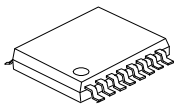
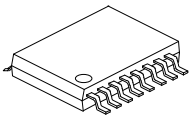
# UT3221/E

**CMOS IC**

# +3.0V TO +5.5V POWER SUPPLY, 250KBPS, MULTICHANNAEL RS-232 LINE DRIVER/RECEIVER



SSOP-16N
(209mil)



TSSOP-16

## ■ DESCRIPTION

The UTC **UT3221/E** consists of 1 driver and 1 receiver. It meets EIA/TIA-232 and V.28/V.24 specifications, it intended for notebook computer applications. A high-efficiency, dual charge-pumps power supply and a low-dropout transmitter combine to deliver true RS-232 performance from a single +3.0V~+5.5V power supply. A guaranteed data rate of 250kbps provides compatibility with popular software for communicating with PCs.

The UTC **UT3221/E** achieves 1μA supply current in shutdown condition. When the **UT3221/E** doesn't detect a valid signal level on its receiver input, the on-board power supply and driver will shutdown, and when a valid level is applied to RS-232 receiver input, then the system turns on again. Therefore, the system saves power without changes to the existing BIOS or operating system.

The UTC **UT3221/E** requires only 0.1μF capacitors in 3.3V operation, and can operate from input voltages ranging from +3.0V ~+5.5V. It is ideal for 3.3V-only systems, 5.0V-only systems, or mixed 3.3V and 5.0V systems that require true RS-232 performance.

## ■ FEATURES

* Operates With 3.0V to 5.5V Power Supply
* One Driver and One Receiver
* Operates Up To 250 kbps
* Designed to Transmit at a Data Rate of 250 kbps
* Low Standby Current (1μA Typical)
* External Capacitors (4*0.1μF)
* Accepts 5.0V Logic Input With 3.3V Supply
* Serial-Mouse Drivability
* Exceeds ±8KV ESD Protection(HBM) for RS-232 I/O Pins

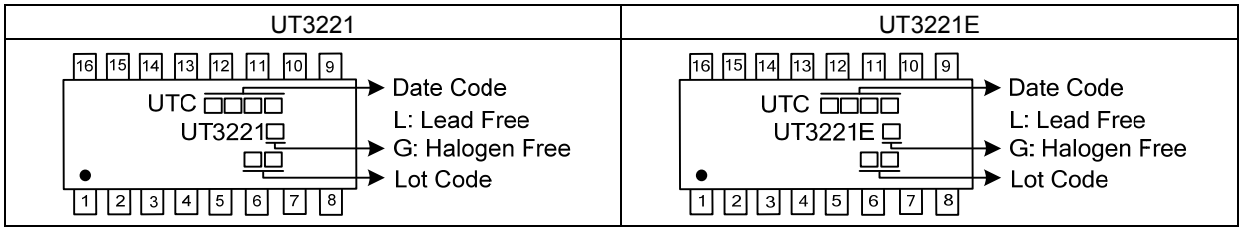
## ■ ORDERING INFORMATION

| Ordering Number | | Package | Packing |
|---|---|---|---|
| Lead Free | Halogen Free | | |
| UT3221L-R16N-R | UT3221G-R16N-R | SSOP-16N | Tape Reel |
| UT3221L-P16-R | UT3221G-P16-R | TSSOP-16 | Tape Reel |
| UR3221EL-R16N-R | UR3221EG-R16N-R | SSOP-16N | Tape Reel |
| UR3221EL-P16-R | UR3221EG-P16-R | TSSOP-16 | Tape Reel |

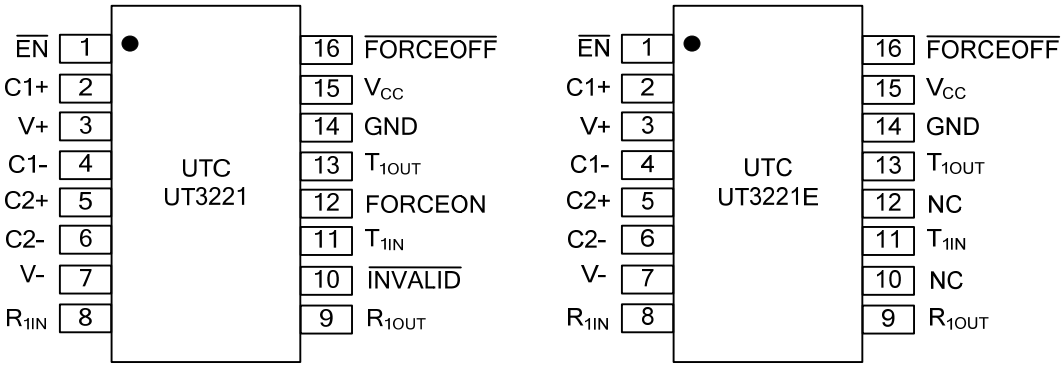
UT3221G-R16N-R
(1)Packing Type
(2)Package Type
(3)Green Package

