# CES6301

10bit Resolution VCM driver IC with I2C interface

## Descriptions

The CES6301 is single 10-bit DAC with 120mA output current sink capability. Designed for linear control of voice coil motors, the CES6301 is capable of operating voltage to 3.6V. The DAC is controlled via a I2C serial interface that operates DAC by clock rates up to 400kHz.

The CES6301 incorporates with a power-on reset circuit, power-down function, and exactly matched sense resistor. Power-on reset circuit ensure when supply power up, DAC output is to 0V until valid write-bit value takes place. It has a power down features that reduces the current consumption of the device to 1uA maximum.

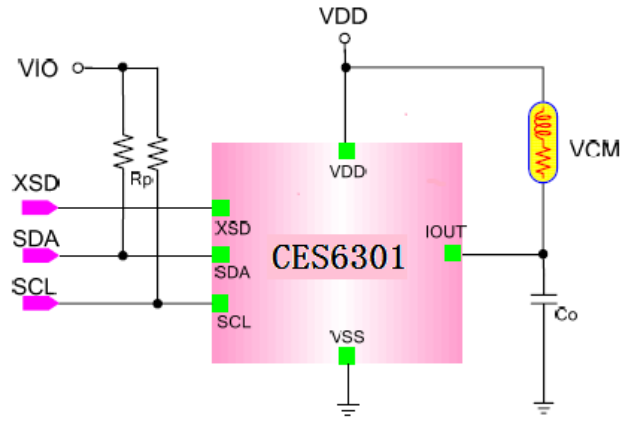
The CES6301 is designed for auto focus and optical zoom camera phones, digital still cameras, and camcorders applications.

The I2C address for the CES6301 is 0x18.

## Features

- VCM driver for auto-focus
- Shutdown function
  XSD=Active Low
- 10-bit resolution current sinking of 120mA for VCM
- I2C serial interface (Available in 1.8V Input level)
- Integrated current sense resistor
- Guaranteed monotonic over all codes
- Power down to 0.5uA typical
- Power on reset
- Power down function
- 2.3V to 3.6V operation
- Package : 0.80mm(W) x 1.20mm(H) x 0.30mm(T)
  6pins WLCSP

## Typical Application Circuit

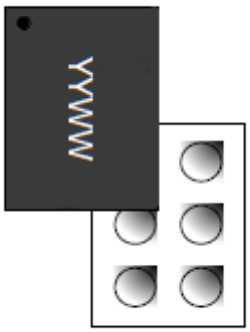



## Ordering Information

| Device | Marking | Package | Operating Temp |
|---|---|---|---|
| CES6301 | YYWW | WLCSP | -35℃ ~ +85℃ |

