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

1 FEATURES

- **-3dB Bandwidth: 550MHz**
- **Supply Range: +1.8V to +5.5V**
- **R_{ON} is Typically 6Ω**
- **Fast Switching Times:**
  t_{ON} 20ns
  t_{OFF} 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: UQFN1.4X1.8-10, MSOP10**

2 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**

3 DESCRIPTIONS

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.

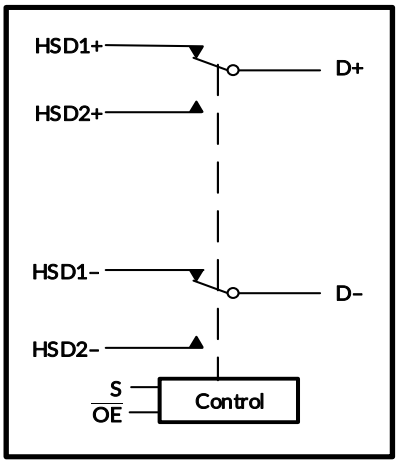
The RS2228 is available UQFN1.4X1.8-10 and MSOP10 package. It operates over an ambient temperature range of -40°C to +85°C.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RS2228	UQFN1.4X1.8-10	1.80mm×1.40mm
	MSOP10	3.00mm×3.00mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

4 FUNCTIONAL BLOCK DIAGRAM



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5 REVISION HISTORY

Note: Page numbers for previous revisions may different from page numbers in the current version.

Version	Change Date	Change Item
C.1	2021/07/06	Changed UQFN1.4X1.8-10 Package Marking in Page 5@B.4 Version
C.1.1	2024/03/11	1. Added the TAPE AND REEL INFORMATION 2. Modify packaging naming
C.2	2024/05/10	1. Add MSL on Page 6@RevC.1.1 2. Add Package thermal impedance on Page 5@RevC.1.1 3. Update PACKAGE note

6 PACKAGE/ORDERING INFORMATION (1)

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING (2)	MSL (3)	PACKAGE OPTION
RS2228	RS2228XN	-40°C ~+85°C	MSOP10	RS2228	MSL3	Tape and Reel, 4000
	RS2228XUTQK10	-40°C ~+85°C	UQFN1.4X1.8-10	2228	MSL3	Tape and Reel, 4000

NOTE:

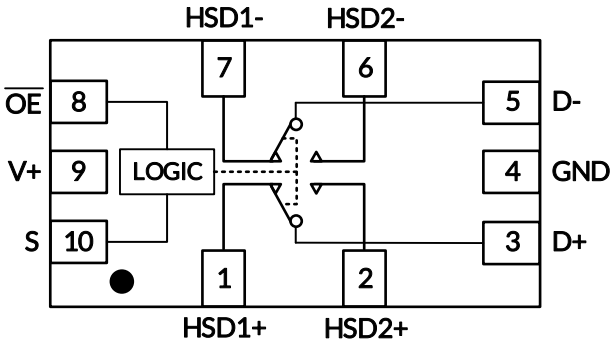
(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(2) 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.

(3) MSL, The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications.

7 PIN CONFIGURATIONS

(TOP VIEW)



UQFN1.4X1.8-10

7.1 Pin Description

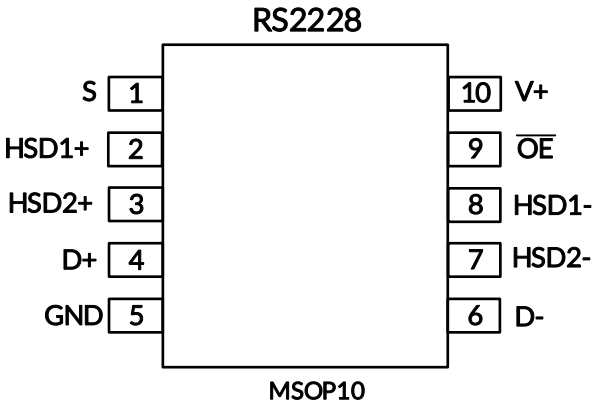
NAME	PIN	FUNCTION
V+	9	Power Supply
GND	4	Ground
S	10	Select Input
$\overline{OE}$	8	Output Enable
HSD1+, HSD2+	1,2	Data Port
HSD1-, HSD2-	7,6	
D+, D-	3,5	

