Low-Cost Fuel Gauge IC with Low-SOC Alert

Features
- System-Side or Pack-Side Fuel Gauging
- 3% Maximum Total SOC Measurement Error
- 14-bit Delta Sigma ADC for Temperature and Cell Voltage Measurement
- Precision Voltage Measurement
- No Offset Accumulation During Life Time
- No Full-to-Empty Battery Learning Cycles Necessary
- No Sense Resistor Required
- SOC and RRT available
- External Alarm/Interrupt for Low-Battery Warning Available
- Patented “FastCali” gas gauging algorithm
- Calibration After Quick Soft-Reset
- Very Low Active and Sleep Power Consumption
  - Normal mode 15uA
  - Sleep mode <1uA
- General I\(^2\)C interface
- Tiny, Lead(Pb)-Free, TDFN and CSP Package

Order Information

<table>
<thead>
<tr>
<th>Name</th>
<th>Operation Temperature</th>
<th>Package</th>
<th>Package Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>CW2015CSAD</td>
<td>-20°C to 70°C</td>
<td>TDFN8</td>
<td>2015CSAD</td>
</tr>
<tr>
<td>CW2015CSAC</td>
<td>-20°C to 70°C</td>
<td>CSP9</td>
<td>2015CSAC</td>
</tr>
</tbody>
</table>

Applications
- Smartphone
- Tablet PCs
- Handheld and Portable Applications

General Description
The CW2015 is an ultra-compact, low-cost, host-side/pack-side, sensing resistor free, fuel gauging system IC for Lithium-ion(Li+) based batteries in handheld and portable devices.

CW2015 tracks Li+ battery’s operational condition and uses state-of-art algorithm to report the relative State-of-Charge (SOC) of very different battery chemistry systems (LiCoOx, polymer Li-ion, LiMnOx etc.).

CW2015 includes a 14-bit Sigma-Delta ADC, a precision voltage reference and build-in accurate temperature sensor. The IC allows the end-user to eliminate the expensive sensing resistor which occupies large board area. And the IC also sends out the alarm signal if the battery SOC level reaches pre-programmed threshold.

Quick start function offers the possibility to make an initial estimation of the battery’s SOC, which also enables the IC to be located on system side or pack side, giving the flexibility to system maker on pack selection.

CW2015 uses a 2-wire I\(^2\)C compatible serial interface that operates in standard (100 kHz), fast (400 kHz).
Gas Gauge IC Series

**Type number**

CW2015 X X X X

- Package type: D: TDFN8; C: CSP9
- Parameter generation: A: Standard firmware and parameter, A version
- Embedded Battery profile type: S: CellWise Li-Polymer profile
- Function and revision: C: C generation product

*This is only means the embedded profile for test is Li-polymer, not means the CW2015 is only used for Li-polymer battery. The CW2015 is compatible with Li-ion, Li-polymer and other type Li batteries.

**Function Block Diagram**

![Function Block Diagram](image)

**Absolute Maximum Ratings**

- Voltage on Supply VDD Pin Relative to GND: -0.3 to +6V
- Voltage on All Other Pins Relative to GND: -0.3 to +6V
- Operating Temperature Range: -20°C to 70°C
- Junction Temperature: 150°C
- Store Temperature Range: -55°C to 125°C

Caution:
Stresses beyond "Absolute Maximum Ratings" condition may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
Gas Gauge IC Series

**Electrical Characteristics Recommended DC Operating Conditions**

(2.5 ≤ VDD ≤ 4.5, T_A = -20 to 70°C, unless otherwise specified.)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>VDD</td>
<td></td>
<td>+2.5</td>
<td></td>
<td>+4.5</td>
<td>V</td>
</tr>
<tr>
<td>Data I/O Pins</td>
<td>SCL, SDA, QSTRT, ALRT</td>
<td></td>
<td>-0.3</td>
<td></td>
<td>+5.5</td>
<td>V</td>
</tr>
<tr>
<td>Analog I/O</td>
<td>CELL, CTG</td>
<td></td>
<td>-0.3</td>
<td></td>
<td>+5.5</td>
<td>V</td>
</tr>
</tbody>
</table>

