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

GENERAL DESCRIPTION

The SGM7223 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 SGM7223 is bidirectional, which can ensure that the high speed signals have little or no attenuation at the outputs.

The SGM7223 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 SGM7223 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 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

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

FEATURES

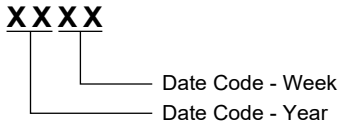
- **Supply Voltage Range: 1.8V to 4.3V**
- **On-Resistance: 4.5Ω (TYP) at 3V**
- **-3dB Bandwidth: 500MHz**
- **Low Bit-to-Bit Skew: 50ps (TYP)**
- **Fast Switching Times:**
  t_{ON}: 11ns
  t_{OFF}: 20ns
- **High Off-Isolation: -30dB (R_L = 50Ω, f = 250MHz)**
- **Low Crosstalk: -33dB (R_L = 50Ω, f = 250MHz)**
- **Power-Off and Power-On Protections**
- **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**

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

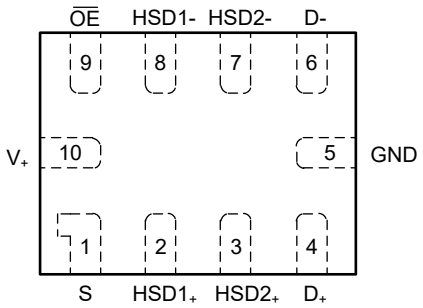
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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 Pin.
2, 3, 8, 7, 4, 6	$HSD1_+$, $HSD2_+$, $HSD1_-$, $HSD2_-$, D_+, D_-	Data Ports.
5	GND	Ground.
9	$\overline{OE}$	Output Enable Control Pins.
10	V_+	Positive Power Supply.

FUNCTION TABLE

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

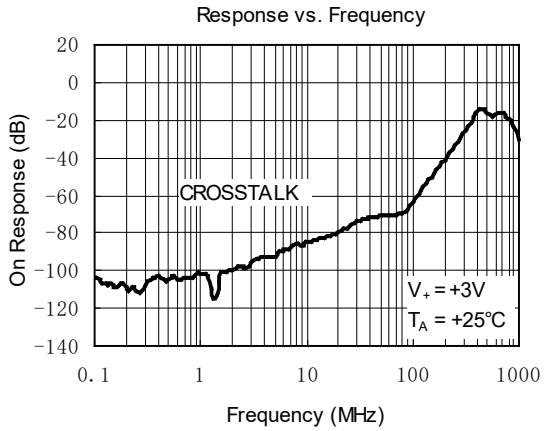
NOTE: Switches Shown For Logic "0" Input.

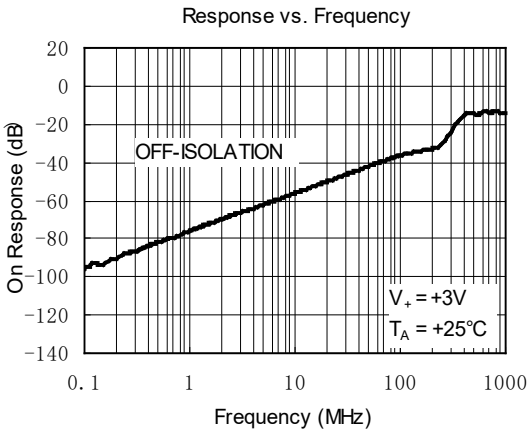
ELECTRICAL CHARACTERISTICS

(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.)

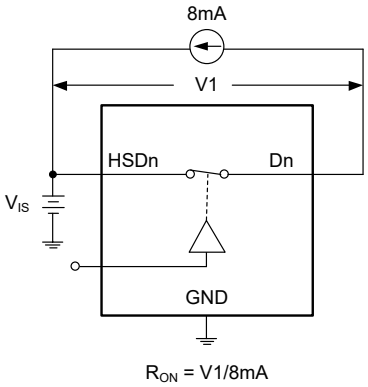
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Analog Switch							
Analog I/O Voltage ($HSD1_+$, $HSD1_-$, $HSD2_+$, $HSD2_-$)	V_{IS}		Full	0		V_+	V
On-Resistance	R_{ON}	V_+ = 3V, V_{IS} = 0V to 0.4V, I_D = 8mA, Test Circuit 1	+25℃		4.5	8.5	Ω
			Full			9	
On-Resistance Match between Channels	ΔR_{ON}	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

