

## ***4-Bit Bidirectional Voltage-Level Translator for Open-Drain and Push-Pull Application***

***UM3204H CSP12 1.9×1.4***

***UM3204Q QFN14 3.5×3.5***

***UM3204QS QFN14 3.5×3.5***

***UM3204UE TSSOP14***

***UM3204QT QFN12 1.7×2.0***

### **General Description**

The UM3204 is quad channel ESD-protected level translator provide the level shifting necessary to allow data transfer in a multi-voltage system. Externally applied voltages,  $V_{CCB}$  and  $V_{CCA}$ , set the logic levels on either side of the device. A low-voltage logic signal present on the  $V_{CCA}$  side of the device appears as a high-voltage logic signal on the  $V_{CCB}$  side of the device, and vice-versa. The UM3204 bidirectional level translator utilizes a transmission-gate based design to allow data translation in either direction ( $V_{CCA} \leftrightarrow V_{CCB}$ ) on any single data line. The UM3204 accepts  $V_{CCA}$  from +1.65V to +3.6V and  $V_{CCB}$  from +2.3V to +5.5V, making it ideal for data transfer between low-voltage ASICs / PLDs and higher voltage systems.

The UM3204 enters a three-state output mode to reduce supply current when output enable (OE) is low. The UM3204 is designed so that the OE input circuit is supplied by  $V_{CCA}$ .  $\pm 5kV$  ESD protection on the  $V_{CCB}$  side for greater protection in applications that route signals externally. The UM3204 is a quad level translator available in CSP12 1.9×1.4, QFN14 3.5×3.5, TSSOP14 and QFN12 1.7×2.0 packages.

### **Applications**

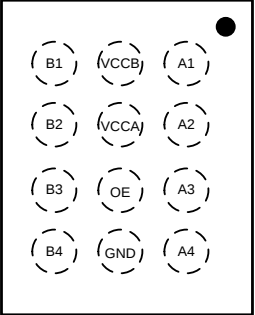
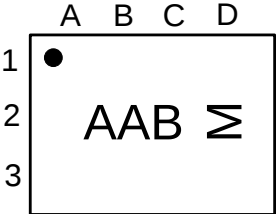
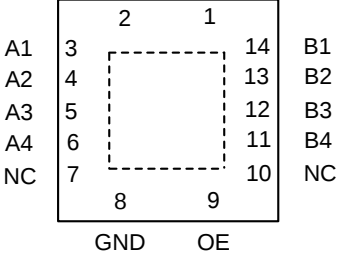
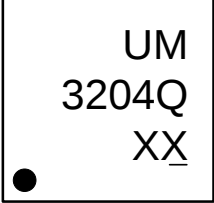
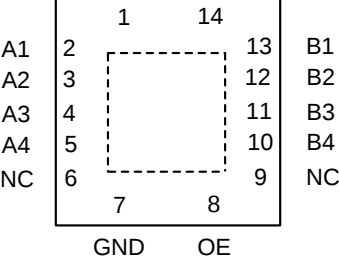
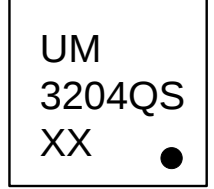
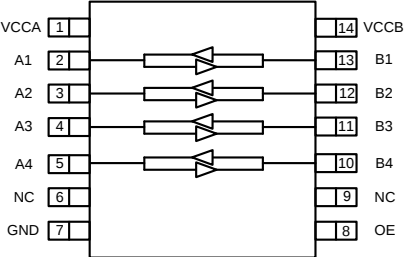
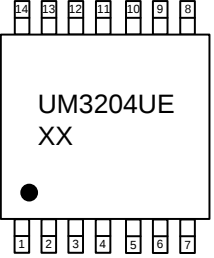
- SPI, MICROWIRE, and I<sup>2</sup>C Level Translation
- Low-Voltage ASIC Level Translation
- Smart Card Readers
- Cell-Phone Cradles
- Portable POS Systems
- Portable Communication Devices
- Low-Cost Serial Interfaces
- Cell-Phones
- GPS
- Telecommunications Equipment

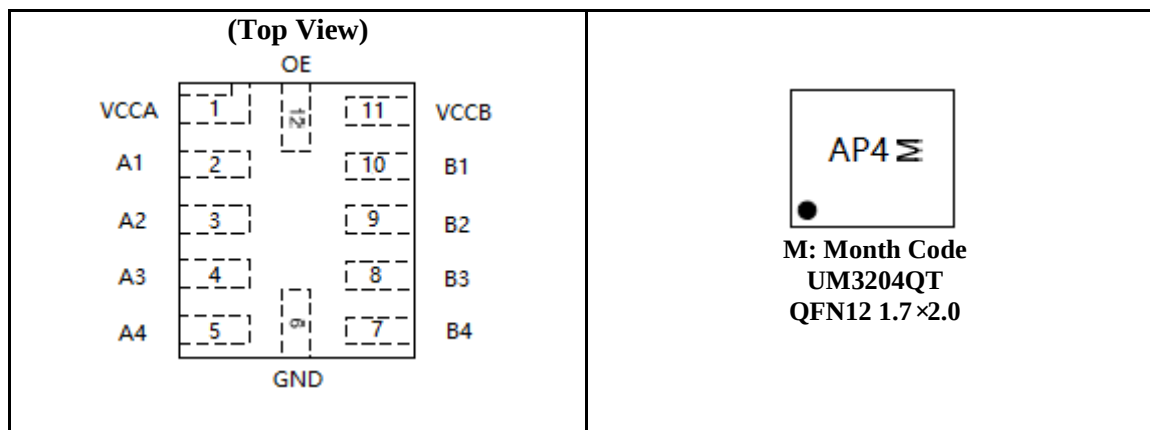
### **Features**

- Max Data Rates:  
24Mbps(Push Pull),  
2Mbps(Open Drain)
- Bidirectional Level Translation
- 1.65V to 3.6V on A Port and 2.3V to 5.5V on B Port( $V_{CCA} \leq V_{CCB}$ )
- $\pm 5kV$  ESD Protection on B Port
- No Power-Supply Sequencing Required  
 $V_{CCA}$  or  $V_{CCB}$  Can Be Ramped First
- CSP12, QFN14, TSSOP14 and QFN12 Packages

## Pin Configurations

## Top View

|                                                                                                                                                                                                                    |                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <p>(Top View)</p>  <p>A<br/>B<br/>C<br/>D</p>                                                                                     |  <p>M: Month Code<br/>UM3204H<br/>CSP12 1.9×1.4</p>    |
| <p>(Top View)</p>  <p>A1<br/>A2<br/>A3<br/>A4<br/>NC</p> <p>B1<br/>B2<br/>B3<br/>B4<br/>NC</p>                                   |  <p>XX: Week Code<br/>UM3204Q<br/>QFN14 3.5×3.5</p>   |
| <p>(Top View)</p>  <p>A1<br/>A2<br/>A3<br/>A4<br/>NC</p> <p>B1<br/>B2<br/>B3<br/>B4<br/>NC</p>                                  |  <p>XX: Week Code<br/>UM3204QS<br/>QFN14 3.5×3.5</p> |
| <p>(Top View)</p>  <p>VCCA<br/>A1<br/>A2<br/>A3<br/>A4<br/>NC<br/>GND</p> <p>VCCB<br/>B1<br/>B2<br/>B3<br/>B4<br/>NC<br/>OE</p> |  <p>XX: Week Code<br/>UM3204UE<br/>TSSOP14</p>       |



