# 1.8V Low Power Dual RS-232 Transceiver Support 1.65V to 5V IO

**UM3122EEQA**

## General Description

The UM3122EEQA is a two-driver and two-receiver RS-232 interface device, with split supply pins for mixed-voltage operation. All RS-232 inputs and outputs are protected to ±15kV using the IEC 61000-4-2 Air-Gap Discharge method, ±8kV using the IEC 61000-4-2 Contact Discharge method, and ±8kV using the Human-Body Model. The charge pump requires five small 0.1μF capacitors for operation from as low as a 1.8V supply. The UM3122EEQA is capable of running at data rates up to 1000 kbps, while maintaining RS-232 compatible output levels. The UM3122EEQA has a unique $V_L$ pin that allows operation in mixed-logic voltage systems. Both driver in ($D_{IN}$) and receiver out ($R_{OUT}$) logic levels are pin programmable through the $V_L$ pin. This eliminates the need for additional voltage level shifter while interfacing with low-voltage microcontrollers or UARTs. Auto Powerdown Plus automatically places the device in a low power mode when the device has not received or transmitted data for more than 30 seconds. This feature makes this device a very attractive option for battery powered or other power sensitive applications.

## Applications

- Remote Radio Unit (RRU)
- Base Band Unit (BBU)
- Electronic Point of Sale (EPOS)
- Diagnostics & Data Transmission
- Battery-Powered Equipment

## Features

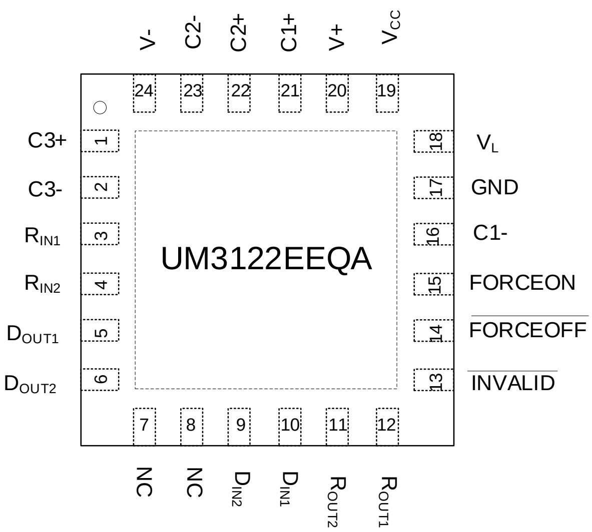
- Extended $V_{CC}$ operating nodes: 1.8V, 3.3V, or 5.0V
  - Unique Tripler Charge Pump Architecture Enables Low $V_{CC}$ of 1.8V While Maintaining Compatibility with 3.3V and 5V Supplies
- Integrated Level-Shifting Functionality Eliminates the Need for External Power or Additional Level Shifter While Interfacing with Low-Voltage MCUs
- Enhanced ESD Protection on $R_{IN}$ Inputs and $D_{OUT}$ Outputs
  - ±15kV IEC 61000-4-2 Air-Gap Discharge
  - ±8kV IEC 61000-4-2 Contact Discharge
  - ±8kV Human-Body Model
- Specified 1000 kbps Data Rate
- Auto Powerdown Plus Feature
- Low 0.5uA Shutdown Supply Current
- Meets or Exceeds Compatibility Requiremen of RS-232 Interface

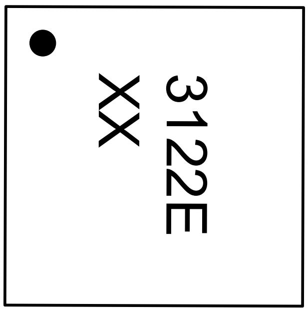
## Ordering Information

| Part Number | Temp. Range | Marking Code | Package Type | Shipping Qty |
|---|---|---|---|---|
| UM3122EEQA | -40°C to +105°C | 3122E | QFN24 4.0×4.0 | 3000pcs/13Inch Tape & Reel |

## Pin Configurations

## Top View




**XX: Week Code**
**UM3122EEQA**
**QFN24 4.0×4.0**

## Pin Description

| Pin No. | Pin Name | Function |
|---|---|---|
| 1 | C3+ | Positive terminal of voltage-tripler charge-pump capacitor (Not needed for $V_{CC}$ 3V to 5.5V) |
| 2 | C3- | Negative terminal of voltage-tripler charge-pump capacitor (Not needed for $V_{CC}$ 3V to 5.5V) |
| 3 | $R_{IN1}$ | RS-232 Receiver Input |
| 4 | $R_{IN2}$ | RS-232 Receiver Input |
| 5 | $D_{OUT1}$ | RS-232 Driver Output |
| 6 | $D_{OUT2}$ | RS-232 Driver Output |
| 7 | NC | Factory pin, can be unconnected or connected to GND |
| 8 | NC | Factory pin, can be unconnected or connected to GND |
| 9 | $D_{IN2}$ | RS-232 Driver Input |
| 10 | $D_{IN1}$ | RS-232 Driver Input |
| 11 | $R_{OUT2}$ | RS-232 Receiver Output |
| 12 | $R_{OUT1}$ | RS-232 Receiver Output |
| 13 | $\overline{\text{INVALID}}$ | Invalid Output Pin |
| 14 | $\overline{\text{FORCEOFF}}$ | Auto Powerdown Control input (Refer to Truth Table) |
| 15 | FORCEON | Auto Powerdown Control input (Refer to Truth Table) |
| 16 | C1- | Negative terminal of voltage-doubler charge-pump capacitors (required) |
| 17 | GND | Ground |
| 18 | $V_L$ | Logic-level supply. All CMOS inputs ($D_{IN}$) and outputs ($R_{OUT}$) are referenced to this supply |
| 19 | $V_{CC}$ | 1.8V or 3V to 5V Supply Voltage Input |
| 20 | $V_+$ | Positive charge pump storage capacitor (required) |
| 21 | C1+ | Positive terminal of voltage-doubler charge-pump capacitor (required) |
| 22 | C2+ | Positive terminal of voltage-doubler charge-pump capacitor (required) |
| 23 | C2- | Negative terminal of voltage-doubler charge-pump capacitors (required) |
| 24 | V- | Negative charge pump storage capacitor (required) |

## Absolute Maximum Ratings（Note1）

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Charge pump power supply | -0.3 to +6 | V |
| $V_L$ | Logic Power Supply | -0.3 to +6 | V |
| $V_+$ | Positive storage capacitor voltage₊ | -0.3 to +7 | V |
| $V_-$ | Negative storage capacitor voltage | -7 to +0.3 | V |
| $D_{IN}$ | Voltage on $D_{IN}$ | -0.3 to ($V_L$ +0.3) | V |
| $R_{IN}$ | (0Ω series resistance) | ±20 | V |
| | (≥250Ω series resistance) | ±25 | |
| $D_{OUT}$ | Output voltage | $V_-$ -0.3 to $V_+$ + 0.3 | V |
| $R_{OUT}$ | Output voltage | -0.3 to ($V_L$+0.3) | V |
| $V_+ + \|V_-\|$ (Note2) | | 13 | |
| $\overline{\text{FORCEOFF}}$ | Input voltage | -0.3 to +6 | V |
| FORCEON | Input voltage | -0.3 to +6 | V |
| $T_J$ | Junction temperature | 150 | °C |
| $T_{stg}$ | Storage temperature range | -65 to 150 | °C |

Note1: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note2: $V_+$ and $V_-$ can have maximum magnitudes of 7V, but their absolute difference cannot exceed 13V.