7.2 Function Table

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

Note: 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

Note: X =Don't care

8 SPECIFICATIONS

8.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) (1)

SYMBOL	PARAMETER		MIN	MAX	UNIT
V_+	Supply Voltage		-0.3	6.0	V
	Analog, Digital Voltage Range (2)		-0.3	$(V_+)+0.3$	
	Continuous Current HSDn or Dn		-100	+100	mA
I_{PEAK}	Peak Current HSDn or Dn		-150	+150	
θ_{JA}	Package thermal impedance (3)	MSOP10		200	°C/W
		UQFN1.4X1.8-10		115	
T_J	Junction Temperature (4)		-40	150	°C
T_{stg}	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.
(3) The package thermal impedance is calculated in accordance with JESD-51.
(4) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

8.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-Body Model (HBM)	±3000	V
		Machine Model (MM)	±200	V

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.

8.3 Recommended Operating Conditions

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

SYMBOL	PARAMETER	MIN	MAX	UNIT
V_{CC}	Supply Voltage	1.8	5.5	V
T_A	Operating temperature	-40	+85	°C

8.4 Electrical Characteristics

($V+$ = +1.8V to +5.5V, GND = 0V, V_{IH} = +1.5V, V_{IL} = +0.5V, T_A = -40°C to + 85°C. Typical values are at $V+$ = +3.3V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN(2)	TYP(3)	MAX(2)	UNIT
ANALOG SWITCH							
Analog I/O Voltage (HSD1+, HSD1-, HSD2+, HSD2-)	V_{IS}		-40°C to +85°C	0		V+	V
On-Resistance	R_{ON}	V+ = 3.0V, V_{IS} = 0V to 0.4V, I_D = 8mA, See Figure 1	+25°C		6	10	Ω
			-40°C to +85°C			10.5	
On-Resistance Match Between Channels	ΔR_{ON}	V+ = 3.0V, V_{IS} = 0V to 0.4V, I_D = 8mA, See Figure 1	+25°C		0.15	0.6	Ω
			-40°C to +85°C			1.6	Ω
On-Resistance Flatness	$R_{FLAT(ON)}$	V+ = 3.0V, V_{IS} = 0V to 1.0V, I_D = 8mA, See Figure 1	+25°C		5	7	Ω
			-40°C to +85°C			8	
Power Off Leakage Current (D+, D-)	I_{OFF}	V+ = 0V, V_D = 0V to 3.6 V, V_S, $V_{\overline{OE}}$ = 0V or 3.6 V	-40°C to +85°C			1	μA
Increase in I_{+} per Control Voltage	I_{CCT}	V+ = 3.6V, V_S or $V_{\overline{OE}}$ = 2.6 V	-40°C to +85°C			40	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	-40°C to +85°C			1	μA
Channel On Leakage Current	$I_{HSD2(ON)}$ $I_{HSD1(ON)}$	V+ = 3.6V, V_{IS} = 3.3V/ 0.3V, V_D = 0.3V/ 3.3V or floating	-40°C to +85°C			1	μA
DIGITAL CONTROL INPUTS (1)							
Input High Voltage	V_{IH}		-40°C to +85°C	1.6			V
Input Low Voltage	V_{IL}		-40°C to +85°C			0.5	V
Input Leakage Current	I_{IN}	V+ = 3.0V, V_S, $V_{\overline{OE}}$ = 0V or V+	-40°C to +85°C			1	μA

(1) All unused digital inputs of the device must be held at V_{IO} or GND to ensure proper device operation.
(2) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.
(3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

Electrical Characteristics (continued)

