CMOS Single 8-Channel Analog Multiplexer/Demultiplexer

1 FEATURES

- **Qualified for Automotive Applications**
- **AEC-Q100 Qualified with the Grade 1**
- **-3dB Bandwidth: 180MHz**
- **Single Supply Operation: +2.5V to +5.5V**
- **Low ON Resistance: 48Ω(TYP) With 5V Supply**
- **High Off-Isolation: -83dB (R_L = 50Ω, f = 1MHz)**
- **Break-Before-Make Switching**
- **Binary Address Decoding on Chip**
- **Operating Temperature Range: -40°C to +125°C**
- **PACKAGES: TSSOP16**

2 APPLICATIONS

- **Automotive Infotainment and Cluster**
- **Automotive Zonal & Body Domain Controller**
- **HEV/EV Battery Management System (BMS)**

3 DESCRIPTIONS

The RS2251-Q1 is a CMOS analog IC configured as an 8-channel multiplexer. This CMOS device can operate from 2.5 V to 5.5 V.

The RS2251-Q1 device are digitally-controlled analog switches. It has low on-resistance (48Ω TYP) and very low off-leakage current (1nA TYP).

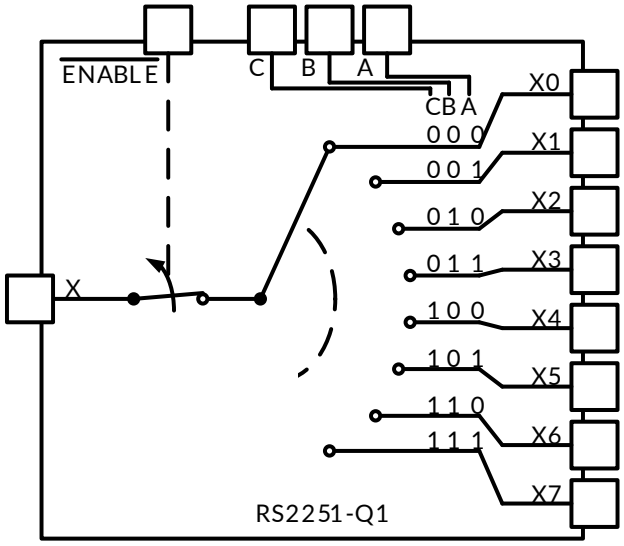
The RS2251-Q1 is available in Green TSSOP16 packages. It operates over an ambient temperature range of -40°C to +125°C.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RS2251-Q1	TSSOP16	5.00mm×4.40mm

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

4 Functional Diagrams of RS2251-Q1



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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
A.1	2023/02/23	Initial version completed
A.2	2023/07/01	1. Update PIN DESCRIPTION on Page 5@RevA.1 2. Modify packaging naming 3. Delete SOP16 and QFN3X3-16 PACKAG 4. Update ESD Ratings

6 PACKAGE/ORDERING INFORMATION (1)

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	Lead finish/Ball material (2)	MSL Peak Temp (3)	PACKAGE MARKING (4)	PACKAGE OPTION
RS2251 -Q1	RS2251XTSS16-Q1	-40°C ~+125°C	TSSOP16	NIPDAUAG	MSL1-260°-Unlimited	RS2251	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.

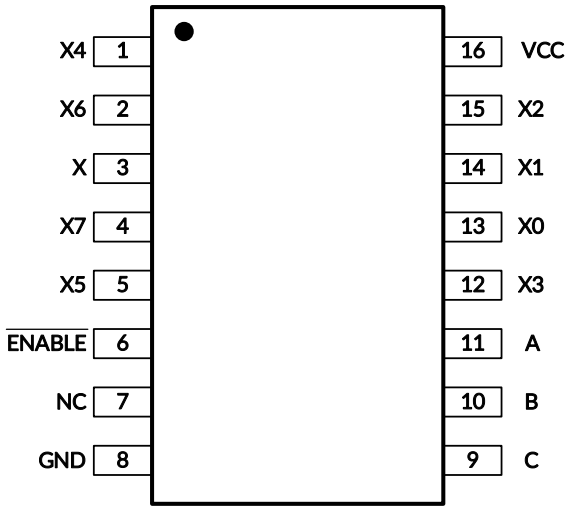
(2) Lead finish/Ball material. Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(3) MSL Peak Temp. The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) 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.

