## 380kHz, 2A Asynchronous DC-DC Buck Converter — AP3201A

## General Description

The AP3201A is a 380kHz fixed frequency, current mode, PWM buck (step-down) DC-DC converter, capable of driving a 2A load with high efficiency, excellent line and load regulation. The device integrates N-channel power MOSFET switch with low on-resistance. Current mode control provides fast transient response and cycle-by-cycle current limit.

A standard series of inductors are available from several different manufacturers optimized for use with the AP3201A. This feature greatly simplifies the design of switch-mode power supplies.

This IC is available in HMSOP-10 package.

## Features

- Input Voltage Range: 4.75V to 18V
- Fixed 380kHz Frequency
- High Efficiency: up to 93%
- Output Current: 2A
- Current Mode Control
- Built-in Over Current Protection
- Built-in Thermal Shutdown Function
- Built-in UVLO Function
- Built-in Over Voltage Protection
- Programmable Soft-start

## Applications

- LCD TV
- Set Top Box
- Portable DVD
- Digital Photo Frame



HMSOP-10

Figure 1. Package Type of AP3201A

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## Pin Configuration

MH Package
(HMSOP-10)
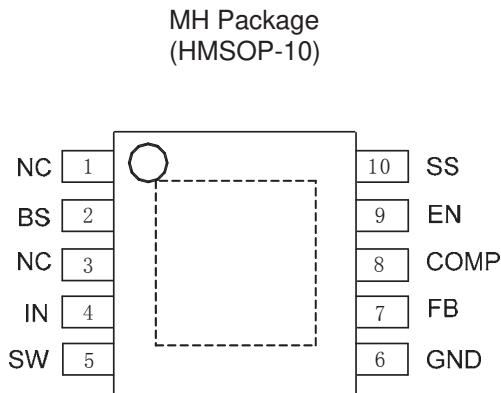


Figure 2. Pin Configuration of AP3201A (Top View)

## Pin Description

| Pin Number | Pin Name | Function |
|:---:|:---:|:---|
| 1, 3 | NC | No connection or tied to ground |
| 2 | BS | Bootstrap pin. A bootstrap capacitor is connected between the BS pin and SW pin. The voltage across the bootstrap capacitor drives the internal high-side power MOSFET |
| 4 | IN | Supply input pin. A capacitor should be connected between the IN pin and GND pin to keep the input voltage constant |
| 5 | SW | Power switch output pin. This pin is connected to the inductor and bootstrap capacitor |
| 6 | GND | Ground pin |
| 7 | FB | Feedback pin. This pin is connected to an external resistor divider to program the system output voltage. When the FB pin voltage exceeds 20% of the nominal regulation value of 0.920V, the over voltage protection is triggered. When the FB pin voltage is below 0.6V, the oscillator frequency is lowered to realize short circuit protection |
| 8 | COMP | Compensation pin. This pin is the output of the transconductance error amplifier and the input to the current comparator. It is used to compensate the control loop. Connect a series RC network from this pin to GND. In some cases, an additional capacitor from this pin to GND pin is required |
| 9 | EN | Control input pin. Forcing this pin above 1.5V or set this pin floating enables the IC. Forcing this pin below 0.5V shuts down the IC. When the IC is in shutdown mode, all functions are disabled to decrease the supply current below 1μA |
| 10 | SS | Soft-start control input pin. SS controls the soft start period. Connect a capacitor from SS to GND to set the soft-start period. A 0.1μF capacitor sets the soft-start period to 10ms. To disable the soft-start feature, leave SS unconnected |

