# 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.

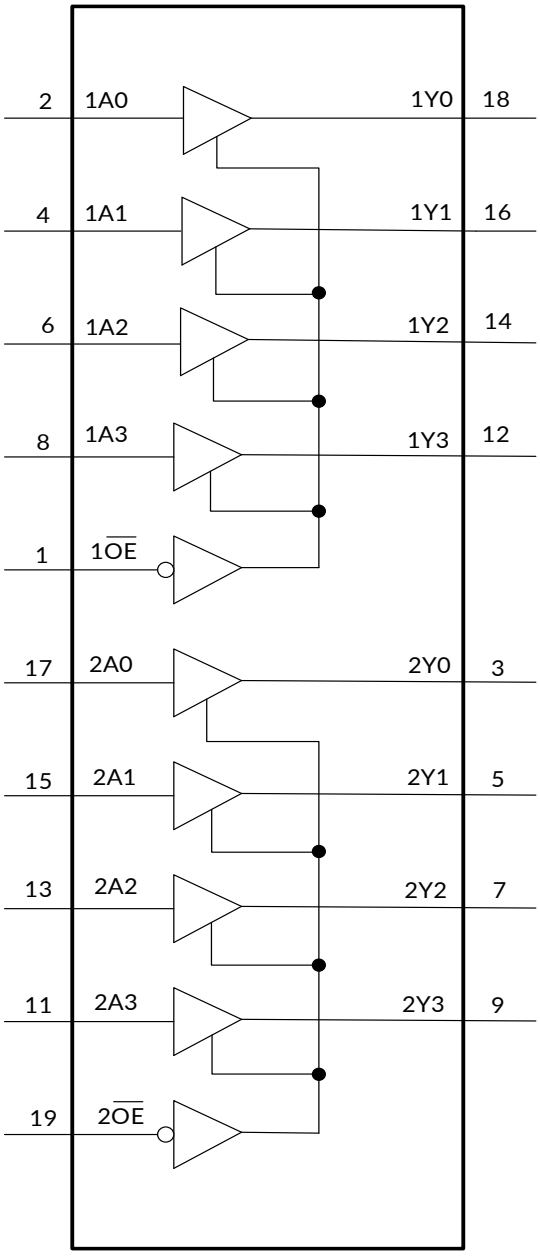
To ensure the high-impedance state during power up or power down, $\overline{OE}$ should be tied to $V_{CC}$ through a pullup resistor, the minimum value of the resistor is determined by the current-sinking capability of the driver.

**Device Information (1)**

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|---|---|---|
| RS244-Q1 | TSSOP20 | 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<br>2.Add $I_I$ PARAMETER FULL data on Page 9@RevA.0<br>3.Delete SOP20 Package |
| A.1.1 | 2024/03/06 | Modify packaging naming |
| A.2 | 2024/05/17 | 1. Update PACKAGE note<br>2. Update KEY PARAMETER LIST OF TAPE AND REEL |

# 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:

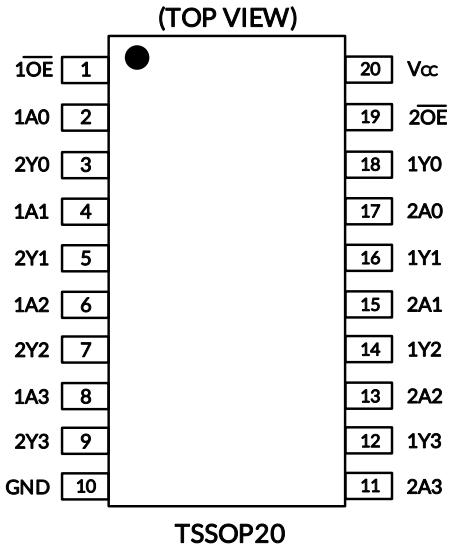
(1) This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.

(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 |
| $\theta_{JA}$ | 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 | |
| $\Delta I_{CC}$ | 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.