## Ball Mapping for UM3204H

|   | A                | B                | C  | D   |
|---|------------------|------------------|----|-----|
| 1 | A1               | A2               | A3 | A4  |
| 2 | V <sub>CCB</sub> | V <sub>CCA</sub> | OE | GND |
| 3 | B1               | B2               | B3 | B4  |

Transparent Top View

## Pin Description

| Pin Name         | Function                                                                                                |
|------------------|---------------------------------------------------------------------------------------------------------|
| V <sub>CCA</sub> | A-Port supply voltage. $1.65V \leq V_{CCA} \leq 3.6V$ and $V_{CCA} \leq V_{CCB}$                        |
| A1               | Input/Output 1. Referenced to V <sub>CCA</sub>                                                          |
| A2               | Input/Output 2. Referenced to V <sub>CCA</sub>                                                          |
| A3               | Input/Output 3. Referenced to V <sub>CCA</sub>                                                          |
| A4               | Input/Output 4. Referenced to V <sub>CCA</sub>                                                          |
| GND              | Ground                                                                                                  |
| OE               | 3-state output enable. Pull OE low to place all outputs in 3-state mode. Referenced to V <sub>CCA</sub> |
| B4               | Input/Output 4. Referenced to V <sub>CCB</sub>                                                          |
| B3               | Input/Output 3. Referenced to V <sub>CCB</sub>                                                          |
| B2               | Input/Output 2. Referenced to V <sub>CCB</sub>                                                          |
| B1               | Input/Output 1. Referenced to V <sub>CCB</sub>                                                          |
| V <sub>CCB</sub> | B-Port supply voltage. $2.3V \leq V_{CCB} \leq 5.5V$                                                    |

## Ordering Information

| Part Number | Packaging Type | Marking Code | Shipping Qty               |
|-------------|----------------|--------------|----------------------------|
| UM3204H     | CSP12 1.9×1.4  | AAB          | 3000pcs/7Inch Tape & Reel  |
| UM3204Q     | QFN14 3.5×3.5  | UM3204Q      | 3000pcs/13Inch Tape & Reel |
| UM3204QS    | QFN14 3.5×3.5  | UM3204QS     | 3000pcs/13Inch Tape & Reel |
| UM3204UE    | TSSOP14        | UM3204UE     | 3000pcs/13Inch Tape & Reel |
| UM3204QT    | QFN12 1.7×2.0  | AP4          | 3000pcs/7Inch Tape & Reel  |

## Absolute Maximum Ratings (Note 1)

Over operating free-air temperature range (unless otherwise noted)

| Symbol    | Parameter                                                                    |           | Value                     | Unit |
|-----------|------------------------------------------------------------------------------|-----------|---------------------------|------|
| $V_{CCA}$ | Supply Voltage Range                                                         |           | -0.5 to +4.5              | V    |
| $V_{CCB}$ | Supply Voltage Range                                                         |           | -0.5 to +6.5              | V    |
| $V_I$     | Input Voltage Range                                                          | A ports   | -0.5 to +4.5              | V    |
|           |                                                                              | B ports   | -0.5 to +6.5              |      |
| $V_O$     | Voltage Range applied to any output in the high-impedance or power-off state | A ports   | -0.5 to +4.5              | V    |
|           |                                                                              | B ports   | -0.5 to +6.5              |      |
| $V_O$     | Voltage Range applied to any output in the high or low state (Note 2)        | A ports   | -0.5 to ( $V_{CCA}+0.5$ ) | V    |
|           |                                                                              | B ports   | -0.5 to ( $V_{CCB}+0.5$ ) |      |
| $I_{IK}$  | Input Clamp Current                                                          | $V_I < 0$ | -50                       | mA   |
| $I_{OK}$  | Output Clamp Current                                                         | $V_O < 0$ | -50                       | mA   |
| $I_O$     | Continuous Output Current                                                    |           | ±50                       | mA   |
|           | Continuous Current through $V_{CCA}$ , $V_{CCB}$ , or GND                    |           | ±100                      | mA   |
| $T_{OP}$  | Operating Temperature Range                                                  |           | -40 to +85                | °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 under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Note2. The value of  $V_{CCA}$  and  $V_{CCB}$  are provided in the recommended operating conditions table.

## Recommended Operating Conditions (Note 1, 2)

| Symbol           | Parameter                          |                          | V <sub>CCA</sub> | V <sub>CCB</sub> | Min                    | Max                    | Unit |
|------------------|------------------------------------|--------------------------|------------------|------------------|------------------------|------------------------|------|
| V <sub>CCA</sub> | Supply Voltage                     |                          |                  |                  | 1.65                   | 3.6                    | V    |
| V <sub>CCB</sub> |                                    |                          |                  |                  | 2.3                    | 5.5                    |      |
| V <sub>IH</sub>  | High Level Input Voltage           | A- Port                  | 1.65V to 1.95V   | 2.3V to 5.5V     | V <sub>CCI</sub> -0.2  | V <sub>CCI</sub>       | V    |
|                  |                                    |                          | 2.3V to 3.6V     |                  | V <sub>CCI</sub> -0.4  | V <sub>CCI</sub>       |      |
|                  |                                    | B- Port                  | 1.65V to 3.6V    | 2.3V to 5.5V     | V <sub>CCI</sub> -0.4  | V <sub>CCI</sub>       | V    |
|                  |                                    | OE                       |                  |                  | V <sub>CCA</sub> ×0.65 | 5.5                    |      |
| V <sub>IL</sub>  | Low Level Input Voltage            | A- Port                  | 1.65V to 3.6V    | 2.3V to 5.5V     | 0                      | 0.15                   | V    |
|                  |                                    | B- Port                  |                  |                  | 0                      | 0.15                   |      |
|                  |                                    | OE                       |                  |                  | 0                      | V <sub>CCA</sub> ×0.35 |      |
|                  |                                    |                          |                  |                  |                        |                        |      |
| Δt/ΔV            | Input Transition Rise or Fall Time | A-Port push-pull driving | 1.65V to 3.6V    | 2.3V to 5.5V     |                        | 10                     | ns/V |
|                  |                                    | B-Port push-pull driving |                  |                  |                        | 10                     |      |
|                  |                                    | Control input            |                  |                  |                        | 10                     |      |
|                  |                                    |                          |                  |                  |                        |                        |      |

Note1. V<sub>CCI</sub> is the supply voltage associated with the input port.

Note2. V<sub>CCA</sub> must be less than or equal to V<sub>CCB</sub> and must not exceed 3.6 V.

