

## BCT8902

### 8.5V Adaptive DF-Chargepump High Efficiency Large Volume Audio Amplifier

#### General Description

The BCT8902 is specifically designed to improve the musical output dynamic range, enhance the overall sound quality, which is a new high efficiency boosted mono Class-D audio amplifier.

The charge pump converter doubles the VDD up to 8.5V supply that can deliver 2.8W output power into an 8Ω speaker.

BCT8902 integrated efficiency up to 90% of adaptive switch with Single-Frequency or Dual-Frequency Chargepump technology, significantly improving the dynamic range of the music output and power consumption of audio system. BCT8902 noise floor is as low as to 36μV at speaker mode, with 102dB high signal-to-noise-ratio (SNR). The ultra-low distortion 0.009% and unique AGC technology bring high quality music enjoyment.

BCT8902 is equipped with the one-wire-interface (OWI), that enables the device to work either SPK mode or RCV mode.

The chip is available in a 0.4mm pitch 15-bump ultra-compact 1.645mm\*1.675mm WLCSP package, which makes this solution the industrial smallest high voltage smart audio amplifier. The product can work in a wide temperature range from -40°C to +85°C.

#### FEATURES

- 2x Charge pump doubler converter  
Highest Voltage:8.5V
- Overall efficiency more than 82%
- 98dB SNR at 1W with 8Ω speaker
- High output power at THD+N=1%
  - 2.8W@8Ω, VDD = 4.2V
  - 3.2W@6Ω, VDD = 4.2V
- On-chip DPM control
- Speaker &Receiver 2-in-1 application support
- Single/dual-ended analog input interface
- 15 one wire pulse control modes
- Small size 15 bump WLCSP packaging

#### APPLICATIONS

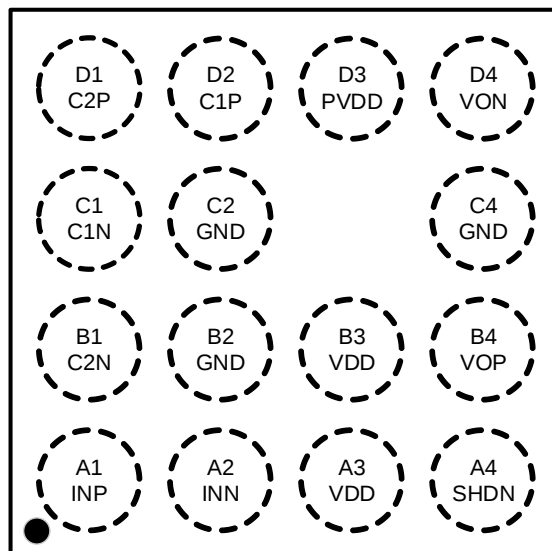
- PDAs
- Portable Instrumentation

#### ORDERING INFORMATION

| Order Number  | Package Type | Temperature Range | Marking        | QTY/Reel |
|---------------|--------------|-------------------|----------------|----------|
| BCT8902EWX-TR | WLCSP-15L    | -40°C to +85°C    | XGZP<br>XXXXXX | 3000     |

Note: "XXXXXX" in Marking will be appeared as the batch code.

