Universal Voltage Transmitter IC AM401

When including sensors in systems, the system designer still comes face to face with the question of just how the sensor signal has to be processed in order that it can be optimally adapted to suit the system requirements. For industrial applications there are – and have been for some time – the standards 0/4–20 mA and 0–5/10 V for subsequent processing in SPC, for example. In the automobile industry ratiometric sensors connected to a 5 volt supply are normally used. For the latter area of application there are several integrated solutions (e.g. AM427/17 from Analog Microelectronics, ratiometric sensor interface ICs), which support sensor calibration by laser trimming– as well as being economically viable. Integrated circuits which permit electronic calibration and compensation are at present only available from a handful of manufacturers.

There are a number of integrated solutions available for industrial applications. These include Burr-Brown's XTR105, Analog Devices' AD693 and the AM4X2 series from Analog Microelectronics, all integrated solutions which can convert sensor signals into an industrial standard signal.

Yet for industrial applications which need voltage outputs (0–5 V or 0–10 V), engineers are still forced to come up with a solution themselves. Depending on the application, designs have to resort to active single components, such as instrumentation amplifiers, operational amplifiers, references, transistors and diodes, which, all requirements considered, demands a comprehensive knowledge of the ins and outs of circuit technology.

There is a large number of the discrete components mentioned above available on the market, supplied by various companies, yet there are often considerable disadvantages to this kind of solution:

- **Miniaturisation –** the more complex the application, the more problems concerning space arise.
- **Cost –** the discrete components currently on the market often do not meet the requirements of the application (e.g. temperature behaviour) and in turn require more demanding circuitry, all of which adds up to a solution which is expensive.
- **Acquisition –** problems of logistics arise when the solution design requires specific component models: "The device you require is unfortunately not available for the next six months"!
- **Development and design –** the lack of application support which often goes hand in hand with standard devices results in more hours of engineering and thus higher costs. Reverse polarity protection may have to be integrated into the system, for example, or the temperature effects of the reference compensated.

With the new AM401 IC (Figure 1), **Analog Microelectronics** presents a voltage transmitter which has been specially developed with the aim of providing systems designers with a universal chip for analog signal processing.

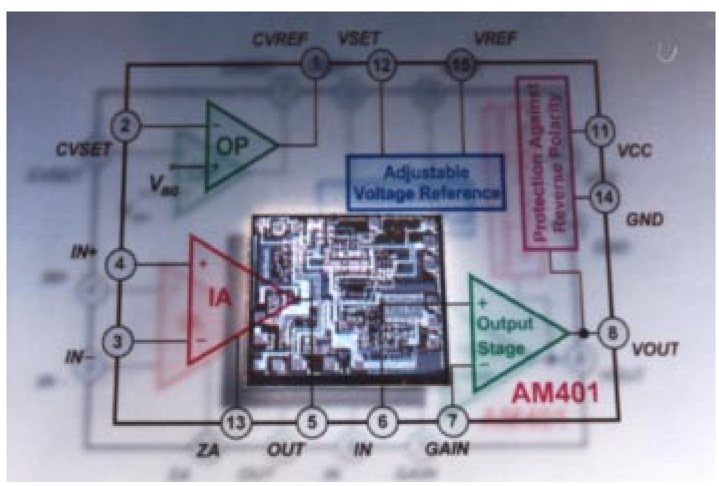

Figure 1: all four of AM401's function blocks are accessible externally and individually.

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AM401 has two input amplifiers which can process both differential signals (such as those from piezoresistive pressure transducers, for example) and single ended signals. Following the instrumentation amplifier stage the signal path is cut. This design enables a number of circuit variations with a follow-on op amp output stage (voltage output) to be used as subtracters, followers, etc. Finally, the signal at this point can be calibrated, compensated and linearised as the system requires with a suitable microcontroller and then, following D/A conversion in AM401, converted to the desired output voltage signal.

IC AM401 can be broken down into four main function blocks:

1. At the input, the IA (instrumentation amplifier) amplifies the differential input signal with a pre-set amplification. With this amplifier, this centre voltage can be set externally, meaning it is suitable for positive and negative signals with the respect to the centre setting and thus also for control applications.
2. A whole range of outputs (0–5 V, 0–10 V, 0.5–4.5 V, 1–5 V, etc.) can be set via an operational amplifier output stage and a small number of external components. The output stage can also be configured as a normal op amp, making a large number of applications possible.
3. The third function block integrated into IC AM401 is an adjustable voltage reference which can feed additional components and/or the sensing element. The voltage can be set to 5 or 10 V via a simple pin connection. With the use of an external voltage divider the voltage can also be set to any value between 4.5 and 10 V.
4. One special feature of this particular device is the second internal amplifier stage, which can be used to set the centre voltage of the instrumentation amplifier mentioned above or provide a current source to power the sensor, for example.

