

## Features

- Resolution 12 Bits
- Conversion Rate 500MSPS
- SFDR: > 65dB
- Programmable (nominal) input voltage range: 1.18 V p-p to 1.6 V p-p
- PIN compatible with AD9434 series

## Applications

- Receiver
- Radar and satellite subsystems
- Linearization of power amplifiers
- Communication testing equipment
- Wireless and broadband communication

## Description

CBM94AD34 is a 12 bit, single-chip sampling analog-to-digital converter (ADC) designed specifically for high performance, low power consumption, and ease of use. Its conversion rate can reach 500 MSPS, and it has excellent dynamic performance in broadband applications. All required functions are integrated on the chip, including a sampling and holding amplifier (SHA) and an on chip reference voltage source, to provide a complete signal conversion solution. The  $V_{REF}$  pin can be used to change the internal reference voltage or accept a reference voltage from an external source (the external reference mode needs to be enabled through the SPI port).

This ADC requires a 1.8 V analog power supply and a differential clock to maintain excellent overall ADC performance. The digital output is compatible with LVDS (ANSI-644), and the data format is binary complement, Gray code or offset binary. There is a data output clock to ensure that the corresponding data output has the correct timing.

This product is manufactured using SiGe BiCMOS technology, with 56 lead plastic packaging (QFN56), which can effectively replace ADI's AD9434BCPZ-500 in the United States.

## Functional Block Diagram

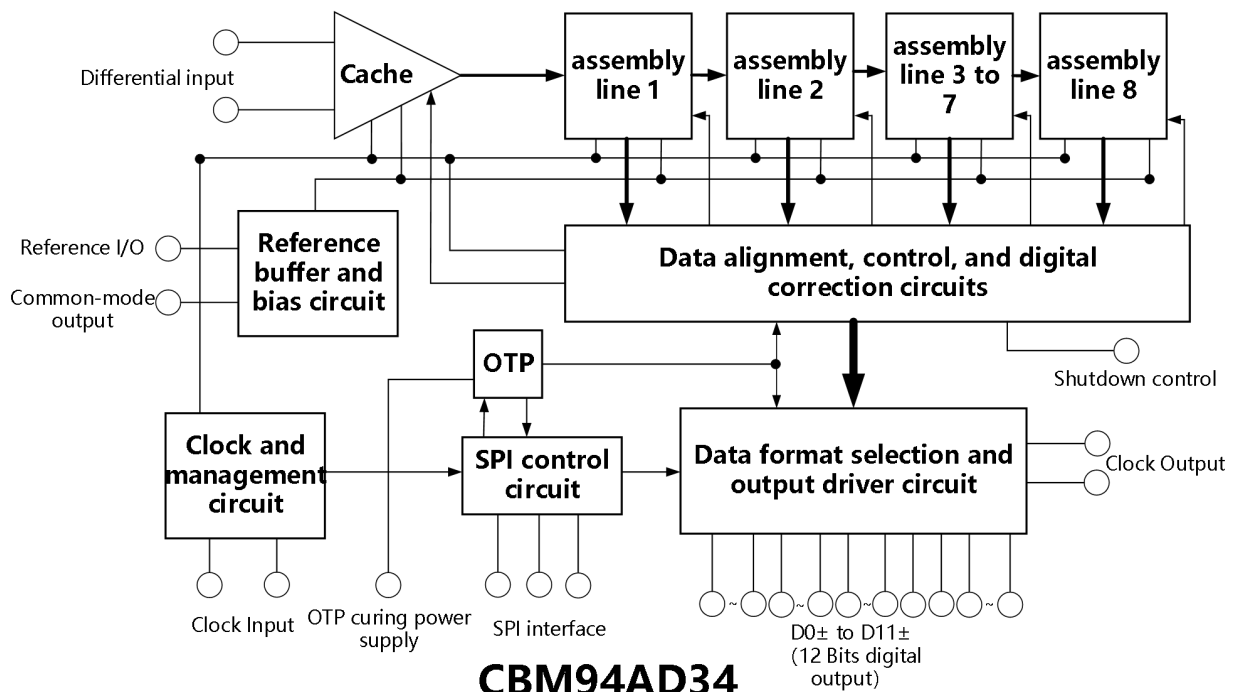


Figure 1. Functional block diagram

## Catalog

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## Revision Log

| Version | Revision date | Change content    | Reason for Change    | Modified by | Reviewed By | Note |
|---------|---------------|-------------------|----------------------|-------------|-------------|------|
| V1.0    | 2025.9.10     | Update QFN-56 POD | updates and upgrades | WW          | LYL         |      |

