ = -15V, 0V, 15V, $I_S$ = -200mA | TQFN-4×4-16L | Full | | 0.23 | 0.33 | Ω |
| | | | WLCSP-2.11×2.2-12B | Full | | 0.2 | 0.27 | |
| On-Resistance Match between Channels | $\Delta R_{ON}$ | $V_S$ = -15V, 0V, 15V, $I_S$ = -200mA | TQFN-4×4-16L | Full | | 0.002 | 0.012 | Ω |
| | | | WLCSP-2.11×2.2-12B | Full | | 0.0006 | 0.01 | |
| On-Resistance Flatness | $R_{FLAT(ON)}$ | $V_S$ = -15V, 0V, 15V, $I_S$ = -200mA | TQFN-4×4-16L | Full | | 0.0003 | 0.0035 | Ω |
| | | | WLCSP-2.11×2.2-12B | Full | | 0.0002 | 0.0035 | |
| Source OFF Leakage Current | $I_{S(OFF)}$ | $V_S$ = -15V, 15V, $V_D$ = 15V, -15V | | Full | | | 1 | μA |
| Channel ON Leakage Current | $I_{S(ON)}$, $I_{D(ON)}$ | $V_S$ = -15V, 15V, $V_D$ = floating, or $V_S$ = floating, $V_D$ = -15V, 15V | | Full | | | 1 | μA |
| **Digital Inputs** | | | | | | | | |
| Logic High | $V_{INH}$ | $V_{CC}$ = 2.7V to 5.5V | | Full | 0.78 | | | V |
| Logic Low | $V_{INL}$ | $V_{CC}$ = 2.7V to 5.5V | | Full | | | 0.42 | V |
| Pull Down Resistor | $R_{PULL\ DOWN}$ | | | +25℃ | | 550 | | kΩ |
| **Dynamic Characteristics** | | | | | | | | |
| Turn-On Time | $t_{ON}$ | $V_S$ = 1V, $V_{IH}$ = 1.6V, $V_{IL}$ = 0V, $R_L$ = 50Ω, $C_L$ = 35pF, Test Circuit 1 | | +25℃ | | 280 | | ns |
| Turn-Off Time | $t_{OFF}$ | $V_S$ = 1V, $V_{IH}$ = 1.6V, $V_{IL}$ = 0V, $R_L$ = 50Ω, $C_L$ = 35pF, Test Circuit 1 | | +25℃ | | 1340 | | ns |
| Off-Isolation | $O_{ISO}$ | f = 1kHz, $R_L$ = 32Ω, Signal = 0dBm, Test Circuit 2 | | +25℃ | | -132 | | dB |
| | | f = 1MHz, $R_L$ = 50Ω, Signal = 0dBm, $C_L$ = 5pF, Test Circuit 2 | | +25℃ | | -60 | | |
| Channel-to-Channel Crosstalk | $X_{TALK}$ | f = 1kHz, $R_L$ = 32Ω, Signal = 0dBm, Test Circuit 3 | | +25℃ | | -117 | | dB |
| | | f = 1MHz, $R_L$ = 50Ω, Signal = 0dBm, $C_L$ = 5pF, Test Circuit 3 | | +25℃ | | -74 | | |
| -3dB Bandwidth | BW | Signal = 0dBm, $R_L$ = 50Ω, $C_L$ = 5pF, Test Circuit 4 | | +25℃ | | 140 | | MHz |
| Channel On Capacitance | $C_{ON}$ | f = 1MHz | | +25℃ | | 36 | | pF |
| Channel Off Capacitance | $C_{OFF}$ | f = 1MHz | | +25℃ | | 98 | | pF |
| Injection Select Input to Common I/O | Q | $V_G$ = GND, $R_G$ = 0Ω, $C_L$ = 1nF, Test Circuit 5 | | +25℃ | | 2550 | | pC |
| Total Harmonic Distortion + Noise | THD+N | A-Weighting, Test Circuit 6 | $V_S$ = $2V_{RMS}$, $R_L$ = 600Ω | +25℃ | | -118 | | dB |
| | | | $V_S$ = $2V_{PP}$, $R_L$ = 600Ω | +25℃ | | -115 | | |
| | | | $V_S$ = $2V_{PP}$, $R_L$ = 32Ω | +25℃ | | -114 | | |
| | | | $V_S$ = $1V_{PP}$, $R_L$ = 600Ω | +25℃ | | -112 | | |
| | | | $V_S$ = $1V_{PP}$, $R_L$ = 32Ω | +25℃ | | -107 | | |
| Start-Up Time | $t_{START}$ | Switch $V_{EN}$ = 0V to $V_{EN}$ = 1.6V, $C_P$ = $C_N$ = 10nF | | +25℃ | | 4.2 | | ms |
| **Power Requirements** | | | | | | | | |
| Power Supply Current | $I_{CC}$ | $V_{IN}$ = 0V, $V_{EN}$ = 1.6V | | Full | | 1070 | 1600 | μA |
| | | $V_{IN}$ = 1.6V, $V_{EN}$ = 1.6V | | Full | | 1200 | 1600 | |
| Power Supply Current in Shutdown State | $I_{CC}$ | $V_{IN}$ = 0V, $V_{EN}$ = 0V | | Full | | 0.75 | 1.7 | μA |
| | | $V_{IN}$ = 1.6V, $V_{EN}$ = 0V | | Full | | 2.3 | 4 | |