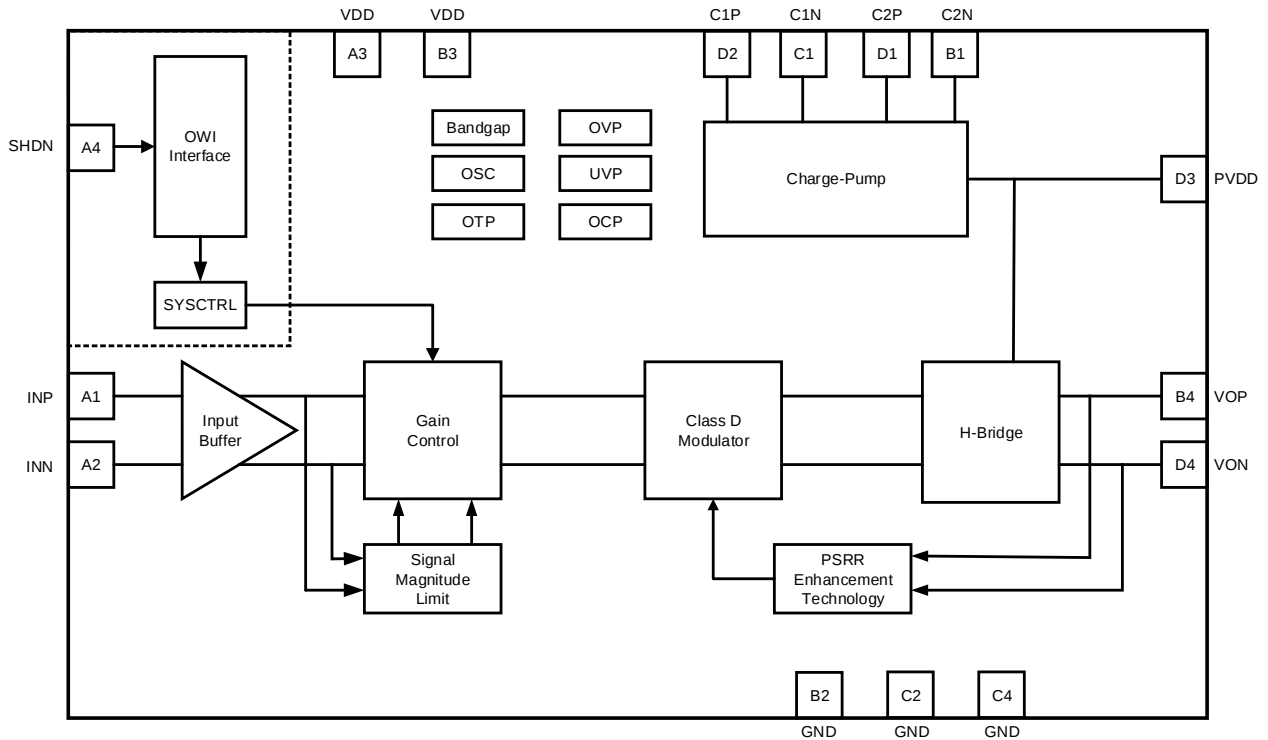
### PIN CONFIGURATION (TOP VIEW)