(1) R: Tape Reel
(2) R16N: SSOP-16N, P16: TSSOP-16
(3) G: Halogen Free and Lead Free, L: Lead Free

## ■ MARKING



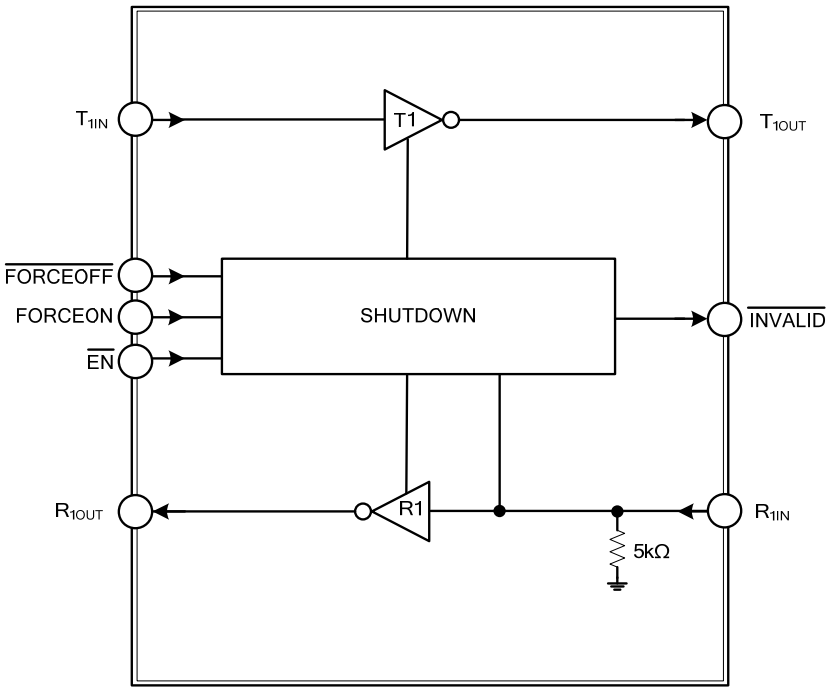

## ■ PIN CONFIGURATION



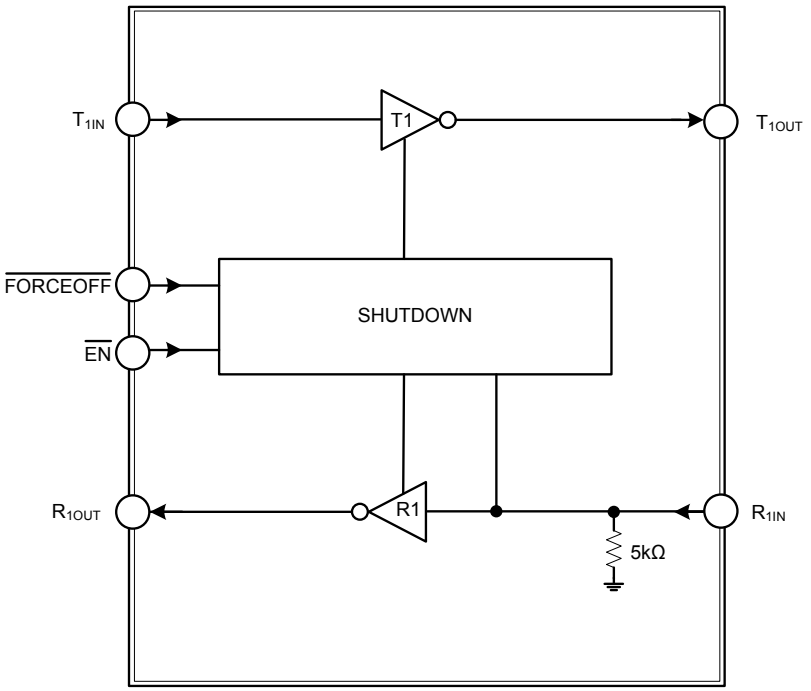

## ■ PIN DESCRIPTION

| PIN NO. | | PIN NAME | DESCRIPTION |
|---|---|---|---|
| UT3221 | UT3221E | | |
| 1 | 1 | $\overline{EN}$ | Receiver Enable Control. Drive low for normal operation. Drive high to force the receiver output (R_OUT) into a high-impedance state. |
| 2 | 2 | C1+ | Positive terminal of the voltage doubler charge-pump capacitor. |
| 3 | 3 | V+ | +5.5V generated by the charge pump. |
| 4 | 4 | C1- | Negative terminal of the voltage doubler charge-pump capacitor. |
| 5 | 5 | C2+ | Positive terminal of inverting charge-pump capacitor. |
| 6 | 6 | C2- | Negative terminal of inverting charge-pump capacitor. |
| 7 | 7 | V- | -5.5V generated by the charge pump. |
| 8 | 8 | $R_{1IN}$ | RS-232 Receiver 1 Input. |
| 9 | 9 | $R_{1OUT}$ | TTL/CMOS Receiver 1 Output. |
| 10 | - | $\overline{INVALID}$ | Output of the valid signal detector. Indicates if a valid RS-232 level is present on receiver input logic “1”. |
| 11 | 11 | $T_{1IN}$ | TTL/CMOS Transmitter 1 Input. |
| 12 | - | FORCEON | Drive high to override automatic circuitry keeping transmitter on ($\overline{FORCEOFF}$ must be high) (Table 2). |
