

# 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: QFN-1.4×1.8-10L,MSOP-10**

## 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

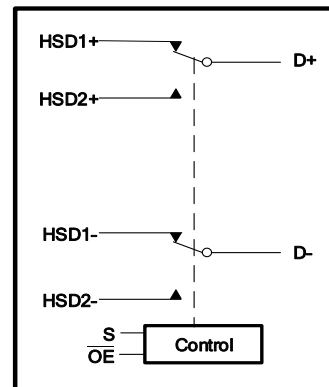
The RS2228 is a high-speed, low-power double-pole/double-throw (DPDT) analog switch with single Enable. It is designed to operate from 1.8 V to 5.5 V.

The RS2228 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.

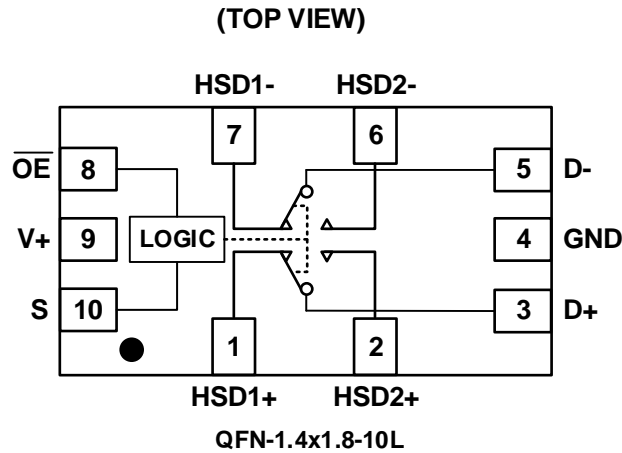
The RS2228 is a high-bandwidth switch specially designed for the switching of high-speed USB2.0 signals in handset and consumer applications, such as cell phones, digital cameras, and notebooks with hubs or controllers with limited USB I/Os.

The RS2228 is available QFN-1.4x1.8-10L and MSOP-10 package. It operates over an ambient temperature range of -40°C to +85°C.

## Functional Block Diagram



## PIN CONFIGURATIONS



## PIN DESCRIPTION

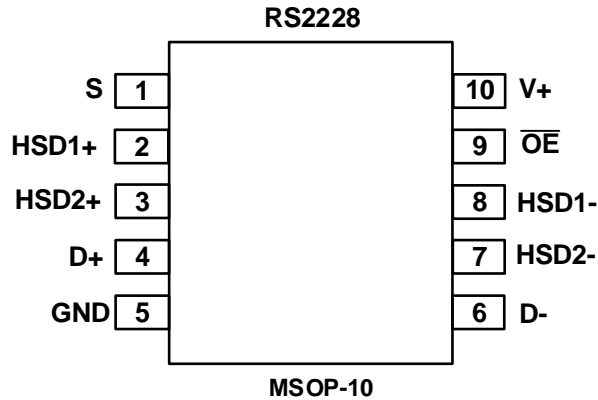
NAME	PIN	FUNCTION
V+	9	Power Supply
GND	4	Ground
S	10	Select Input
$\overline{OE}$	8	Output Enable
HSD1+, HSD2+	1,2	Data Port
HSD1-, HSD2-	7,6	
D+, D-	3,5	

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

## 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

**ABSOLUTE MAXIMUM RATINGS (1)**

V+ to GND.....	0V to 6V
Analog, Digital Voltage Range (2) .....	- 0.3 to (V+) + 0.3V
Continuous Current HSDn or Dn.....	±100mA
Peak Current HSDn or Dn.....	±150mA
Storage Temperature .....	-65°C to +150°C
Operating Temperature .....	-40°C to +85°C
Junction Temperature.....	+150°C
Package Thermal Resistance @ TA = +25°C	
QFN-1.4×1.8-10L.....	120°C/W
MSOP-10.....	204°C/W
Lead Temperature (Soldering, 10s) .....	260°C
ESD Susceptibility	
HBM .....	3000V
MM .....	200V


**ESD SENSITIVITY CAUTION**

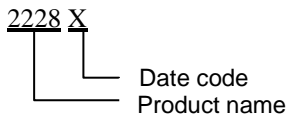
ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

- (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.