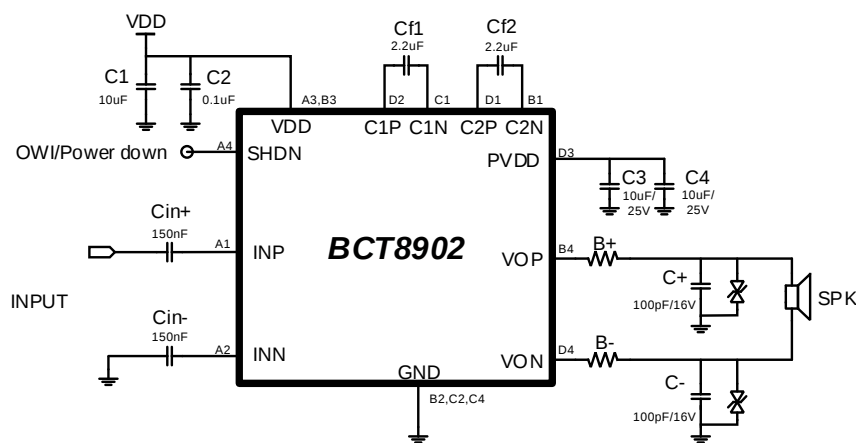
### PIN DESCRIPTION

| Number | Name | Function                                       |
|--------|------|------------------------------------------------|
| A1     | INP  | Positive audio input terminal                  |
| A2     | INN  | Negative audio input terminal                  |
| A3     | VDD  | Power Supply                                   |
| A4     | SHDN | OWI control / chip power down                  |
| B1     | C2N  | Negative input charge pump flying capacitor C2 |
| B2     | GND  | Ground                                         |
| B3     | VDD  | Power Supply                                   |
| B4     | VOP  | Positive audio output terminal                 |
| C1     | C1N  | Negative input charge pump flying capacitor C1 |
| C2     | GND  | Ground                                         |
| C4     | GND  | Ground                                         |
| D1     | C2P  | Positive input charge pump flying capacitor C2 |
| D2     | C1P  | Positive input charge pump flying capacitor C1 |
| D3     | PVDD | Charge pump doubler output voltage             |
| D4     | VON  | Negative audio output terminal                 |

### BLOCK DIAGRAM

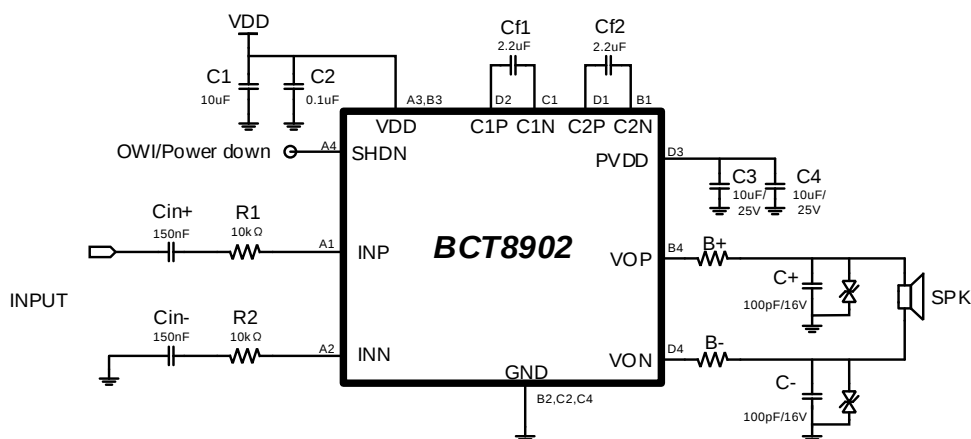


### TYPICAL APPLICATION CIRCUIT



Typical BCT8902 application circuit

#### TYPICAL APPLICATION CIRCUIT (Continued)



Typical BCT8902 application circuit with extra 10kΩ input resistance

**Note:**

To ensure better performance, two 10uF capacitors are recommended to be used as PVDD capacitors. The minimum PVDD capacitance value of the chip that can work normally is 4.7uF. In BCT8902 typical applications, it is necessary to ensure the output value of the PVDD capacitor  $\geq 1.5\mu\text{F}$  when PVDD=8.5V.

#### ABSOLUTE MAXIMUM RATINGS

| Parameters                   | Symbol        | Min  | Typ | Max            | Units |
|------------------------------|---------------|------|-----|----------------|-------|
| Supply Voltage               | VDD           | -0.3 |     | 5.5            | V     |
| PVDD Output Voltage          | VPVDD         | -0.3 |     | 9              | V     |
| Switching                    | C1P, C2P      | -0.3 |     | $V_{PVDD}+0.7$ | V     |
| Digital Input voltage        | SHDN          | -0.3 |     | 5.5            | V     |
| Analog Input voltage         | INP, INN      | -0.3 |     | 5.5            | V     |
| Output voltage               | VON, VOP      | -0.3 |     | $V_{PVDD}+0.7$ | V     |
| Package Thermal Resistance   | $\theta_{JA}$ |      | 76  |                | °C/W  |
| Ambient Temperature Range    |               | -40  |     | 85             | °C    |
| Maximum Junction Temperature | $T_{JMAX}$    |      | 160 |                | °C    |
| Storage Temperature Range    | $T_{STG}$     | -55  |     | 150            | °C    |
| Lead Temperature             |               |      | 260 |                | °C    |

**Note:**

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and 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 affect device reliability.

