

## 2D Infrared Object Tracking ASIC

### General Description

uE4002 is an object tracking ASIC for consumer application, which includes up to 4 infrared objects tracking capability and single channel PDM audio output driver. The coordinate data of the infrared object could be obtained via the popular serial interface - UART and I2C.

### Ordering Information

| Order Number  | Package Type | Remark |
|---------------|--------------|--------|
| uE4002ACP1-01 | Wafer w/i CP |        |

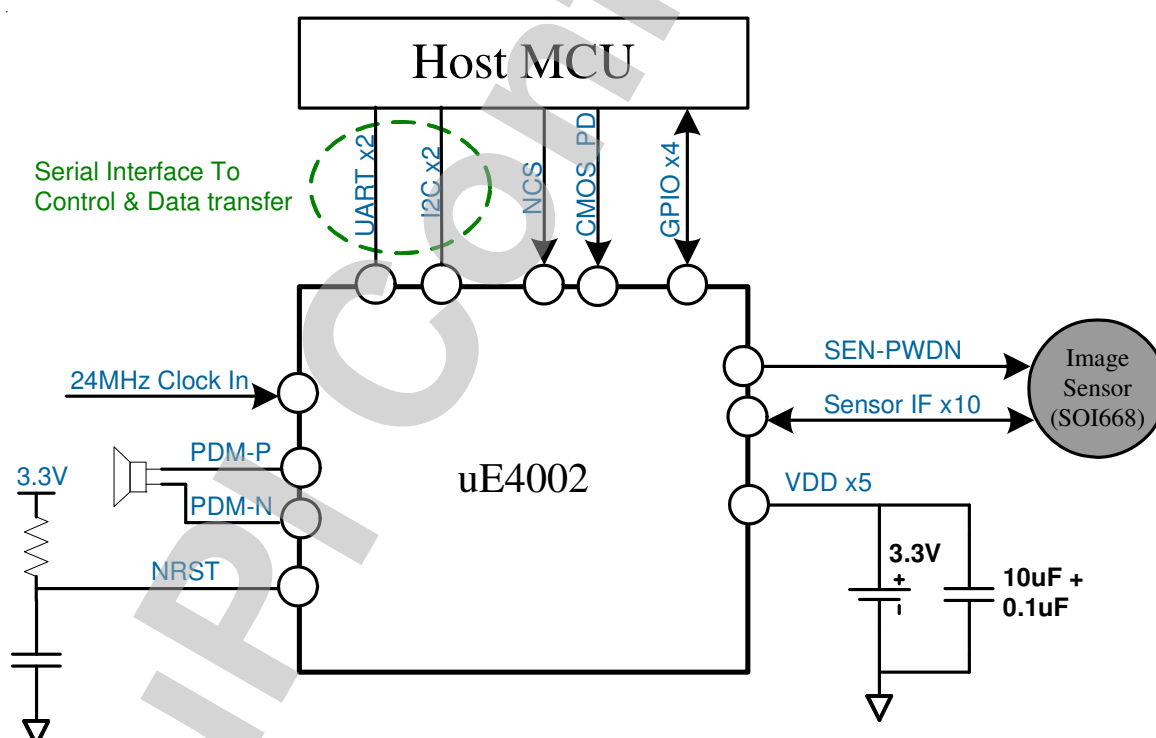
### Applications

- ❑ HID(Human Interface Device) in Computer Area
- ❑ HID(Human Interface Device) in Home Theater
- ❑ Toy Application