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## Functional Block Diagram
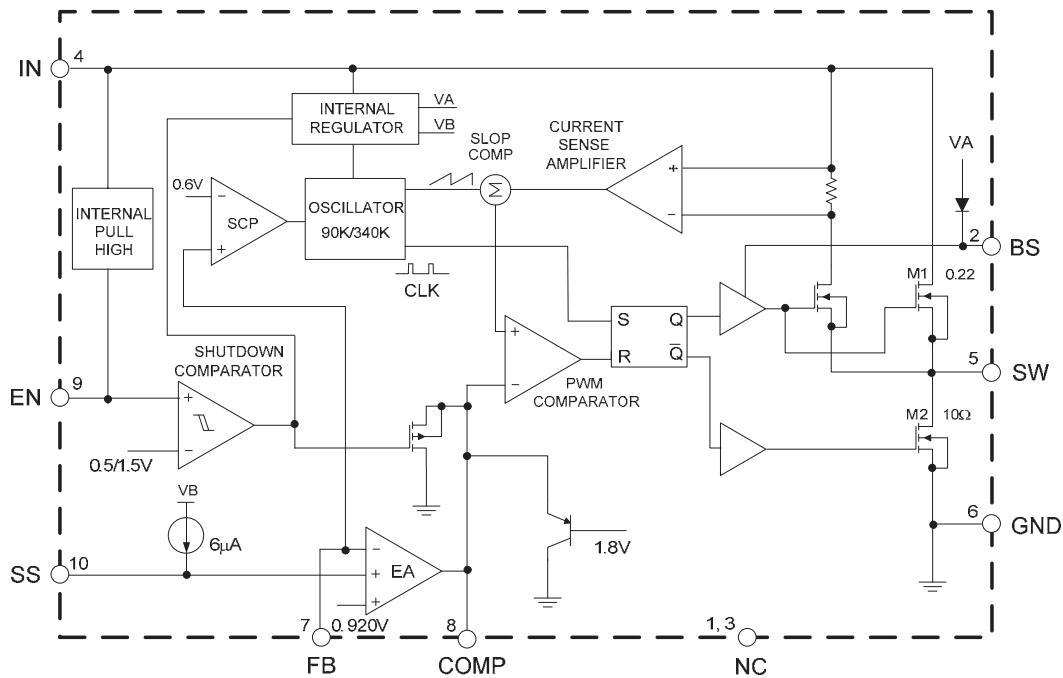


Figure 3. Functional Block Diagram of AP3201A

## Ordering Information

AP3201A □ □ - □

Circuit Type

Package
MH: HMSOP-10

G1: Green
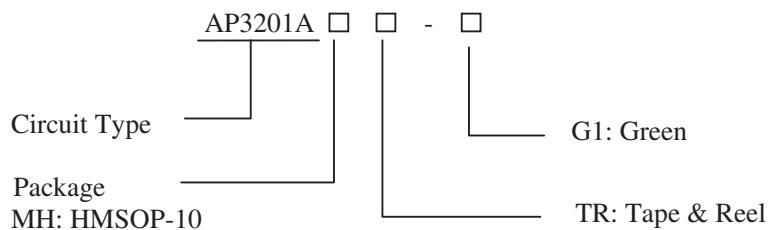
TR: Tape & Reel

| Package | Temperature Range | Part Number | Marking ID | Packing Type |
|---|---|---|---|---|
| HMSOP-10 | -40 to 85ºC | AP3201AMHTR-G1 | 3201AMH-G1 | Tape & Reel |

BCD Semiconductor's Pb-free products, as designated with "G1" suffix in the part number, are RoHS compliant and green.

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## Absolute Maximum Ratings (Note 1)

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| IN Pin Voltage | $V_{IN}$ | -0.3 to 20 | V |
| EN Pin Voltage | $V_{EN}$ | -0.3 to $V_{IN}$ | V |
| SW Pin Voltage | $V_{SW}$ | 20 | V |
| BS Pin Voltage | $V_{BS}$ | -0.3 to $V_{SW}$+6 | V |
| FB Pin Voltage | $V_{FB}$ | -0.3 to 6 | V |
| COMP Pin Voltage | $V_{COMP}$ | -0.3 to 6 | V |
| SS Pin Voltage | $V_{SS}$ | -0.3 to 6 | V |
| Thermal Resistance | $\theta_{JA}$ | 60 | ℃/W |
| Operating Junction Temperature | $T_J$ | 150 | ℃ |
| Storage Temperature | $T_{STG}$ | -65 to 150 | ℃ |
| Lead Temperature (Soldering, 10sec) | $T_{LEAD}$ | 260 | ℃ |
| ESD (Machine Model) | | 200 | V |
| ESD (Human Body Model) | | 2000 | V |

Note 1: Stresses greater than 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 under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

## Recommended Operating Conditions

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | 4.75 | 18 | V |
| Maximum Output Current | $I_{OUT (Max)}$ | 2 | | A |
| Operating Ambient Temperature | $T_A$ | -40 | 85 | ℃ |

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## Electrical Characteristics

$V_{IN}=V_{EN}=12V$, $V_{OUT}=3.3V$, unless otherwise specified. Specification with standard typeface are for $T_A=25$ ºC, and those in **boldface type** apply over the full operating temperature range ($T_A=-40$ ºC to 85 ºC)