#### ESD Rating

| Parameters                  | Symbol      | Value      | Units |
|-----------------------------|-------------|------------|-------|
| Electrostatic discharge HBM | $ESD_{HBM}$ | $\pm 2000$ | V     |

## DC ELECTRICAL CHARACTERISTICS

Conditions:  $T_A = +25^{\circ}\text{C}$ ,  $V_{DD} = 3.6\text{V}$ ,  $PVDD \text{ OVP} = 8.5\text{V}$ ,  $f = 1\text{kHz}$ ,  $R_L = 8\Omega + 33\mu\text{H}$ , unless otherwise noted.

| Parameters                       | Symbol                 | Condition                                                                     | Min  | Typ  | Max | Units |
|----------------------------------|------------------------|-------------------------------------------------------------------------------|------|------|-----|-------|
| Power Supply Voltage Range       | VDD                    |                                                                               | 3    | 4.2  | 5   | V     |
| VDD Under Voltage Lockout        | VDD-UVLO               | VDD falling                                                                   | 2.6  | 2.7  | 2.8 | V     |
|                                  |                        | VDD rising                                                                    | 2.8  | 2.9  | 3.0 | V     |
| Operating quiescent current      | I <sub>VDD</sub>       | Speaker mode, VDD=4V, PVDD=2*VDD, Input AC to ground, R <sub>L</sub> =8Ω+33μH |      | 13.5 |     | mA    |
|                                  |                        | Receiver mode, VDD=4V, PVDD=VDD, Input AC to ground, R <sub>L</sub> =8Ω+33μH  |      | 6.5  |     | mA    |
| Shutdown quiescent current       | I <sub>VDD (off)</sub> | SHDN=GND                                                                      |      | 0.1  | 1   | μA    |
| Thermal Shutdown                 | T <sub>STD</sub>       | Junction Temperature                                                          |      | 160  |     | °C    |
| Thermal Shutdown Hysteresis      | T <sub>HYS</sub>       | Junction Temperature                                                          |      | 30   |     | °C    |
| High-level input voltage of SHDN | V <sub>IH</sub>        |                                                                               | 1.42 |      | VDD | V     |
| Low-level input voltage of SHDA  | V <sub>IL</sub>        |                                                                               | 0    |      | 0.4 | V     |
| Star-up time                     | T <sub>ON</sub>        | C <sub>PVDD</sub> =20μF, VDD=4.2V                                             |      | 40   |     | ms    |
| Turn-off time                    | T <sub>OFF</sub>       |                                                                               |      | 1.8  |     | ms    |

## Charge Pump Doubler

| Parameters                        | Symbol             | Condition                                                                                       | Min | Typ   | Max | Units |
|-----------------------------------|--------------------|-------------------------------------------------------------------------------------------------|-----|-------|-----|-------|
| Soft Start Time                   | T <sub>SST</sub>   | No Load, C <sub>PVDD</sub> =20μF<br>C <sub>fly1</sub> =C <sub>fly2</sub> =2.2μF,<br>VDD=3V~4.2V |     | 2.56  |     | ms    |
| Switching Frequency               | F <sub>CP</sub>    |                                                                                                 |     | 1500  |     | kHz   |
| Efficiency                        | η <sub>boost</sub> | VDD=4.2V, I <sub>load</sub> =200mA                                                              |     | 93    |     | %     |
|                                   |                    | VDD=3.6V; I <sub>load</sub> =200mA                                                              |     | 92    |     | %     |
| Output Voltage                    | VPVDD              | VDD=3.3~4.2V                                                                                    |     | 2*VDD |     | V     |
|                                   |                    | VDD>4.2V                                                                                        |     | 8.5   | 8.6 | V     |
| Absolute Output Voltage Ripple    |                    | C <sub>PVDD</sub> =20μF,<br>I <sub>load</sub> =0.2A                                             |     | 46    |     | mV    |
| Maximum Peak Output Current Limit | I <sub>limit</sub> | VDD=3V~5V                                                                                       |     | 1.2   |     | A     |
| PVDD short to GND                 | I <sub>short</sub> |                                                                                                 |     | 300   |     | mA    |