## Thermal Characteristics

| Symbol | Thermal Metric | Value | Unit |
|---|---|---|---|
| $\theta_{JA}$ | Junction-to-ambient thermal resistance | 34.2 | °C/W |
| $\theta_{JC}$ | Junction-to-case thermal resistance | 27.2 | |

**Recommended Operating Conditions**

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Charge pump power supply | $V_{CC}$ | Tripler Mode | 1.65 | 1.8 | 2 | V |
| | | Doubler Mode | 3 | 3.3 | 3.6 | |
| | | | 4.5 | 5 | 5.5 | |
| Logic power supply | $V_L$ | | 1.65 | | $V_{CC}$ | V |
| RS-232 Receiver interface | $R_{IN}$ | | -15 | | 15 | V |
| RS-232 Transmitter interface | $D_{OUT}$ | | -7 | | 7 | V |
| GPIO Input logic threshold low （$D_{IN}$， $\overline{FORCEOFF}$ ， FORCEON） | $V_{IL}$ | $V_L$ = 5.0 V | 0 | | 1.7 | V |
| | | $V_L$ = 3.3V | 0 | | 1.1 | |
| | | $V_L$ = 1.8 V | 0 | | 0.6 | |
| GPIO Input logic threshold high （$D_{IN}$，$\overline{FORCEOFF}$ ， FORCEON） | $V_{IH}$ | $V_L$ = 5.0V | 3.3 | | $V_L$ | V |
| | | $V_L$ = 3.3V | 2.2 | | $V_L$ | |
| | | $V_L$ = 1.8V | 1.2 | | $V_L$ | |
| $R_{OUT}$ disabled | $V_{OZ}$ | $\overline{FORCEOFF}$ = 0V | 0 | | $V_L$ | V |
| Operating temperature | | | –40 | | 105 | °C |

## Electrical Characteristics

$V_{CC}$ = $V_L$ = (1.65 V to 2.0 V) & (3.0V to 5.5V), $T_A$ = -40°C to 105°C (unless otherwise noted). Typical data is $T_A$ = 25°C, $V_{CC}$ =$V_L$=3.3V (unless otherwise noted).

<table>
<tr><td colspan="9">Power and Status Electrical Characteristics</td></tr>
<tr><th>Parameter</th><th>Symbol</th><th colspan="3">Condition</th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td rowspan="3">Static</td><td rowspan="3">$I_{CC\,(static)}$</td><td rowspan="3">$D_{IN1}$ = GND or $V_L$;<br>$D_{IN2}$ = GND or $V_L$,<br>$\overline{\text{FORCEOFF}}$ = $V_L$<br>FORCEON = $V_L$</td><td rowspan="3">No load</td><td>$V_{CC}$= 1.65V to 2.0V</td><td></td><td>1.0</td><td>1.9</td><td rowspan="3">mA</td></tr>
<tr><td>$V_{CC}$= 3.0V to 3.6V</td><td></td><td>0.7</td><td>1.4</td></tr>
<tr><td>$V_{CC}$= 4.5V to 5.5V</td><td></td><td>0.8</td><td>1.9</td></tr>
<tr><td>off</td><td>$I_{CC\,(off)}$</td><td colspan="3">$\overline{\text{FORCEOFF}}$=GND</td><td></td><td>0.4</td><td>10</td><td>µA</td></tr>
<tr><td>$R_{IN}$ positive voltage threshold for $\overline{\text{INVALID}}$ output change</td><td>$V_{IT+}$</td><td colspan="3" rowspan="2">$R_{IN1}$ = $R_{IN2}$</td><td>0.3</td><td></td><td>2.4</td><td rowspan="2">V</td></tr>
<tr><td>$R_{IN}$ negative voltage threshold for $\overline{\text{INVALID}}$ output change</td><td>$V_{IT-}$</td><td>-2.4</td><td></td><td>-0.3</td></tr>
<tr><td>$\overline{\text{INVALID}}$ high-level output voltage</td><td>$V_{OH}$</td><td colspan="3">$I_{OH}$ = -1 mA, FORCEON = GND, $\overline{\text{FORCEOFF}}$ = $V_L$</td><td>$V_L$-0.4</td><td>$V_L$-0.08</td><td>$V_L$</td><td>V</td></tr>
<tr><td>$\overline{\text{INVALID}}$ low-level output voltage</td><td>$V_{OL}$</td><td colspan="3">$I_{OL}$ = 1.6 mA, FORCEON = GND, $\overline{\text{FORCEOFF}}$ = $V_L$</td><td>0</td><td>0.06</td><td>0.4</td><td>V</td></tr>
<tr><td colspan="9">Driver Electrical Characteristics</td></tr>
<tr><td rowspan="2">Output voltage swing</td><td rowspan="2">$V_{OUT}$</td><td colspan="3">All driver outputs loaded with 3 kΩ to ground<br>C3 = 100 nF, $V_{CC}$= 1.8 V</td><td>±4.25</td><td>±4.7</td><td></td><td rowspan="2">V</td></tr>
<tr><td colspan="3">All driver outputs loaded with 3 kΩ to ground<br>C3 = 0 F, $V_{CC}$= 3.3 V or 5 V</td><td>±5</td><td>±5.4</td><td></td></tr>
<tr><td>Output short-circuit</td><td>Ios</td><td colspan="3">$V_{DOUT}$ = 0</td><td></td><td></td><td>±60</td><td>mA</td></tr>
<tr><td>Input leakage current</td><td></td><td colspan="3">$D_{IN}$ = GND to $V_L$; $\overline{\text{FORCEOFF}}$ = GND to $V_L$; FORCEON = GND to $V_L$</td><td></td><td>0</td><td>±10</td><td>µA</td></tr>
</table>

## Electrical Characteristics （continued）

$V_{CC}$ = $V_L$ = (1.65 V to 2.0 V) & (3.0V to 5.5V), $T_A$ = -40°C to 105°C (unless otherwise noted).
Typical data is $T_A$ = 25°C, $V_{CC}$ =$V_L$ = 3.3V (unless otherwise noted).

