CMOS Triple 2-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**
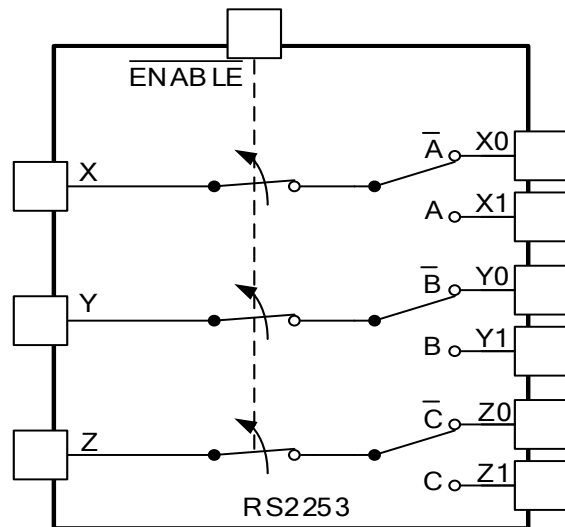- **Appliances**
- **Communications Circuits**

DESCRIPTION

The RS2253 is a CMOS analog IC configured as three single-pole/double-throw (SPDT) switches. This CMOS device can operate from 2.5 V to 5.5 V.
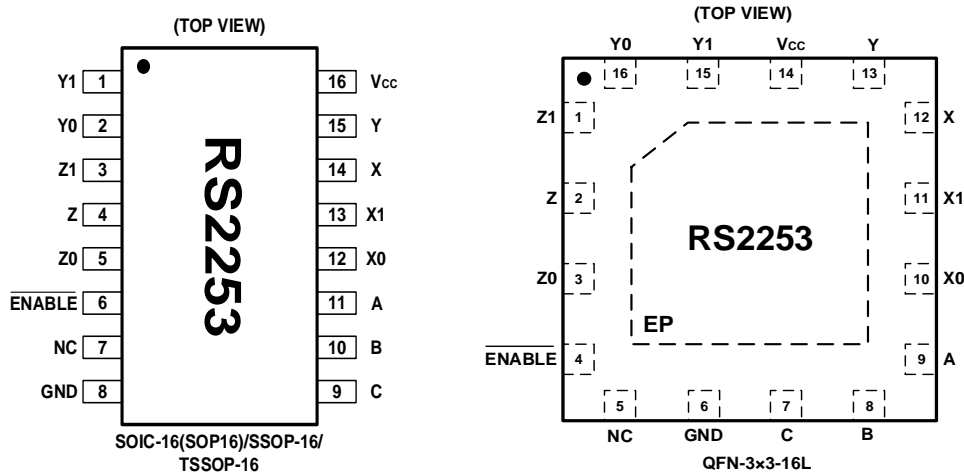
The RS2253 device are digitally-controlled analog switches. It has low on-resistance (48Ω TYP) and very low off-leakage current (1nA TYP).

The RS2253 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 RS2253

PIN CONFIGURATIONS

(TOP VIEW)

Y1	1		16	Vcc
Y0	2		15	Y
Z1	3		14	X
Z	4	RS2253	13	X1
Z0	5		12	X0
$\overline{\text{ENABLE}}$	6		11	A
NC	7		10	B
GND	8		9	C

SOIC-16(SOP16)/SSOP-16/
TSSOP-16

(TOP VIEW)

QFN-3×3-16L

PIN DESCRIPTION

NAME	PIN SOIC-16/SSOP-16/TSSOP-16	PIN QFN-3×3-16L	FUNCTION
Y1	1	15	Analog Switch "Y" Normally Open Input.
Y0	2	16	Analog Switch "Y" Normally Closed Input.
Z1	3	1	Analog Switch "Z" Normally Open Input.
Z	4	2	Analog Switch "Z" Output.
Z0	5	3	Analog Switch "Z" Normally Closed Input.
$\overline{\text{ENABLE}}$	6	4	Digital Enable Input. Normally connected to GND.
NC	7	5	No Connect.
GND	8	6	Ground. Connect to digital ground.
C	9	7	Digital Address "C" Input.
B	10	8	Digital Address "B" Input.
A	11	9	Digital Address "A" Input.
X0	12	10	Analog Switch "X" Normally Closed Input.
X1	13	11	Analog Switch "X" Normally Open Input.
X	14	12	Analog Switch "X" Output.
Y	15	13	Analog Switch "Y" Output.
Vcc	16	14	Positive Analog and Digital Supply Voltage Input
EP	—	Exposed Pad	Exposed Pad. Connect EP to GND.

