CMOS Single 8-Channel Analog Multiplexer/Demultiplexer

FEATURES

- **-3dB Bandwidth: 180MHz**
- **Single Supply Operation +2.5V to +5.5V**
- **Low ON Resistance, 48Ω(TYP) With 5V Supply**
- **High Off-Isolation: -83dB (RL = 50Ω, f = 1MHz)**
- **Break-Before-Make Switching**
- **Binary Address Decoding on Chip**
- **Operating Temperature Range: -40°C to +125°C**
- **PACKAGES: SOIC-16(SOP16), SSOP-16, TSSOP-16 and QFN-3×3-16L**

APPLICATIONS

- **Sensors**
- **Analog and Digital Multiplexing and Demultiplexing**
- **A/D and D/A Conversion**
- **Signal Gating**
- **Battery-Operated Equipment**
- **Factory Automation**
- **Appliances**
- **Communications Circuits**

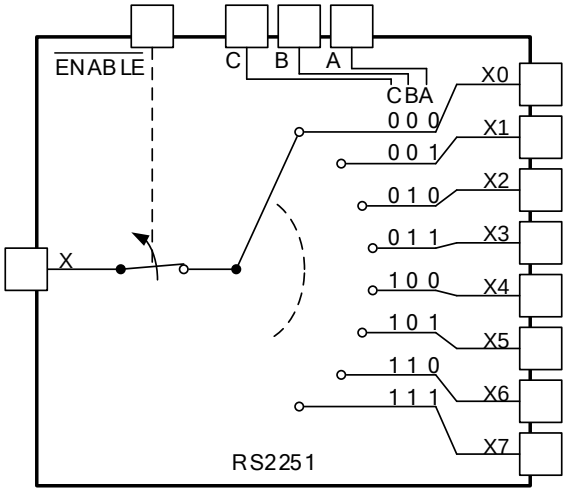
DESCRIPTION

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

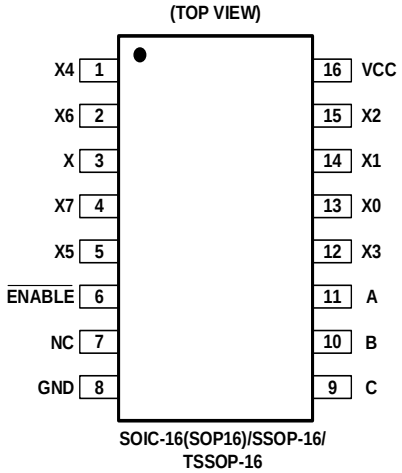
The RS2251 device are digitally-controlled analog switches. It has low on-resistance (48Ω TYP) and very low off-leakage current (1nA TYP).

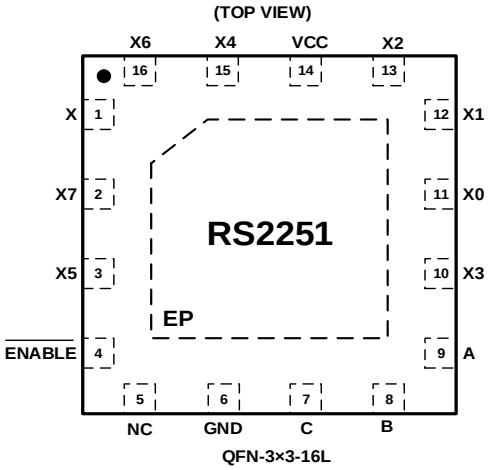
The RS2251 is available in Green SOIC-16, SSOP-16, TSSOP-16 and QFN-3×3-16L packages. It operates over an ambient temperature range of -40°C to +125°C.

Functional Diagrams of RS2251



PIN CONFIGURATIONS





PIN DESCRIPTION

NAME	PIN (SOIC-16/SSOP-16/TSSOP-16)	PIN (QFN-3×3-16L)	FUNCTION
X0-X7	13,14,15,12,1,5,2,4	11,12,13,10,15,3,16,2	Analog Switch Inputs X0-X7.
X	3	1	Analog Switch "X" Output.
V_{CC}	16	14	Positive Analog and Digital Supply Voltage Input
A	11	9	Digital Address "A" Input.
B	10	8	Digital Address "B" Input.
C	9	7	Digital Address "C" Input.
GND	8	6	Ground. Connect to digital ground.
NC	7	5	No Connect.
$\overline{ENABLE}$	6	4	Digital Enable Input. Normally connected to GND.
EP	—	Exposed Pad	Exposed Pad. Connect EP to GND.