## Electrical Characteristics (Note 1, 2, 3)

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

| Parameter                          |             | Test Conditions                                         | V <sub>CCA</sub>          | V <sub>CCB</sub> | T <sub>A</sub> =25°C |     | -40°C to 85°C         |      | Unit |
|------------------------------------|-------------|---------------------------------------------------------|---------------------------|------------------|----------------------|-----|-----------------------|------|------|
|                                    |             |                                                         |                           |                  | Typ                  | Max | Min                   | Max  |      |
| V <sub>OHA</sub>                   |             | I <sub>OH</sub> =-20μA                                  | 1.65V to 3.6V             | 2.3V to 5.5V     |                      |     | V <sub>CCA</sub> ×0.8 |      | V    |
| V <sub>OLA</sub>                   |             | I <sub>OL</sub> =1mA                                    | 1.65V to 3.6V             | 2.3V to 5.5V     |                      |     |                       | 0.4  | V    |
| V <sub>OHB</sub>                   |             | I <sub>OH</sub> =-20μA                                  | 1.65V to 3.6V             | 2.3V to 5.5V     |                      |     | V <sub>CCB</sub> ×0.8 |      | V    |
| V <sub>OLB</sub>                   |             | I <sub>OL</sub> =1mA                                    | 1.65V to 3.6V             | 2.3V to 5.5V     |                      |     |                       | 0.4  | V    |
| I <sub>I</sub>                     | OE          | V <sub>I</sub> =V <sub>CCI</sub> or GND                 | 1.65V to 3.6V             | 2.3V to 5.5V     |                      | ±1  |                       | ±2   | μA   |
| I <sub>OZ</sub>                    | A or B Port | OE=V <sub>IL</sub>                                      | 1.65V to 3.6V             | 2.3V to 5.5V     |                      | ±1  |                       | ±2   | μA   |
| I <sub>CCA</sub>                   |             | V <sub>I</sub> =V <sub>O</sub> =open, I <sub>O</sub> =0 | 1.65V to V <sub>CCB</sub> | 2.3V to 5.5V     |                      |     |                       | 2.4  | μA   |
|                                    |             |                                                         | 3.6V                      | 0V               |                      |     |                       | 2.2  |      |
|                                    |             |                                                         | 0V                        | 5.5V             |                      |     |                       | -1   |      |
| I <sub>CCB</sub>                   |             | V <sub>I</sub> =V <sub>O</sub> =open, I <sub>O</sub> =0 | 1.65V to V <sub>CCB</sub> | 2.3V to 5.5V     |                      |     |                       | 12   | μA   |
|                                    |             |                                                         | 3.6V                      | 0V               |                      |     |                       | -1   |      |
|                                    |             |                                                         | 0V                        | 5.5V             |                      |     |                       | 1    |      |
| I <sub>CCA</sub> +I <sub>CCB</sub> |             | V <sub>I</sub> =V <sub>O</sub> =open, I <sub>O</sub> =0 | 1.65V to 3.6V             | 2.3V to 5.5V     |                      |     |                       | 14.4 | μA   |
| C <sub>i</sub>                     | OE          |                                                         | 3.3V                      | 3.3V             | 2.5                  |     |                       | 3.5  | pF   |
| C <sub>iO</sub>                    | A Port      |                                                         | 3.3V                      | 3.3V             | 5                    |     |                       | 6.5  | pF   |
|                                    | B Port      |                                                         |                           |                  | 12                   |     |                       | 16.5 |      |

Note1. V<sub>CCI</sub> is the supply voltage associated with the input port.

Note2. V<sub>CCO</sub> is the supply voltage associated with the output port.

Note3. V<sub>CCA</sub> must be less than or equal to V<sub>CCB</sub> and must not exceed 3.6 V.

## Timing Requirements

Over recommended operating free-air temperature range,  $V_{CCA} = 1.8V \pm 0.15V$  (unless otherwise noted)

|                               |                    |             | V <sub>CCB</sub> =2.5V<br>±0.2V |     | V <sub>CCB</sub> =3.3V<br>±0.3V |     | V <sub>CCB</sub> =5V<br>±0.5V |     | Unit |
|-------------------------------|--------------------|-------------|---------------------------------|-----|---------------------------------|-----|-------------------------------|-----|------|
|                               |                    |             | Min                             | Max | Min                             | Max | Min                           | Max |      |
| Data Rate                     | Push-pull driving  |             | 24                              |     | 24                              |     | 24                            |     | Mbps |
|                               | Open-drain driving |             | 2                               |     | 2                               |     | 2                             |     |      |
| t <sub>w</sub> Pulse duration | Push-pull driving  | Data inputs | 41                              |     | 41                              |     | 41                            |     | ns   |
|                               | Open-drain driving |             | 500                             |     | 500                             |     | 500                           |     |      |

## Timing Requirements

Over recommended operating free-air temperature range,  $V_{CCA} = 2.5V \pm 0.2V$  (unless otherwise noted)

|                               |                    |             | V <sub>CCB</sub> =2.5V<br>±0.2V |     | V <sub>CCB</sub> =3.3V<br>±0.3V |     | V <sub>CCB</sub> =5V<br>±0.5V |     | Unit |
|-------------------------------|--------------------|-------------|---------------------------------|-----|---------------------------------|-----|-------------------------------|-----|------|
|                               |                    |             | Min                             | Max | Min                             | Max | Min                           | Max |      |
| Data Rate                     | Push-pull driving  |             | 24                              |     | 24                              |     | 24                            |     | Mbps |
|                               | Open-drain driving |             | 2                               |     | 2                               |     | 2                             |     |      |
| t <sub>w</sub> Pulse duration | Push-pull driving  | Data inputs | 41                              |     | 41                              |     | 41                            |     | ns   |
|                               | Open-drain driving |             | 500                             |     | 500                             |     | 500                           |     |      |

## Timing Requirements

Over recommended operating free-air temperature range,  $V_{CCA} = 3.3V \pm 0.3V$  (unless otherwise noted)

|                               |                    |             | V <sub>CCB</sub> =3.3V±0.3V |     | V <sub>CCB</sub> =5V±0.5V |     | Unit |
|-------------------------------|--------------------|-------------|-----------------------------|-----|---------------------------|-----|------|
|                               |                    |             | Min                         | Max | Min                       | Max |      |
| Data Rate                     | Push-pull driving  |             | 24                          |     | 24                        |     | Mbps |
|                               | Open-drain driving |             | 2                           |     | 2                         |     |      |
| t <sub>w</sub> Pulse duration | Push-pull driving  | Data inputs | 41                          |     | 41                        |     | ns   |
|                               | Open-drain driving |             | 500                         |     | 500                       |     |      |