#### DC ELECTRICAL CHARACTERISTICS (Continued)

##### Class-D

| Parameters                           | Symbol        | Condition                                                                     | Min | Typ   | Max | Units      |
|--------------------------------------|---------------|-------------------------------------------------------------------------------|-----|-------|-----|------------|
| Output offset voltage                | $V_{os}$      |                                                                               | -20 | 0     | 20  | mV         |
| Class-D switching frequency          | $F_{class-D}$ |                                                                               |     | 750   |     | kHz        |
| Voltage gain                         | $AV$          | Without INP, INN external resistors                                           |     | 18    |     | dB         |
| Input Resistor                       | $R_{in}$      | Speaker mode Gain=18dB                                                        |     | 18    |     | k $\Omega$ |
|                                      |               | Receiver mode Gain=0dB                                                        |     | 18    |     | k $\Omega$ |
|                                      |               | Receiver mode Gain=3dB                                                        |     | 12.5  |     | k $\Omega$ |
| Total efficiency                     | $\eta$        | VDD=4.2V, $P_{out}$ =1.25W, $Z_L$ =8 $\Omega$ +33uH                           |     | 82    |     | %          |
| VDD Power Supply Rejection Ratio     | PSRR          | Speaker Mode; VDD=4.2V, f=217Hz, 200mVpp sinewave ripple                      |     | 70    |     | dB         |
|                                      |               | Speaker Mode; VDD=4.2V, f=1kHz, 200mVpp sinewave ripple                       |     | 77    |     | dB         |
|                                      |               | Receiver Mode; VDD=4.2V, f=217Hz, 200mVpp sinewave ripple                     |     | 82    |     | dB         |
|                                      |               | Receiver Mode; VDD=4.2V, f=1kHz, 200mVpp sinewave ripple                      |     | 86    |     | dB         |
| Output voltage noise                 | $E_N$         | Speaker Mode; AV=8V/V, $Z_L$ =8 $\Omega$ +33uH, f=20Hz to 20kHz, A-weighting  |     | 36    |     | $\mu$ Vrms |
|                                      |               | Receiver Mode; AV=1V/V, $Z_L$ =8 $\Omega$ +33uH, f=20Hz to 20kHz, A-weighting |     | 10    |     | $\mu$ Vrms |
| Signal-to-noise ratio                | SNR           | VDD=4.2V, $P_{OUT}$ =2.7W, $Z_L$ =8 $\Omega$ +33uH, A-weighting               |     | 102   |     | dB         |
|                                      |               | VDD=4.2V, $P_{OUT}$ =1W, $Z_L$ =8 $\Omega$ +33uH, A-weighting                 |     | 98    |     | dB         |
| Total harmonic distortion plus noise | THD+N         | f=1kHz, $P_{OUT}$ =1W, $Z_L$ =8 $\Omega$ +33uH                                |     | 0.009 |     | %          |
| Output power                         | $P_{OUT}$     | VDD=4.2V, f=1kHz, $Z_L$ =8 $\Omega$ +33uH, THD+N=10%.                         |     | 3.4   |     | W          |
|                                      |               | VDD=4.2V, f=1kHz, $Z_L$ =8 $\Omega$ +33uH, THD+N=1%.                          |     | 2.8   |     | W          |
|                                      |               | VDD=4.2V, f=1kHz, $Z_L$ =6 $\Omega$ +33uH, THD+N=10%.                         |     | 3.9   |     | W          |
|                                      |               | VDD=4.2V, f=1kHz, $Z_L$ =6 $\Omega$ +33uH, THD+N=1%.                          |     | 3.2   |     | W          |