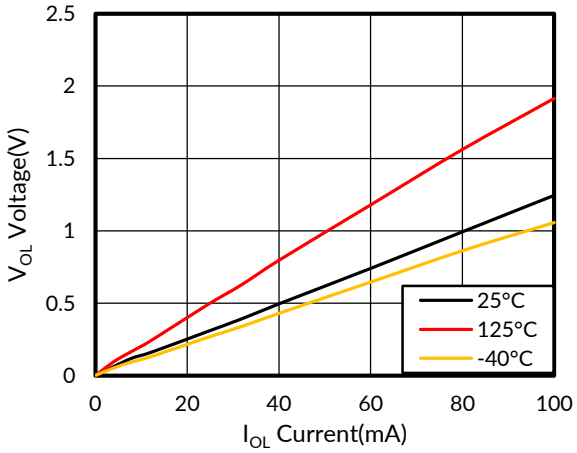



**Figure 1. Voltage vs Current**

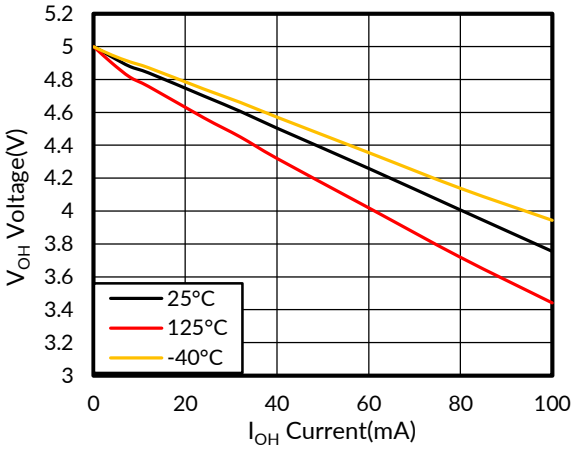
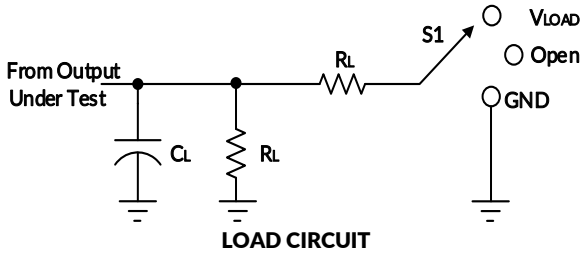


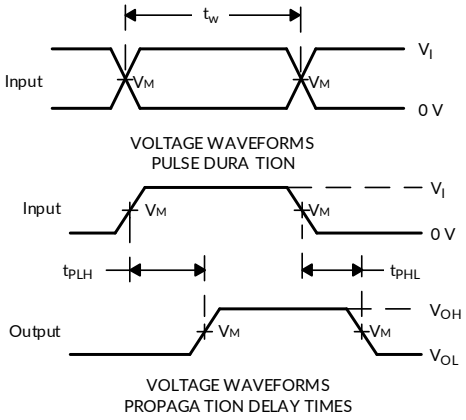

**Figure 2. Voltage vs Current**

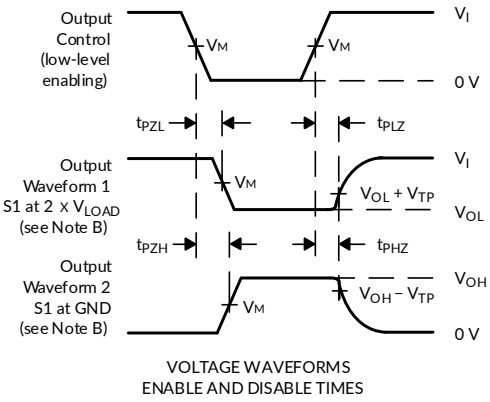
# 9 PARAMETER MEASUREMENT INFORMATION




| 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 |




NOTES: A. $C_L$ 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, $Z_O$ = 50 Ω, 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

