Octal Buffer/Driver With 3-State Outputs

1 FEATURES

- **Qualified for Automotive Applications**
- **AEC-Q100 Qualified with the Grade 1**
- **Power-Supply Range:1.65V to 5.5V**
- **V_{CC} Isolation: If V_{CC} is at GND, Both Ports are in the High-Impedance State**
- **I_{OFF}: Supports Partial-Power-Down Mode Operation**
- **Extended Temperature: -40°C to +125°C**

2 APPLICATIONS

- **Automotive Zonal & Body Domain Controller (BCM)**
- **HEV/EV Inverter & Motor Control**

3 DESCRIPTIONS

This RS244-Q1 is an octal non-inverting buffer/driver with 3-state outputs. The 3-state outputs are controlled by the output enable inputs $1\overline{OE}$ and $2\overline{OE}$. A HIGH on $\overline{OE}$ causes the outputs to assume a high impedance OFF-state. V_{CC} supporting operating voltage from 1.65 V to 5.5 V.

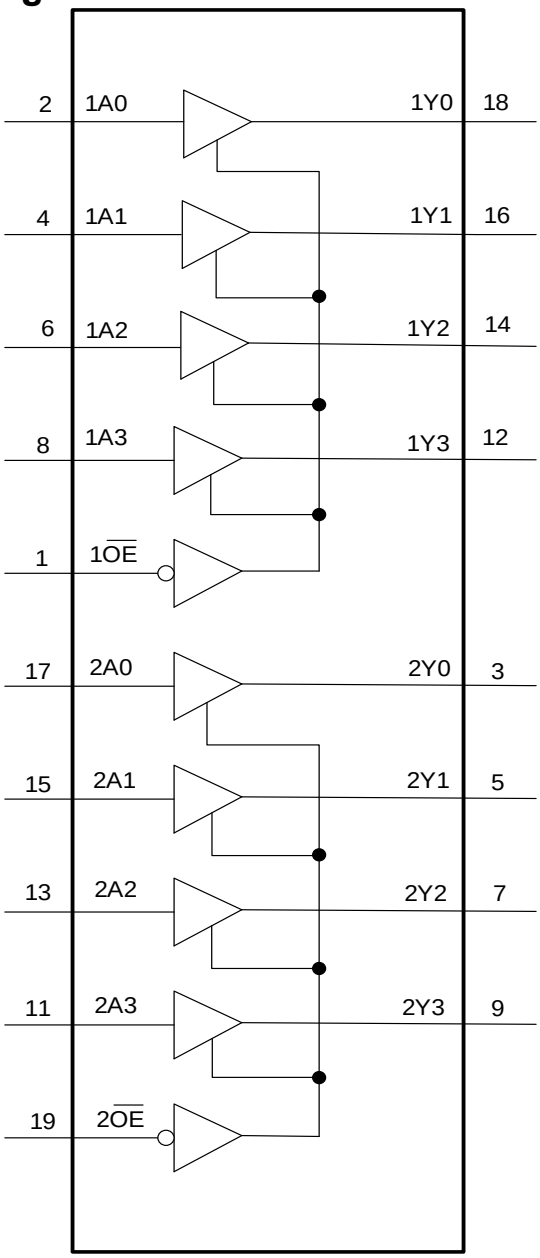
To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to V_{CC} through a pullup resistor, the minimum value of the resistor is determined by the current-sinking capability of the driver.