## DC ELECTRICAL CHARACTERISTICS (Continued)

### Signal Clipping & Output Power Controllers

| Parameters                             | Symbol | Condition | Min | Typ  | Max | Units    |
|----------------------------------------|--------|-----------|-----|------|-----|----------|
| Signal Clipping Controller attack time |        |           |     | 50   |     | us/0.5dB |
| Output Power Controller 1 attack time  |        |           |     | 300  |     | us/0.5dB |
| Output Power Controller 2 attack time  |        |           |     | 20   |     | ms/0.5dB |
| Output Power Controller 2 hold on time |        |           |     | 1    |     | s        |
| Gain Controller release time           |        |           |     | 10   |     | ms/0.5dB |
| Maximum gain attenuation               |        |           |     | 13.5 |     | dB       |

## MODE DESCRIPTION

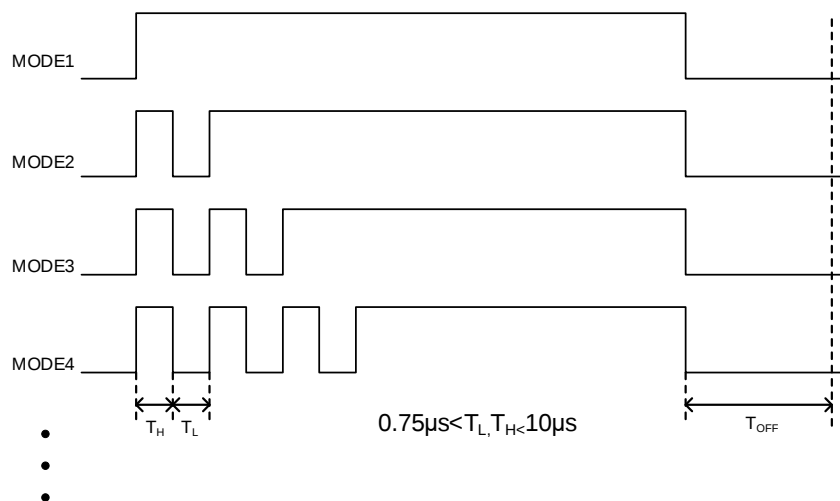
| Mode | Enable Signal                                                                       | Gain (dB) | DPM Power (W)         |                       | Class-D EN | Charge Pump EN | Speaker Mode | DPM | Receiver Mode | PSRR Enhance | EXT-RES EN | Comment                               |
|------|-------------------------------------------------------------------------------------|-----------|-----------------------|-----------------------|------------|----------------|--------------|-----|---------------|--------------|------------|---------------------------------------|
|      |                                                                                     |           | $R_L=8\Omega+33\mu H$ | $R_L=6\Omega+33\mu H$ |            |                |              |     |               |              |            |                                       |
| 1    |  | 18        |                       |                       | Y          | Y              | Y            |     |               | Y            |            | SPK MODE 18dB DPM disable             |
| 2    |  | 18        | 1.2                   | 1.6                   | Y          | Y              | Y            | Y   |               | Y            |            | SPK MODE 18dB DPM enable              |
| 3    |  | 18        | 1.0                   | 1.33                  | Y          | Y              | Y            | Y   |               | Y            |            | SPK MODE 18dB DPM enable              |
| 4    |  | 18        | 0.8                   | 1.06                  | Y          | Y              | Y            | Y   |               | Y            |            | SPK MODE 18dB DPM enable              |
| 5    |  | 18        | 1.2                   | 1.6                   | Y          | Y              | Y            | Y   |               | Y            |            |                                       |
| 6    |  | 18        | 1.0                   | 1.33                  | Y          | Y              | Y            | Y   |               | Y            |            |                                       |
| 7    |  | 0         |                       |                       | Y          |                |              |     | Y             | Y            |            | RCV MODE 0dB                          |
| 8    |  | 3         |                       |                       | Y          |                |              |     | Y             | Y            |            | RCV MODE 3dB                          |
| 9    |  | 18        |                       |                       | Y          | Y              |              |     |               | Y            | Y          | EXT RES=10k SPK MODE 18dB DPM disable |
| 10   |  | 18        | 1.2                   | 1.6                   | Y          | Y              | Y            | Y   |               | Y            | Y          | EXT RES=10k SPK MODE 18dB DPM enable  |
| 11   |  | 18        | 1.0                   | 1.33                  | Y          | Y              | Y            | Y   |               | Y            | Y          | EXT RES=10k SPK MODE 18dB DPM enable  |
| 12   |  | 18        | 0.8                   | 1.06                  | Y          | Y              | Y            | Y   |               | Y            | Y          | EXT RES=10k SPK MODE 18dB DPM enable  |
| 13   |  | 18        | 1.2                   | 1.6                   | Y          | Y              | Y            | Y   |               | Y            | Y          |                                       |
| 14   |  | 18        | 1.0                   | 1.33                  | Y          | Y              | Y            | Y   |               | Y            | Y          |                                       |
| 15   |  | 0/3/6     |                       |                       | Y          |                | Y            |     |               | Y            | Y          | EXT RES=10k/4.5k/1k                   |