## Switching Characteristics

Over recommended operating free-air temperature range,  $V_{CCA} = 1.8V \pm 0.15V$  (unless otherwise noted)

| Parameter     | From (Input)       | To (Output) | Test Conditions | $V_{CCB}=2.5V \pm 0.2V$ |      | $V_{CCB}=3.3V \pm 0.3V$ |      | $V_{CCB}=5V \pm 0.5V$ |      | Unit |
|---------------|--------------------|-------------|-----------------|-------------------------|------|-------------------------|------|-----------------------|------|------|
|               |                    |             |                 | Min                     | Max  | Min                     | Max  | Min                   | Max  |      |
| $t_{PHL}$     | A                  | B           | Push-pull       |                         | 4.6  |                         | 4.7  |                       | 5.8  | ns   |
|               |                    |             | Open-drain      | 2.9                     | 8.8  | 2.9                     | 9.6  | 3                     | 10   |      |
| $t_{PLH}$     |                    |             | Push-pull       |                         | 6.8  |                         | 6.8  |                       | 7    |      |
|               |                    |             | Open-drain      | 45                      | 260  | 36                      | 208  | 27                    | 198  |      |
| $t_{PHL}$     | B                  | A           | Push-pull       |                         | 4.4  |                         | 4.5  |                       | 4.7  | ns   |
|               |                    |             | Open-drain      | 1.9                     | 5.3  | 1.1                     | 4.4  | 1.2                   | 4    |      |
| $t_{PLH}$     |                    |             | Push-pull       |                         | 5.3  |                         | 4.5  |                       | 0.5  |      |
|               |                    |             | Open-drain      | 45                      | 175  | 36                      | 140  | 27                    | 102  |      |
| $t_{dis}$     | OE                 | A           |                 |                         | 200  |                         | 200  |                       | 200  | ns   |
|               |                    | B           |                 |                         | 200  |                         | 200  |                       | 200  |      |
| $t_{en}$      | OE                 | A           |                 |                         | 50   |                         | 40   |                       | 35   | ns   |
|               |                    | B           |                 |                         | 50   |                         | 40   |                       | 35   |      |
| $t_{rA}$      | A port rise time   |             | Push-pull       | 3.2                     | 9.5  | 2.3                     | 9.3  | 2                     | 7.6  | ns   |
|               |                    |             | Open-drain      | 38                      | 165  | 30                      | 132  | 22                    | 95   |      |
| $t_{rB}$      | B port rise time   |             | Push-pull       | 4                       | 10.8 | 2.7                     | 9.1  | 2.7                   | 7.6  | ns   |
|               |                    |             | Open-drain      | 34                      | 145  | 23                      | 106  | 10                    | 58   |      |
| $t_{fA}$      | A port fall time   |             | Push-pull       | 2                       | 5.9  | 1.9                     | 6    | 1.7                   | 3.3  | ns   |
|               |                    |             | Open-drain      | 4.4                     | 6.9  | 4.3                     | 6.4  | 4.2                   | 6.1  |      |
| $t_{fB}$      | B port fall time   |             | Push-pull       | 2.9                     | 7.6  | 2.8                     | 7.5  | 2.8                   | 8.8  | ns   |
|               |                    |             | Open-drain      | 6.9                     | 13.8 | 7.5                     | 16.2 | 7                     | 16.2 |      |
| $t_{SK(O)}$   | Channel-to-channel |             |                 |                         | 1    |                         | 1    |                       | 1    | ns   |
| Max data rate |                    |             | Push-pull       |                         | 24   |                         | 24   |                       | 24   | Mbps |
|               |                    |             | Open-drain      |                         | 2    |                         | 2    |                       | 2    |      |

## Switching Characteristics

Over recommended operating free-air temperature range,  $V_{CCA} = 2.5V \pm 0.2V$  (unless otherwise noted)

| Parameter          | From<br>(Input)    | To<br>(Output) | Test<br>Conditions | V <sub>CCB</sub> =2.5V<br>±0.2V |     | V <sub>CCB</sub> =3.3V<br>±0.3V |     | V <sub>CCB</sub> =5V<br>±0.5V |      | Unit |
|--------------------|--------------------|----------------|--------------------|---------------------------------|-----|---------------------------------|-----|-------------------------------|------|------|
|                    |                    |                |                    | Min                             | Max | Min                             | Max | Min                           | Max  |      |
| t <sub>PHL</sub>   | A                  | B              | Push-pull          |                                 | 3.2 |                                 | 3.3 |                               | 3.4  | ns   |
| t <sub>PLH</sub>   |                    |                | Open-drain         | 1.7                             | 6.3 | 2                               | 6   | 2.1                           | 5.8  |      |
|                    |                    |                | Push-pull          |                                 | 3.5 |                                 | 4.1 |                               | 4.4  |      |
|                    |                    |                | Open-drain         | 43                              | 250 | 36                              | 206 | 27                            | 190  |      |
| t <sub>PHL</sub>   | B                  | A              | Push-pull          |                                 | 3   |                                 | 3.6 |                               | 4.3  | ns   |
| t <sub>PLH</sub>   |                    |                | Open-drain         | 1.8                             | 4.7 | 2.6                             | 4.2 | 1.2                           | 4    |      |
|                    |                    |                | Push-pull          |                                 | 2.5 |                                 | 1.6 |                               | 0.7  |      |
|                    |                    |                | Open-drain         | 44                              | 170 | 37                              | 140 | 27                            | 103  |      |
| t <sub>dis</sub>   | OE                 | A              |                    |                                 | 200 |                                 | 200 |                               | 200  | ns   |
|                    |                    | B              |                    |                                 | 200 |                                 | 200 |                               | 200  |      |
| t <sub>en</sub>    | OE                 | A              |                    |                                 | 50  |                                 | 40  |                               | 35   | ns   |
|                    |                    | B              |                    |                                 | 50  |                                 | 40  |                               | 35   |      |
| t <sub>rA</sub>    | A port rise time   |                | Push-pull          | 2.8                             | 7.4 | 2.6                             | 6.6 | 1.8                           | 5.6  | ns   |
|                    |                    |                | Open-drain         | 34                              | 149 | 28                              | 121 | 24                            | 89   |      |
| t <sub>rB</sub>    | B port rise time   |                | Push-pull          | 3.2                             | 8.3 | 2.9                             | 7.2 | 2.4                           | 6.1  | ns   |
|                    |                    |                | Open-drain         | 35                              | 151 | 24                              | 112 | 12                            | 64   |      |
| t <sub>fA</sub>    | A port fall time   |                | Push-pull          | 1.9                             | 5.7 | 1.9                             | 5.5 | 1.8                           | 5.3  | ns   |
|                    |                    |                | Open-drain         | 4.4                             | 6.9 | 4.3                             | 6.2 | 4.2                           | 5.8  |      |
| t <sub>fB</sub>    | B port fall time   |                | Push-pull          | 2.2                             | 7.8 | 2.4                             | 6.7 | 2.6                           | 6.6  | ns   |
|                    |                    |                | Open-drain         | 5.1                             | 8.8 | 5.4                             | 9.4 | 5.4                           | 10.4 |      |
| t <sub>SK(O)</sub> | Channel-to-channel |                |                    |                                 | 1   |                                 | 1   |                               | 1    | ns   |
| Max data<br>rate   |                    |                | Push-pull          | 24                              |     | 24                              |     | 24                            |      | Mbps |
|                    |                    |                | Open-drain         | 2                               |     | 2                               |     | 2                             |      |      |

## Switching Characteristics

Over recommended operating free-air temperature range,  $V_{CCA} = 3.3V \pm 0.3V$  (unless otherwise noted)

