SGM7223
High Speed USB 2.0 (480Mbps) DPDT Analog Switch

GENERAL DESCRIPTION

The SGM7223 is a high-speed, low-power double-pole/ double-throw (DPDT) analog switch that operates from a single 1.8V to 4.3V power supply.

SGM7223 is designed for the switching of high-speed USB 2.0 signals in handset and consumer applications, such as cell phones, digital cameras, and notebooks with hubs or controllers with limited USB I/Os.

The SGM7223 has low bit-to-bit skew and high channel-to-channel noise isolation, and is compatible with various standards, such as high-speed USB 2.0 (480Mbps). Each switch is bidirectional and offers little or no attenuation of the high-speed signals at the outputs. Its bandwidth is wide enough to pass high-speed USB 2.0 differential signals (480Mbps) with good signal integrity.

The SGM7223 contains special circuitry on the D+/D- pins which allows the device to withstand a V_{BUS} short to D+ or D- when the USB devices are either powered off or powered on.

The SGM7223 is available in a Green TQFN-2.1×1.6-10L package. It operates over an ambient temperature range of -40℃ to +85℃.

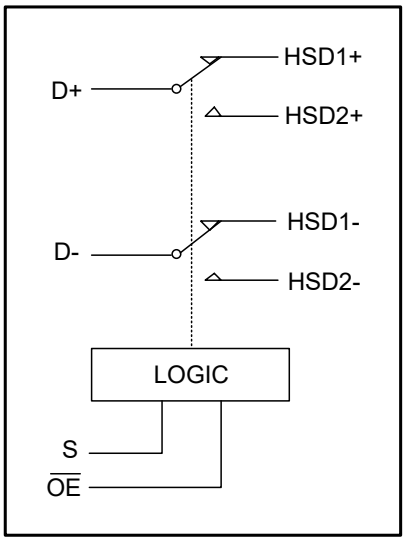
APPLICATIONS

Route Signals for USB 2.0
MP3 and Other Personal Media Players
Digital Cameras and Camcorders
Portable Instrumentation
Set-Top Boxes
PDAs

FEATURES

- **R_{ON} is Typically 4.5Ω at 3V**
- **Low Bit-to-Bit Skew: 50ps (TYP)**
- **Voltage Operation: 1.8V to 4.3V**
- **Fast Switching Times:**
  t_{ON} = 11ns
  t_{OFF} = 20ns
- **Low Crosstalk: -33dB at 250MHz**
- **Power-Off Protection when V_+ = 0V,**
  D+/D- Pins can Tolerate up to 5.25V
- **High Off-Isolation: -30dB at 250MHz**
- **Rail-to-Rail Input and Output Operation**
- **Break-Before-Make Switching**
- **-40℃ to +85℃ Operating Temperature Range**
- **Available in a Green TQFN-2.1×1.6-10L Package**

BLOCK DIAGRAM

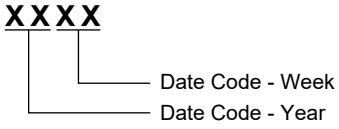


PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM7223	TQFN-2.1×1.6-10L	-40℃ to +85℃	SGM7223YTQD10/TR	7223 XXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXX = Date 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

V_+, IN to GND ..... 0V to 4.6V
Analog, Digital Voltage Range ..... -0.3V to (V_+) + 0.3V
Continuous Current HSDn or Dn ..... ±100mA
Peak Current HSDn or Dn ..... ±150mA
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM 4000V
MM 400V

RECOMMENDED OPERATING CONDITIONS

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

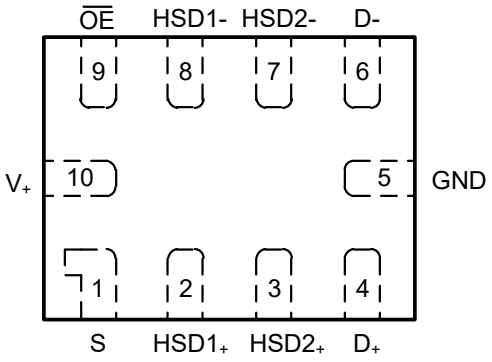
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its 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)



TQFN-2.1×1.6-10L

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	S	Select Input.
2, 3, 8, 7, 4, 6	$HSD1_+$, $HSD2_+$, $HSD1_-$, $HSD2_-$, D_+, D_-	Data Ports.
5	GND	Ground.
9	$\overline{OE}$	Output Enable.
10	V_+	Power Supply.