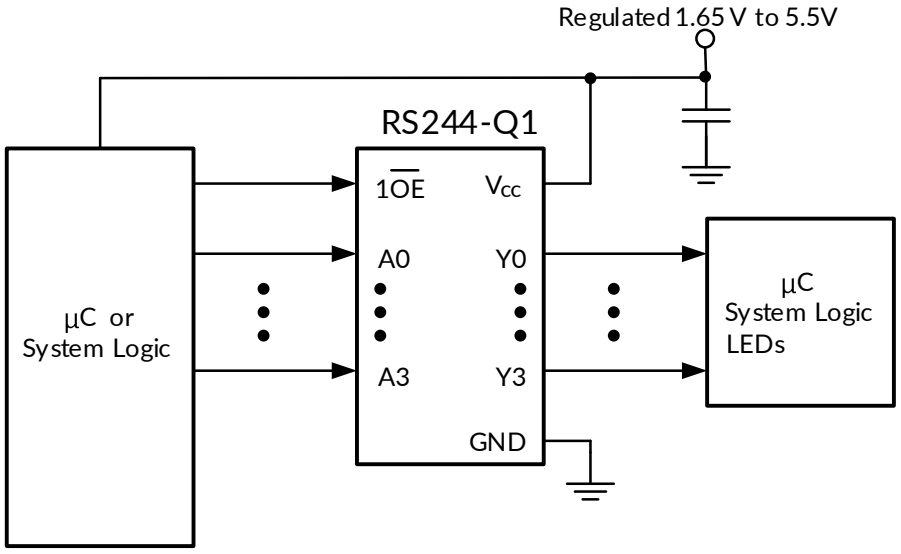



**Figure 4. Typical Application Schematic**

# 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

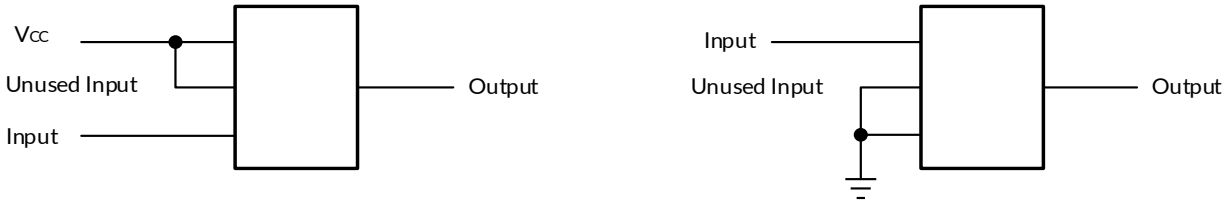
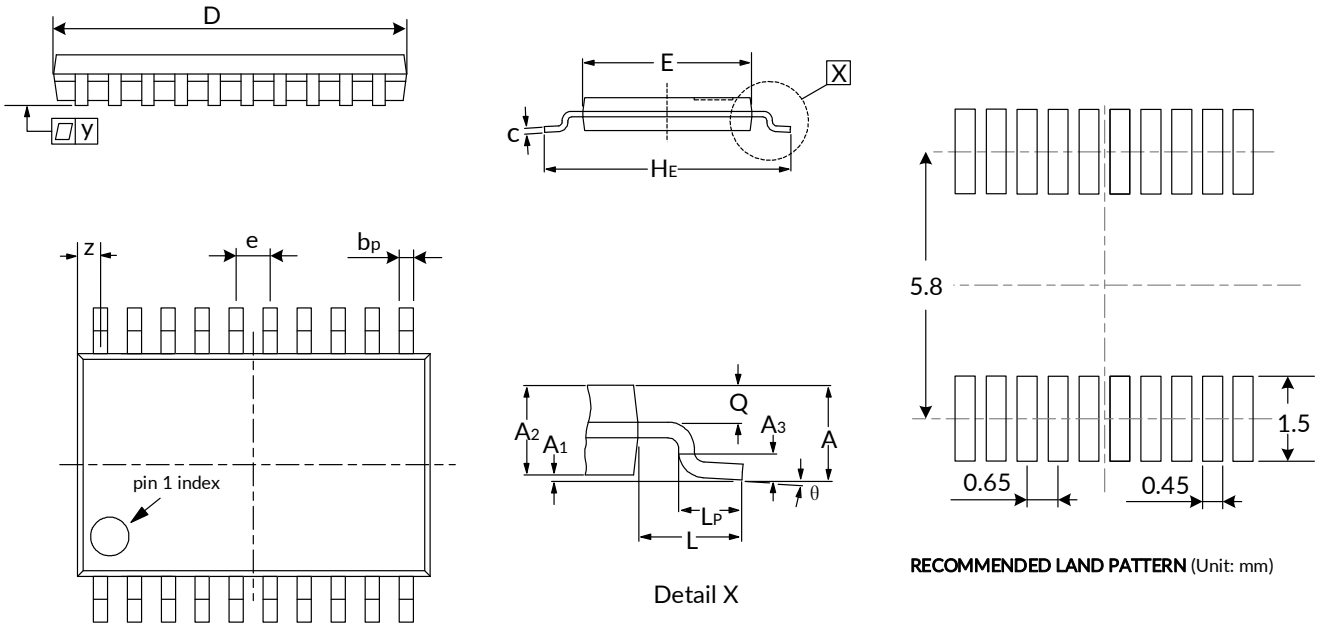