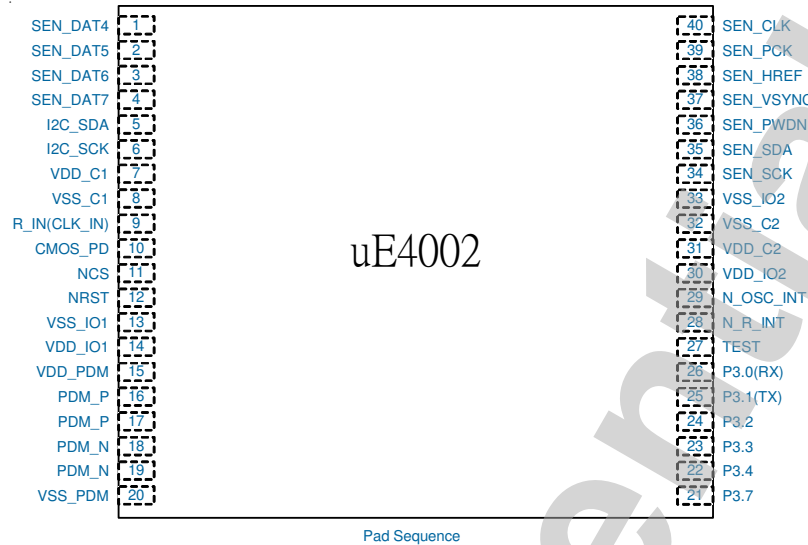
### Features

- ❑ 2D Coordinate Data Output Capability
- ❑ Single Channel PDM Audio Output Driver
- ❑ Coporate with popular SOI668 CMOS CIF (352x288 pixels) Sensor, Control by SCCB (Serial Camera Control Bus)
- ❑ NCS Pin for Power Control
- ❑ Serial Interface - UART and I2C(slave) for Controlling and Coordinate Data Output
- ❑ Wafer/Die Form is Adopted

### Typical Application Circuit



## Pin Configuration



## Functional Pin Description

(IP=Input; OP=Output; IO=Bidirection; PU=Pull-up; PD=Pull-down; TRI=Tri-state)

| No. | Name             | Type   | Pin Function                                                       |
|-----|------------------|--------|--------------------------------------------------------------------|
| 1   | SEN_DAT4         | IP/TRI | Sensor data bus bit-4                                              |
| 2   | SEN_DAT5         | IP/TRI | Sensor data bus bit-5                                              |
| 3   | SEN_DAT6         | IP/TRI | Sensor data bus bit-6                                              |
| 4   | SEN_DAT7         | IP/TRI | Sensor data bus bit-7                                              |
| 5   | I2C_SDA          | IO/TRI | I2C data pin                                                       |
| 6   | I2C_SCK          | IP/TRI | I2C clock pin                                                      |
| 7   | VDD_C1           | Power  | 3.3V core power                                                    |
| 8   | VSS_C1           | Power  | VSS                                                                |
| 9   | R_IN<br>(CLK_IN) | IP     | Resistor connection of internal oscillator or external clock input |
| 10  | CMOS_PD          | IP/PD  | Power down image sensor only [high active]                         |
| 11  | NCS              | IP/PD  | Chip select [low active]                                           |
| 12  | NRST             | IP/PU  | System reset [low active]                                          |
| 13  | VSS_IO1          | Power  | VSS                                                                |
| 14  | VDD_IO1          | Power  | 3.3V I/O power                                                     |
| 15  | VDD_PDM          | Power  | 3.3V PDM power                                                     |