FUNCTION TABLE

$\overline{OE}$	S	HSD1+ HSD1-	HSD2+ HSD2-
0	0	ON	OFF
0	1	OFF	ON
1	x	OFF	OFF

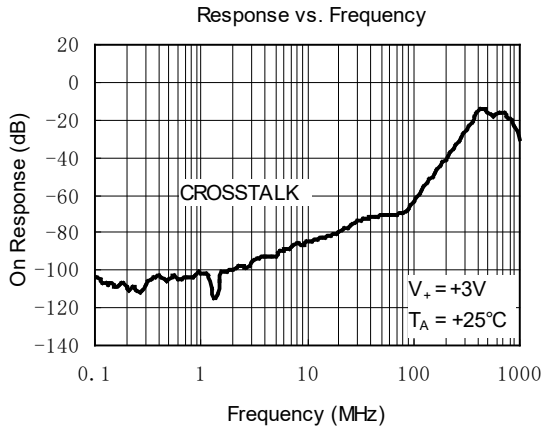
NOTE: Switches Shown For Logic "0" Input.

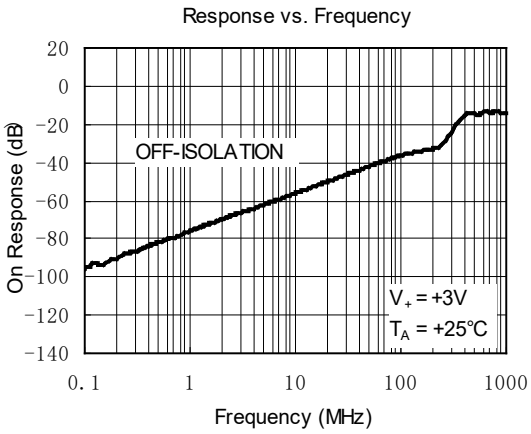
ELECTRICAL CHARACTERISTICS

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

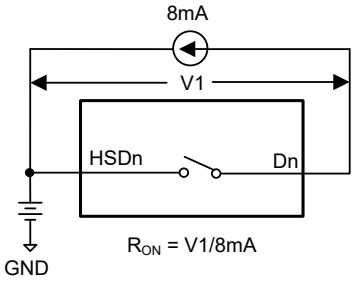
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Analog Switch							
Analog I/O Voltage ($HSD1_+$, $HSD1_-$, $HSD2_+$, $HSD2_-$)	V_{IS}		Full	0		V_+	V
On-Resistance	R_{ON}	V_+ = 3V, V_{IS} = 0V to 0.4V, I_D = 8mA, Test Circuit 1	+25℃		4.5	8.5	Ω
			Full			9	
On-Resistance Match between Channels	ΔR_{ON}	V_+ = 3V, V_{IS} = 0V to 0.4V, I_D = 8mA, Test Circuit 1	+25℃		0.2	0.6	Ω
			Full			1.5	
On-Resistance Flatness	$R_{FLAT(ON)}$	V_+ = 3V, V_{IS} = 0V to 1.0V, I_D = 8mA, Test Circuit 1	+25℃		1.8	2.2	Ω
			Full			2.8	
Power Off Leakage Current (D_+, D)	I_{OFF}	V_+ = 0V, V_D = 0V to 3.6V, V_S , $V_{\overline{OE}}$ = 0V or 3.6V	Full			1	μA
Increase in I_+ per Control Voltage	I_{CCT}	V_+ = 3.6V, V_S or $V_{\overline{OE}}$ = 2.6V	Full			5	μA
Source Off Leakage Current	$I_{HSD2(OFF)}$, $I_{HSD1(OFF)}$	V_+ = 3.6V, V_{IS} = 3.3V/0.3V, V_D = 0.3V/3.3V	Full			1	μA
