



# SGM7227

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

### GENERAL DESCRIPTION

The SGM7227 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.

SGM7227 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 SGM7227 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 (480 Mbps). 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 (480 Mb/s) with good signal integrity.

The SGM7227 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.

SGM7227 is available in Green UTQFN1.8×1.4-10L and MSOP10 packages. It operates over an ambient temperature range of -40°C to +85°C.

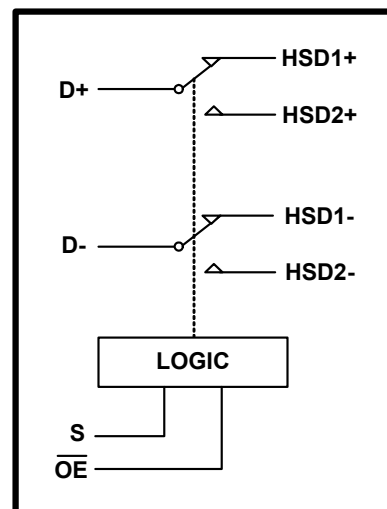
### APPLICATIONS

- Route Signals for USB 2.0
- MP3 and Other Personal Media Players
- Digital Cameras and Camcorders
- Portable Instrumentation
- Set-Top Box
- PDA's

### FEATURES

- $R_{ON}$  is Typically 5Ω at 3.0V
- Voltage Operation: 1.8V to 4.3V
- Fast Switching Times:
  - $t_{ON}$  15ns
  - $t_{OFF}$  20ns
- Crosstalk: -30dB at 250MHz
- Off-Isolation: -35dB at 250MHz
- Rail-to-Rail Input and Output Operation
- Break-Before-Make Switching
- Extended Industrial Temperature Range: -40°C to +85°C
- Available in Green UTQFN1.8×1.4-10L and MSOP10 Packages

### BLOCK DIAGRAM



**PACKAGE/ORDERING INFORMATION**

MODEL	PIN-PACKAGE	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKAGE OPTION
SGM7227	MSOP10	-40°C to +85°C	SGM7227YMS10G/TR	SGM7227YMS10	Tape and Reel, 3000
	UTQFN1.8×1.4-10L	-40°C to +85°C	SGM7227YUWQ10G/TR	7227	Tape and Reel, 3000

**ABSOLUTE MAXIMUM RATINGS**

V <sub>CC</sub> to GND.....	0V to 4.6V	Storage Temperature.....	-65°C to +150°C
Analog, Digital voltage range .....	-0.3V to (V <sub>CC</sub> ) + 0.3V	Lead Temperature (soldering, 10s).....	260°C
Continuous Current HSDn or Dn.....	±50mA	ESD Susceptibility	
Peak Current HSDn or Dn.....	±100mA	HBM (UTQFN1.8×1.4-10L).....	4000V
Operating Temperature Range.....	-40°C to +85°C	MM (UTQFN1.8×1.4-10L) .....	400V
Junction Temperature.....	150°C		

**NOTE:**

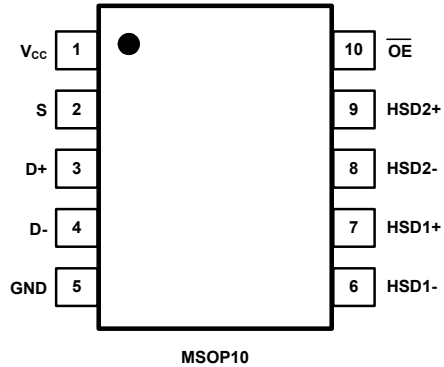
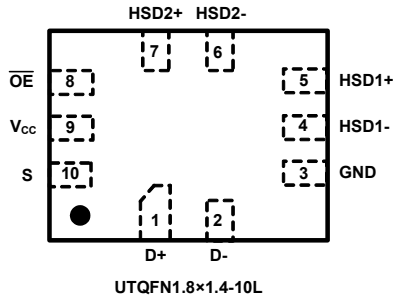
Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**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.