| Receiver Electrical Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Condition** | | **Min** | **Typ** | **Max** | **Unit** |
| Output leakage current | $I_{off}$ | $R_{OUT}$, receives disabled | | | ±0.01 | ±10 | µA |
| Output voltage low | $V_{OL}$ | $I_{out}$=2.0mA | | | 0.04 | 0.3 | V |
| Output voltage high | $V_{OH}$ | $I_{out}$= -2.0mA | | $V_L$-0.3 | $V_L$-0.04 | | V |
| Input threshold low | $V_{IT-}$ | $T_A$=25°C | $V_L$=5 | 0.8 | 1.5 | | V |
| | | | $V_L$=3.3V | 0.7 | 1.1 | | |
| | | | $V_L$=1.8V | 0.6 | 0.7 | | |
| Input threshold high | $V_{IT+}$ | $T_A$=25°C | $V_L$=5V | | 2.0 | 2.4 | V |
| | | | $V_L$=3.3V | | 1.5 | 2.4 | |
| | | | $V_L$=1.8V | | 0.9 | 1.4 | |
| Input hysteresis | $V_{hys}$ | $T_A$=25°C | $V_L$=5V | | 0.45 | | V |
| | | | $V_L$=3.3V | | 0.35 | | |
| | | | $V_L$=1.8V | | 0.26 | | |
| Input resistance | | $T_A$= -40 to 105 °C | | 3 | 5 | 7 | kΩ |
| **Driver Switching Characteristics** | | | | | | | |
| Maximum data rate | | $R_L$ = 3 kΩ, $C_L$ = 500 pF (one driver) | | 1000 | | | kbps |
| | | $R_L$ = 3 kΩ, $C_L$ = 1000 pF (one driver) | | 500 | | | |
| Time-to-exit powerdown | | \|$V_{DOUT}$\| > 3.7 V | | | 30 | 150 | µs |
| Driver skew (Note1) | \|$t_{PHL}$ – $t_{PLH}$\| | $R_L$ = 3 kΩ | | 0 | 50 | 100 | ns |
| Transition-Region slew rate | | $R_L$ = 3 kΩ to 7 kΩ, $T_A$ = 25°C Measured from 3 V to –3V or –3 V to 3 V | $V_{CC}$ = 1.8V, $C_L$ = 200 pF | | 33 | | V/µs |
| | | | $V_{CC}$ = 1.8V, $C_L$ = 1000pF | | 25 | | |
| | | | $V_{CC}$ = 3.3 V, $C_L$ = 200 pF | | 38 | | |
| | | | $V_{CC}$ = 3.3 V, $C_L$ = 1000pF | | 28 | | |
| | | | $V_{CC}$ = 5 V, $C_L$ = 200 pF | | 41 | | |
| | | | $V_{CC}$ = 5 V, $C_L$= 1000 pF | | 30 | | |

## Electrical Characteristics （continued）

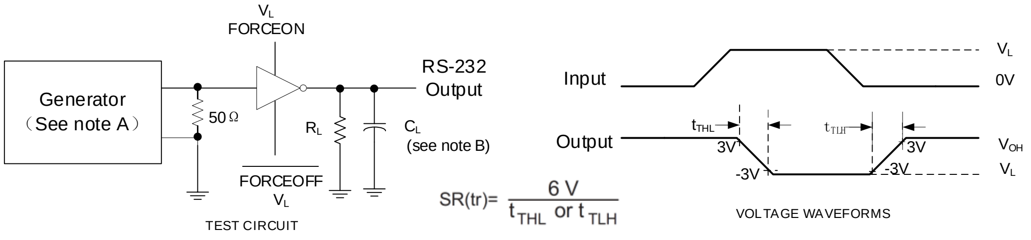
$V_{CC}$ = $V_L$ = (1.65 V to 2.0 V) & (3.0V to 5.5V), $T_A$ = -40°C to 105°C (unless otherwise noted).
Typical data is $T_A$ = 25°C, $V_{CC}$ =$V_L$ = 3.3V(unless otherwise noted).

<table>
<tr><td colspan="8">Receiver Switching Characteristics</td></tr>
<tr><th>Parameter</th><th>Symbol</th><th colspan="2">Condition</th><th>Min</th><th>Typ</th><th>Max</th><th>Unit</th></tr>
<tr><td>Receiver propagation delay, high to low</td><td>$t_{PHL}$</td><td colspan="2" rowspan="2">Receiver input to receiver output<br>$C_L$ = 150 pF</td><td></td><td>0.15</td><td>0.4</td><td>µs</td></tr>
<tr><td>Receiver propagation delay, low to high</td><td>$t_{PLH}$</td><td></td><td>0.15</td><td>0.4</td><td>µs</td></tr>
<tr><td>Receiver skew</td><td>$t_{PHL}$ –$t_{PLH}$</td><td colspan="2"></td><td></td><td>50</td><td>300</td><td>ns</td></tr>
<tr><td>Receiver output enable time</td><td>$t_{en}$</td><td colspan="2" rowspan="2">From $\overline{\text{FORCEOFF}}$ to $R_{OUT}$= $V_L$/2<br>$C_L$ = 150 pF, $R_L$ = 3 kΩ</td><td></td><td>200</td><td>400</td><td>ns</td></tr>
<tr><td>Receiver output disable time</td><td>$t_{dis}$</td><td></td><td>200</td><td>400</td><td>ns</td></tr>
<tr><td colspan="8">Power and Status Switching Characteristics</td></tr>
<tr><td>Propagation delay time, low to high level output</td><td>$t_{valid}$</td><td colspan="2"></td><td></td><td>1</td><td></td><td>µs</td></tr>
<tr><td>Propagation delay time, high to low level output</td><td>$t_{invalid}$</td><td colspan="2"></td><td></td><td>30</td><td></td><td>µs</td></tr>
<tr><td>Receiver or driver edge to auto powerdown plus</td><td>$t_{dis}$</td><td colspan="2"></td><td>15</td><td>30</td><td>60</td><td>s</td></tr>
<tr><td colspan="8">ESD</td></tr>
<tr><td rowspan="4">Electrostatic discharge</td><td rowspan="4">$V_{(ESD)}$</td><td rowspan="2">Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins (Note2)</td><td>All pins except RS-232 bus</td><td colspan="3">±2000</td><td rowspan="4">V</td></tr>
<tr><td>RS-232 bus pins</td><td colspan="3">±8000</td></tr>
<tr><td>IEC 61000-4-2 Air-Gap Discharge</td><td rowspan="2">RS-232 bus pins</td><td colspan="3">±15000</td></tr>
<tr><td>IEC 61000-4-2 Contact Discharge</td><td colspan="3">±8000</td></tr>
</table>

Note1： Driver skew is measured at the driver zero crosspoint.

Note2： JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.