**PACKAGE/ORDERING INFORMATION**

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING	PACKAGE OPTION
RS2228	RS2228XN	-40°C ~+85°C	MSOP-10	RS2228	Tape and Reel,3000
	RS2228XUTQK10	-40°C ~+85°C	QFN-1.4x1.8-10L	2228X	Tape and Reel,4000

NOTE: 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 3.6V, V <sub>S</sub> , V <sub>OE</sub> = 0V or 3.6V	-40°C to +85°C			1	μA
Increase in I+ per Control Voltage	I <sub>CCT</sub>	V+ = 3.6V, V <sub>S</sub> or V <sub>OE</sub> = 2.6V	-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

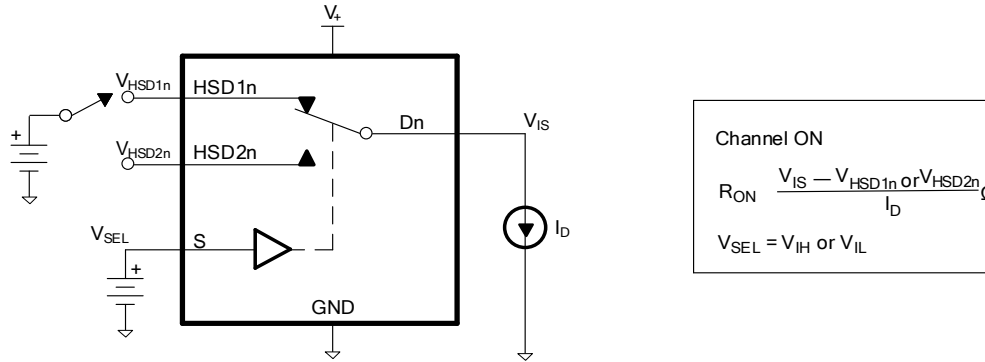
(1) All unused digital inputs of the device must be held at V<sub>IO</sub> or GND to ensure proper device operation.

**ELECTRICAL CHARACTERISTICS (continued)**

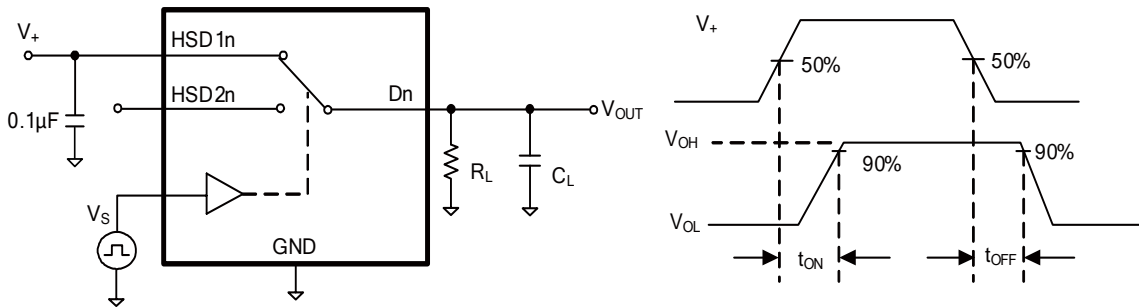
(V<sub>+</sub> = +1.8V to +5.5V, GND = 0V, V<sub>IH</sub> = +1.5V, V<sub>IL</sub> = +0.5V, T<sub>A</sub> = -40°C to +85°C. Typical values are at V<sub>+</sub> = +3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.)

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 <sub>+</sub>		-40°C to +85°C	1.8		5.5	V
Power Supply Current	I <sub>+</sub>	V <sub>+</sub> = 3.0V, V <sub>S</sub> , V <sub>OE</sub> = 0V or V <sub>+</sub>	-40°C to +85°C			1	μA