Channel On Leakage Current	$I_{HSD2(ON)}$, $I_{HSD1(ON)}$	V_+ = 3.6V, V_{IS} = 3.3V/0.3V, V_D = 3.3V/0.3V or floating	Full			1	μA
Digital Inputs							
Input High Voltage	V_{IH}		Full	1.6			V
Input Low Voltage	V_{IL}		Full			0.5	V
Input Leakage Current	I_{IN}	V_+ = 3V, V_S , $V_{\overline{OE}}$ = 0V or V_+	Full			1	μA
Dynamic Characteristics							
Turn-On Time	t_{ON}	V_{IS} = 0.8V, R_L = 50Ω, C_L = 10pF, Test Circuit 2	+25℃		11		ns
Turn-Off Time	t_{OFF}		+25℃		20		ns
Break-Before-Make Time Delay	t_D	V_{IS} = 0.8V, R_L = 50Ω, C_L = 10pF, Test Circuit 3	+25℃		5		ns
Propagation Delay	t_{PD}	R_L = 50Ω, C_L = 10pF	+25℃		0.3		ns
Off Isolation	O_{ISO}	Signal = 0dBm, R_L = 50Ω, f = 250MHz, Test Circuit 4	+25℃		-30		dB
Channel-to-Channel Crosstalk	X_{TALK}	Signal = 0dBm, R_L = 50Ω, f = 250MHz, Test Circuit 5	+25℃		-33		dB
-3dB Bandwidth	BW	Signal = 0dBm, R_L = 50Ω, C_L = 5pF Test Circuit 6	+25℃		500		MHz
Channel-to-Channel Skew	t_{SKEW}	R_L = 50Ω, C_L = 10pF	+25℃		0.05		ns
Charge Injection Select Input to Common I/O	Q	V_G = GND, C_L = 1nF, R_G = 0Ω, Q = C_L × V_{OUT}, Test Circuit 7	+25℃		9.8		pC
HSD_+, HSD_-, D_+, D_- On Capacitance	C_{ON}		+25℃		6.5		pF
Power Requirements							
Power Supply Range	V_+		Full	1.8		4.3	V
Power Supply Current	I_+	V_+ = 3V, V_S , $V_{\overline{OE}}$ = 0V or V_+	Full			1	μA