| 13 | 13 | $T_{1OUT}$ | RS-232 Transmitter 1 Output. |
| 14 | 14 | GND | Ground. |
| 15 | 15 | $V_{CC}$ | +3.0V ~ +5.5V Supply Voltage. |
| 16 | - | $\overline{FORCEOFF}$ | Drive low to shut down transmitter and on-board power supply. This over-rides all automatic circuitry and FORCEON (Table 2). |
| - | 10, 12 | NC | No connect |
| - | 16 | $\overline{FORCEOFF}$ | Shut off Pump Power and Transmitters. Active low. |

## ■ BLOCK DIAGRAM




UT3221




UT3221E

## ■ ABSOLUTE MAXIMUM RATING

| PARAMETER | | SYMBOL | RATINGS | UNIT |
|---|---|---|---|---|
| $V_{CC}$ | | $V_{CC}$ | 6.0 | V |
| V+ (Note 2) | | V+ | 7.0 | V |
| V- (Note 2) | | V- | -7.0 | V |
| V+ +\|V-\| (Note 2) | | $V_{PUMP}$ | +13.0 | V |
| Input Voltages | T_IN, $\overline{\text{FORCEOFF}}$, FORCEON, $\overline{\text{EN}}$ | $V_{IN}$ | 6.0 | V |
| | R_IN | | ±25 | V |
| Output Voltages | T_OUT | $V_{OUT}$ | ±13.2 | V |
| | R_OUT, $\overline{\text{INVALID}}$ | | -0.3 ~ ($V_{CC}$+0.3) | V |
| Short-Circuit Duration | T_OUT | SC | Continuous | |
| Power Dissipation($T_A$=25°C) | | $P_D$ | 680 | mW |
| Operating Temperature | | $T_{OPR}$ | -40 ~ +85 | °C |
| Storage Temperature | | $T_{STG}$ | -65 ~ +150 | °C |

Notes: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.
2. V+ and V- can have maximum magnitudes of 7.0V, but their absolute difference cannot exceed 13.0V.