YYWW：Date Code

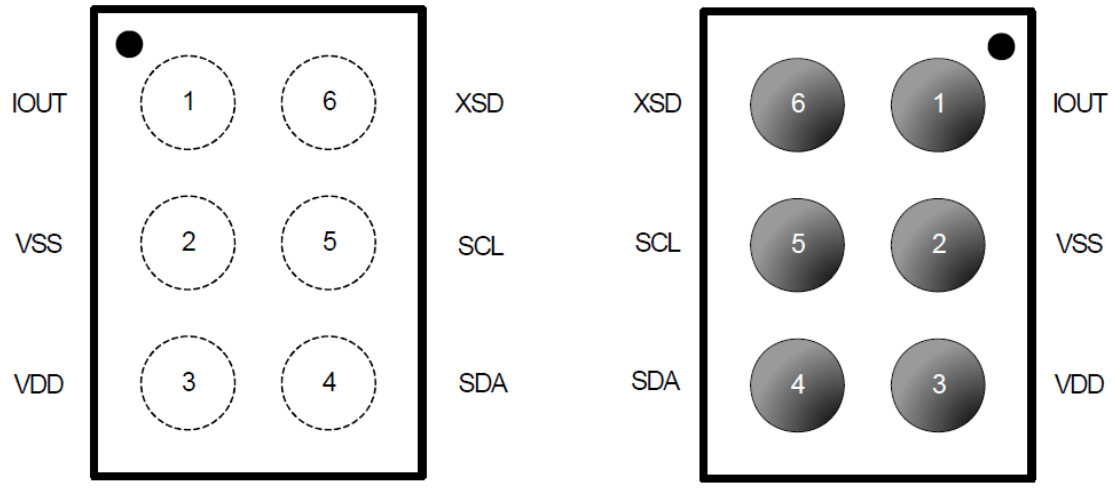
## Package Information




6 WLCSP

| Package | Size |
|---|---|
| 6 WLCSP | 0.8x1.2x0.30 |

## Pin Connection




Top View　　Bottom View

IC size : 0.80(W) X 1.20(L) X 0.30(T) (mm)
Minimum pin pitch = 0.4mm ( 6pins WLCSP)

## Pin Description

| NO. | Pin Name | I/O | Description | Note |
|---|---|---|---|---|
| 1 | IOUT | O | Output current sink | |
| 2 | VSS | - | Ground | |
| 3 | VDD | - | Power supply | |
| 4 | SDA | I/O | I2C interface input (DATA) | |
| 5 | SCL | I | I2C interface input/output (CLOCK) | |
| 6 | XSD(1) | I | Shutdown mode (active low) | |

(1) XSD : Shutdown mode (active low)
1: Normal operation mode
0: Shutdown mode

## Absolute Maximum ratings

| Symbol | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| VDD | Power supply voltage | -0.3 | 4.5 | V |
| Vin | Control input voltage | -0.3 | VDD+0.3 | V |
| Vhbm | Human body model | | 8 | KV |
| Vmm | Machine model | | 200 | V |
| Topr | Operating temperature range | -40 | 85 | ℃ |
| Tj | Junction temperature | | 150 | ℃ |

Note> Continuous Power Dissipation (Ta=25℃)

0.80mm X 1.20mm WLCSP, 100 ℃/W

**Absolute maximum ratings**

Use of the IC in excess of absolute maximum ratings such as the applied voltage or operating temperature range (Topr) may result in IC damage. Assumptions should not be made regarding the state of the IC (short mode or open mode) when such damage is suffered. The implementation of a physical safety measure such as a fuse should be considered when use of the IC in a special mode when the absolute maximum ratings may be exceeded is anticipated.

## Recommended Operating condition

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| VDD | Power supply voltage | 2.3 | 2.8 | 3.6 | V |
| Vin | Control input voltage | 1.8 | 2.8 | VDD | V |
| SCL | I2C bus transmission rate | | | 400 | kHz |