7 PIN CONFIGURATIONS (TOP VIEW)

(TOP VIEW)



TSSOP16

7.1 PIN DESCRIPTION

NAME	PIN	FUNCTION
	TSSOP16	
X0-X7	13,14,15,12,1,5,2,4	Analog Switch Inputs or Outputs X0-X7.
X	3	Analog Switch "X" Input or Output.
V_{CC}	16	Positive Analog and Digital Supply Voltage Input
A	11	Digital Address "A" Input.
B	10	Digital Address "B" Input.
C	9	Digital Address "C" Input.
GND	8	Ground. Connect to digital ground.
NC	7	No Connect.
$\overline{\text{ENABLE}}$	6	Digital Enable Input. Normally connected to GND.

7.2 FUNCTION TABLE

$\overline{\text{ENABLE}}$ INPUT	INPUT STATES			ON CHANNEL(S)
	C	B	A	
1	X	X	X	NONE
0	0	0	0	X0
0	0	0	1	X1
0	0	1	0	X2
0	0	1	1	X3
0	1	0	0	X4
0	1	0	1	X5
0	1	1	0	X6
0	1	1	1	X7

X=Don't care

NOTE: Input and output pins are identical and inter-changeable. Either may be considered an input or output; signals pass equally well in either direction.

8 SPECIFICATIONS

8.1 Absolute Maximum Ratings

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

SYMBOL	PARAMETER		MIN	MAX	UNIT
V_{CC}	Supply Voltage		-0.3	6	V
V_{IN}	Input Voltage (All inputs)		-0.3	V_{CC}+0.3	
I_{IN}	Switch Input Current	Any one input	-20	+20	mA
I_{PEAK}	Peak Switch Current	Pulsed at 1ms Duration, <10% Duty Cycle	-40	+40	
θ_{JA}	Package thermal impedance (2)	TSSOP16		45	°C/W
T_J	Junction Temperature (3)		-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) The package thermal impedance is calculated in accordance with JESD-51.
(3) 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), per AEC Q100-002 (1)	±500	V
		Charged-Device Model (CDM), per AEC Q100-011	±500	
		Latch-Up (LU), per AEC Q100-004	±100	mA

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

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	2.5	5.5	V
T_A	Operating temperature	-40	+125	°C

8.4 ELECTRICAL CHARACTERISTICS

V_{CC}= 5.0 V or 3.3V, FULL= -40°C to +125°C Typical values are at T_A = +25°C (unless otherwise noted)

PARAMETER	SYMBOL	CONDITIONS	V_{CC}	T_A	MIN (1)	TYP (2)	MAX (1)	UNIT
ANALOG SWITCH								
Analog Signal Range	$V_{X\_}$, V_X			FULL	GND		V_{CC}	V
On-Resistance	R_{ON}	V_{CC}=5V, Ix=1mA	5V	+25°C		48	58	Ω
				FULL			67	Ω
		V_{CC}=3.3V, Ix=1mA	3.3V	+25°C		100	130	Ω
				FULL			140	Ω
On-Resistance Match Between Channels	ΔR_{ON} (3)	V_{CC}=5V, Ix=1mA Switch ON	5V	+25°C		1.5	5	Ω
				FULL			5.3	Ω
On-Resistance Flatness	$R_{FLAT(ON)}$ (4)	V_{CC}=5V, Ix=1mA Switch ON	5V	+25°C		17	25	Ω
				FULL			28	Ω
X_ Off, X Off, X On Leakage Current	$I_{X\_(OFF)}$ $I_{X(OFF)}$ $I_{X(ON)}$	V_{CC}=5V, $V_{X\_}$=4.5V or 0V V_X=4.5V or 0V	5V	+25°C		1	1000	nA
				FULL			1000	
		V_{CC}=3.3V, $V_{X\_}$=1V or 3V V_X=3V or 1V	3.3V	+25°C		1	1000	nA
				FULL			1000	
DIGITAL CONTROL INPUTS (5)								
Logic Input Logic Threshold High	V_{AH}, V_{BH}, V_{CH}, $V_{\overline{ENABLE}}$(H)		5V	+25°C	1.7			V
			3.3V	+25°C	1.7			V
Logic Input Logic Threshold Low	V_{AL}, V_{BL}, V_{CL} $V_{\overline{ENABLE}}$(L)		5V	+25°C			0.5	V
			3.3V	+25°C			0.5	V
Input-Current High	I_{AH}, I_{BH}, I_{CH} $I_{\overline{ENABLE}}$ (H)	V_A, V_B, V_C, $V_{\overline{ENABLE}}$ = V_{CC}	3.3V to 5V	+25°C		1	1000	nA
				FULL			1000	
Input-Current Low	I_{AL}, I_{BL}, I_{CL} $I_{\overline{ENABLE}}$ (L)	V_A, V_B, V_C, $V_{\overline{ENABLE}}$= 0V	3.3V to 5V	+25°C		1	1000	nA
				FULL			1000	

(1) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.

