



# AK7864A

3 channel LED driver with Charge Pump

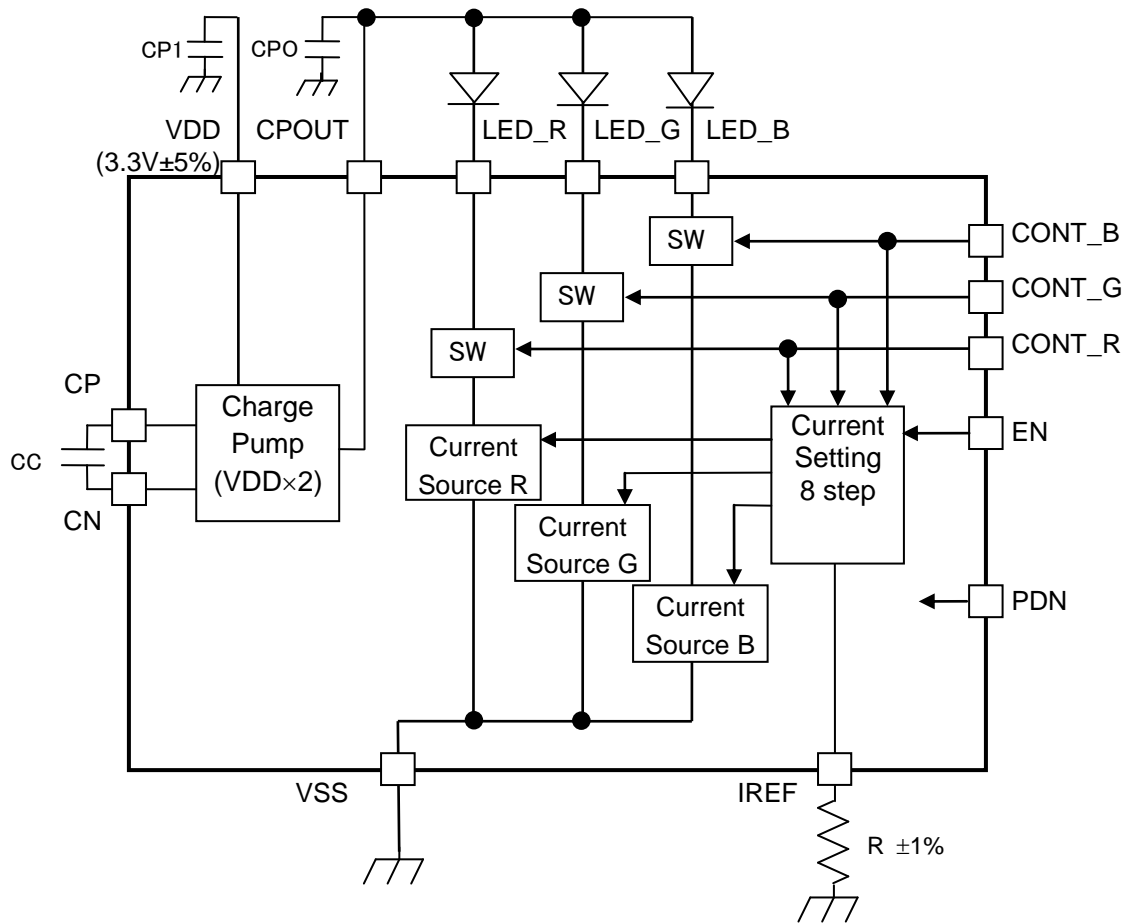
## Device Outline

This product includes the charge pump power supply and the 3 channel LED driver who drives the LED of the anode common in the constant current. The current to pass for each channel can be adjusted by the external resistance and the register setting. Also, it has the control pins which turn on or off the current. It is the suitable for the LED drive for the CIS sensor.

