

# High-Speed USB 2.0 (480-Mbps) 1:2 Multiplexer/Demultiplexer Switch

## FEATURES

- **-3dB Bandwidth: 550MHz**
- **Supply Range: +1.8V to +5.5V**
- **R<sub>ON</sub> is Typically 6Ω**
- **Fast Switching Times:**  
t<sub>ON</sub> 20ns  
t<sub>OFF</sub> 15ns
- **Break-Before-Make Switching**
- **Low Power Consumption (1μA Maximum)**
- **Rail-to-Rail Input and Output Operation**
- **Extended Industrial Temperature Range:**  
-40°C to +85°C
- **Micro SIZE PACKAGES: MSOP-10, QFN-1.4×1.8-10L**

## APPLICATIONS

- Routes Signals for USB 1.0, 1.1, and 2.0
- MP3 and Other Personal Media Players
- Portable Instrumentation
- USB Switching
- Digital Cameras
- Set-Top Box
- Cell Phones
- PDAs

## DESCRIPTION

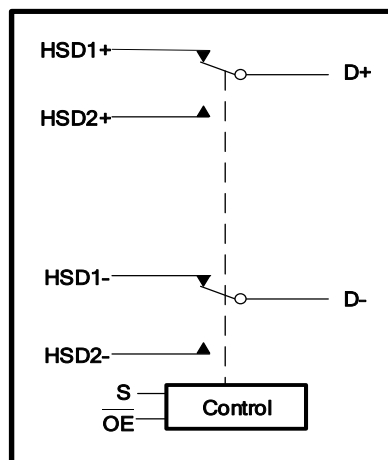
The RS2227 is a high-speed, low-power double-pole/double-throw (DPDT) analog switch with single Enable. It is designed to operate from 1.8 V to 5.5 V.

The RS2227 has a bus-switch enable pin,  $\overline{OE}$ , that can place the signal paths in high impedance. This allows the user to isolate the bus when it is not in use and consume less current.

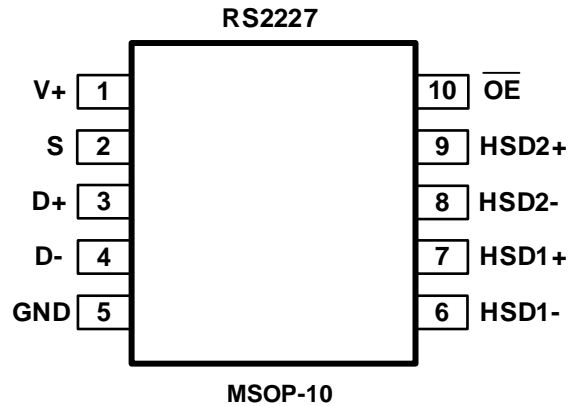
The RS2227 is a high-bandwidth switch specially designed for the switching of high-speed USB2.0 signals in handset and consumer applications, such as cell phones, digital cameras, and notebooks with hubs or controllers with limited USB I/Os.

The RS2227 is available MSOP-10 and QFN-1.4×1.8-10L package. It operates over an ambient temperature range of -40°C to +85°C.

## Functional Block Diagram



## PIN CONFIGURATIONS



### PIN DESCRIPTION

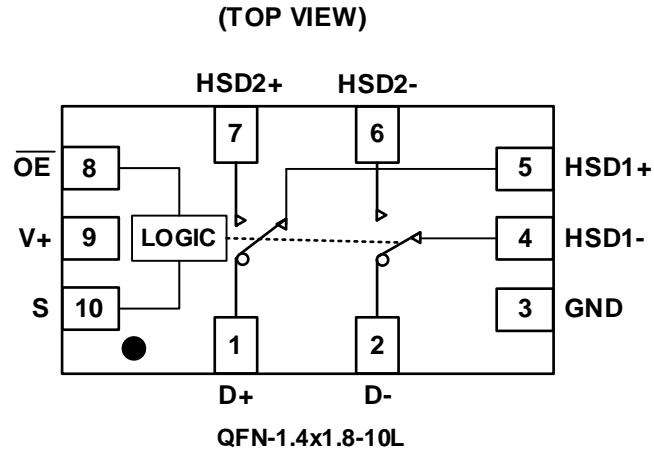
NAME	PIN	FUNCTION
V+	1	Power Supply
GND	5	Ground
S	2	Select Input
$\overline{OE}$	10	Output Enable
HSD1+, HSD2+	7,9	Data Port
HSD1-, HSD2-	6,8	
D+, D-	3,4	