FUNCTION TABLE

$\overline{\text{ENABLE}}$ INPUT	INPUT STATES			ON CHANNEL(S)
	C	B	A	
1	X	X	X	NONE
0	0	0	0	X0, Y0, Z0
0	0	0	1	X1, Y0, Z0
0	0	1	0	X0, Y1, Z0
0	0	1	1	X1, Y1, Z0
0	1	0	0	X0, Y0, Z1
0	1	0	1	X1, Y0, Z1
0	1	1	0	X0, Y1, Z1
0	1	1	1	X1, Y1, Z1

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		RS2253				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
RS2253	RS2253XS16	-40°C ~+125°C	SOIC-16(SOP16)	RS2253	Tape and Reel,4000
	RS2253XSS16	-40°C ~+125°C	SSOP-16	RS2253	Tape and Reel,4000
	RS2253XTSS16	-40°C ~+125°C	TSSOP-16	RS2253	Tape and Reel,4000
	RS2253XTQC16	-40°C ~+125°C	QFN-3×3 -16L	RS2253	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	$V_{X\_}$, $V_{Y\_}$, $V_{Z\_}$ V_X, V_Y, V_Z			FULL	GND		V_{CC}	V
On-Resistance	R_{ON}	V_{CC}=5V, I_X, I_Y, I_Z =1mA	5V	+25°C		48	65	Ω
				FULL			70	Ω
		V_{CC}=3.3V, I_X, I_Y, I_Z =1mA	3.3V	+25°C		100	130	Ω
				FULL			140	Ω
On-Resistance Match Between Channels	ΔR_{ON}	V_{CC}=5V, I_X, I_Y, I_Z =1mA	5V	+25°C		1.5	5	Ω
				FULL			5.3	Ω
On-Resistance Flatness	$R_{FLAT(ON)}$	V_{CC}=5V, I_X, I_Y, I_Z =1mA	5V	+25°C		17	25	Ω
				FULL			28	Ω
X_, Y_, Z_ Off Leakage Current	$I_{X\_(OFF)}$ $I_{Y\_(OFF)}$ $I_{Z\_(OFF)}$	$V_{X\_}$, $V_{Y\_}$, $V_{Z\_}$ =1V, 4.5V V_X, V_Y, V_Z =4.5V, 1V	5V	+25°C		1	100	n A
		$V_{X\_}$, $V_{Y\_}$, $V_{Z\_}$ =1V, 3V V_X, V_Y, V_Z =3V, 1V	3.3V	+25°C		1	100	n A
X, Y, Z Off Leakage Current	$I_{X(OFF)}$ $I_{Y(OFF)}$ $I_{Z(OFF)}$	$V_{X\_}$, $V_{Y\_}$, $V_{Z\_}$ =1V, 4.5V V_X, V_Y, V_Z =4.5V, 1V	5V	+25°C		1	100	n A
		$V_{X\_}$, $V_{Y\_}$, $V_{Z\_}$ =1V, 3V V_X, V_Y, V_Z =3V, 1V	3.3V	+25°C		1	100	n A
X, Y, Z On Leakage Current	$I_{X(ON)}$ $I_{Y(ON)}$ $I_{Z(ON)}$	V_{CC}=5V, V_X, V_Y, V_Z =4.5V, 1V	5V	+25°C		1	100	n A
		V_{CC}=3.3V, V_X, V_Y, V_Z =3V, 1V	3.3V	+25°C		1	100	n A
DIGITAL CONTROL INPUTS[1]								
Logic Input Logic Threshold High	V_{AH}, V_{BH}, V_{CH}, $V_{\overline{ENABLE}}$		5V	+25°C	1.7			V
			3.3V	+25°C	1.7			V
Logic Input Logic Threshold Low	V_{AL}, V_{BL}, V_{CL} $V_{\overline{ENABLE}}$		5V	+25°C			0.5	V
			3.3V	+25°C			0.5	V
Input-Current High	I_{AH}, I_{BH}, I_{CH} $I_{\overline{ENABLE}}$	V_A, V_B, V_C, $V_{\overline{ENABLE}}$ = V_{CC}	3.3V to 5V	+25°C		1	100	n A
Input-Current Low	I_{AL}, I_{BL}, I_{CL} $I_{\overline{ENABLE}}$	V_A, V_B, V_C, $V_{\overline{ENABLE}}$= 0V	3.3V to 5V	+25°C		1	100	n A

