CMOS Single 8-Channel Analog Multiplexer/Demultiplexer

1 FEATURES

- **-3dB Bandwidth: 200MHz**
- **Single Supply Operation: 2.5V to 5.5V**
- **Low ON Resistance: 53Ω(TYP) With 5V Supply**
- **High Off-Isolation: -75dB (R_L = 50Ω, f = 1MHz)**
- **Break-Before-Make Switching**
- **Binary Address Decoding on Chip**
- **Operating Temperature Range: -40°C to +125°C**
- **PACKAGES: SOP16, TSSOP16 and QFN3X3-16**

2 APPLICATIONS

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

3 DESCRIPTIONS

The RS2251F 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 RS2251F device are digitally-controlled analog switches. It has low on-resistance (53Ω TYP) and very low off-leakage current (1nA TYP).

The RS2251F is available in Green SOP16, TSSOP16 and QFN3X3-16 packages. It operates over an ambient temperature range of -40°C to +125°C.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RS2251F	SOP16	9.90mm×3.91mm
	TSSOP16	5.00mm×4.40mm
	QFN3X3-16	3.00mm×3.00mm

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

4 Functional Diagrams of RS2251F

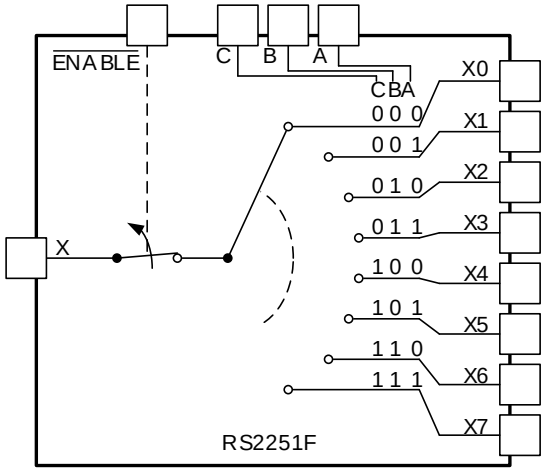


Table of Contents

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	2023/05/30	Initial version completed
A.2	2023/07/03	1. Add t_{pd} and X_{TALK} PARAMETER on Page 8@RevA.1 2. Update O_{ISO} PARAMETER on Page 8@RevA.1 3. Update Parameter Measurement Information on Page 10@RevA.1
A.2.1	2024/03/11	Modify packaging naming

6 PACKAGE/ORDERING INFORMATION (1)

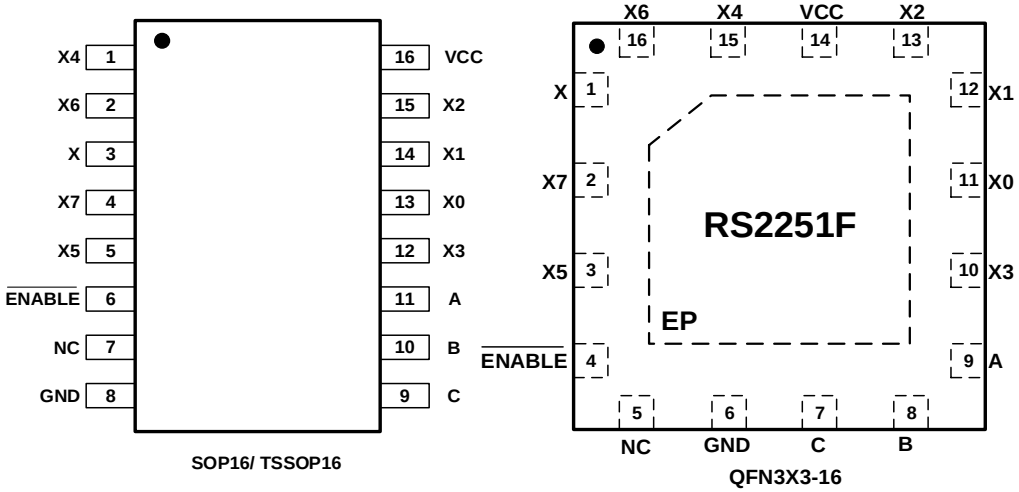
PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING (2)	PACKAGE OPTION
RS2251F	RS2251FXS16	-40°C ~+125°C	SOP16	RS2251	Tape and Reel,4000
	RS2251FXTSS16	-40°C ~+125°C	TSSOP16	RS2251	Tape and Reel,4000
	RS2251FXTQC16	-40°C ~+125°C	QFN3X3-16	RS2251	Tape and Reel,5000

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.

7 PIN CONFIGURATIONS (TOP VIEW)



7.1 PIN DESCRIPTION

NAME	PIN		FUNCTION
	SOP16/TSSOP16	QFN3X3-16	
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.

7.2 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.