### FUNCTION TABLE

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

X =Don't care

## PIN CONFIGURATIONS



### PIN DESCRIPTION

NAME	PIN	FUNCTION
V+	9	Power Supply
GND	3	Ground
S	10	Select Input
$\overline{OE}$	8	Output Enable
HSD1+, HSD2+	5,7	Data Port
HSD1-, HSD2-	4,6	
D+, D-	1,2	

### FUNCTION TABLE

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

X =Don't care

## SPECIFICATIONS

### Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

SYMBOL	PARAMETER	MIN	MAX	UNIT
V <sub>+</sub>	Supply Voltage	-0.3	6.0	V
	Analog, Digital Voltage Range	-0.3	(V <sub>+</sub> )+0.3	
	Continuous Current HSDn or Dn	-100	+100	mA
I <sub>PEAK</sub>	Peak Current HSDn or Dn	-150	+150	
T <sub>J</sub>	Junction Temperature		150	°C
T <sub>stg</sub>	Storage temperature	-65	+150	

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.3V beyond the supply rails should be current-limited to 10mA or less.

### ESD Ratings

			VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM)	±3000	V
		Machine Model (MM)	±200	V

### Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

SYMBOL	PARAMETER	MIN	MAX	UNIT
V <sub>CC</sub>	Supply Voltage	1.8	5.5	V
T <sub>A</sub>	Operating temperature	-40	+85	°C

### Thermal Information

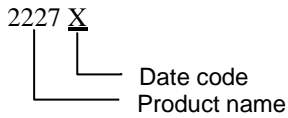
THERMAL METRIC		RS2227		UNIT
		10 PINS		
		MSOP-10	QFN-1.4x1.8-10L	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	180.7	120	°C/W
R <sub>θJC(top)</sub>	Junction-to-case(top) thermal resistance	66.2	46.0	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	103.2	44.5	°C/W
Ψ <sub>JT</sub>	Junction-to-top characterization parameter	11.2	1.5	°C/W
Ψ <sub>JB</sub>	Junction-to-board characterization parameter	101.3	44.5	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case(bottom) thermal resistance	N/A	31.2	°C/W

**PACKAGE/ORDERING INFORMATION**

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING <sup>(1/2)</sup>	PACKAGE OPTION
RS2227	RS2227XN	-40°C ~+85°C	MSOP-10	RS2227	Tape and Reel,4000
	RS2227XUTQK10	-40°C ~+85°C	QFN-1.4x1.8-10L	2227 <u>X</u>	Tape and Reel,4000

**NOTE:**

- (1) There may be additional marking, which relates to the lot trace code information(data code and vendor code), the logo or the environmental category on the device.  
 (2) X = Date Code