(1) All unused digital inputs of the device must be held at V_{IO} 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$_{X\_}$, V$_{Y\_}$, V$_{Z\_}$ = 3V/0V, R$_L$ = 300Ω, C$_L$ = 35pF, Test Circuit 1	5V	+25°C		160		ns
		V$_{X\_}$, V$_{Y\_}$, V$_{Z\_}$ = 3V/0V, R$_L$ = 300Ω, C$_L$ = 35pF, Test Circuit 1	3.3V	+25°C		240		ns
$\overline{\text{ENABLE}}$ Turn-On Time	t$_{ON}$	V$_{X\_}$, V$_{Y\_}$, V$_{Z\_}$ = 3V, R$_L$ = 300Ω, C$_L$ = 35pF, Test Circuit 2	5V	+25°C		90		ns
			3.3V			140		
$\overline{\text{ENABLE}}$ Turn-Off Time	t$_{OFF}$	V$_{X\_}$, V$_{Y\_}$, V$_{Z\_}$ = 3V, R$_L$ = 300Ω, C$_L$ = 35pF, Test Circuit 2	5V	+25°C		70		ns
			3.3V			100		
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			85		ns
Break-Before-Make Time Delay	t$_D$	V$_{X\_}$, V$_{Y\_}$, V$_{Z\_}$ = 3V, R$_L$ = 300Ω, C$_L$ = 35pF, Test Circuit 3	5V	+25°C		60		ns
			3.3V			90		ns
Charge Injection	Q	R$_S$ = 0Ω, C$_L$ = 1nF, Test Circuit 4	5V	+25°C		6		pC
		R$_S$ = 0Ω, C$_L$ = 1nF, Test Circuit 4	3.3V			4		pC
Off Isolation	O$_{ISO}$	R$_L$ = 50Ω, f = 1MHz, Test Circuit 5	5V	+25°C		-83		dB
Channel-to-Channel Crosstalk	X$_{TALK}$	R$_L$ = 50Ω, f = 1MHz, Test Circuit 5	5V	+25°C		-110		dB
-3dB Bandwidth	BW	R$_L$ = 50Ω	5V	+25°C		180		MHz
			3.3V			180		MHz
Input Off-Capacitance	C$_{X\_(OFF)}$ C$_{Y\_(OFF)}$ C$_{Z\_(OFF)}$	V$_{X\_}$, V$_{Y\_}$, V$_{Z\_}$ = 0V, f = 1MHz, Test Circuit 6	5V	+25°C		4.7		pF
Output Off-Capacitance	C$_{X(OFF)}$ C$_{Y(OFF)}$ C$_{Z(OFF)}$	V$_{X\_}$, V$_{Y\_}$, V$_{Z\_}$ = 0V, f = 1MHz, Test Circuit 6	5V	+25°C		12.7		pF
Output On- Capacitance	C$_{X(ON)}$ C$_{Y(ON)}$ C$_{Z(ON)}$	V$_{X\_}$, V$_{Y\_}$, V$_{Z\_}$ = 0V, f = 1MHz, Test Circuit 6	5V	+25°C		16		pF
Total Harmonic Distortion	THD	R$_L$ = 600Ω, 5V$_{P-P}$, 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	2	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	1	μ A