FUNCTION TABLE

$\overline{ENABLE}$ 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.

SPECIFICATIONS

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	
T_J	Junction Temperature			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.

ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	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) (3)

SYMBOL	PARAMETER	MIN	MAX	UNIT
V_{CC}	Supply Voltage	2.5	5.5	V
T_A	Operating temperature	-40	+125	°C

Thermal Information

THERMAL METRIC		RS2251				UNIT
		16 PINS				
		SOIC-16 (SOP-16)	SSOP-16	TSSOP-16	QFN3X3-16L	
$R_{\Theta JA}$	Junction-to-ambient thermal resistance	76	118.7	111.3	51.9	°C/W
$R_{\Theta JC(top)}$	Junction-to-case(top) thermal resistance	42.1	66.4	45.3	53.3	°C/W
$R_{\Theta JB}$	Junction-to-board thermal resistance	34.8	62.2	56.9	26.6	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	26.9	20.9	5.4	1.7	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	34.7	61.7	56.3	26.6	°C/W
$R_{\Theta JC(bot)}$	Junction-to-case(bottom) thermal resistance	N/A	N/A	N/A	11.6	°C/W

PACKAGE/ORDERING INFORMATION

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING (1)	PACKAGE OPTION
RS2251	RS2251XS16	-40°C ~+125°C	SOIC-16(SOP16)	RS2251	Tape and Reel,4000
	RS2251XSS16	-40°C ~+125°C	SSOP-16	RS2251	Tape and Reel,4000
	RS2251XTSS16	-40°C ~+125°C	TSSOP-16	RS2251	Tape and Reel,4000
	RS2251XTQC16	-40°C ~+125°C	QFN-3×3 -16L	RS2251	Tape and Reel,5000

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.

ELECTRICAL CHARACTERISTICS

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

PARAMETER	SYMBOL	CONDITIONS	V_{CC}	T_A	MIN	TYP	MAX	UNITS
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}	V_{CC}=5V, Ix=1mA Switch ON	5V	+25°C		1.5	5	Ω
				FULL			5.3	Ω
On-Resistance Flatness	$R_{FLAT(ON)}$	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	n A
		V_{CC}=3.3V, $V_{X\_}$=1V or 3V V_X=3V or 1V	3.3V	+25°C		1	1000	n A
DIGITAL CONTROL INPUTS(1)								
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, $V_{\overline{ENABLE}}$ = VCC	3.3V to 5V	+25°C		1	1000	n A
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	n A

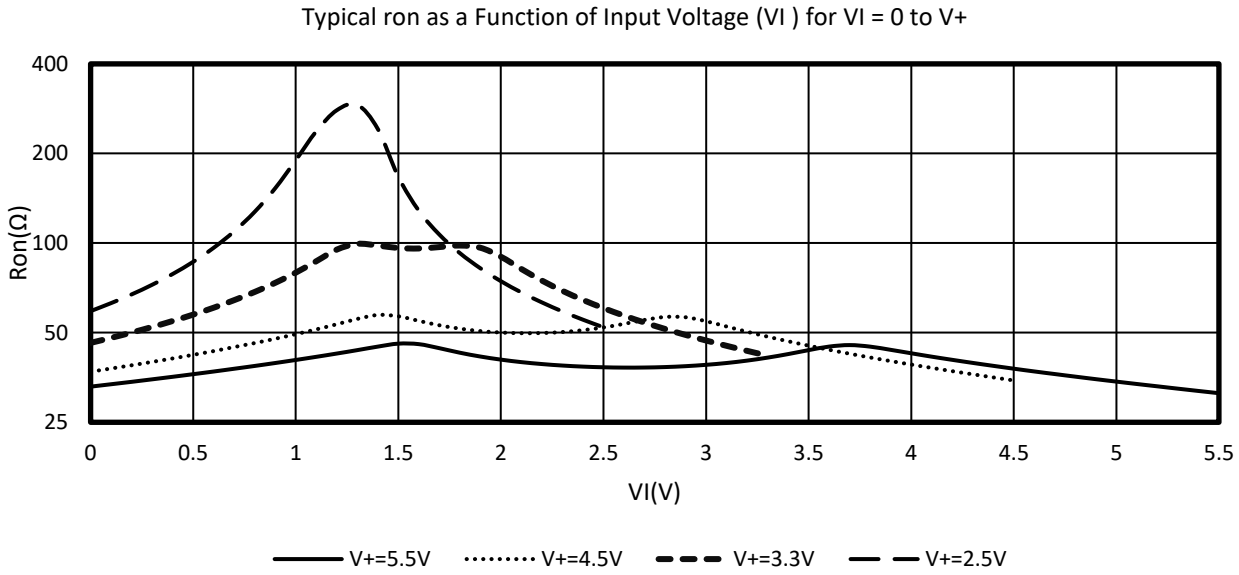
(1) All unused digital inputs of the device must be held at V_{CC} or GND to ensure proper device operation.