**MARKING INFORMATION**


## ELECTRICAL CHARACTERISTICS

(V+ = +1.8V to +5.5V, GND = 0V, V<sub>IH</sub> = +1.5V, V<sub>IL</sub> = +0.5V, T<sub>A</sub> = -40°C to +85°C. Typical values are at V+ = +3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	T <sub>A</sub>	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog I/O Voltage (HSD1+, HSD1-, HSD2+, HSD2-)	V <sub>IS</sub>		-40°C to +85°C	0		V+	V
On-Resistance	R <sub>ON</sub>	V+ = 3.0V, V <sub>IS</sub> = 0V to 0.4V, I <sub>D</sub> = 8mA, Test Circuit 1	+25°C		6	10	Ω
			-40°C to +85°C			10.5	
On-Resistance Match Between Channels	ΔR <sub>ON</sub>	V+ = 3.0V, V <sub>IS</sub> = 0V to 0.4V, I <sub>D</sub> = 8mA, Test Circuit 1	+25°C		0.15	0.6	Ω
			-40°C to +85°C			1.6	Ω
On-Resistance Flatness	R <sub>FLAT(ON)</sub>	V+ = 3.0V, V <sub>IS</sub> = 0V to 1.0V, I <sub>D</sub> = 8mA, Test Circuit 1	+25°C		5	7	Ω
			-40°C to +85°C			8	
Power Off Leakage Current (D+, D-)	I <sub>OFF</sub>	V+ = 0V, V <sub>D</sub> = 0V to 3.6 V, V <sub>S</sub> , V <sub>OE</sub> = 0V or 3.6 V	-40°C to +85°C			1	μA
Increase in I <sub>+</sub> per Control Voltage	I <sub>CCT</sub>	V+ = 4.3V, V <sub>S</sub> or V <sub>OE</sub> = 2.6 V	-40°C to +85°C			40	μA
Source Off Leakage Current	I <sub>HSD2(OFF)</sub> I <sub>HSD1(OFF)</sub>	V+ = 3.6V, V <sub>IS</sub> = 3.3V/ 0.3V, V <sub>D</sub> = 0.3V/ 3.3V	-40°C to +85°C			1	μA
Channel On Leakage Current	I <sub>HSD2(ON)</sub> I <sub>HSD1(ON)</sub>	V+ = 3.6V, V <sub>IS</sub> = 3.3V/ 0.3V, V <sub>D</sub> = 0.3V/ 3.3V or floating	-40°C to +85°C			1	μA
<b>DIGITAL CONTROL INPUTS<sup>(1)</sup></b>							
Input High Voltage	V <sub>IH</sub>		-40°C to +85°C	1.6			V
Input Low Voltage	V <sub>IL</sub>		-40°C to +85°C			0.5	V
Input Leakage Current	I <sub>IN</sub>	V+ = 3.0V, V <sub>S</sub> , V <sub>OE</sub> = 0V or V+	-40°C to +85°C			1	μA

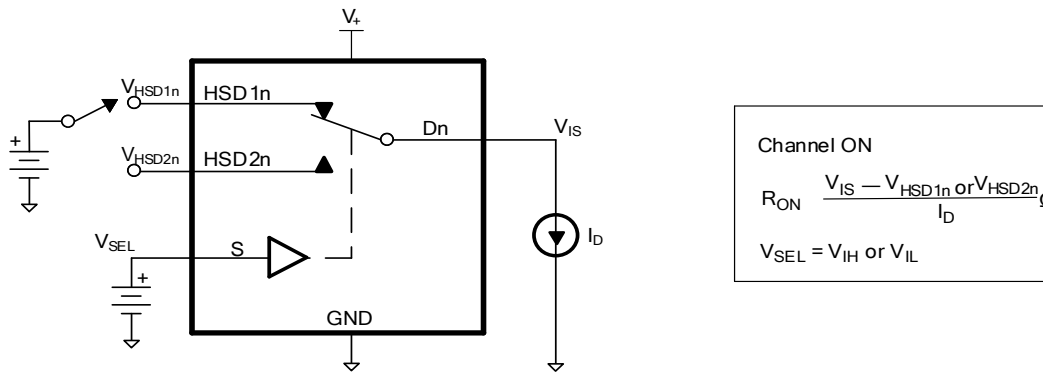
(1) All unused digital inputs of the device must be held at V<sub>IO</sub> or GND to ensure proper device operation.

