Ver 1.0

# BCT2358

## 1MHz, 60uA, Rail-to-Rail I/O CMOS Operational Amplifiers

## GENERAL DESCRIPTION

The BCT2358 (dual) is low cost, rail-to-rail input and output voltage feedback amplifiers. It has a wide input common-mode voltage range and output voltage swing, and take the minimum operating supply voltage down to 2.1V. The maximum recommended supply voltage is 5.5V. It's specified over the extended -40°C to 85°C temperature range.

BCT2358 provides 1MHz bandwidth at a low current consumption of 60uA per amplifier. Very low input bias currents of 10pA enable BCT2358 to be used for integrators, photodiode amplifiers, and piezoelectric sensors. Rail-to-rail input and output are useful to designers for buffering ASIC in single-supply systems. Applications for this series of amplifiers include safety monitoring, portable equipment, battery and power supply control, and signal conditioning and interfacing for transducers in very low power systems. The BCT2358 comes in the Green SOIC-8 packages.

## FEATURES

- Low Cost
- Rail-to-Rail Input and Output
- 0.8mV Typical Vos
- Unity Gain Stable
- Gain Bandwidth Product:1MHz
- Very Low Input Bias Current:10pA
- Supply Voltage Range:2.1V to 5.5V
- Input Voltage Range:-0.1V to +5.6V with $V_S$=5.5V
- Low Supply Current:60uA/Amplifier
- Small Packaging: BCT2358 available in SOIC8

## APPLICATIONS

ASIC Input or Output Amplifier
Sensor Interface
Piezoelectric Transducer Amplifier
Medical Instrumentation
Mobile Communication
Audio Output
Portable Systems
Smoke Detectors
Notebook PC
Battery-Powered Equipment
DSP Interface

## ORDERING INFORMATION

| Order Number | Package Type | Temperature Range | Marking | QTY/Reel |
|---|---|---|---|---|
| BCT2358ESA-TR | SOIC-8 | -40°C to +85°C | 2358 | 3000 |

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage, +Vs to -Vs .........................-0.3V to +6.0V
Common-Mode Input Voltage ...(-Vs)-0.3V to (+Vs)+ 0.3V
Storage Temperature Range.....................-65℃ to +150℃
Junction Temperature...............................................150℃
Operating Temperature Range...................-40℃ to +85℃
Package Thermal Resistance @ TA=+25℃
SOIC-8, $\theta_{JA}$……………………................................125℃/W
Lead Temperature (Soldering, 10 sec).......................260℃
ESD Susceptibility
HBM.........................................................................4000V
MM...........................................................................400V

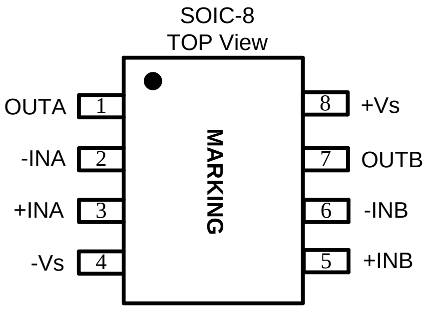
NOTE:
Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## CAUTION

This integrated circuit can be damaged by ESD if you don’t pay attention to ESD protection. BCTICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

Broadchip reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time. Please contact Broadchip sales office to get the latest datasheet.

## PIN CONFIGURATION (TOP VIEW)




## PIN DESCRIPTION

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | OUTA | Output |
| 2 | -INA | Negative Input |
| 3 | +INA | Positive Input |
| 4 | -Vs | Power Supply |
| 5 | +INB | Positive Input |
| 6 | -INB | Negative Input t. |
| 7 | OUTB | Output |
| 8 | +Vs | Power Supply |

# ELECTRICAL CHARACTERISTICS

($V_S$= +5V, RL= 100kΩ connected to Vs/2, and $V_{OUT}$=Vs/2, unless otherwise specified.)