($V+$ = +1.8V to +5.5V, GND = 0V, V_{IH} = +1.5V, V_{IL} = +0.5V, T_A = -40°C to + 85°C. Typical values are at $V+$ = +3.3V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNIT
DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	V_{IS} = 0.8V, R_L = 50Ω, C_L = 10pF, See Figure 2	+25°C		20		ns
Turn-Off Time	t_{OFF}		+25°C		15		ns
Break-Before-Make Time Delay	t_D	V_{IS} = 0.8V, R_L = 50Ω, C_L = 10pF, See Figure 3	+25°C		4		ns
Propagation Delay	t_{PD}	R_L = 50Ω, C_L = 10pF	+25°C		0.35		ns
Off Isolation	O_{ISO}	Signal = 0dBm, R_L = 50Ω, f = 250MHz, See Figure 4	+25°C		-35		dB
Channel-to-Channel Crosstalk	X_{TALK}	Signal = 0dBm, R_L = 50Ω, f = 250MHz, See Figure 5	+25°C		-40		dB
-3dB Bandwidth	BW	Signal = 0dBm, R_L = 50Ω, C_L = 5pF, See Figure 6	+25°C		550		MHz
Channel-to-Channel Skew	t_{SKEW}	R_L = 50Ω, C_L = 10pF	+25°C		0.05		ns
Charge Injection Select Input to Common I/O	Q	V_G = GND, C_L = 1.0nF, R_G = 0Ω, Q = C_L x V_{OUT}, See Figure 7	+25°C		11		pC
HSD+, HSD-, D+, D- ON Capacitance	C_{ON}		+25°C		7		pF
POWER REQUIREMENTS							
Power Supply Range	V_+		-40°C to +85°C	1.8		5.5	V
Power Supply Current	I_+	$V+$ = 3.0V, V_S, $V_{\overline{OE}}$ = 0V or $V+$	-40°C to +85°C			1	µA

9 PARAMETER MEASUREMENT INFORMATION

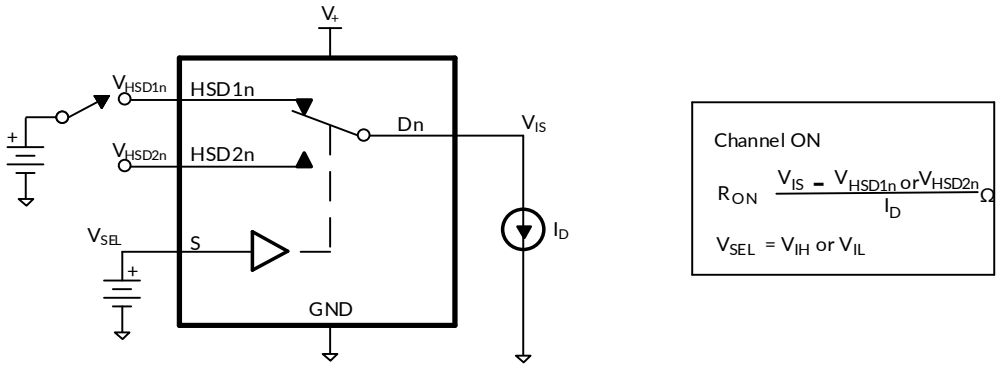


Figure 1. ON-State Resistance (R_{ON})

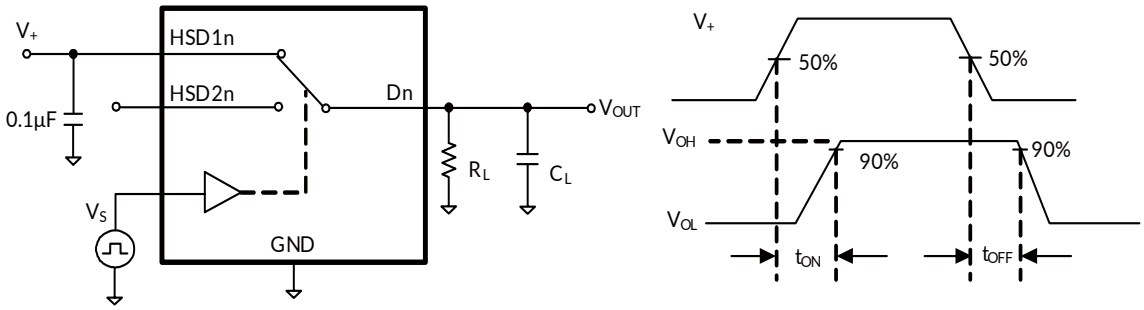


Figure 2. Turn-On (t_{ON}) and Turn-Off Time (t_{OFF})