(2) 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.

(3) This parameter is ensured by design and/or characterization and is not tested in production.

(4) Flatness is defined as the difference between the maximum and minimum values of ON-state resistance over the specified range of conditions.

(5) All unused digital inputs of the device must be held at V_{CC} or GND to ensure proper device operation.

ELECTRICAL CHARACTERISTICS (continued)

V_{CC}= 5.0 V or 3.3V, FULL= -40°C to +125°C Typical values are at T_A = +25°C (unless otherwise noted)

PARAMETER	SYMBOL	CONDITIONS	V_{CC}	T_A	MIN	TYP	MAX	UNIT
DYNAMIC CHARACTERISTICS								
Address Transition Time	t_{TRANS}	$V_{X\_}$ = 3V/0V, R_L = 300Ω, C_L = 35pF, See Figure 2	5V	+25°C		150	230	ns
				FULL			290	
		$V_{X\_}$ = 3V/0V, R_L = 300Ω, C_L = 35pF, See Figure 2	3.3V	+25°C		230	380	ns
				FULL			450	
$\overline{ENABLE}$ Turn-On Time	t_{ON}	$V_{X\_}$ = 3V, R_L = 300Ω, C_L = 35pF, See Figure 3	5V	+25°C		65	120	ns
				FULL			160	
			3.3V	+25°C		120	210	
				FULL			230	
$\overline{ENABLE}$ Turn-Off Time	t_{OFF}	$V_{X\_}$ = 3V, R_L = 300Ω, C_L = 35pF, See Figure 3	5V	+25°C		150	240	ns
				FULL			260	
			3.3V	+25°C		200	320	
				FULL			360	
Internal A, B, C Rise Time	t_R		5V	+25°C		50		ns
			3.3V			80		
Internal A, B, C Fall Time	t_F		5V	+25°C		60		ns
			3.3V	+25°C		85		ns
Break-Before-Make Time Delay	t_D	$V_{X\_}$ = 3V, R_L = 300Ω, C_L = 35pF, See Figure 4	5V	+25°C		65	130	ns
				FULL			170	
			3.3V	+25°C		95	160	ns
				FULL			180	
Charge Injection (1)	Q	R_S = 0Ω, C_L = 1nF, See Figure 5	5V	+25°C		6		pC
		R_S = 0Ω, C_L = 1nF, See Figure 5	3.3V	+25°C		4		pC
Off Isolation	O_{ISO}	R_L = 50Ω, f = 1MHz, See Figure 6	5V	+25°C		-83		dB
-3dB Bandwidth	BW	R_L = 50Ω	5V	+25°C		180		MHz
			3.3V	+25°C		180		MHz
Input Off-Capacitance	$C_{X\_(OFF)}$	$V_{X\_}$ = 0V, f = 1MHz, See Figure 7	5V	+25°C		4.7		pF
Output Off-Capacitance	$C_{X(OFF)}$	$V_{X\_}$ = 0V, f = 1MHz, See Figure 7	5V	+25°C		12.7		pF
Output On- Capacitance	$C_{X(ON)}$	$V_{X\_}$ = 0V, f = 1MHz, See Figure 7	5V	+25°C		16		pF
Total Harmonic Distortion	THD	R_L = 600Ω, f = 20Hz to 20kHz	5V	+25°C		0.7		%
POWER REQUIREMENTS								
Power Supply Range	V_{CC}			FULL	2.5		5.5	V
Power Supply Current	I_{CC}	V_{CC} = 5.0V, V_A, V_B, V_C, $V_{\overline{ENABLE}}$ = V_{CC} or 0	5V	+25°C		0.001	6	µA
		V_{CC} = 3.3V, V_A, V_B, V_C, $V_{\overline{ENABLE}}$ = V_{CC} or 0	3.3V	+25°C		0.001	3	µA

(1) This parameter is ensured by design and/or characterization and is not tested in production.