## Features

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>■ Operating Voltage</li> <li>■ Operating Temperature Range</li> <li>■ LED Driver Current</li> </ul>                                  | <p>3.3V±5%</p> <p>0 ~ 70 °C</p> <p>RED: 66mA</p> <p>GREEN: 66mA</p> <p>BLUE: 66mA</p> <p>The LED current is adjustable from 22mA to 66mA by the external resistor. In addition, the LED current can be reduced to 100%~12.5% by the register.</p> <p>Allowable maximum Vf of the LED is 4.8V. The 1/16 watt type is usable to external resistor.</p> <ul style="list-style-type: none"> <li>● 3 channel independently ON/OFF<br/>(50% setting is an upper bound when 3ch becoming turning on at the same time)</li> <li>● Current setting in eight steps</li> </ul> <p>When the external resistance value becomes the assumption outside, a internal protection circuit restricts the LED current equal to or less than 150mA (-30%~+45%)</p> |
| <ul style="list-style-type: none"> <li>■ Current Accuracy</li> <li>■ LED Current Rise / Fall time</li> <li>■ Charge Pump Preprocessor Circuit</li> <li>■ Package</li> </ul> | <p>±9.1% (by ideal resistance)</p> <p>10μs (typ.) (10% ~ 90%)</p> <p>Generate the necessary voltage for the LED (Vf max 4.8V)</p> <p>16pin QFN 3mm×3mm, 0.75mm thickness with radiation TAB in solderside</p>   |
| <ul style="list-style-type: none"> <li>■ Power Supply</li> <li>■ Application</li> </ul>   | <p>VDD 3.135 ~ 3.465V</p> <p>A light source driver for CIS module of MFP</p>  |

### Block Diagram



### Circuit Block Description

#### □ Charge Pump Circuit

A necessary voltage for LED ( $V_f$  4.8V or less) lighting is generated from the voltage supplied to VDD pin. Please supply the generated voltage from CPOUT pin to external LED.

#### □ LED Driver Part

This product has 3 channel LED driver to drive RGB constant current. Use the ON/ OFF digital terminal to control the constant current.

The current setting can be set to 8 levels (100%/87.5%/75%/62.5%/50%/37.5%/25%/12.5%) with CONT\_R/G/B and EN combination. The current of 3 channels are same.

It is possible to light 1ch or 3ch simultaneously. Please set the LED current less than 50% by 3ch simultaneously.

|                               |
|-------------------------------|
| <b>Functional Description</b> |
|-------------------------------|

 **Power Down**

Set PDN to Low at VDD power on, AK7864A will be in power down state.

In power down state, the current inside AK7864A will be stopped, LED\_R/G/B will be High-Z and CPOUT will be Low.

 **Circuit reset**

PDN is also carrying out the reset of an internal counter, please start supplying VDD to AK7864A by PDN=Low.

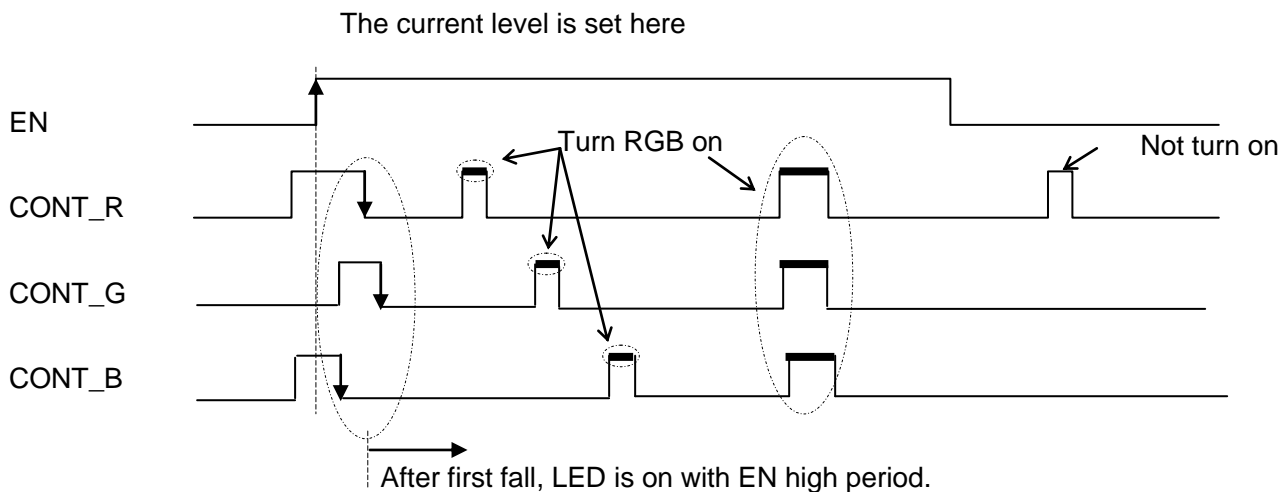
The period of soft start of charge pump is decided at the internal counter.