TYPICAL PERFORMANCE CHARACTERISTICS

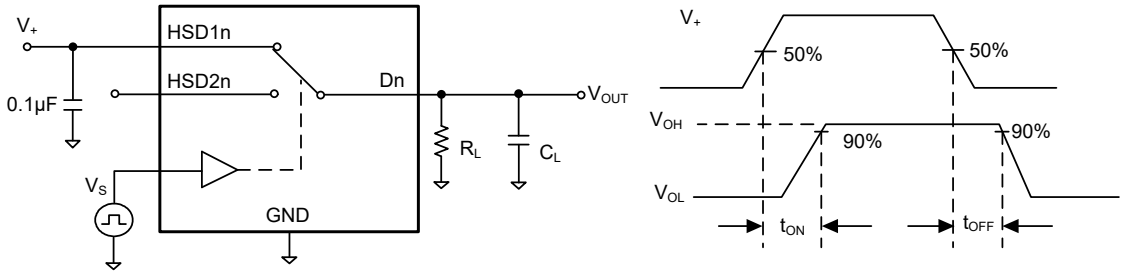




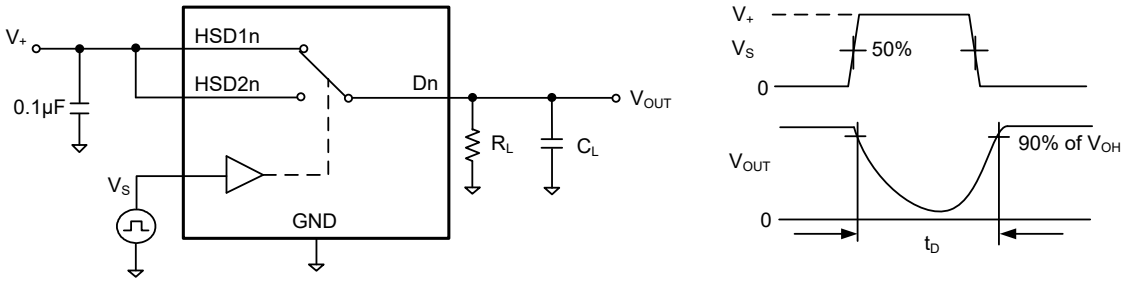
TEST CIRCUITS



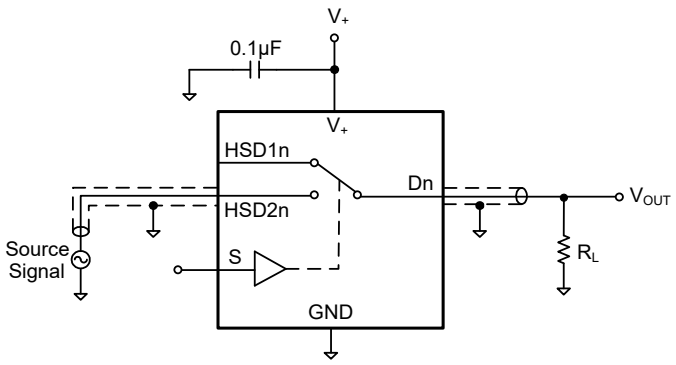
Test Circuit 1. On-Resistance



Test Circuit 2. Switching Times (t_{ON}, t_{OFF})

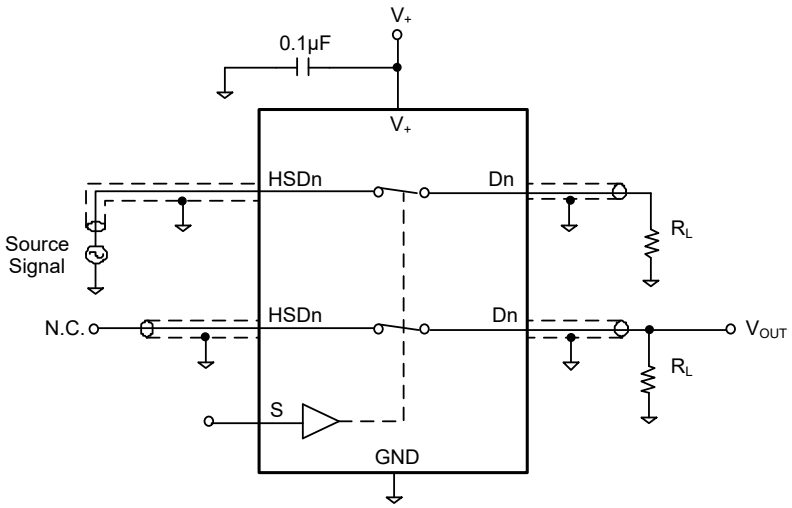


Test Circuit 3. Break-Before-Make Time (t_D)



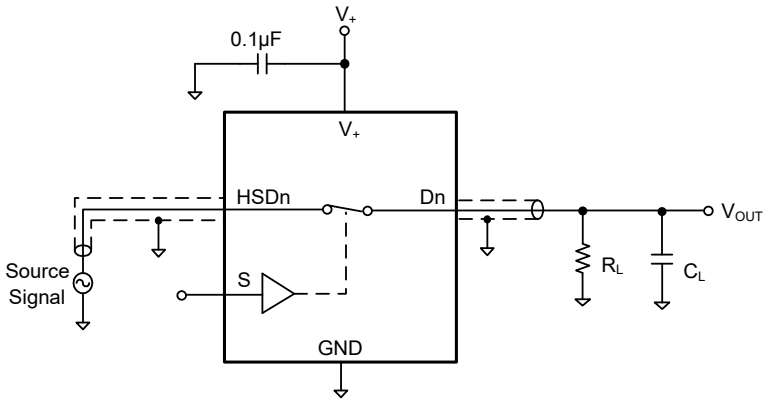
Test Circuit 4. Off Isolation

TEST CIRCUITS (continued)