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)	SOP16		150	°C/W
		TSSOP16		45	
		QFN3X3-16		70	
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)	±3000	V
		Charged-device model (CDM)	±1000	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	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		53	58	Ω
				FULL			77	Ω
		V_{CC}=3.3V, Ix=1mA	3.3V	+25°C		102	120	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		23	27	Ω
				FULL			40	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	FULL		1	1000	nA
		V_{CC}=3.3V, $V_{X\_}$=1V or 3V V_X=3V or 1V	3.3V	FULL		1	1000	nA
DIGITAL CONTROL INPUTS (5)								
Logic Input Logic Threshold High	V_{AH}, V_{BH}, V_{CH}, $V_{\overline{ENABLE}}$(H)		5V	FULL	1.8			V
			3.3V	FULL	1.5			V
Logic Input Logic Threshold Low	V_{AL}, V_{BL}, V_{CL} $V_{\overline{ENABLE}}$(L)		5V	FULL			0.7	V
			3.3V	FULL			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	FULL		1	1000	nA
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	FULL		1	1000	nA

(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								
Propagation Delay	t_{pd}	R_L = 300Ω, C_L = 35pF, See Figure 2	5V	+25°C		6		ns
			3.3V	+25°C		8		ns
Address Transition Time	t_{TRANS}	$V_{X\_}$ = 3V/0V, R_L = 300Ω, C_L = 35pF, See Figure 3	5V	+25°C		95		ns
		$V_{X\_}$ = 3V/0V, R_L = 300Ω, C_L = 35pF, See Figure 3	3.3V	+25°C		130		ns
$\overline{ENABLE}$ Turn-On Time	t_{ON}	$V_{X\_}$ = 3V, R_L = 300Ω, C_L = 35pF, See Figure 4	5V	+25°C		70		ns
			3.3V	+25°C		90		
$\overline{ENABLE}$ Turn-Off Time	t_{OFF}	$V_{X\_}$ = 3V, R_L = 300Ω, C_L = 35pF, See Figure 4	5V	+25°C		100		ns
			3.3V	+25°C		115		
Break-Before-Make Time Delay	t_D	$V_{X\_}$ = 3V, R_L = 300Ω, C_L = 35pF, See Figure 5	5V	+25°C		60		ns
			3.3V	+25°C		70		ns
Charge Injection (1)	Q	R_S = 0Ω, C_L = 1nF, See Figure 6	5V	+25°C		3		pC
		R_S = 0Ω, C_L = 1nF, See Figure 6	3.3V	+25°C		2.5		pC
Off Isolation	O_{ISO}	R_L = 50Ω, f = 1MHz, See Figure 7	5V	+25°C		-75		dB
Crosstalk	X_{TALK}	R_L=50Ω， f=1MHz, See Figure 8	5V	+25°C		-76		dB
-3dB Bandwidth	BW	R_L = 50Ω, See Figure 9	5V	+25°C		200		MHz
			3.3V	+25°C		200		MHz
Input Off-Capacitance	$C_{X\_(OFF)}$	f = 1MHz, See Figure 10	5V	+25°C		3.5		pF
Output Off-Capacitance	$C_{X(OFF)}$	f = 1MHz, See Figure 10	5V	+25°C		10		pF
Output On- Capacitance	$C_{X(ON)}$	f = 1MHz, See Figure 10	5V	+25°C		13		pF
Total Harmonic Distortion	THD	R_L = 600Ω, $5V_{P-P}$, f = 20Hz to 20kHz	5V	+25°C		1.5		%
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	FULL		0.001	6	μA
		V_{CC} = 3.3V, V_A, V_B, V_C, $V_{\overline{ENABLE}}$ = V_{CC} or 0	3.3V	FULL		0.001	3	μA

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

8.5 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.