**ELECTRICAL CHARACTERISTICS (continued)**

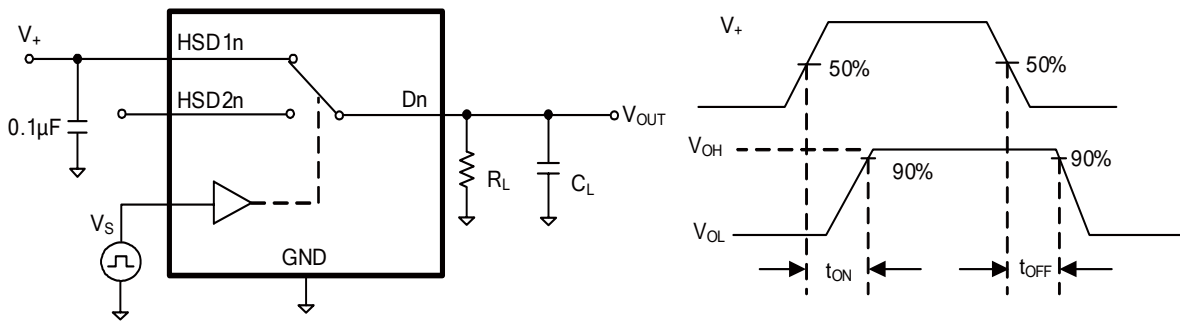
(V+ = +1.8V to +5.5V, GND = 0V, V<sub>IH</sub> = +1.5V, V<sub>IL</sub> = +0.5V, T<sub>A</sub> = -40°C to +85°C. Typical values are at V+ = +3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
<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	+25°C		20		ns
Turn-Off Time	t <sub>OFF</sub>		+25°C		15		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	+25°C		4		ns
Propagation Delay	t <sub>PD</sub>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF	+25°C		0.35		ns
Off Isolation	O <sub>ISO</sub>	Signal = 0dBm, R <sub>L</sub> = 50Ω, f = 250MHz, Test Circuit 4	+25°C		-35		dB
Channel-to-Channel Crosstalk	X <sub>TALK</sub>	Signal = 0dBm, R <sub>L</sub> = 50Ω, f = 250MHz, Test Circuit 5	+25°C		-40		dB
-3dB Bandwidth	BW	Signal = 0dBm, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, Test Circuit 6	+25°C		550		MHz
Channel-to-Channel Skew	t <sub>SKEW</sub>	R <sub>L</sub> = 50Ω, C <sub>L</sub> = 10pF	+25°C		0.05		ns
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	+25°C		11		pC
HSD+, HSD-, D+, D- ON Capacitance	C <sub>ON</sub>		+25°C		7		pF
<b>POWER REQUIREMENTS</b>							
Power Supply Range	V+		-40°C to +85°C	1.8		5.5	V
Power Supply Current	I+	V+ = 3.0V, V <sub>S</sub> , V <sub>OE</sub> = 0V or V+	-40°C to +85°C			1	μA