9 TYPICAL CHARACTERISTICS

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

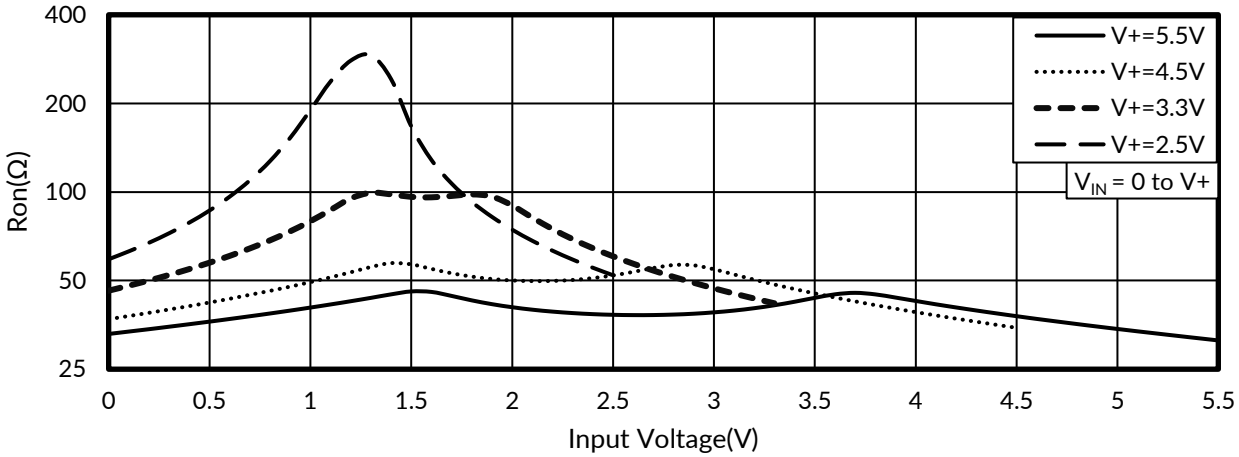


Figure 1. Typical Ron as a Function of Input Voltage

10 Parameter Measurement Information

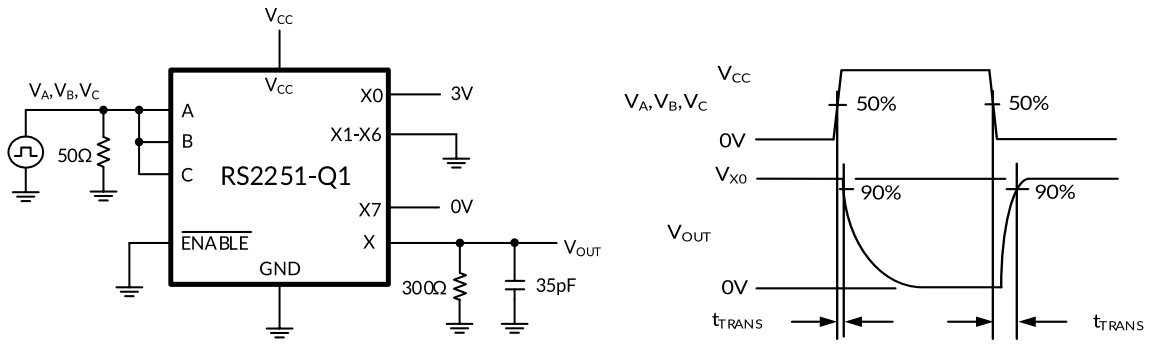


Figure 2. Address Transition Times (t_{TRANS})

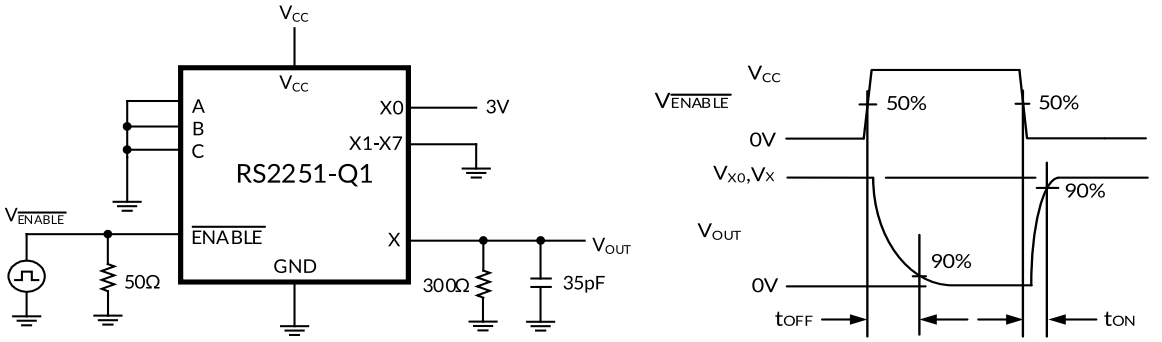


Figure 3. Switching Times (t_{ON}, t_{OFF})