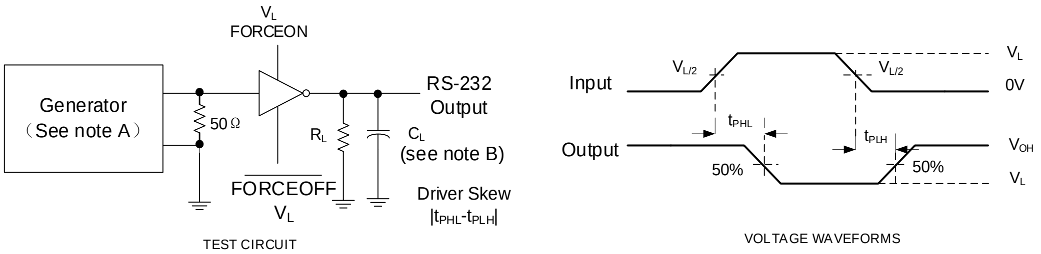
## Parameter Measurement Information




Notes: A. The pulse generator has the following characteristics: PRR = 1000 kbit/s, $Z_O$ = 50Ω, 50% duty cycle, $t_r \leqslant 10$ ns, $t_f \leqslant 10$ ns.

B. $C_L$ includes probe and jig capacitance.

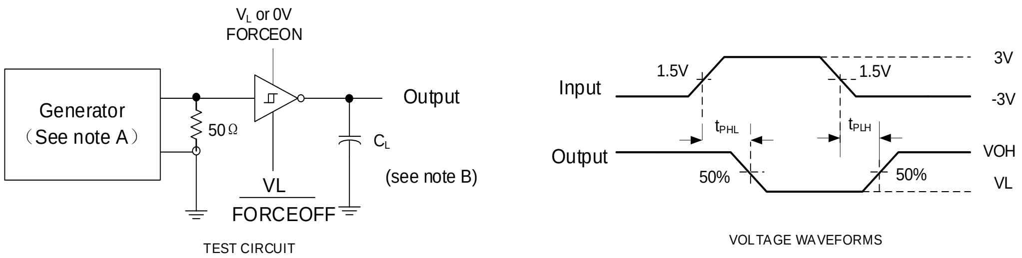
**Figure 1. Driver Slew Rate**




Notes: A. The pulse generator has the following characteristics: PRR = 1000 kbit/s, $Z_O$ = 50Ω, 50% duty cycle, $t_r \leqslant 10$ ns, $t_f \leqslant 10$ ns.

B. $C_L$ includes probe and jig capacitance.

**Figure 2. Driver Pulse Skew**

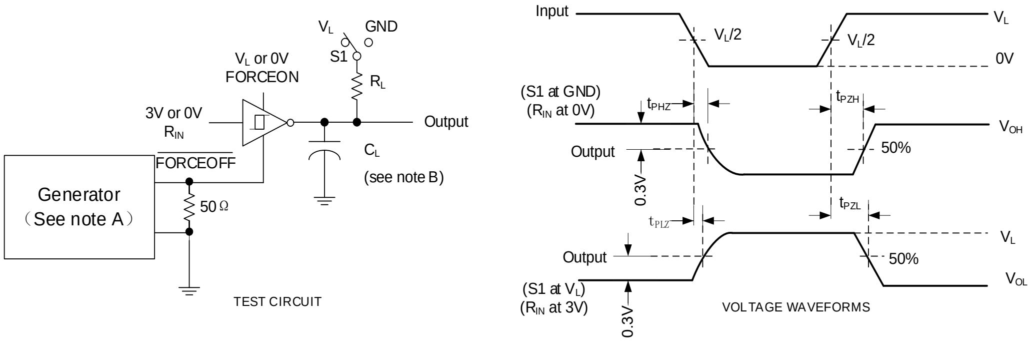



Notes: A. The pulse generator has the following characteristics: $Z_O$ = 50Ω, 50% duty cycle, $t_r \leqslant 10$ ns, $t_f \leqslant 10$ ns.

B. $C_L$ includes probe and jig capacitance.

**Figure 3. Receiver Propagation Delay Times**

## Parameter Measurement Information （continued）




Note：A. The pulse generator has the following characteristics: $Z_O$ = 50Ω, 50% duty cycle, $t_r \leqslant 10$ ns, $t_f \leqslant 10$ ns.