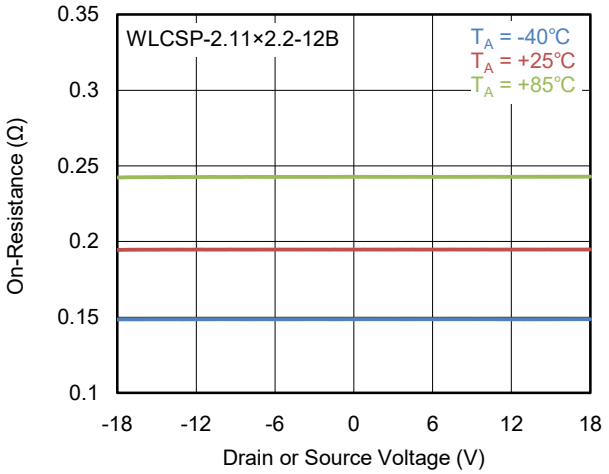
## TYPICAL PERFORMANCE CHARACTERISTICS

$T_A$ = +25℃, $V_{CC}$ = 5V, unless otherwise noted.

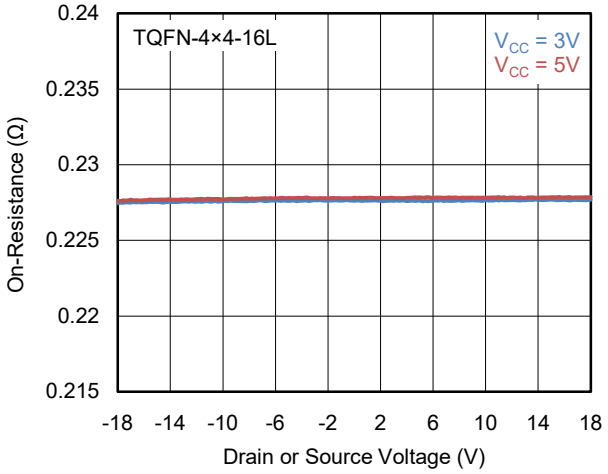
On Resistance vs. Drain or Source Voltage



