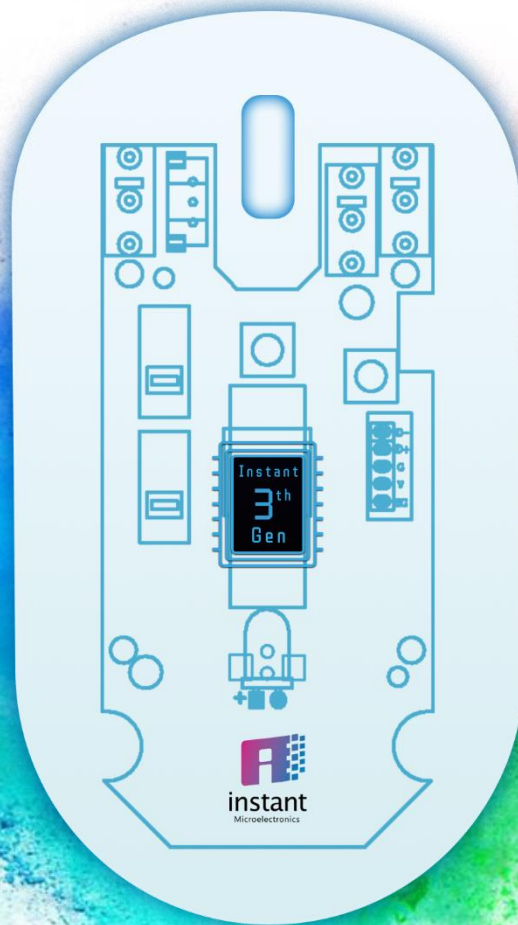


# Instant

## **A704E** USB Optic Mouse

### ***DATASHEET***



Instant Microelectronics Co., Ltd.

Version: V1.02

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## 1. General Description

A704E is a high performance single chip CMOS process optical mouse sensor. This chip solution is used to implement a non-mechanical tracking engine for USB computer mouse.

A704E is based on algorithm which measures changes of sequential surface images and then determines the movement. It has the basic mouse function (L/M/R button, X/Y motion and Z axis wheel) and additional support for some advanced functions (with driver). A704E supports 4-level CPI resolution (800/1200/1600/2400).

A704E is in a 14-pin optical DIP package. It has a built-in LED driver and internal oscillator to minimize the external components.

## 2. Feature

- Optical Navigation Technology,
- Compliant with USB2.0 and USB HID Specification V1.1.
- Support Winxp/Win2003/Win2008/Vista/Win7/Win8/Win10/Linux system, MAC OS, and Android system
- 5V Power Supply, Internal crystal-less oscillator and on-chip LED Driver
- Supports L/M/R/B4/ B5 buttons and X/Y/Z three axis
- Supports three additional multi-function keys: Boss, DB and Fire (see Section 6.2 for details)
- Supports 4-level resolution (800/1200/1600/2400) ,the default is 800
- Supports Single and Double CPI mode
- Supports 4-level brightness of LED to indicate 4-level CPI
- Supports 4-Color LED indicator to match with each CPI resolution
- Backlight LED Mode (4-Color Breathing, Color-locked Breathing, MUTE) can be switched by combination button K4/K5+CPI/CPI-
- IDIP-14 package and RoHS Compliant