## Functional Pin Description

| No. | Name      | Type  | Pin Function                                                                                                                |
|-----|-----------|-------|-----------------------------------------------------------------------------------------------------------------------------|
| 16  | PDM_P     | OP    | PDM output - positive                                                                                                       |
| 17  | PDM_P     | OP    | PDM output - positive                                                                                                       |
| 18  | PDM_N     | OP    | PDM output - negative                                                                                                       |
| 19  | PDM_N     | OP    | PDM output - negative                                                                                                       |
| 20  | VSS_PDM   | Power | VSS                                                                                                                         |
| 21  | P3.7      | IO    | GPIO - P3.7                                                                                                                 |
| 22  | P3.4      | IO    | GPIO - P3.4                                                                                                                 |
| 23  | P3.3      | IO    | GPIO - P3.3                                                                                                                 |
| 24  | P3.2      | IO    | GPIO - P3.2                                                                                                                 |
| 25  | P3.1 (TX) | IO    | GPIO - P3.1 or transmit pin of UART                                                                                         |
| 26  | P3.0 (RX) | IO    | GPIO - P3.0 or receive pin of UART                                                                                          |
| 27  | TEST      | IP/PD | Test pin                                                                                                                    |
| 28  | N_R_INT   | IP/PD | External/internal resistor connection of internal oscillator<br>High: External resistor<br>Low: Internal resistor (default) |
| 29  | N_OSC_INT | IP/PD | External/internal oscillator selection<br>High: External oscillator<br>Low: Internal oscillator (default)                   |
| 30  | VDD_IO2   | Power | 3.3V I/O power                                                                                                              |
| 31  | VDD_C2    | Power | 3.3V core power                                                                                                             |
| 32  | VSS_C2    | Power | VSS                                                                                                                         |
| 33  | VSS_IO2   | Power | VSS                                                                                                                         |
| 34  | SEN_SCK   | OP/PU | Sensor Serial Camera Control Bus - clock                                                                                    |
| 35  | SEN_SDA   | IO/PU | Sensor Serial Camera Control Bus - data                                                                                     |
| 36  | SEN_PWDN  | OP    | Power-down control of image sensors [high active]                                                                           |
| 37  | SEN_VSYNC | IP    | Sensor VSYNC pin                                                                                                            |
| 38  | SEN_HREF  | IP    | Sensor HREF pin                                                                                                             |
| 39  | SEN_PCK   | IP    | Sensor pixel clock pin                                                                                                      |
| 40  | SEN_CLK   | OP    | Sensor clock pin                                                                                                            |

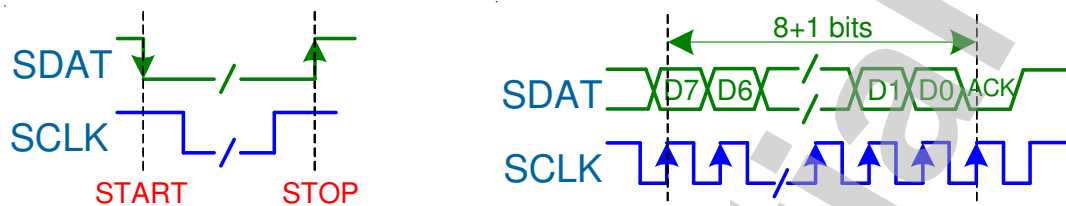
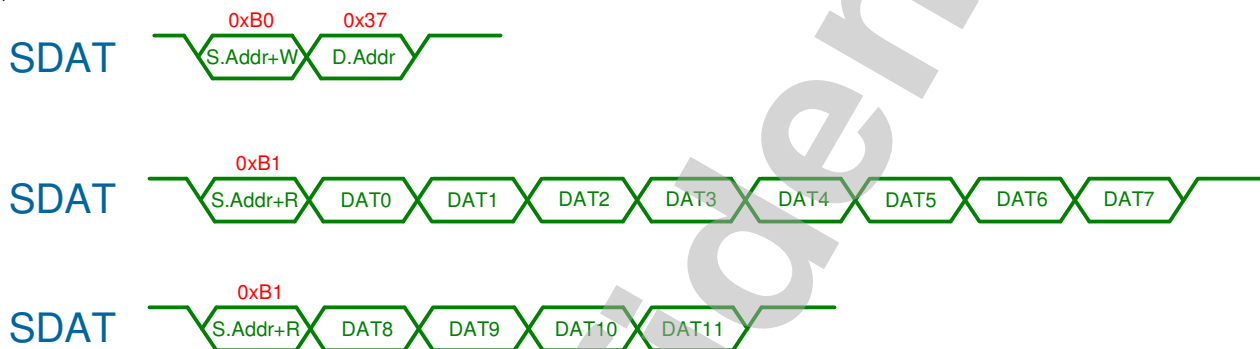