B. $C_L$ includes probe and jig capacitance.

C. $t_{PLZ}$ and $t_{PHZ}$ are the same as $t_{dis}$.

D. $t_{PLZ}$ and $t_{PHZ}$ are the same as $t_{en}$.

**Figure 4. Receiver Enable and Disable Times**

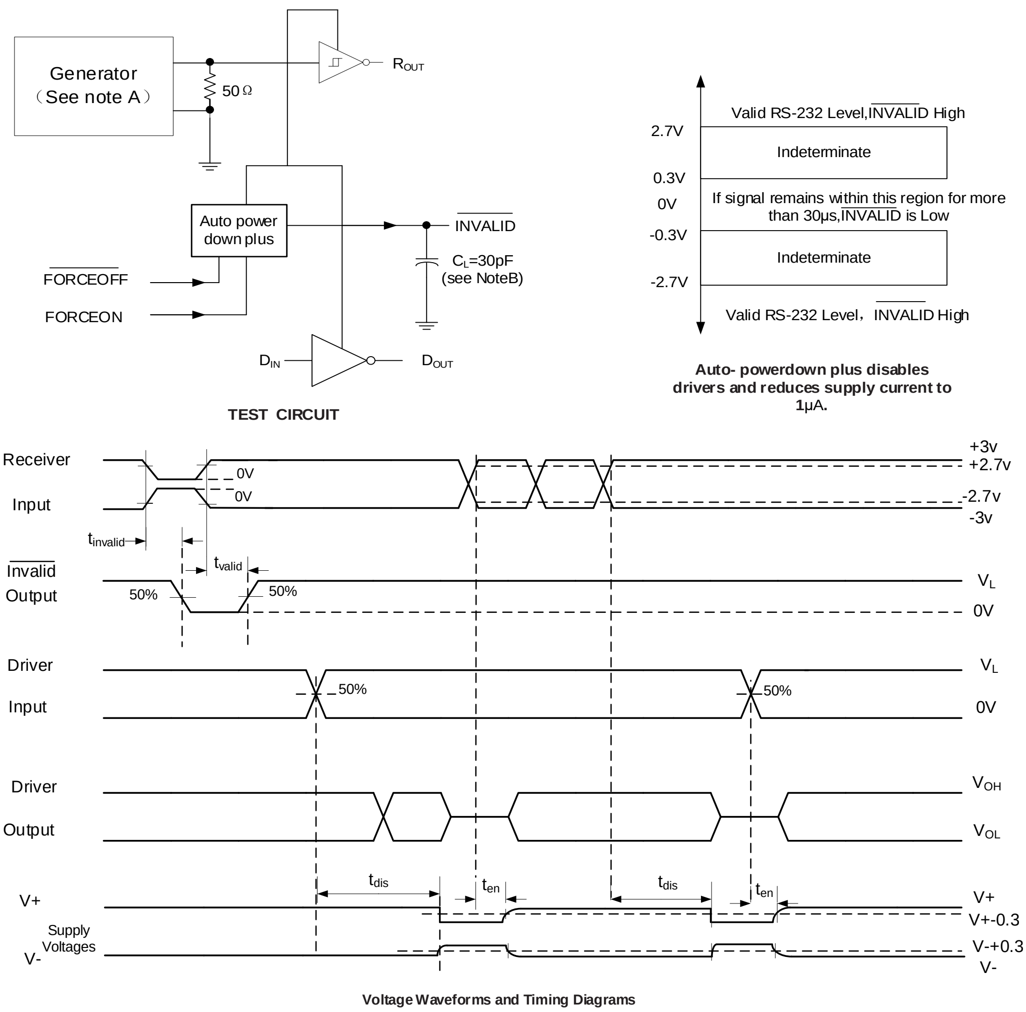



**Figure 5. INVALID Propagation-Delay Times and Supply-Enabling Time**

## Typical Characteristics

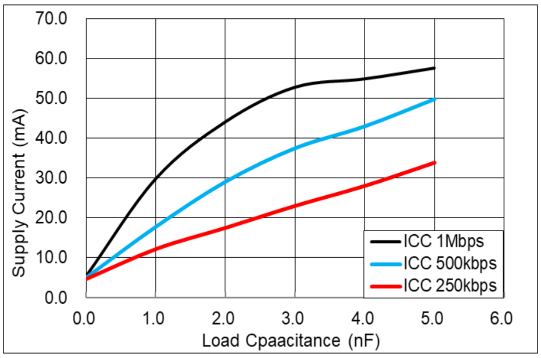



**Figure 6. Supply Current vs Load Capacitance**
$V_{CC}$=3.3V, $V_L$=1.8V, $R_{LOAD}$=3kΩ, CH2=32kbps

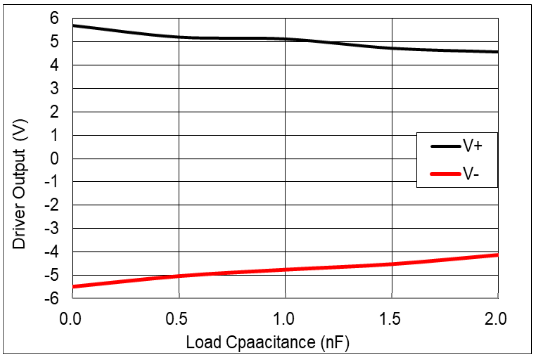



**Figure 7. Driver Output vs Load Capacitance**
$V_{CC}$=3.3V, $V_L$=1.8V, $R_{LOAD}$=3kΩ, CH1=1Mbps, CH2=32kbps

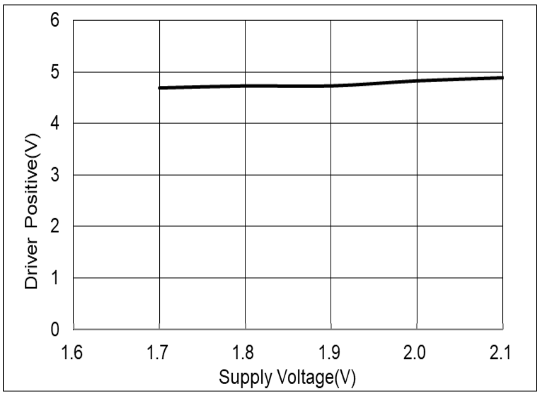



**Figure 8. Driver Positive vs Supply Voltage (Tripler Mode)**
1Mbps, $R_{LOAD}$=3kΩ, $C_{LOAD}$=560pF

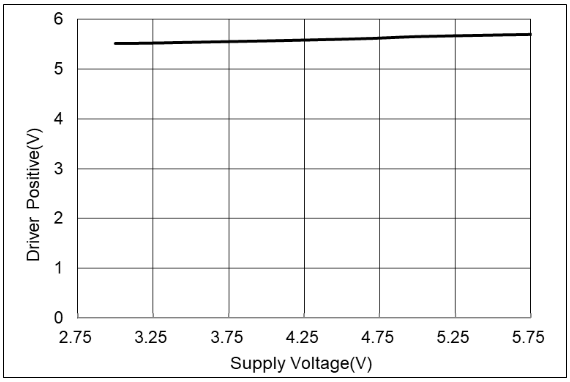



**Figure 9. Driver Positive vs Supply Voltage (Doubler Mode)**
1Mbps, $R_{LOAD}$=3kΩ, $C_{LOAD}$=560pF

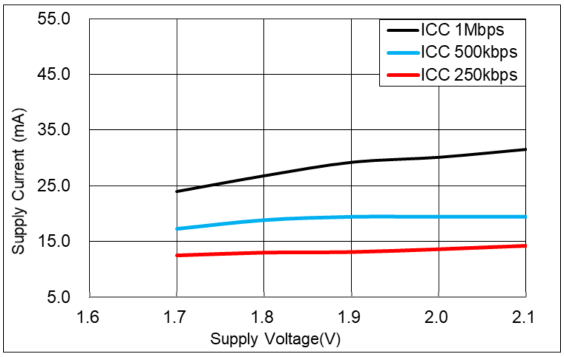



**Figure 10. Supply Current vs Supply Voltage (Tripler Mode)**
$V_L$=1.8V, $R_{LOAD}$=3kΩ, $C_{LOAD}$=1nF, CH2=32kbps

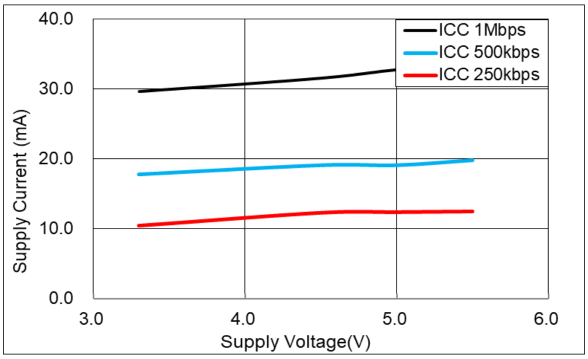



**Figure 11. Supply Current vs Supply Voltage (Tripler Mode)**
$V_L$=1.8V, $R_{LOAD}$=3kΩ, $C_{LOAD}$=1nF, CH2=32kbps

# Detailed Description

## Overview

The UM3122EEQA is an upgrade to standard RS-232 transceivers, offering compatibility with modern system needs like 1.8V GPIO capability, enhanced ESD & ultralow stand-by current. The majority of RS-232 transceivers with 1.8V GPIO compatibility require a logic supply pin for the I/O translation, in addition to a minimum 3.3V $V_{CC}$ for all of the other active circuitry on the chip. Unlike these transceivers, UM3122EEQA can operate with both $V_L$ and $V_{CC}$ equal to 1.8V. When $V_{CC}$=3.0V to 5.5V, the charge pump will sense $V_{CC}$ and switch to doubler mode. C1 & C2 are the necessary flying capacitors, C3 is not needed, and the charge pump outputs $V_+$ & $V_-$ will regulate to ~+/-5.4V. When $V_{CC}$=1.65V to 2.0V, the charge pump will sense $V_{CC}$ and switch to tripler mode. C1, C2&C3 are all necessary, and the charge pump outputs $V_+$ & $V_-$ will regulate to ~+/-2.65*$V_{CC}$ from $V_{CC}$=1.65V to 2.0V.