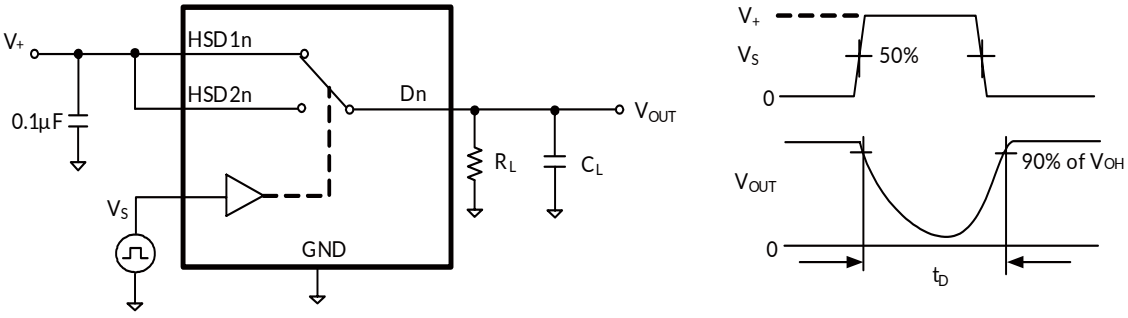


Figure 3. Break-Before-Make Time (t_D)

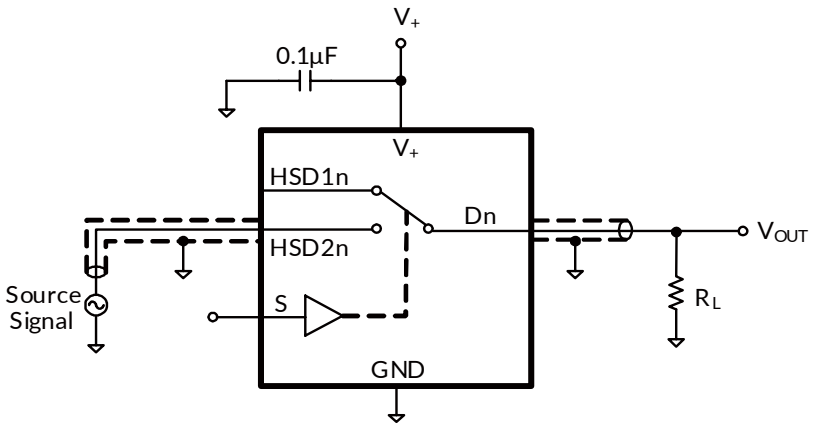


Figure 4. OFF Isolation (O_{ISO})