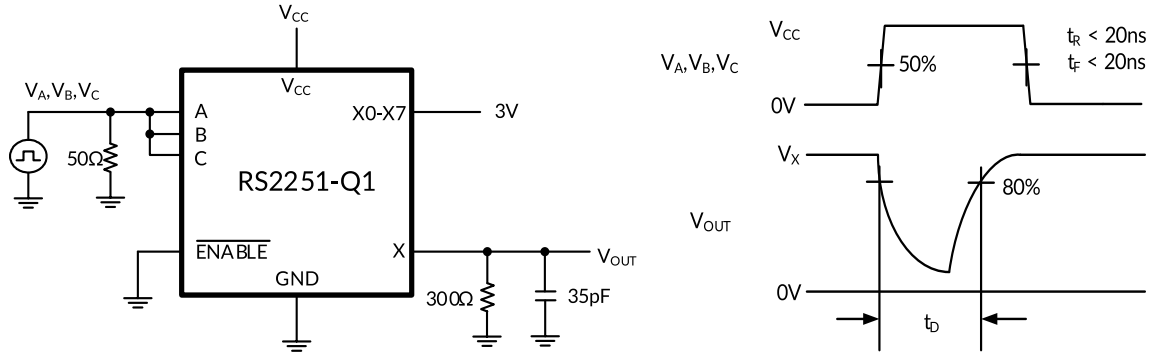


Figure 4. Break-Before-Make Time Delay (t_D)

Parameter Measurement Information (continued)

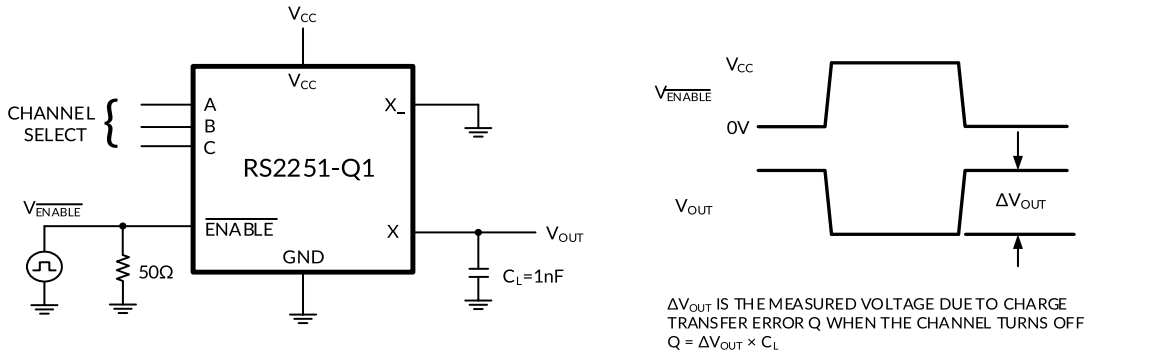
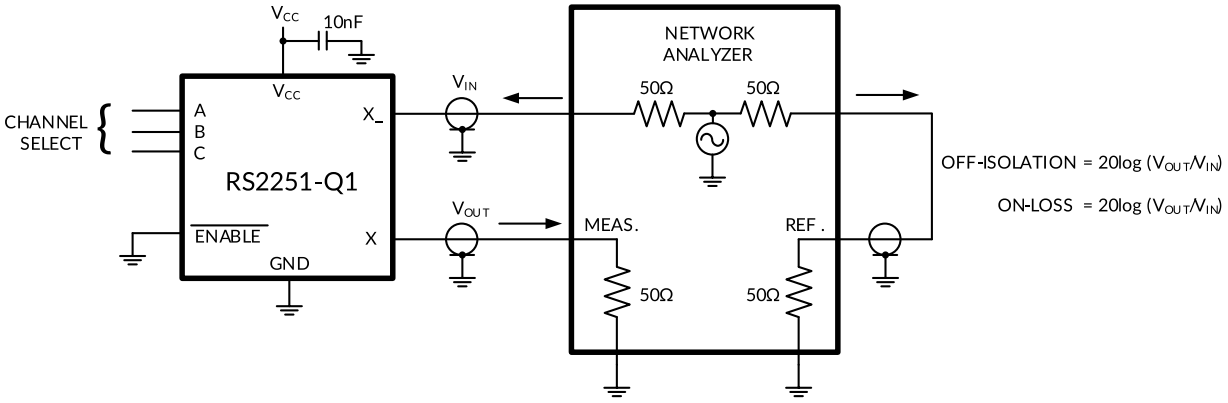