| PARAMETER | SYM | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **INPUT CHARACTERISTICS** | | | | | | |
| Input Offset Voltage | $V_{OS}$ | $V_{CM}$=Vs/2 | | 0.8 | 5.6 | mV |
| Input Bias Current | $I_B$ | | | 10 | | pA |
| Input Offset Current | $I_{OS}$ | | | 10 | | pA |
| Common-Mode Voltage Range | $V_{CM}$ | Vs=5.5V | | -0.1 to +5.6 | | V |
| Common-Mode Rejection Ration | CMRR | Vs=5.5V, VCM=-0.1V to 4V | | 62 | | dB |
| | | Vs=5.5V, VCM=-0.1V to 5.6V | | 60 | | dB |
| Open-Loop Voltage Gain | $A_{OL}$ | $R_L$=5kΩ, Vo=+0.1V to +4.9V | | 80 | | dB |
| | | $R_L$=100KΩ, Vo=+0.035V to +4.965V | | 84 | | dB |
| Input Offset Voltage Drift | $\Delta V_{OS}/\Delta T$ | | | 2.7 | | uV/℃ |
| **OUTPUT CHARACTERISTICS** | | | | | | |
| Output Voltage Swing from Rail | $V_{OH}$ | RL=100kΩ | | 4.997 | | V |
| | $V_{OL}$ | RL=100kΩ | | 5 | | mV |
| | $V_{OH}$ | RL=100kΩ | | 4.992 | | V |
| | $V_{OL}$ | RL=100kΩ | | 8 | | mV |
| Output Current | $I_{SOURCE}$ | $R_L$=10Ω to Vs/2 | | 84 | | mA |
| | $I_{SINK}$ | | | 75 | | |
| **POWER SUPPLY** | | | | | | |
| Operating Voltage Range | $V_S$ | | 2.1 | | 5.5 | V |
| Power Supply Rejection Ration | PSRR | Vs=+2.5V to +5.5V, VCM=+0.5V | | 72 | | dB |
| Quiescent Current/Amplifier | $I_Q$ | | | 60 | | uA |
| **DYNAMIC PERFORMANCE**($C_L$=100pF) | | | | | | |
| Gain-Bandwidth Product | GBP | | | 1 | | MHz |
| Slew Rate | SR | G=+1, 2V Output Step | | 0.52 | | V/uS |
| Setting Time to 0.1% | ts | G=+1, 2V Output Step | | 5.3 | | us |
| Overload Recovery Time | | $V_{IN}$ GAIN=$V_S$ | | 2.6 | | us |
| **NOISE PERFORMANCE** | | | | | | |
| Voltage Noise Density | $e_n$ | f=1kHz | | 27 | | $nV/\sqrt{Hz}$ |
| | | f=10kHz | | 20 | | $nV/\sqrt{Hz}$ |

# APPLICATION NOTES

## Driving Capacitive Loads

The BCT2358 can directly drive 250pF in unity-gain without oscillation. The unity-gain follower (buffer) is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers and this results in ringing or even oscillation. Applications that require greater capacitive driving capability should use an isolation resistor between the output and the capacitive load like the circuit in Figure1. The isolation resistor $R_{ISO}$ and the load capacitor CL form a zero to increase stability. The bigger the $R_{ISO}$ resistor value, the more stable $V_{OUT}$ will be. Note that this method results in a loss of gain accuracy because $R_{ISO}$ forms a voltage divider with $R_{LOAD}$.

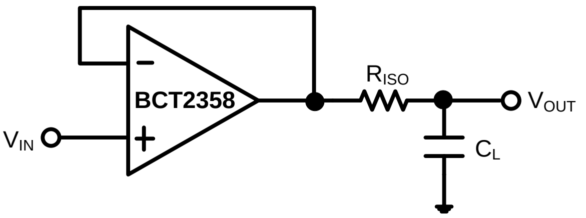



**Figure 1. Indirectly Driving Heavy Capacitive Load**

An improved circuit is shown in Figure 2. It provides DC accuracy as well as AC stability. $R_F$ provides the DC accuracy by connecting the inverting signal with the output. $C_F$ and $R_{ISO}$ serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving phase margin in the overall feedback loop.