ELECTRICAL CHARACTERISTICS (continued)

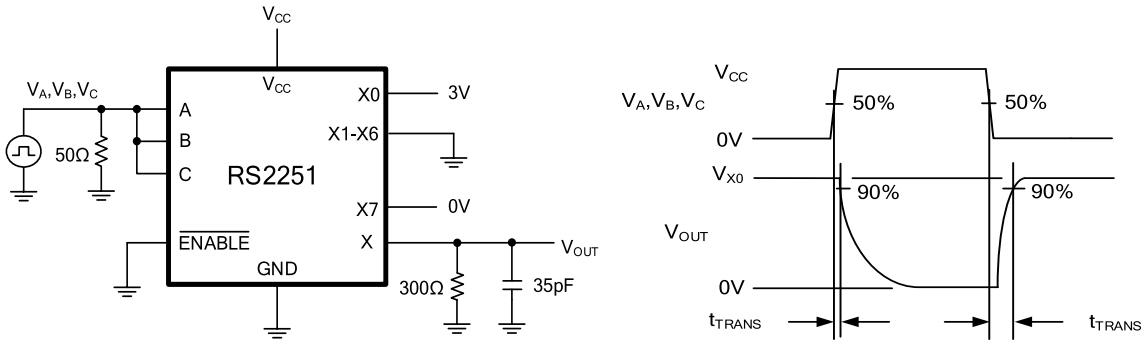
V_{CC}= 5.0 V or 3.3V, FULL= –40°C to +125°C Typical values are at TA = +25°C (unless otherwise noted)

PARAMETER	SYMBOL	CONDITIONS	V_{CC}	TEMP	MIN	TYP	MAX	UNITS
DYNAMIC CHARACTERISTICS								
Address Transition Time	t_{TRANS}	$V_{X\_}$ = ±3V, R_L = 300Ω, C_L = 35pF, Test Circuit 1	5V	+25°C		150		ns
		$V_{X\_}$ = 3V/0V, R_L = 300Ω, C_L = 35pF, Test Circuit 1	3.3V	+25°C		230		ns
$\overline{ENABLE}$ Turn-On Time	t_{ON}	$V_{X\_}$ = 3V, R_L = 300Ω, C_L = 35pF, Test Circuit 2	5V	+25°C		65		ns
			3.3V			110		
$\overline{ENABLE}$ Turn-Off Time	t_{OFF}	$V_{X\_}$ = 3V, R_L = 300Ω, C_L = 35pF, Test Circuit 2	5V	+25°C		80		ns
			3.3V			130		
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, Test Circuit 3	5V	+25°C		60		ns
			3.3V	+25°C		90		ns
Charge Injection	Q	R_S = 0Ω, C_L = 1nF, Test Circuit 4	5V	+25°C		6		p C
		R_S = 0Ω, C_L = 1nF, Test Circuit 4	3.3V	+25°C		4		p C
Off Isolation	O_{ISO}	R_L = 50Ω, f = 1MHz, Test Circuit 5	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, Test Circuit 6	5V	+25°C		4.7		pF
Output Off-Capacitance	$C_{X(OFF)}$	$V_{X\_}$ = 0V, f = 1MHz, Test Circuit 6	5V	+25°C		12.7		pF
Output On- Capacitance	$C_{X(ON)}$	$V_{X\_}$ = 0V, f = 1MHz, Test Circuit 6	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	μ A
		V_{CC} = 3.3V, V_A, V_B, V_C, $V_{\overline{ENABLE}}$ = V_{CC} or 0	3.3V	+25°C		0.001	3	μ A