The IC includes integrated protection against reverse polarity and an output current limit. In addition, all four function blocks are individually accessible and can be used as separate components.

From the great number of possible applications, three are mentioned in the following examples. The relevant figures and methods of calculation are given in the detailed data sheets, available from Analog Microelectronics in Mainz or at the Web site **www.analogmicro.de.**

Example 1: in this example (Figure 2), the IC is used as a sensor transmitter for differential voltage signals. A sensing element (indicated by the bridge symbol) is excited with a 5 volt supply by the integrated voltage reference. The additional op amp integrated into the chip is used to set the centre voltage of the instrumentation amplifier. This enables the output voltage with positive and negative sensor signals to be set to optimally match the dynamic range of a follow-on A/D converter. The only external components in use, besides the necessary capacitances, are two voltage dividers which are needed for amplification and to set the centre voltage.

In short: *differential input voltages of up to ±400 mV, an output voltage of 0.5–4.5 V, voltage supply for the sensing element.*

Example 2: the second example shows an application which is based on typical industrial voltages (Figure 3). The output voltages here are in the range of 0–5/10 V. The sensing element is supplied with current which can be set via the R_{SET} resistor. In this example, the reference voltage source could be used to feed other external components (e.g. A/D converters, processors, etc.).

In short: *differential input voltages of up to ±400mV, an output voltage of 0–5/10 V, current supply for the sensor, additional voltage source for external components.*

Example 3: in order to illustrate the universal character and versatility of IC AM401, this third example creates an industrial output signal from an input voltage of 0.5–4.5 V, often used with preamplified sensors (Figure 4). With this the output stage (an adjustable voltage-to-voltage conversion) can be used as an input for the asymmetrical signal. The voltage to be subtracted is created with the additional operational amplifier. The sensing element is supplied by the reference voltage source. The instrumentation amplifier is not required for this application. In order to prevent the IA interacting with the system, it is set to a defined operating point with the aid of the voltage reference.

In short: *asymmetrical input voltage (0.5–4.5 V), an output voltage of 0–10 V, voltage supply for the sensing element, circuit is a subtracter.*

As this article shows, with AM401 Analog Microelectronics has introduced an extremely versatile IC which, with its freely accessible functional units, can justifiably be described as a universal signal evaluation IC.