When soft start does not operate correctly, at the time of starting, incoming current will be large and the device may break.

□ **Current setting method**

The method of setting the LED current is as follows.

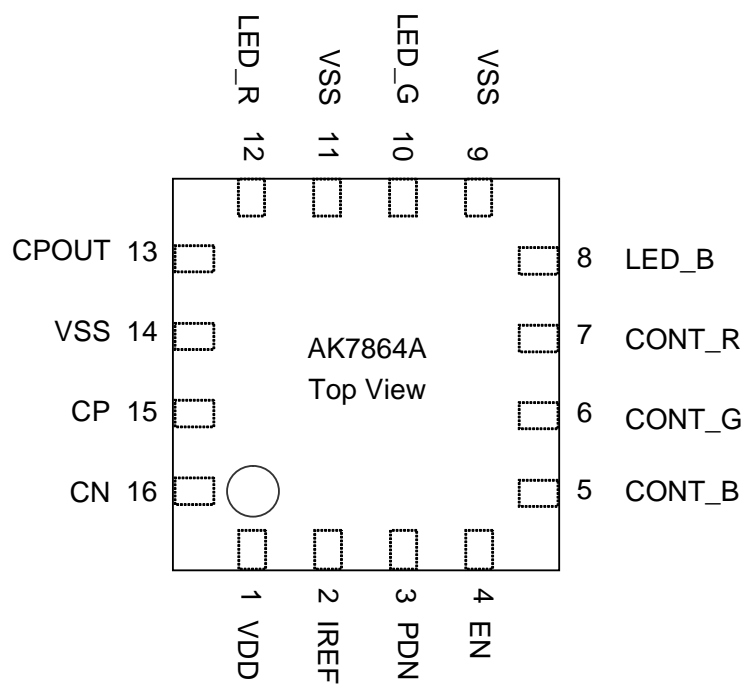
Latch the logic level of CONT\_R, CONT\_G, CONT\_B at the EN rise. This logic pattern decides the current level. After the falling edge of the CONT\_R, CONT\_G, CONT\_B, the LED current interlocks with CONT\_R, CONT\_G, CONT\_B's on or off.



The relation between the CONT\_R, CONT\_G, CONT\_B pattern and the current level follows.

| CONT_R | CONT_G | CONT_B | Current setting |
|--------|--------|--------|-----------------|
| 0      | 0      | 0      | 100%            |
| 0      | 0      | 1      | 87.5%           |
| 0      | 1      | 0      | 75%             |
| 0      | 1      | 1      | 62.5%           |
| 1      | 0      | 0      | 50%             |
| 1      | 0      | 1      | 37.5%           |
| 1      | 1      | 0      | 25%             |
| 1      | 1      | 1      | 12.5%           |

Pin Allocation



|                      |
|----------------------|
| <b>Pin Functions</b> |
|----------------------|