## ■ ELECTRICAL CHARACTERISTICS

($V_{CC}$=+3.0V~+5.5V, C1~C4=0.1μF (Note 2), $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise specified)

| PARAMETER | | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| **DC CHARACTERISTICS** | | | | | | | | |
| Supply Current, Shutdown | | $I_{SHDN}$ | $V_{CC}$=3.3V or 5.0V, $T_A$= 25°C | All R_IN open, $\overline{\text{FORCEOFF}}$ =$V_{CC}$, FORCEON=GND | | 1.0 | 10 | μA |
| | | | | $\overline{\text{FORCEOFF}}$ =GND, All R_IN=GND ($\overline{\text{FORCEOFF}}$ =GND,UT3221E) | | 1.0 | 10 | μA |
| Supply Current, Shutdown Disabled | | $I_{CC}$ | | FORCEON= $\overline{\text{FORCEOFF}}$ =$V_{CC}$, no load ($\overline{\text{FORCEOFF}}$ =$V_{CC}$,UT3221E) | | 0.3 | 1.0 | mA |
| **LOGIC INPUTS** | | | | | | | | |
| Input Logic Threshold | Low | $V_{LGL}$ | $\overline{\text{EN}}$ ,T_IN, FORCEON, $\overline{\text{FORCEOFF}}$ | | | | 0.8 | V |
| | High | $V_{LGH}$ | $\overline{\text{EN}}$ ,T_IN, EN, FORCEON, $\overline{\text{FORCEOFF}}$ | $V_{CC}$ = 3.3V | 2.0 | | | V |
| | | | | $V_{CC}$ = 5.0V | 2.4 | | | |
| Input Leakage Current | | $I_{IN(LK)}$ | T_IN, $\overline{\text{EN}}$ , FORCEON, $\overline{\text{FORCEOFF}}$ | | | ±0.01 | ±1.0 | μA |
| **RECEIVER OUTPUT** | | | | | | | | |
| Output Leakage Current | | $I_{ROUT(LK)}$ | Receiver disabled | | | ±0.05 | ±10 | μA |
| Output Voltage | Low | $V_{ROUTL}$ | $I_{OUT}$ = 1.6mA | | | | 0.4 | V |
| | High | $V_{ROUTH}$ | $I_{OUT}$ = -1.0mA | | $V_{CC}$ - 0.6 | $V_{CC}$ - 0.1 | | V |
| **AUTOSHUTDOWN (FORCEON=GND, $\overline{\text{FORCEOFF}}$ =$V_{CC}$ , UT3221)** | | | | | | | | |
| Receiver Input Thresholds to Transmitter | Enabled | $V_{R(EN)}$ | Fig.1 | Positive threshold | | | 2.7 | V |
| | | | | Negative threshold | -2.7 | | | |
| | Disabled | $V_{R(DIS)}$ | 1μA supply current, Fig.1 | | -0.3 | | 0.3 | V |
| $\overline{\text{INVALID}}$ Output Voltage | Low | $V_{INVL}$ | $I_{OUT}$=1.6mA | | | | 0.4 | V |
| | High | $V_{INVH}$ | $I_{OUT}$=-1.0mA | | $V_{CC}$ - 0.6 | | | V |
| Receiver Threshold to Transmitter Enabled | | $t_{WU}$ | Fig.2 | | | 100 | | μs |

## ■ ELECTRICAL CHARACTERISTICS (Cont.)

($V_{CC}$=+3.0V~+5.5V, C1~C4=0.1μF (Note 2), $T_A = T_{MIN}$ to $T_{MAX}$, Unless Otherwise Specified)