With many modern applications expanding into products that use UM3122EEQA as a backup communication protocol, itis important for the transceiver to have efficient standby operation. In order to accommodate this, Auto Powerdown Plus has been integrated to shut-off all active circuitry, allowing UM3122EEQA to achieve an $I_{off}$ of 1uA.

In order to comply with common interface system needs and environments, the RS-232 receive and transmit I/O pins comply with IEC 61000-4-2 ratings.

## Detailed Functional Block Diagram

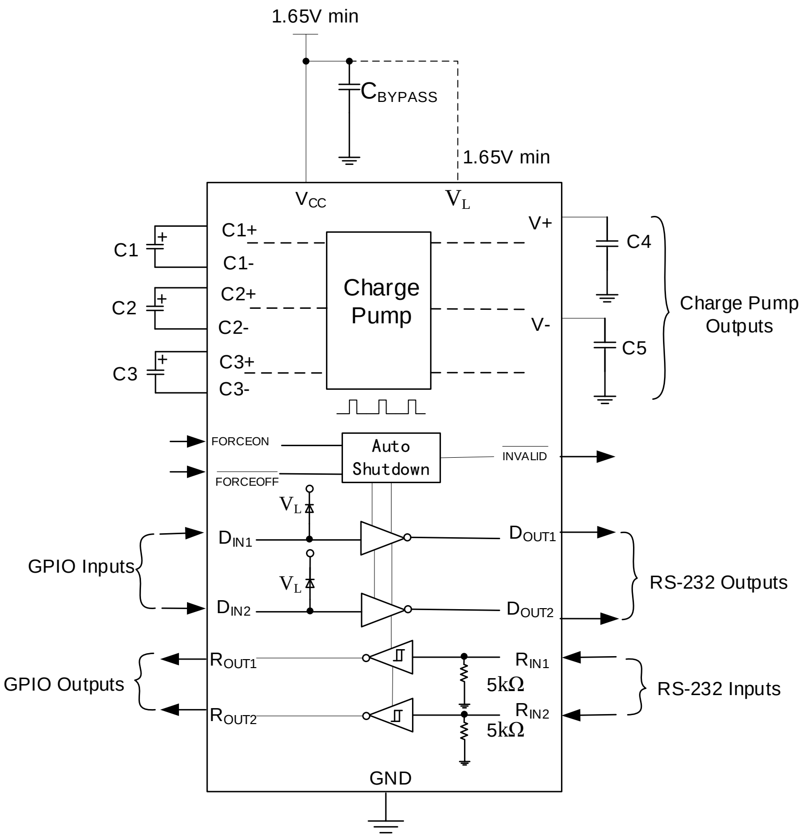



**Figure 12. Schematic**

## Feature Description

### Charge Pump

The internal power supply consists of a regulated auto-sensing charge pump that provides RS-232 compatible output voltages, over the 1.65V to 2.0V and 3.0V to 5.5V $V_{CC}$ ranges. The charge pump operates in two modes to efficiently accommodate low voltage (1.8V) and higher voltage (3.3V & 5.0V) supplies.

**Doubler Mode:** The charge pump requires two flying capacitors (C1, C2) and reservoir capacitors (C4, C5) to generate the $V_+$ and V- supplies of approximately ±5.4V when $V_{CC}$ is greater than 3 V. When $V_{CC}$ is >2.9V, UM3122EEQA will sense the supply voltage level and switch the charge pump to a doubler. Hence, no need for a third flying capacitor. C3+&C3- pins can be left open for proper operation. If a capacitor is placed between C3+&C3-, the charge pump will ignore this capacitor and still behave as a doubler. For capacitor choice recommendations, please refer to Capacitor Selection Table.

**Tripler Mode:** The charge pump requires three flying capacitors (C1, C2&C3) and reservoir capacitors (C4, C5) to generate the $V_+$ and V- supplies of approximately ±2.65*$V_{CC}$ when $V_{CC}$ is greater than 1.65V. When $V_{CC}$ is < 2.1V, UM3122EEQA will sense the supply voltage level and switch the charge pump to a tripler.

### Drivers

The drivers are inverting level transmitters that convert TTL or CMOS logic levels to RS-232 levels. For $V_{CC}$ =3.0V to 5.0V, the RS-232 output voltage swing is typically ±5.4V fully loaded and ±5 V minimum fully loaded. For $V_{CC}$ = 1.8V, the RS-232 output voltage swing is typically ±.4.7V fully loaded and ±4.25V minimum fully loaded. The driver outputs are protected against indefinite short-circuits to ground without degradation in reliability. These drivers are compatible with RS-232 logic levels and all previous RS-232 versions. Unused driver inputs should be connected to GND or $V_{CC.}$

### Receivers

The receivers convert EIA/TIA-232 levels to TTL or CMOS logic output levels. Receivers have an inverting output that can be disabled by using the $\overline{\text{FORCEOFF}}$ pin. Receivers remain active when the Auto Powerdown Plus circuitry autonomously enters a low power state. See Auto Powerdown Plus for more information on the Auto Powerdown mode. If the $\overline{\text{FORCEOFF}}$ pin is manually set low, the receivers will be disabled and put into 3-state mode. In either of these Powerdown modes, the device will typically consume about 0.5 uA. The truth table logic of the UM3122EEQA driver and receiver outputs can be found in Device Functional Modes. Since receiver input is usually from a transmission line where long cable lengths and system interference can degrade the signal, the inputs have a typical hysteresis margin of 300 mV. This ensures that the receiver is virtually immune to noisy transmission lines. Should an input be left unconnected, an internal 5kΩ pull-down resistor to ground will commit the output of the receiver to a HIGH state.

### Auto Powerdown Plus

Powerdown is engaged in two separate cases: automatically, when no activity has occurred for a period of time, and manually, using the $\overline{\text{FORCEOFF}}$ device pin.

**Automatic Powerdown:** Auto Powerdown Plus is enabled when FORCEON is set LOW and

$\overline{\text{FORCEOFF}}$ is set HIGH. Using UM3122EEQA's integrated edge detection circuitry and timer, the device can sense when there is no activity on the driver or receiver inputs for 30 seconds. When this condition is sensed by the device, it automatically shuts the charge pump off, reducing supply current to 0.5μA. When a valid transition is sensed on one of the driver or receiver inputs, the charge pump turns back on and UM3122EEQA exits powerdown. The typical time to exit powerdown is typically in 30 us, but can be as long as 150 us. As a result, the system saves power without requiring any software control. Device Functional Modes summarizes the operating modes in truth table form. While in the low power mode with Automatic Powerdown enabled ($\overline{\text{FORCEOFF}}$ = HIGH and FORCEON = LOW), the receiver inputs are still enabled.