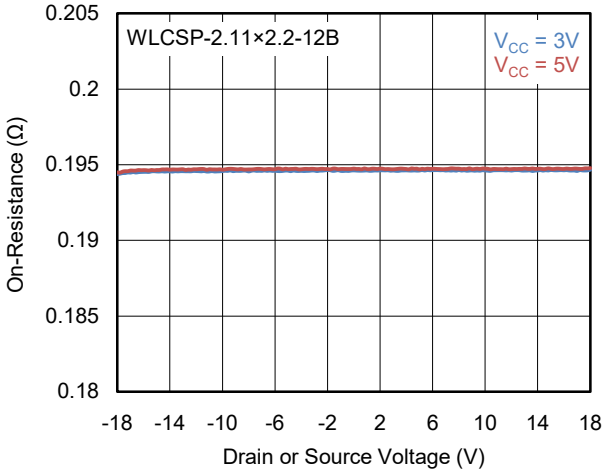

On Resistance vs. Drain or Source Voltage



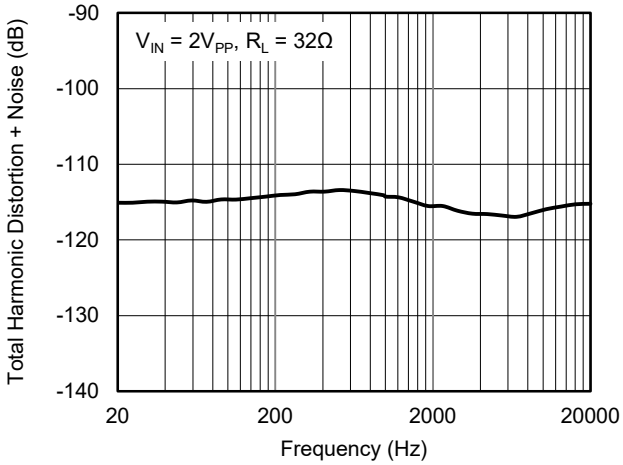

On Resistance vs. Drain or Source Voltage



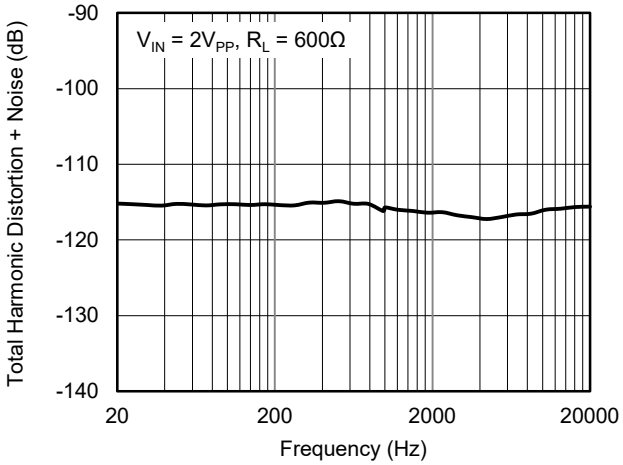

On Resistance vs. Drain or Source Voltage




Total Harmonic Distortion + Noise vs. Frequency



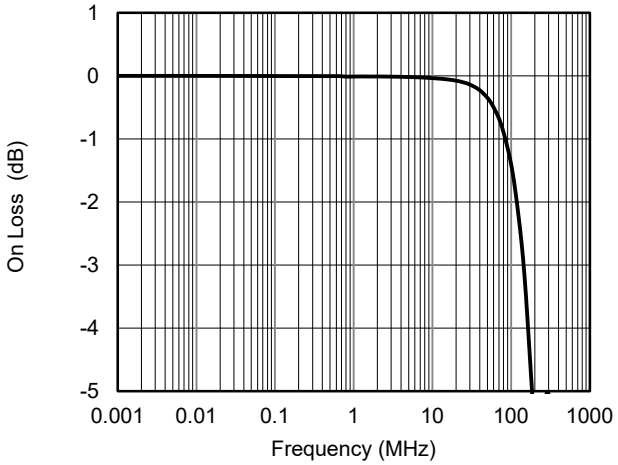

Total Harmonic Distortion + Noise vs. Frequency



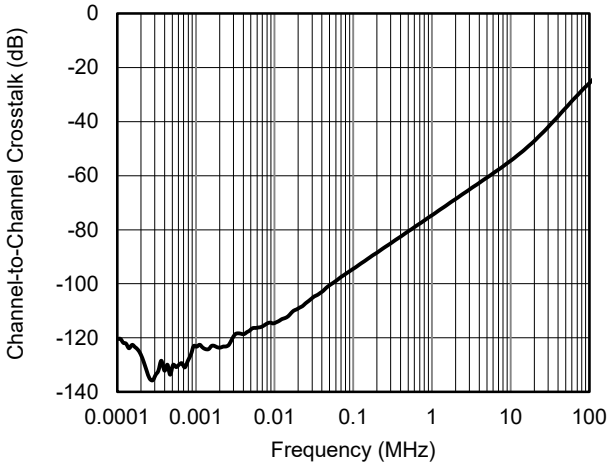
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

$T_A$ = +25℃, $V_{CC}$ = 5V, unless otherwise noted.