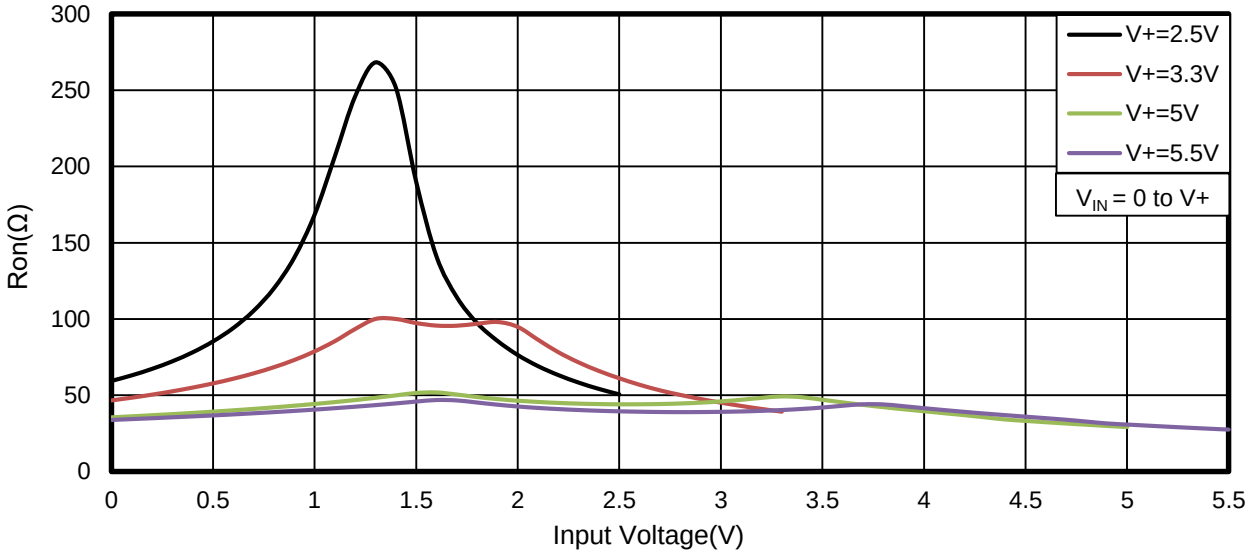


Figure 1. Typical Ron as a Function of Input Voltage

9 Parameter Measurement Information

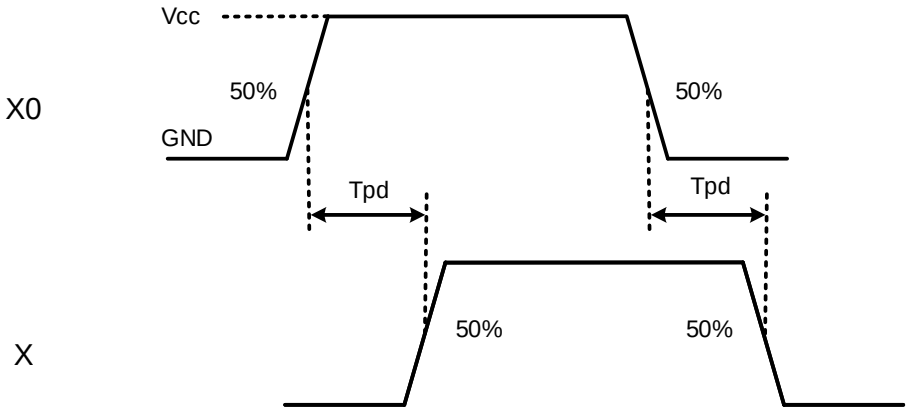


Figure 2. Propagation Delay (t_{pd})

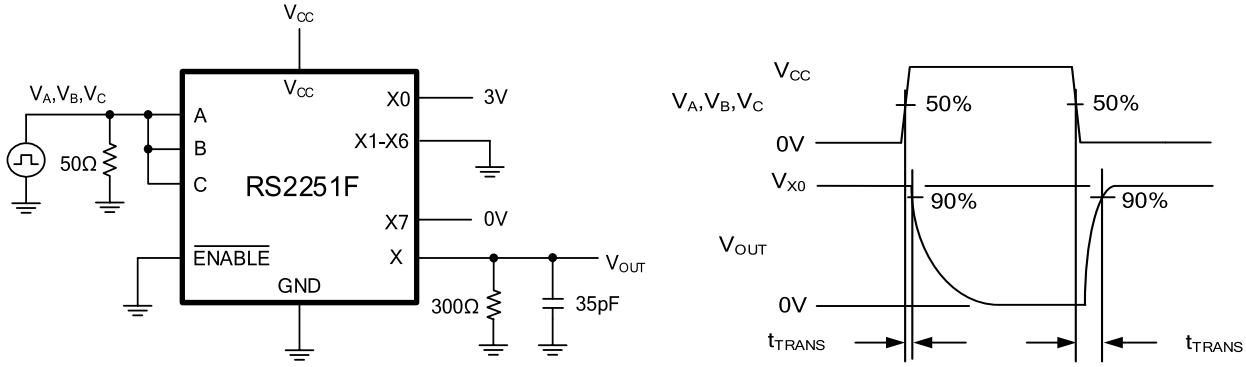


Figure 3. Address Transition Times (t_{TRANS})

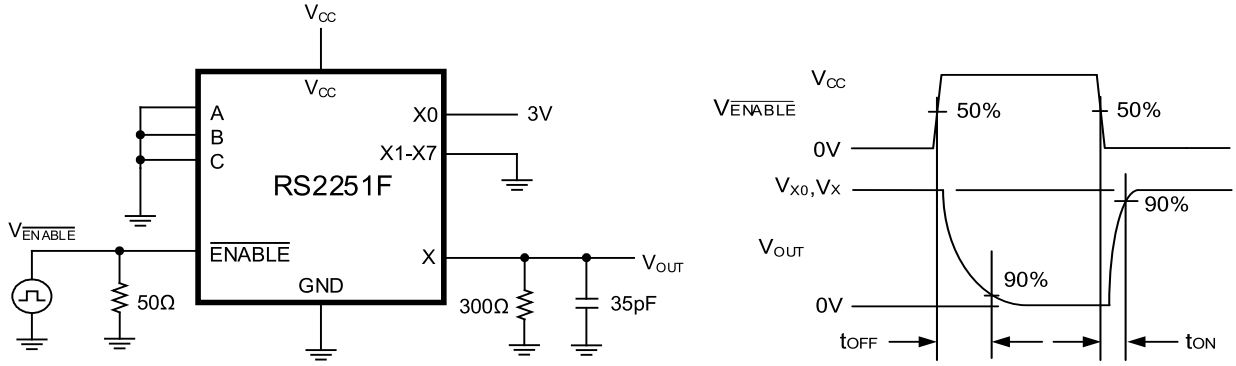


Figure 4. Switching Times (t_{ON}, t_{OFF})