| No.           | Name   | IO | Description  |
|---------------|--------|----|--|
| 1             | VDD    | P  | Power supply   |
| 2             | IREF   | O  | LED current setting external resistor connecting pin<br>(Pulled down by external resistor at power down) |
| 3             | PDN    | I  | Power down mode terminal<br>High: power up, Low: power down  |
| 4             | EN     | I  | LED current enable terminal<br>High: enable, Low: disable  |
| 5             | CONT_B | I  | LED current control input for LED_B<br>High: ON, Low: OFF  |
| 6             | CONT_G | I  | LED current control input for LED_G<br>High: ON, Low: OFF  |
| 7             | CONT_R | I  | LED current control input for LED_R<br>High: ON, Low: OFF  |
| 8             | LED_B  | O  | LED current output pin B (High-Z at Power down)  |
| 9             | VSS    | P  | GND  |
| 10            | LED_G  | O  | LED current output pin G (High-Z at Power down)  |
| 11            | VSS    | P  | GND  |
| 12            | LED_R  | O  | LED current output pin R (High-Z at Power down)  |
| 13            | CPOUT  | O  | Charge pump output pin<br>(Pulled down by internal resistor at power down)                               |
| 14            | VSS    | P  | GND  |
| 15            | CP     | I  | External capacitor connecting pin for charge pump<br>(Pulled down by internal resistor at power down)    |
| 16            | CN     | I  | External capacitor connecting pin for charge pump<br>(Pulled down by internal resistor at power down)    |
| radiation pad |        |    | Connect to GND.  |

I: Input, O: Output, P: Power supply

### Absolute Maximum Ratings

Voltages are referenced to corresponding ground level. VSS=0V

| Item                | Symbol | Min. | Max.    | Unit | Remarks |
|---------------------|--------|------|---------|------|---------|
| Power supply        | VDD    | -0.3 | 4.0     | V    |         |
| Input Voltage       | VINA   | -0.3 | VDD+0.3 | V    |         |
| Storage temperature | Tstg   | -65  | 150     | °C   |         |

Operation under a condition exceeding above limits may cause permanent damage to the device. Normal operation is not guaranteed under the above extreme conditions.

### Recommended Operating Conditions

Voltages are referenced to corresponding ground level. VSS=0V

| Item                | Symbol | Min.  | Typ. | Max.  | Unit | Remarks |
|---------------------|--------|-------|------|-------|------|---------|
| Power supply        | VDD    | 3.135 | 3.3  | 3.465 | V    |         |
| Storage temperature | Ta     | 0     |      | 70    | °C   |         |

### Electrical Characteristics

#### 1. Digital input DC characteristics

(VDD=3.135~3.465V, Ta=0~70°C unless otherwise specified)

| Item                  | Symbol | Pin   | Min.        | Typ. | Max.        | Unit | Remarks |
|-----------------------|--------|-------|-------------|------|-------------|------|---------|
| H level input voltage | VIH    | Note1 | 0.7×<br>VDD |      |             | V    |         |
| L level input voltage | VIL    | Note1 |             |      | 0.3×<br>VDD | V    |         |
| Input leakage current | IL     | Note1 | -2          |      | 2           | μA   |         |

(Note 1)PDN, EN, CONT\_R, CONT\_G, CONT\_B

#### 2. Charge pump block analog characteristics

(VDD=3.135~3.465V, Ta=0~70°C unless otherwise specified)

| Item                | Min. | Typ. | Max. | Unit | Remarks              |
|---------------------|------|------|------|------|----------------------|
| CPOUT Voltage       | 6.27 | 6.6  | 6.93 | V    | @LED current disable |
| CPOUT Rise time     |      |      | 1    | ms   |                      |
| CPOUT Fall time     |      |      | 20   | ms   |                      |
| Current Consumption |      | 4.0  |      | mA   |                      |

## 3. LED driver block analog characteristics

(VDD=3.135~3.465V, Ta=0~70°C unless otherwise specified)