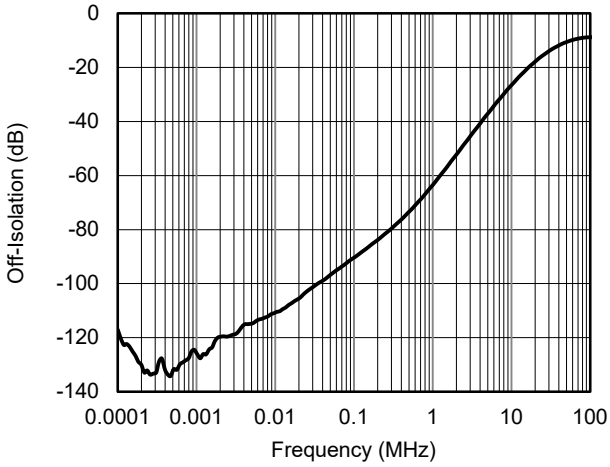
On Loss vs. Frequency



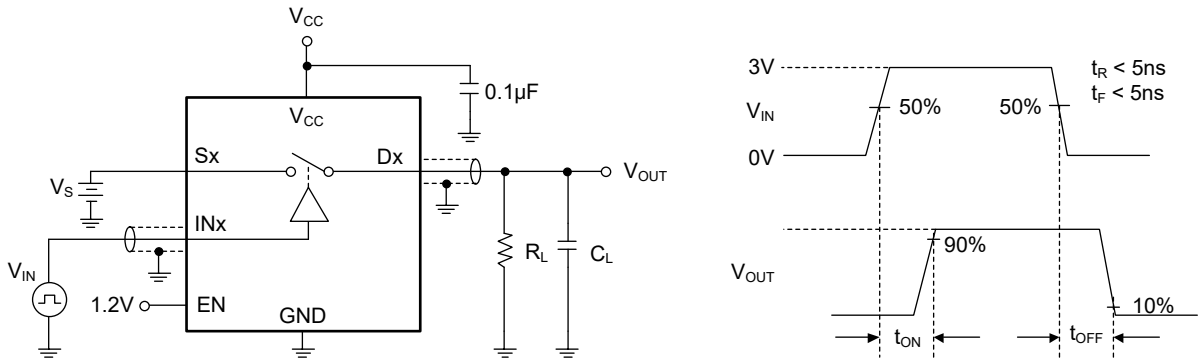

Channel-to-Channel Crosstalk vs. Frequency



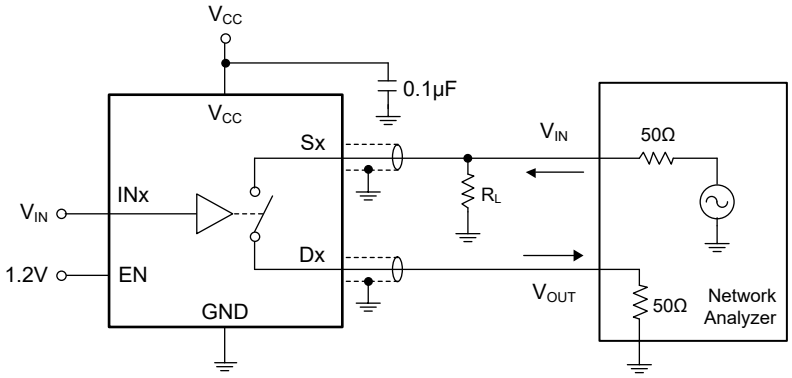

Off-Isolation vs. Frequency



## TEST CIRCUITS

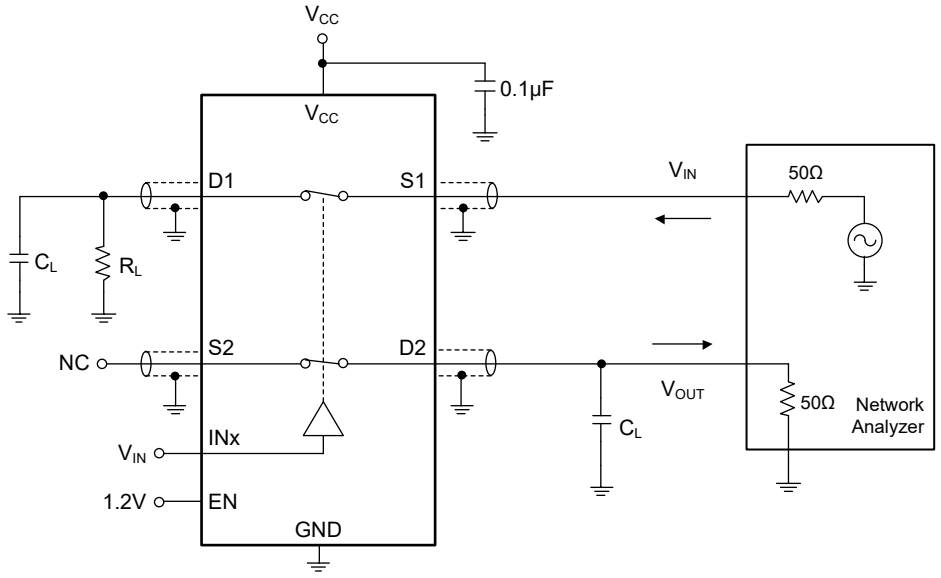



**Test Circuit 1. Switching Times ($t_{ON}$, $t_{OFF}$)**




Off-Isolation = 20log($V_{OUT}$/$V_{IN}$)

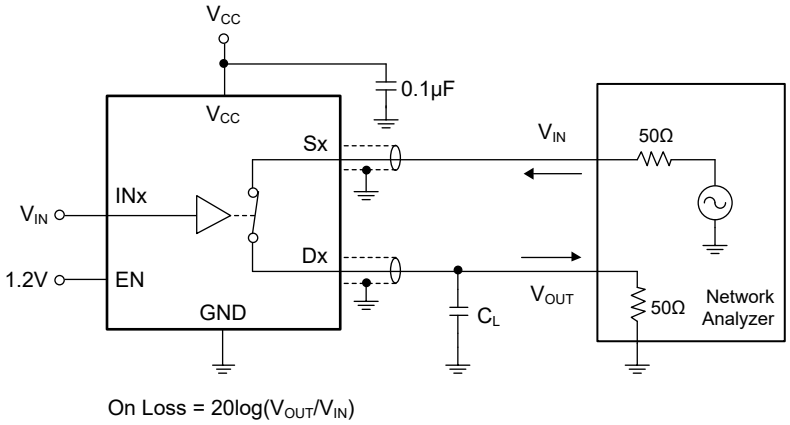
**Test Circuit 2. Off-Isolation**




Channel-to-Channel Crosstalk = 20log($V_{OUT}$/$V_{IN}$)