Parameter Measurement Information (continued)

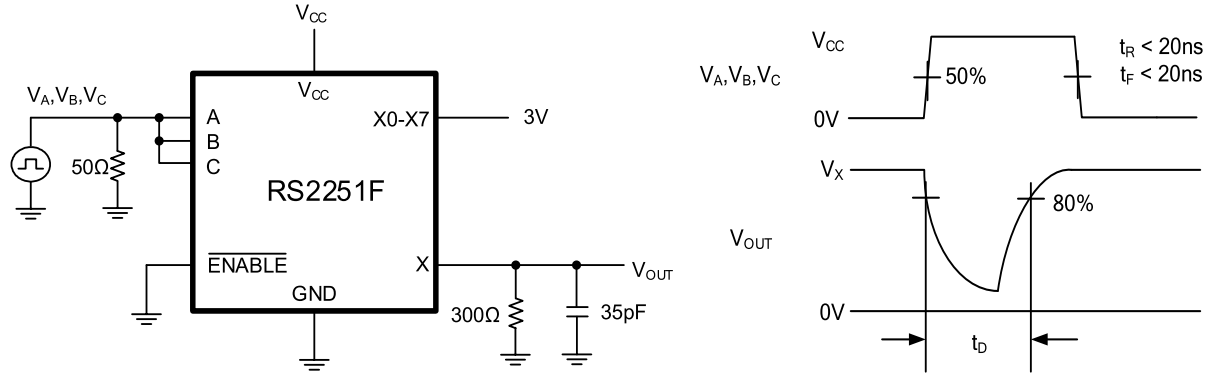


Figure 5. Break-Before-Make Time Delay (t_D)

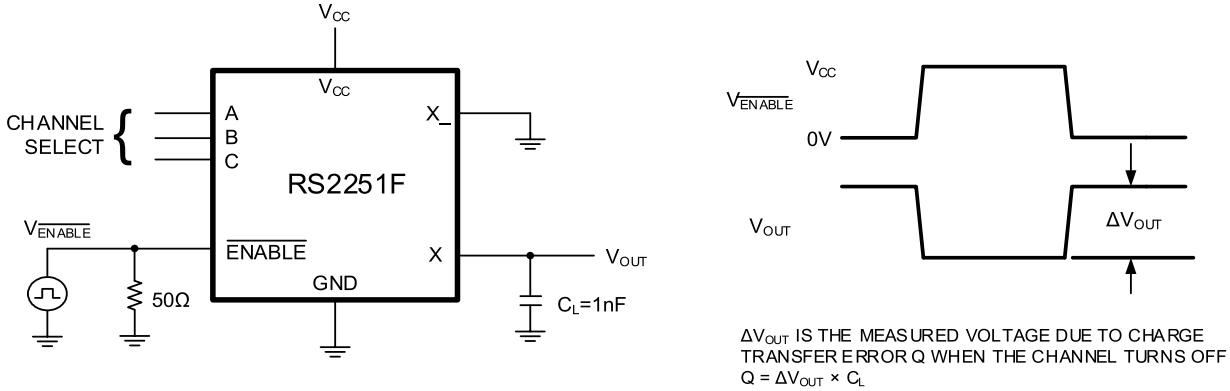


Figure 6. Charge Injection (Q)