Device Information (1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RS244-Q1	TSSOP20(20)	6.50mm×4.40mm

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

4 Functional Block Diagram



Function Table

INPUTS		OUTPUT
$\overline{OE}$	A PORT	Y PORT
L	H	H
L	L	L
H	X	Hi-Z

NOTE:
H=HIGH voltage level
L=LOW voltage level
X=don't care
Z=high impedance OFF-state

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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.0	2023/02/02	Preliminary version completed
A.1	2023/04/17	1.Update APPLICATIONS on Page 1@RevA.0 2.Add I_I PARAMETER FULL data on Page 9@RevA.0 3.Delete SOP20 Package

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
RS244 -Q1	RS244XT SS20-Q1	-40°C ~+125°C	TSSOP20	NIPDAUAG	MSL1-260°- Unlimited	RS244	Tape and Reel,4000

NOTE:

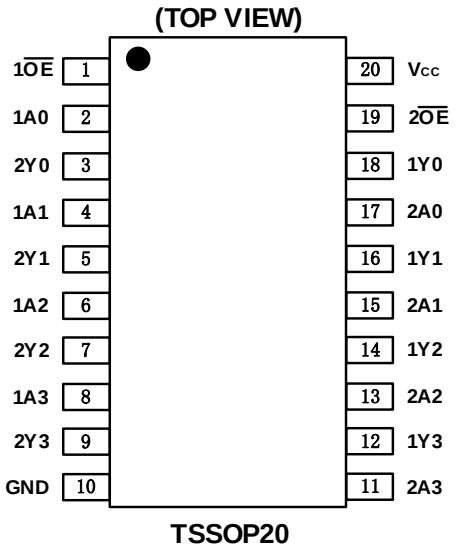
(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(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



PIN DESCRIPTION

PIN	NAME	TYPE (1)	FUNCTION
TSSOP20			
1	$1\overline{OE}$	I	Output Enable (Active Low). Pull $1\overline{OE}$ high to place all outputs in 3-state mode.
2	1A0	I	Input
3	2Y0	O	Output
4	1A1	I	Input
5	2Y1	O	Output
6	1A2	I	Input
7	2Y2	O	Output
8	1A3	I	Input
9	2Y3	O	Output
10	GND	G	Ground.
11	2A3	I	Input
12	1Y3	O	Output
13	2A2	I	Input
14	1Y2	O	Output
15	2A1	I	Input
16	1Y1	O	Output
17	2A0	I	Input
18	1Y0	O	Output
19	$2\overline{OE}$	I	Output Enable (Active Low). Pull $2\overline{OE}$ high to place all outputs in 3-state mode.
20	V_{CC}	P	Supply voltage. 1.65V≤V_{CC}≤5.5V

(1) I=input, O=output, I/O=input and output, P=power, G=Ground.

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 Range		-0.5	6.5	V
V_I(2)	Input Voltage Range	A port	-0.5	6.5	V
		Control inputs	-0.5	6.5	V
V_O(2)	Voltage range applied to any output in the high-impedance or power-off state	Y port	-0.5	6.5	V
V_O(2)(3)	Voltage range applied to any output in the high or low state	Y port	-0.5	V_{CC}+0.5	V
I_{IK}	Input clamp current	V_I<0		-50	mA
I_{OK}	Output clamp current	Vo<0		-50	mA
I_O	Continuous output current			±50	mA
	Continuous current through V_{CC} or GND			±100	mA
θ_{JA}	Package thermal impedance (4)	TSSOP20		40	°C/W
T_J	Junction Temperature (5)		-40	150	°C
T_{stg}	Storage temperature		-65	150	

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The input and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
(3) The value of V_{CC} are provided in the recommended operating conditions table.
(4) The package thermal impedance is calculated in accordance with JESD-51.
(5) 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)	±2000	V
		Charged-Device Model (CDM), per AEC Q100-011	±1000	V
		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

V_{CC} is the supply voltage associated with the input port and output port.(1)(2)