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | | 4.75 | | 18 | V |
| Quiescent Current | $I_Q$ | $V_{FB}=1.0V$, $V_{EN}=2V$ | | 1.0 | 1.5 | mA |
| Shutdown Supply Current | $I_{SHDN}$ | $V_{EN}=0V$ | | 1 | 10 | μA |
| Feedback Voltage | $V_{FB}$ | | **0.902** | **0.920** | **0.938** | V |
| Feedback Over Voltage Threshold | $V_{FBOV}$ | | | 1.1 | | V |
| Feedback SCP Voltage Threshold | $V_{FBSCP}$ | | | 0.6 | | V |
| Feedback Bias Current | $I_{FB}$ | $V_{FB}=1V$ | -0.1 | | 0.1 | μA |
| High-side Switch On-resistance (Note 2) | $R_{DSONH}$ | $I_{SW}=0.5A$ | | 0.22 | | Ω |
| Low-side Switch On-resistance (Note 2) | $R_{DSONL}$ | $I_{SW}=0.05A$ | | 10 | | Ω |
| High-side Switch Leakage Current | $I_{LEAKH}$ | $V_{IN}=18V$, $V_{EN}=0V$ $V_{SW}=0V$ | | 0.1 | 10 | μA |
| High-side Switch Current Limit | $I_{LIMH}$ | | 2.8 | 3.8 | | A |
| Low-side Switch Current Limit | $I_{LIML}$ | From drain to source | | 0.15 | | A |
| EN Pin Threshold | $V_{ENH}$ | | 1.5 | | | V |
| | $V_{ENL}$ | | | | 0.5 | |
| EN Pull-up Current | $I_{EN-PH}$ | $V_{EN}=0V$ | | 1.0 | | μA |
| Input UVLO Threshold | $V_{UVLO}$ | $V_{IN}$ Rising | 3.5 | 3.9 | 4.4 | V |
| Input UVLO Hysteresis | $V_{HYS}$ | | | 0.3 | | V |
| Oscillator Frequency | $F_{OSC1}$ | | | 380 | | kHz |
| Short Circuit Oscillator Frequency | $F_{OSC2}$ | | | 90 | | kHz |
| Maximum Duty Cycle | $D_{MAX}$ | $V_{FB}=0.8V$ | | 90 | | % |
| Minimum Duty Cycle | $D_{MIN}$ | $V_{FB}=1.0V$ | | | 0 | % |
| Error Amplifier Voltage Gain (Note 3) | $A_{EA}$ | | | 400 | | V/V |
| Error Amplifier Transconductance | $G_{EA}$ | | | 700 | | μA/V |
| COMP to Current Sense Transconductance | $G_{CS}$ | | | 2.4 | | A/V |
| Thermal Shutdown (Note 3) | $T_{OTSD}$ | | | 160 | | ºC |
| Thermal Shutdown Hysteresis (Note 3) | $T_{HYS}$ | | | 30 | | ºC |
| Soft-start Time (Note 3) | $t_{SS}$ | $I_{OUT}=500mA$ $C_{SS}=0.1μF$ | | 10 | | ms |
| Soft-start Current | $I_{SS}$ | | | 6 | | μA |

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Note 2: $R_{DSON} = \dfrac{V_{SW1} - V_{SW2}}{I_{SW1} - I_{SW2}}$

Note 3: Not tested, guaranteed by design.

## Typical Performance Characteristics

$T_A$=25ºC, $V_{IN}$=12V, $V_{OUT}$=3.3V, unless otherwise noted.
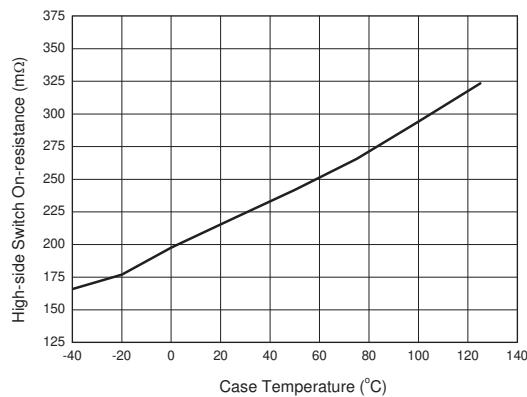