## Electrical Specification

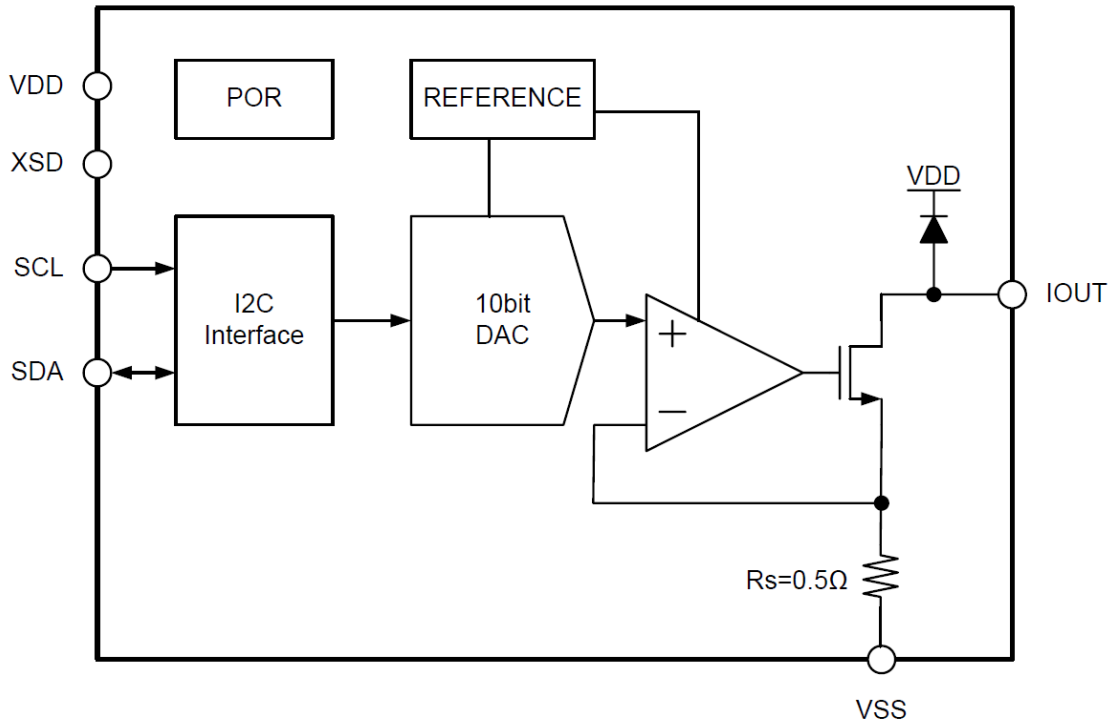
(VDD=2.3 to 3.6V, Vin=1.8V to VDD, Ta= -40 to 85℃, unless otherwise specified. Typical values are at 25℃)

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Overall | | | | | | |
| Supply Voltage | $V_{DD}$ | | 2.3 | | 3.6 | V |
| $V_{DD}$ Current | $I_{SD}$ | Shutdown mode | -1 | | +1 | uA |
| | $I_{PD}$ | Power down mode | -1 | | +1 | uA |
| | $I_Q$ | Quiescent mode | 0.24 | 0.32 | 0.35 | mA |
| Logic input / output (XSD) | | | | | | |
| Input current | | | -1 | | +1 | uA |
| Low Level Input Voltage | $V_{IL}$ | | | | 0.54 | V |
| High Level Input Voltage | $V_{IH}$ | | 1.26 | | | V |
| Logic input / output (SCL,SDA) | | | | | | |
| Input current | | | -1 | | +1 | uA |
| Low Level Input Voltage | $V_{IL}$ | | | | 0.54 | V |
| High Level Input Voltage | $V_{IH}$ | | 1.26 | | | V |
| Low Level Output Voltage | $V_{OL}$ | IIN=3mA(SDA) | | | 0.4 | V |
| Glitch rejection | | | | 70 | | ns |
| VCM driver | | | | | | |
| Current resolution | | 117.3uA/LSB | | 10 | | bits |
| INL | INL | | -2 | | +2 | LSB |
| DNL | DNL | | -1 | | +1 | LSB |
| Zero code error | ZCE | Zero data loaded to DAC | -0.2 | | +0.2 | mA |
| IOUT compliance voltage(1) | | Output current = 100mA | 150 | | | mV |
| Maximum output current | Imax | | | 120 | | mA |
| Power on time(2) | $T_{PON}$ | | | 5 | | ms |

(1) The output compliance voltage is guaranteed by design and characterization, not mass production test.

(2) CES6301 requires waiting time of 5ms after power on. During this waiting time, the offset calibration of internal amplifier is operating for minimization of output offset current .