Fig1. I2C (slave) start / stop condition and typical format of one byte



Notes:

- S.Addr+W - Slave Address ( "0x68" - 7bits, MSB) + Write ( "0" )
- S.Addr+R - Slave Address ( "0x68" - 7bits, MSB) + Read ( "1" )
- D.Addr - Data Address of 2D coordinate data ( "0x37" )
- DAT0 ~ Dat7 - The first 8 bytes of coordinate data (max 8 bytes in one packet)
- DAT8 ~ Dat11 - The rest 4 bytes of coordinate data (if exceed 8 bytes)

Fig2. I2C (slave) data flow of coordinate data output

### 1. Coordinate data format & setting:

uE4002 could track 4 infrared objects at most, and it supports 2 kinds of data format - basic mode and extend mode. The way to switch mode is shown below.

a. Basic mode: Write 0x01 (data) to 0x33 (data address), the data length is 10 bytes.

Note: When the object is not shown, the data would be [0xFF, 0xFF, 0x0F/0xF0]

|      | Bit      |   |          |   |          |   |          |   |
|------|----------|---|----------|---|----------|---|----------|---|
| Byte | 7        | 6 | 5        | 4 | 3        | 2 | 1        | 0 |
| 0    | X1 [7:0] |   |          |   |          |   |          |   |
| 1    | Y1 [7:0] |   |          |   |          |   |          |   |
| 2    | Y1 [9:8] |   | X1 [9:8] |   | Y2 [9:8] |   | X2 [9:8] |   |
| 3    | X2 [7:0] |   |          |   |          |   |          |   |
| 4    | Y2 [7:0] |   |          |   |          |   |          |   |
| 5    | X3 [7:0] |   |          |   |          |   |          |   |
| 6    | Y3 [7:0] |   |          |   |          |   |          |   |
| 7    | Y3 [9:8] |   | X3 [9:8] |   | Y4 [9:8] |   | X4 [9:8] |   |
| 8    | X4 [7:0] |   |          |   |          |   |          |   |
| 9    | Y4 [7:0] |   |          |   |          |   |          |   |

b. Extend mode: Write 0x03 (data) to 0x33 (data address), the data length is 12 bytes.

Note: When the object is not shown, the data would be [0xFF, 0xFF, 0xFF]

|      | Bit      |   |          |   |          |   |   |   |
|------|----------|---|----------|---|----------|---|---|---|
| Byte | 7        | 6 | 5        | 4 | 3        | 2 | 1 | 0 |
| 0    | X1 [7:0] |   |          |   |          |   |   |   |
| 1    | Y1 [7:0] |   |          |   |          |   |   |   |
| 2    | Y1 [9:8] |   | X1 [9:8] |   | S1 [3:0] |   |   |   |
| 3    | X2 [7:0] |   |          |   |          |   |   |   |
| 4    | Y2 [7:0] |   |          |   |          |   |   |   |
| 5    | Y2 [9:8] |   | X2 [9:8] |   | S2 [3:0] |   |   |   |
| 6    | X3 [7:0] |   |          |   |          |   |   |   |
| 7    | Y3 [7:0] |   |          |   |          |   |   |   |
| 8    | Y3 [9:8] |   | X3 [9:8] |   | S3 [3:0] |   |   |   |
| 9    | X4 [7:0] |   |          |   |          |   |   |   |
| 10   | Y4 [7:0] |   |          |   |          |   |   |   |
| 11   | Y4 [9:8] |   | X4 [9:8] |   | S4 [3:0] |   |   |   |

c. Extend mode: Write 0x05 (data) to 0x33 (data address), the data length is 36 bytes.