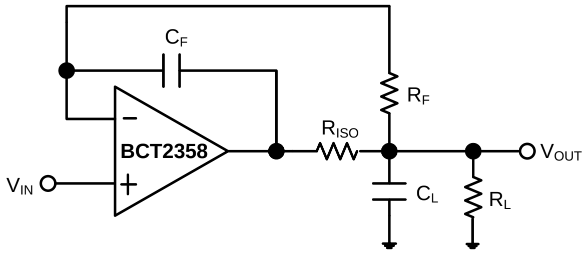



**Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy**

For non-buffer configuration, there are two other ways to increase the phase margin: (a) by increasing the amplifier's gain or (b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node.

## Power-Supply Bypassing and Layout

The BCT2358 can operate from either a single +2.1V to +5.5V supply or dual ±1.05V to ±2.75V supplies. For single-supply operation, bypass the power supply +Vs with a 0.1uF ceramic capacitor which should be placed close to the +Vs pin. For dual supply operation, both the +Vs and the –Vs supplies should be bypassed to ground with separate 0.1uF ceramic capacitors. 2.2uF tantalum capacitor can be added for better performance.

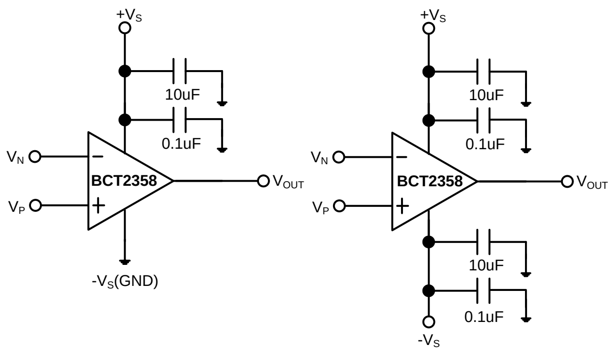



**Figure 3. Amplifier with Bypass Capacitors**

# TYPICAL APPLICATION CIRCUITS

### Differential Amplifier

The circuit shown in Figure 4 performs the difference function. If the resistor ratios are equal to (R4/R3=R2/R1). Then

$V_{OUT}=(V_P-V_N)*R2/R1+V_{REF}$.

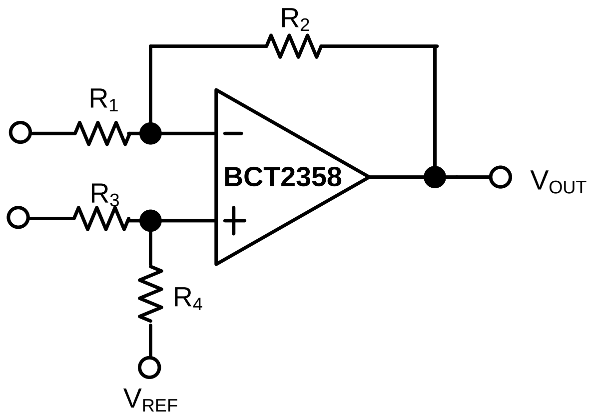



**Figure 4. Differential Amplifier**

### Instrumentation Amplifier

The circuit in Figure 5 performs the same function as that in Figure 4 but with a high input impedance.

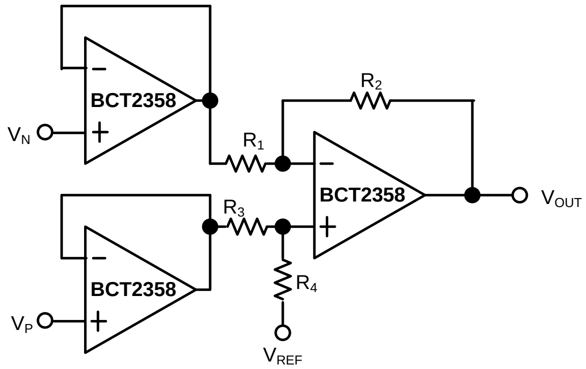



**Figure 5. Instrumentation Amplifier**

### Low Pass Active Filter

The low pass filter shown in Figure 6 has a DC gain of (-R2/R1) and the -3dB corner frequency is $1/2\pi R_2C$. Make sure the filter bandwidth is within the bandwidth of the amplifier. The large values of feedback resistors can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistor values as low as possible and consistent with output loading consideration。