| PARAMETER | | SYMBOL | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| Receiver Positive or Negative Threshold to $\overline{\text{INVALID}}$ | High | $t_{INVH}$ | Fig.2 | | | 1.0 | | μs |
| | Low | $t_{INVL}$ | | | | 30 | | μs |
| **RECEIVER INPUT** | | | | | | | | |
| Input Voltage Range | | $V_{RR}$ | | | -25 | | 25 | V |
| Input Threshold Low | | $V_{RINL}$ | $T_A$=25°C | $V_{CC}$=3.3V | 0.6 | 1.2 | | V |
| | | | | $V_{CC}$=5.0V | 0.8 | 1.5 | | |
| Input Threshold High | | $V_{RINH}$ | $T_A$=25°C | $V_{CC}$=3.3V | | 1.5 | 2.4 | V |
| | | | | $V_{CC}$=5.0V | | 1.8 | 2.4 | |
| Input Hysteresis | | $V_{RINHYS}$ | | | | 0.5 | | V |
| Input Resistance | | $V_{RINRES}$ | $T_A$=25°C | | 3 | 5 | 7 | kΩ |
| **TRANSMITTER OUTPUT** | | | | | | | | |
| Output Voltage Swing | | $V_{TOUTSW}$ | The transmitter output loaded with 3kΩ to ground | | ±5.0 | ±5.4 | | V |
| Output Resistance | | $V_{TOUTRES}$ | $V_{CC}$= V+=V-=0V, Transmitter output=±2V | | 300 | 10M | | Ω |
| Output Short-Circuit Current | | $I_{TSC}$ | | | | ±35 | ±60 | mA |
| Output Leakage Current | | $I_{TOUT(LK)}$ | $V_{CC}$=3.0V~5.0V, $V_{OUT}$=±12V, Transmitter disabled | | | | ±25 | μA |
| **TIMING CHARACTERISTICS** | | | | | | | | |
| Maximum Data Rate | | DR | $R_L$=3kΩ, $C_L$=1000pF, one transmitter switching | | 250 | | | kbps |
| Receiver Propagation Delay | | $t_{PHL}$ | Receiver input to receiver output, $C_L$=150pF | | | 0.15 | | μs |
| | | $t_{PLH}$ | | | | 0.15 | | |
| Receiver Output Time | Enable | $t_{R(EN)}$ | Normal operation | | | 200 | | ns |
| | Disable | $t_{R(DIS)}$ | | | | 200 | | ns |
| Transmitter Skew | | $t_{TS}$ | $\lvert t_{PHL} - t_{PLH} \rvert$ | | | 100 | | ns |
| Receiver Skew | | $t_{RS}$ | $\lvert t_{PHL} - t_{PLH} \rvert$ | | | 50 | | ns |
| Transition-Region Slew Rate | | SR | $V_{CC}$=3.3V, $T_A$=25°C, $R_L$=3kΩ~7kΩ, measured from +3V ~ -3V or -3V~+3V | $C_L$=150pF~1000pF | 4 | | 35 | V/μs |

Notes: 1. Typical values are at $T_A$=25°C.

2. C1~C4=0.1μF, measured at 3.3V±10%. C1=0.047μF, C2~C4=0.33μF, measured at 5.0V ±10%.

## ■ DETAILED DESCRIPTION

**Charge-Pump Voltage Converter**

The UTC **UT3221/E** consists of a regulated dual charge pumps that provide output voltages of +5.5V and -5.5V, regardless of the input voltage ($V_{CC}$) changing from +3.0V to +5.5V.

The charge pumps operate in a discontinuous mode: if the output voltages are less than 5.5V, the charge pumps are enabled; if the output voltages exceed 5.5V, the charge pumps are disabled.

Each charge pump requires a flying capacitor (C1, C2) and a reservoir capacitor (C3, C4) to generate the V+ and V- supplies, refer to application circuit.

**RS-232 Transmitter**

UTC **UT3221/E**'s transmitter is inverting level translators that convert CMOS-logic levels to 5.0V EIA/TIA-232 levels. They guarantee a 250kbps data rate with worst-case loads of 3kΩ in parallel with 1000pF, providing compatibility with PC-to-PC communication software.

Transmitter can be paralleled to drive multiple receiver or mouse. When $\overline{\text{FORCEOFF}}$ is driven to ground, or shutdown circuitry senses invalid voltage levels at the receiver input, the transmitter is disabled and the output is forced into a high-impedance state.

**RS-232 Receiver**

The UTC **UT3221/E**'s receiver convert RS-232 signals to CMOS-logic output levels. The receiver has one inverting three-state output. In shutdown or in autoshutdown, the **UT3221/E**'s receiver is active. Drive $\overline{\text{EN}}$ high to place the receiver in a high-impedance state.

Table 1. $\overline{\text{EN}}$ Control Truth Table

| $\overline{\text{EN}}$ | R_OUT |
|---|---|
| 0 | Active |
| 1 | High-Z |

**Shutdown Function(UT3221E)**

Supply current falls to less than 1μA in shutdown mode ( $\overline{\text{FORCEOFF}}$ = GND). When shutdown, the device's charge pumps are shut off, V+ is pulled down to VCC, V- is pulled to ground, and the transmitter outputs are disabled (high impedance). Connect $\overline{\text{FORCEOFF}}$ to VCC if shutdown mode is not used. $\overline{\text{FORCEOFF}}$ has no effect on R_OUT.