**PIN CONFIGURATIONS (TOP VIEW)**



**PIN DESCRIPTION**

PIN		NAME	FUNCTION
UTQFN1.8x1.4-10L	MSOP10		
9	1	V <sub>CC</sub>	Power Supply
3	5	GND	Ground
10	2	S	Select Input
8	10	OE	Output Enable
5	7	HSD1+	Multiplexed Source Inputs
4	6	HSD1-	Multiplexed Source Inputs
7	9	HSD2+	Multiplexed Source Inputs
6	8	HSD2-	Multiplexed Source Inputs
1	3	D+	USB Data Bus
2	4	D-	USB Data Bus

**FUNCTION TABLE**

OE	S	HSD1+, HSD1-	HSD2+, HSD2-
0	0	ON	OFF
0	1	OFF	ON
1	x	OFF	OFF

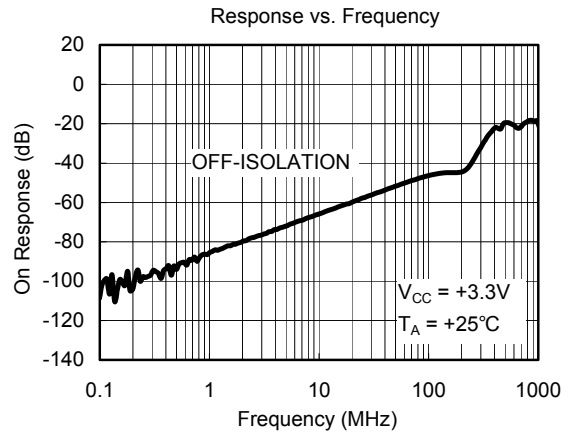
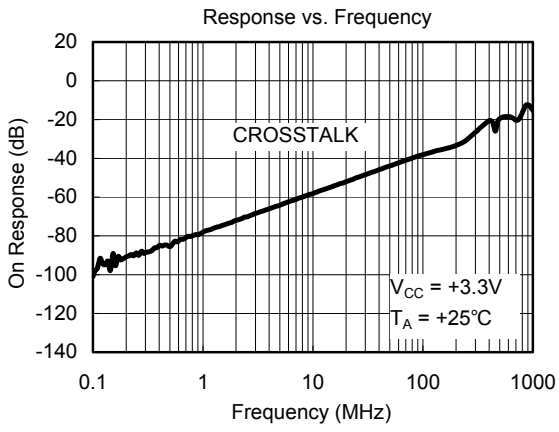
Switches Shown For Logic "0" Input