Figure 5. Charge Injection (Q)



MEASUREMENTS ARE STANDARDIZED AGAINST SHORT AT SOCKET TERMINALS .
OFF-ISOLATION IS MEASURED BETWEEN COM AND "OFF" NO TERMINAL ON EACH SWITCH.
ON-LOSS IS MEASURED BETWEEN COM AND "ON" NO TERMINAL ON EACH SWITCH.
SIGNAL DIRECTION THROUGH SWITCH IS REVERSED ; WORST VALUES ARE RECORDED .

Figure 6. Off Isolation, On Loss

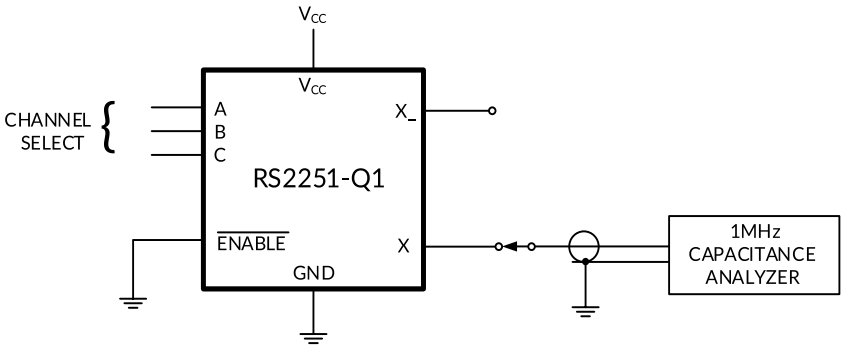


Figure 7. Capacitance

11 Application and Implementation

Information in the following applications sections is not part of the RUNIC component specification, and RUNIC does not warrant its accuracy or completeness. RUNIC's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

11.1 APPLICATION NOTES

The RS2251-Q1 device is a single 8-channel multiplexer having three binary control inputs, A, B, and C, and an inhibit input. The three binary signals select 1 of 8 channels to be turned on and connect one of the 8 inputs to the output.

One application of the RS2251-Q1 is to use it in conjunction with a microcontroller to poll a keypad. Figure 8 shows the basic schematic for such a polling system. The microcontroller uses the channel select pins to cycle through the different channels while reading the input to see if a user is pressing any of the keys. This is a very robust setup, allowing for multiple simultaneous key-presses with very little power consumption. It also utilizes very few pins on the microcontroller. The down side of polling is that the microcontroller must continually scan the keys for a press and can do little else during this process.