TYPICAL CHARACTERISTICS

Typical ron as a Function of Input Voltage (VI) for VI = 0 to V+

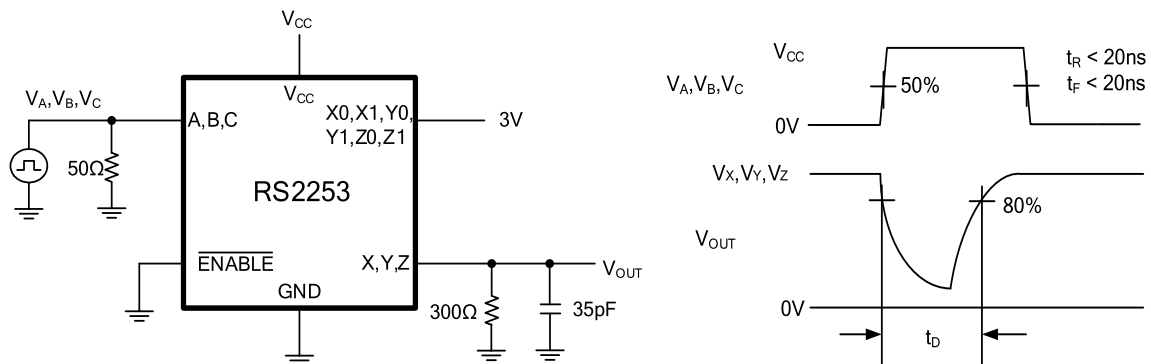────── V+=5.5V   ·········· V+=4.5V   ▬ ▬ ▬ V+=3.3V   ── ── V+=2.5V
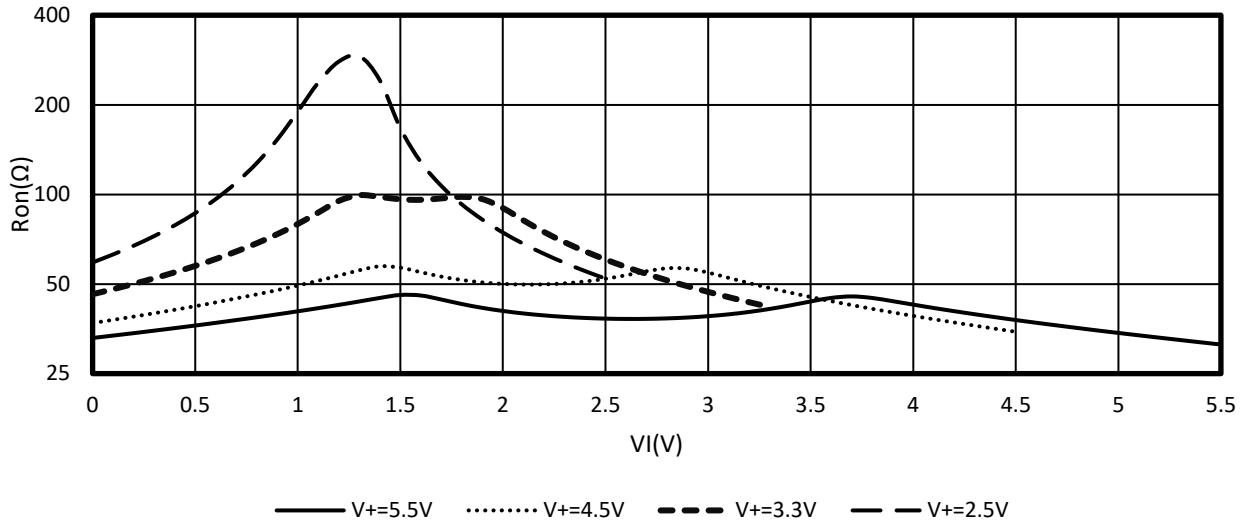