**Figure 5. Layout Diagram**

# 12 PACKAGE OUTLINE DIMENSIONS

## TSSOP20 (2)




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 |
| $A_3$ | 0.250 | | 0.010 | |
| $b_p$ | 0.190 | 0.300 | 0.007 | 0.012 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| D (1) | 6.400 | 6.600 | 0.251 | 0.260 |
| 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 | 1.000 | | 0.039 | |
| $L_P$ | 0.500 | 0.750 | 0.020 | 0.030 |
| Q | 0.300 | 0.400 | 0.012 | 0.016 |
| Z | 0.200 | 0.500 | 0.008 | 0.020 |
| y | 0.100 | | 0.004 | |
| θ | 0° | 8° | 0° | 8° |

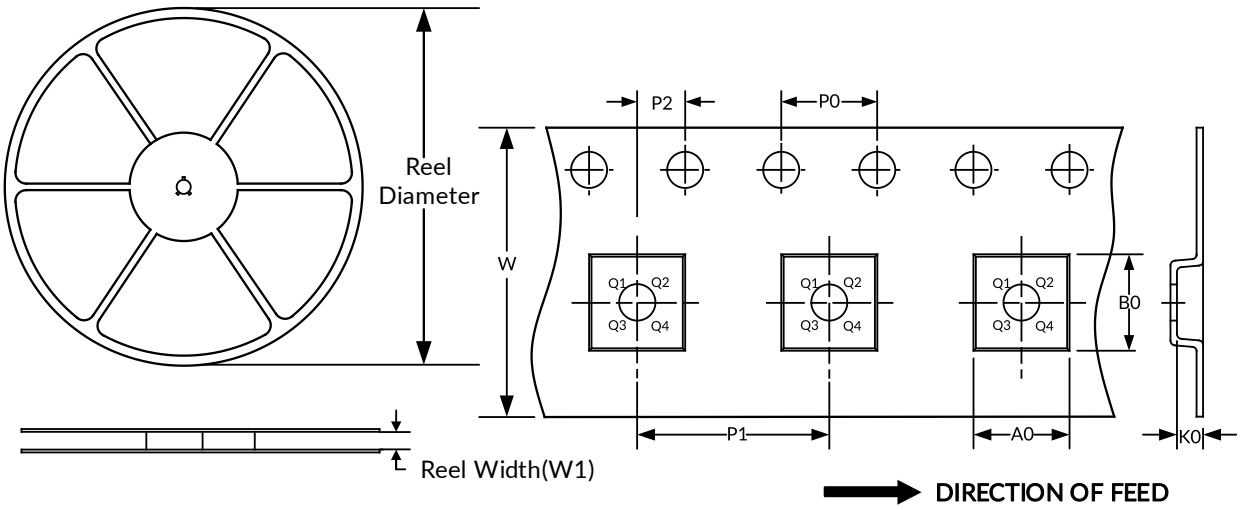
NOTE:

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 |
|---|---|---|---|---|---|---|---|---|---|---|
| TSSOP20 | 13” | 12.4 | 6.75 | 6.95 | 1.20 | 4.0 | 8.0 | 2.0 | 16.0 | 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

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