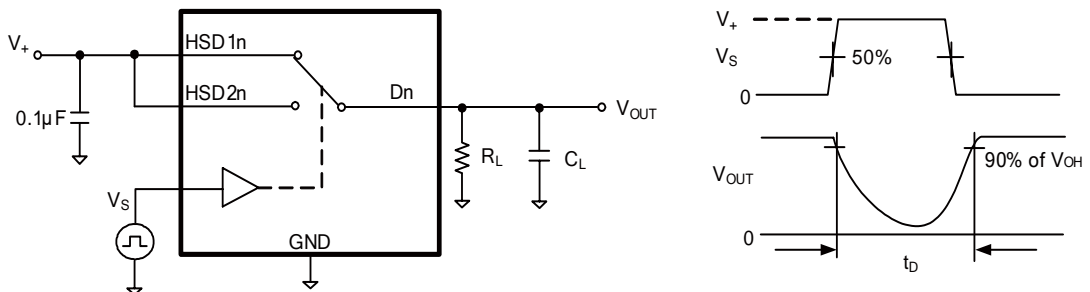
### Parameter Measurement Information



**Test Circuit 1. ON-State Resistance ( $R_{ON}$ )**



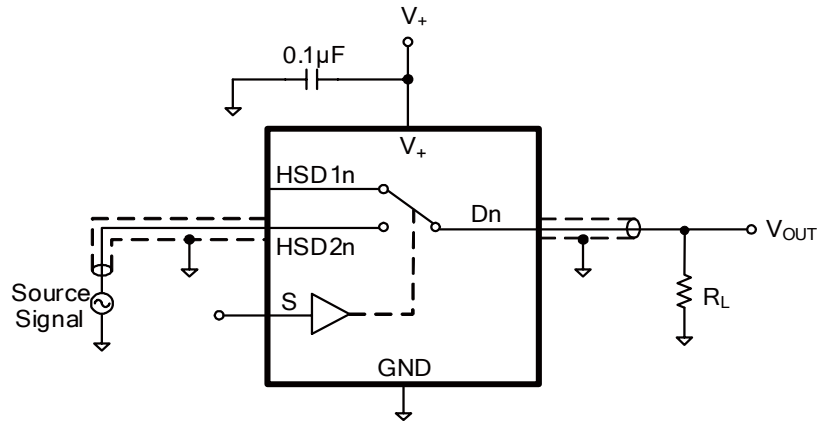
**Test Circuit 2. Turn-On ( $t_{ON}$ ) and Turn-Off Time ( $t_{OFF}$ )**



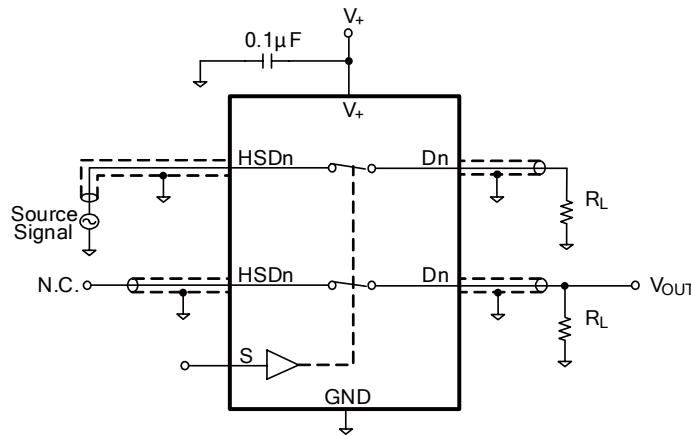
**Test Circuit 3. Break-Before-Make Time ( $t_b$ )**



## Parameter Measurement Information

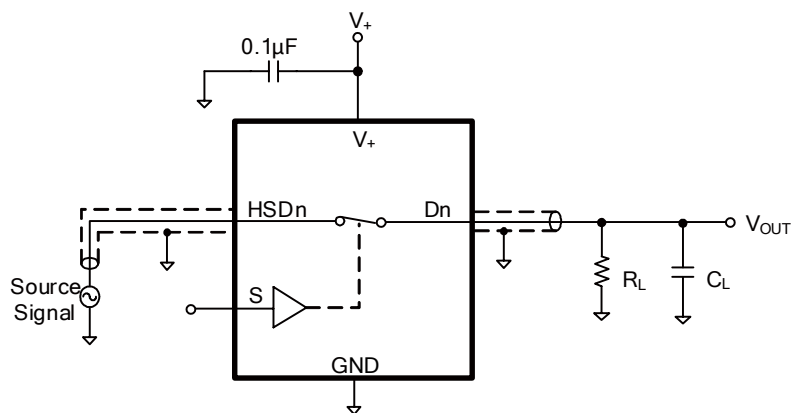


**Test Circuit 4.OFF Isolation ( $O_{iso}$ )**



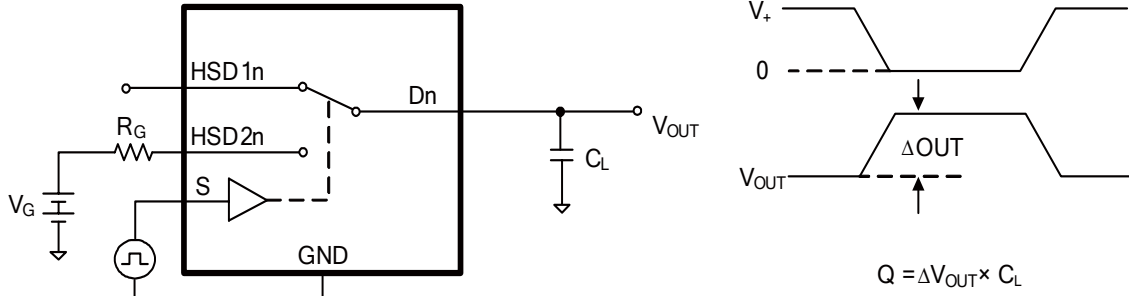
$$\text{Channel To Channel Crosstalk} = -20 \times \log \frac{V_{HSDn}}{V_{OUT}}$$