PARAMETER		V_{CC}	MIN	TYP	MAX	UNIT
Supply voltage	V_{CC}		1.65		5.5	V
High-level input Voltage (V_{IH}) (3)	Inputs	1.65V to 1.95V	V_{CC} x0.75			V
		2.3V to 2.7V	V_{CC} x0.7			
		3V to 3.6V	V_{CC} x0.7			
		4.5V to 5.5V	V_{CC} x0.7			
Low-level input Voltage (V_{IL}) (3)	Inputs	1.65V to 1.95V			V_{CC} x0.35	V
		2.3V to 2.7V			V_{CC} x0.3	
		3V to 3.6V			V_{CC} x0.3	
		4.5V to 5.5V			V_{CC} x0.3	
Input voltage (V_I)	Input voltage		0		5.5	V
Output voltage (V_O)	Output voltage		0		V_{CC}	V
High-level output current (I_{OH})		1.65V to 1.95V			-4	mA
		2.3V to 2.7V			-8	
		3V to 3.6V			-24	
		4.5V to 5.5V			-32	
Low-level output current (I_{OL})		1.65V to 1.95V			4	mA
		2.3V to 2.7V			8	
		3V to 3.6V			24	
		4.5V to 5.5V			32	
Input transition rise or fall rate(Δt/Δv)	Data inputs	1.65V to 1.95V			20	ns/V
		2.3V to 2.7V			20	
		3V to 3.6V			10	
		4.5V to 5.5V			5	
T_A Operating free-air temperature			-40		125	°C

(1) All unused or driven (floating) data inputs (I/Os) of the device must be held at logic HIGH or LOW (preferably V_{CC} or GND) to ensure proper device operation and minimize power.
(2) All unused control inputs must be held at V_{CC} or GND to ensure proper device operation and minimize power consumption.
(3) For V_{CC} values not specified in the data sheet, V_{IH} min = V_{CC} × 0.7 V, V_{IL} max = V_{CC} × 0.3 V.

8.4 Electrical Characteristics

over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	CONDITIONS	V_{CC}	TEMP	MIN(1)	TYP(2)	MAX(1)	UNIT
V_{OH}	I_{OH} = –100 µA V_I = V_{IH}	1.65V to 4.5V	Full	V_{CC}-0.1			V
	I_{OH} = –4mA V_I = V_{IH}	1.65V		1.2			
	I_{OH} = –8mA V_I = V_{IH}	2.3V		1.9			
	I_{OH} = –24mA V_I = V_{IH}	3V		2.4			
	I_{OH} = –32mA V_I = V_{IH}	4.5V		3.8			
V_{OL}	I_{OL} = 100 µA V_I = V_{IL}	1.65V to 4.5V				0.1	V
	I_{OL} = 4mA V_I = V_{IL}	1.65V				0.45	
	I_{OL} = 8mA V_I = V_{IL}	2.3V				0.3	
	I_{OL} = 24mA V_I = V_{IL}	3V				0.55	
	I_{OL} = 32mA V_I = V_{IL}	4.5V				0.55	
I_I	V_I = 5.5V or GND	5.5V	+25°C			±1	µA
			Full			±2	
I_{off}	V_I or V_O= 0 to 5.5V	0V	+25°C			±1	µA
			Full			±2	
I_{OZ} (3)	V_O = V_{CC} or GND, $\overline{OE}$=V_{IH}	1.65V to 5.5V	+25°C			±1	µA
			Full			±2	
I_{CC} V_{CC} supply current	V_I = V_{CC} or GND (4) I_O = 0	1.65V to 5.5V	+25°C			1	µA
			Full			5	
		0V	Full			-2	
ΔI_{CC}	One A port at V_{CC} – 0.6V, Y port = open	3V to 5.5V	Full			50	µA
C_I	V_I = V_{CC} or GND	3.3V	+25°C		8.5		pF
C_O	V_O = V_{CC} or GND	3.3V	+25°C		8.5		pF

(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) For I/O ports, the parameter I_{OZ} includes the input leakage current.
(4) Hold all unused data inputs of the device at V_{CCI} or GND to assure proper device operation.

8.5 Switching Characteristics

over recommended operating free-air temperature range, Full=-40°C to 125°C.