Parameter Measurement Information
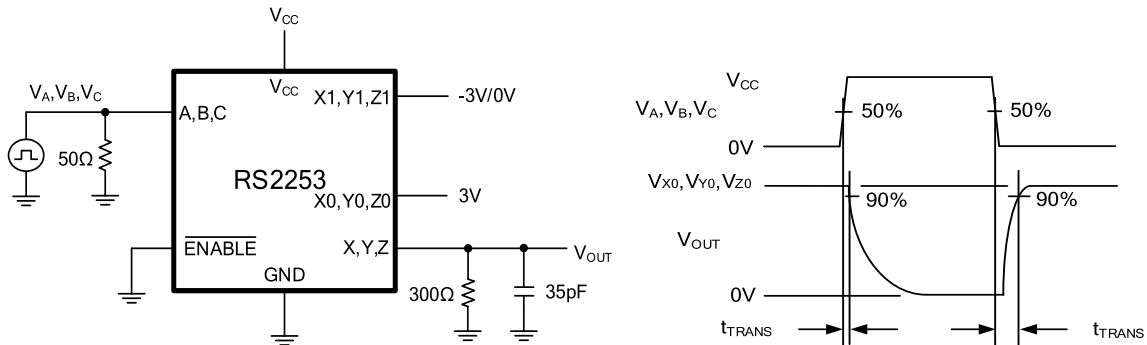
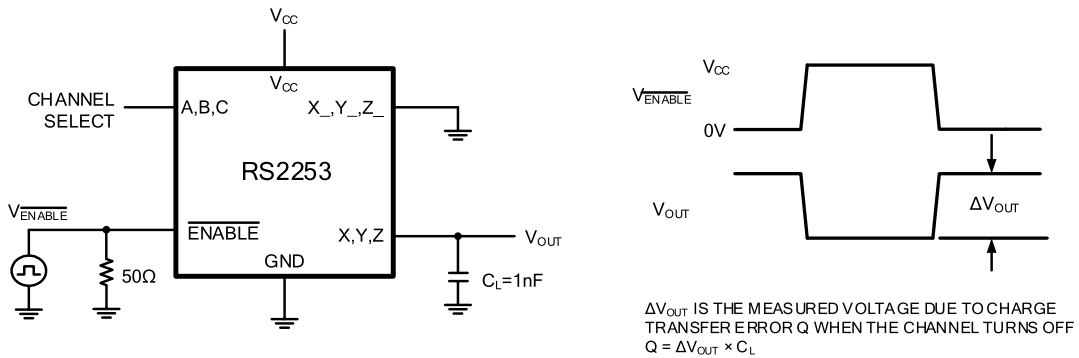**Test Circuit 1. Address Transition Times (t_TRANS)**
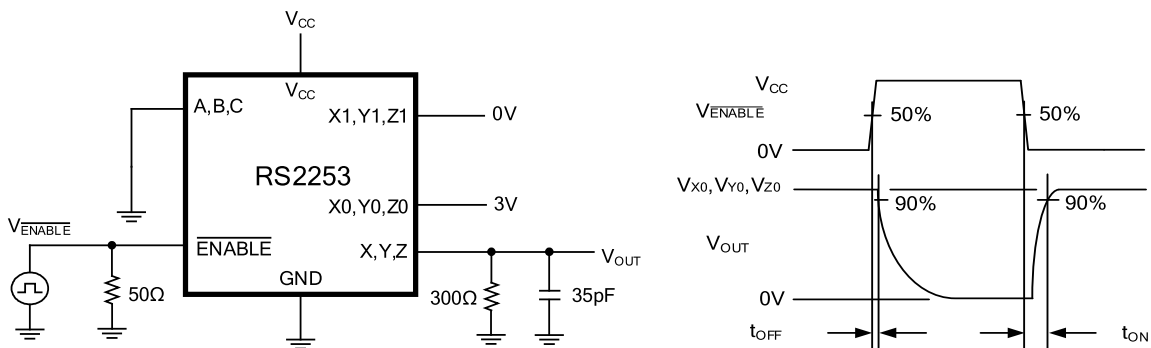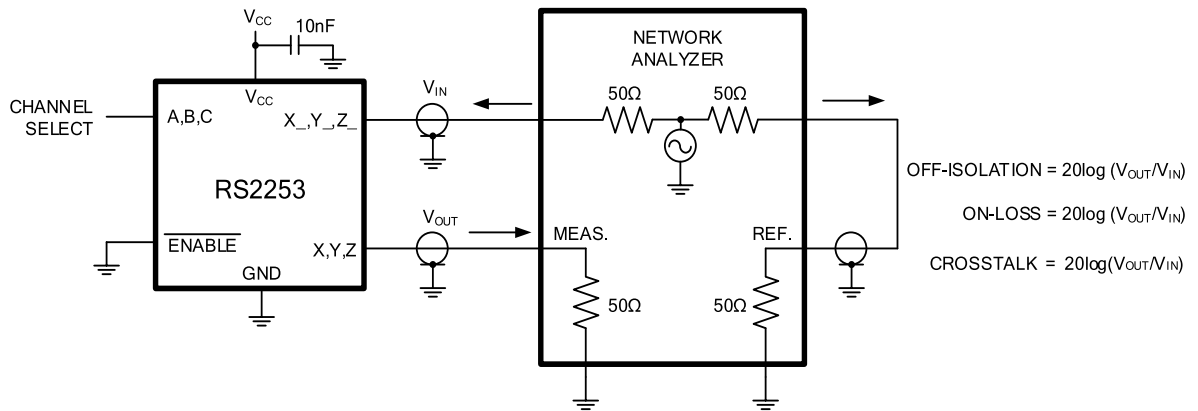