### 3. Pin Assignment

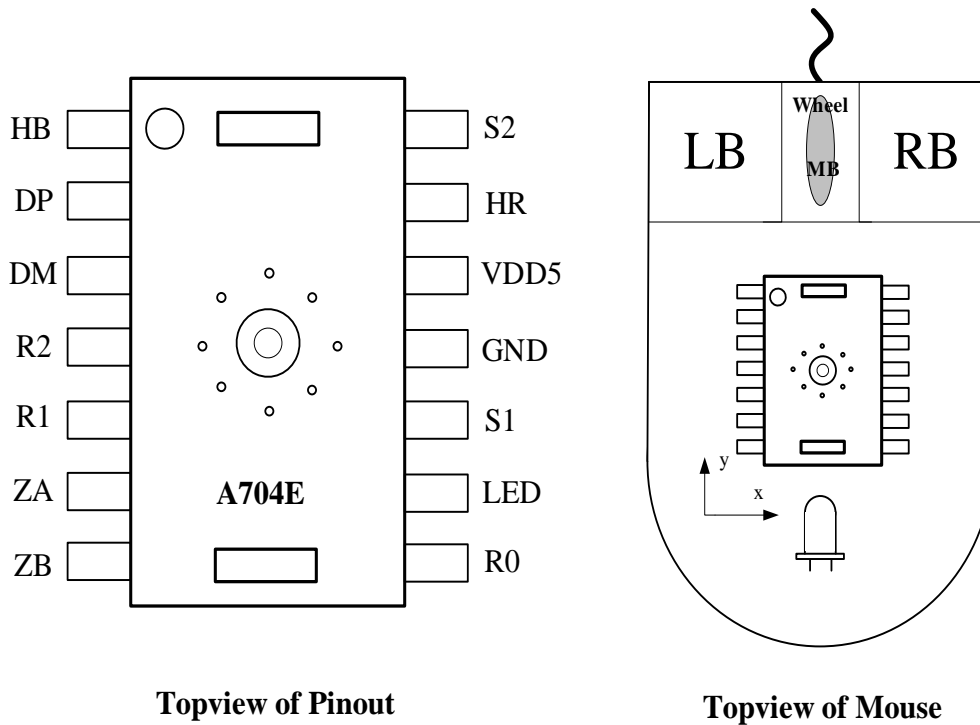


Figure 1. Pinout

### 4. Pin Description

| Pin No. | Pin Name | Type   | Description                                       |
|---------|----------|--------|---|
| 1       | HB       | OUT    | Backlight LED output. Blue LED driver             |
| 2       | DP       | IN/OUT | USB D+  |
| 3       | DM       | IN/OUT | USB D-  |
| 4       | R2       | IN     | Button array scan in, Single or double CPI select |
| 5       | R1       | IN     | Button array scan in                              |
| 6       | ZA       | IN     | Z axis in   |
| 7       | ZB       | IN     | Z axis in   |
| 8       | R0       | IN     | Button array scan in                              |
| 9       | LED      | OUT    | LED open drain output                             |
| 10      | S1       | OUT    | Button array scan out                             |
| 11      | GND      | GND    | GROUND  |
| 12      | VDD5     | POWER  | Power 5v input                                    |
| 13      | HR       | OUT    | Backlight LED output. Red LED driver              |
| 14      | S2       | OUT    | Button array scan out                             |

## 5. Block Diagram

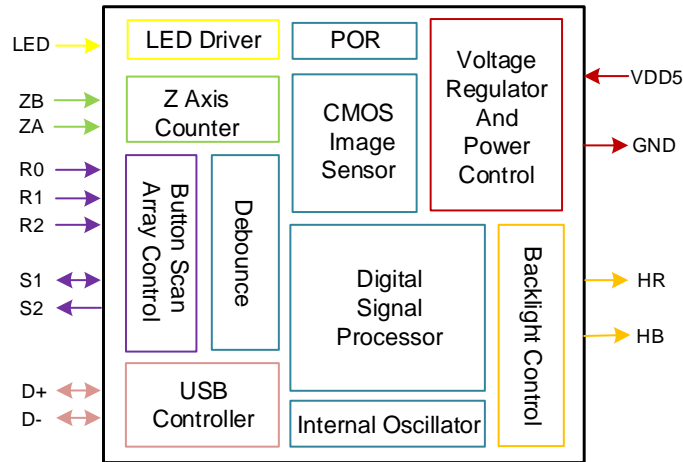


Figure 2. Block Diagram

## 6. Function Description

### 6.1 Button Array

The location of the keys in the array:

| PIN | GND | S1 | S2 |
|-----|-----|----|----|
| R0  | K1  | K4 | K7 |
| R1  | K2  | K5 | K8 |
| R2  | K3  | K6 | K9 |

The functions of the buttons are show in the table below. In Double CPI Mode, there are two CPI related buttons (CPI-/CPI+). While in Single CPI Mode, only one CPI related button (CPI).