## Pin Configurations and Function Descriptions

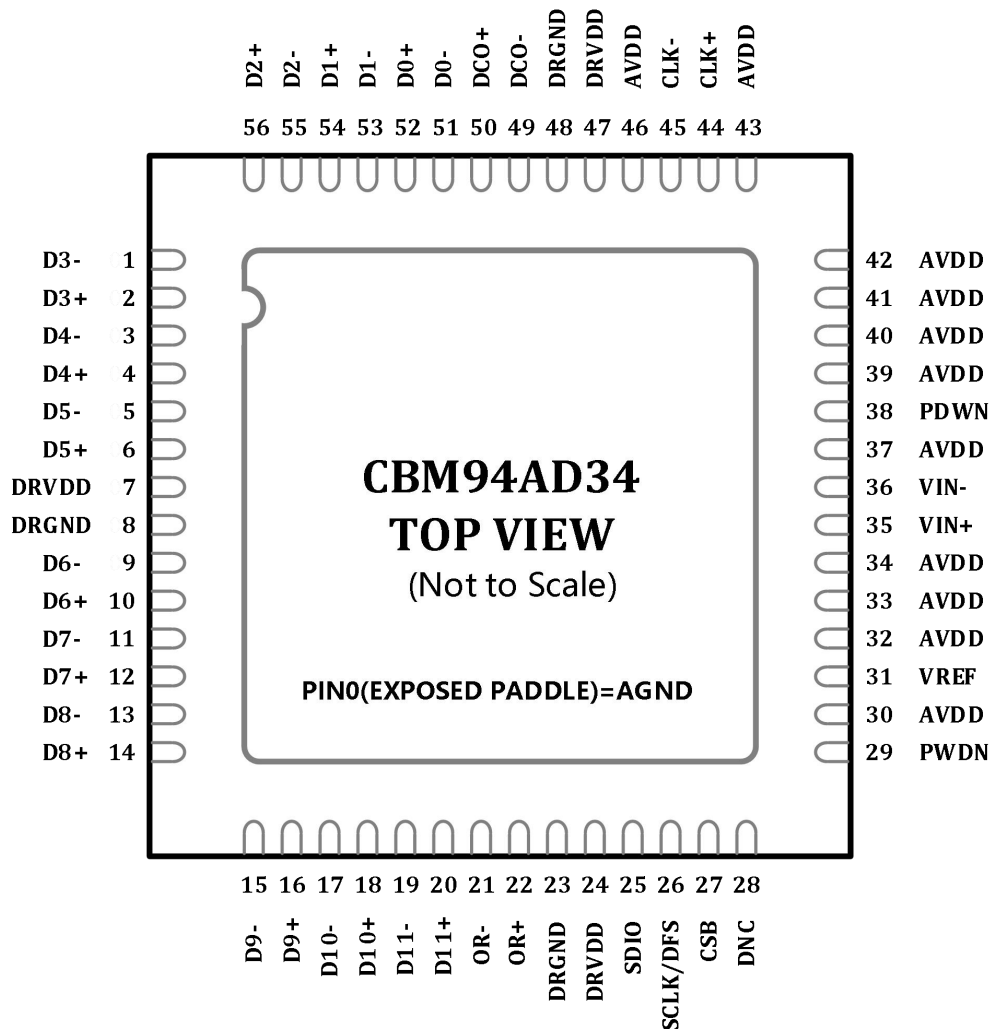


Figure 2. Pin Configuration

| Pin No. | Mnemonic | Description                                                           |
|---------|----------|-----------------------------------------------------------------------|
| 0       | AGND     | Analog Ground. The exposed paddle must be soldered to a ground plane. |
| 1       | D3-      | D3 Complement Output.                                                 |
| 2       | D3+      | D3 True Output.                                                       |
| 3       | D4-      | D4 Complement Output.                                                 |
| 4       | D4+      | D4 True Output.                                                       |
| 5       | D5-      | D5 Complement Output.                                                 |
| 6       | D5+      | D5 True Output.                                                       |

|                                  |          |                                                                                                                                   |
|----------------------------------|----------|-----------------------------------------------------------------------------------------------------------------------------------|
| 7,24,47                          | DRVDD    | 1.8 V Digital Output Supply.                                                                                                      |
| 8,23,48                          | DRGND    | Digital Output Ground.                                                                                                            |
| 9                                | D6-      | D6 Complement Output.                                                                                                             |
| 10                               | D6+      | D6 True Output.                                                                                                                   |
| 11                               | D7-      | D7 Complement Output.                                                                                                             |
| 12                               | D7+      | D7 True Output.                                                                                                                   |
| 13                               | D8-      | D8 Complement Output.                                                                                                             |
| 14                               | D8+      | D8 True Output.                                                                                                                   |
| 15                               | D9-      | D9 Complement Output.                                                                                                             |
| 16                               | D9+      | D9 True Output.                                                                                                                   |
| 17                               | D10-     | D10 Complement Output.                                                                                                            |
| 18                               | D10+     | D10 True Output.                                                                                                                  |
| 19                               | D11-     | D11 Complement Output (MSB).                                                                                                      |
| 20                               | D11+     | D11 True Output (MSB).                                                                                                            |
| 21                               | OR-      | Overrange Complement Output.                                                                                                      |
| 22                               | OR+      | Overrange True Output.                                                                                                            |
| 25                               | SDIO     | Serial Port Interface (SPI) Data Input/Output (Serial Port Mode).                                                                 |
| 26                               | SCLK/DFS | Serial Port Interface Clock (Serial Port Mode)/Data Format Select (External Pin Mode).                                            |
| 27                               | CSB      | Serial Port Chip Select (Active Low).                                                                                             |
| 28                               | DNC      | Do Not Connect. Do not connect to this pin. This pin should be left floating.                                                     |
| 29                               | PWDN     | Chip Power-Down.                                                                                                                  |
| 30,32 to 34,37 to 39,41 to 43,46 | AVDD     | 1.8 V Analog Supply.                                                                                                              |
| 35                               | VIN+     | Analog Input—True.                                                                                                                |
| 36                               | VIN-     | Analog Input—Complement.                                                                                                          |
| 40                               | CML      | Common-Mode Output. Enabled through the SPI, this pin provides a reference for the optimized internal bias voltage for VIN+/VIN-. |
| 44                               | CLK+     | Clock Input—True.                                                                                                                 |
| 45                               | CLK-     | Clock Input—Complement.                                                                                                           |
| 49                               | DCO-     | Data Clock Output—Complement.                                                                                                     |
| 50                               | DCO+     | Data Clock Output—True.                                                                                                           |

|    |     |                       |
|----|-----|-----------------------|
| 51 | D0- | D0 Complement Output. |
| 52 | D0+ | D0 True Output.       |
| 53 | D1- | D1 Complement Output. |
| 54 | D1+ | D1 True Output.       |
| 55 | D2- | D2 Complement Output. |
| 56 | D2+ | D2 True Output.       |

## Recommended Operation Conditions

- Operating Frequency ( $f_{CLK}$ ):  $\leq 500\text{MHz}$
- Analog power supply voltage( $V_{CC}$ ):  $1.75\text{V} \sim 1.9\text{V}$
- Digital power supply voltage( $V_{DD}$ ):  $1.75\text{V} \sim 1.9\text{V}$
- Analog input common mode voltage( $V_{IC}$ ):  $1.6\text{V} \sim 1.8\text{V}$
- Operating temperature( $T_A$ ):  $-40^{\circ}\text{C} \sim 85^{\circ}\text{C}$
- Input signal amplitude range (peak to peak): ( $V_{IN(P-P)} \leq 1.5\text{V}$ )

## Absolute Maximum Ratings

- Analog power supply voltage( $V_{CC}$ ):  $2\text{V}$
- Digital power supply voltage( $V_{DD}$ ):  $2\text{V}$
- Storage temperature  $T_S$ :  $-65^{\circ}\text{C} \sim 150^{\circ}\text{C}$
- Junction temperature  $T_J$ :  $175^{\circ}\text{C}$
- Lead Temperature (Soldering, 10 sec):  $300^{\circ}\text{C}$

## Electrical Characteristics

$V_{CC}=1.8\text{V}$ ,  $V_{DD}=1.8\text{V}$ ,  $\text{GND}=\text{GND}_D=0\text{V}$ ,  $V_{IN(P-P)} \leq 1.5\text{V}$ ,  $-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , unless otherwise noted.