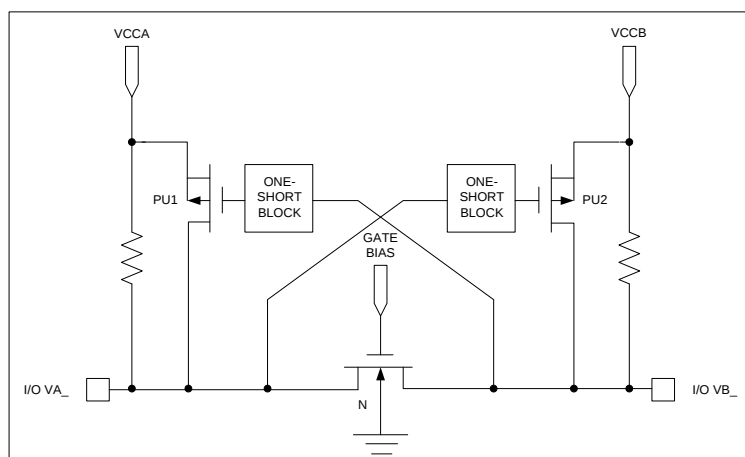
| Parameter          | From<br>(Input)    | To<br>(Output) | Test Conditions | V <sub>CCB</sub> =3.3V<br>±0.3V |     | V <sub>CCB</sub> =5V<br>±0.5V |     | Unit |
|--------------------|--------------------|----------------|-----------------|---------------------------------|-----|-------------------------------|-----|------|
|                    |                    |                |                 | Min                             | Max | Min                           | Max |      |
| t <sub>PHL</sub>   | A                  | B              | Push-pull       |                                 | 2.4 |                               | 3.1 | ns   |
| t <sub>PLH</sub>   |                    |                | Open-drain      | 1.2                             | 4.2 | 1.4                           | 4.6 |      |
|                    |                    |                | Push-pull       |                                 | 4.2 |                               | 4.4 |      |
|                    |                    |                | Open-drain      | 36                              | 204 | 28                            | 165 |      |
| t <sub>PHL</sub>   | B                  | A              | Push-pull       |                                 | 2.5 |                               | 3.3 | ns   |
| t <sub>PLH</sub>   |                    |                | Open-drain      | 1                               | 124 | 1                             | 97  |      |
|                    |                    |                | Push-pull       |                                 | 2.5 |                               | 2.6 |      |
|                    |                    |                | Open-drain      | 3                               | 139 | 3                             | 105 |      |
| t <sub>dis</sub>   | OE                 | A              |                 |                                 | 200 |                               | 200 | ns   |
|                    |                    | B              |                 |                                 | 200 |                               | 200 |      |
| t <sub>en</sub>    | OE                 | A              |                 |                                 | 40  |                               | 35  | ns   |
|                    |                    | B              |                 |                                 | 40  |                               | 35  |      |
| t <sub>rA</sub>    | A port rise time   |                | Push-pull       | 2.3                             | 5.6 | 1.9                           | 4.8 | ns   |
|                    |                    |                | Open-drain      | 25                              | 116 | 19                            | 85  |      |
| t <sub>rB</sub>    | B port rise time   |                | Push-pull       | 2.5                             | 6.4 | 2.1                           | 7.4 | ns   |
|                    |                    |                | Open-drain      | 26                              | 116 | 14                            | 72  |      |
| t <sub>fA</sub>    | A port fall time   |                | Push-pull       | 2                               | 5.4 | 1.9                           | 5   | ns   |
|                    |                    |                | Open-drain      | 4.3                             | 6.1 | 4.2                           | 5.7 |      |
| t <sub>fB</sub>    | B port fall time   |                | Push-pull       | 2.3                             | 7.4 | 2.4                           | 7.6 | ns   |
|                    |                    |                | Open-drain      | 5                               | 7.6 | 4.8                           | 8.3 |      |
| t <sub>SK(O)</sub> | Channel-to-channel |                |                 |                                 | 1   |                               | 1   | ns   |
| Max data<br>rate   |                    |                | Push-pull       | 24                              |     | 24                            |     | Mbps |
|                    |                    |                | Open-drain      | 2                               |     | 2                             |     |      |

## Applications Information

The UM3204 can be used in level-translation applications for interfacing devices or systems operating at different interface voltages with one another. The UM3204 is ideal for use in application where an open-drain driver is connected to the data I/Os. The UM3204 can also be used in applications where a push-pull driver is connected to the data I/Os, but the UM3304 might be a better option for such push-pull applications.

## Block Diagram

The UM3204 (block diagram see Figure 1) does not require a direction-control signal to control the direction of data flow from A to B or from B to A. Each A-port I/O has an internal 10-k $\Omega$  pull-up resistor to  $V_{CCA}$ , and each B-port I/O has an internal 10-k $\Omega$  pull-up resistor to  $V_{CCB}$ . During a rising edge, the one-shot turns on the PMOS transistors (PU1, PU2) for a short duration, which speed up the low-to-high transition.



### Figure 1 Block Diagram of UM3204 I/O Cell

## Input Driver Requirements

The fall time ( $t_{fA}$ ,  $t_{fB}$ ) of a signal depends on the output impedance of the external device driving the data I/Os of the UM3204. Similarly, the  $t_{PHL}$  and the maximum data rates also depend on the output impedance of the external driver. The values for  $t_{fA}$ ,  $t_{fB}$ ,  $t_{PHL}$ , and the maximum data rates in the data sheet assume that the output impedance of the external driver is less than  $50\Omega$ .

## Power Up

During operation, ensure that  $V_{CCA} \leq V_{CCB}$  at all times. During power-up sequencing,  $V_{CCA} \geq V_{CCB}$  does not damage the device, so any power supply can be ramped up first. The UM3204 has circuitry that disables all output ports when either  $V_{CC}$  is switched off ( $V_{CCA/B}=0V$ ).