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEMP	V_{CC}=1.8V ±0.15V (1)		V_{CC}=2.5V ±0.2V (1)		V_{CC}=3.3V ±0.3V (1)		V_{CC}=5V ±0.5V (1)		UNIT
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	An	Yn	Full	2.0	24.9	1.3	16.6	0.8	15.5	0.4	15.3	ns
t_{PHL}												
t_{PHZ}	$\overline{OE}$	Yn	Full	2.6	27.9	2.0	16.9	1.7	20.1	0.8	14.8	ns
t_{PLZ}												
t_{PZH}	$\overline{OE}$	Yn	Full	2.0	24.1	1.7	15.5	1.1	17.2	1.0	12.9	ns
t_{PZL}												

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

8.6 Operating Characteristics

T_A=25°C

PARAMETER		TEST CONDITIONS	V_{CC}=1.8V	V_{CC}=2.5V	V_{CC}=3.3V	V_{CC}=5V	UNIT
			TYP	TYP	TYP	TYP	
C_{pd}(1)	Outputs enabled	C_L=0, f=10MHz, t_r=t_f=5ns	14	17	22	32	pF

(1) Power dissipation capacitance per transceiver.

8.7 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.

At T_A = +25°C, V_{CC}=5V, unless otherwise noted.

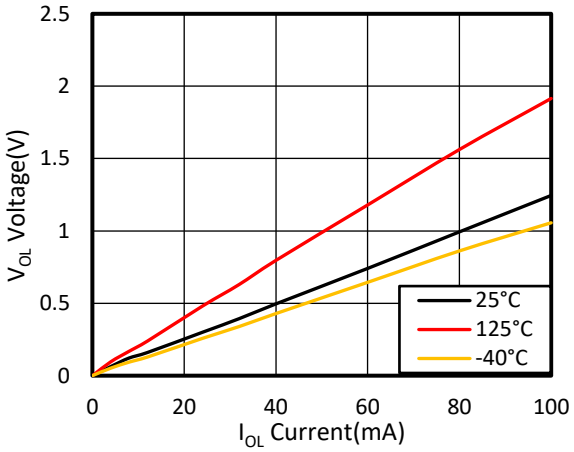


Figure 1. Voltage vs Current

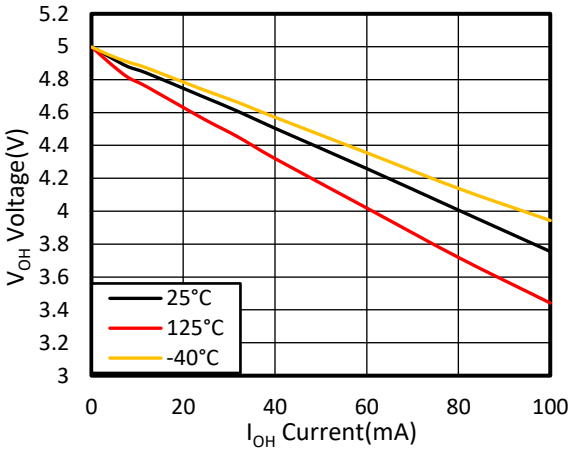
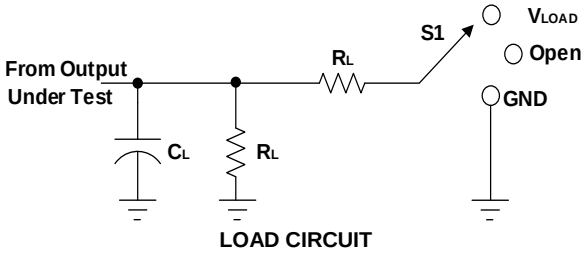