Table1. Electrical Operating Parameters

**DC Electrical Characteristics**

(2.5 ≤ VDD ≤ 4.5, T_A = -20 to 70°C, unless otherwise specified.)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Current</td>
<td>I_ACTIVE</td>
<td>Normal Operation</td>
<td>15</td>
<td>20</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>Sleep-Mode Current</td>
<td>I_SLEEP</td>
<td>VDD ≤ 2.0V</td>
<td>0.5</td>
<td>1.0</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>Time-Based Accuracy</td>
<td>t_ERR</td>
<td>VDD = 3.7V</td>
<td>-3</td>
<td></td>
<td>+3</td>
<td>%</td>
</tr>
<tr>
<td>ADC input resistor</td>
<td>R_ADIN</td>
<td>VDD = Vcell = 3.7V</td>
<td>10</td>
<td></td>
<td></td>
<td>MΩ</td>
</tr>
<tr>
<td>ADC resolution</td>
<td></td>
<td></td>
<td>14</td>
<td></td>
<td></td>
<td>bits</td>
</tr>
<tr>
<td>ADC conversion time</td>
<td>t_ADCON</td>
<td>VDD = Vcell = 3.7V</td>
<td>10</td>
<td></td>
<td></td>
<td>ms</td>
</tr>
<tr>
<td>Battery Voltage update time</td>
<td>t_VUPDATE</td>
<td>VDD = Vcell = 3.7V</td>
<td>250</td>
<td></td>
<td></td>
<td>ms</td>
</tr>
<tr>
<td>Input Logic-High</td>
<td>V_{IH}</td>
<td>VDD = 3.7V</td>
<td>1.4</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input Logic-Low</td>
<td>V_{IL}</td>
<td>VDD = 3.7V</td>
<td>0.6</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Input Hysteresis</td>
<td>V_{IHYS}</td>
<td></td>
<td>0.2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Output Logic-Low: SDA, ALRT</td>
<td>V_{OL}</td>
<td>I_{OL} = 4mA</td>
<td>0.2</td>
<td>0.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Pull down current: SDA, ALRT</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
</tbody>
</table>

Table2. DC Electrical Characteristics
Pin Arrangement and Description

TDFN Package Top view
2mm*3mm – 8pin

CSP Package Top view
1.48mm*1.41mm – 9pin

Fig2. Pin arrangement

<table>
<thead>
<tr>
<th>TDFN Pin No.</th>
<th>CSP Pin No.</th>
<th>Pin Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9</td>
<td>CTG</td>
<td>Connect to ground</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>CELL</td>
<td>Battery voltage monitor I/O</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>VDD</td>
<td>System power supply</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>GND</td>
<td>General purpose ground connection</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>ALRT</td>
<td>Low SOC alarm signal for MCU interrupt controller</td>
</tr>
<tr>
<td>6</td>
<td>7</td>
<td>QSTRT</td>
<td>Quick start, allows to do a quick SOC estimate</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>SCL</td>
<td>Serial clock input</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>SDA</td>
<td>Serial data Input/output</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>EP</td>
<td>Exposed pad, connect to GND or let floating</td>
</tr>
</tbody>
</table>

Table3. Pin description

Function
CW2015 is an ultra-compact, high precise gas gauging IC that embed new generational battery SOC estimate algorithm.

CW2015 provide the battery voltage, SOC and RRT estimate to user by measuring the cell voltage and temperature.

FastCali algorithm
From battery OCV (open circuits voltage), we deduce the SOC (state of charge) of this battery. Obtains OCV from two ways: idle battery voltage that has been relaxed at least half an hour; battery voltage adds the internal resistor voltage drop when charging or discharging.

Creative “equipment current track” technology precisely calculates the present voltage drop of the internal resistor, combine with the FastCali algorithm, CW2015 promptly infer the OCV value no matter the battery in charging, relaxing, or different current varying state.

First SOC Estimate after Power Up
CW2015 considers the battery as a free one that has been relaxed more than 0.5 hour when power up.

CW2015 treats the battery voltage measured by the 14bits ADC as an OCV voltage. According to this voltage, CW2015 deduces the first SOC value. Error in the first SOC value will be calibrated during the normal use.
**RRT**

RRT offers the system remaining run time to user for reference. RRT is determined by the present SOC and battery discharging current, i.e. total system power dissipation. Battery remaining capacitor divide the current is the run time. Base on the “equipment current track” technology, CW2015 obtains the discharging current only through measure the battery voltage.

RRT updates all the time and vary according to the present current. Minimum scale of the RRT is 1min.

**Quick Start**

Quick start allows CW2015 to restart fuel gauge calculations in the same manner as an initial power-up by pull up the quick start pin or set the MODE register [0x0A].

This action used to reduce the large error in the SOC value.