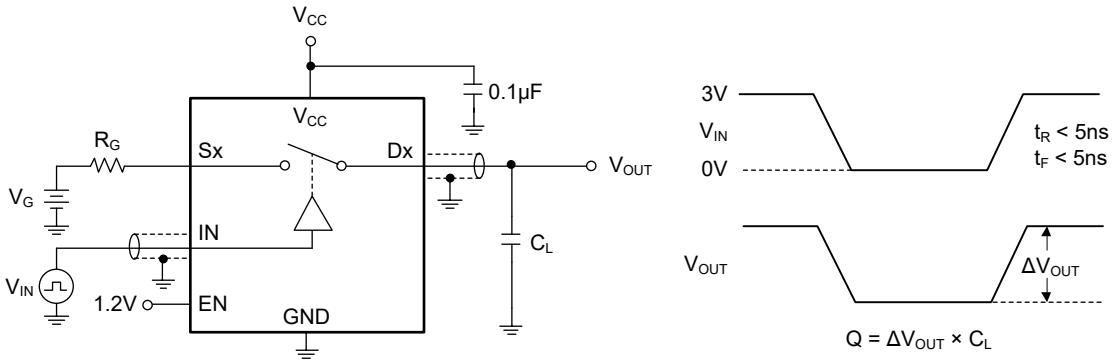
**Test Circuit 3. Channel-to-Channel Crosstalk**

## TEST CIRCUITS (continued)



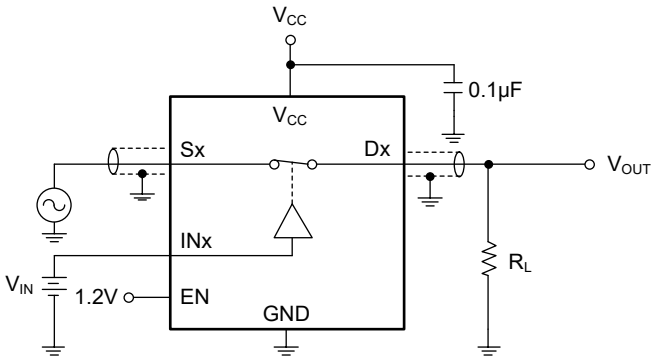

On Loss = 20log($V_{OUT}$/$V_{IN}$)

**Test Circuit 4. On Loss**




Q = $\Delta V_{OUT} \times C_L$

**Test Circuit 5. Charge Injection (Q)**




**Test Circuit 6. Total Harmonic Distortion + Noise (THD+N)**

## APPLICATION INFORMATION

Speaker + Receiver is always used in smart phone, and high voltage class D speaker driver (smart audio PA) is used to drive speaker for high volume audio. But the high output voltage of class D speaker driver will damage the receiver driver because receiver driver is designed by low voltage technology. The SGM3705 can solve this design issue by providing the safe isolation between receiver driver and high voltage class D speaker driver. The SGM3705 provides low $R_{ON}$ channels to pass the positive and negative signals from capless receiver driver. The circuit is shown in Figure 1.