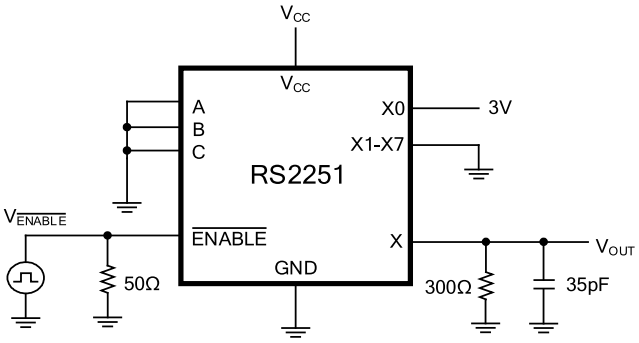
TYPICAL CHARACTERISTICS



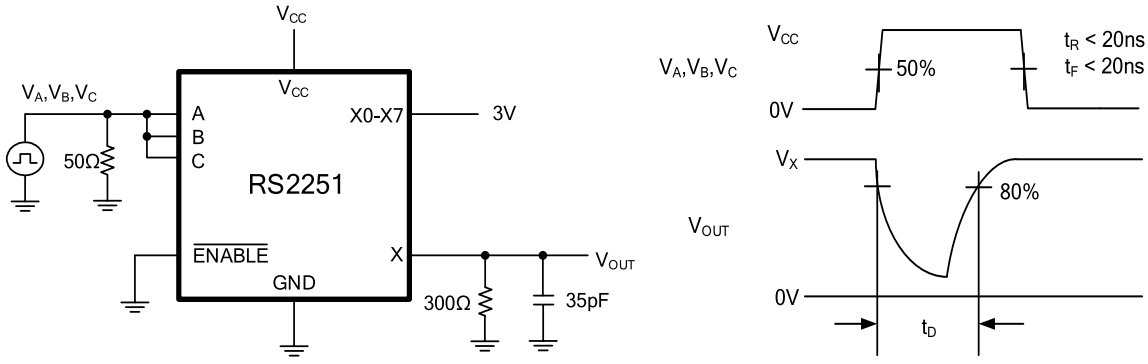
Parameter Measurement Information



Test Circuit 1. Address Transition Times (t_{TRANS})

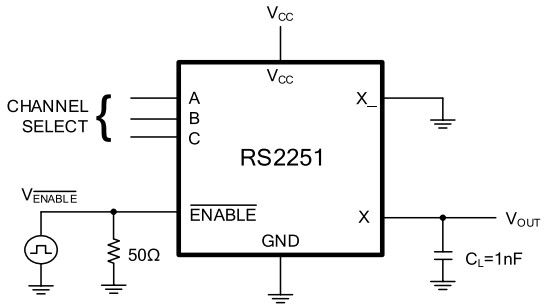


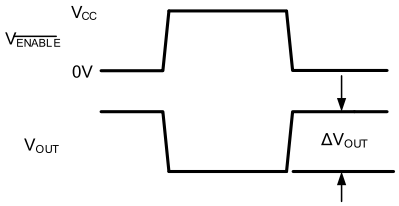
Test Circuit 2. Switching Times (t_{ON}, t_{OFF})