**Low SOC Alert**

When battery SOC lower than or equal to the setting threshold [0x06~0x07], low SOC alert triggered. CW2015 set the ALRT flag to 1, and pull down the ALRT pin to inform the external host. The ALRT pin remains logic-low until the host reset the ALRT flag to logic 0 by i²C bus.

Cleared ALRT don’t generate another alert signal while the SOC remains below the alert threshold. The SOC must rise above and then fall below or equal to the alert threshold value before another interrupt is generated.

**Sleep Mode**

All the function will be halt in the sleep mode, power dissipation of CW2015 reduced to the lowest level.

Set the MODE register bit Sleep to 11 to enter into the sleep mode. All the data update stop, when recover from sleep mode, SOC algorithm begins from the stop point. When the battery voltage lower than 2.5V, CW2015 enter into the sleep mode automatically.

**POR**

Power on reset. Set the MODE register bit POR to 1111 to reset the device, all the registers and date except flash will reset to zero.

**Register Map**

Below table shows the i²C register map for the CW2015.

<table>
<thead>
<tr>
<th>Register Name</th>
<th>Address</th>
<th>Description</th>
<th>Read/Write*</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERSION</td>
<td>0x00</td>
<td>Returns IC version, software version</td>
<td>R</td>
<td>0x6F</td>
</tr>
<tr>
<td>VCELL</td>
<td>0x02-0x03</td>
<td>Report 14-bit A/D measurement of battery voltage</td>
<td>R</td>
<td>0x00</td>
</tr>
<tr>
<td>SOC</td>
<td>0x04-0x05</td>
<td>Report 16-bit SOC result calculated</td>
<td>R</td>
<td>0x00</td>
</tr>
<tr>
<td>RRT_ALRT</td>
<td>0x06-0x07</td>
<td>13 bits remaining run time and low SOC alert bit</td>
<td>W/R</td>
<td>0x00</td>
</tr>
<tr>
<td>CONFIG</td>
<td>0x08</td>
<td>Configure register, alert threshold set</td>
<td>W/R</td>
<td>0x18</td>
</tr>
<tr>
<td>MODE</td>
<td>0x0A</td>
<td>Special command for IC state</td>
<td>W/R</td>
<td>0xC0</td>
</tr>
</tbody>
</table>

*Read/Write means they can be read from application processor outside our IC
**VCELL Register**
The VCELL register is a read-only register that updates continuously the battery terminal voltage. Battery voltage is measured at the CELL pin with GND pin as a ground reference. A 14bit sigma-delta A/D converter is used and the voltage resolution is 305uV for CW2015. This A/D converter updates the cell voltage for a period of <10ms after IC POR and then four times a second afterwards.

![VCELL Register Format](image)

**SOC Register**
The SOC register is also a read-only register that indicates the State-of-Charge of the battery cell. SOC value is a relative concept which display as a percentage of the cell’s total capacity. This register intrinsically adjusts itself to the change of battery cell’s parameter due to aging, poor cell parameter distribution control or rapid change in total capacity.

In this register, the high 8bit part contains the SOC information in % units which can be directly used by end user if this accuracy is already good enough for application. The low 8bit part provides more accurate part of the SOC information until 1/256%.

![SOC Register Format](image)

**RRT_ALRT Register**
ALRT, Flag register bit. This bit is set by the IC when the SOC register value falls below or equal to the alert threshold setting and an interrupt is generated. This bit can only be cleared by the host through I2C bus . The power-up default value for ALRT is logc 0.

The read-only register RRT indictors the remaining run time of the battery according to the present the SOC and discharging current. RRT is not a linear variation value, and update per 1s.

Register RRT provide 13bits to record the remaining time, 1 LSB represents 1 minute.

![RRT_ALRT Register Format](image)
**CONFIG Register**
ATHD is low SOC alert threshold setting register. The alert threshold is a 5-bit value that sets the state of charge level where an interrupt is generated on the ALRT pin. The alert threshold has an LSB weight of 1% and can be programmed from 0% up to 31%. The power-up default value for ATHD is 3%.
UFG is a flag bit used to indicator the battery information update state.