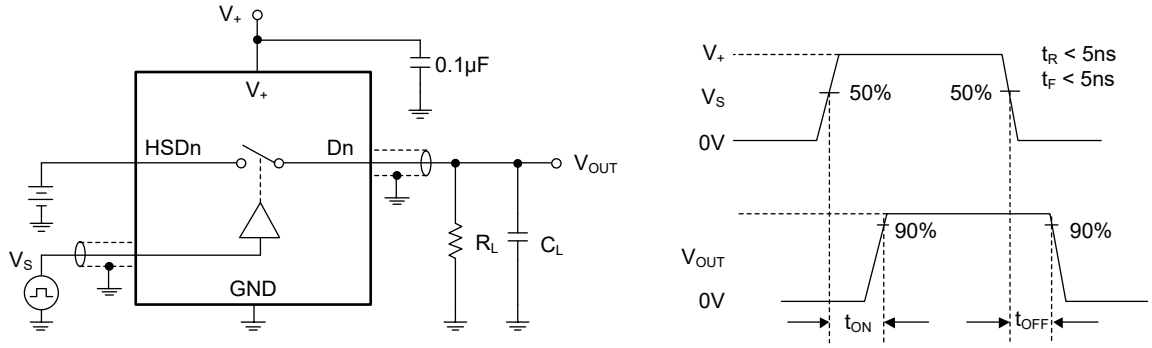




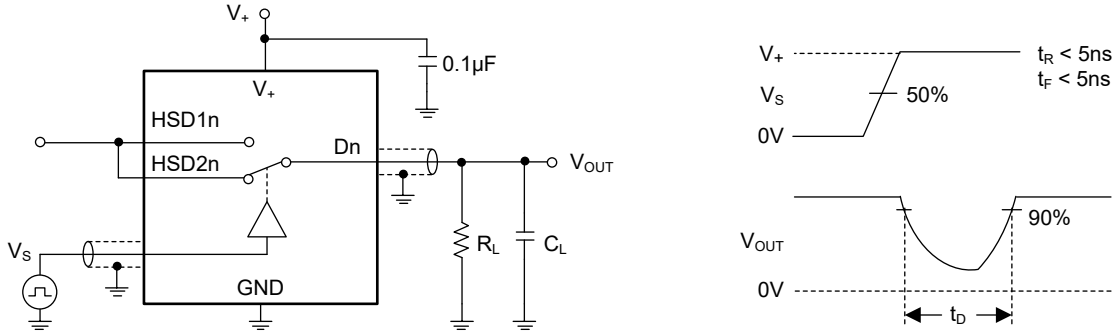
TEST CIRCUITS



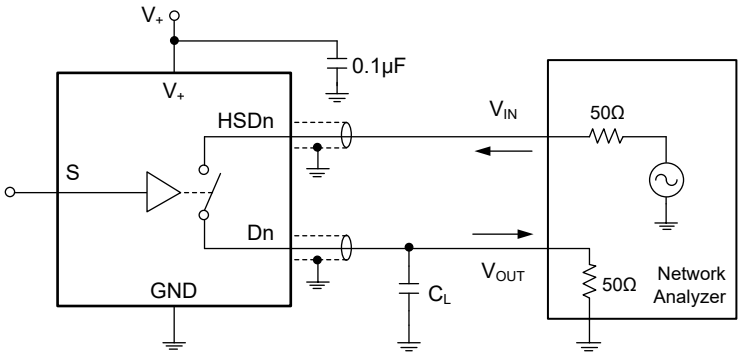
Test Circuit 1. On-Resistance



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

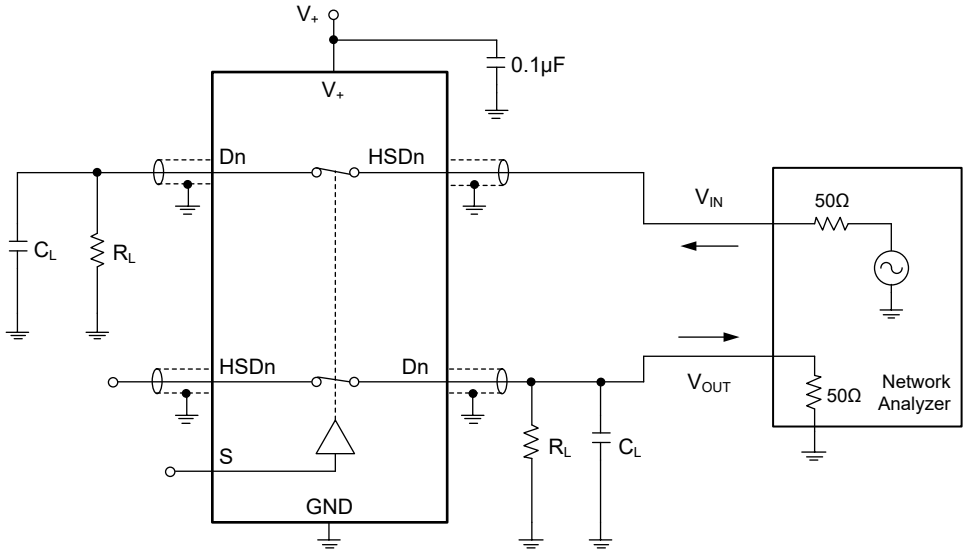


Test Circuit 3. Break-Before-Make Time (t_D)



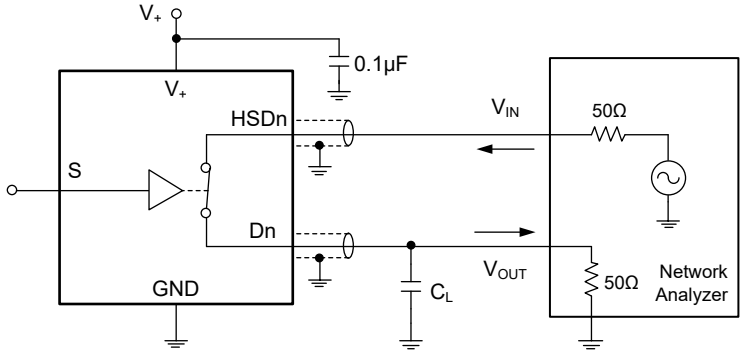
Test Circuit 4. Off Isolation