Figure 4. High-side Switch On-resistance vs.
Case Temperature
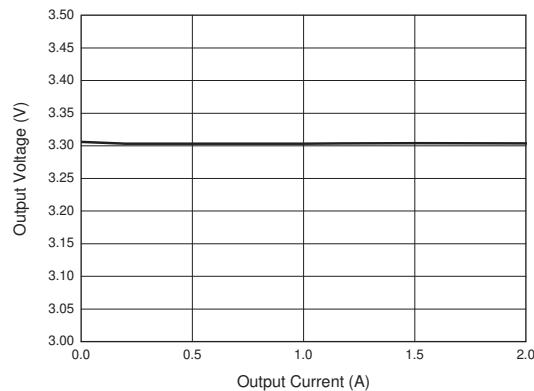


Figure 5. Output Voltage vs. Output Current
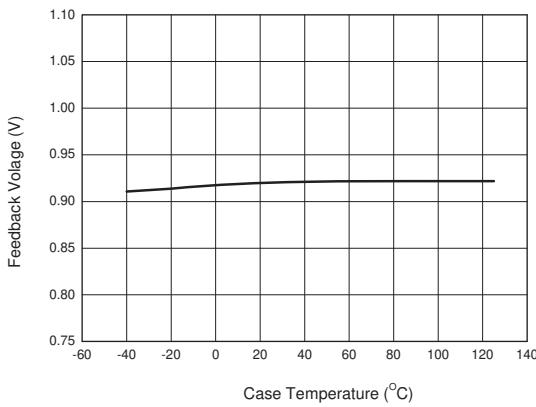


Figure 6. Feedback Voltage vs. Case Temperature
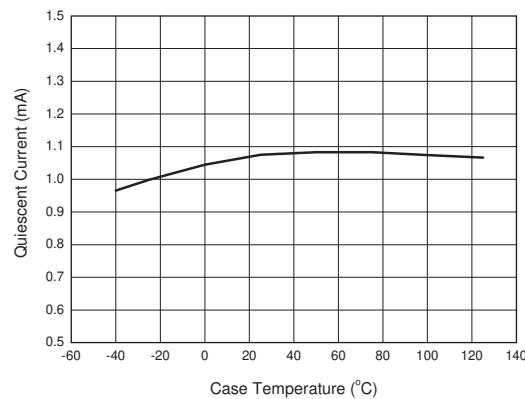


Figure 7. Quiescent Current vs. Case Temperature

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## Typical Performance Characteristics (Continued)

$T_A$=25ºC, $V_{IN}$=12V, $V_{OUT}$=3.3V, unless otherwise noted.

Time (2μs/div)
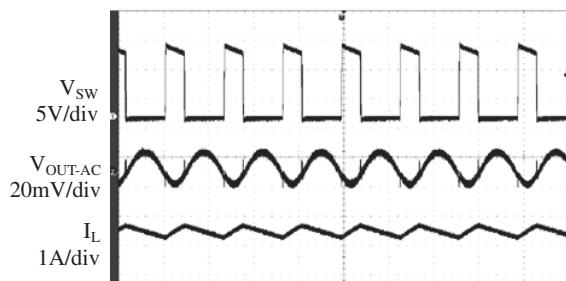
Figure 8. Output Ripple ($I_{OUT}$=2A)
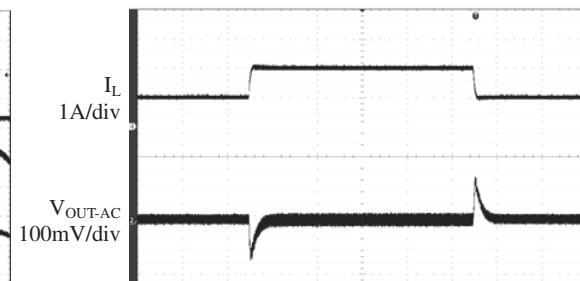
Time (200μs/div)

Figure 9. Load Transient ($I_{OUT}$=1 to 2A)
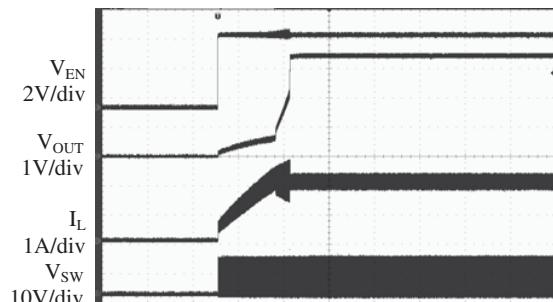
Time (10ms/div)