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

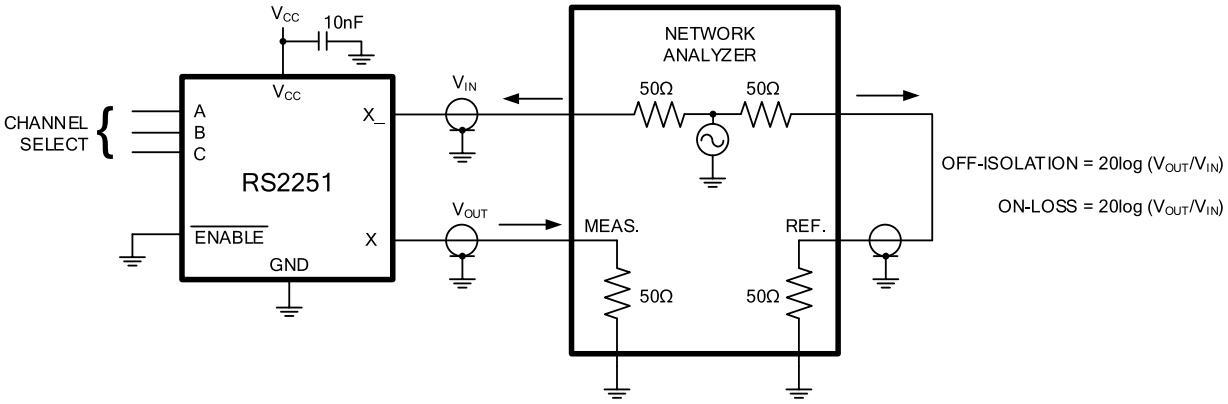
Parameter Measurement Information (continued)





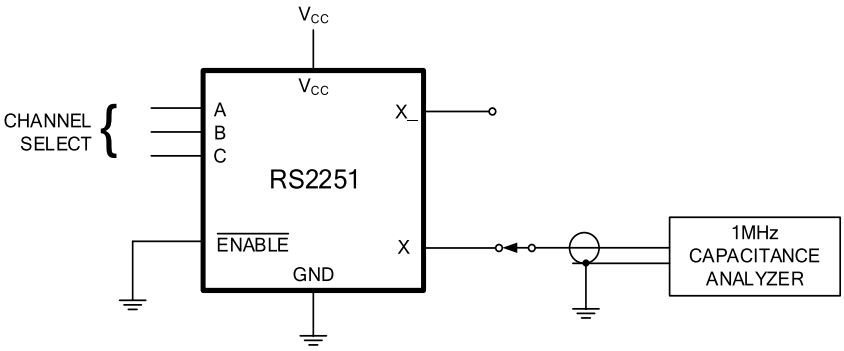
ΔV_{OUT} IS THE MEASURED VOLTAGE DUE TO CHARGE TRANSFER ERROR Q WHEN THE CHANNEL TURNS OFF
$Q = \Delta V_{OUT} \times C_L$

Test Circuit 4. 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.

Test Circuit 5. Off Isolation, On Loss



Test Circuit 6. Capacitance

APPLICATION NOTES

The RS2251 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 is to use it in conjunction with a microcontroller to poll a keypad. Figure 1 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.