| Item  | Min. | Typ. | Max.  | Unit | Remarks   |
|---|------|------|-------|------|---|
| LED drive current range                       | 22   |      | 66    | mA   | (note 1)  |
| The LED protection circuit activation current | 105  | 150  | 217.5 | mA   |   |
| LED current (R/G/B)                           | 60   | 66   | 72    | mA   | IREF resistor =4.7kΩ±1%<br>LED pin voltage=2×VDD-3.1V |
| LED current accuracy (R/G/B)                  |      |      |       |      | LED pin voltage=2×VDD-3.1V<br>CONT_R/G/B              |
|   |      | 100  |       | %    | 000   |
|   | 86.0 | 87.5 | 89.0  | %    | 001   |
|   | 73.5 | 75   | 76.5  | %    | 010   |
|   | 60.5 | 62.5 | 64.5  | %    | 011   |
|   | 48   | 50   | 52    | %    | 100   |
|   | 35.5 | 37.5 | 39.5  | %    | 101   |
|   | 23   | 25   | 27    | %    | 110   |
|   | 10.5 | 12.5 | 14.5  | %    | 111   |
| LED current LED Vf dependency                 | -2.5 |      | 2.5   | %    | Refer to<br>LED pin voltage=(2×VDD-3.1)V              |
| LED Vf  | 1.1  |      | 4.8   | V    | (note 2)  |
| Current Consumption                           |      | 1.1  |       | mA   | Except LED drive current                              |

(note 1) IREF resistance [kΩ] =  $66 \div [\text{LED drive current [mA]}] \times 4.7[\text{k}\Omega]$ . [LED drive current] is possible to be set to 22mA ~ 66mA.

(note 2) In order to keep the normal operation at generation of heat of device, when RGB 3ch simultaneous lighting, the minimum of Vf has restriction.

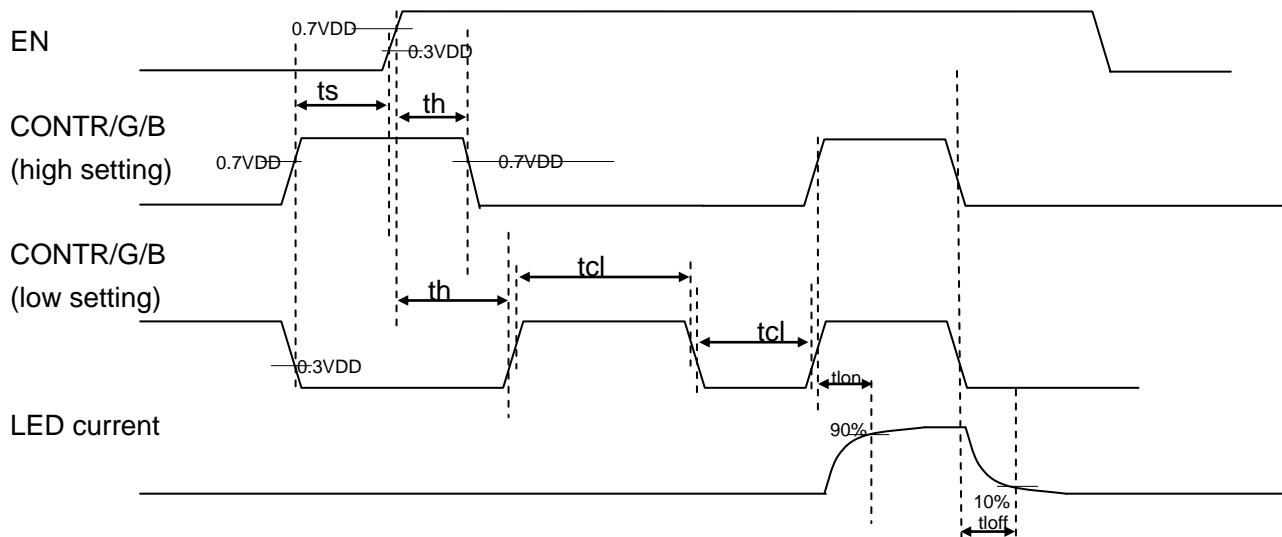
Example: (when 3ch simultaneous lighting with drive current 33mA, as for the minimum of Vf, in 1ch 1.1V and the remaining 2ch are 2.0V) When you use simultaneous lighting, since we can check for you whether LED Vf combination to use of a drive current value are possible, please contact us.

(note 3) External load: The total line resistance of CPOUT pin ~ LED anode and LED cathode ~ LED\_R/G/G pin must be within 2Ω.

(note 4) 50% setting is an upper bound when all channels turn on at the same time.