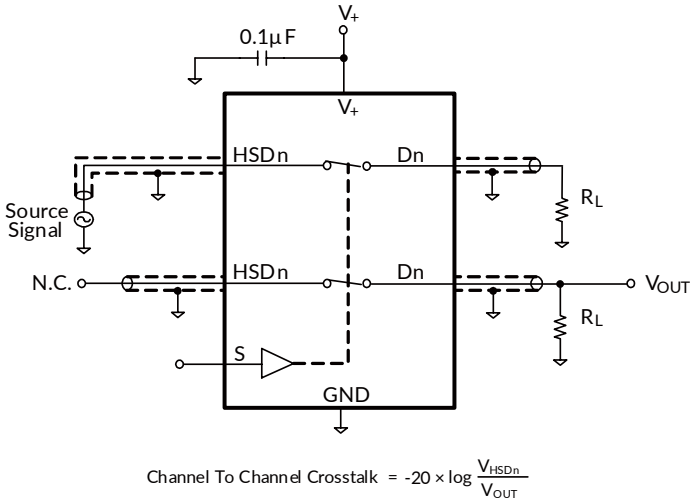


Figure 5. Channel-to-Channel Crosstalk

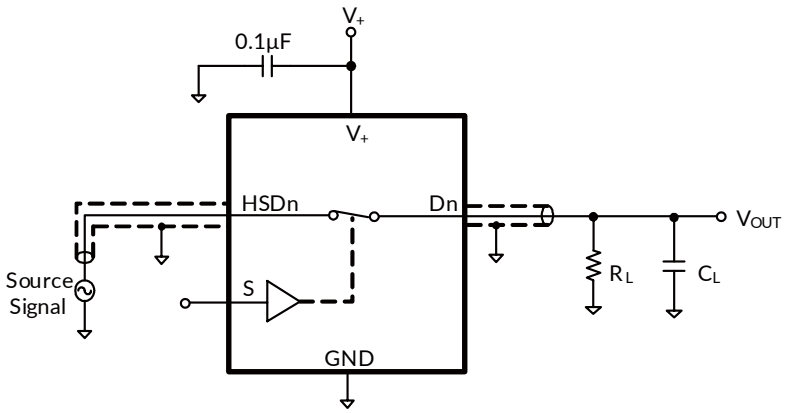


Figure 6. -3dB Bandwidth

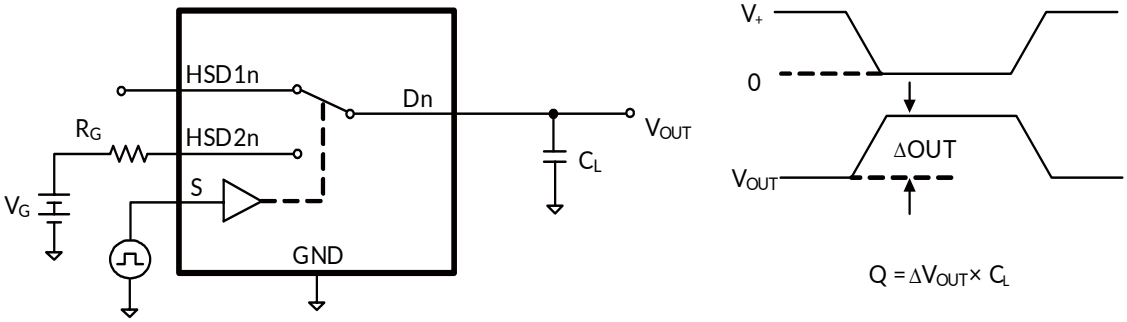


Figure 7. Charge Injection(Q)

10 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.

