# SMD-3.6k-AMP

**PRELIMINARY DATASHEET**

## Differential amplifier for SMD detectors

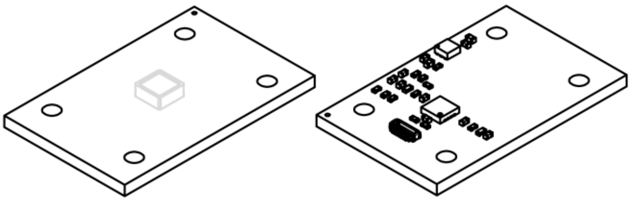

FIGURE 1. The SMD-3.6k-AMP amplifier (SMD detector is not included)

## FEATURES

- Compatible with single-channel SMD detectors
- Compatible with AMS accessories
- Low 1/f noise corner
- Bandwidth: DC up to 7 MHz[1]
- Single, low-voltage power supply: 3.3 V
- Differential output
- Small board-to-board connector
- Small dimensions: 30 mm × 19 mm × 10 mm
- Low weight: 5 g
- Evaluation kit and additional accessories available

## APPLICATIONS

- Gas detectors with MEMS, LED, or laser sources
- Temperature sensors
- Embedded systems
- Portable devices

## GENERAL DESCRIPTION

The SMD-3.6k-AMP is a differential amplifier designed especially for single-channel SMD detectors. Providing compatibility with AMS accessories it enables fast evaluation of the detector in test environments. Wide frequency bandwidth and low 1/f noise corner frequency provide efficient measurements with generally available sources of radiation, including MEMS heaters and pulsed LEDs or lasers. With differential output, the amplifier offers easy connectivity over tiny and low-cost connectors with high immunity to electromagnetic interference.

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[1] Depends on used detector

## CONNECTIVITY

The SMD-3.6k-AMP amplifier features a tiny connector with 14 signal pins and 2 high current pins. The description of pins and pins ordering are shown in TABLE 1, FIGURE 2, and FIGURE 3.

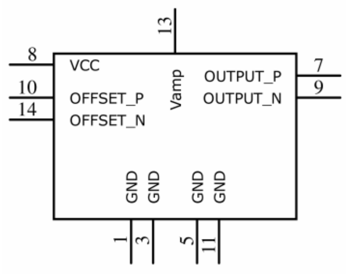


FIGURE 2. Pinout of the J1 connector

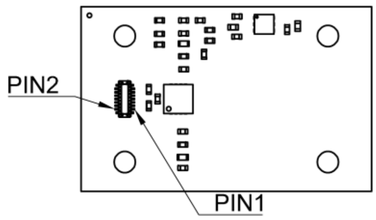


FIGURE 3. Pins ordering on the J1 connector

The recommended mating connector is Amphenol 101R014FB110. Keep in mind that this type of connector has very limited number of mating cycles. Please refer to chapter MECHANICAL REQUIREMENTS and datasheet of the connector for more information.

TABLE 1. J1 Pin functions. All undescribed pins are reserved and must be left floating

| Pin number | Symbol | Function |
|---|---|---|
| 1, 3, 5, 11 | GND | Signal and amplifier supply ground |
| 7 | OUTPUT_P | Positive signal output |
| 9 | OUTPUT_N | Negative signal output |
| 13 | $V_{amp}$ | Amplifier supply input |
| 8 | $V_{cc}$ | Internal supply voltage output. Use only to set DC offset voltage using OFFSET_P and OFFSET_N. For more information see the chapter SIGNAL OUTPUTS. Do not use it for any other purpose |
| 10 | OFFSET_P | DC offset for positive signal output. Leave floating if no output offset is required. Connect directly to $V_{cc}$ to introduce the maximum possible DC offset. The optional resistor can be used if a lower value of DC offset is required. For more information see the chapter SIGNAL OUTPUTS |
| 14 | OFFSET_N | DC offset for negative signal output. Leave floating if no output offset is required. Connect directly to GND to introduce the maximum possible DC offset. The optional resistor can be used if a lower value of DC offset is required |
| Others | RESERVED | Leave floating |

## ABSOLUTE MAXIMUM RATINGS

Do not stress the device above the limits specified in this chapter since it may cause permanent damage to the device.