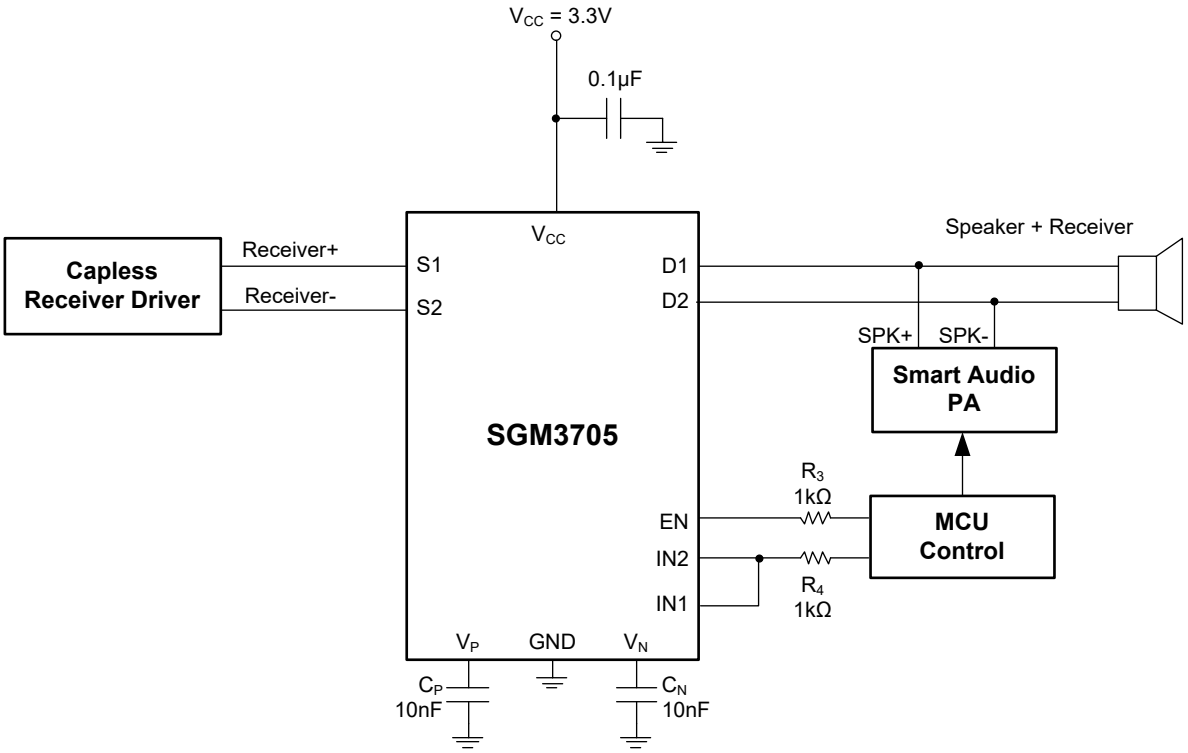



**Figure 1. Typical Application Circuit for Speaker + Receiver**

## APPLICATION INFORMATION (continued)

To improve audio quality of portable devices, external audio power amplifier is always used to drive speaker, and the integrated speaker power amplifier in PMIC will be ignored. The high performance SGM3705 is used to pass the audio signal in application. The circuit is shown in Figure 2 and a stable 3.3V power supply is required in this circuit.

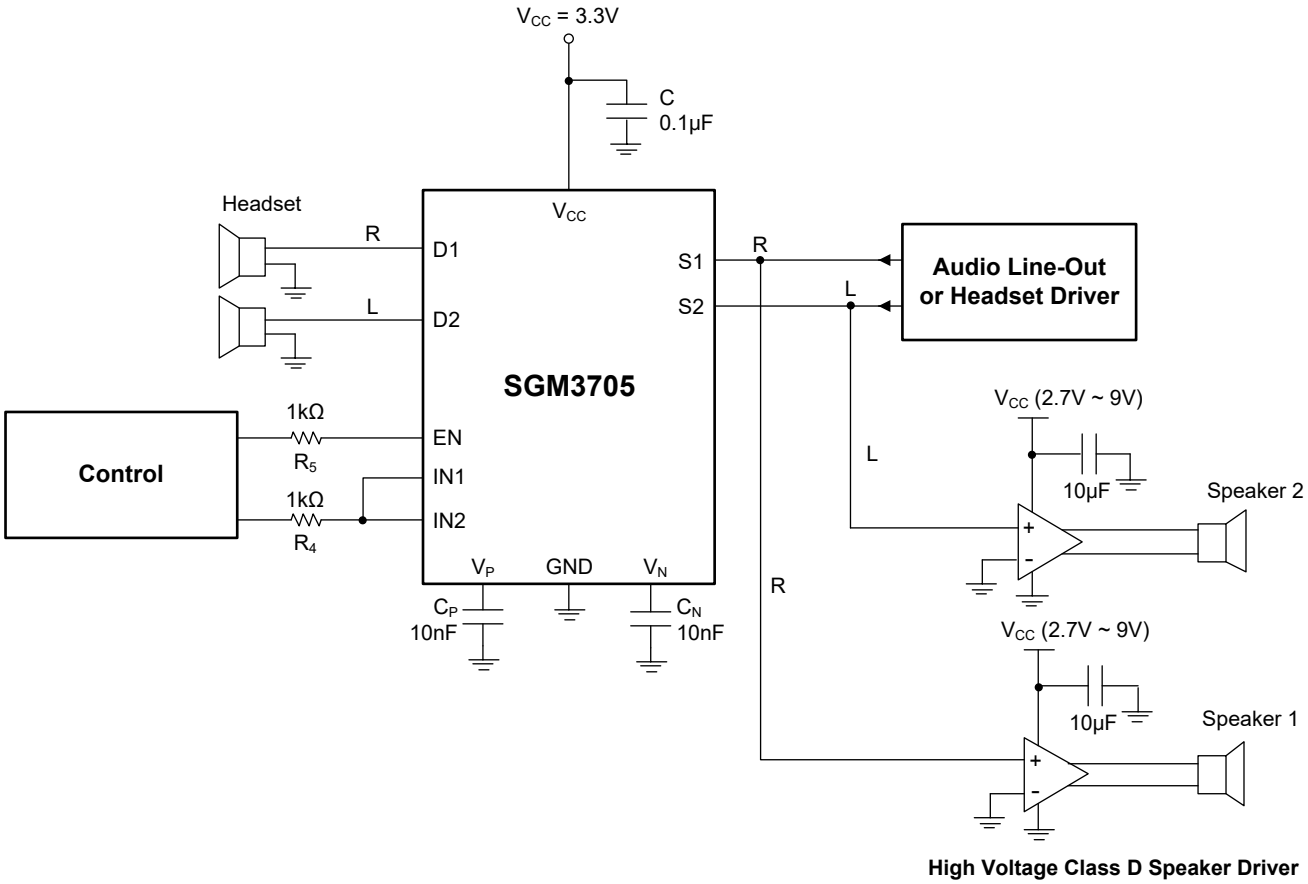
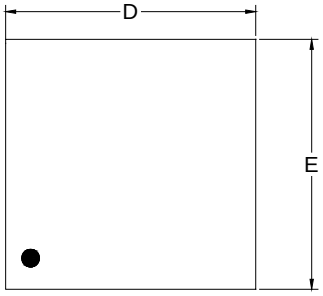