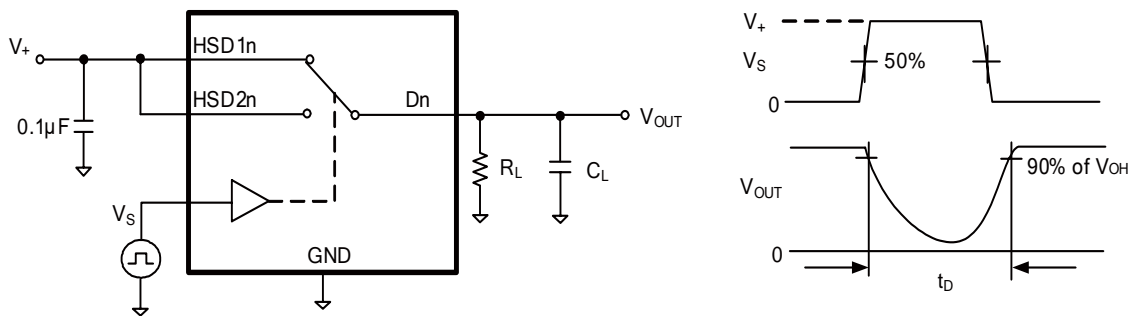
## Parameter Measurement Information



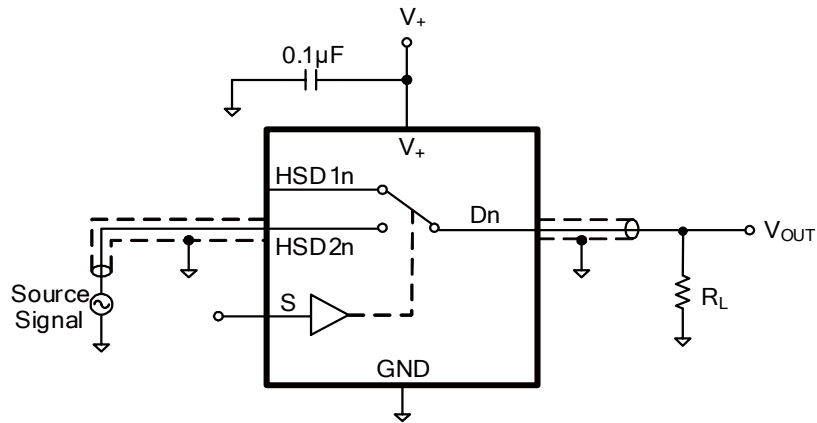
**Test Circuit 1.ON-State Resistance (RON)**



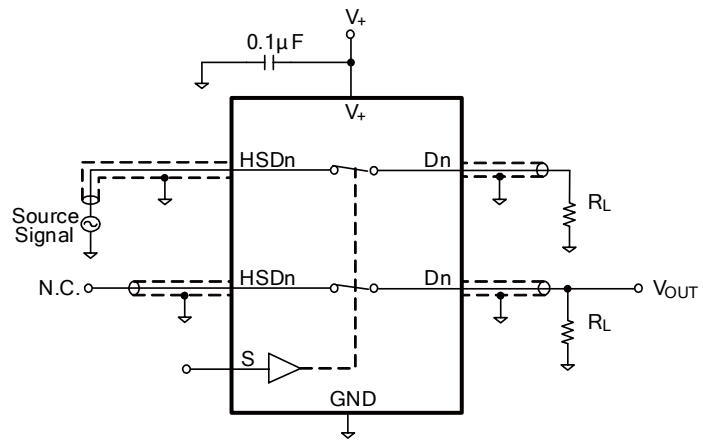
**Test Circuit 2. Turn-On (ton) and Turn-Off Time (toff)**



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

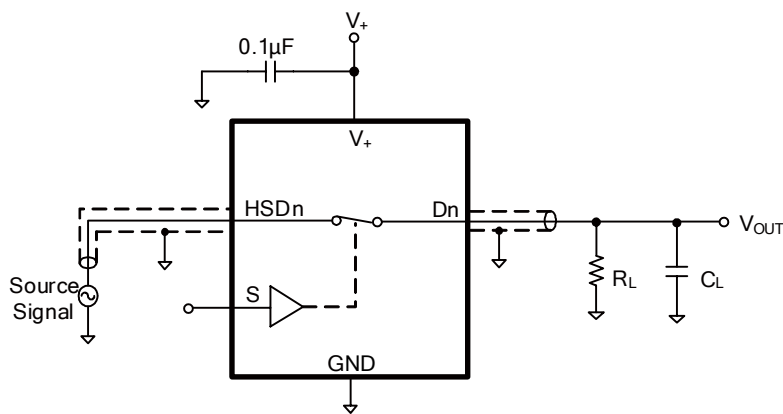


**Test Circuit 4.OFF Isolation ( $O_{iso}$ )**



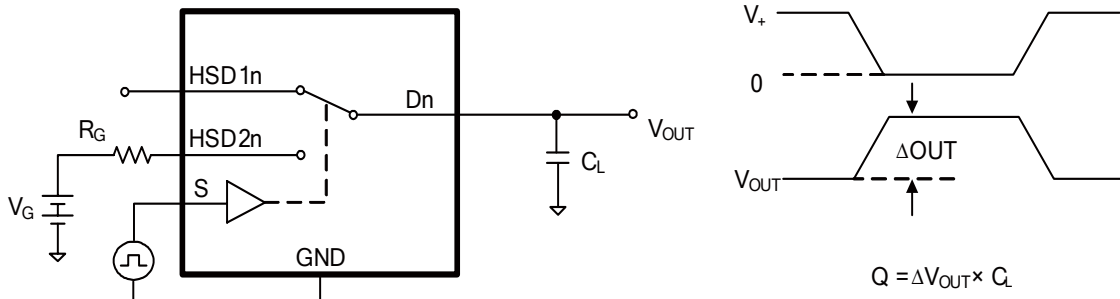
$$\text{Channel To Channel Crosstalk} = -20 \times \log \frac{V_{HSDn}}{V_{OUT}}$$