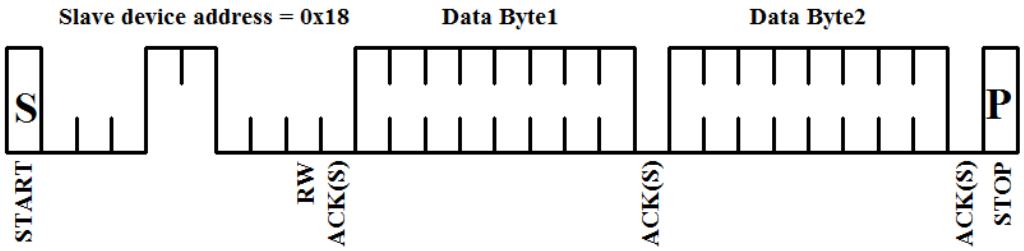
## Block Diagram



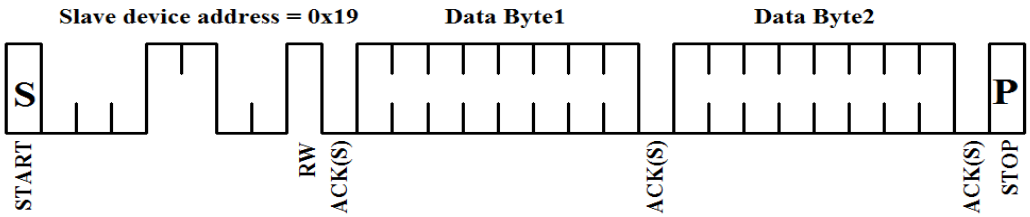
## Register

**I2C format**

- **Write Operation**




- **Read Operation**




**Register Format**

| Byte1 | | | | | | | | Byte2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PD | FL AG | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | S3 | S2 | S1 | S0 |

**PD** : Power down mode
1: Power down mode (active high)
0: Normal operation mode

**FLAG** : FLAG must keep “L” at writing operation.

**D[9:0]** : Data input
Output current = (D[9:0]/1023) X 120mA

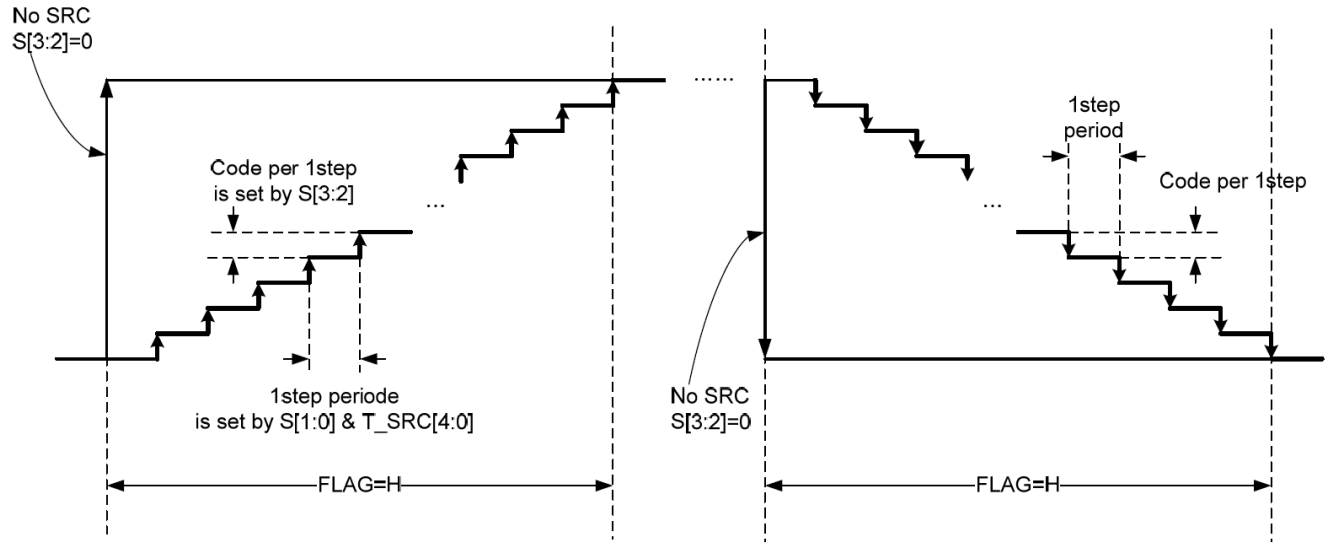
**S[3:2]** : Codes per step for “Linear slope control”

| S[3:2] | Codes per step |
|---|---|
| 00 | 0 (no SRC) – direct driving |
| 01 | 1 |
| 10 | 2 |
| 11 | 4 |