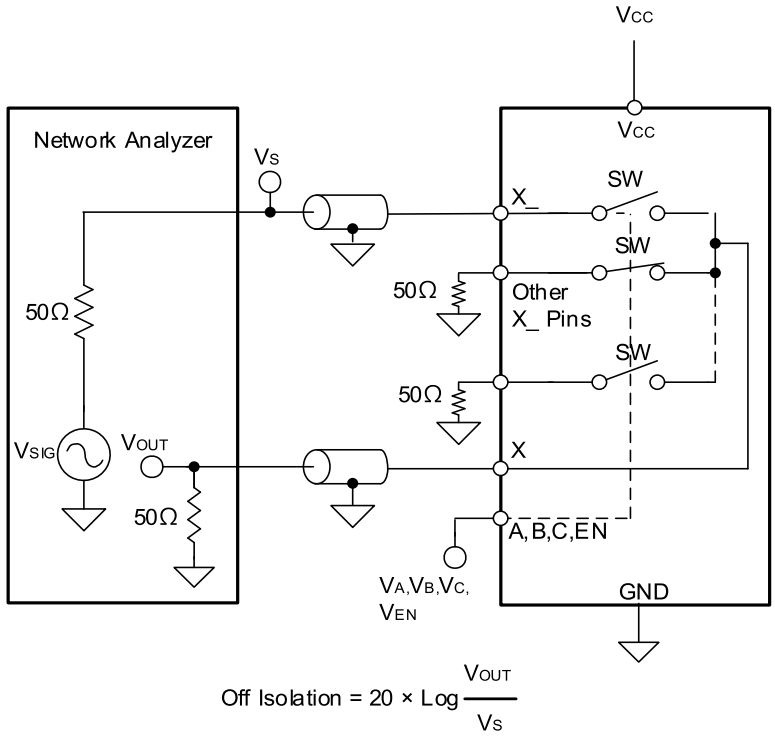
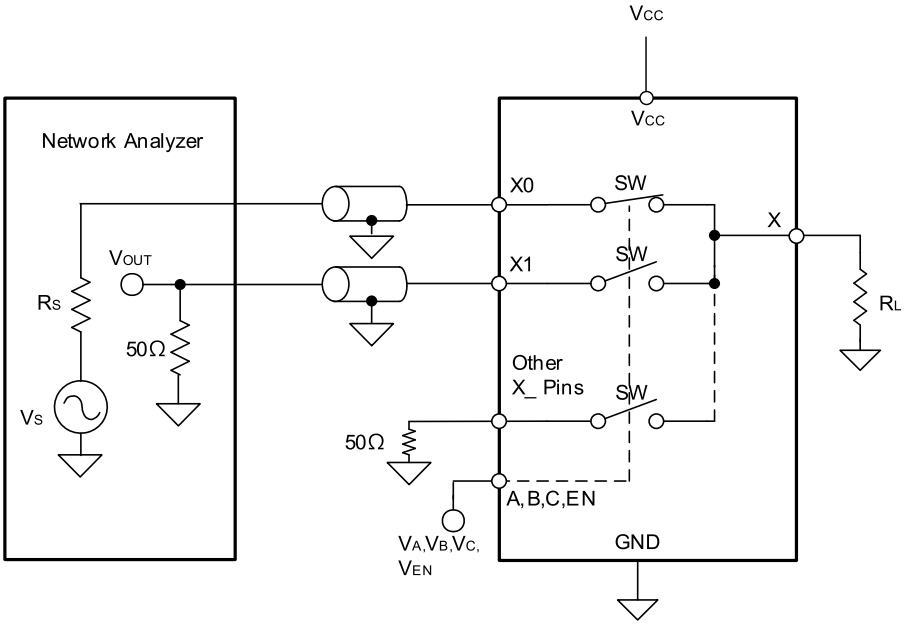


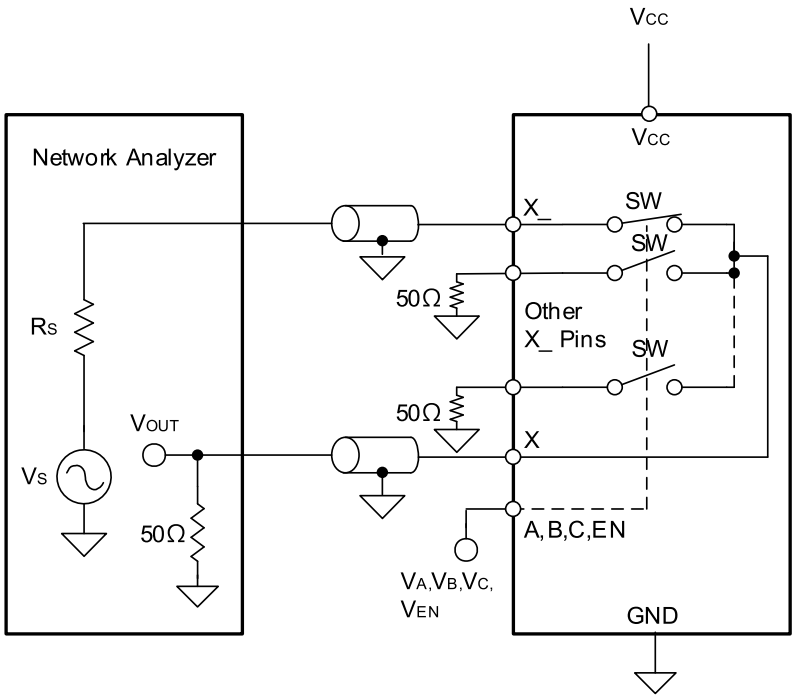
Figure 7. Off Isolation Measurement Setup

Parameter Measurement Information (continued)



$$\text{Intra-channel Crosstalk} = 20 \times \text{Log} \frac{V_{OUT}}{V_S}$$

Figure 8. Intra-Channel Crosstalk Measurement Setup



$$\text{Bandwidth} = 20 \times \text{Log} \frac{V_{OUT}}{V_S}$$

Figure 9. Bandwidth Measurement Setup

Parameter Measurement Information (continued)