**Manual Powerdown:**

The device can be manually powered down by externally setting $\overline{\text{FORCEOFF}}$ pin to low logic level. Both the drivers and receivers will be powered off. Device Functional Modes summarizes the operating modes in truth table form.

**Forced On:** If the $\overline{\text{FORCEOFF}}$ and FORCEON pins are both set HIGH, the device will power on with Auto Powerdown Plus disabled. Both the drivers and receiver will be active regardless of inactivity. Because Powerdown is autonomous, FORCEON can be used ensure drivers are ready for new data transmission if the time since last transmission (or receive data) was more than 15 seconds. Device Functional Modes summarizes the operating modes in truth table form.

## Device Functional Modes

**Each Driver (Note1)**

| Inputs | | | | Outputs | Driver status |
|---|---|---|---|---|---|
| $D_{IN}$ | FORCEON | $\overline{\text{FORCEOFF}}$ | Time elapsed since last $R_{IN}$ or $D_{IN}$ transition | $D_{OUT}$ | |
| X | X | L | X | Z | Powered off |
| L | H | H | X | H | Normal operation with auto-powerdown plus disabled |
| H | H | H | X | L | |
| L | L | H | <30s | H | Normal operation with auto-powerdown plus enabled |
| H | L | H | <30s | L | |
| L | L | H | >30s | Z | Normal operation with auto-powerdown plus feature |
| H | L | H | >30s | Z | |

Note1: H = high level, L = low level, X = irrelevant, Z = high impedance (off), 30s is typical inactivity time.

**Each Receiver (Note1)**

| Inputs | | | Outputs | Receiver status |
|---|---|---|---|---|
| $R_{IN}$ | $\overline{\text{FORCEOFF}}$ | Time elapsed since last $R_{IN}$ or $D_{IN}$ transition | $R_{OUT}$ | |
| X | L | X | Z | Powered off |
| L | H | X | H | Normal operation with auto-powerdown plus disabled |
| H | H | X | L | |
| Open | H | X | H | Normal operation with auto-powerdown plus enabled |

Note1：H = high level, L = low level, X = irrelevant, Z = high impedance (off), Open = input disconnected or connected driver off.

**$\overline{\text{Invalid}}$ Status Truth (Note1)**

| Inputs | | | | Outputs |
|---|---|---|---|---|
| $R_{IN1}$, $R_{IN2}$ | FORCEON | $\overline{\text{FORCEOFF}}$ | Time elapsed since last $R_{IN}$ or $D_{IN}$ transition | $\overline{\text{Invalid}}$ |
| Any L or H | X | X | X | H |
| All Open | X | X | X | L |

Note1：H = high level, L = low level, X = irrelevant, Z = high impedance (off), 30s is typical inactivity time.

## Applications Information

UM3122EEQA is used to communicate between two electrical units on separate PCBs across cables <40 ft. Common UM3122EEQA cables are RJ45, DB9 & DB25.Typical 1.8V Application is shown in the figure below.

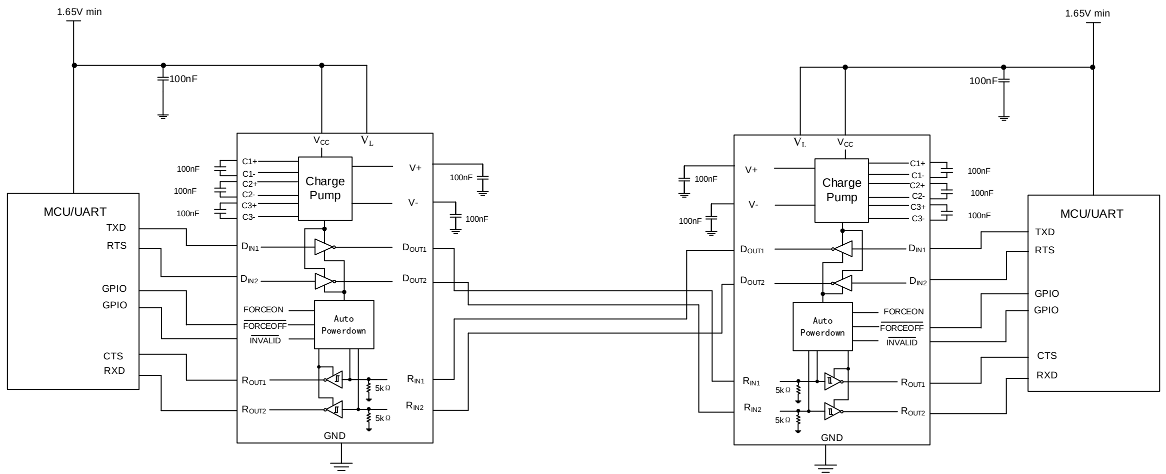



**Figure 13. Typical 1.8V Application**

## Data-Rate and Cable Length

RS-232 intended is for short range data transmission. The rise time for RS-232 driver edges is slow enough that the data cable appears as a capacitor instead of a transmission line impedance. The elapsed time for one bit of data far exceeds the transit time of any practical RS-232 cable length. The capacitance of the cable is the limiting factor. Therefore， the capacitance per foot (or meter) of the cable is important if long data cables are used. Capacitance slows the rise and fall time of the signal. For low data rates, the delay is insignificant. However, high data rates will have reduced percentage of time that the output is at $V_{OL}$ or $V_{OH}$ and more time in the transitions.
The timing of the UART (universal asynchronous receiver/transmitter) must sample the signal at the right time to coincide with $V_{OL}$ and $V_{OH}$ plateaus. At some point data reliability will be impacted. There are no hard limits for cable capacitance and data rate.

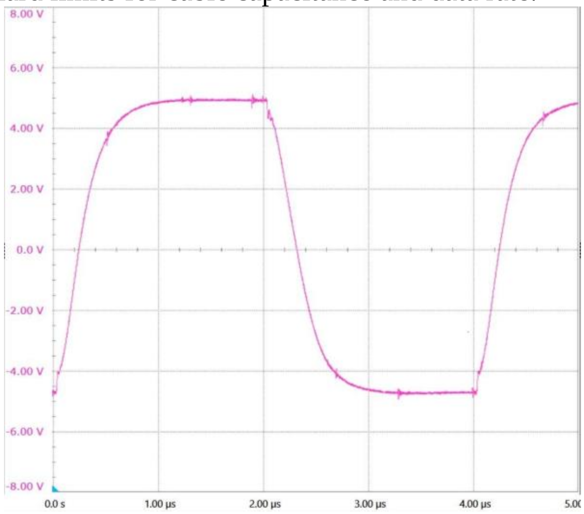



**Figure 14. Typical Waveform with Capacitive Load**

$V_{CC}$ = 3.3 V, $R_{LOAD}$ = 3 kΩ, Date Rate = 500kbps，C=2nF

The maximum cable length depends on the cable used (pf/ft), data rate, timing of receiving UART, system tolerance to data errors.