Table1.

| Parameter name               | Symbol   | Conditions | Electrical characteristics |     |     | Unit |
|------------------------------|----------|------------|----------------------------|-----|-----|------|
|                              |          |            | Min                        | Typ | Max |      |
| Resolution                   | RES      |            | 12                         |     |     | bits |
| Offset Error                 | $E_O$    |            | -5.0                       | --  | 5.0 | mV   |
| Gain error                   | $E_G$    |            | -9                         | --  | 9   | %FS  |
| Differential linearity error | $E_{DL}$ |            | -1.5                       | --  | 1.5 | LSB  |
| Integral Linearity Error     | $E_L$    |            | -4.5                       | --  | 4.5 | LSB  |

|                                                                                                                                      |           |                                                                     |      |    |      |      |
|--------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------------------------------------------------------------|------|----|------|------|
| Internal reference voltage                                                                                                           | $V_{REF}$ |                                                                     | 0.7  | -- | 0.8  | LSB  |
| Power supply current                                                                                                                 | $I$       |                                                                     | --   | -- | 500  | mA   |
| LVDS differential output voltage                                                                                                     | $V_{OD}$  |                                                                     | 200  | -- | 500  | mV   |
| LVDS common mode output voltage                                                                                                      | $V_{OS}$  |                                                                     | 1.0  | -- | 1.45 | V    |
| power dissipation                                                                                                                    | $P_D$     |                                                                     | --   | -- | 900  | mW   |
| Standby power                                                                                                                        | $P_{SDB}$ |                                                                     | --   | -- | 60   | mW   |
| Powerdown consumption                                                                                                                | $P_{PDN}$ |                                                                     | --   | -- | 12   | mW   |
| Signal to Noise Ratio                                                                                                                | SNR       | $f_{CLK}=500MHz, T_A=25^{\circ}C, f_{IN}=30.3MHz$                   | 63   | -- | --   | dBFS |
|                                                                                                                                      |           | $f_{CLK}=500MHz, T_A=25^{\circ}C, f_{IN}=450.3MHz$                  | 61   | -- | --   |      |
|                                                                                                                                      |           | $f_{CLK}=500MHz, T_A=-40^{\circ}C \sim 85^{\circ}C, f_{IN}=30.3MHz$ | 58   | -- | --   |      |
| Signal-to-noise distortion ratio                                                                                                     | SINAD     | $f_{CLK}=500MHz, T_A=25^{\circ}C, f_{IN}=30.3MHz$                   | 62   | -- | --   | dBFS |
|                                                                                                                                      |           | $f_{CLK}=500MHz, T_A=25^{\circ}C, f_{IN}=450.3MHz$                  | 60   | -- | --   |      |
|                                                                                                                                      |           | $f_{CLK}=500MHz, T_A=-40^{\circ}C \sim 85^{\circ}C, f_{IN}=30.3MHz$ | 57   | -- | --   |      |
| Effective number of bits                                                                                                             | ENOB      | $f_{CLK}=500MHz, T_A=25^{\circ}C, f_{IN}=30.3MHz$                   | 10.0 | -- | --   | bits |
|                                                                                                                                      |           | $f_{CLK}=500MHz, T_A=25^{\circ}C, f_{IN}=450.3MHz$                  | 9.5  | -- | --   |      |
|                                                                                                                                      |           | $f_{CLK}=500MHz, T_A=-40^{\circ}C \sim 85^{\circ}C, f_{IN}=30.3MHz$ | 9.2  | -- | --   |      |
| Spurious free dynamic range                                                                                                          | SFDR      | $f_{CLK}=500MHz, T_A=25^{\circ}C, f_{IN}=30.3MHz$                   | 72   | -- | --   | dBFS |
|                                                                                                                                      |           | $f_{CLK}=500MHz, T_A=25^{\circ}C, f_{IN}=450.3MHz$                  | 66   | -- | --   |      |
|                                                                                                                                      |           | $f_{CLK}=500MHz, T_A=-40^{\circ}C \sim 85^{\circ}C, f_{IN}=30.3MHz$ | 65   | -- | --   |      |
| Data propagation delay                                                                                                               | $t_{PD}$  |                                                                     | --   | -- | 10   | ns   |
| Note: The power supply current is the sum of analog power supply current ( $I_{CC}$ ) and digital power supply current ( $I_{DD}$ ). |           |                                                                     |      |    |      |      |

## Operating Characteristic Curves

### 1. DNL and INL test results

Test conditions: Sampling rate:  $f_{CLK}=500\text{MHz}$ ; Input signal frequency  $f_{IN}=30.3\text{MHz}$ ; Test result:

DNL:  $-0.51/+0.49$  LSB

INL:  $-1.1/+1.1$  LSB

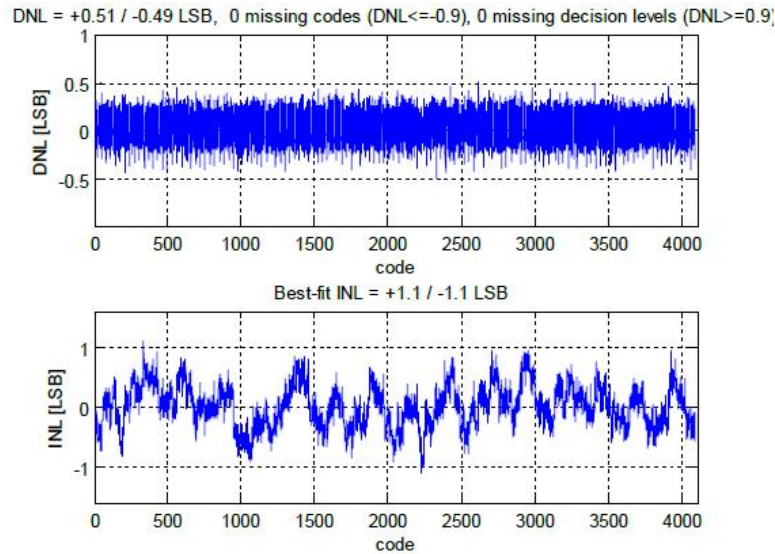


Figure 3. DNL and INL test results

### 2. Dynamic parameter test results

Test conditions: Sampling rate:  $f_{CLK}=499.999970304\text{MHz}$ ;

Input signal frequency  $f_{IN}=30.28867830\text{MHz}$ ;

Test results: SFDR=79.23dBFS;  $HD_{2,3\text{rd}}=78.89\text{dBFS}$ ;  $HD_{4\text{rd}}=81.48\text{dBFS}$ ; SNR=65.6dBFS;