TABLE 2. Absolute maximum ratings

| Parameter | Rating |
|---|---|
| Amplifier supply, $V_{amp}$ | 5.5 V |
| OFFSET_N and OFFSET_P voltage | -0.1 V to 3.1 V |
| Ambient operating temperature | -40ºC to 65ºC, non-condensing |
| Storage temperature | -50ºC to 85ºC |

## SPECIFICATION

+3.3 V supply, $T_{chip}$ = 20°C, $T_{amb}$ = 20°C, $R_{load}$ = 1 MΩ to ground, unless otherwise noted.

TABLE 3. Electrical specification

| Parameter | Test conditions, remarks | Value | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| Differential transimpedance | | | 3600 | | Ohm |
| Output differential offset | No radiation, OFFSET_P and OFFSET_N floating | -5 | | 5 | mV |
| Output single-ended common mode voltage, $V_{CM}$ | OFFSET_P and OFFSET_N floating | | 1.22 | | V |
| Output single-ended common mode voltage | OFFSET_P and OFFSET_N floating, $R_{load}$ = 50 Ω | | 0.61 | | V |
| Output impedance, $R_{OUT}$ | OUTPUT_P and OUTPUT_N, single-ended | | 50 | | Ω |
| Output voltage swing, negative | OUTPUT_P and OUTPUT_N, single-ended | | 0.2 | | V |
| Output voltage swing, positive | OUTPUT_P and OUTPUT_N, single-ended | | 2.2 | | |
| Low cut-off frequency, $f_{lo}$ | | | DC | | |
| High cut-off frequency, $f_{hi}$ | $R_{load}$ = 50 Ω | | 7.0[1] | | MHz |
| Supply current on $V_{amp}$ | $R_{load}$ = 50 Ω | | 50 | | mA |
| OFFSET_N and OFFSET_P input resistance, $R_{OFFSET}$ | | | 3.3 | | kΩ |
| OFFSET_N and OFFSET_P input capacitance | | | 100 | | nF |
| $V_{CC}$ | | | 3.0 | | V |

## SIGNAL OUTPUTS

Output signals paths or wires must be as short as possible and placed close to each other to minimize loop area formed by them and therefore reduce EMI interference.
The impedance of both outputs is fixed to 50 Ω. If fast pulsed source of radiation is used and the shape of the rising or falling slope is important, both outputs should be terminated with 50 Ω to GND. In this case please use precise resistors with a tolerance not worse than 0.1% to keep the signal path symmetrical. The termination pattern is presented in FIGURE 4.

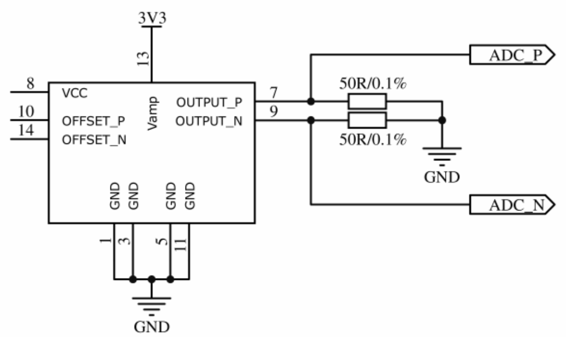


FIGURE 4. Outputs termination for high-speed signals

However, in most typical applications signal termination is not necessary. Provided slowly changing radiation sources are used and/or signal paths are short, outputs may be left unterminated. Connecting outputs to high impedance has one additional benefit: bigger dynamic range of output voltages, since common-mode voltage is bigger for unterminated outputs.
The module is designed to keep the DC output offset to as low value as possible. However, in some applications (i.e. direct connection to differential ADC) it may be beneficial to introduce some known value to the DC component. This can be done by connecting the OFFSET_P pin to $V_{cc}$ and OFFSET_N pin to GND.
This approach can be used to match the full scale of differential ADC. If lower offset is required additional resistors may be used, according to FIGURE 5.