Test Circuit 2. Switching Times (t_ON, t_OFF)

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)

OFF-ISOLATION = $20\log (V_{OUT}/V_{IN})$

ON-LOSS = $20\log (V_{OUT}/V_{IN})$

CROSSTALK = $20\log(V_{OUT}/V_{IN})$

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.
CROSSTALK IS MEASURED FROM ONE CHANNEL(A,B,C) TO ALL OTHER CHANNELS.

SIGNAL DIRECTION THROUGH SWITCH IS REVERSED; WORST VALUES ARE RECORDED.

Test Circuit 5. Off Isolation, On Loss
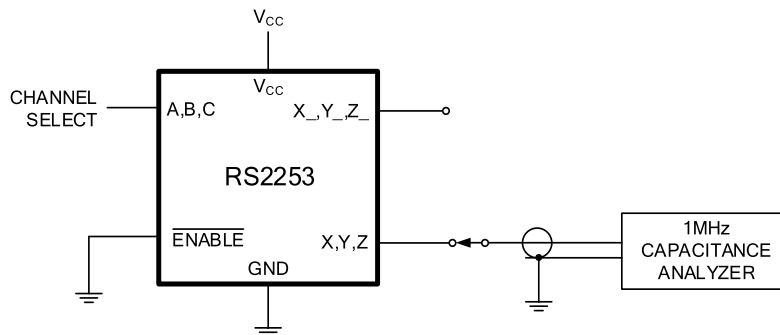
Test Circuit 6. Capacitance

APPLICATION NOTES

The RS2253 device is a triple 2-channel multiplexer having three separate digital control inputs, A, B, and C, and an inhibit input. Each control input selects one of a pair of channels which are connected in a single-pole, double-throw configuration.

When the devices are used as demultiplexers, the CHANNEL IN/OUT terminals are the outputs and the COMMON OUT/IN terminals are the inputs.
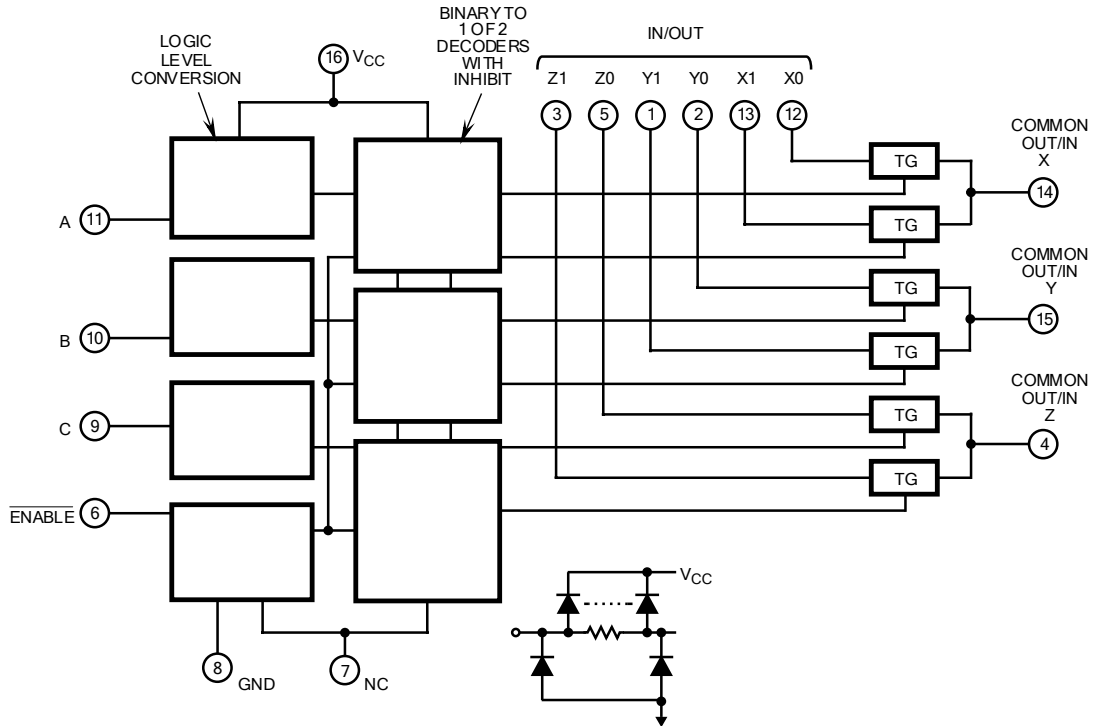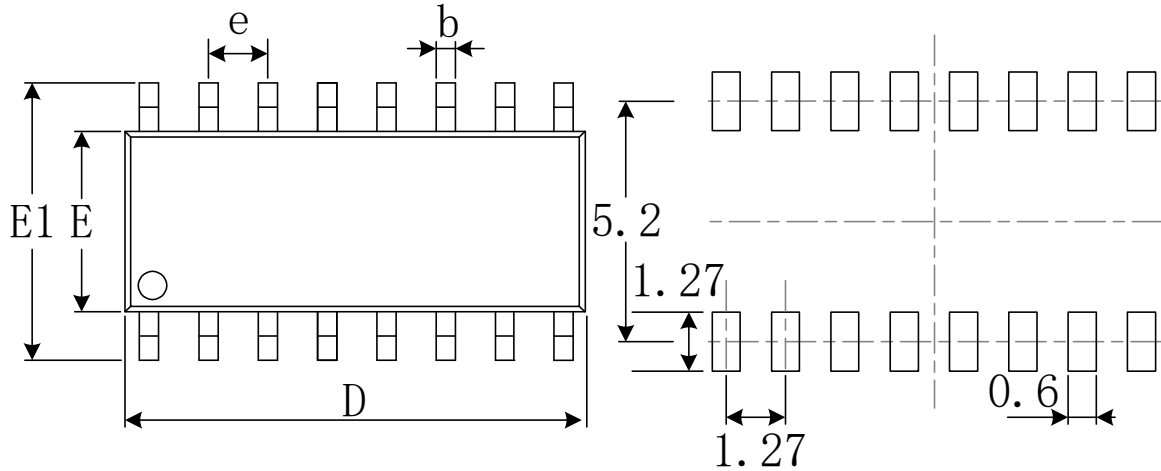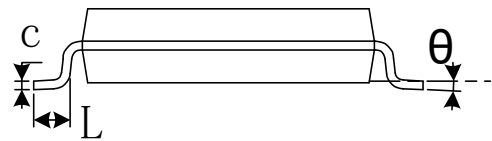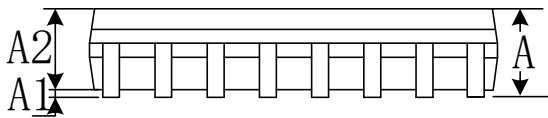