**ELECTRICAL CHARACTERISTICS**(V<sub>CC</sub> = +3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.)

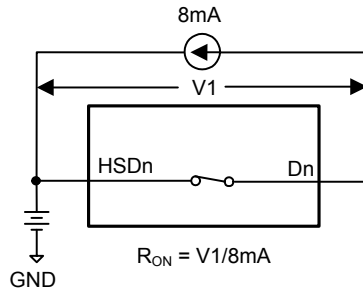
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>						
Analog I/O Voltage (HSD1+, HSD1-, HSD2+, HSD2-)	V <sub>IS</sub>		0		V <sub>CC</sub>	V
On-Resistance	R <sub>ON</sub>	V <sub>CC</sub> = 3.0V, V <sub>IS</sub> = 0V to 0.4V, I <sub>D</sub> = 8mA, Test Circuit 1		5	9	Ω
On-Resistance Match Between Channels	ΔR <sub>ON</sub>	V <sub>CC</sub> = 3.0V, V <sub>IS</sub> = 0V to 0.4V, I <sub>D</sub> = 8mA, Test Circuit 1		0.3	0.8	Ω
On-Resistance Flatness	R <sub>FLAT(ON)</sub>	V <sub>CC</sub> = 3.0V, V <sub>IS</sub> = 0V to 1.0V, I <sub>D</sub> = 8mA, Test Circuit 1		1	2	Ω
Power Off Leakage Current (D+, D-)	I <sub>OFF</sub>	V <sub>CC</sub> = 0V, V <sub>D</sub> = 0V to 3.6V, V <sub>S</sub> , V <sub>OE</sub> = 0V or 3.6V			1	μA
Increase in I <sub>CC</sub> per Control Voltage	I <sub>CC</sub> T	V <sub>CC</sub> = 3.6V, V <sub>S</sub> or V <sub>OE</sub> = 2.6V			5	μA
Source Off Leakage Current	I <sub>HSD2(OFF)</sub> , I <sub>HSD1(OFF)</sub>	V <sub>CC</sub> = 3.6V, V <sub>IS</sub> = 3.3V/ 0.3V, V <sub>D</sub> = 0.3V/ 3.3V			1	μA
Channel On Leakage Current	I <sub>HSD2(ON)</sub> , I <sub>HSD1(ON)</sub>	V <sub>CC</sub> = 3.6V, V <sub>IS</sub> = 3.3V/ 0.3V, V <sub>D</sub> = 3.3V/ 0.3V or floating			1	μA
<b>DIGITAL INPUTS</b>						
Input High Voltage	V <sub>IH</sub>		1.6			V
Input Low Voltage	V <sub>IL</sub>				0.5	V
Input Leakage Current	I <sub>IN</sub>	V <sub>CC</sub> = 3.0V, V <sub>S</sub> , V <sub>OE</sub> = 0V or V <sub>CC</sub>			1	μA
<b>DYNAMIC CHARACTERISTICS</b>						
Turn-On Time	t <sub>ON</sub>	V <sub>IS</sub> = 0.8V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF, Test Circuit 2		15		ns
Turn-Off Time	t <sub>OFF</sub>			20		ns
Break-Before-Make Time Delay	t <sub>D</sub>	V <sub>IS</sub> = 0.8V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF, Test Circuit 3		3.5		ns
Propagation Delay	t <sub>PD</sub>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF		0.5		ns
Off Isolation	O <sub>ISO</sub>	Signal = 0dBm, R <sub>L</sub> = 50Ω, f = 250MHz, Test Circuit 4		-35		dB
Channel-to-Channel Crosstalk	X <sub>TALK</sub>	Signal = 0dBm, R <sub>L</sub> = 50Ω, f = 250MHz, Test Circuit 5		-30		dB
-3dB Bandwidth	BW	Signal = 0dBm, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, Test Circuit 6		550		MHz
Channel-to-Channel Skew	t <sub>SKEW</sub>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF		130		ps
Charge Injection Select Input to Common I/O	Q	V <sub>G</sub> = GND, C <sub>L</sub> = 1.0nF, R <sub>G</sub> = 0Ω, Q = C <sub>L</sub> × V <sub>OUT</sub> , Test Circuit 7		10		pC
HSD+, HSD-, D+, D- ON Capacitance	C <sub>ON</sub>	f = 1MHz		6.5		pF
		f = 250MHz		7		
<b>POWER REQUIREMENTS</b>						
Power Supply Range	V <sub>CC</sub>		1.8		4.3	V
Power Supply Current	I <sub>CC</sub>	V <sub>CC</sub> = 3.0V, V <sub>S</sub> , V <sub>OE</sub> = 0V or V <sub>CC</sub>			1	μA

Specifications subject to changes without notice.