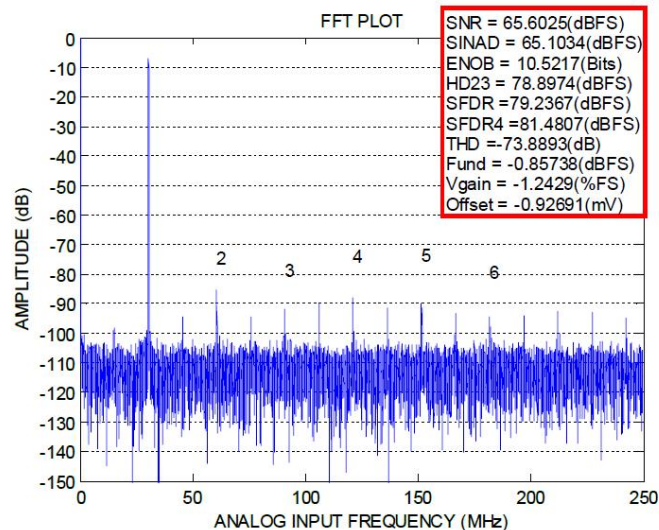


Figure 4. Dynamic Indicator Test Results

### 3. Curve of SNR and SFDR with sampling frequency

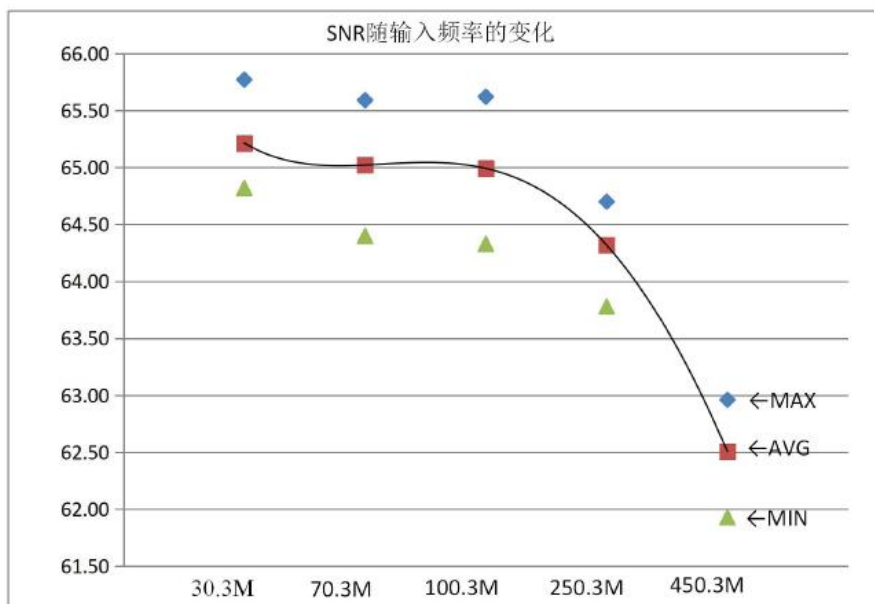


Figure 5. SNR variation curve with sampling frequency

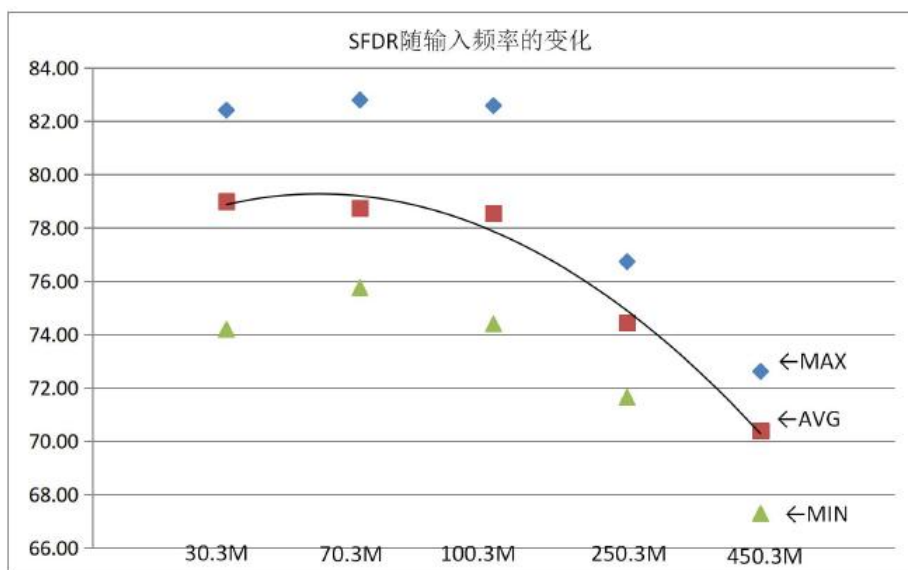


Figure 6. SFDR variation curve with sampling frequency

## Typical Application Circuits

### 1. Analog input circuit

When driving the CBM94AD34 through differential input configuration, the optimal performance of the chip can be achieved. In baseband applications, the AD8138 differential driver can provide excellent performance and flexible interfaces for ADC. The output common mode voltage of AD8138 can be easily set to  $AVDD/2 + 0.5\text{ V}$ , and this driver can be configured as Sallen Key filter topology circuit structure, so as to Bandwidth throttling of the input signal.