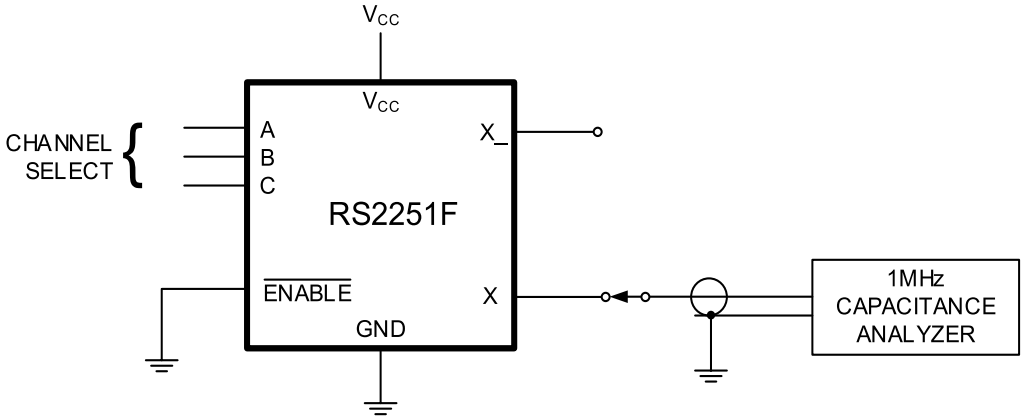


Figure 10. Capacitance

10 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.

10.1 APPLICATION NOTES

The RS2251F 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 RS2251F is to use it in conjunction with a microcontroller to poll a keypad. Figure 11 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.

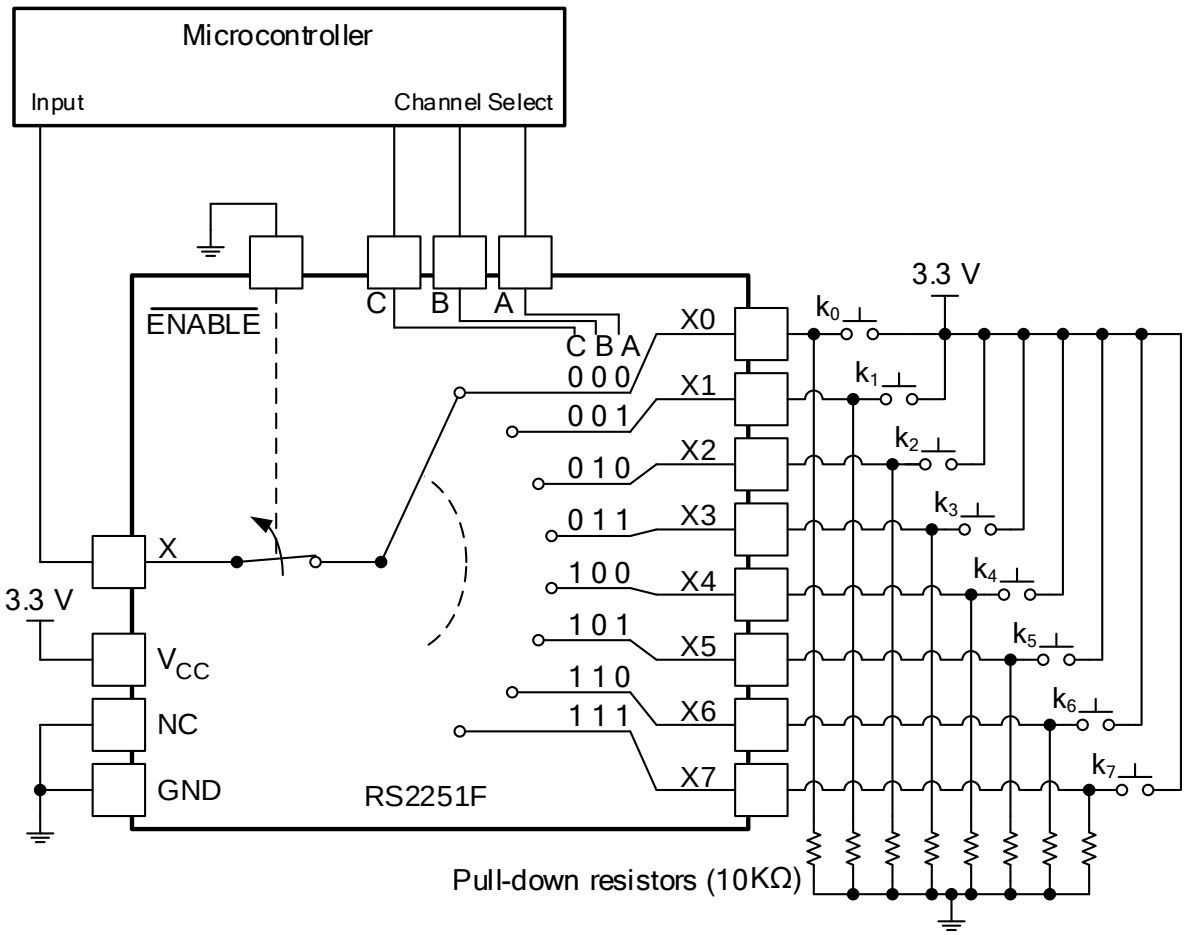
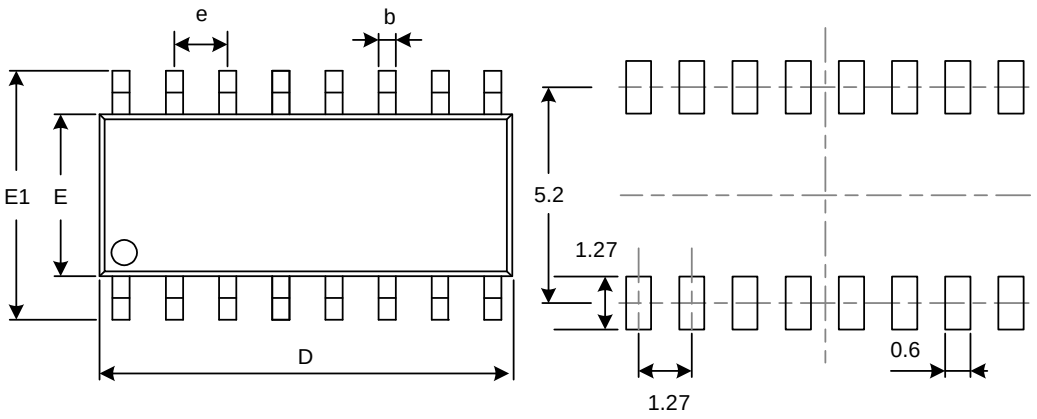