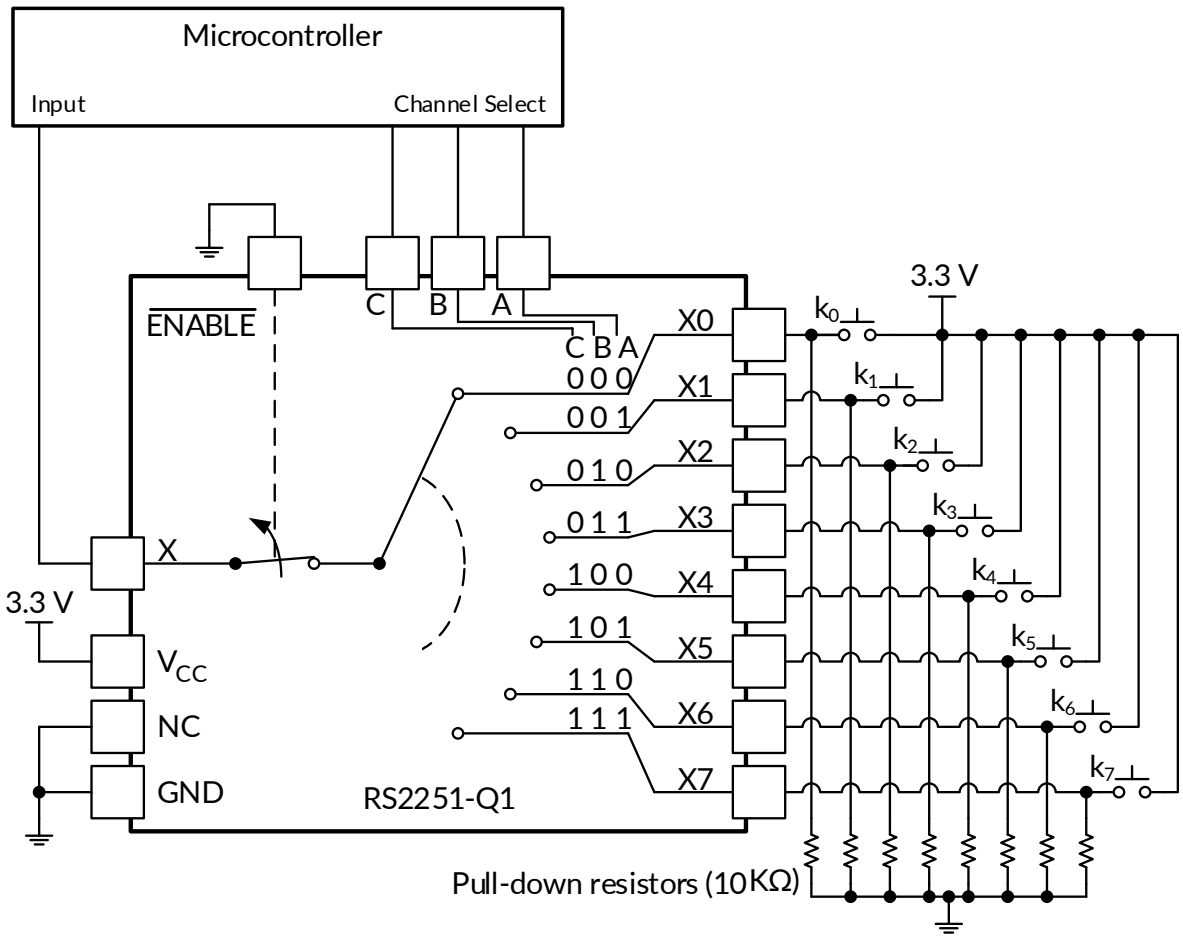
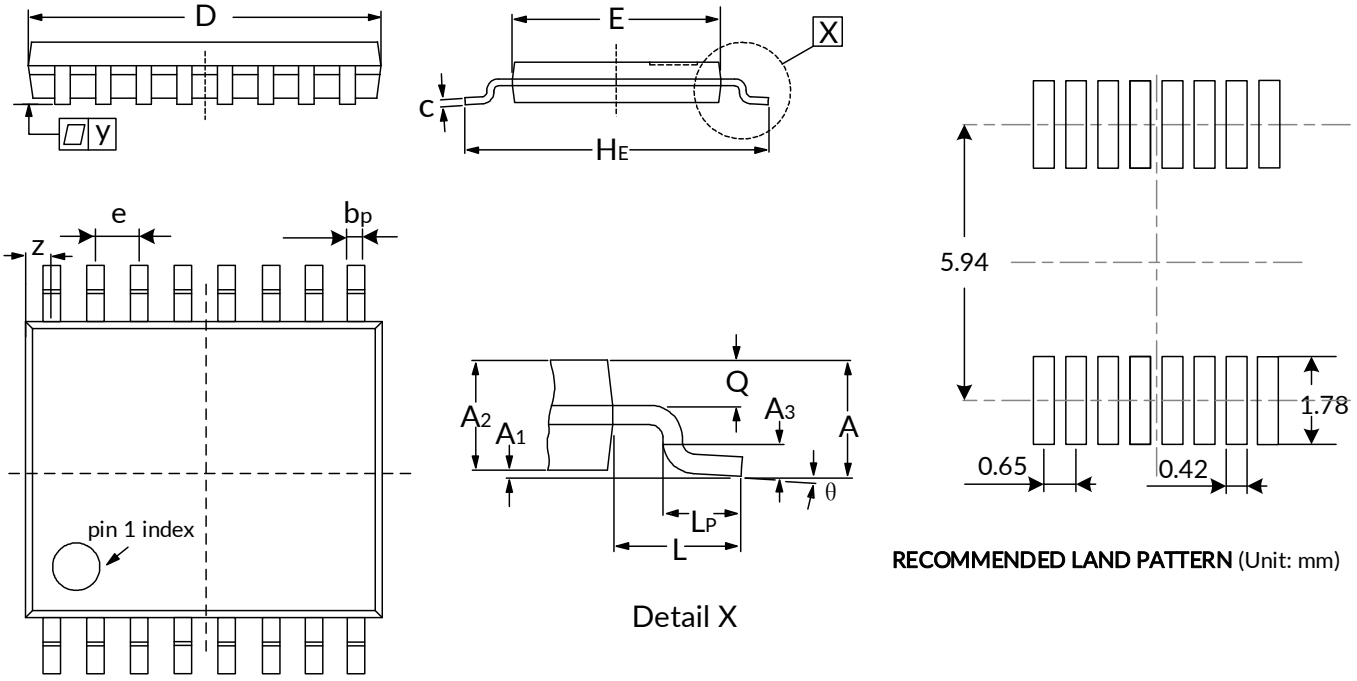