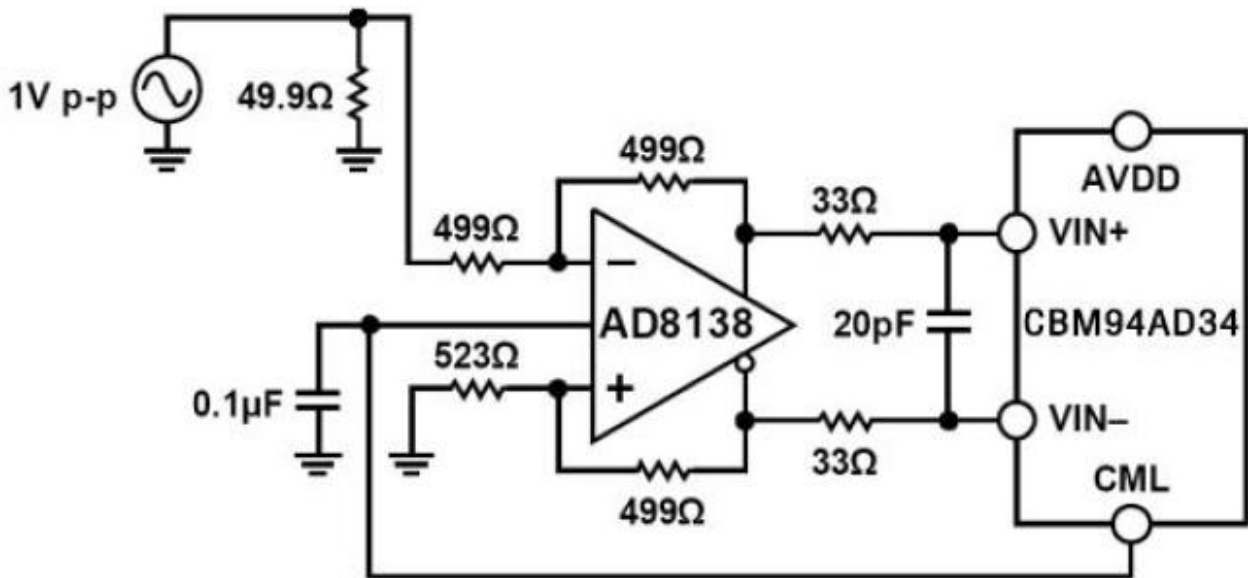


Figure 7. Differential Input Configuration Using AD8138

When the input frequency is in the second or higher Nyquist region, the noise performance of most amplifiers cannot meet the requirements to achieve the true SNR performance of CBM94AD34. This phenomenon is particularly evident in intermediate frequency undersampling applications with frequencies ranging from 70 MHz to 100 MHz. For such applications, the recommended input configuration is differential double balun coupling. When selecting a transformer, it is necessary to consider its signal characteristics. Most RF transformers experience saturation when operating at frequencies below a few megahertz; Excessive signal power can also cause saturation of the core magnetic core, leading to distortion.

In any configuration, the parallel capacitance value  $C$  depends on the input frequency and source impedance, and it may be necessary to reduce the capacitance or remove the parallel capacitance.

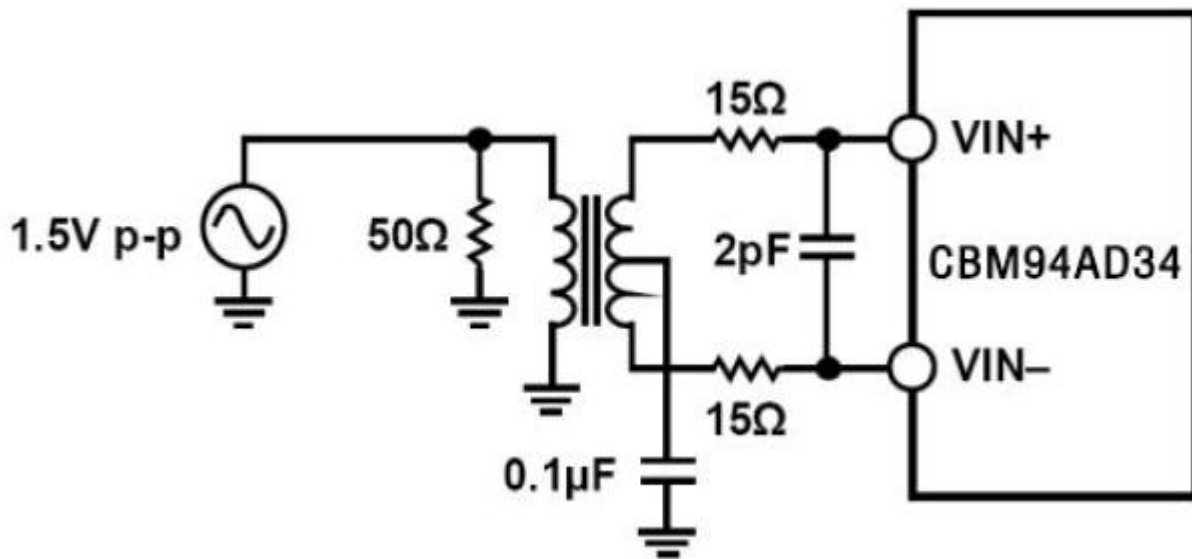


Figure 8 Differential Transformer Coupling Configuration

When the frequency is within the second Nyquist region, in addition to coupling the input with a transformer, an AD8352 differential driver can also be used, as shown in Figure 9.

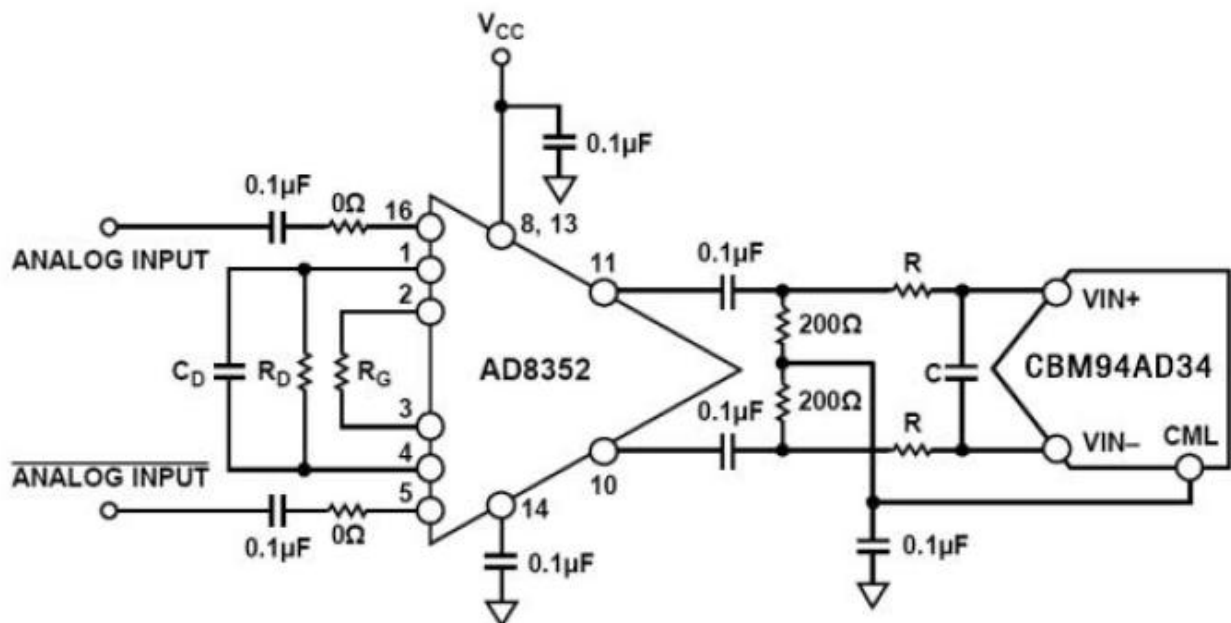


Figure 9. Differential Input Configuration Using AD8352

### Clock input circuit

In order to fully utilize the performance of the chip, a differential signal should be used as the clock signal for the CBM94AD34 sampling clock inputs (CLK+ and CLK -). Usually, a transformer

or two capacitors should be used to AC couple the signal to the CLK+ pin and CLK - pin. The CLK+ and CLK - pins have an internal bias of approximately 0.9 V and do not require external bias. If the clock signal is DC coupled, it is necessary to maintain the common mode voltage within the range of 0.9 V.