TEST CIRCUITS (continued)

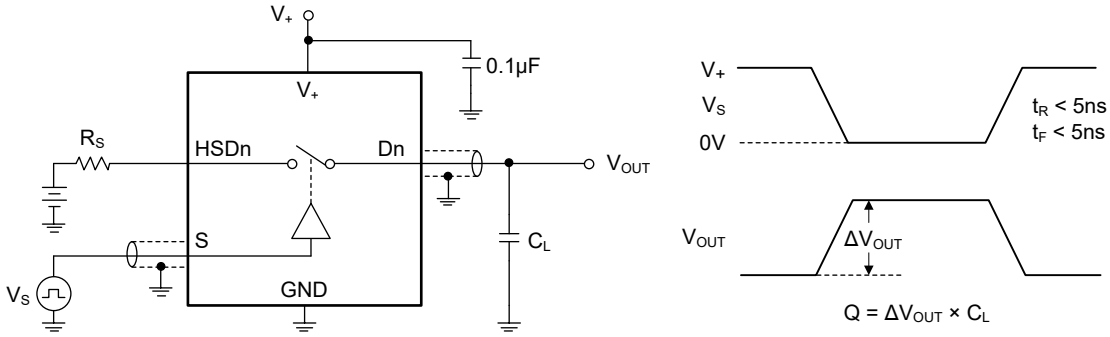


Channel-to-Channel Crosstalk = -20 log (V_{HSDn}/V_{OUT})

Test Circuit 5. Channel-to-Channel Crosstalk



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 SGM7223 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 SGM7223, 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 SGM7223 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.