**Shutdown Function(UT3221)**

A 1μA supply current is achieved with shutdown feature, which operates when FORCEON is low and $\overline{\text{FORCEOFF}}$ is high. When the UTC **UT3221** senses no valid signal levels on the receiver input for 30μs, the on-board power supply and driver is shut off, reducing supply current to 1μA. This occurs if the RS-232 cable is disconnected or the connected peripheral transmitter is turned off. The system turns on again when a valid level is applied to RS-232 receiver input. As a result, the system saves power without changes to the existing BIOS or operating system. $\overline{\text{INVALID}}$ indicates the receiver input' condition, when using shutdown function, the $\overline{\text{INVALID}}$ output is high when the device is on and low when the device is shut down.

Table 2. Shutdown Logic Control Truth Table

| OPERATION STATUS | $\overline{\text{FORCEOFF}}$ INPUT | FORCEON INPUT | $\overline{\text{INVALID}}$ OUTPUT | T_OUT |
|---|---|---|---|---|
| Normal Operation (Forced On) | H | H | X | Active |
| Normal Operation (AutoShutdown) | H | L | H | Active |
| Normal Operation (AutoShutdown) | H | L | L | High-Z |
| Shutdown (Forced Off) | L | X | X | High-Z |

## ■ DETAILED DESCRIPTION (Cont.)

Table 2 summarizes the UTC **UT3221** operating modes. FORCEON and $\overline{\text{FORCEOFF}}$ override the automatic circuitry and force the transmitter into its normal operating state or into its low-power standby state. When neither control is asserted, the IC selects between these states automatically based on receiver input levels.

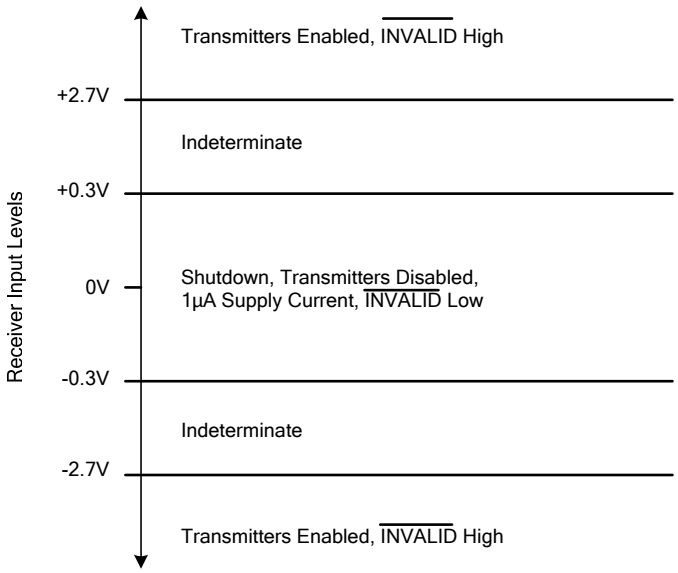



Fig.1 Shutdown Input Levels

When shutdown, the UTC **UT3221**'s charge pumps are turned off, V+ decays to $V_{CC}$, V- decays to ground, the transmitter output is disabled (high impedance). The time required to exit shutdown is typically 100µs.