<table>
<thead>
<tr>
<th>MSB – Address 0x08</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSB</td>
</tr>
<tr>
<td>annie</td>
</tr>
</tbody>
</table>

Fig 6.CONFIG Register Format

**MODE Register**
Mode register is used for Master to control the IC.
Sleep mode, two bits to control. Default value 11, write 11 to force the CW2015 enter the sleep mode; write 00 to wake up.
QSTRT, quick start, two bits to control. Default value 00, write 11 to start.
Quick-start allows the IC to restart fuel-gauge calculations in the same manner as initial power-up of the IC. For example, if an application’s power-up sequence is exceedingly noisy such that excess error is introduced into the IC’s “first guess” of SOC, the host can issue a quick-start to reduce the error. A quick-start is also initiated by a rising edge on the QSTRT pin.
POR, power of reset, four bits to control. Default value 0000, write 1111 to completely restart the IC as if power removed.

<table>
<thead>
<tr>
<th>MSB – Address 0x0A</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSB</td>
</tr>
<tr>
<td>Sleep</td>
</tr>
<tr>
<td>01</td>
</tr>
</tbody>
</table>

Fig 7. MODE Register Format

**I²C Interface**
The CW2015 communicates through an I²C interface. I²C is a two-wire open-drain interface supporting multiple devices and masters on a single bus. Some I²C devices can act as masters or slaves, but the CW2015 can only act as a slave device that only pull the bus wires LOW and never drive the bus HIGH. Data on the I²C-bus can be transferred at rates of up to 100kbit/s in standard mode or fast (400 kHz) or fast mode plus (1 MHz) modes.

**Device Address**
I²C device address is consist of 7bits slave address and 1 read/write control bit.

<table>
<thead>
<tr>
<th>ADD6</th>
<th>ADD5</th>
<th>ADD4</th>
<th>ADD3</th>
<th>ADD2</th>
<th>ADD1</th>
<th>ADD0</th>
<th>R/W</th>
</tr>
</thead>
</table>

Fig 8. I²C address structure
Address of CW2015 is fixed on 0b1100010. Combine with de R/W bit:
Read command of CW2015 is 0xC5;
Write command of CW2015 is 0xC4.

START and STOP Conditions
When the bus is idle, both SCL and SDA must be HIGH. A bus master signals the beginning of a transmission with a START condition by transitioning SDA from HIGH to LOW while SCL is HIGH. When the master has finished communicating with the slave, it issues a STOP condition by transitioning SDA from LOW to HIGH while SCL is HIGH. The bus is then free for another transmission. When the bus is in use, it stays busy if a repeated START (Sr) is generated instead of a STOP condition. The repeated START (Sr) conditions are functionally identical to the START (S).

Read and Write Command
Figure 11 shows an overview of the read and write command on the I²C bus.

Read

<table>
<thead>
<tr>
<th>S</th>
<th>0xC4</th>
<th>Sr</th>
<th>0xC5</th>
<th>Register data (8bits)</th>
<th>A</th>
<th>P</th>
</tr>
</thead>
</table>

Write

<table>
<thead>
<tr>
<th>S</th>
<th>0xC4</th>
<th>Register Address (8bits)</th>
<th>Write data (8bits)</th>
<th>A</th>
<th>P</th>
</tr>
</thead>
</table>

From Master to Slave  S  Start
From Slave Master  A  Acknowlage

Fig9. Read and write command
Typical Operation Parameter

**CW2015 VOLTAGE ADC ERROR vs. TEMPERATURE**

- TEMP. = 5 deg C
- TEMP. = 25 deg C
- TEMP. = 45 deg C

**QUIESCENT CURRENT vs. SUPPLY VOLTAGE**

**SIMPLE C/5 RATE DISCHARGE SOC ACCURACY**

**SIMPLE C/2 RATE DISCHARGE SOC ACCURACY**

**C/2 RATE ZIGZAG PATTERN SOC ACCURACY 1**

**C/2 RATE ZIGZAG PATTERN SOC ACCURACY 2**
Gas Gauge IC Series

REAL APPLICATION/DISCHARGE SOC

ACCURACY 1

REAL APPLICATION/DISCHARGE SOC

ACCURACY 2

REAL APPLICATION UNDER CV MODE

SOC ACCURACY 1

REAL APPLICATION UNDER CV MODE

SOC ACCURACY 2

STATE OF CHARGE (%)

DISCHARGE CURRENT RATE (C)

SOC ERROR (%)

CURRENT RATE (C)

STATE OF CHARGE (%)

TIME (h)

TIME (h)

TIME (h)

TIME (h)
**Application Diagram**

Fig10 is a typical application diagram of CW2015 used in system side, recommended value of the external components is mark on the figure.

Fig11 is a typical application diagram of CW2015 used in pack side, recommended value of the external components is mark on the figure.