Figure 1. The RS2253 Functional Block Diagram
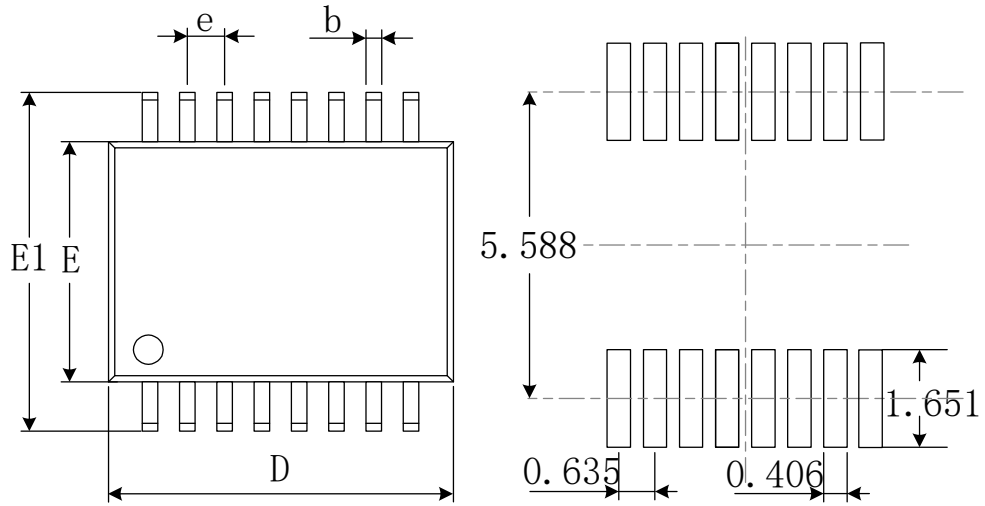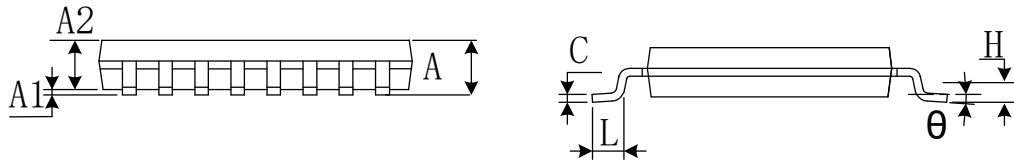
PACKAGE OUTLINE DIMENSIONS
SOIC-16