Figure 2. Voltage vs Current

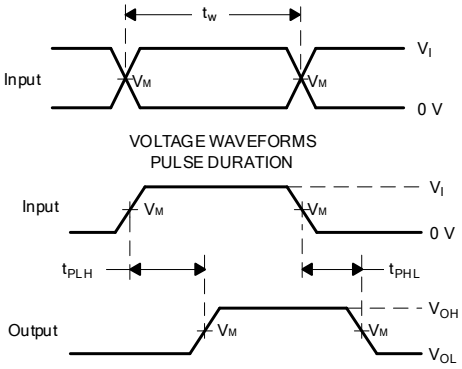
9 Parameter Measurement Information



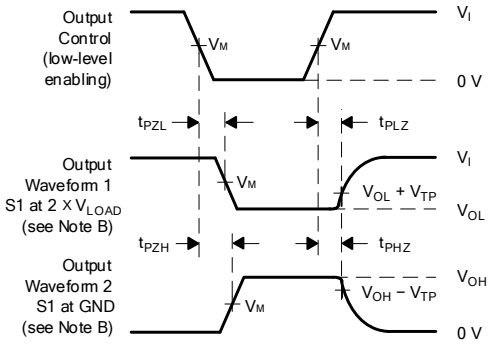
LOAD CIRCUIT

TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	V_{LOAD}
t_{PHZ}/t_{PZH}	GND

V_{CC}	V_I	V_M	C_L	R_L	V_{TP}
1.8V±0.15V	V_{CC}	$V_{CC}/2$	15pF	2kΩ	0.15V
2.5V±0.2V	V_{CC}	$V_{CC}/2$	15pF	2kΩ	0.15V
3.3V±0.3V	2.7V	1.5V	15pF	2kΩ	0.3V
5V±0.5V	2.7V	1.5V	15pF	2kΩ	0.3V



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

NOTES: A.CL includes probe and jig capacitance.
B.Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control.
Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
C. All input pulses are supplied by generators having the following characteristics: PRR≤10 MHz, ZO = 50 , dv/dt≥1V/ns.
D. The outputs are measured one at a time, with one transition per measurement.
E. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
F. t_{PZL} and t_{PZH} are the same as t_{en}.
G. t_{PLH} and t_{PHL} are the same as t_{pd}.
H. All parameters and waveforms are not applicable to all devices.

Figure 3. Load Circuit and Voltage Waveforms

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 Information

RS244-Q1 is a high drive CMOS device that can be used for a multitude of bus interface type applications where output drive or PCB trace length is a concern. The inputs can accept voltages to 5.5 V at any valid V_{CC} making it ideal for down translation.

10.2 Typical Application

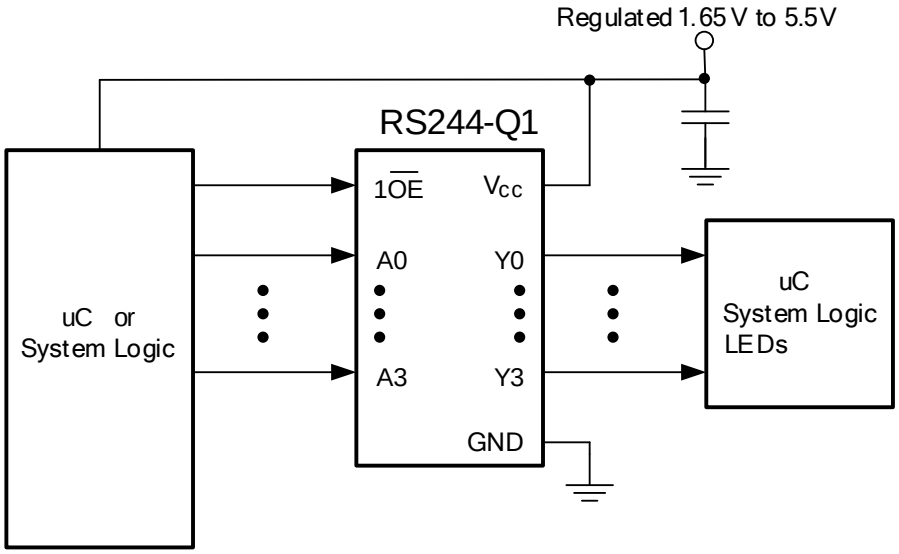


Figure 4. Typical Application Schematic

11 LAYOUTS

11.1 Layout Guidelines

When using multiple bit logic devices, inputs should not float. In many cases, functions or parts of functions of digital logic devices are unused. Some examples are when only two inputs of a triple-input AND gate are used, or when only 3 of the 4-buffer gates are used. Such input pins should not be left unconnected because the undefined voltages at the outside connections result in undefined operational states.