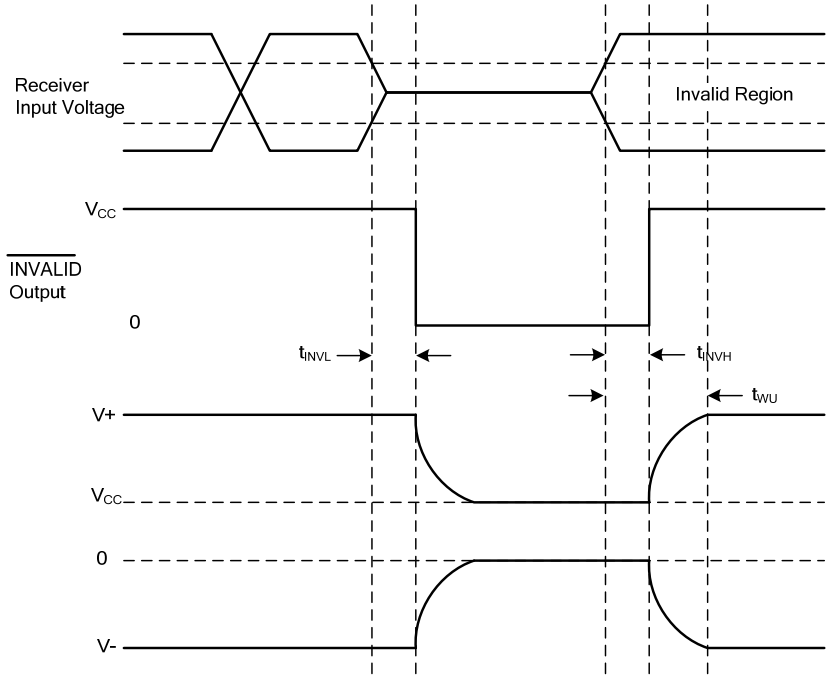
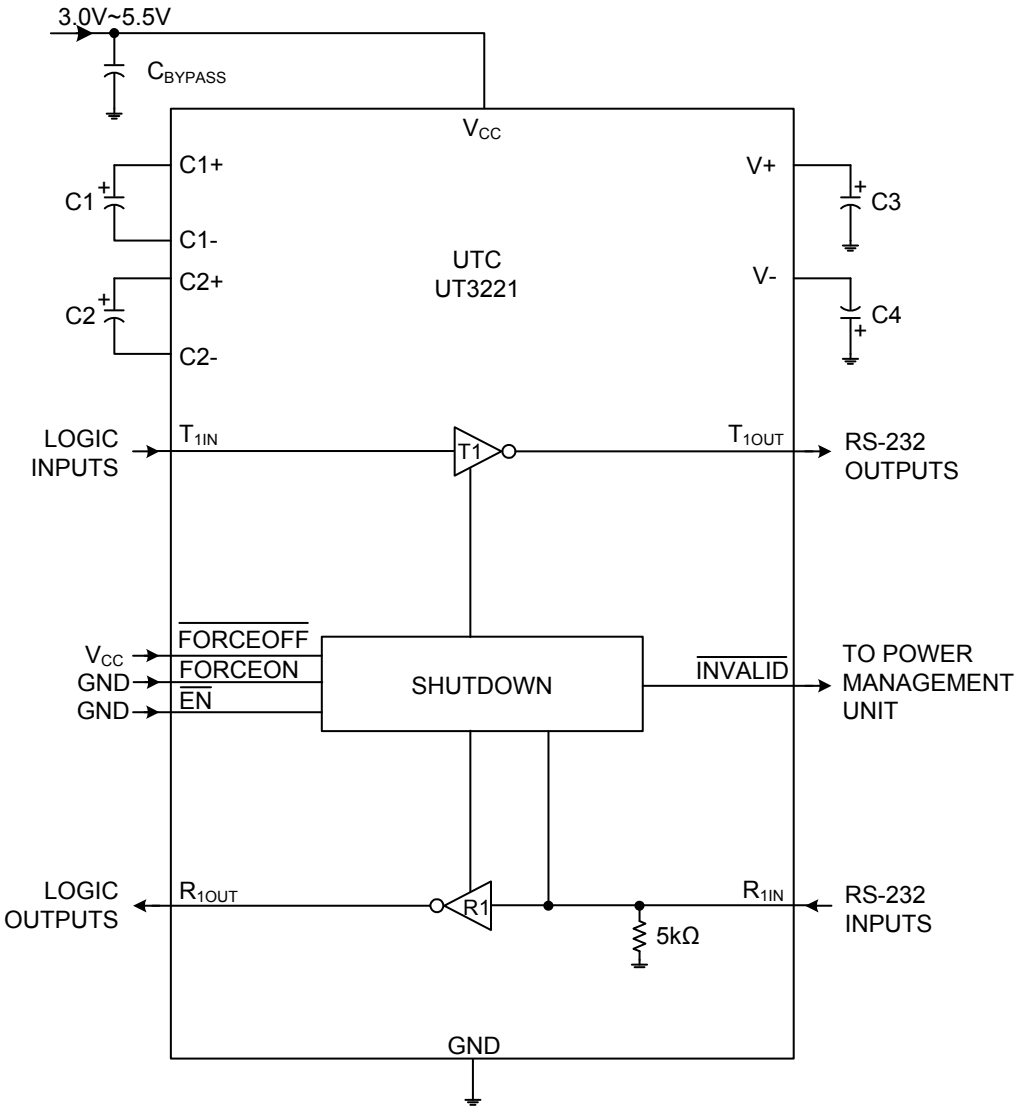