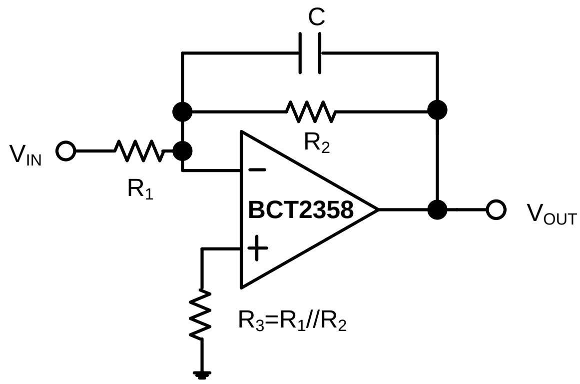
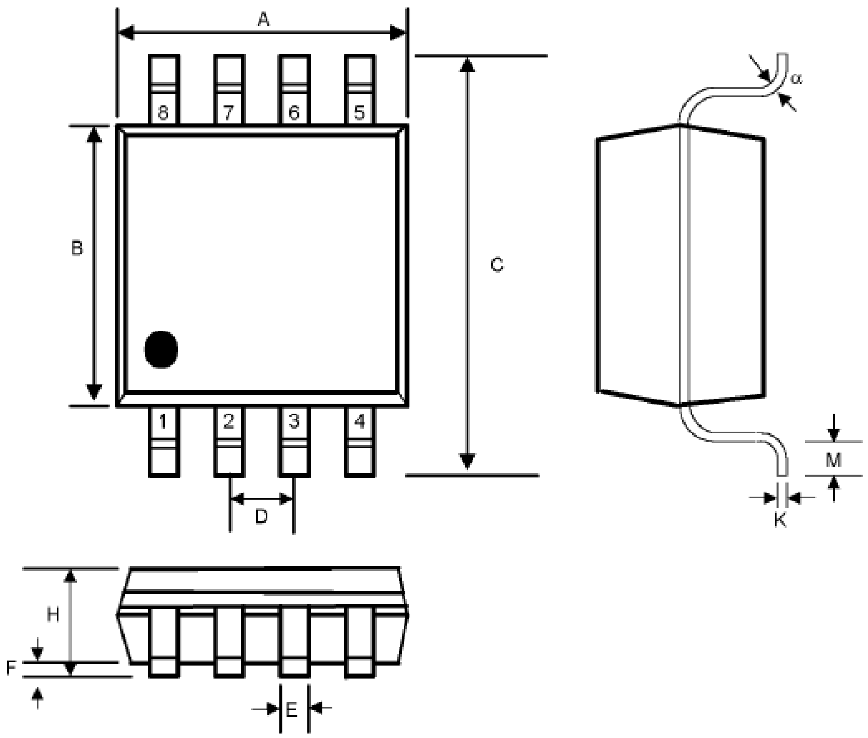



**Figure 6. Low Pass Active Filter**

## PACKAGE OUTLINE DIMENSIONS




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 4.80 | 5.00 | 0.188 | 0.197 |
| B | 3.80 | 4.00 | 0.149 | 0.158 |
| C | 5.80 | 6.20 | 0.228 | 0.244 |
| D | 1.27 BSC | | 0.050 | |
| E | 0.33 | 0.51 | 0.013 | 0.020 |
| F | 0.10 | 0.25 | 0.004 | 0.010 |
| H | 1.35 | 1.75 | 0.053 | 0.069 |
| K | 0.19 | 0.25 | 0.007 | 0.010 |
| M | 0.40 | 1.27 | 0.016 | 0.050 |
| α | 0º | 8º | 0º | 8º |

SOIC-8 Surface Mount Package