Figure 8. The RS2251-Q1 Being Used to Help Read Button Presses on a Keypad.

12 PACKAGE OUTLINE DIMENSIONS

TSSOP16 (2)



Detail X

RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A (1)		1.100		0.043
A_1	0.050	0.150	0.002	0.006
A_2	0.800	0.950	0.031	0.037
A_3	0.25		0.010	
b_p	0.190	0.300	0.007	0.012
c	0.100	0.200	0.004	0.008
D (1)	4.900	5.100	0.193	0.201
E (1)	4.300	4.500	0.169	0.177
H_E	6.200	6.600	0.244	0.260
e	0.650		0.026	
L	1		0.039	
L_P	0.500	0.750	0.020	0.030
Q	0.300	0.400	0.012	0.016
Z	0.060	0.400	0.002	0.016
y	0.1		0.004	
θ	0°	8°	0°	8°

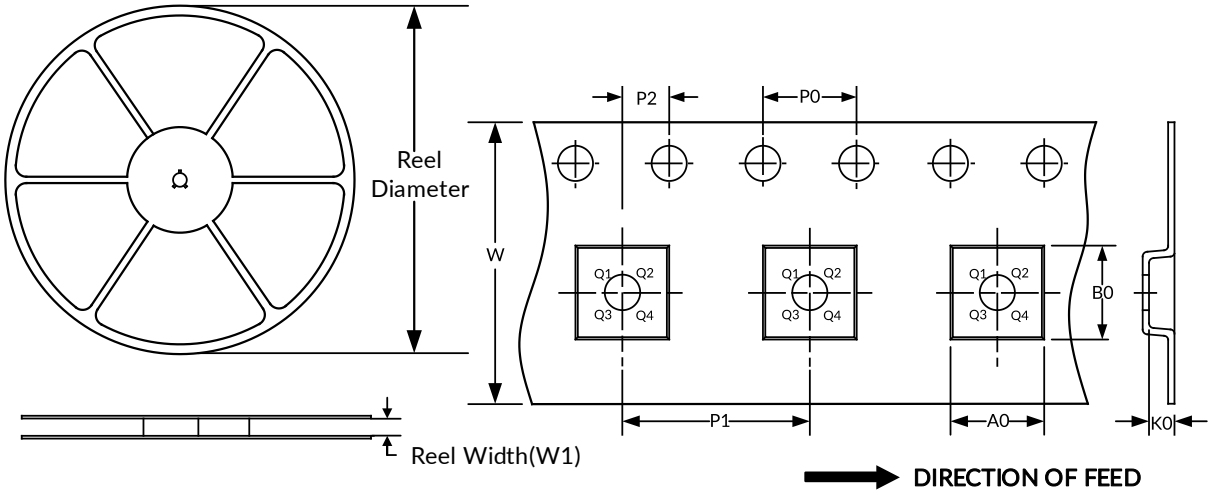
NOTE:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. This drawing is subject to change without notice.

13 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
TSSOP16	13”	12.4	6.90	5.60	1.20	4.0	8.0	2.0	12.0	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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