## Register

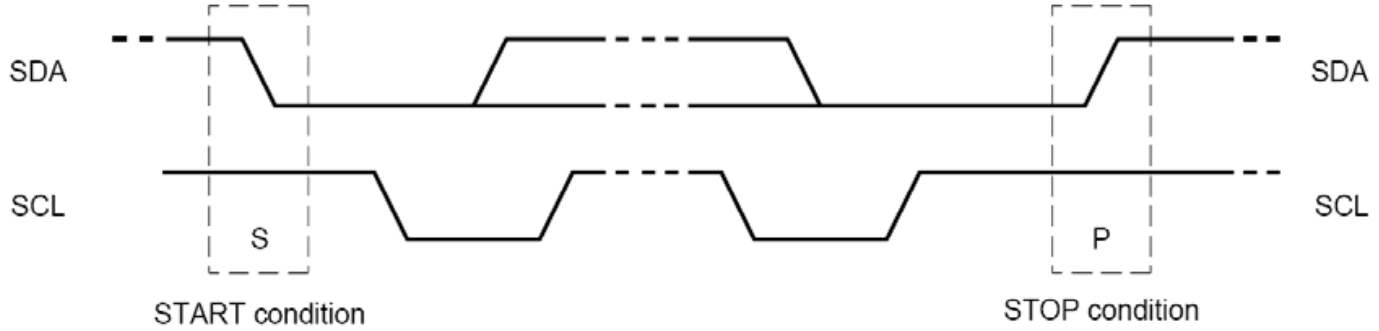
**S[1:0]** : SRC step period

| S[1:0] | Period [us] |
|---|---|
| 00 | 64 |
| 01 | 128 |
| 10 | 256 |
| 11 | 512 |