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



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





**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 RS2228 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. RS2228 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.

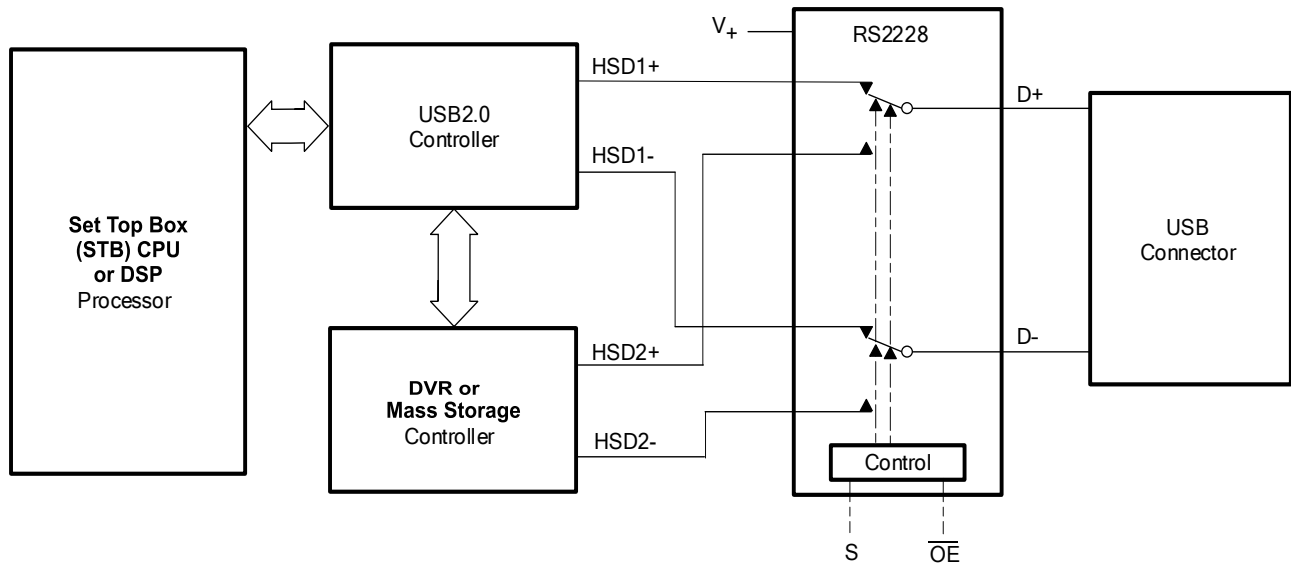
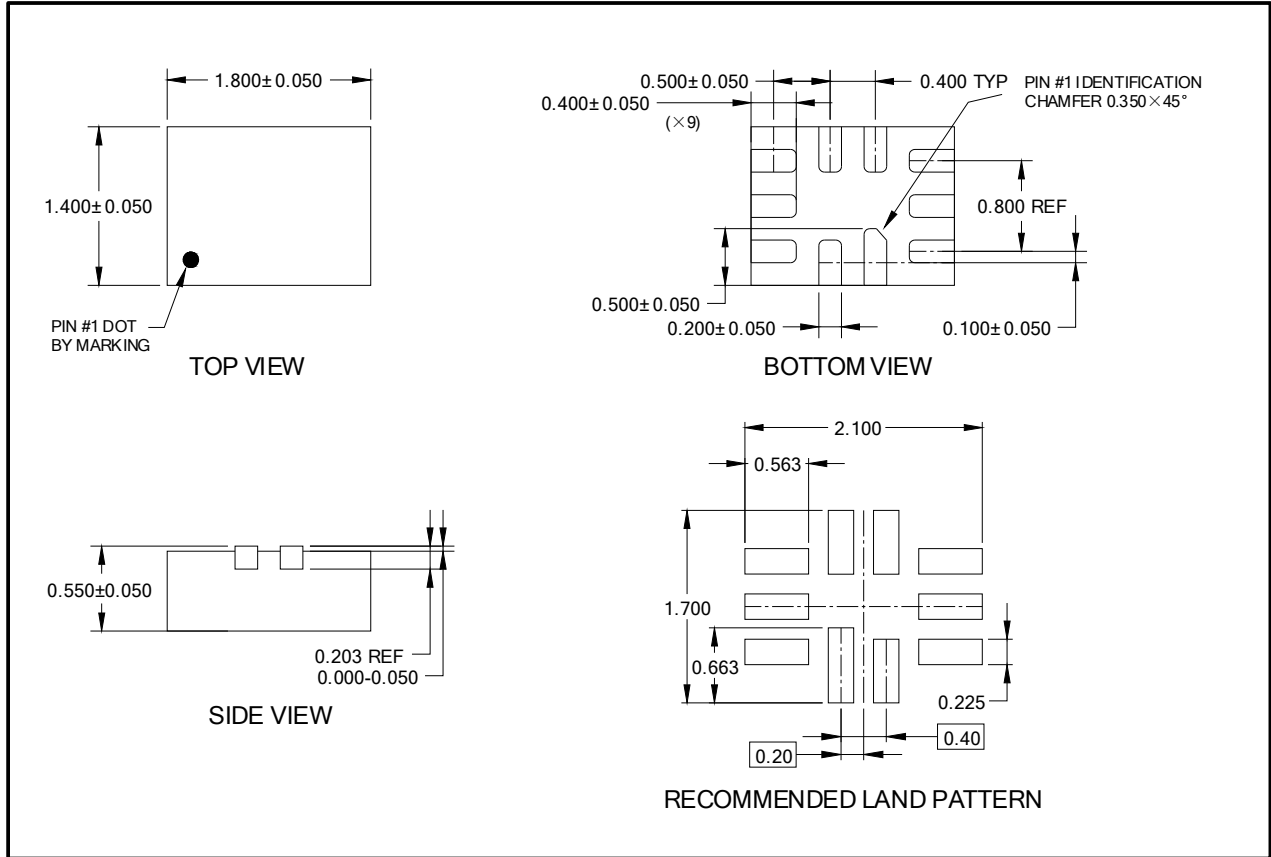