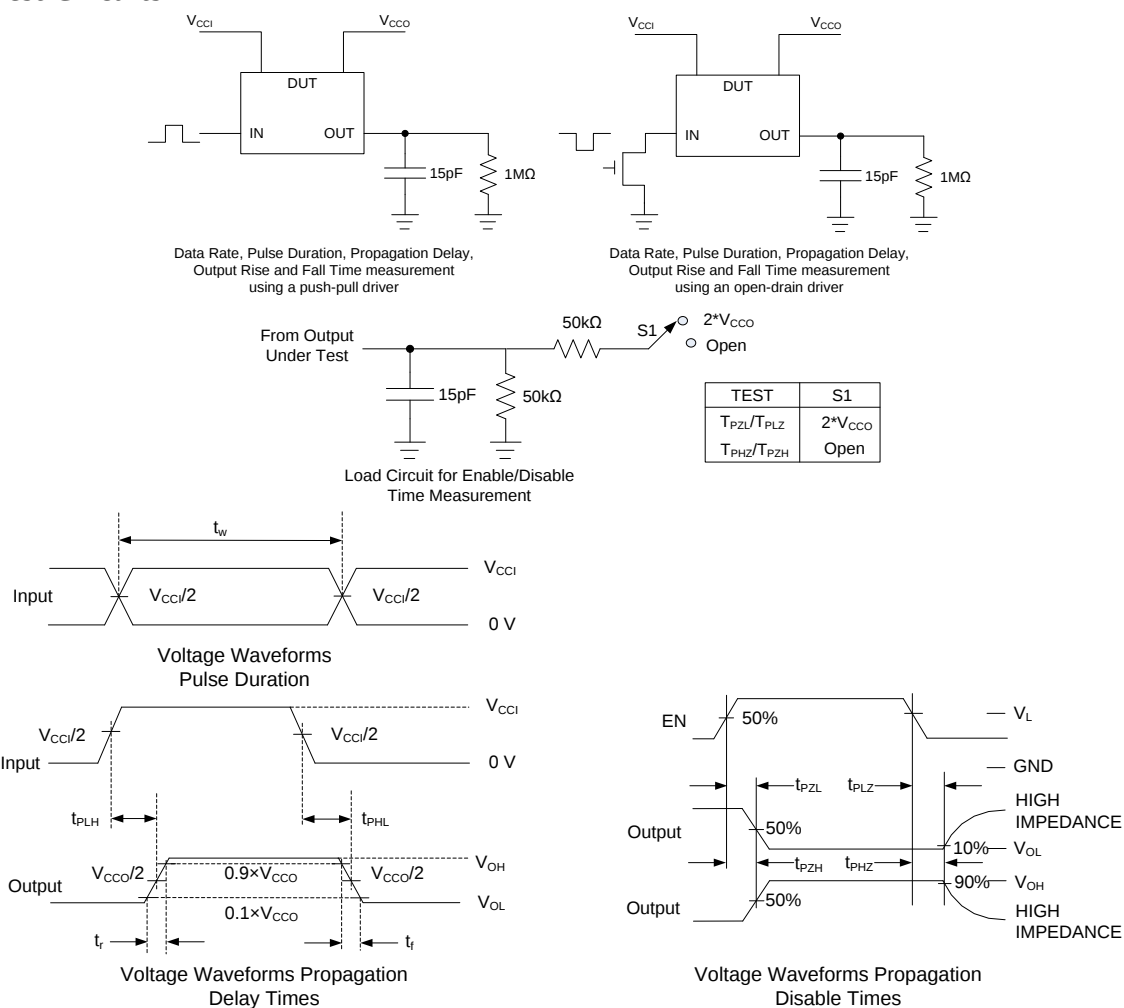
## Enable and Disable

The UM3204 has an OE input that is used to disable the device by setting OE = low, which places all I/Os in the high-impedance (Hi-Z) state. The disable time (tdis) indicates the delay between the time when OE goes low and when the outputs actually get disabled (Hi-Z). The enable time (ten) indicates the amount of time the user must allow for the one-shot circuitry to become operational after OE is taken high.

## Pull-up or Pull-down Resistors on I/O Lines

Each A-port I/O has an internal 10-k $\Omega$  pull-up resistor to  $V_{CCA}$ , and each B-port I/O has an internal 10-k $\Omega$  pull-up resistor to  $V_{CCB}$ . If a smaller value of pull-up resistor is required, an external resistor must be added from the I/O to  $V_{CCA}$  or  $V_{CCB}$  (in parallel with the internal 10-k $\Omega$  resistor).

## Test Circuits



- $C_L$  includes probe and jig capacitances.
- 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.
- All input pulses are supplied by generators having the following characteristics:  $PRR \leq 100\text{MHz}$ ,  $Z_0 = 50\Omega$ ,  $dv/dt \geq 1\text{V/ns}$ .
- The outputs are measured one at a time, with one transition per measurement.
- $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
- $t_{PZL}$  and  $t_{PHZ}$  are the same as  $t_{en}$ .
- $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .
- $V_{CCI}$  is the  $V_{CC}$  associated with the input port.
- $V_{CCO}$  is the  $V_{CC}$  associated with the output port.
- All parameters and waveforms are not applicable to all devices.

**Figure 2 Load Circuits and Voltage Waveforms**

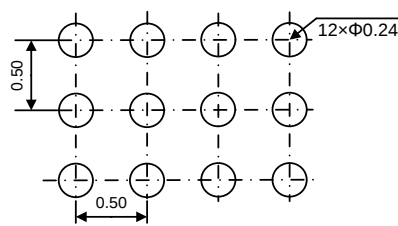
## Package Information

### UM3204H CSP12 1.9×1.4

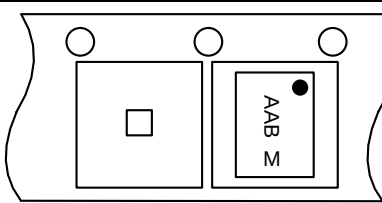
#### Outline Drawing

| DIMENSIONS |             |       |      |          |        |        |
|------------|-------------|-------|------|----------|--------|--------|
| Symbol     | MILLIMETERS |       |      | INCHES   |        |        |
|            | Min         | Typ   | Max  | Min      | Typ    | Max    |
| A          | -           | -     | 0.68 | -        | -      | 0.027  |
| A1         | 0.21        | 0.231 | 0.24 | 0.0083   | 0.0091 | 0.0094 |
| A2         | 0.40        | 0.42  | 0.44 | 0.0157   | 0.0165 | 0.0173 |
| b          | 0.27        | 0.30  | 0.32 | 0.011    | 0.012  | 0.013  |
| C          | 0.50TYP     |       |      | 0.020TYP |        |        |
| D          | 1.82        | -     | 1.90 | 0.072    | -      | 0.075  |
| D1         | 1.50TYP     |       |      | 0.059TYP |        |        |
| E          | 1.32        | -     | 1.40 | 0.052    | -      | 0.055  |
| E1         | 1.00TYP     |       |      | 0.039TYP |        |        |
| e          | 0.50TYP     |       |      | 0.020TYP |        |        |

#### Land Pattern

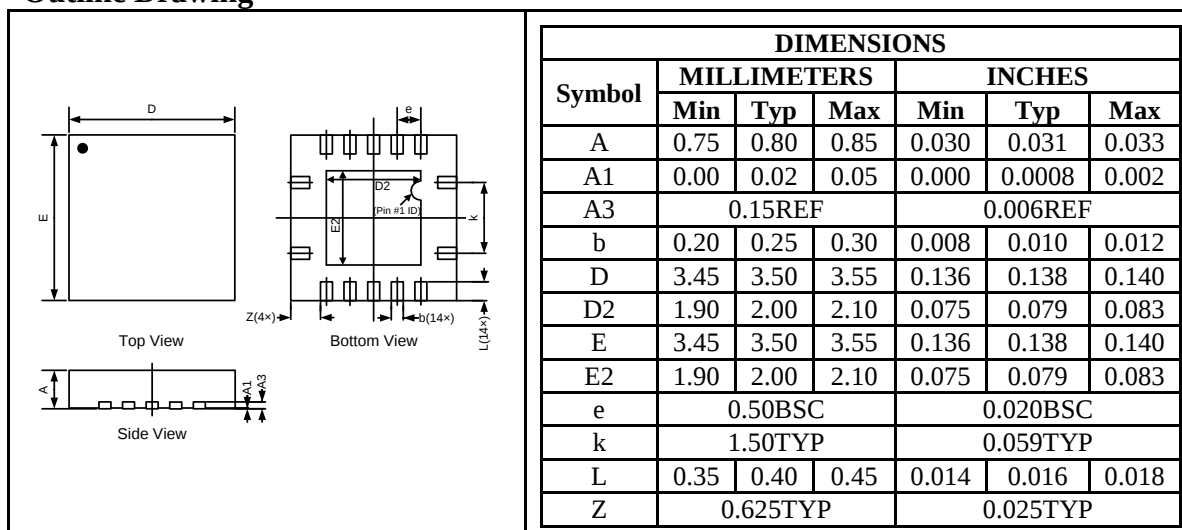
|                                                                                     |                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>NOTES:</p> <ol style="list-style-type: none"> <li>1. Bump is Lead Free Sn/Ag/Cu.</li> <li>2. Unit: mm.</li> <li>3. Non-solder mask defined copper landing pad.</li> <li>4. Laser Mark on silicon die back; back-lapped.</li> </ol> |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