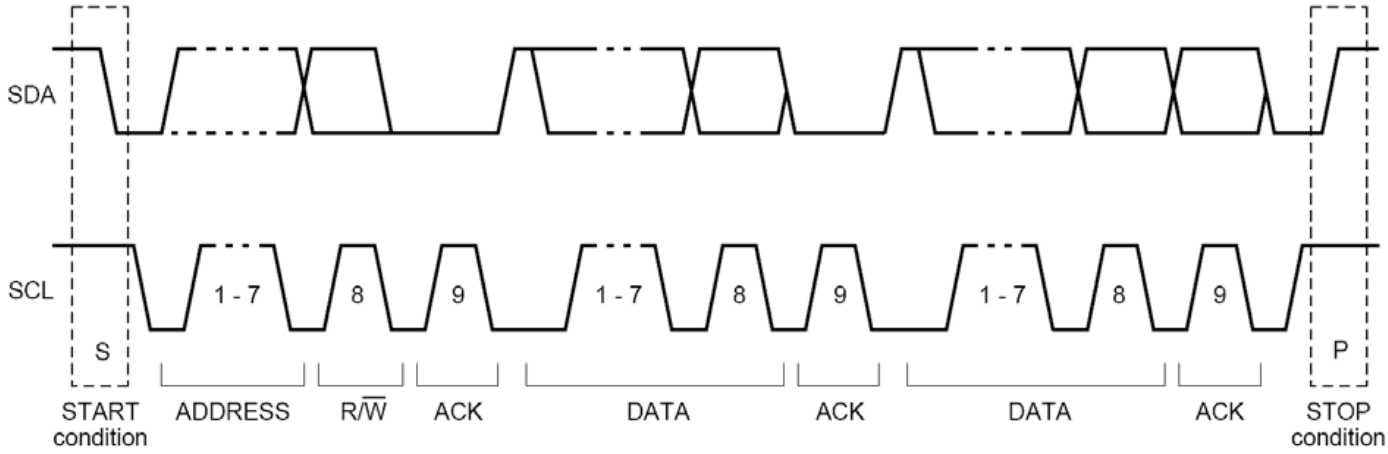
## I2C Protocol

➢ **Start and Stop condition**




Within the procedure of the I2C-bus, unique situations arise which are defined as START (S) and STOP (P) conditions. A HIGH to LOW transition on the SDA line while SCL is HIGH is one such unique case. This situation indicates a START condition. A LOW to HIGH transition on the SDA line while SCL is HIGH defines a STOP condition.

➢ **Complete I2C Data Transfer**

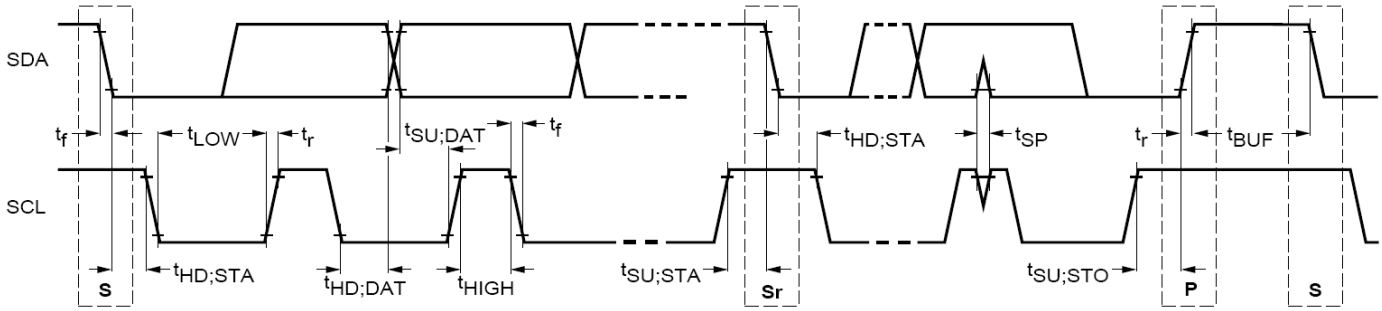



Data transfers follow the format. After the START condition (S), a slave address is sent. A data transfer is always terminated by a STOP condition (P) generated by the master. However, if a master still wishes to communicate on the bus, it can generate a repeated.