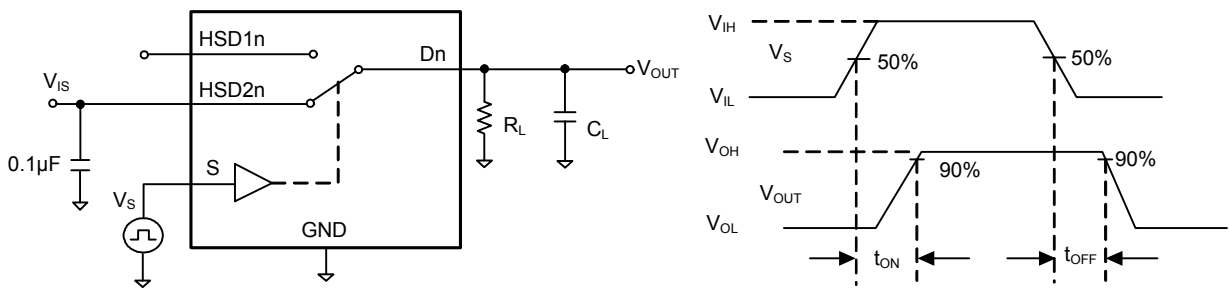
TYPICAL PERFORMANCE CHARACTERISTICS



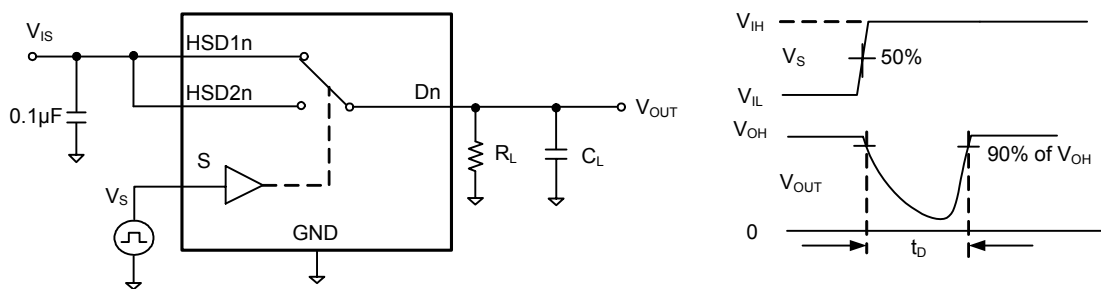
TEST CIRCUITS



Test Circuit 1. On Resistance

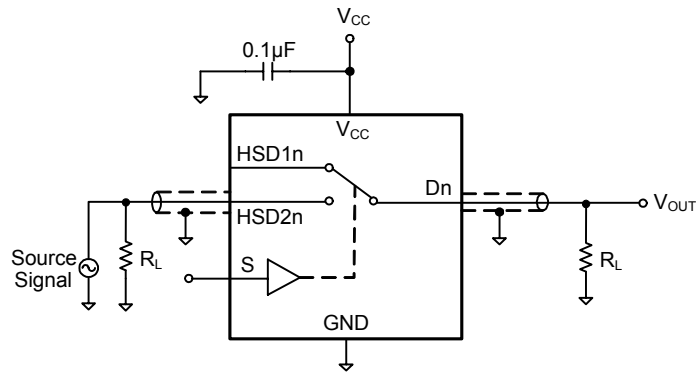


Test Circuit 2. Switching Times ( $t_{ON}$ ,  $t_{OFF}$ )

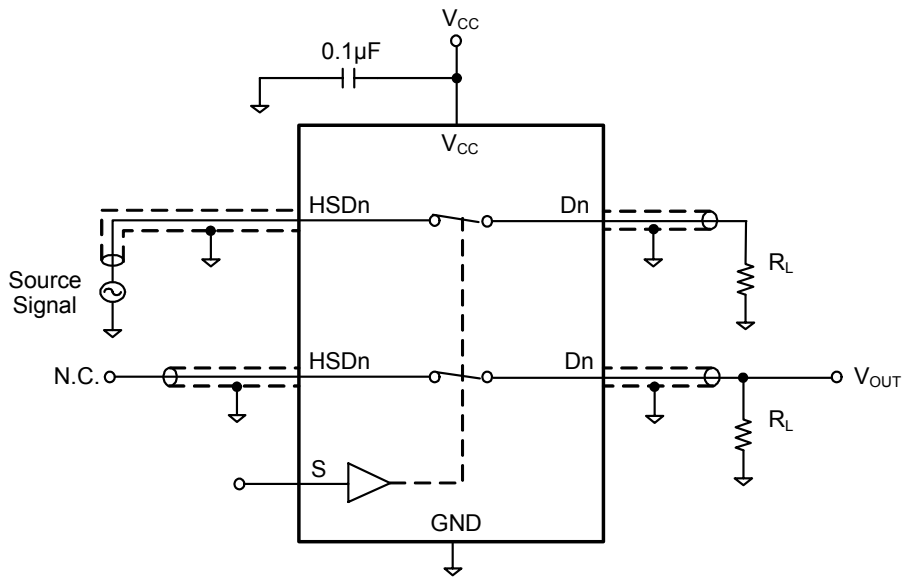


Test Circuit 3. Break-Before-Make Time ( $t_D$ )

TEST CIRCUITS (Cont.)