Figure 10 shows a preferred method for providing clock signals for CBM94AD34. By using an RF transformer, the single ended signal of a low jitter clock source can be converted into a differential signal. The back to back Schottky diode connected across the transformer secondary can limit the clock signal input to CBM94AD34 to approximately 0.8 V differential peak to peak. In this way, not only the fast rise and Fall time of the signal can be reserved, but also the large voltage swing of the clock can be prevented from feeding to other parts of the CBM94AD34, which is very important for low jitter performance.

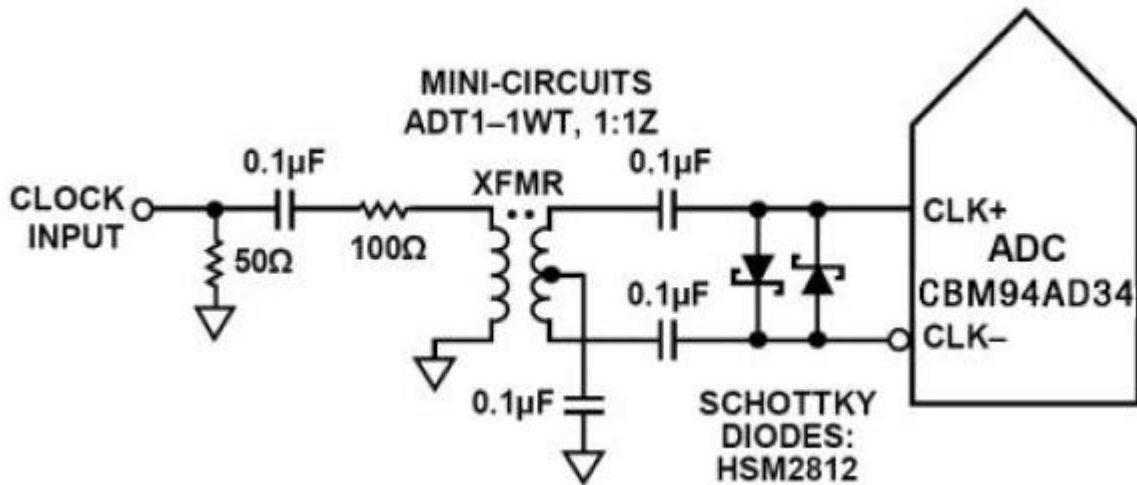


Figure 10. Transformer coupled differential clock configuration

If there is no low jitter clock source, another method is to AC couple the differential PECL signal and transmit it to the sampling clock input pin (as shown in Figure 11). The AD9510/AD9511/AD9512/AD9513/AD9514/AD9515 series clock drivers have excellent jitter performance.

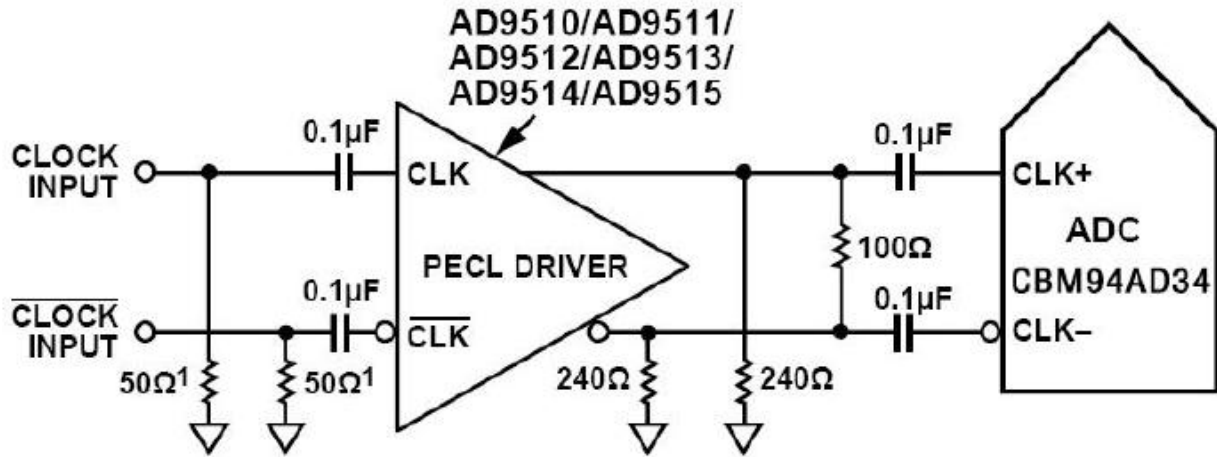


Figure 11. Differential PECL sampling clock

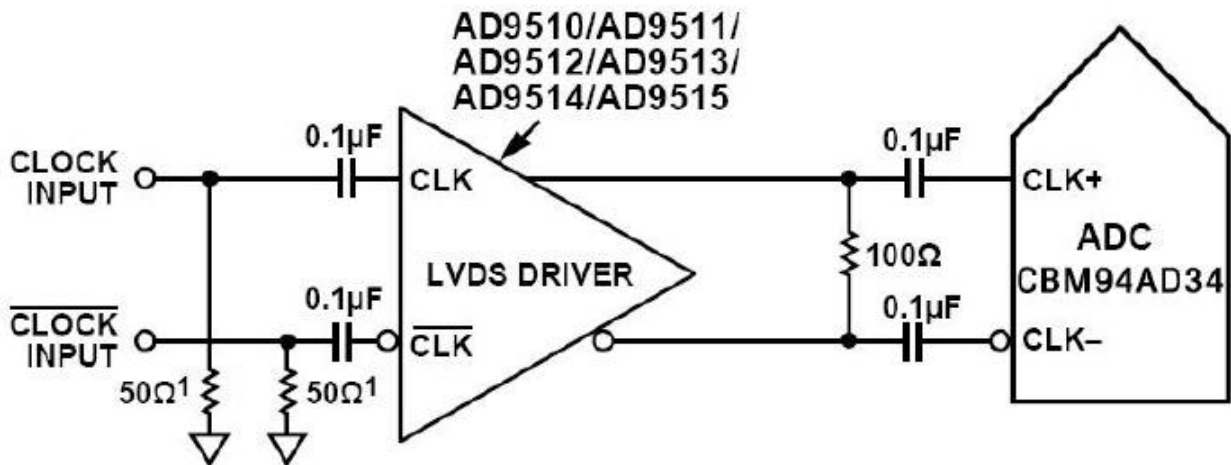


Figure 12. Differential LVDS sampling clock

In some applications, a single ended CMOS signal can be used to drive the sampling clock input. In such applications, the CLK+ pin is directly driven by a CMOS gate circuit, while the CLK pin is bypassed to ground through a 0.1 F capacitor. When driving CLK+ with a 1.8 V CMOS signal, a parallel biased CLK pin with a 0.1 F capacitor and a 39 k resistor is required (see Figure 13).