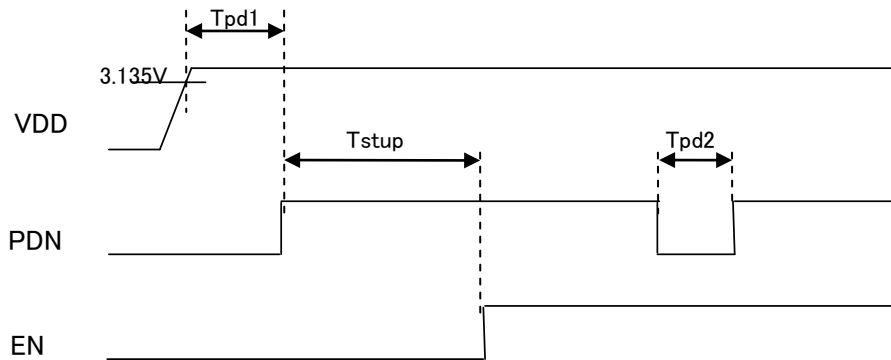
4. LEDD block, switching characteristics



(VDD=3.135~3.465V, Ta=0~70°C, unless otherwise specified)

| No.               | Item  | min. | typ. | max. | Unit | Conditions                    |
|-------------------|---|------|------|------|------|-------------------------------|
| t <sub>lon</sub>  | LED current rise time                               |      | 10   |      | μs   |                               |
| t <sub>loff</sub> | LED current fall time                               |      | 10   |      | μs   |                               |
| t <sub>s</sub>    | Reset valid setup time<br>LEDB_EN(0.3AVDD):standard | 1    |      |      | μs   | CONTR/G/B<br>to<br>EN(0.3VDD) |
| t <sub>h</sub>    | Count up setup time<br>LEDB_EN(0.7AVDD):standard    | 1    |      |      | μs   | EN(0.7VDD)<br>to<br>CONTR/G/B |
| t <sub>cl</sub>   | Current set clearing<br>CONT_R/G/B:0.7VDD standard  | 1    |      |      | μs   |                               |

## 5. PDN switching characteristics



(VDD=3.135~3.465V, Ta=0~70°C, unless otherwise specified)

| Item                | Symbol | Pin | Min. | Typ. | Max. | Unit | Conditions |
|---------------------|--------|-----|------|------|------|------|------------|
| Power down period 1 | Tpd1   | PDN | 150  |      |      | ns   |            |
| Power down period 2 | Tpd2   | PDN | 150  |      |      | ns   |            |
| Start up time       | Tstup  | EN  |      |      | 1    | ms   |            |

(note 1) Please make PDN and EN Low when you turn on the power supply.

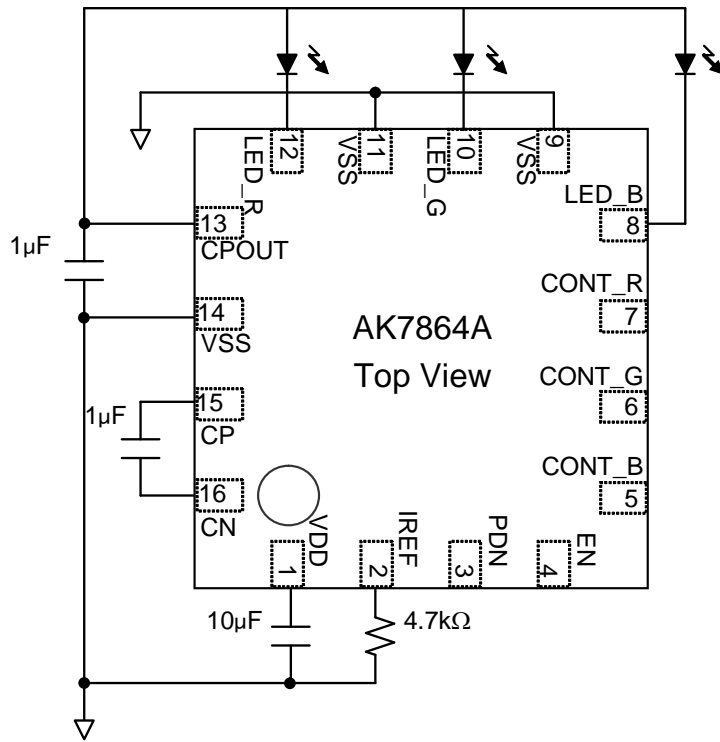
(note 2) LED (CONT\_R/G/B control) lighting after max.1ms after EN rise to high.