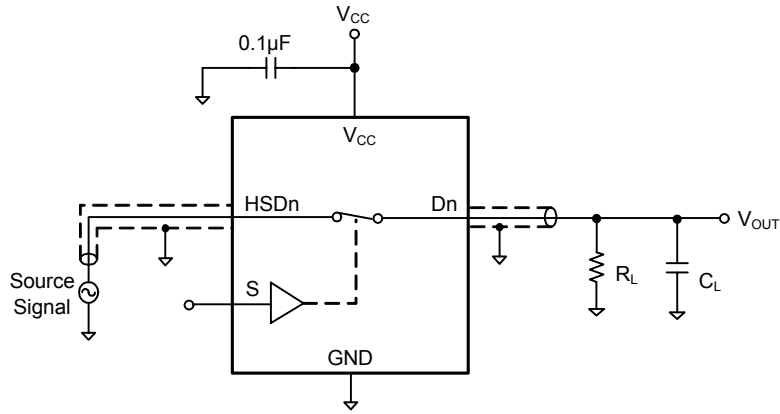
Test Circuit 4. Off Isolation



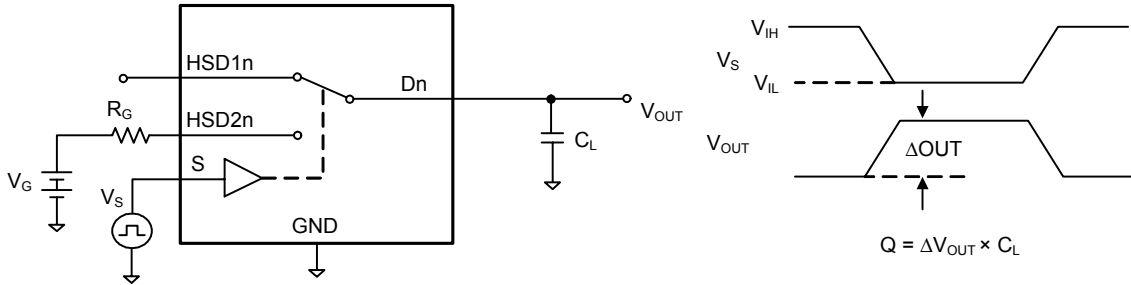
$$\text{Channel To Channel Crosstalk} = -20 \times \log \frac{V_{\text{HSDn}}}{V_{\text{OUT}}}$$

Test Circuit 5. Channel-to-Channel Crosstalk

TEST CIRCUITS (Cont.)



Test Circuit 6. -3dB Bandwidth



Test Circuit 7. Charge Injection (Q)



## APPLICATION NOTES

### Meeting USB 2.0 $V_{BUS}$ Short 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 SGM7227 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  $V_{CC}$  rail during the over-voltage event so current remains within the safe operating range.

SGM7227 USB2.0 Signal Quality Compliance Test Results

Figures 1 and 2 show the test results for USB eye diagram tests.