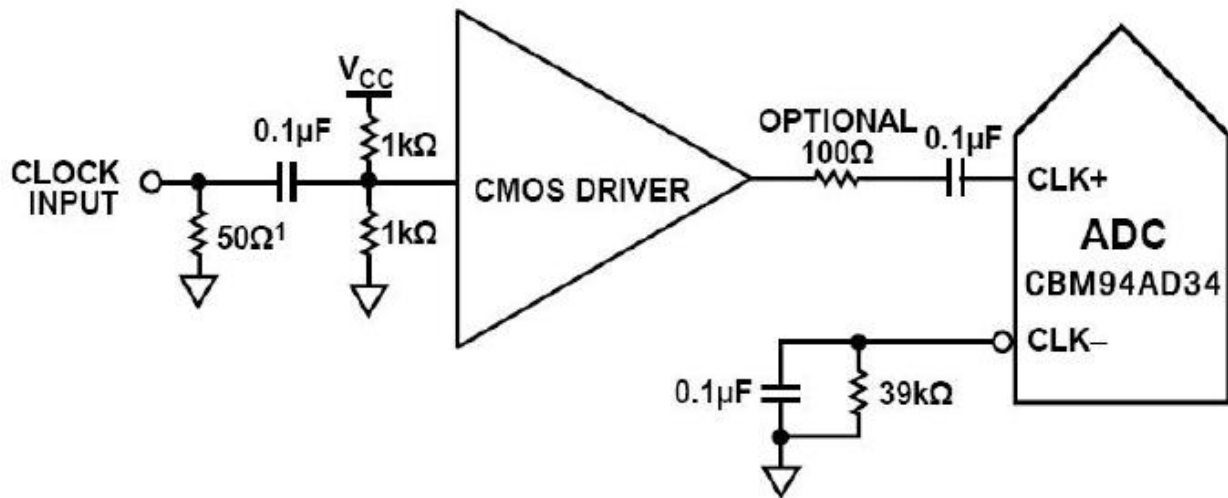


Figure 13. Single ended 1.8 V CMOS input clock

### Digital Output

By default, the differential output data format of CBM94AD34 complies with the ANSI-644 LVDS standard. The data format can be changed to a low-power, less signal selection, and format similar to the IEEE 1596.3 standard through SPI. This LVDS standard can further reduce the power consumption of the chip, approximately 39mW. For more relevant information, please refer to the overseas AD9434BCPZRL7-500 memory address function section. The current of the LVDS driver comes from within the chip, and the output current size of each output bit is generally set to 3.5 mA. Adding a 100 Ω terminal resistor to the input of the LVDS receiver will generate a 350 mV swing. The LVDS output data format of CBM94AD34 is conducive to connecting with LVDS receivers in customized ASICs and FPGAs, and can have good switching performance in noisy environments. It is recommended to place a single point-to-point network topology with a terminal resistor of 100 Ω as close to the receiver as possible. Placing the receiver's terminal too far or with poor differential distribution lines will result in timing errors. It is recommended that the wiring length should not exceed 24 inches, and the differential output wiring should be placed together and of the same length.

### Relationship table between output code and analog input

| Input                  | Conditions                | Offset binary mode, D11 to D0 | Binary complement mode, D11 to D0 | OR± |
|------------------------|---------------------------|-------------------------------|-----------------------------------|-----|
| $V_{IN+}$ to $V_{IN-}$ | $< -0.75-0.5 \text{ LSB}$ | 0000 0000 0000                | 1000 0000 0000                    | 1   |
| $V_{IN+}$ to $V_{IN-}$ | $= -0.75$                 | 0000 0000 0000                | 1000 0000 0000                    | 0   |
| $V_{IN+}$ to $V_{IN-}$ | $= 0$                     | 1000 0000 0000                | 0000 0000 0000                    | 0   |
| $V_{IN+}$ to $V_{IN-}$ | $= 0.75$                  | 1111 1111 1111                | 0111 1111 1111                    | 0   |
| $V_{IN+}$ to $V_{IN-}$ | $> 0.75+0.5 \text{ LSB}$  | 1111 1111 1111                | 0111 1111 1111                    | 1   |

Table 2. Power on delay time control function table ( $P_D$  is low level)

### Data output format

The default format for output data is offset binary.

The typical application circuit of this circuit is shown in the figure below. For detailed information, please refer to the product manual of AD9434BCPZ-500 abroad.