Fig.2 Shutdown Input Timing

## ■ TYPICAL APPLICATION CIRCUIT



## ■ TYPICAL APPLICATION CIRCUIT (Cont.)

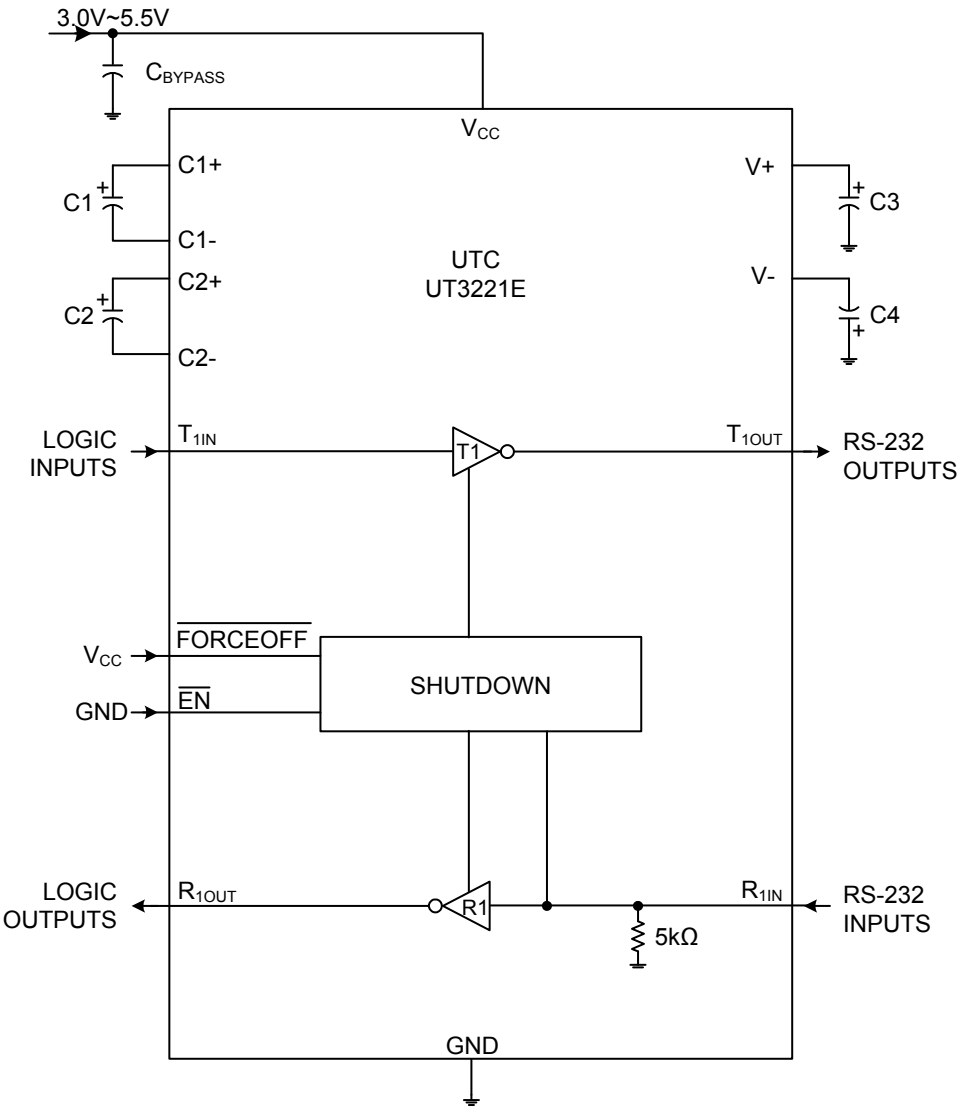



Fig.3 Application Circuit

Table 3. Required Capacitor Value

| $V_{CC}$ (V) | C1 (μF) | C2, C3, C4 (μF) | $C_{BYPASS}$ (μF) |
|---|---|---|---|
| 3.0 ~ 3.6 | 0.22 | 0.22 | 0.22 |
| 3.15 ~ 3.6 | 0.1 | 0.1 | 0.1 |
| 4.5 ~ 5.5 | 0.047 | 0.33 | 0.047 |
| 3.0 ~ 5.5 | 0.22 | 1.0 | 0.22 |

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