Specified in Figure 5 are rules that must be observed under all circumstances. All unused inputs of digital logic devices must be connected to a high or low bias to prevent them from floating. The logic level that should be applied to any particular unused input depends on the function of the device. Generally, they will be tied to GND or V_{CC}, whichever makes more sense or is more convenient.

11.2 Layout Example

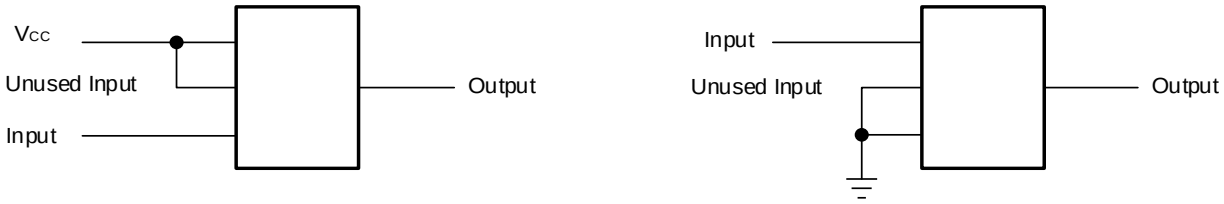
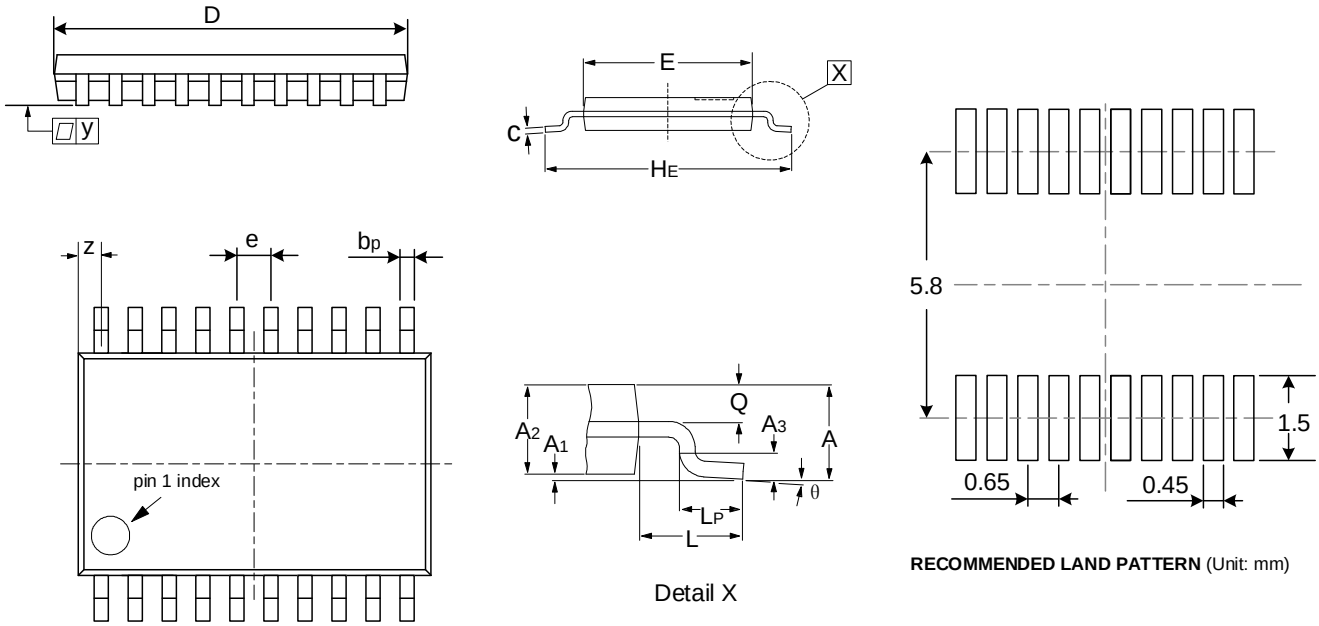