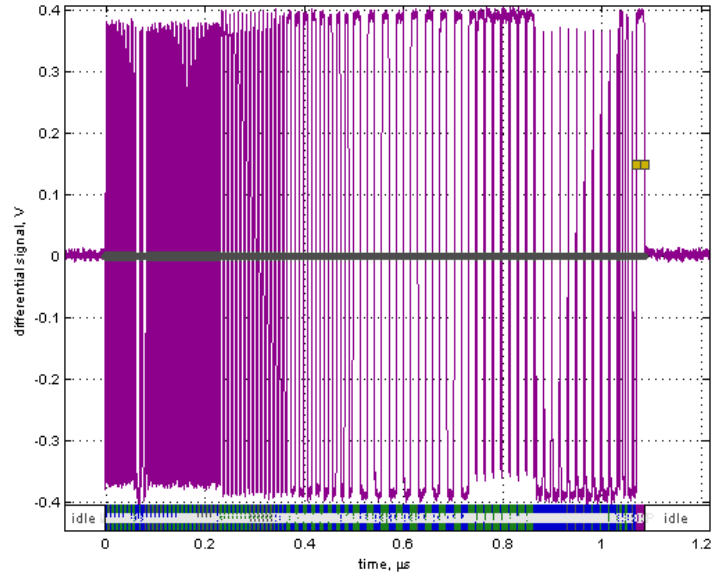


Figure 1. Waveform Plot

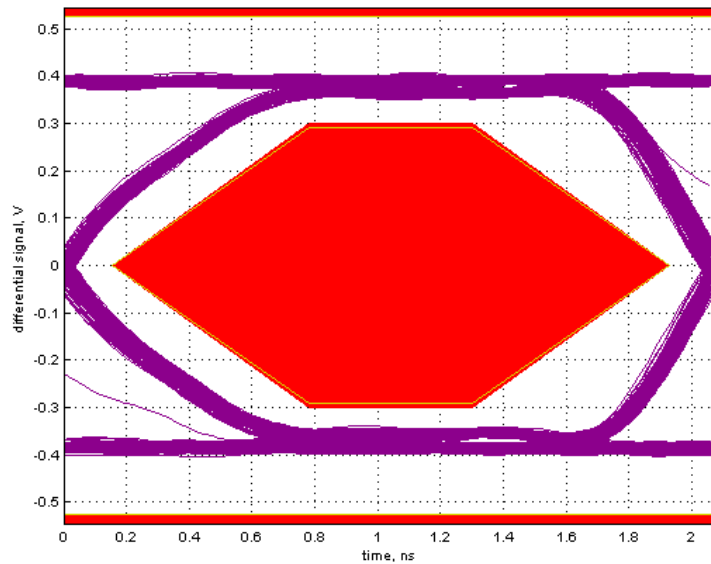


Figure 2. High Speed Signal Quality Eye Diagram Test (V+ = 3.3V)

The following is a summary of the USB test Results. The SGM7227 passes the high speed signal quality, eye diagram and jitter tests.

**Required Tests**

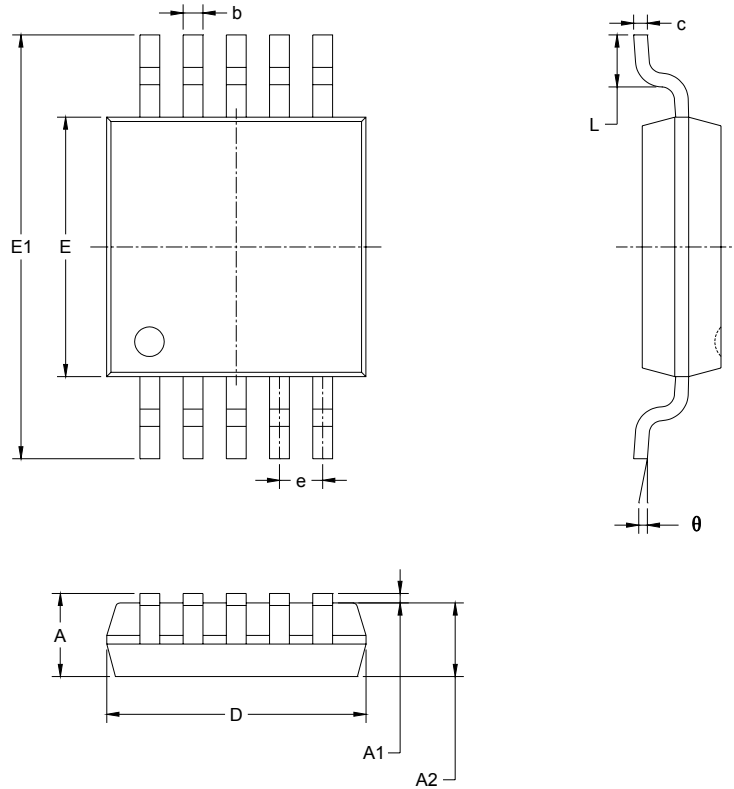
- Overall result:  
Pass!
- Signal eye:  
Eye passes
- EOP width: 7.91 bits  
EOP width passes
- Measured signaling rate: 480.0551 MHz  
Signal rate passes
- Rising Edge Rate: 901.28 V/us (710.10 ps equivalent risetime)  
Passes
- Falling Edge Rate: 889.18 V/us (719.77 ps equivalent risetime)  
Passes