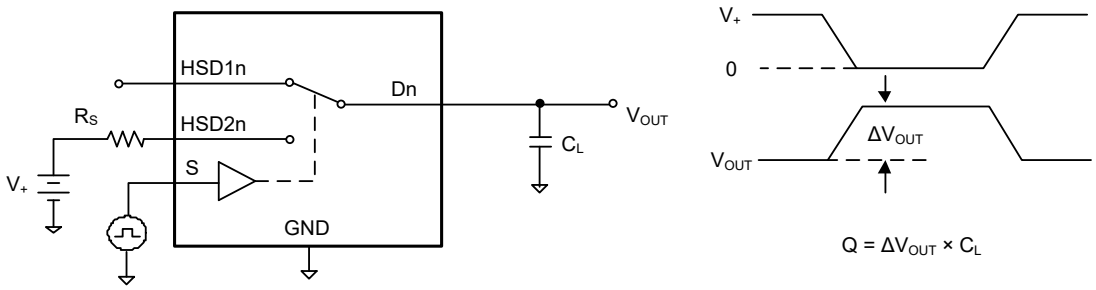


$$\text{Channel-to-Channel Crosstalk} = -20 \times \log \frac{V_{HSDn}}{V_{OUT}}$$

Test Circuit 5. Channel-to-Channel Crosstalk



Test Circuit 6. -3dB Bandwidth



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

Test Circuit 7. Charge Injection (Q)

APPLICATION INFORMATION

Meeting USB 2.0 V_{BUS} Short Requirements

In section 7.1.1 of the USB 2.0 specification, it notes that USB devices must be able to withstand a V_{BUS} short to D+ or D- when the USB devices is either powered off or powered on. The SGM7223 can be successfully configured to meet both these requirements.

Power-Off Protection

For a V_{BUS} short circuit, the switch is expected to withstand such a condition for at least 24 hours. The SGM7223 has specially designed circuitry which prevents unintended signal bleed through as well as guaranteed system reliability during a power-down, over-voltage condition. The protection has been added to the common pins (D+, D-).

Power-On Protection

The USB 2.0 specification also notes that the USB device should be capable of withstanding a V_{BUS} short during transmission of data. This modification works by limiting current flow back into the V_+ rail during the over-voltage event so current remains within the safe operating range. In this application, the switch passes the full 5.25V input signal through to the selected output, while maintaining specified off isolation on the un-selected pins.

SGM7223 USB 2.0 Signal Quality Compliance Tests

Figures 1 and 2 show the test results for USB eye diagram tests. A summary of the USB tests is provided in Table 1. The SGM7223 passes the high speed signal quality, eye diagram and jitter tests.