|      | Bit              |             |          |   |          |   |   |   |
|------|------------------|-------------|----------|---|----------|---|---|---|
| Byte | 7                | 6           | 5        | 4 | 3        | 2 | 1 | 0 |
| 0    | X1 [7:0]         |             |          |   |          |   |   |   |
| 1    | Y1 [7:0]         |             |          |   |          |   |   |   |
| 2    | Y1 [9:8]         |             | X1 [9:8] |   | S1 [3:0] |   |   |   |
| 3    | 0                | X1_min[6:0] |          |   |          |   |   |   |
| 4    | 0                | Y1_min[6:0] |          |   |          |   |   |   |
| 5    | 0                | X1_max[6:0] |          |   |          |   |   |   |
| 6    | 0                | Y1_max[6:0] |          |   |          |   |   |   |
| 7    | 0                |             |          |   |          |   |   |   |
| 8    | Intensity1 [7:0] |             |          |   |          |   |   |   |
| 9    | X2 [7:0]         |             |          |   |          |   |   |   |
| 10   | Y2 [7:0]         |             |          |   |          |   |   |   |
| 11   | Y2 [9:8]         |             | X2 [9:8] |   | S2 [3:0] |   |   |   |
| 12   | 0                | X2_min[6:0] |          |   |          |   |   |   |
| 13   | 0                | Y2_min[6:0] |          |   |          |   |   |   |
| 14   | 0                | X2_max[6:0] |          |   |          |   |   |   |
| 15   | 0                | Y2_max[6:0] |          |   |          |   |   |   |
| 16   | 0                |             |          |   |          |   |   |   |
| 17   | Intensity2 [7:0] |             |          |   |          |   |   |   |
| 18   | X3 [7:0]         |             |          |   |          |   |   |   |
| 19   | Y3 [7:0]         |             |          |   |          |   |   |   |
| 20   | Y3 [9:8]         |             | X3 [9:8] |   | S3 [3:0] |   |   |   |
| 21   | 0                | X3_min[6:0] |          |   |          |   |   |   |
| 22   | 0                | Y3_min[6:0] |          |   |          |   |   |   |
| 23   | 0                | X3_max[6:0] |          |   |          |   |   |   |
| 24   | 0                | Y3_max[6:0] |          |   |          |   |   |   |
| 25   | 0                |             |          |   |          |   |   |   |
| 26   | Intensity3 [7:0] |             |          |   |          |   |   |   |
| 27   | X4 [7:0]         |             |          |   |          |   |   |   |
| 28   | Y4 [7:0]         |             |          |   |          |   |   |   |
| 29   | Y4 [9:8]         |             | X4 [9:8] |   | S4 [3:0] |   |   |   |
| 30   | 0                | X4_min[6:0] |          |   |          |   |   |   |
| 31   | 0                | Y4_min[6:0] |          |   |          |   |   |   |
| 32   | 0                | X4_max[6:0] |          |   |          |   |   |   |
| 33   | 0                | Y4_max[6:0] |          |   |          |   |   |   |
| 34   | 0                |             |          |   |          |   |   |   |
| 35   | Intensity4 [7:0] |             |          |   |          |   |   |   |

## 2. 2D coordinate data sensitivity setting:

uE4002 could adjust the sensitivity level from 1 to 5. The way to set it is shown in the table below. The 12 bytes data are separated into two blocks, block-1 is started from data address [0x00], and block-2 is started from data address [0x1A]. Means that if host want to set the sensitivity level to level-3, the programming flow should be:

[0xB0], [0x00], [0x02], [0x00], [0x00], [0x71], [0x01], [0x00], [0xAA]

[0xB0], [0x07], [0x00], [0x64]

[0xB0], [0x1A], [0x63], [0x03]

Note: The first byte [0xB0] is slave address (write), 2nd byte is the data address, and the rest are the actual data.