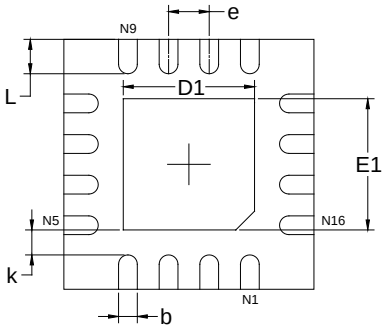

**Figure 2. Typical Application Circuit for Audio Signal Switch**

# PACKAGE OUTLINE DIMENSIONS

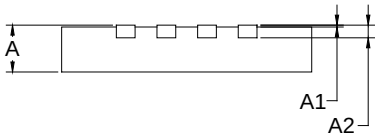
## TQFN-4×4-16L



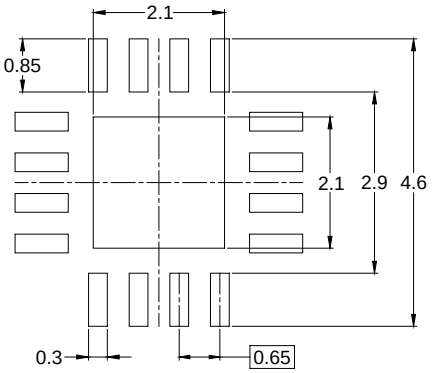

**TOP VIEW**




**BOTTOM VIEW**




**SIDE VIEW**



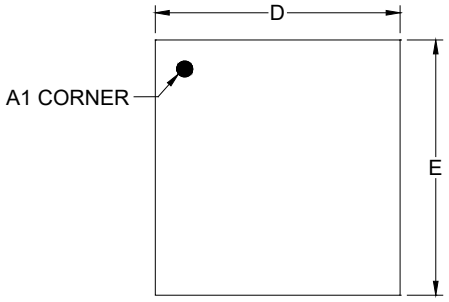

**RECOMMENDED LAND PATTERN** (Unit: mm)

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.700 | 0.800 | 0.028 | 0.031 |
| A1 | 0.000 | 0.050 | 0.000 | 0.002 |
| A2 | 0.203 REF | | 0.008 REF | |
| D | 3.900 | 4.100 | 0.154 | 0.161 |
| D1 | 2.000 | 2.200 | 0.079 | 0.087 |
| E | 3.900 | 4.100 | 0.154 | 0.161 |
| E1 | 2.000 | 2.200 | 0.079 | 0.087 |
| k | 0.200 MIN | | 0.008 MIN | |
| b | 0.250 | 0.350 | 0.010 | 0.014 |
| e | 0.650 TYP | | 0.026 TYP | |
| L | 0.450 | 0.650 | 0.018 | 0.026 |

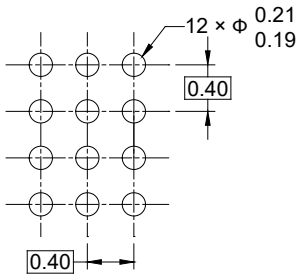
NOTE: This drawing is subject to change without notice.