CW2015 can be also used in the 2 batteries connected in series, or several cells connected in parallel.

More detailed application information please refers to the application notes or connects CellWise for more support.
Tape and Reel Information
TDFN Package Reel Information

Color: Blue
All DIM in mm

TDFN Package Tape Information

Carrier Tape Color: Black
Cover Tape Width: 5.30±0.10
Cover Tape Color: Transparent
All DIM in mm

All the package materials are Pb free and Halogen free.
Tape and Reel Information
CSP Package Reel Information

All DIM in mm

CSP Package Tape Information

All DIM in mm

All the package materials are Pb free and Halogen free.
## Package Information

**TDFN2 x 3-8L(P0.50T0.75/0.85) PACKAGE OUTLINE DIMENSIONS**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Dimensions In Millimeters</th>
<th>Dimensions In Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td><strong>A</strong></td>
<td>0.700/0.800</td>
<td>0.800/0.900</td>
</tr>
<tr>
<td><strong>A1</strong></td>
<td>0.000</td>
<td>0.050</td>
</tr>
<tr>
<td><strong>A3</strong></td>
<td>0.203REF.</td>
<td>0.008REF.</td>
</tr>
<tr>
<td><strong>D</strong></td>
<td>1.924</td>
<td>2.076</td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>2.924</td>
<td>3.076</td>
</tr>
<tr>
<td><strong>D1</strong></td>
<td>1.400</td>
<td>1.600</td>
</tr>
<tr>
<td><strong>E1</strong></td>
<td>1.400</td>
<td>1.600</td>
</tr>
<tr>
<td><strong>K</strong></td>
<td>0.20MIN</td>
<td>0.008MIN</td>
</tr>
<tr>
<td><strong>b</strong></td>
<td>0.200</td>
<td>0.300</td>
</tr>
<tr>
<td><strong>e</strong></td>
<td>0.500TYP.</td>
<td>0.020TYP.</td>
</tr>
<tr>
<td><strong>L</strong></td>
<td>0.224</td>
<td>0.376</td>
</tr>
</tbody>
</table>
### CSP9 PACKAGE OUTLINE DIMENSIONS

**Top View (BGA side)**

- Ball center = (25, 10)
- Package center = (0, 0)

**Bottom View (Back cover)**

- BGA ball center to package center offset in X-direction: X = 0.0250, 0.0000, 0.0500, 0.0010, 0.0000, 0.0020
- BGA ball center to package center offset in Y-direction: Y = 0.0010, -0.0240, 0.0260, 0.0000, -0.0009, 0.0010
- BGA ball center to chip center offset in X-direction: X1 = 0.0250, -0.0140, 0.0140, 0.0010, -0.0006, 0.0006
- BGA ball center to chip center offset in Y-direction: Y1 = 0.0010, -0.0140, 0.0140, 0.0000, -0.0006, 0.0006
- Edge to Ball Center Distance along X: S1 = 0.3000, 0.2700, 0.3300, 0.0118, 0.0106, 0.0130
- Edge to Ball Center Distance along Y: S2 = 0.2800, 0.2500, 0.3100, 0.0110, 0.0098, 0.0122

**Cross Section**

- Package Size: 1450 * 1380
- Min ball pitch: 400
- Ball diameter: 200

**Unit:** um

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Nominal</th>
<th>Min</th>
<th>Max</th>
<th>Nominal</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package Body Dimension X</td>
<td>A</td>
<td>1.4500</td>
<td>1.4250</td>
<td>1.4750</td>
<td>0.0571</td>
<td>0.0561</td>
<td>0.0581</td>
</tr>
<tr>
<td>Package Body Dimension Y</td>
<td>B</td>
<td>1.3800</td>
<td>1.3550</td>
<td>1.4050</td>
<td>0.0543</td>
<td>0.0533</td>
<td>0.0553</td>
</tr>
<tr>
<td>Package Height</td>
<td>C</td>
<td>0.6000</td>
<td>0.5550</td>
<td>0.6450</td>
<td>0.0236</td>
<td>0.0219</td>
<td>0.0254</td>
</tr>
<tr>
<td>Silicon + Back cover Thickness</td>
<td>C2</td>
<td>0.4850</td>
<td>0.4700</td>
<td>0.5000</td>
<td>0.0191</td>
<td>0.0185</td>
<td>0.0197</td>
</tr>
<tr>
<td>Ball Height</td>
<td>C1</td>
<td>0.1000</td>
<td>0.0700</td>
<td>0.1300</td>
<td>0.0039</td>
<td>0.0028</td>
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<tr>
<td>Ball Diameter</td>
<td>D1</td>
<td>0.2000</td>
<td>0.1700</td>
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<td>0.0091</td>
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<td>Total Ball Count</td>
<td>N</td>
<td>9(1NC)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Ball Count X axis</td>
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<td>3.0000</td>
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<td></td>
<td></td>
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<tr>
<td>Ball Count Y axis</td>
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<td></td>
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</tr>
<tr>
<td>Pins Pitch X axis</td>
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<td></td>
<td></td>
<td>0.0157</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pins Pitch Y axis</td>
<td>J2</td>
<td>0.4000</td>
<td></td>
<td></td>
<td>0.0157</td>
<td></td>
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</tbody>
</table>