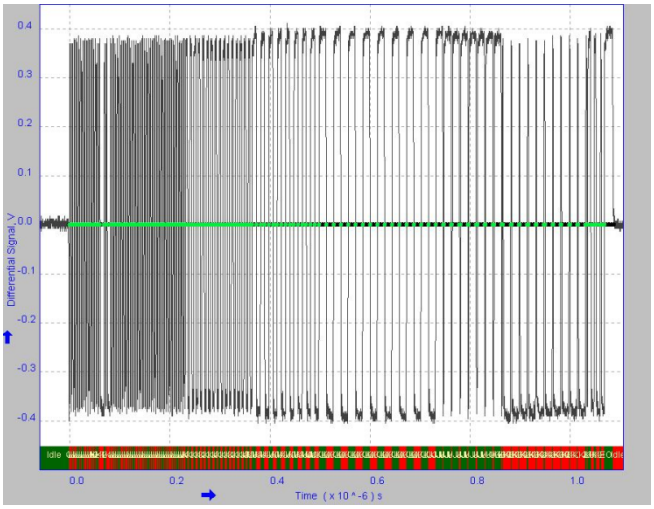


Figure 1. Waveform Plot

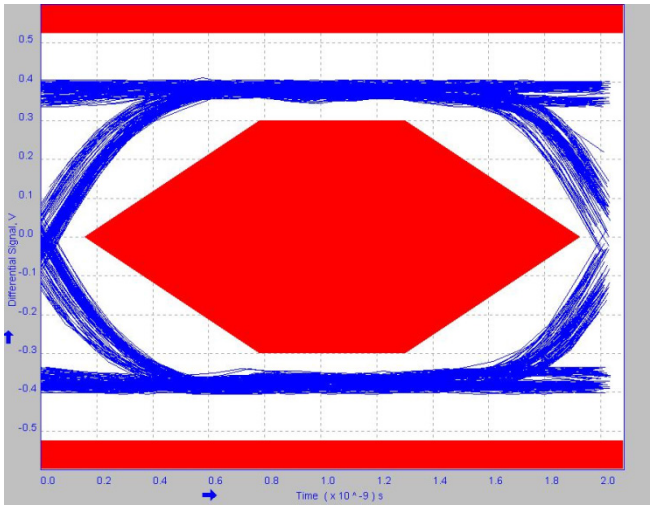


Figure 2. High Speed Signal Quality Eye Diagram Test (V_+ = 3.3V)

APPLICATION INFORMATION (continued)

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	467.3807 Mbps	496.5449 Mbps	479.9494 Mbps	0.0000 bps	6.174360 Mbps	480.4821 Mbps	512	Pass
EOP Width	-	-	16.61442ns	-	-	-	1	Pass
EOP Width (Bits)	-	-	7.974082	-	-	-	1	Pass
Falling Edge Rate	1.100184 kV/μs	1.304518 kV/μs	1.187936 kV/μs	204.3340 V/μs	52.11665 V/μs	1.189068 kV/μs	107	Pass
Rising Edge Rate	1.058148 kV/μs	1.232657 kV/μs	1.137964 kV/μs	174.5099 V/μs	46.35985 V/μs	1.138899 kV/μs	108	Pass

Additional Information:
Consecutive Jitter range: -115.0ps to 71.20ps RMS Jitter 40.26ps
KJ Paired Jitter range: -34.68ps to 29.00ps RMS Jitter 11.09ps
JK Paired Jitter range: -30.42ps to 35.73ps RMS Jitter 12.11ps

- Rising Edge Rate: 1.137964kV/μs (Equivalent Rise Time = 562.41ps)
- Falling Edge Rate: 1.187936kV/μs (Equivalent Fall Time = 538.75ps)

REVISION HISTORY

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

MAY 2016 – REV.A.1 to REV.A.2 **Page**

Added Recommended Land Pattern section 11
Added Tape and Reel Information section 12, 13

MAY 2011 – REV.A to REV.A.1 **Page**

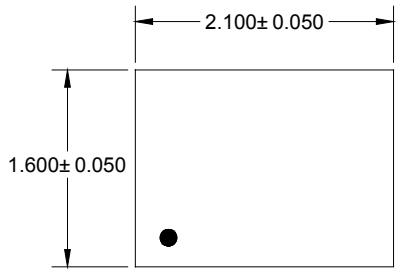
Updated package name ..... All

Changes from Original (AUGUST 2008) to REV.A **Page**

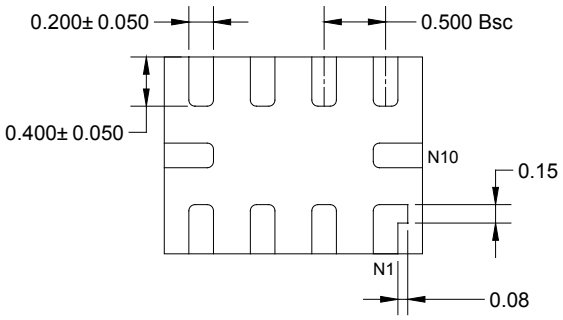
Changed from product preview to production data ..... All