#### Tape and Reel Orientation

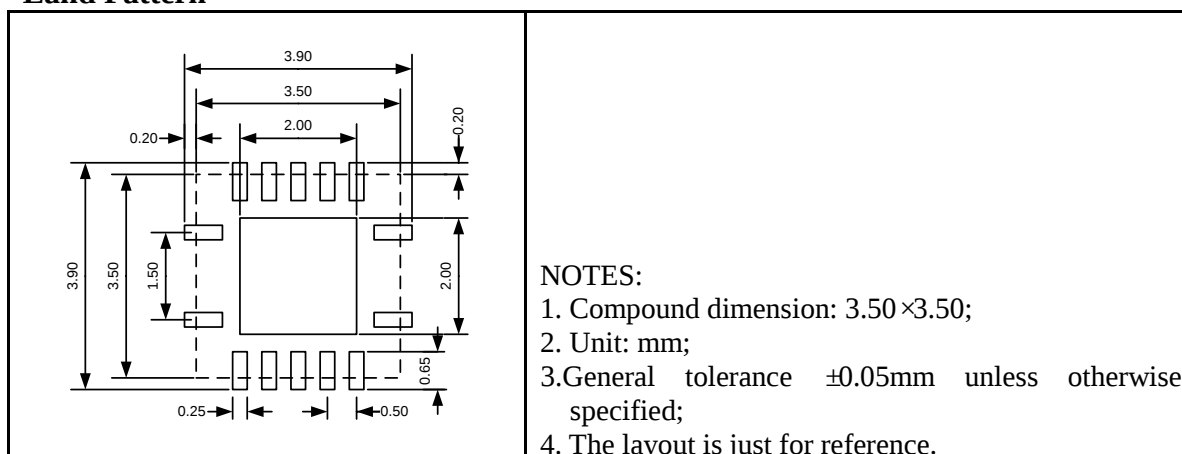
|                                                                                     |
|-------------------------------------------------------------------------------------|
|  |
|-------------------------------------------------------------------------------------|