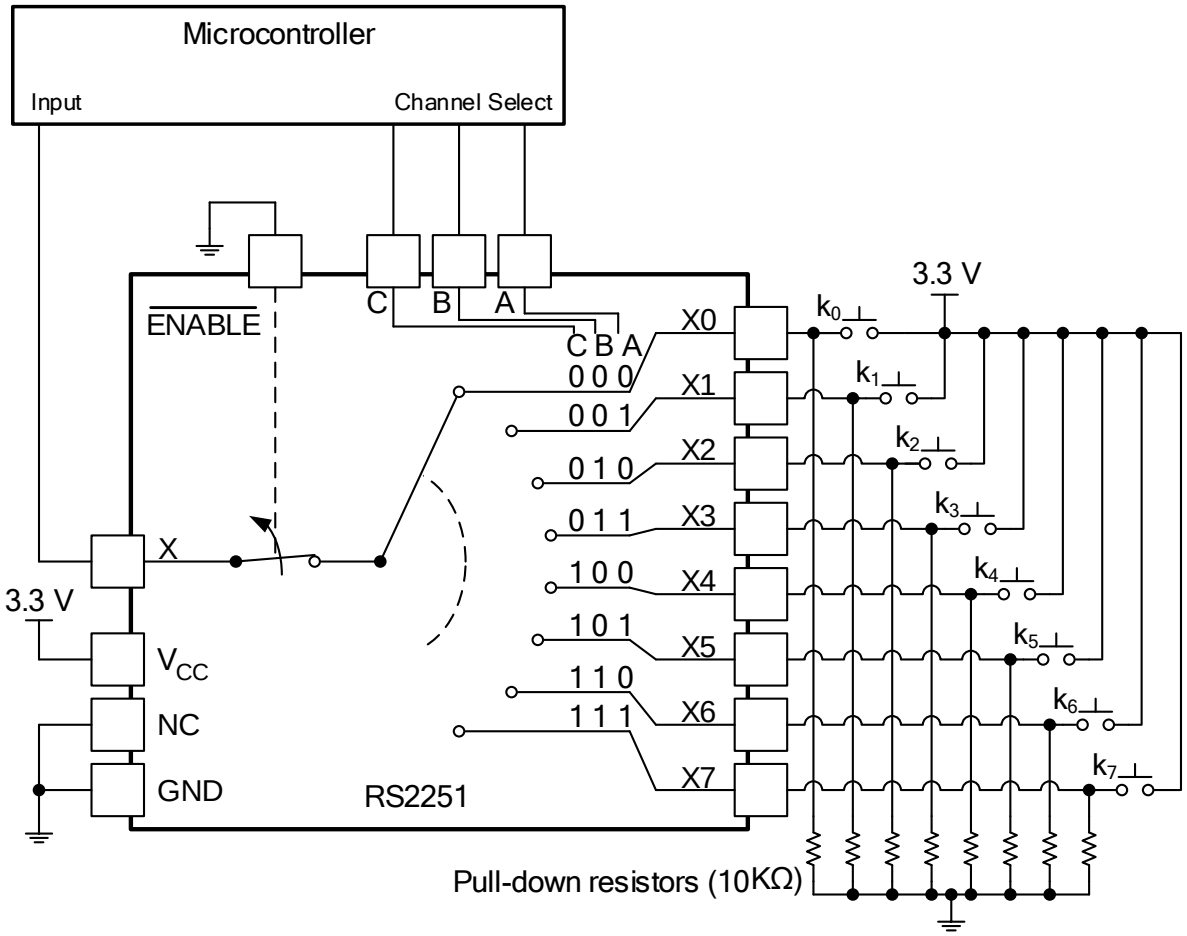
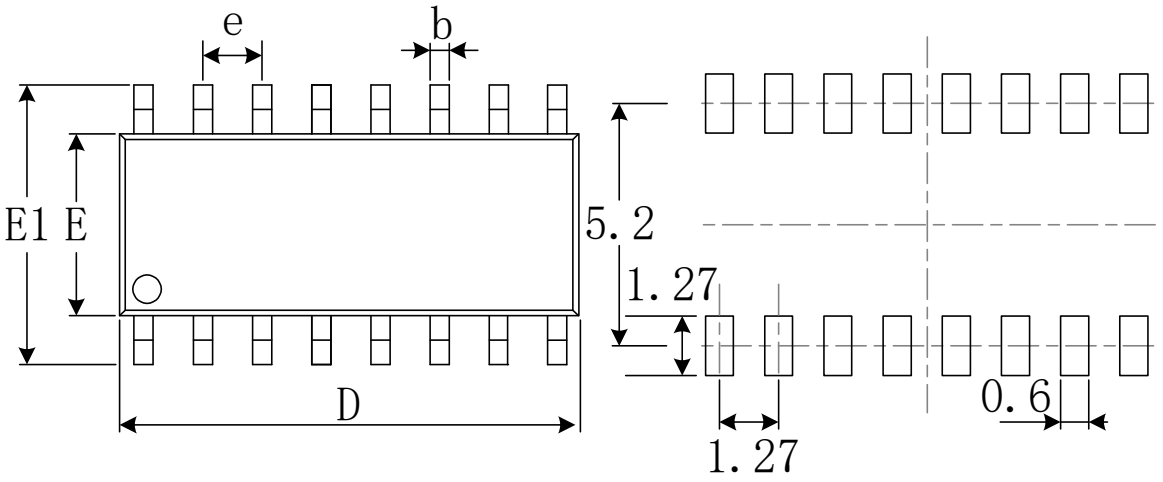
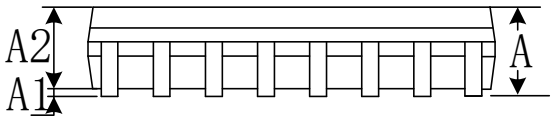


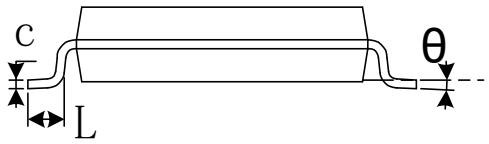
Figure 1. The RS2251 Being Used to Help Read Button Presses on a Keypad.