|       | Block-1 |      |      |      |      |      |      |      |      | Block-2 |      |
|-------|---------|------|------|------|------|------|------|------|------|---------|------|
| Level | 0       | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9       | 11   |
| 1     | 0x02    | 0x00 | 0x00 | 0x71 | 0x01 | 0x00 | 0x64 | 0x00 | 0xFE | 0xFD    | 0x05 |
| 2     | 0x02    | 0x00 | 0x00 | 0x71 | 0x01 | 0x00 | 0x96 | 0x00 | 0xB4 | 0xB3    | 0x04 |
| 3     | 0x02    | 0x00 | 0x00 | 0x71 | 0x01 | 0x00 | 0xAA | 0x00 | 0x64 | 0x63    | 0x03 |
| 4     | 0x02    | 0x00 | 0x00 | 0x71 | 0x01 | 0x00 | 0xC8 | 0x00 | 0x36 | 0x35    | 0x03 |
| 5     | 0x07    | 0x00 | 0x00 | 0x71 | 0x01 | 0x00 | 0x72 | 0x00 | 0x20 | 0x1F    | 0x03 |

## Absolute Maximum Rating

(T<sub>A</sub> = 25 °C)

|                                           |                 |
|-------------------------------------------|-----------------|
| System Power Supply Voltage, VDD (Note 1) | -0.5V to +5V    |
| Control Input Voltage, V <sub>IN</sub>    | -0.5V to +VDD   |
| Power Consumption, P <sub>D</sub>         | TBD             |
| Operating Temperature, T <sub>OPR</sub>   | 0°C to +85°C    |
| Storage Temperature, T <sub>STG</sub>     | -20°C to +125°C |
| Junction Temperature                      | 150°C           |
| ESD Rating (Note 2)                       |                 |
| HBM (Human Body Mode)                     | 2kV             |

## Recommended Operation Conditions

(T<sub>A</sub> = 25 °C)

|                                         |                  |
|-----------------------------------------|------------------|
| System Power Supply Voltage, VDD        | +3.0V to +3.6V   |
| Control Input Voltage, V <sub>IN</sub>  | 0V to VDD        |
| Output Loading, C <sub>OUT</sub>        | 32pF(Max)        |
| Output Driving, I <sub>OUT</sub>        | 4mA(Max)         |
| System Dock Frequency, F <sub>SYS</sub> | 24MHz(Typ)       |
| UART Baud Rate, BR <sub>UART</sub>      | 128Kbps(Typ)     |
| I2C Clock Frequency, F <sub>I2C</sub>   | 100kHz to 400kHz |

**Note 1.** Stresses listed above “Absolute Maximum Ratings” may cause permanent damage to the device. These are for stress ratings. 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 remain possibility to affect device reliability.