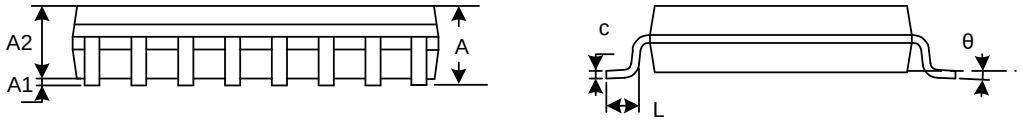
Figure 11. The RS2251F Being Used to Help Read Button Presses on a Keypad.

11 PACKAGE OUTLINE DIMENSIONS

SOP16

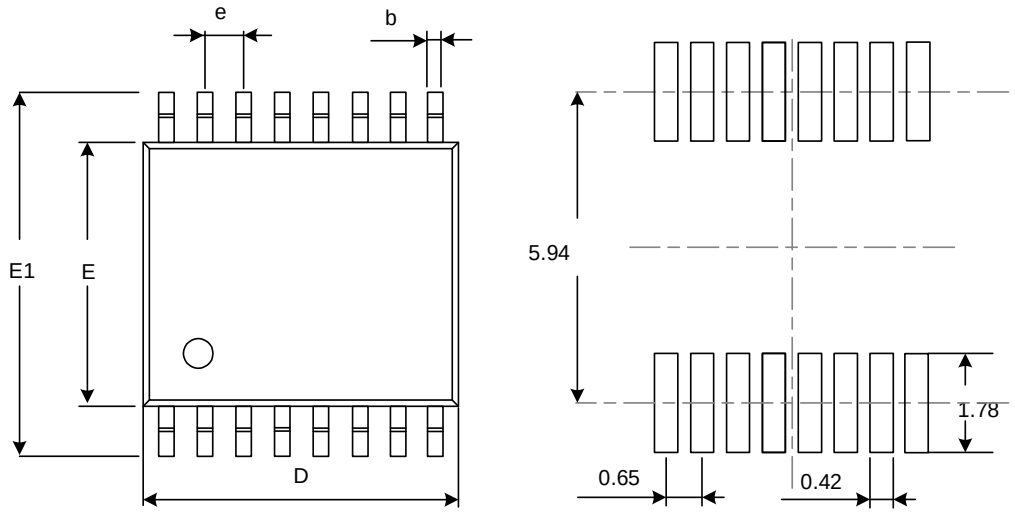


RECOMMENDED LAND PATTERN (Unit: mm)

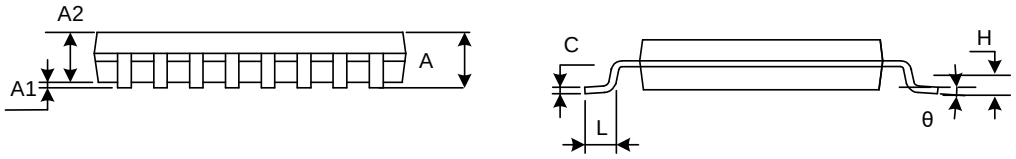


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	9.800	10.200	0.386	0.402
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27(BSC)		0.050(BSC)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