**Additional Information**

Consecutive jitter range: -61.770 ps to 39.668 ps, RMS jitter 21.900 ps  
Paired JK jitter range: -47.800 ps to 42.890 ps, RMS jitter 21.591 ps  
Paired KJ jitter range: -50.590 ps to 49.704 ps, RMS jitter 23.281 ps

PACKAGE OUTLINE DIMENSIONS

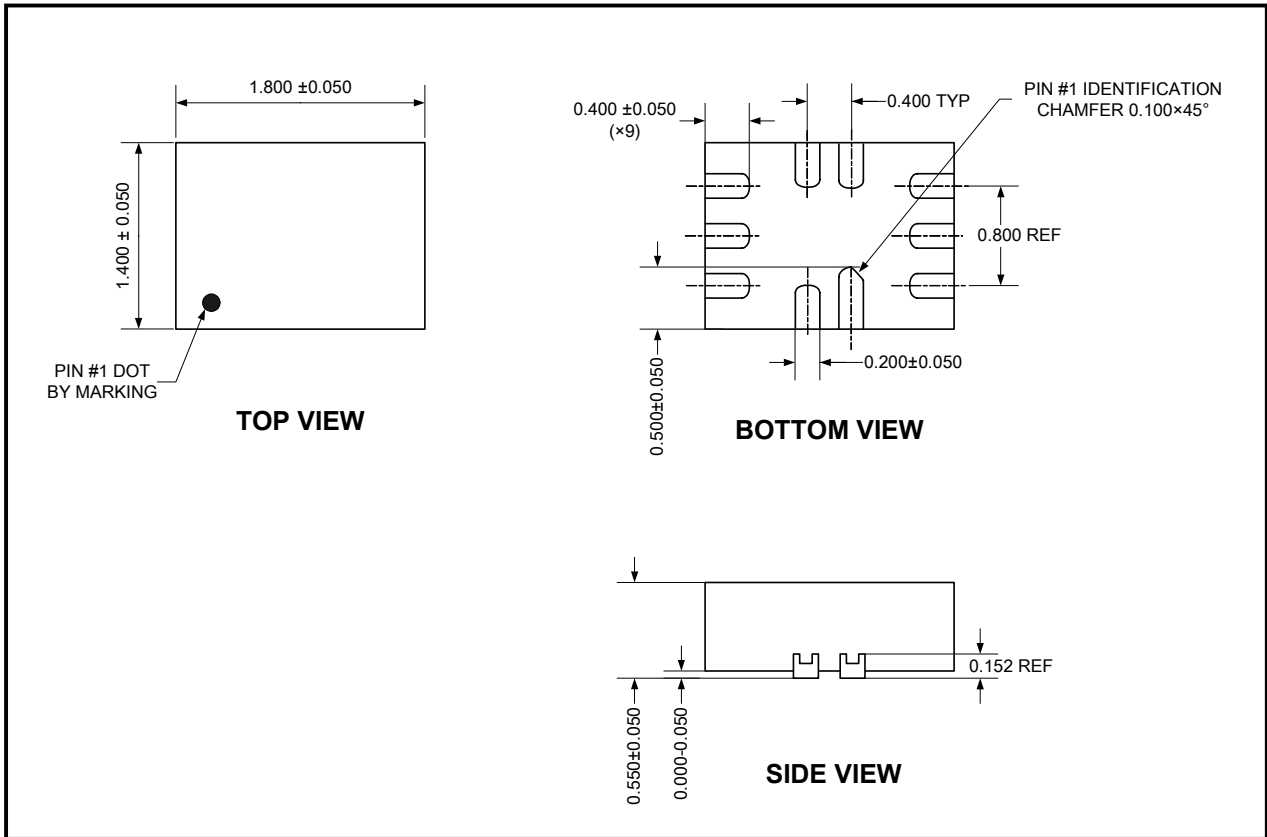
MSOP10



Symbol	Dimensions In Millimeters		Dimensions 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
$\theta$	0°	6°	0°	6°

PACKAGE OUTLINE DIMENSIONS

UTQFN1.8x1.4-10L



NOTE: All linear dimensions are in millimeters.

REV. A

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