**Note 2.** Devices are ESD sensitive. Handling precaution recommended.

**Note 3.** The device is not guaranteed to function outside its operating conditions.

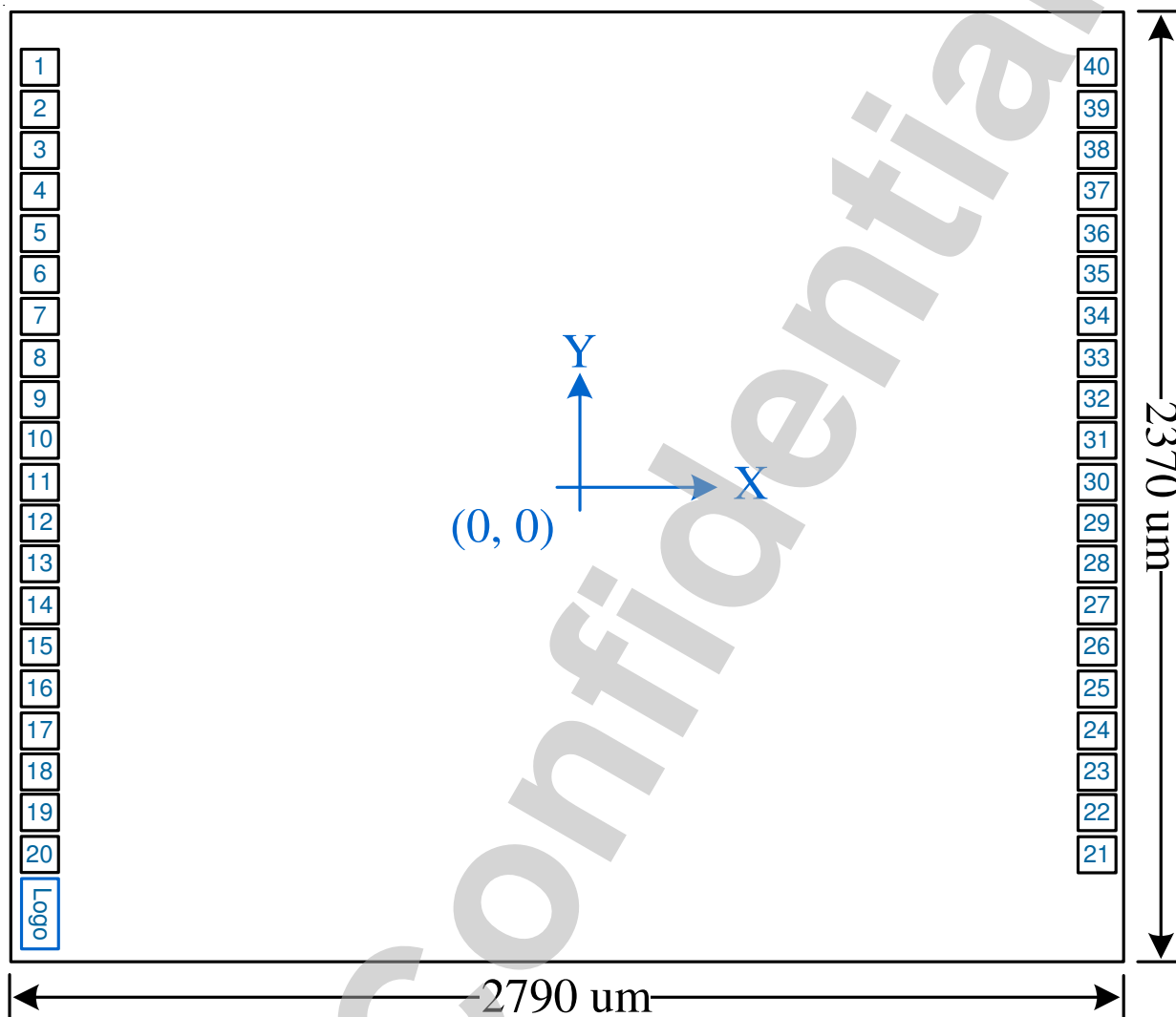
## Electrical Characteristics

( $T_A = 25\text{ }^{\circ}\text{C}$ ,  $V_{DD}=3.3\text{V}$ , unless otherwise specified)

| Parameter                       | Symbol      | Test Conditions                                       | Min                 | Typ | Max                 | Unit             |
|---------------------------------|-------------|-------------------------------------------------------|---------------------|-----|---------------------|------------------|
| <b>Power Supply Current</b>     |             |                                                       |                     |     |                     |                  |
| VDD Power Down Current          | $I_{PD}$    | NCS pin pull to high<br>(internal OSC and internal R) | --                  | 15  | 20                  | $\mu\text{A}$    |
| VDD Operation Current           | $I_{OP}$    | Normal operation<br>(internal OSC and internal R)     | --                  | 27  | 30                  | mA               |
| <b>Input Pins</b>               |             |                                                       |                     |     |                     |                  |
| Input Voltage High Level        | $V_{IH}$    |                                                       | $0.7 \times V_{DD}$ | --  | VDD                 | V                |
| Input Voltage Low Level         | $V_{IL}$    |                                                       | 0                   | --  | $0.3 \times V_{DD}$ | V                |
| Input Current High Level        | $I_{IH}$    |                                                       | -70                 | --  | 70                  | $\mu\text{A}$    |
| Input Current Low Level         | $I_{IL}$    |                                                       | -70                 | --  | 70                  | $\mu\text{A}$    |
| Pull-high / Pull-low Resistance | $R_{IN}$    |                                                       | --                  | 50  | --                  | $\text{k}\Omega$ |
| <b>Serial Interface</b>         |             |                                                       |                     |     |                     |                  |
| I2C Clock Frequency             | $F_{I2C}$   |                                                       | 100                 | --  | 400                 | kHz              |
| UART Baud Rate                  | $BR_{UART}$ |                                                       | --                  | 128 | --                  | kbps             |
| <b>Sensor Interface</b>         |             |                                                       |                     |     |                     |                  |
| Sensor Serial Clock             | $F_{SCK}$   |                                                       | --                  | 400 | --                  | kHz              |
| Sensor Clock                    | $F_{SEN}$   |                                                       | --                  | 12  | --                  | MHz              |