TSSOP16

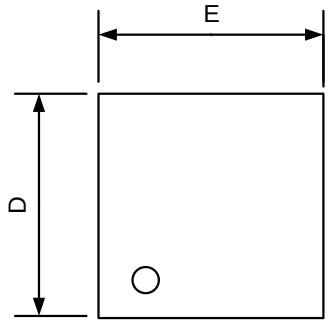


RECOMMENDED LAND PATTERN (Unit: mm)

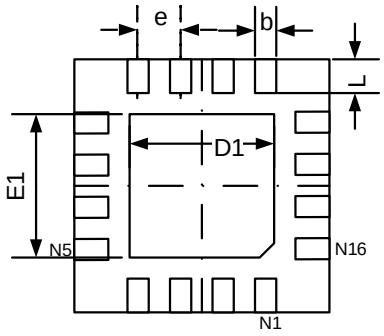


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.200	6.600	0.244	0.260
e	0.650(BSC)		0.026(BSC)	
L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

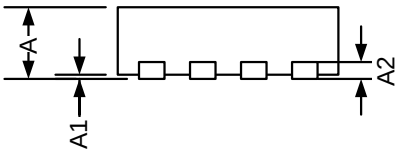
QFN3X3-16



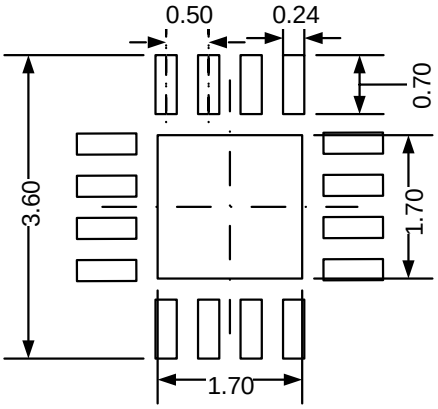
TOP VIEW



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

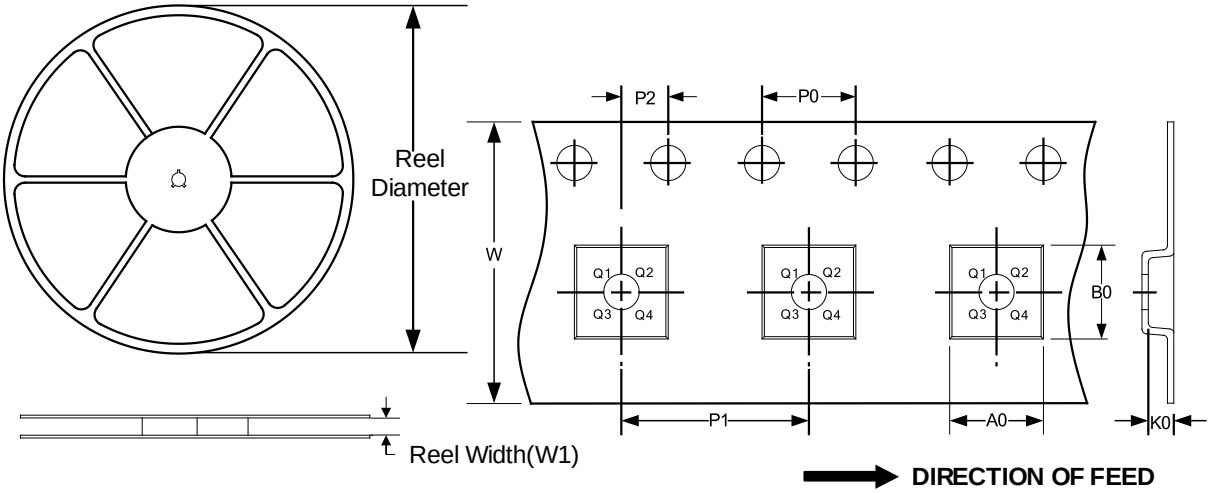
NOTE:

A. All linear dimension is in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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
SOP16	13''	16.4	6.50	10.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP16	13''	12.4	6.90	5.60	1.20	4.0	8.0	2.0	12.0	Q1
QFN3X3-16	13''	12.4	3.35	3.35	1.13	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.

IMPORTANT NOTICE AND DISCLAIMER

Jiangsu RUNIC Technology Co., Ltd. will accurately and reliably provide technical and reliability data (including data sheets), design resources (including reference designs), application or other design advice, WEB tools, safety information and other resources, without warranty of any defect, and will not make any express or implied warranty, including but not limited to the warranty of merchantability Implied warranty that it is suitable for a specific purpose or does not infringe the intellectual property rights of any third party.

These resources are intended for skilled developers designing with RUNIC products You will be solely responsible for: (1) Selecting the appropriate products for your application; (2) Designing, validating and testing your application; (3) Ensuring your application meets applicable standards and any other safety, security or other requirements; (4) RUNIC and the RUNIC logo are registered trademarks of RUNIC INCORPORATED. All trademarks are the property of their respective owners; (5) For change details, review the revision history included in any revised document. The resources are subject to change without notice. Our company will not be liable for the use of this product and the infringement of patents or third-party intellectual property rights due to its use.