PACKAGE OUTLINE DIMENSIONS
SOIC-16



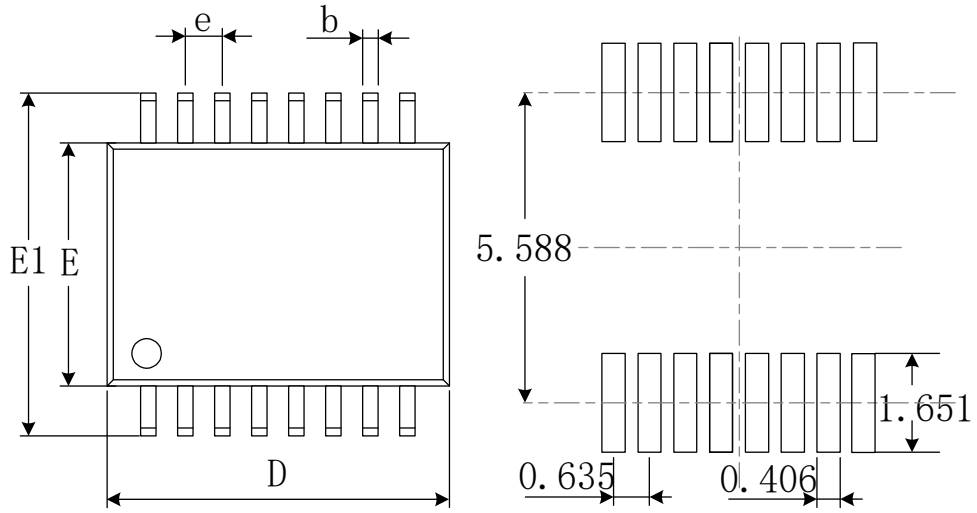
RECOMMENDED LAND PATTERN (Unit: mm)



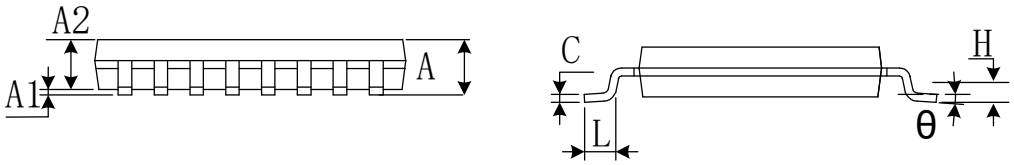


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	9.800	10.200	0.386	0.402
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

SSOP-16

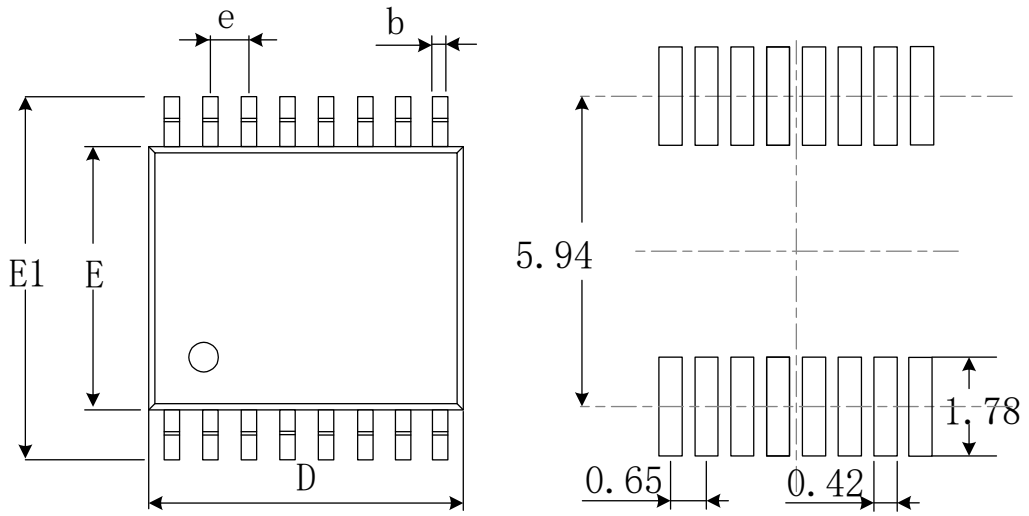


RECOMMENDED LAND PATTERN (Unit: mm)