Figure 10. Enable Turn on Characteristic
($I_{OUT}$=2A, CC Mode)
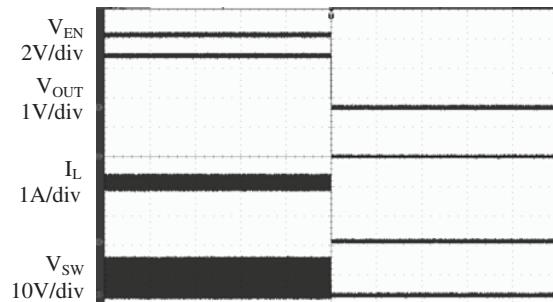
Time (10ms/div)

Figure 11. Enable Turn off Characteristic
($I_{OUT}$=2A, CC Mode)

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## Typical Performance Characteristics (Continued)

$T_A$=25 ℃, $V_{IN}$=12V, $V_{OUT}$=3.3V, unless otherwise noted.



Time  (100μs/div)
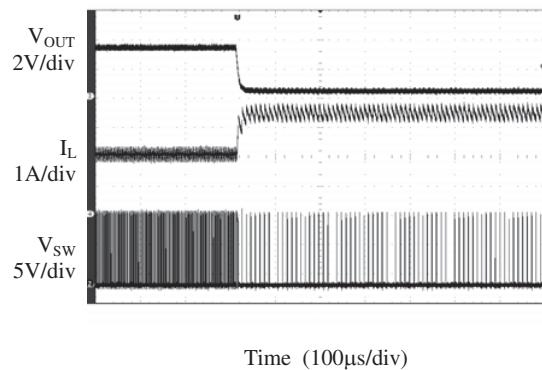
Figure 12. Short Circuit Protection
($I_{OUT}$=2A)



Time  (100μs/div)
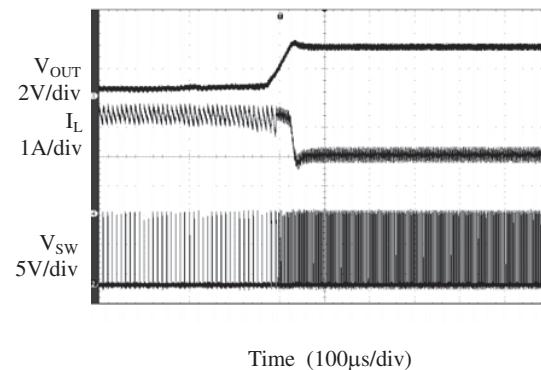
Figure 13. Short Circuit Recovery
($I_{OUT}$=2A)

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## Typical Application
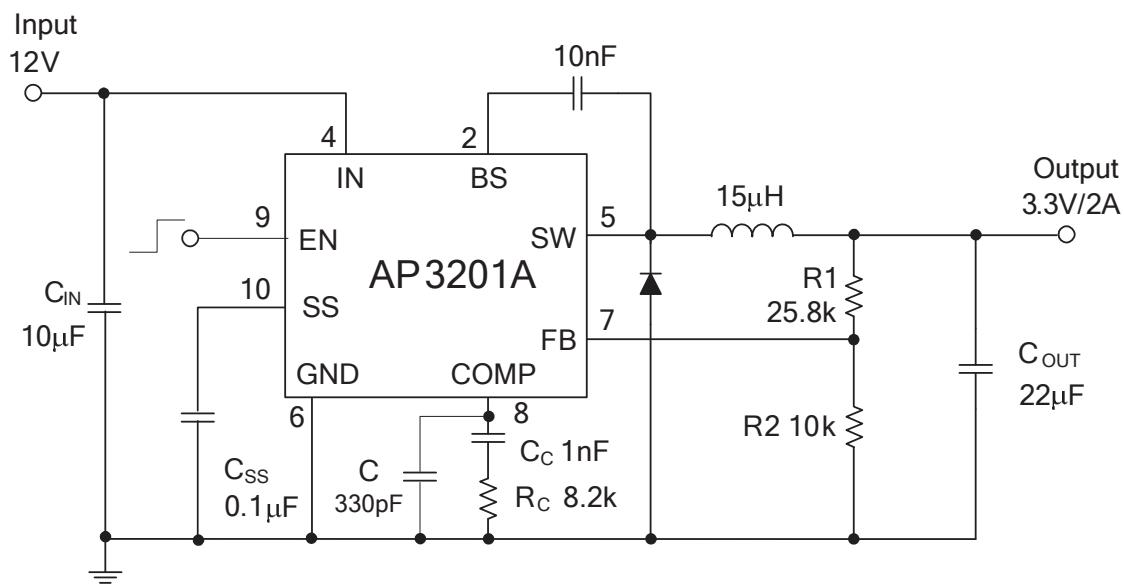