| Key | Single CPI Mode | Double CPI Mode |
|-----|-----------------|-----------------|
| K1  | L               | L               |
| K2  | M               | M               |
| K3  | R               | R               |
| K4  | B4 (Backward)   | B4(Backward)    |
| K5  | B5 (Forward)    | B5 (Forward)    |
| K6  | CPI             | CPI-            |
| K7  | BOSS            | BOSS            |
| K8  | DOUBLE          | CPI+            |
| K9  | FIRE            | FIRE            |

*Note:* 1. When R2 has no pull-up resistance to power supply, the mouse is in single CPI mode. .  
 2. When R2 has pull-up resistance to power supply, the mouse is in dual CPI mode.

## 6.2 Special Keys

| Key Name    | Function Description   |
|-------------|--|
| <b>BOSS</b> | Switch between the current application screen and desktop                      |
| <b>DB</b>   | A pressing is equivalent to double click                                       |
| <b>FIRE</b> | Pressing down this button is equivalent to continuing to click the left button |

## 6.3 Driver Mode

A704E supports extra advanced customized functions in driver mode. Through the driver, a special application programmer, A704E can provide more controls and customized functions (such as multimedia, more CPI levels, MACRO, etc.). See the driver Application Manual for details.

## 6.4 CPI setting

### 6.4.1 CPI Sets and Selection

A704E supports 4-level resolution, the default is 800. The CPI level can be switched via pressing CPI related buttons (CPI /CPI-/CPI+).

- In Single CPI mode: CPI can be switched by CPI button in the following order:  
800(def)->1200->2000->2400->800
- In Double CPI mode: CPI can be switched to 2400 by CPI+ button and 800 by CPI- button

### 6.4.2 LED Indicator For CPI-Level

| CPI-Level | 4-Color Breathing LED |     |        | Single-Color LED |
|-----------|-----------------------|-----|--------|------------------|
|           | HR                    | HB  | Color  | Brightness       |
| 800       | Off                   | On  | Blue   | Off              |
| 1200      | On                    | On  | Pink   | Weak             |
| 1600      | On                    | Off | Red    | Middle           |
| 2400      | On/2                  | On  | Purple | Strong           |

Note: On/2 is half of full brightness, and the color refer to RB(red and blue) LED.

## 6.5 Backlight LED

### 6.5.1 LED Mode

A704E has 3 kinds of LED effects (mode): 4-Color Breathing, FIX-Color Breathing, MUTE. User can switch LED mode by pressing a combination button (B4/B5+CPI/CPI-), the switching sequence is: 4-Color Breathing → Color-locked Breathing → MUTE → 4-Color Breathing.

In 4-Color Breathing mode, backlight LED breathes in up to 4 colors, and may change one color after a breathing cycle. And in Color-locked Breathing mode, backlight LED breathes in the color which LED breathes in when the mode switching (from 4-Color Breathing to this mode) happens. In MUTE, LED is off.

In 4-Color Breathing mode, when CPI level switching happens, backlight LED will show as CPI indicator in the matched color for 6 seconds and then return to 4-Color Breathing mode. While in Color-locked Breathing mode, backlight LED will flash 1~4 times to represent CPI level1~level4 correspondingly when CPI switching, but will not change color. In MUTE mode, LED will keep the light off whether CPI is changed or not.

### 6.5.2 LED Components Selected

In A704E, common anode LEDs must be used. In addition to the recommend color matching method (see Section 6.4), A704E also supports the following color matching methods:

If using RG (red and green) LED, HR is connected to LED's red pin, HB is connected to LED's green pin, the 4-Color sequence is: green, yellow, red, chartreuse.

| 4-Color Breathing LED |     |            |
|-----------------------|-----|------------|
| HR                    | HG  | Color      |
| Off                   | On  | Green      |
| On                    | On  | Yellow     |
| On                    | Off | Red        |
| On/2                  | On  | Chartreuse |