## DETAILED FUNCTIONAL DESCRIPTION

BCT8902 is designed to enhance smart mobile phone sound quality, which is a new high efficiency, low noise, ultra-low distortion, constant large volume, upgrading fifteenth generation Class T audio amplifier. Using a new generation T-Charge pump technology, efficiency reach 93%, power amplifier's overall efficiency is up to 80%, greatly prolong the mobile phone usage time. The BCT8902 noise floor is as low as to 36 $\mu$ V, with 102dB high signal-to-noise-ratio (SNR). The ultra-low distortion 0.009% and unique Digital Power Modulation (DPM) technology brings high quality music enjoyment.

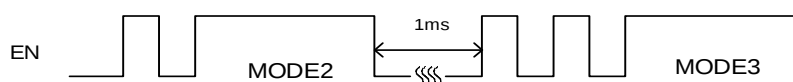
### One Wire Pulse Control

BCT8902 select each mode through the detection of number of the pulse signal rising edge of EN pin, as shown in figure: When EN pin pull high from shutdown mode, there is only a rising edge, BCT8902 enter into mode 1, DPM disable; When high-low-high signal set to EN pin, there are two rising edges, BCT8902 enter into mode 2, DPM output power is 1.2W; When there are three rising edges, BCT8902 enter into mode 3, DPM output power is 1.0W..... BCT8902 has fifteen operation modes, the number of the rising edges does not allow more than fifteen.