Figure 14. Typical Application of AP3201A

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## Mechanical Dimensions

### HMSOP-10                    Unit: mm(inch)
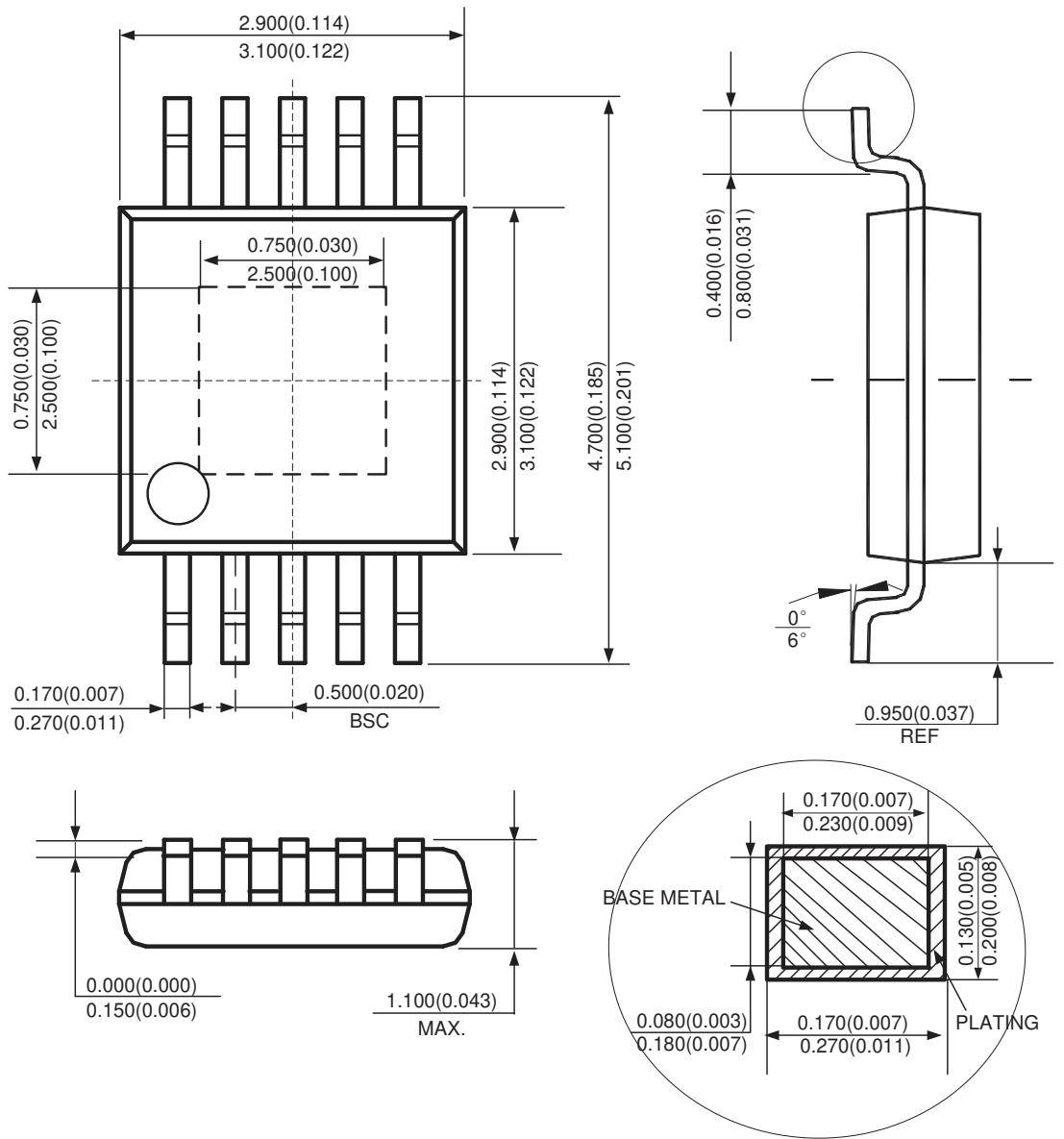


Note: 1.  Eject hole, oriented hole and mold mark is optional.
      2.  The figure of exposed pad is not restrained as regular rectangle.

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