*Note: The recommend color matching method is used in the circuit of Section 9.*

## 7. Electrical Characteristics

### 7.1 Absolute Maximum Rating

| Parameters              | Symbol           | Min  | Max | Unit | Notes                      |
|-------------------------|------------------|------|-----|------|----------------------------|
| Supply Voltage          | VDD              | -0.5 | 5.5 | V    |                            |
| Operating Temperature   | To               | -15  | 55  | °C   |                            |
| Storage Temperature     | Ts               | -40  | 85  | °C   |                            |
| Lead Solder Temperature |                  |      | 260 | °C   |                            |
| Input Voltage           | V <sub>in</sub>  | -0.5 | 5.5 | V    |                            |
| ESD                     | V <sub>ESD</sub> |      | 2   | KV   | All pins, Human Body Model |

## 7.2 Recommend Operating Conditions

| Parameter   | Symbol         | Min | Typical | Max  | Units    |
|---|----------------|-----|---------|------|----------|
| Supply Voltage  | VDD            | 4.5 | 5.0     | 5.5  | V        |
| Operating Temperature                                   | T <sub>A</sub> | 0   | 25      | 40   | °C       |
| System Clock  | CLK            | 22  | 24      | 26   | MHz      |
| Speed   | S              | -   | -       | 40   | Inch/Sec |
| Resolution  | R              | 800 | 1200    | 2400 | CPI      |
| Acceleration  | A              | -   | -       | 10   | G        |
| Frame Rate  | Fr             | -   | -       | 4000 | fps      |
| Distance from the Bottom of Lens to the Working Surface | Z              | 2.1 | 2.2     | 2.3  | mm       |

## 7.3 DC Electrical Characteristic (VDD = 5.0V, Temperature = 25°C)

| Parameter                      | Symbol           | Min | Typical | Max | Units |
|--------------------------------|------------------|-----|---------|-----|-------|
| Supply Current(Motion)         | I <sub>DD</sub>  | -   | 16.5    | -   | mA    |
| Supply Current(Static)         | I <sub>DD1</sub> | -   | 7.8     | -   | mA    |
| Input Voltage High(Input port) | V <sub>IH1</sub> | 2.0 | -       | -   | V     |
| Input Voltage Low(Input port)  | V <sub>IL1</sub> | -   | -       | 0.8 | V     |
| Input Voltage High(I/O port)   | V <sub>IH2</sub> | 2.0 | -       | -   | V     |
| Input Voltage Low(I/O port)    | V <sub>IL2</sub> | -   | -       | 0.8 | V     |
| Output Voltage High(I/O port)  | V <sub>OH1</sub> | 2.8 | -       | 3.6 | V     |
| Output Voltage Low(I/O port)   | V <sub>OL1</sub> | 0   | -       | 0.3 | V     |

## 7.4 AC Electrical Characteristic (VDD = 5.0V, Temperature = 25 °C)

| Parameter                          | Symbol            | Min | Typical | Max  | Units | Notes                    |
|------------------------------------|-------------------|-----|---------|------|-------|--------------------------|
| Internal Ring Oscillator Frequency | F <sub>ROSC</sub> |     | 10      |      | khz   |                          |
| Power-Up Reset delay               | T <sub>PU</sub>   | -   | 10      | -    | us    | POR signal from 0 to 3.5 |
| Debounce Time on Button            | T <sub>DB</sub>   | 9.5 | 11.5    | 13.5 | ms    |                          |
| Z-axis Sampling Time               | T <sub>Z</sub>    | -   | 125     | -    | us    |                          |



## 8. Sensor Pixel Array Mapping

|     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 | 320 | 321 | 322 | 323 |
| 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 | 300 | 301 | 302 | 303 | 304 | 305 |
| 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 | 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 |
| 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 | 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 |
| 234 | 235 | 236 | 237 | 238 | 239 | 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 |
| 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 |
| 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 |
| 180 | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 |
| 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 |
| 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 |
| 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 |
| 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 |
| 90  | 91  | 92  | 93  | 94  | 95  | 96  | 97  | 98  | 99  | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 |
| 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 80  | 81  | 82  | 83  | 84  | 85  | 86  | 87  | 88  | 89  |
| 54  | 55  | 56  | 57  | 58  | 59  | 60  | 61  | 62  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 70  | 71  |
| 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 50  | 51  | 51  | 53  |
| 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  |
| 0   | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  |