## 6. Power Down Characteristic

(VDD=3.135~3.465V, Ta=0~70°C, unless otherwise specified)

| Item                         | Min. | Typ. | Max. | Unit. | Remarks |
|------------------------------|------|------|------|-------|---------|
| Supply Current at Power down |      |      | 20   | μA    |         |

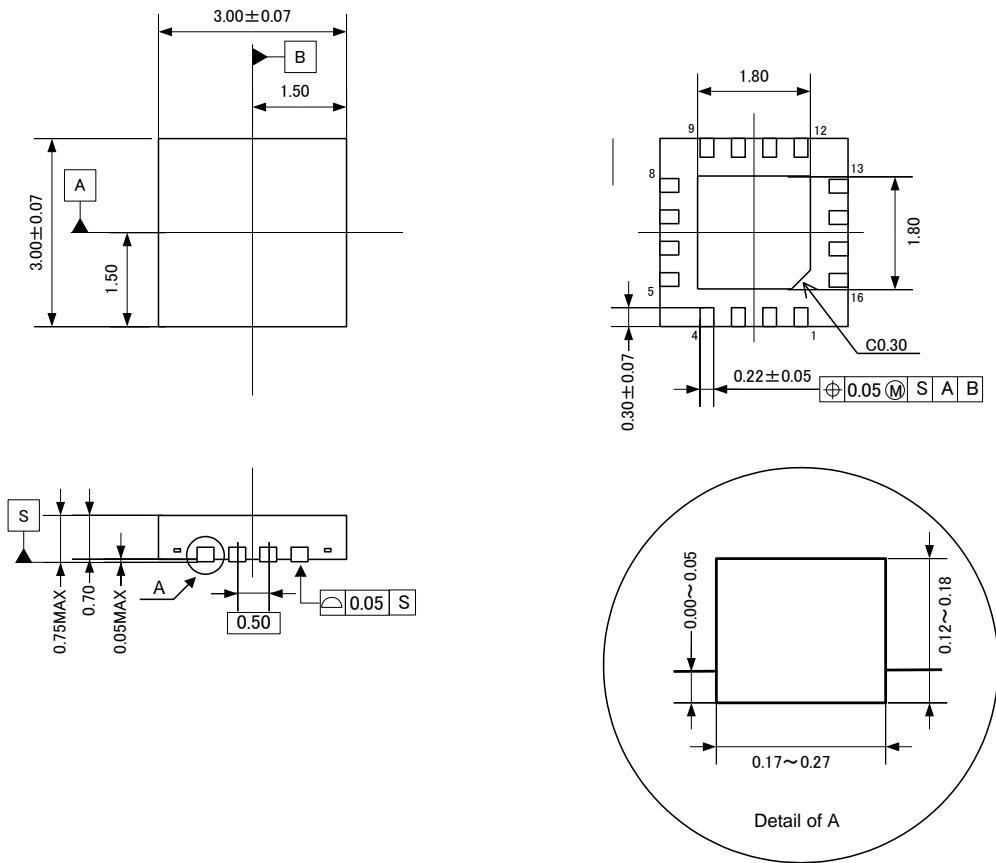
External circuit example



**Package**

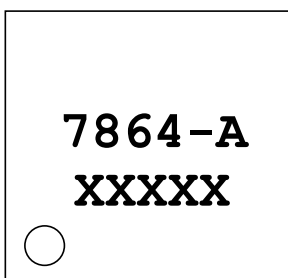
**1. Package dimension**

unit [mm]



**2. Marking**

Marketing code : 7864-A  
 Date code : XXXXX



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