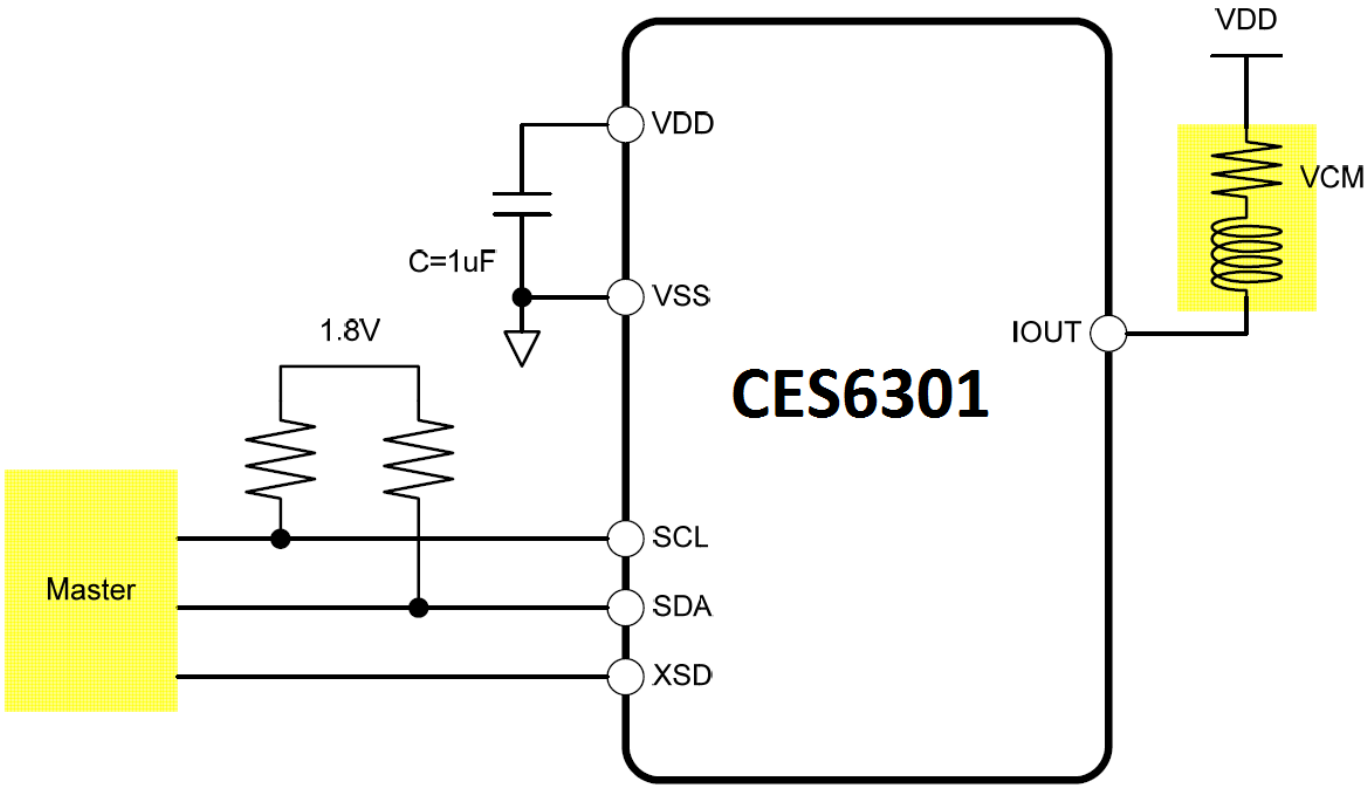
## Timing Specification

| Parameter | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| SCL clock frequency | $f_{SCL}$ | 0 | 400 | kHz |
| Hold time (repeated) START condition. | $t_{HD;STA}$ | 0.6 | - | us |
| Low period of the SCL clock | $t_{LOW}$ | 1.3 | - | us |
| High period of the SCL clock | $t_{HIGH}$ | 0.6 | - | us |
| Set-up time for a repeated START condition | $t_{SU;STA}$ | 0.6 | - | us |
| Data hold time | $t_{HD;DAT}$(1) | - | 0.9 | us |
| Data set-up time | $t_{SU;DAT}$ | 100 | - | ns |
| Rise time of both SDA and SCL signals | $t_r$ | 20+0.1$C_b$(2) | 300 | ns |
| Fall time of both SDA and SCL signals | $t_f$ | 20+0.1$C_b$(2) | 300 | ns |
| Set-up time for STOP condition | $t_{SU;STO}$ | 0.6 | - | us |
| Bus free time between a STOP and START condition | $t_{BUF}$ | 1.3 | - | us |
| Capacitive load for each bus line | $C_b$ | - | 400 | pF |
| Pulse width of spike suppress | $t_{SP}$ | 0 | 50 | ns |

(1) A master device must provide a hold time of at least 100ns for the SDA signal to bridge the undefined region of the falling edge of SCL. The maximum $t_{HD;DAT}$ has only to be met if the device does not stretch the LOW period ($t_{LOW}$) of the SCL signal.
(2) $C_b$ is the total capacitance of one bus line in pF, $t_r$ and $t_f$ are measured between 0.3$V_{DD}$ to 0.7$V_{DD}$.