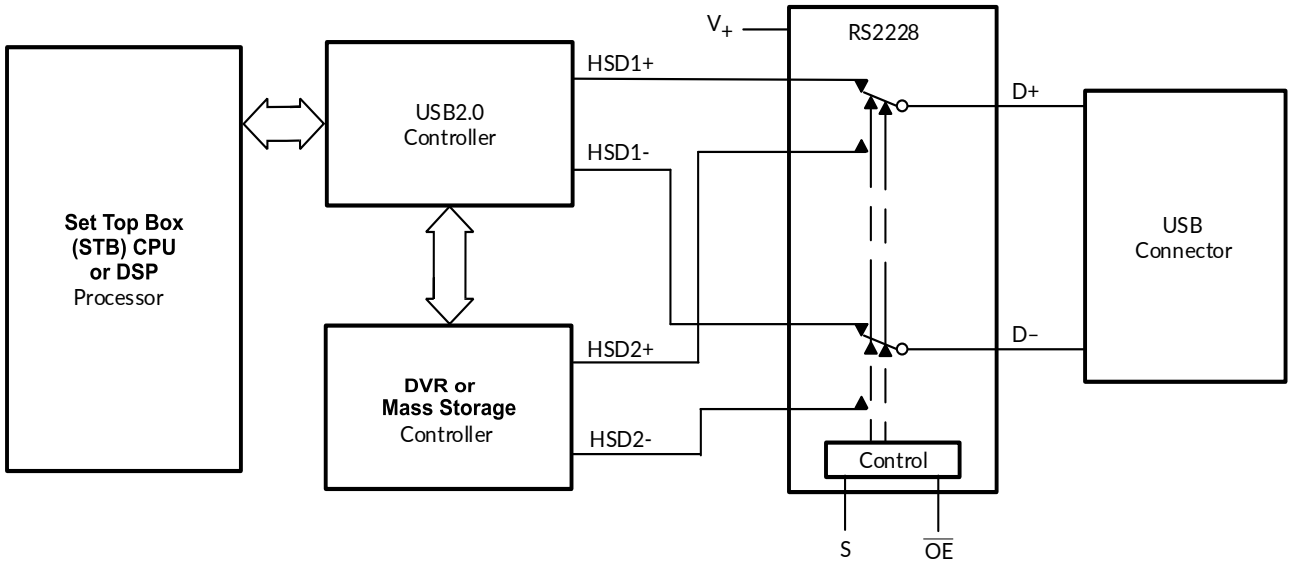
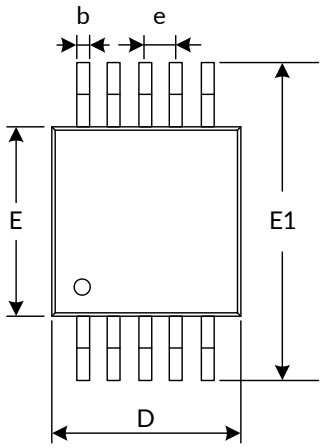
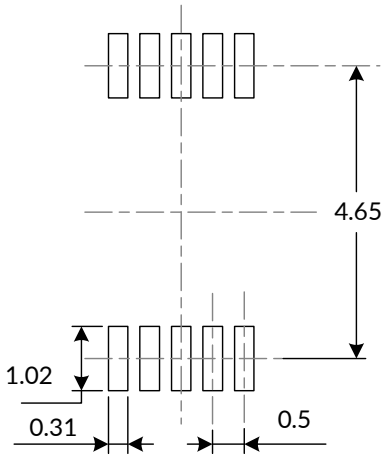


Figure 8. Application Diagram

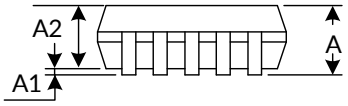
11 PACKAGE OUTLINE DIMENSIONS

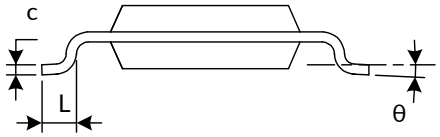
MSOP10 (3)





RECOMMENDED LAND PATTERN (Unit: mm)



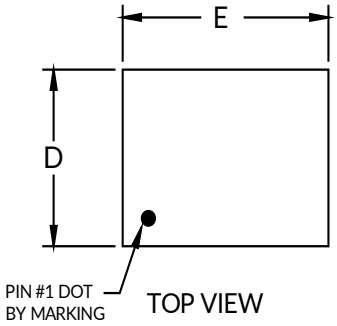


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.180	0.280	0.007	0.011
c	0.090	0.230	0.004	0.009
D (1)	2.900	3.100	0.114	0.122
e	0.500(BSC) (2)		0.020(BSC) (2)	
E (1)	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

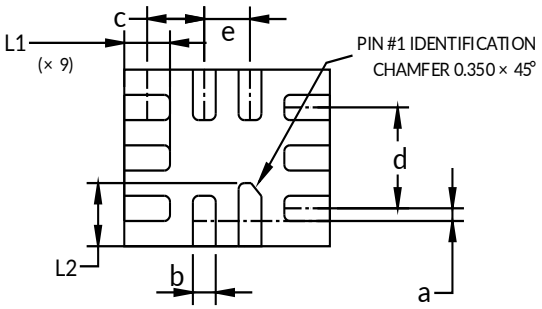
NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