## UM3204Q QFN14 3.5 × 3.5

### Outline Drawing



### Land Pattern

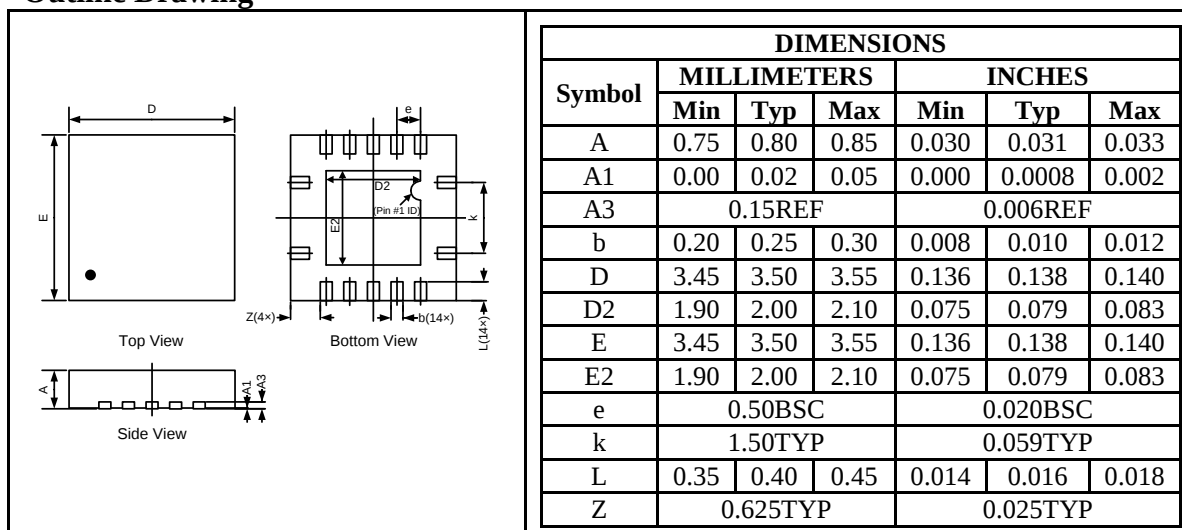


### Tape and Reel Orientation

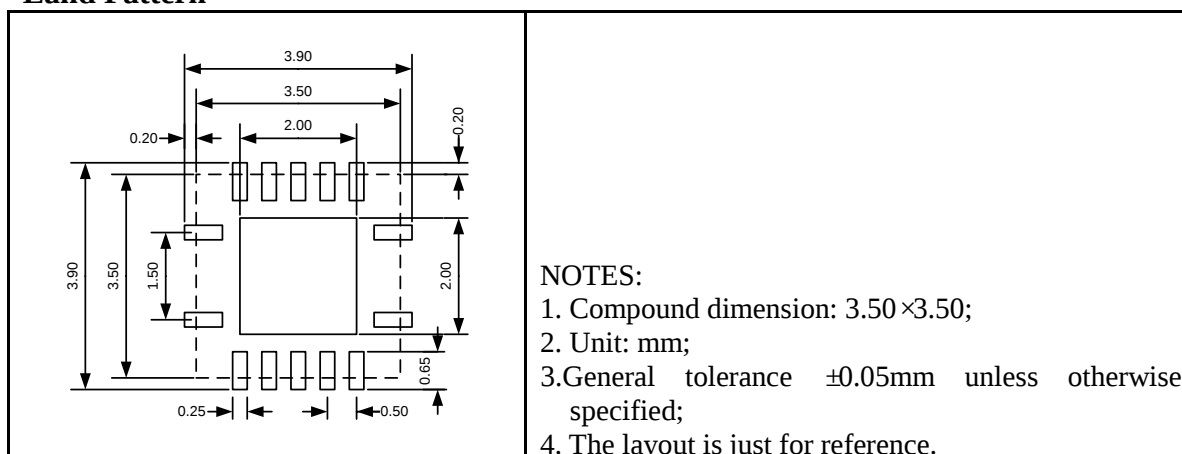


## UM3204QS QFN14 3.5 × 3.5

### Outline Drawing



### Land Pattern



### Tape and Reel Orientation

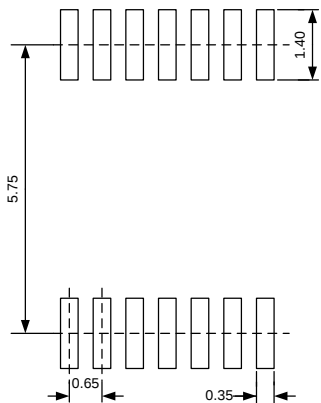


## UM3204UE: TSSOP14

### Outline Drawing

| DIMENSIONS |             |      |      |          |       |       |
|------------|-------------|------|------|----------|-------|-------|
| Symbol     | MILLIMETERS |      |      | INCHES   |       |       |
|            | Min         | Typ  | Max  | Min      | Typ   | Max   |
| A          | -           | -    | 1.20 | -        | -     | 0.047 |
| A1         | 0.05        | -    | 0.15 | 0.002    | -     | 0.006 |
| A2         | 0.90        | 1.00 | 1.05 | 0.035    | 0.039 | 0.041 |
| A3         | 0.34        | 0.44 | 0.54 | 0.013    | 0.017 | 0.021 |
| b          | 0.20        | -    | 0.28 | 0.008    | -     | 0.011 |
| c          | 0.10        | -    | 0.19 | 0.004    | -     | 0.007 |
| D          | 4.86        | 4.96 | 5.06 | 0.191    | 0.195 | 0.199 |
| E          | 4.30        | 4.40 | 4.50 | 0.169    | 0.173 | 0.177 |
| E1         | 6.20        | 6.40 | 6.60 | 0.244    | 0.252 | 0.260 |
| e          | 0.65BSC     |      |      | 0.026BSC |       |       |
| L          | 0.45        | 0.60 | 0.75 | 0.018    | 0.024 | 0.030 |
| L1         | 1.00REF     |      |      | 0.039REF |       |       |
| L2         | 0.25BSC     |      |      | 0.010BSC |       |       |
| θ1         | 0°          | -    | 8°   | 0°       | -     | 8°    |
| θ2         | 10°         | 12°  | 14°  | 10°      | 12°   | 14°   |
| θ3         | 10°         | 12°  | 14°  | 10°      | 12°   | 14°   |

### Land Pattern

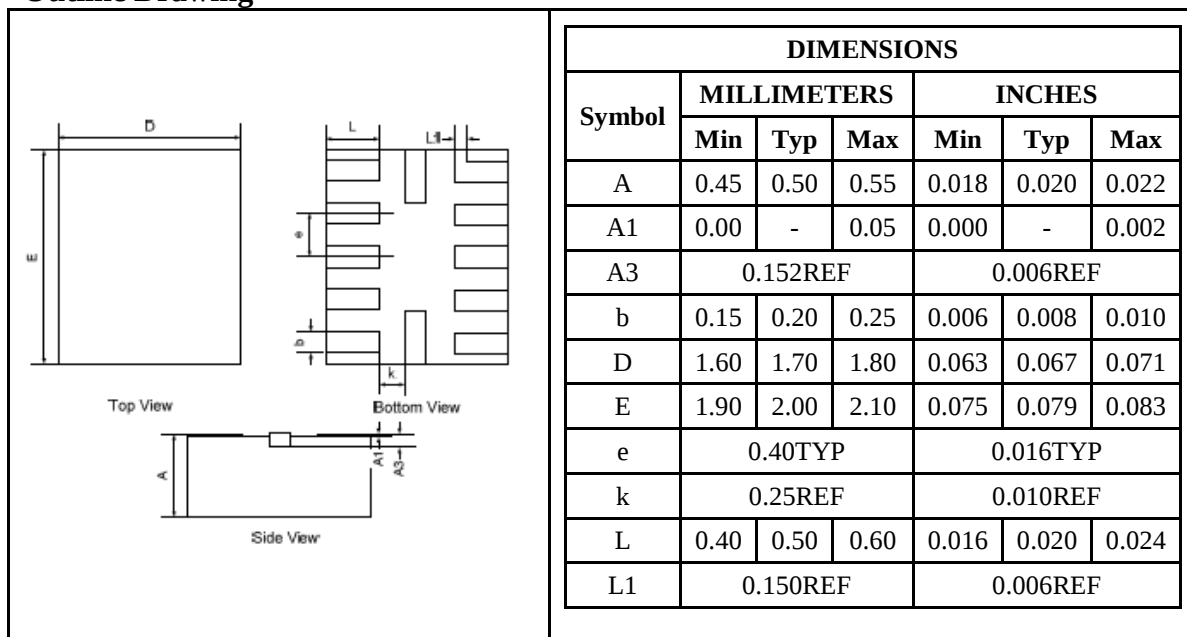
|                                                                                     |                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>NOTES:</p> <ol style="list-style-type: none"> <li>Compound dimension: 4.96×4.40;</li> <li>Unit: mm;</li> <li>General tolerance <math>\pm 0.05\text{mm}</math> unless otherwise specified;</li> <li>The layout is just for reference.</li> </ol> |
|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Tape and Reel Orientation

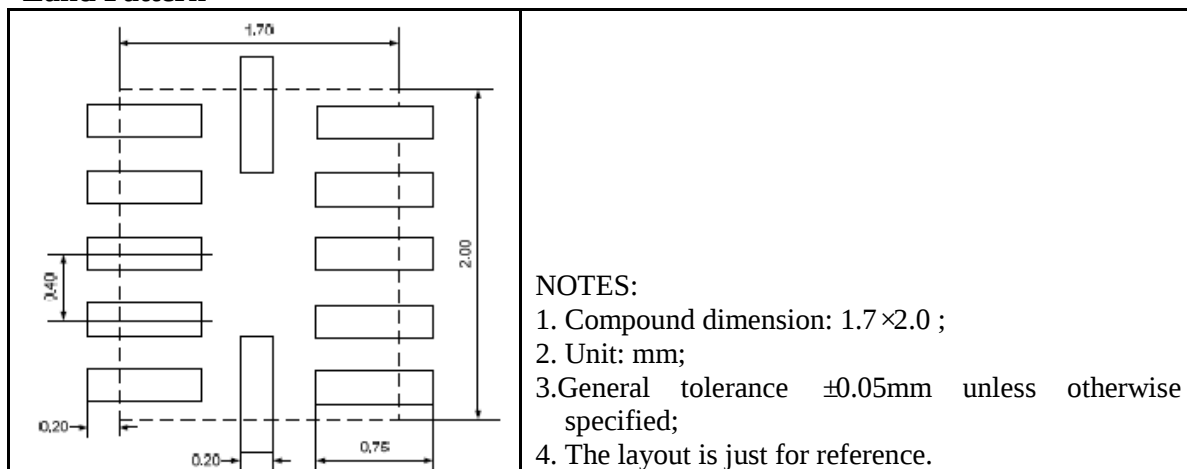


## UM3204QT QFN12 1.7×2.0

### Outline Drawing



### Land Pattern



### Tape and Reel Orientation



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