PACKAGE OUTLINE DIMENSIONS

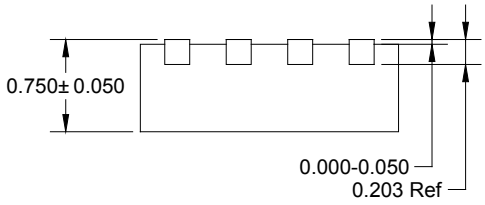
TQFN-2.1×1.6-10L



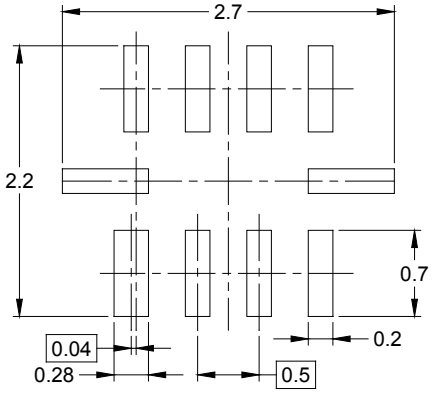
TOP VIEW



BOTTOM VIEW



SIDE VIEW

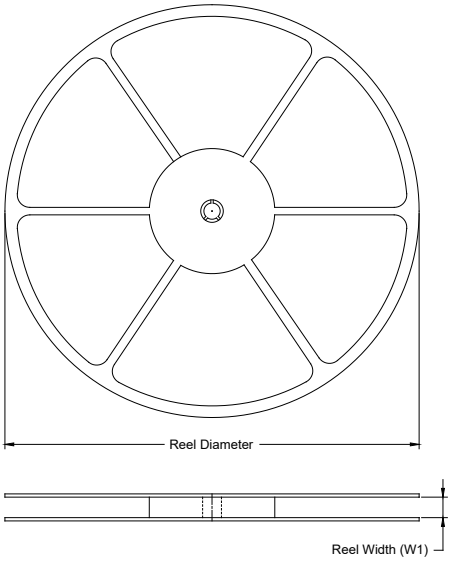


RECOMMENDED LAND PATTERN

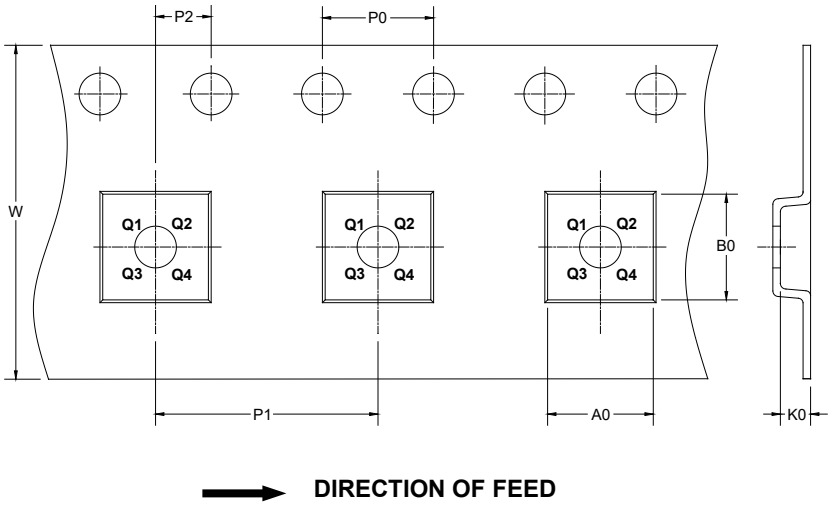
NOTE: All linear dimensions are in millimeters.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



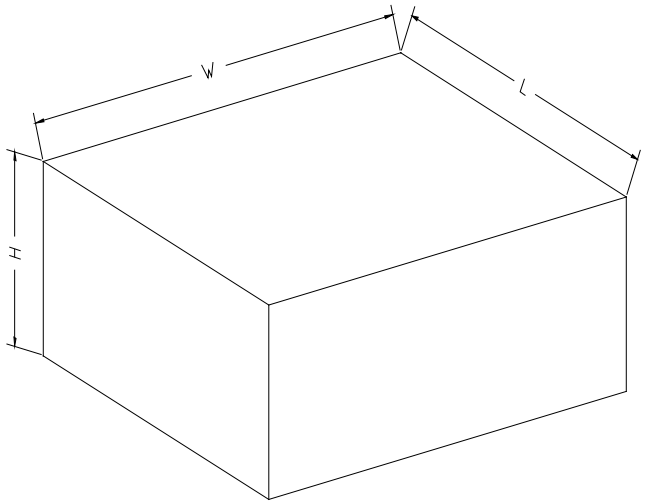
NOTE: The picture is only for reference. Please make the object as the standard.

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-2.1×1.6-10L	7″	9.0	1.90	2.30	0.90	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

DD0002