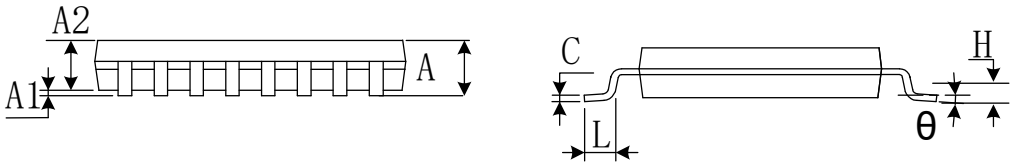


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.200	0.300	0.008	0.012
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	0.635(BSC)		0.025(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

TSSOP-16

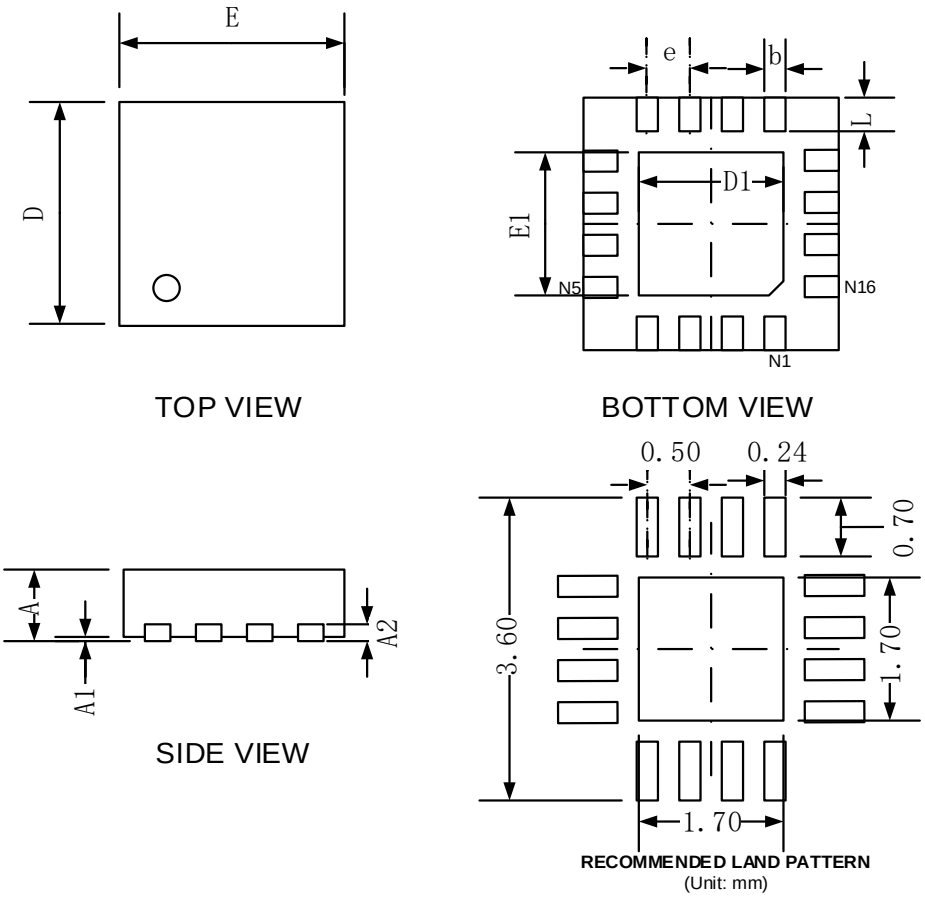


RECOMMENDED LAND PATTERN (Unit: mm)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.200	6.600	0.244	0.260
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.02	0.028
H	0.25TYP		0.01TYP	
θ	1°	7°	1°	7°

QFN-3x3-16L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203		0.008	
b	0.180	0.300	0.007	0.012
D	2.900	3.100	0.114	0.122
D1	1.600	1.800	0.063	0.071
E	2.900	3.100	0.114	0.122
E1	1.600	1.800	0.063	0.071
e	0.500 TYP		0.020 TYP	
L	0.300	0.500	0.012	0.020