Figure 5. Layout Diagram

12 PACKAGE OUTLINE DIMENSIONS

TSSOP20



RECOMMENDED LAND PATTERN (Unit: mm)

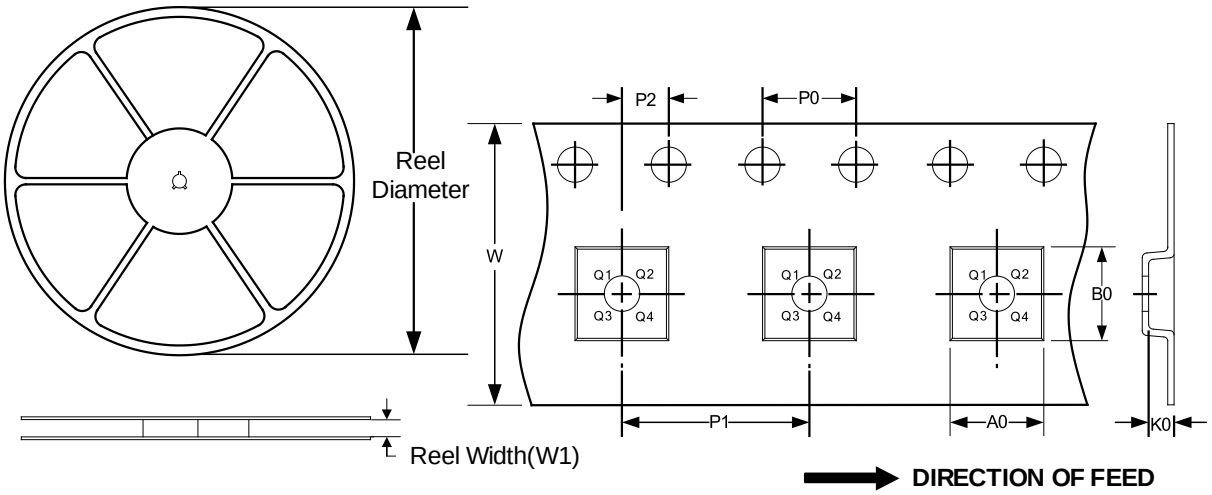
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.100		0.043
A_1	0.050	0.150	0.002	0.006
A_2	0.800	0.950	0.031	0.037
A_3	0.250		0.010	
b_p	0.190	0.300	0.007	0.012
c	0.100	0.200	0.004	0.008
$D^{(A)}$	6.400	6.600	0.251	0.260
$E^{(B)}$	4.300	4.500	0.169	0.177
H_E	6.200	6.600	0.244	0.260
e	0.650		0.026	
L	1.000		0.039	
L_P	0.500	0.750	0.020	0.030
Q	0.300	0.400	0.012	0.016
$Z^{(A)}$	0.200	0.500	0.008	0.020
y	0.100		0.004	
θ	0°	8°	0°	8°

NOTE:

A. Plastic or metal protrusions of 0.15mm maximum per side are not included.
B. Plastic interlead protrusions of 0.25mm maximum per side are not included.
C. All linear dimension is in millimeters.
D. This drawing is subject to change without notice.
E. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
F. BSC: Basic Dimension. Theoretically exact value shown without tolerances.
G. REF: Reference Dimension, usually without tolerance, for information purposes only.

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
TSSOP20	13”	12.4	6.75	6.95	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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