## Package Information

uE4002 does not have package form, provided by die form only. The information of dimension and pad location of uE4002 is listed below.



| PAD | Name          | Location |         | PAD | Name      | Location |         |
|-----|---------------|----------|---------|-----|-----------|----------|---------|
|     |               | X (um)   | Y (um)  |     |           | X (um)   | Y (um)  |
| 1   | SEN_DAT4      | -1281.5  | 1021.15 | 21  | P3.7      | 1281.5   | -878.85 |
| 2   | SEN_DAT5      | -1281.5  | 921.15  | 22  | P3.4      | 1281.5   | -778.85 |
| 3   | SEN_DAT6      | -1281.5  | 821.15  | 23  | P3.3      | 1281.5   | -678.85 |
| 4   | SEN_DAT7      | -1281.5  | 721.15  | 24  | P3.2      | 1281.5   | -578.85 |
| 5   | I2C_SDA       | -1281.5  | 621.15  | 25  | P3.1 (TX) | 1281.5   | -478.85 |
| 6   | I2C_SCK       | -1281.5  | 521.15  | 26  | P3.0 (RX) | 1281.5   | -378.85 |
| 7   | VDD_C1        | -1281.5  | 421.15  | 27  | TEST      | 1281.5   | -278.85 |
| 8   | VSS_C1        | -1281.5  | 321.15  | 28  | N_R_INT   | 1281.5   | -178.85 |
| 9   | R_IN (CLK_IN) | -1281.5  | 221.15  | 29  | N_OSC_INT | 1281.5   | -78.85  |
| 10  | CMOS_PD       | -1281.5  | 121.15  | 30  | VDD_IO2   | 1281.5   | 21.15   |
| 11  | NCS           | -1281.5  | 21.15   | 31  | VDD_C2    | 1281.5   | 121.15  |
| 12  | NRST          | -1281.5  | -78.85  | 32  | VSS_C2    | 1281.5   | 221.15  |
| 13  | VSS_IO1       | -1281.5  | -178.85 | 33  | VSS_IO2   | 1281.5   | 321.15  |
| 14  | VDD_IO1       | -1281.5  | -278.85 | 34  | SEN_SCK   | 1281.5   | 421.15  |
| 15  | VDD_PDM       | -1281.5  | -378.85 | 35  | SEN_SDA   | 1281.5   | 521.15  |
| 16  | PDM_P         | -1281.5  | -478.85 | 36  | SEN_PWDN  | 1281.5   | 621.15  |
| 17  | PDM_P         | -1281.5  | -578.85 | 37  | SEN_VSYNC | 1281.5   | 721.15  |
| 18  | PDM_N         | -1281.5  | -678.85 | 38  | SEN_HREF  | 1281.5   | 821.15  |
| 19  | PDM_N         | -1281.5  | -778.85 | 39  | SEN_PCK   | 1281.5   | 921.15  |
| 20  | VSS_PDM       | -1281.5  | -878.85 | 40  | SEN_CLK   | 1281.5   | 1021.15 |