## 9. Typical Application Circuit

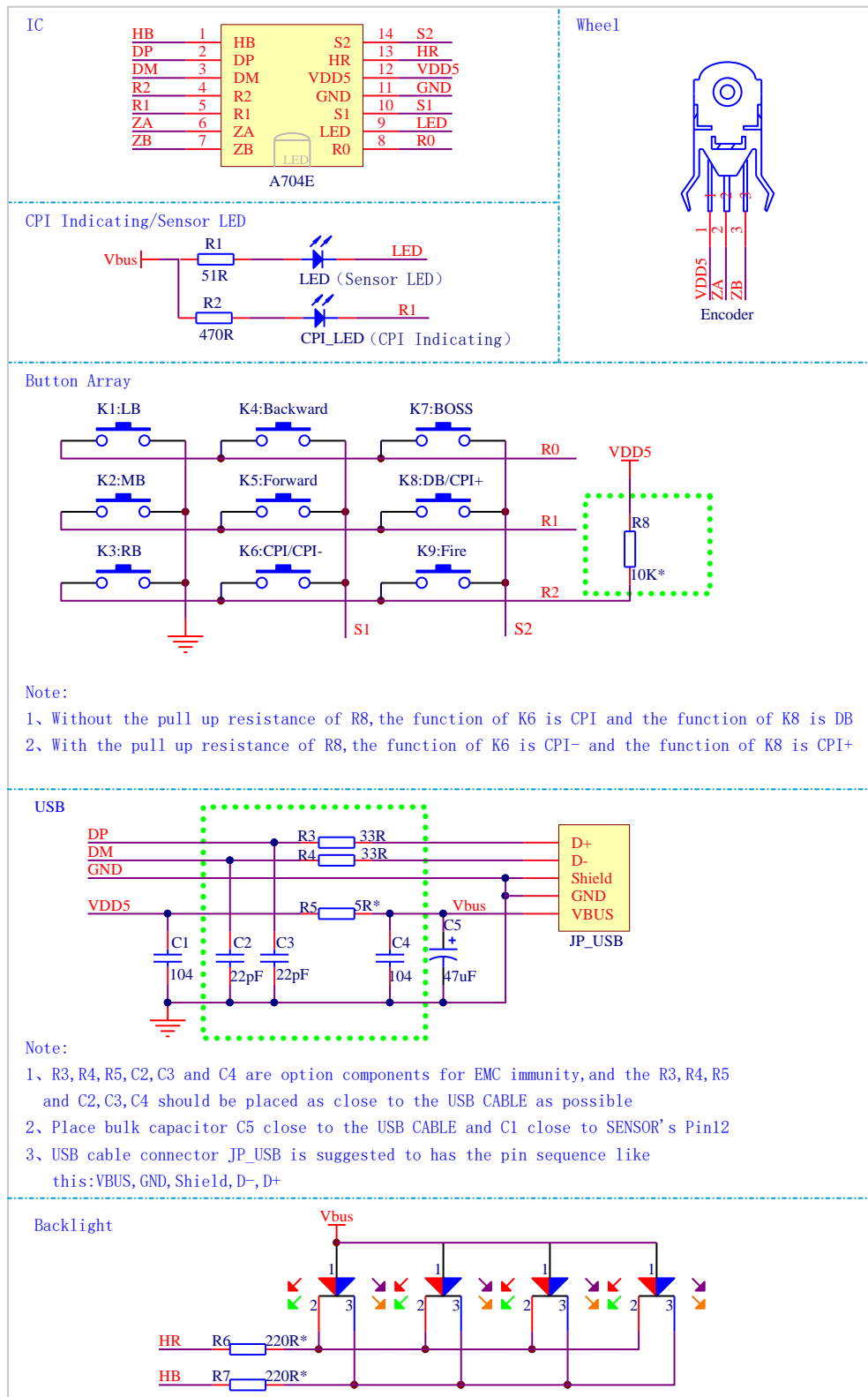
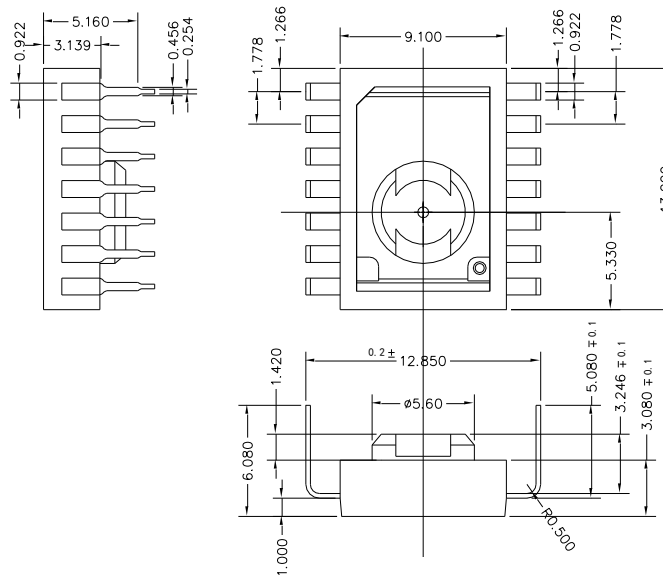