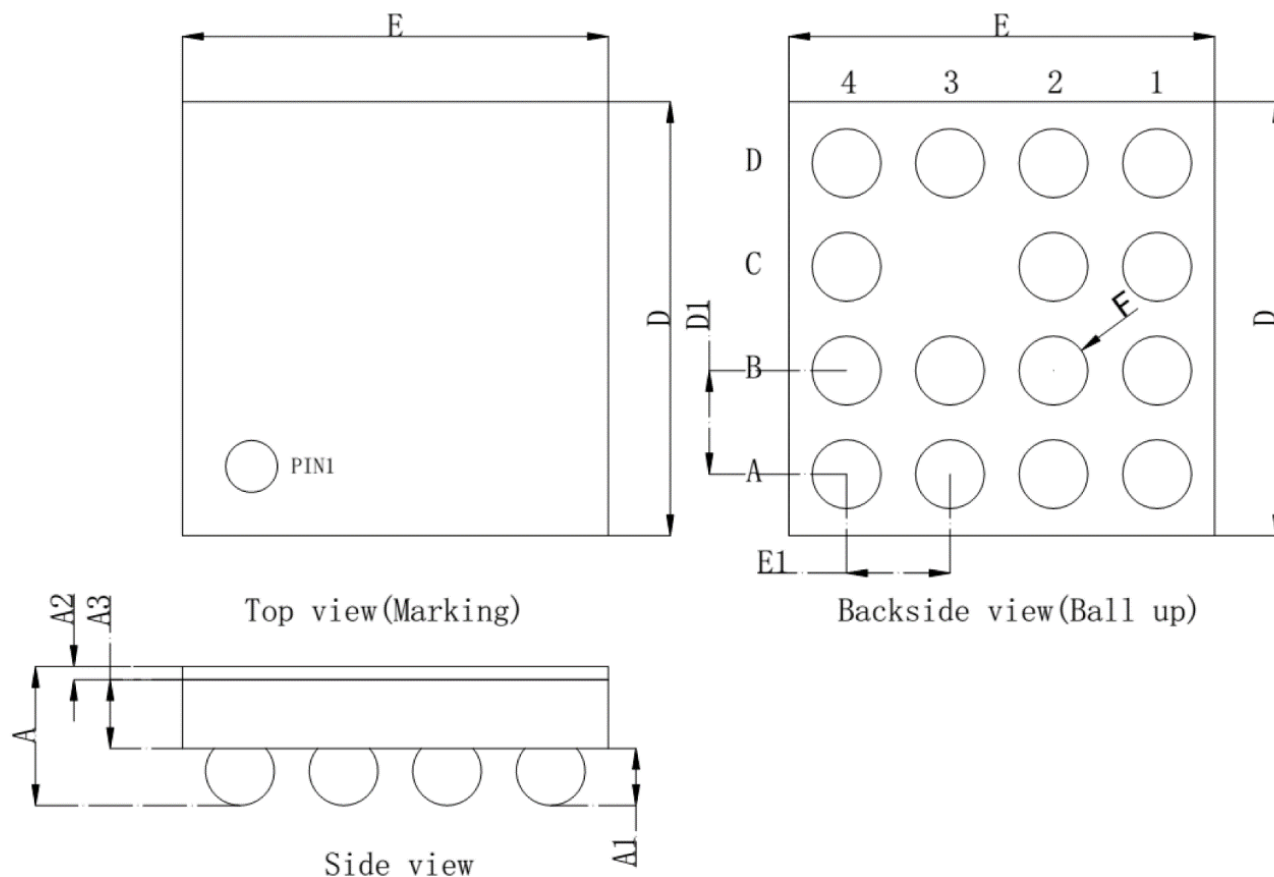
### One Wire Pulse Control

When BCT8902 needs to work in different mode, PIN EN should be pull low longer than  $T_{OFF}$  first (recommended 1ms) which make the BCT8902 shut down, then send series pulse make the BCT8902 enter into right mode



### One Wire Pulse Control Switching Sequence

## PACKAGE OUTLINE DIMENSIONS



| Parameter                | Symbol | Min         | Nominal | Max    |
|--------------------------|--------|-------------|---------|--------|
|                          |        | Millimeters |         |        |
| Package Body Dimension X | E      | 1.625       | 1.645   | 1.665  |
| Package Body Dimension Y | D      | 1.655       | 1.675   | 1.695  |
| Package Height           | A      | 0.550       | 0.580   | 0.610  |
| Si thickness             | A3     | 0.3225      | 0.335   | 0.3475 |
| Bump Height              | A1     | 0.185       | 0.205   | 0.225  |
| Bump Diameter            | F      | 0.245       | 0.265   | 0.285  |
| BC Thickness             | A2     | 0.035       | 0.040   | 0.045  |
| Ball Pitch X axis (min.) | E1     | /           | 0.400   | /      |
| Ball Pitch Y axis (min.) | E2     | /           | 0.400   | /      |