**Test Circuit 5. Channel-to-Channel Crosstalk**



**Test Circuit 6. -3dB Bandwidth**

### Parameter Measurement Information



**Test Circuit 7. Charge Injection(Q)**

### APPLICATION NOTES

There are many USB applications in which the USB hubs or controllers have a limited number of USB I/Os. The RS2227 solution can effectively expand the limited USB I/Os by switching between multiple USB buses in order to interface them to a single USB hub or controller. RS2227 can also be used to connect a single controller to two USB connectors or controllers.

Design requirements of the USB 1.0, 1.1, and 2.0 standards should be followed. It is recommended that the digital control pins S and  $\overline{OE}$  be pulled up to V+ or down to GND to avoid undesired switch positions that could result from the floating pin.

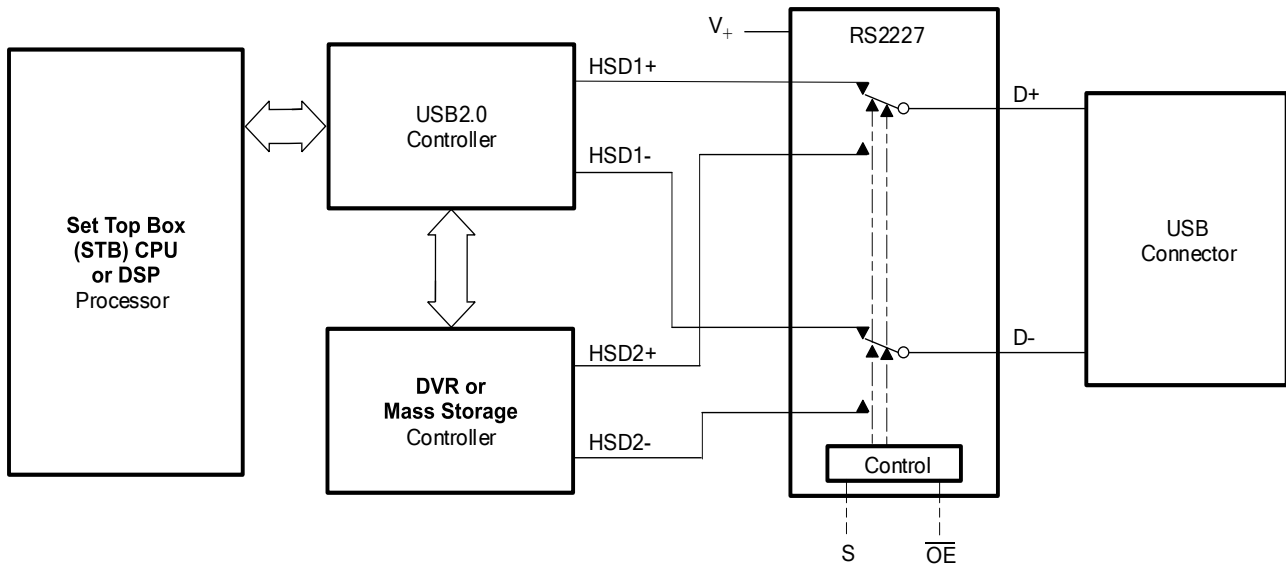
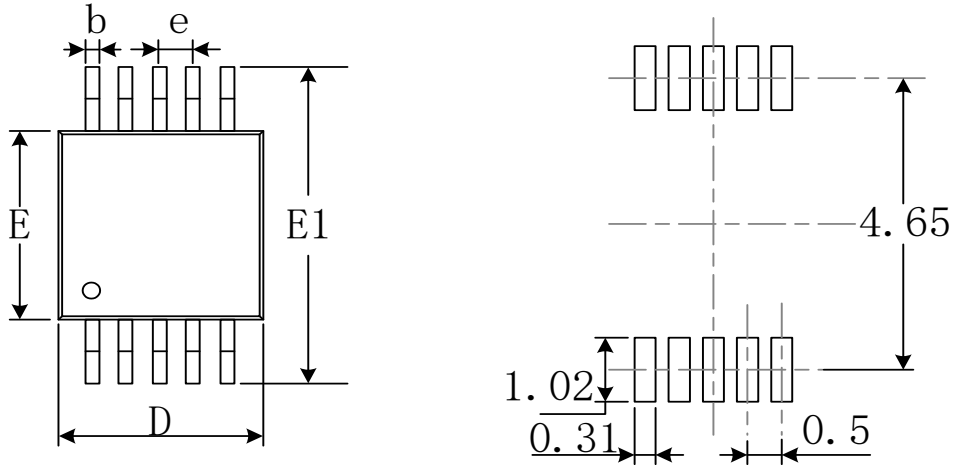