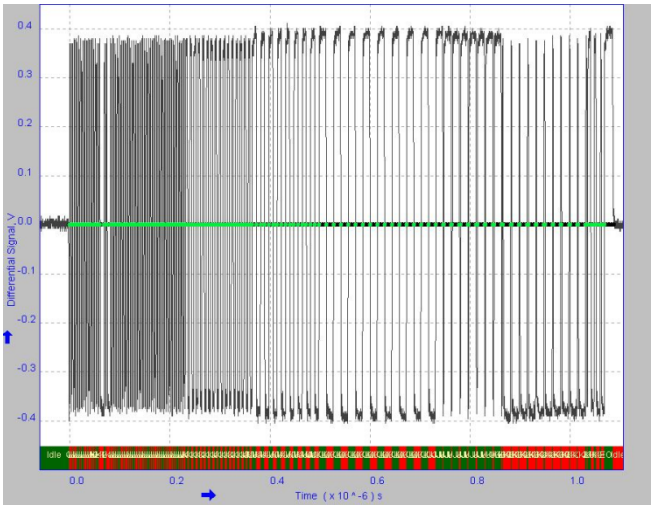


Figure 1. Waveform Plot

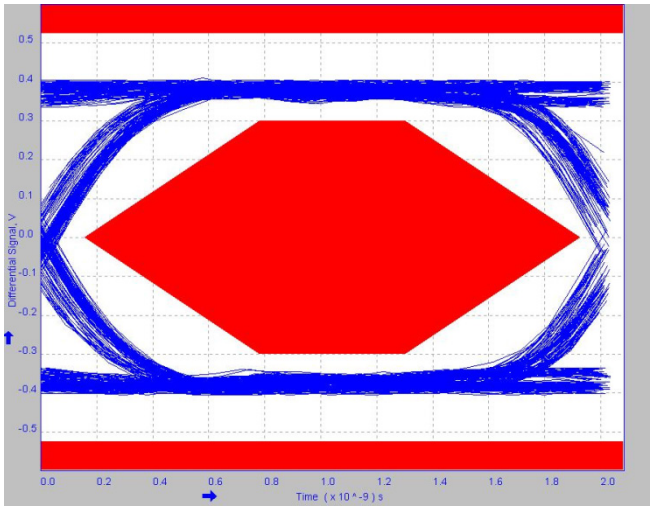


Figure 2. High Speed Signal Quality Eye Diagram Test (V_+ = 3.3V)

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	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.

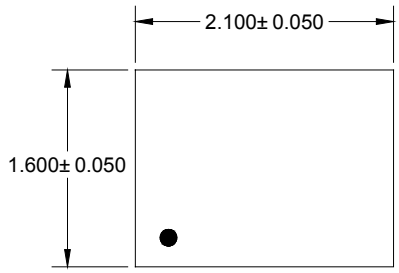
MAY 2016 – REV.A.1 to REV.A.2	Page
Added Recommended Land Pattern section	11
Added Tape and Reel Information section	12, 13

MAY 2011 – REV.A to REV.A.1	Page
Updated package name	All

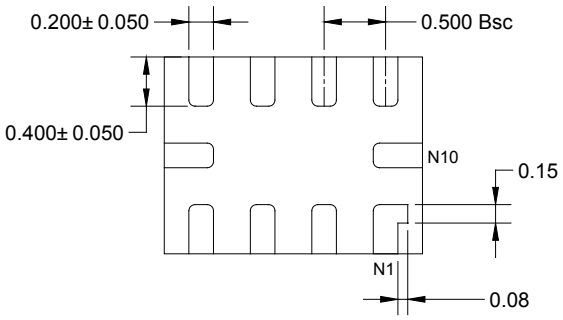
Changes from Original (AUGUST 2008) to REV.A	Page
Changed from product preview to production data	All