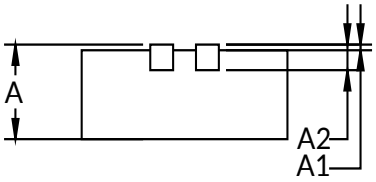
UQFN1.4X1.8-10 (3)



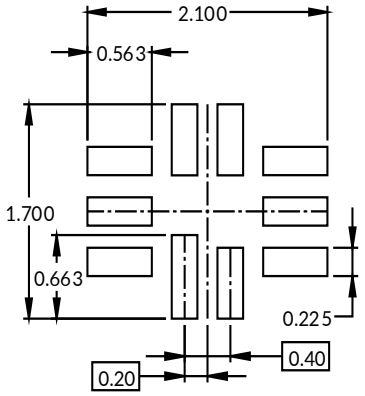
TOP VIEW



BOTTOM VIEW



SIDE VIEW



RECOMMENDED LAND PATTERN

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)	0.500	0.600	0.020	0.024
A1	0.000	0.050	0.000	0.002
A2	0.203 REF (2)		0.008 REF (2)	
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 (2)		0.031 REF (2)	
D (1)	1.350	1.450	0.053	0.057
E (1)	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

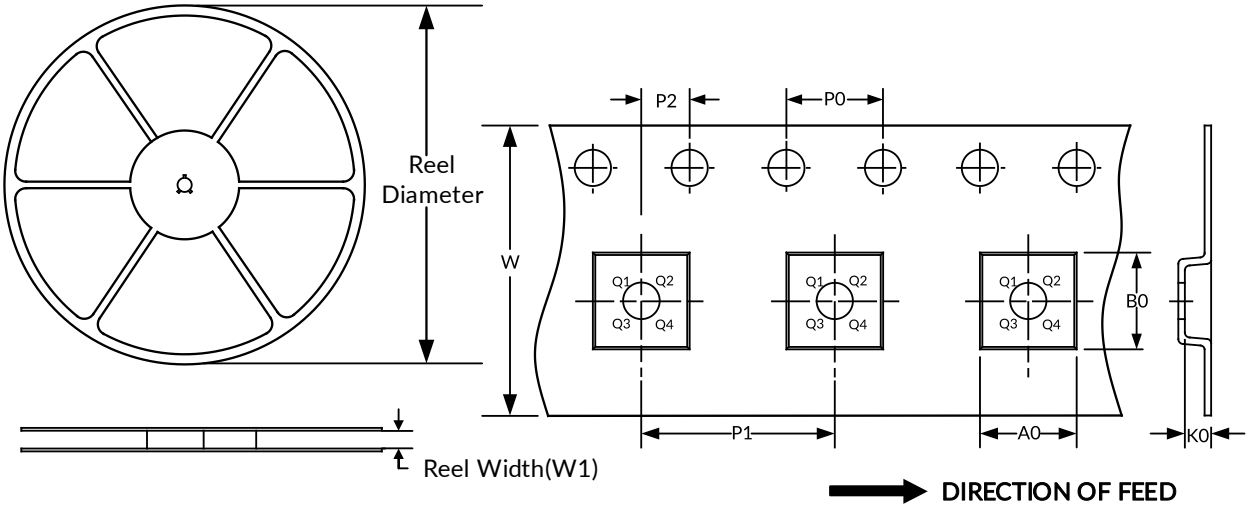
NOTE:

1. Plastic or metal protrusions of 0.075mm maximum per side are not included.
2. REF is the abbreviation for Reference.
3. This drawing is subject to change without notice.

12 TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSION



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 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
MSOP10	13”	12.4	5.20	3.30	1.20	4.0	8.0	2.0	12.0	Q1
UQFN1.4X1.8-10	7”	9.0	1.60	2.00	0.85	4.0	4.0	2.0	8.0	Q1

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

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