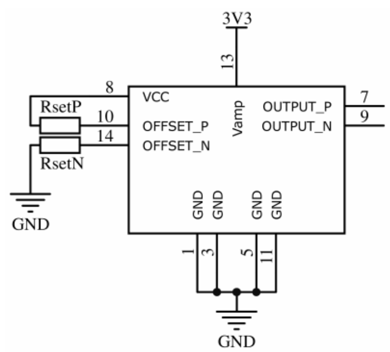


FIGURE 5. Adjusting differential offset of outputs using two resistors. $R_{setP}$ and $R_{setN}$ can be set to 0 Ω for maximum available offset

Connecting OFFSET_P to VCC (using a resistor or short-circuit) will lower the DC component on OUTPUT_P

[1] Depends on connected detector

while connecting OFFSET_N to GND will rise the DC component on OUTPUT_N. If $R_{setP}$ and $R_{setN}$ $R_{se}$ represent non-zero values, please use thin-film resistors to avoid additional flicker noise.

For high impedance loads the impact of $R_{setP}$ and $R_{setN}$ on the outputs can be calculated using the following formulas:

$$V_{DC\_OUTPUT\_P} = V_{CM} - \frac{(V_{CC} - V_{CM})}{R_{OFFSET} + R_{setP}} \cdot 1800\,\Omega \qquad (1)$$

$$V_{DC\_OUTPUT\_N} = V_{CM} + \frac{V_{CM}}{R_{OFFSET} + R_{setN}} \cdot 1800\,\Omega \qquad (2)$$

For matched impedance loads the values calculated with the formula should be divided by 2.

In most applications, an additional voltage amplifier will be necessary. FIGURE 6 shows one of the possible solutions.

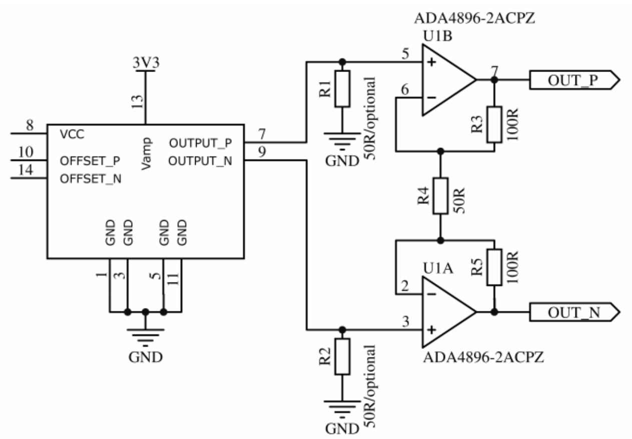


FIGURE 6. Example differential voltage amplifier with gain=5 and DC coupling. R1/R2 are not required for slowly changing signals

This topology of the amplifier is a "simplified instrumentation amplifier". It "copies" common-mode voltage from input to output and amplifies only the differential component. Changing the common-mode voltage to another value is possible using a fully differential amplifier such as LTC6404-1 or LTC6409. Regardless of the chosen solution, please use precise resistors with a tolerance not worse than 0.1% to keep the signal path symmetrical. $R_1$ and $R_2$ provide impedance match and can be omitted for slowly changing signals and/or short connection paths.

In most applications, DC component does not provide any information and can be neglected. In such situations, AC coupling is strongly recommended, since the DC component depends on the temperature of the chip as well as the temperature of the surrounding environment. An example of AC coupling is presented in FIGURE 7.