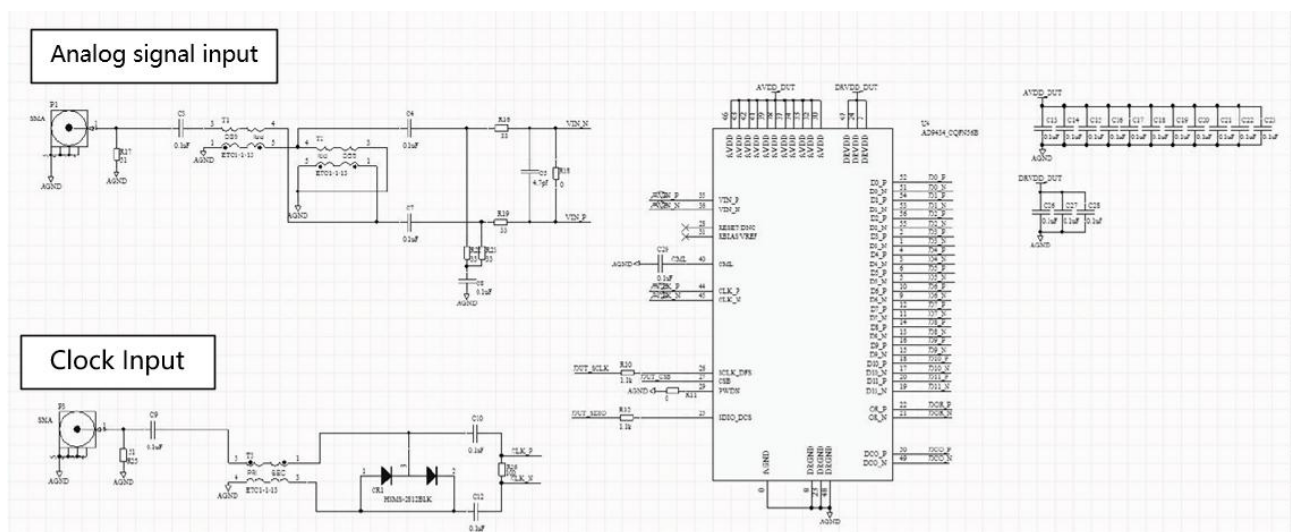


Figure 14. Typical Application Circuit

## Notes

### 1. Product installation precautions:

- (1).It is required that the application object circuit board has a complete and clean ground.
- (2).It is required that the application object is a multi-layer wiring board and contains independent layers.
- (3).It is required to separate the digital ground and analog ground of the application object circuit board as much as possible, and not place the digital line next to the analog line or under the ADC.
- (4).AVDD, DRVDD, and VCM should be connected to high-quality ceramic bypass capacitors, and the bypass capacitors should be as close to the pins as possible. The shorter and wider the connection between the pins and the bypass capacitors, the better.

### 2. Precautions for product use:

- (1).Differential inputs should be as close and parallel as possible.
- (2).The input wiring should be as short as possible to minimize parasitic capacitance and noise introduction.
- (3).In order to achieve better heat dissipation and electrical performance, the bottom plate of the chip should be welded to a large ground end of the PCB board, in order to maximize the thermal performance of the package.
- (4).It is important that the ground of the chip should be connected to the PCB board through as many channels and sufficient area as possible.

### 3. Precautions for product protection:

- (1).Electrostatic charges can easily accumulate on the human body and testing equipment, and may discharge unnoticed. Although this product has a dedicated ESD protection circuit, permanent device damage may occur when encountering high-energy electrostatic discharge. Therefore, it is recommended to take appropriate ESD prevention measures to avoid device performance degradation or loss of function.
- (2).Exceeding the absolute maximum rating may result in permanent damage to the device. This is only the maximum rated value and does not mean that the device can operate normally under these conditions or any other conditions beyond those shown in this product manual. Long term operation under absolute maximum rated conditions can affect the reliability of the device.

### 4.Common faults and solutions

- 1.No signal output: Check if the power voltage, input signal, and clock are loaded correctly.

2. Overflow signal: check whether the benchmark works normally and whether the input signal amplitude is correct.
3. Unstable device operation: Check the power supply to ensure stable power voltage.

## Package Outline Dimensions

### QFN-56

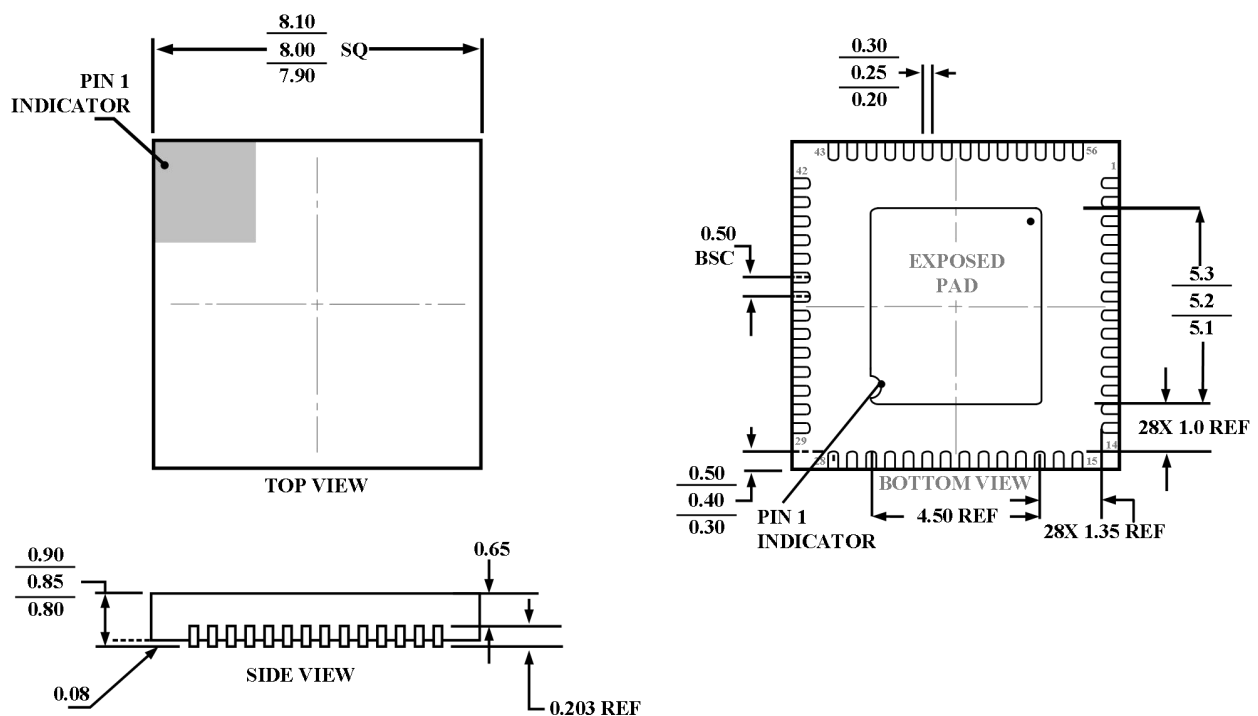


Figure 15. 56 Pin lead packaging (plastic packaging)

8mm×8mm, Dimensions shown in millimeters

## Package/Ordering Information

| PRODUCT   | ORDERING NUMBER | TEMPERATURE | PACKAGE | MAKING INFORMATION | PAKEAGE OPTION    |
|-----------|-----------------|-------------|---------|--------------------|-------------------|
| CBM94AD34 | CBM94AD34-500   | -40°C-85°C  | QFN-56  | CBM94AD34          | Tape and Reel,260 |
|           | CBM94AD34-370   | -40°C-85°C  | QFN-56  | CBM94AD34          | Tape and Reel,260 |