# PACKAGE OUTLINE DIMENSIONS

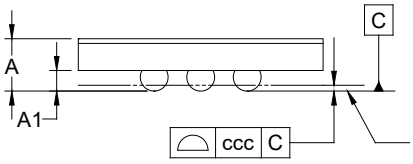
## WLCSP-2.11×2.2-12B



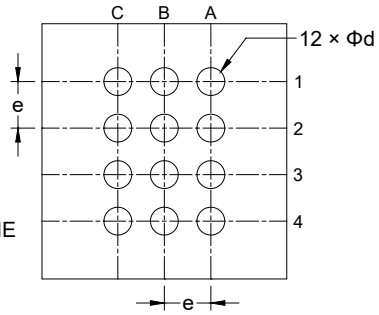

TOP VIEW




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




SIDE VIEW



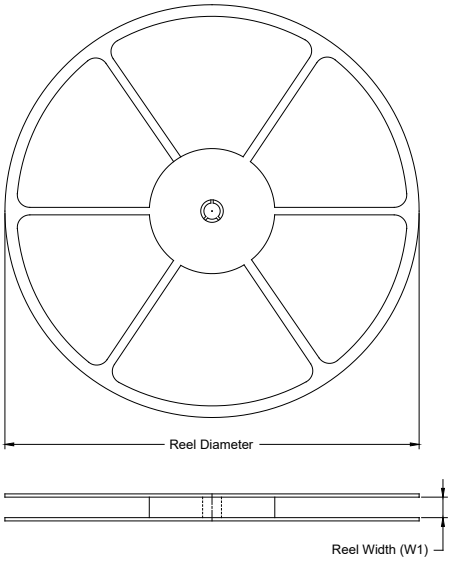

BOTTOM VIEW

| Symbol | Dimensions In Millimeters | | |
|---|---|---|---|
| | MIN | MOD | MAX |
| A | - | - | 0.488 |
| A1 | 0.157 | - | 0.197 |
| D | 2.075 | - | 2.135 |
| E | 2.165 | - | 2.225 |
| d | 0.209 | - | 0.269 |
| e | 0.400 BSC | | |
| ccc | 0.050 | | |

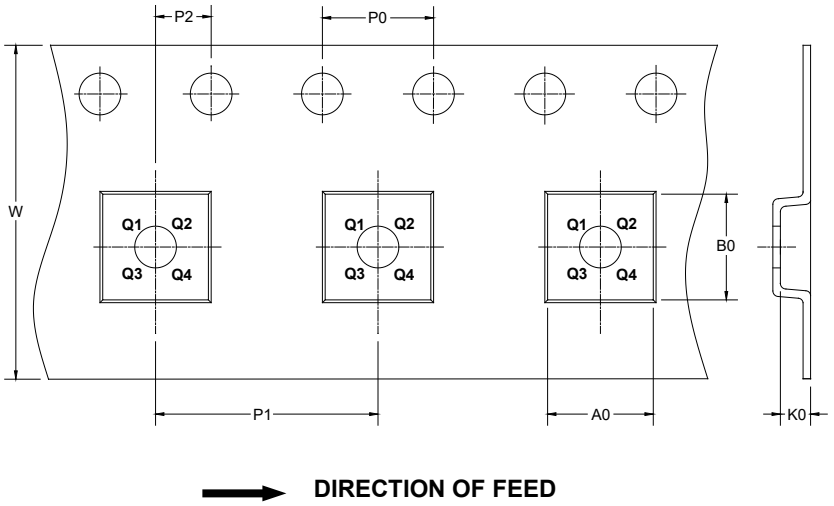
NOTE: This drawing is subject to change without notice.

# TAPE AND REEL INFORMATION

### REEL DIMENSIONS




### TAPE DIMENSIONS



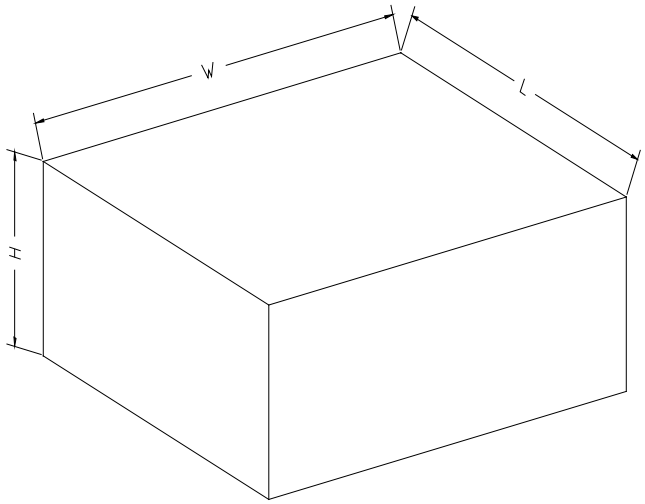

NOTE: The picture is only for reference. Please make the object as the standard.

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| TQFN-4×4-16L | 13″ | 12.4 | 4.30 | 4.30 | 1.10 | 4.0 | 8.0 | 2.0 | 12.0 | Q2 |
| WLCSP-2.11×2.2-12B | 7" | 9.5 | 2.41 | 2.46 | 0.77 | 4.0 | 4.0 | 2.0 | 8.0 | 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 |
|---|---|---|---|---|
| 7″ (Option) | 368 | 227 | 224 | 8 |
| 7″ | 442 | 410 | 224 | 18 |
| 13″ | 386 | 280 | 370 | 5 |

DD0002