## Capacitor Selection

The capacitor type used for C1–C5 is not critical for proper operation; polarized or non-polarized capacitors can be used, though lower ESR capacitors are preferred. The charge pump requires 0.1 µF capacitors for $V_{CC}$ =1.8V or $V_{CC}$ = 3.3V operation. For other supply voltages, see the Capacitor Selection Table for required capacitor values. Do not use values smaller than those listed in Capacitor Selection Table. Increasing the capacitor values, except for C1, reduces ripple on the transmitter outputs and slightly reduces power consumption. C2, C3, C4 and C5 can be increased without changing C1's value. However, do not increase C1 without also increasing the values of C2, C3, C4, C5, $C_{BYPASS1}$, and $C_{BYPASS2}$ to maintain the proper ratios (C1 to the other capacitors). When using the minimum required capacitor values, make sure the capacitor value does not degrade excessively with temperature. If in doubt, use capacitors with a larger nominal value. The capacitor's equivalent series resistance (ESR) usually increases at low temperatures.
For best charge pump efficiency locate the charge pump and bypass capacitors as close as possible to the IC. Surface mount capacitors are best for this purpose. Using capacitors with lower equivalent series resistance (ESR) and self-inductance, along with minimizing parasitic PCB trace inductance will optimize charge pump operation. Designers are also advised to consider that capacitor values may shift over time and operating temperature.

**Capacitor Selection Table**

| $V_{CC} = V_L$ | C1 Capacitor Value | C2 Capacitor Value | C3 Capacitor Value | C4 Capacitor Value | C5 Capacitor Value |
|---|---|---|---|---|---|
| 1.65 V to 2 V （Note1） | 100 nF | | | | |
| 3.0 V to 3.6 V （Note1） | 100 nF | | 100 nF or open | 100nF | |
| 4.5 V to 5.5 V （Note1） | 47 nF | 330 nF | 100 nF or open | 330nF | |
| 3 V to 5.5 V （Note2） | 47 nF | 470 nF | 100 nF or open | 470nF | |

Note1：For optimized performance, we recommend using these configurations.

Note2：For applications where the $V_{CC}$ variation is larger, this configuration is acceptable.

## Application Curves

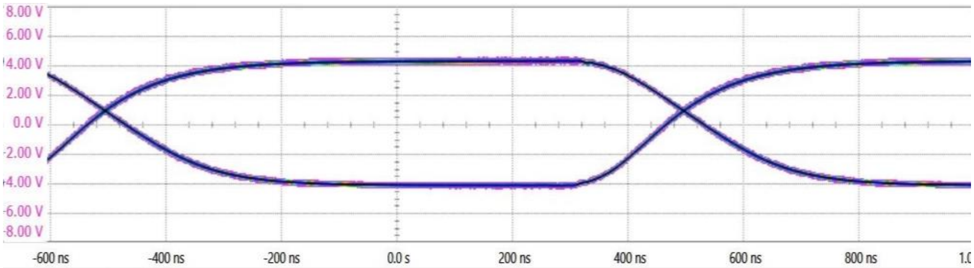



**Figure 14.1 Mbps Eye Diagram, 2 V/div, 200 ns/ div**
$V_{CC}$ = 1.8 V, $C_{LOAD}$ = 500 pF, $R_{LOAD}$ = 3 kΩ

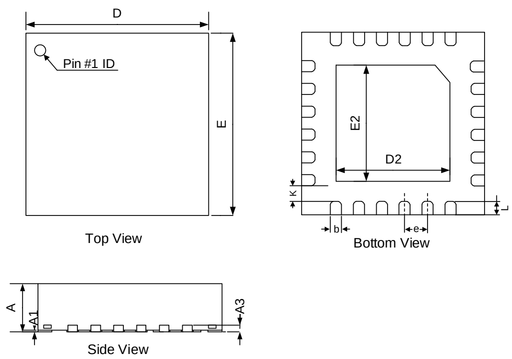
## Power Supply Recommendations

In most circumstances, a 0.1μF $V_{CC}$ bypass capacitor and a 1μF $V_L$ bypass capacitor are adequate. In applications that are sensitive to power-supply noise, use larger value $V_{CC}$ bypass capacitor. There is no maximum limit for bypass capacitor. Place bypass capacitors as close to the IC as possible. It is not recommended to use this device when $V_{CC}$ is powered and $V_L$ = 0 V or floating for an extended period of time because operation is undefined. $V_{CC}$ and $V_L$ must be powered to guarantee charge pump operation. Also, to achieve full functionality as described in Specifications, it is recommended to not use a higher voltage on $V_L$ than $V_{CC}$. Full functionality can be achieved when $V_{CC}$ is greater than or equal to $V_L$.

## Package Information

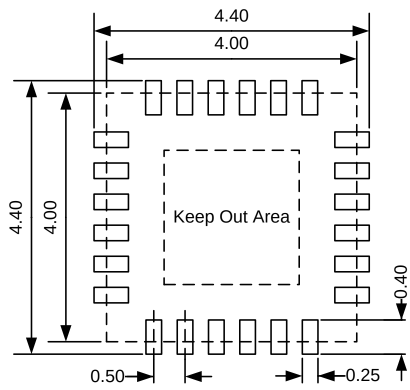
### UM3122EEQA: QFN24 4.0 × 4.0

**Outline Drawing**



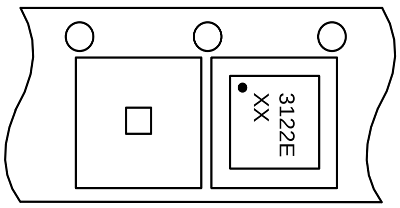

| Symbol | MILLIMETERS | | | INCHES | | |
|---|---|---|---|---|---|---|
| | Min | Typ | Max | Min | Typ | Max |
| A | 0.70 | 0.75 | 0.80 | 0.028 | 0.030 | 0.031 |
| A1 | 0.00 | 0.02 | 0.05 | 0.000 | 0.001 | 0.002 |
| A3 | 0.20REF | | | 0.008REF | | |
| b | 0.20 | 0.25 | 0.30 | 0.008 | 0.010 | 0.012 |
| D | 3.90 | 4.00 | 4.10 | 0.154 | 0.157 | 0.161 |
| E | 3.90 | 4.00 | 4.10 | 0.154 | 0.157 | 0.161 |
| D2 | 2.40 | - | 2.70 | 0.098 | 0.102 | 0.106 |
| E2 | 2.40 | - | 2.70 | 0.098 | 0.102 | 0.106 |
| e | 0.40 | 0.50 | 0.60 | 0.016 | 0.020 | 0.024 |
| K | 0.20 | - | - | 0.008 | - | - |
| L | 0.35 | 0.40 | 0.45 | 0.014 | 0.016 | 0.018 |

**Land Pattern**




NOTES:
1. Compound dimension: 4.00×4.00;
2. Unit: mm;
3. General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.

**Tape and Reel Orientation**



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