Figure 3. Application Circuit

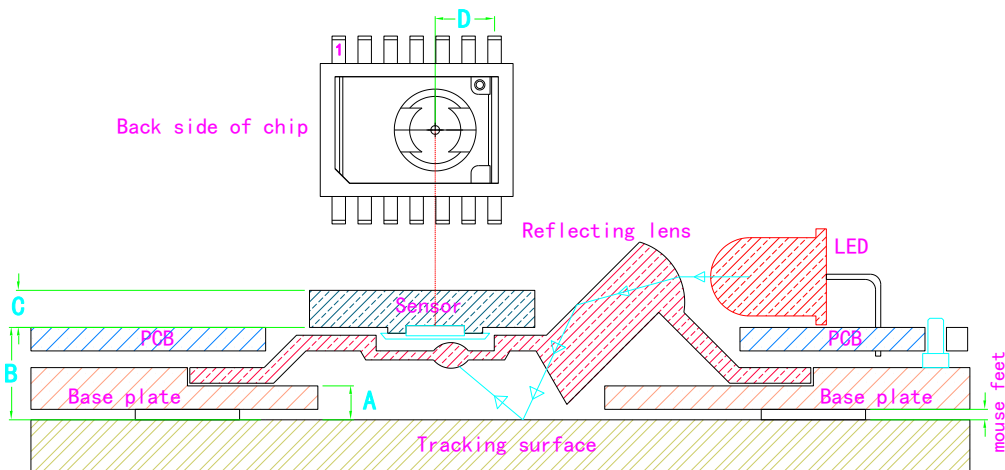
## 10. Package



Note: Unit: mm

Figure 4. Package Outline Drawing

## 11. Assembly Drawing



| 符号 | 说明  | 最小    | 典型    | 最大    | 单位 |
|----|---|-------|-------|-------|----|
| A  | Lens reference plane to tracking surface (Z-Height) | 2.1   | 2.2   | 2.3   | mm |
| B  | Top of PCB to tracking surface                      | 7.3   | 7.5   | 7.7   | mm |
| C  | Chip Thickness                                      | 2.980 | 3.080 | 3.180 | mm |
| D  | Optical center to chip's pin7                       | -     | 4.064 | -     | mm |

Figure 5. Assembly drawing of A704E

## 12. Revision History

| Version             | Description   | Date       |
|---------------------|---|------------|
| A704E_SPEC_EN.V1.00 | Create Preliminary Version                                  | 2019/07/18 |
| A704E_SPEC_EN.V1.01 | Modify the encoder 1 pin in the application circuit to VDD5 | 2019/12/25 |
| A704E_SPEC_EN.V1.02 | Modify the Application Circuit and Assembly drawing         | 2021/06/30 |