PACKAGE OUTLINE DIMENSIONS

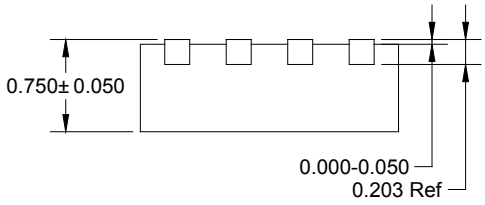
TQFN-2.1×1.6-10L



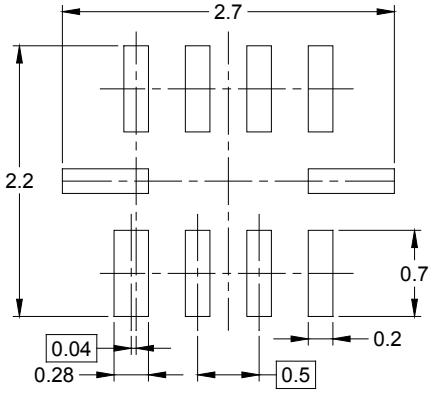
TOP VIEW



BOTTOM VIEW



SIDE VIEW

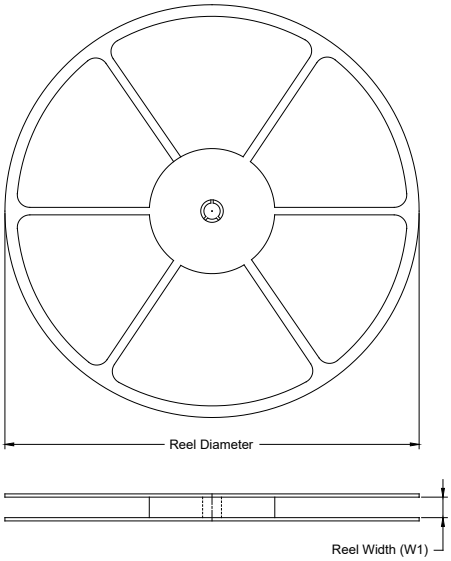


RECOMMENDED LAND PATTERN

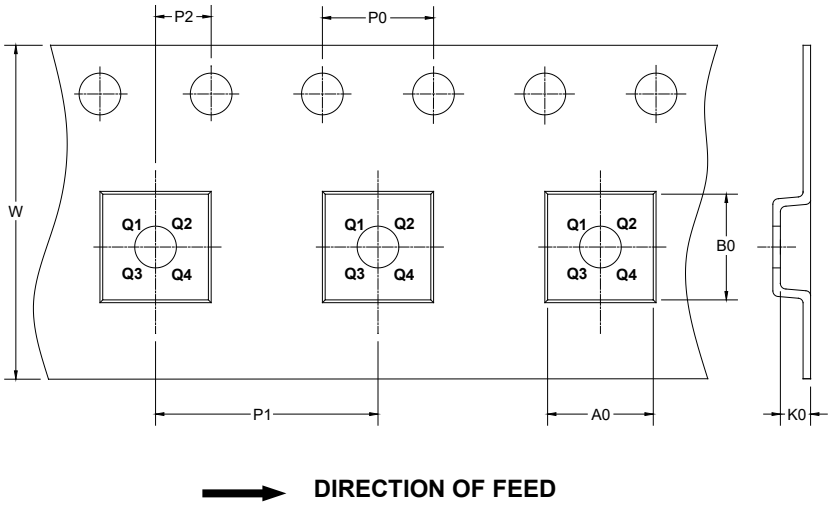
NOTE: All linear dimensions are in millimeters.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



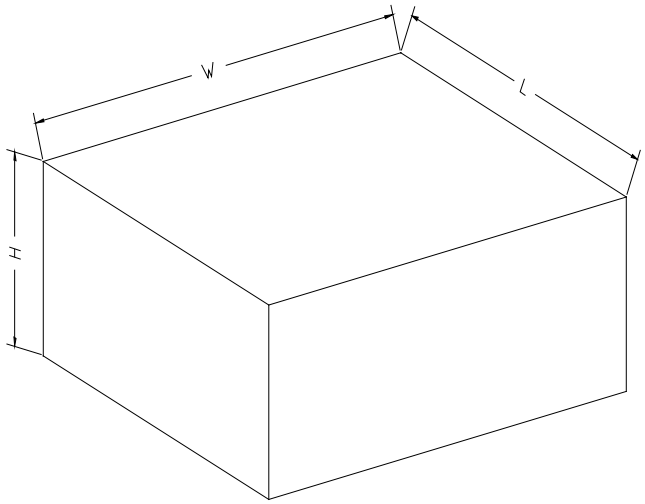
NOTE: The picture is only for reference. Please make the object as the standard.

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