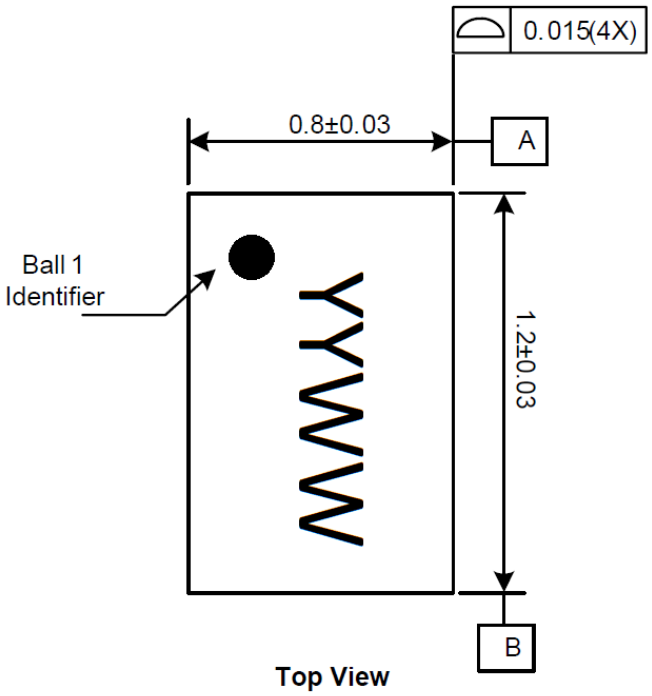
## Typical Application Circuit



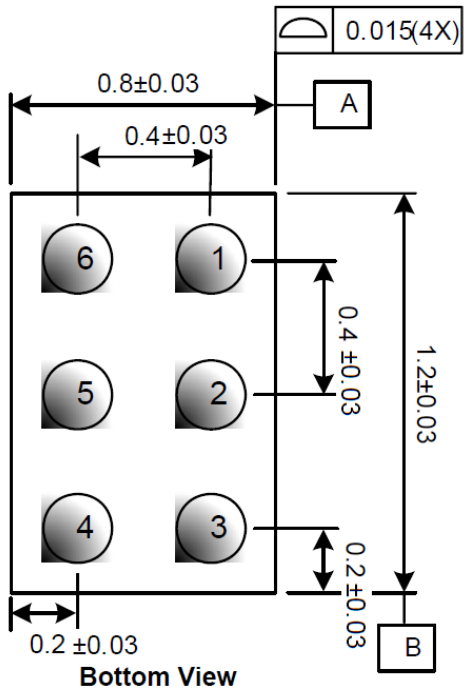

✧ XSD can be connected to VDD

## Package Dimension (6 WLCSP 0.80 x 1.20 x 0.30)

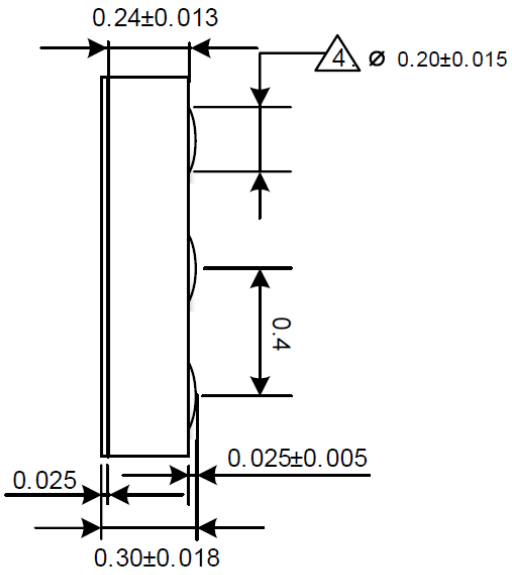
* Unit : mm




Top View




Bottom View




Side View

| NO | NAME | I/O |
|---|---|---|
| 1 | IOUT | O |
| 2 | VSS | - |
| 3 | VDD | - |
| 4 | SDA | I/O |
| 5 | SCL | I |
| 6 | XSD | I |