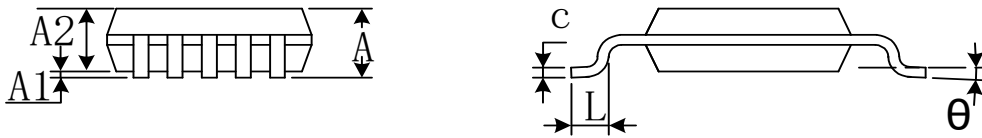
Figure 1. Application Diagram

# PACKAGE OUTLINE DIMENSIONS

## MSOP-10

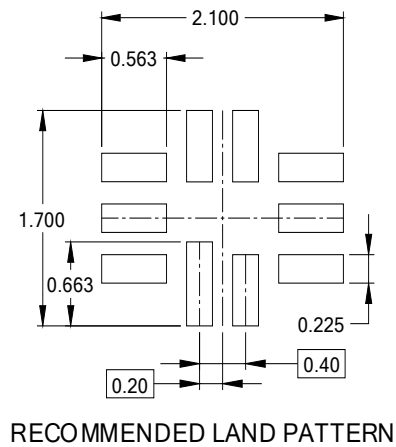
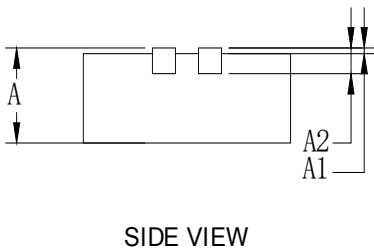
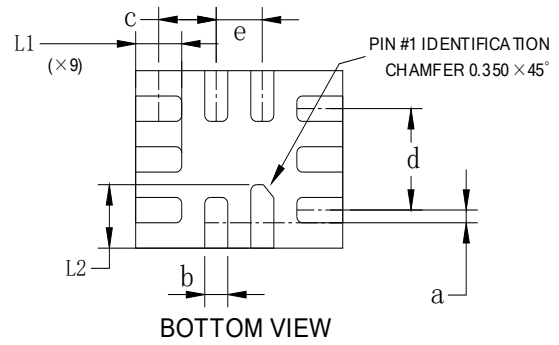
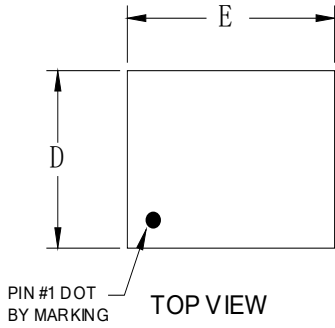


**RECOMMENDED LAND PATTERN (Unit: mm)**



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	0.50(BSC)		0.020(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

# QFN-1.4x1.8-10L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.500	0.600	0.020	0.024
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
a	0.050	0.150	0.002	0.006
b	0.150	0.250	0.006	0.010
c	0.450	0.550	0.018	0.022
d	0.800 REF		0.031 REF	
D	1.350	1.450	0.053	0.057
E	1.750	1.850	0.069	0.073
e	0.400 TYP		0.016 TYP	
L1	0.350	0.450	0.014	0.018
L2	0.450	0.550	0.018	0.022