**Package Outline Dimensions**

- Ball center = (25, 10)
- Package center = (0, 0)
- A
- B
- S1
- J1
- S2
- J2

**Unit:** um

- Package Size: 1450 * 1380
- Min ball pitch: 400
- Ball diameter: 200

**Figure Legend:**

- **A**: Package Body Dimension X
- **B**: Package Body Dimension Y
- **C**: Package Height
- **C1**: Ball Height
- **C2**: Silicon + Back cover Thickness
- **D1**: Ball Diameter
- **N**: Total Ball Count
- **N1**: Ball Count X axis
- **N2**: Ball Count Y axis
- **J1**: Pins Pitch X axis
- **J2**: Pins Pitch Y axis
- **X**: BGA ball center to package center offset in X-direction
- **Y**: BGA ball center to package center offset in Y-direction
- **X1**: BGA ball center to chip center offset in X-direction
- **Y1**: BGA ball center to chip center offset in Y-direction
- **S1**: Edge to Ball Center Distance along X
- **S2**: Edge to Ball Center Distance along Y
## CW2015 Revision Record

<table>
<thead>
<tr>
<th>Date</th>
<th>Version</th>
<th>Changed Item</th>
<th>Written by</th>
<th>Approved by</th>
</tr>
</thead>
</table>
| 2012-06-13 | 0.4     | 1. Add test result curve  
2. Remove CRC and Factory register definition  
3. Update the register type to Visio picture | Jun        | Bob         |
| 2012-06-15 | 0.5     | 1. Correct IC number on P7                                                  | Jun        | Bob         |
| 2012-08-09 | 0.6     | 1. Update register map                                                        | Jun        | Bob         |
| 2012-08-19 | 0.7     | 1. Update package picture  
2. Add test curve | Jun        | Bob         |
| 2012-09-02 | 0.8     | 1. Update test result curve                                                  | Jun        | Bob         |
| 2012-09-04 | 0.9     | 1. Update test waveform  
2. Update part number  
3. Update block diagram | Jun        | Bob         |
| 2012-11-02 | 1.0     | 1. Add type number explanation  
2. Release formal version | Jun        | Bob         |
| 2012-11-06 | 1.1     | 1. Delete CNAD type number  
2. Explain the connection of EP pad  
3. Update application circuits | Jun        | Bob         |
| 2013-01-30 | 1.2     | 1. Re-explain the C/S/A/D  
2. Change the operation temperature | Jun        | Bob         |
| 2013-02-01 | 1.3     | 1. Add ADC electrical parameter  
2. Delete auto power save function and related PD  
3. Delete absolute ADC conversion accuracy | Jun        | Bob         |
| 2013-04-26 | 1.4     | 1. Correct the description of Alert flag clear action  
2. Change I2C character to I\(^2\)C  
3. Rename the application circuits to application diagram  
4. Add the application diagram for pack side  
5. Add the description of application for 2-cells in series or several cells in parallel | Jun        | Bob         |
| 2013-05-02 | 1.5     | Add tape and reel information                                                 | Jun        | Bob         |
| 2013-06-05 | 1.6     | 1. Remove single cell application description  
2. Change the RC filter parameter | Jun        | Bob         |
| 2013-07-21 | 1.7     | 1. Change default value of Mode register  
2. Change website address character | Jun        | Bob         |
| 2013-12-29 | 1.8     | 1. Change default value of Config register from 0x50 to 0x18  
2. Uniform °C, character type | Jun        | Bob         |
| 2014-09-10 | 2.0     | Rotate the package orientation in the tape                                  | Jun        | Bob         |
| 2015-07-13 | 2.1     | 1. Add CSP package information  
2. Revised the default value of version register | Jun        | Bob         |