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

5.588

0.635   0.406

1.651

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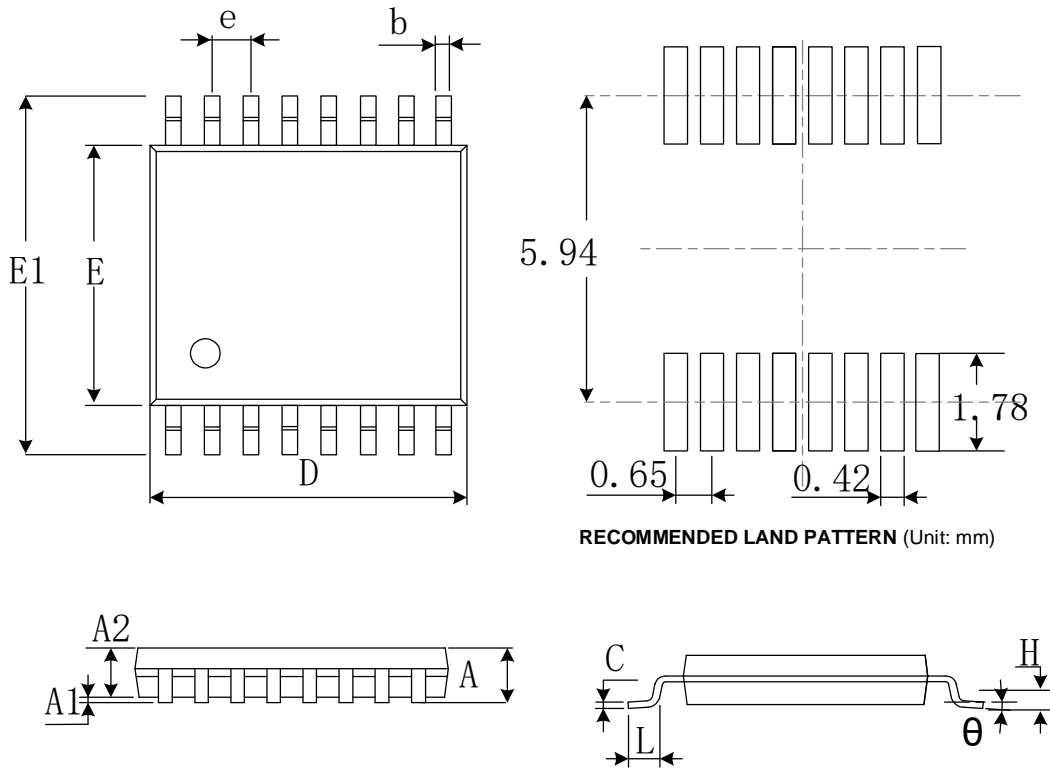
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.200	6.600	0.244	0.260
e	0.650(BSC)		0.026(BSC)	
L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

QFN-3x3-16L
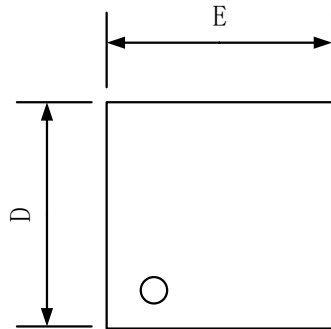
TOP VIEW
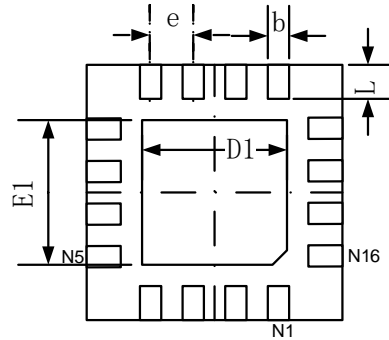
BOTTOM VIEW

SIDE VIEW

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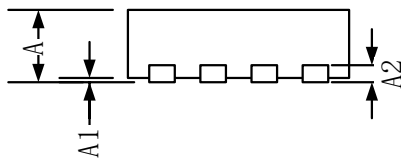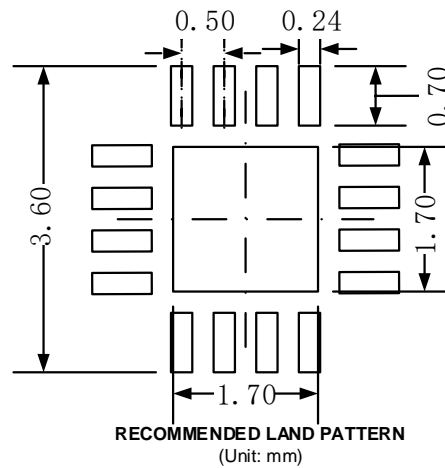
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203		0.008	
b	0.180	0.300	0.007	0.012
D	2.900	3.100	0.114	0.122
D1	1.600	1.800	0.063	0.071
E	2.900	3.100	0.114	0.122
E1	1.600	1.800	0.063	0.071
e	0.500 TYP		0.020 TYP	
L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

www.run-ic.com