Figure 1. Application Diagram

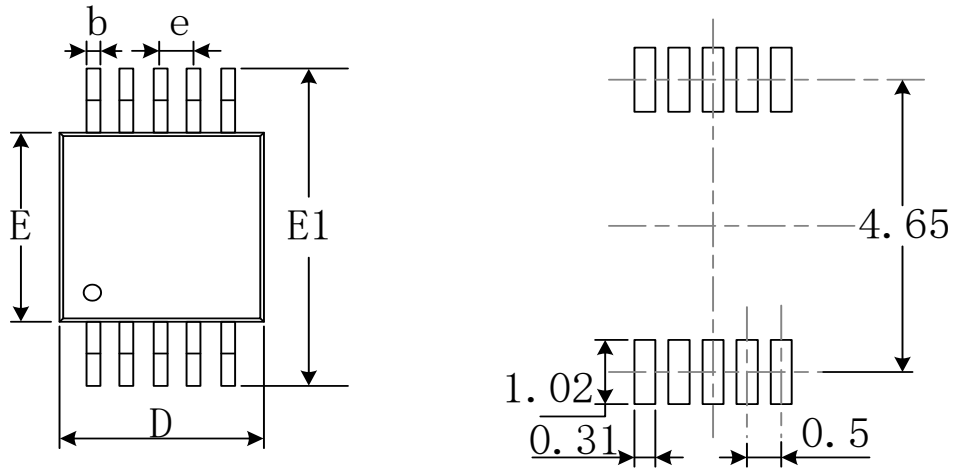
# PACKAGE OUTLINE DIMENSIONS

## QFN-1.4×1.8-10L

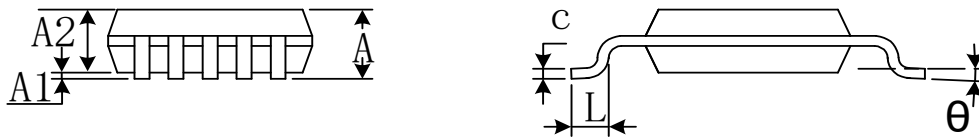


NOTE: All linear dimensions are in millimeters.

# 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
$\theta$	0°	6°	0°	6°