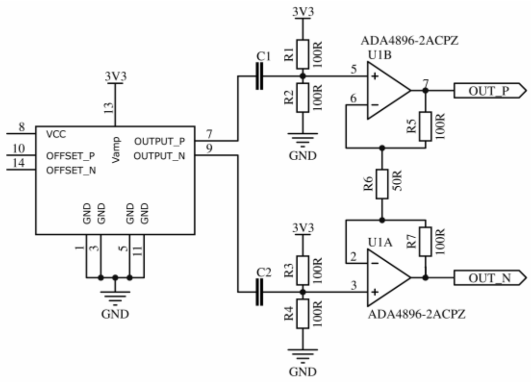


FIGURE 7. Example differential voltage amplifier with gain = 5 and AC coupling

Choose the values of R1, R2, R3, and R4 to set the desired common mode voltage on OUT_N-OUT_P pair. Use low tolerances to keep differential DC component at low values.

Assuming symmetry of "positive" and "negative" paths (i.e. C1=C2, R1=R2, R2=R4), low cut-off frequency is equal to:

$$f_{low3dB} = \frac{1}{2\pi\left(R_{OUT} + \frac{R_1 \cdot R_2}{R_1 + R_2}\right)C_1} \qquad (3)$$

For example:

if $C_1 = C_2 = 10\ \mu F$ and $R_1 = R_2 = R_3 = R_4 = 100\ \Omega$ then low cut-off frequency is equal to 159.15 Hz.

In most applications setting low cut-off frequency to value 10 to 100 times lower than the lowest signal frequency is sufficient. This should not be a problem even for slow signals since impedance matching is not required in this case and therefore $R_1$, $R_2$, $R_3$ and $R_4$ can have high values.

## SOLDERING REQUIREMENTS

Only manual soldering is allowed. For recommended soldering procedure please refer to the documentation of the detector.

## MECHANICAL REQUIREMENTS

All four mounting holes must be used to minimalize mechanical stress and the risk of unexpected disconnection Two connection types are recommended:

- Semi-flexible PCB. Receptacle *Amphenol 101R014FB110* must be placed on the rigid part and the flexible part can be used to connect signals and power supplies to another PCB.

- Direct board to board connection. All components on the module are not higher than 1mm, which enables direct stacking of PCBs using the *Amphenol 101R014FB110* receptacle.

In both cases, the distance between the module and the external PCB needs to be precisely fixed to 1mm to avoid stress on the connector. One of the possible solutions are SMT spacers: *Würth Elektronik 97740109*

## MECHANICAL LAYOUT

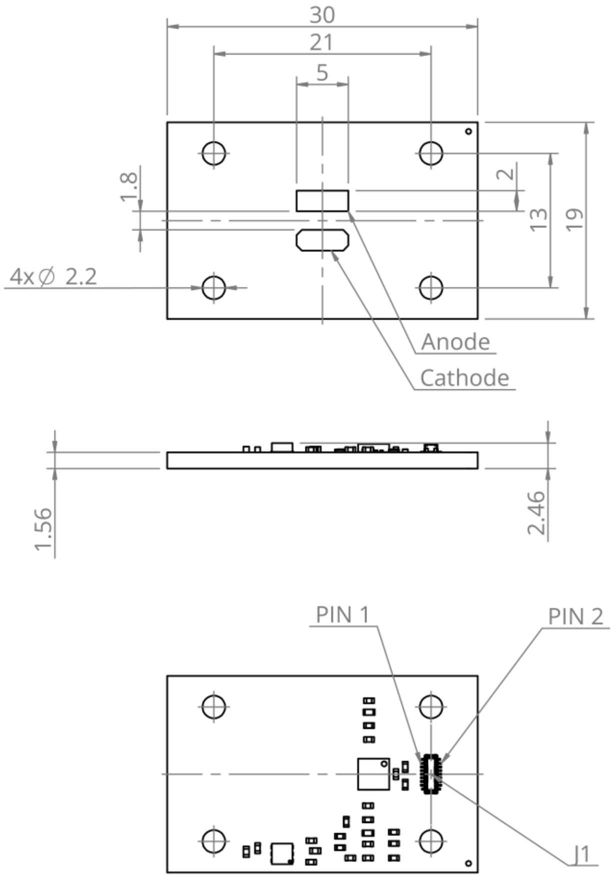


FIGURE 8. Dimensions of the SMD-3.6k-AMP amplifier (given in mm)