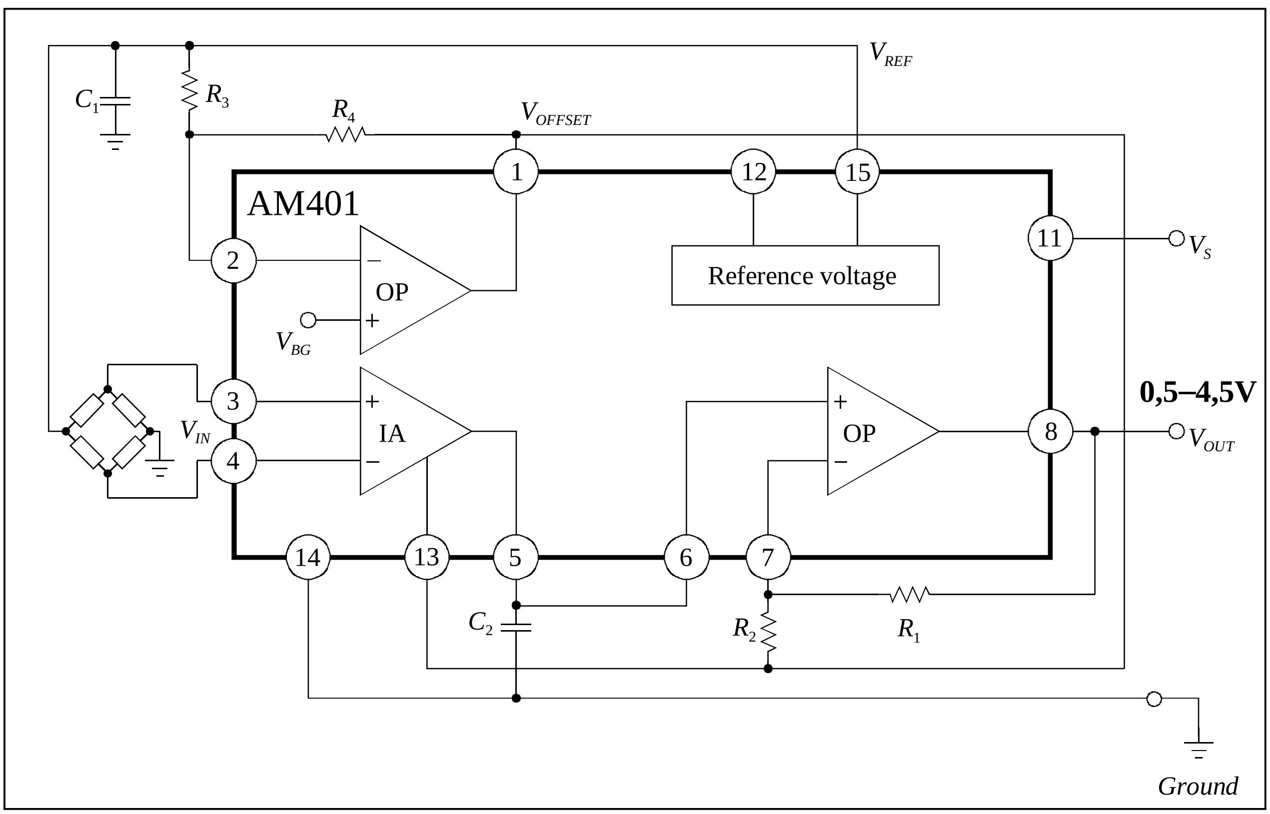

Figure 2: few external components are required to set the output voltage range and power the sensing element.

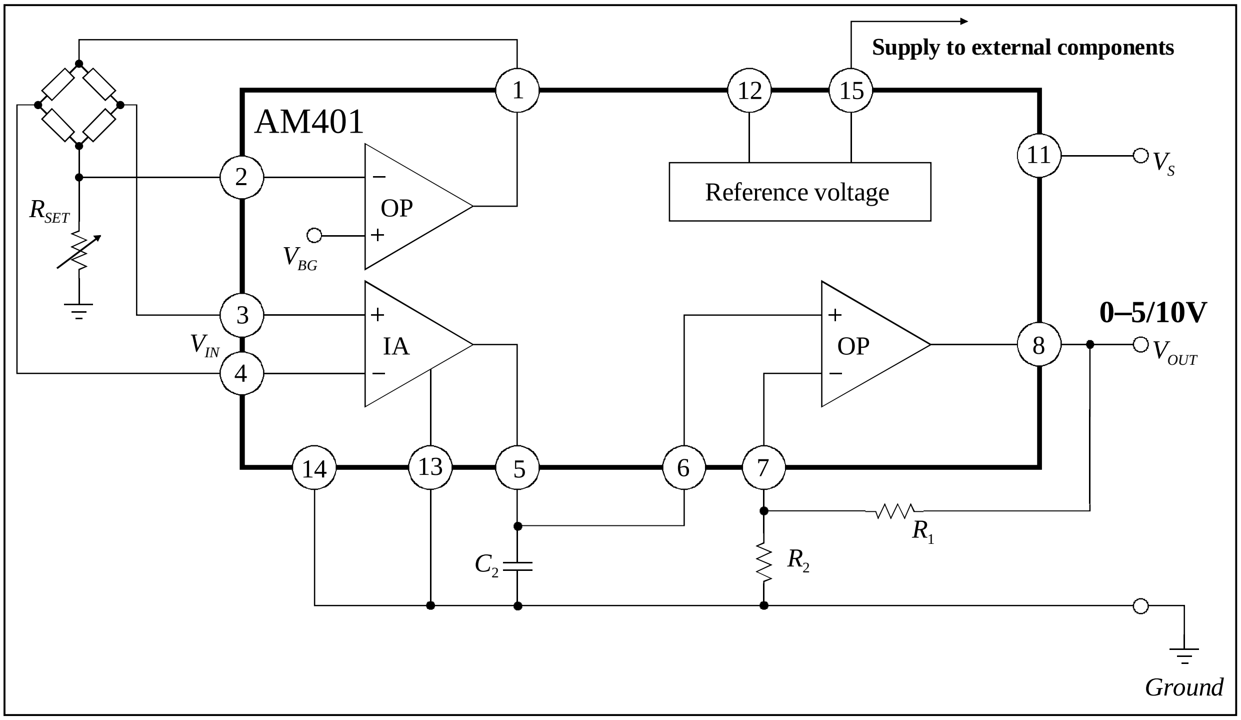

Figure 3: applications with current-powered sensing elements and industrial output voltages are possible.

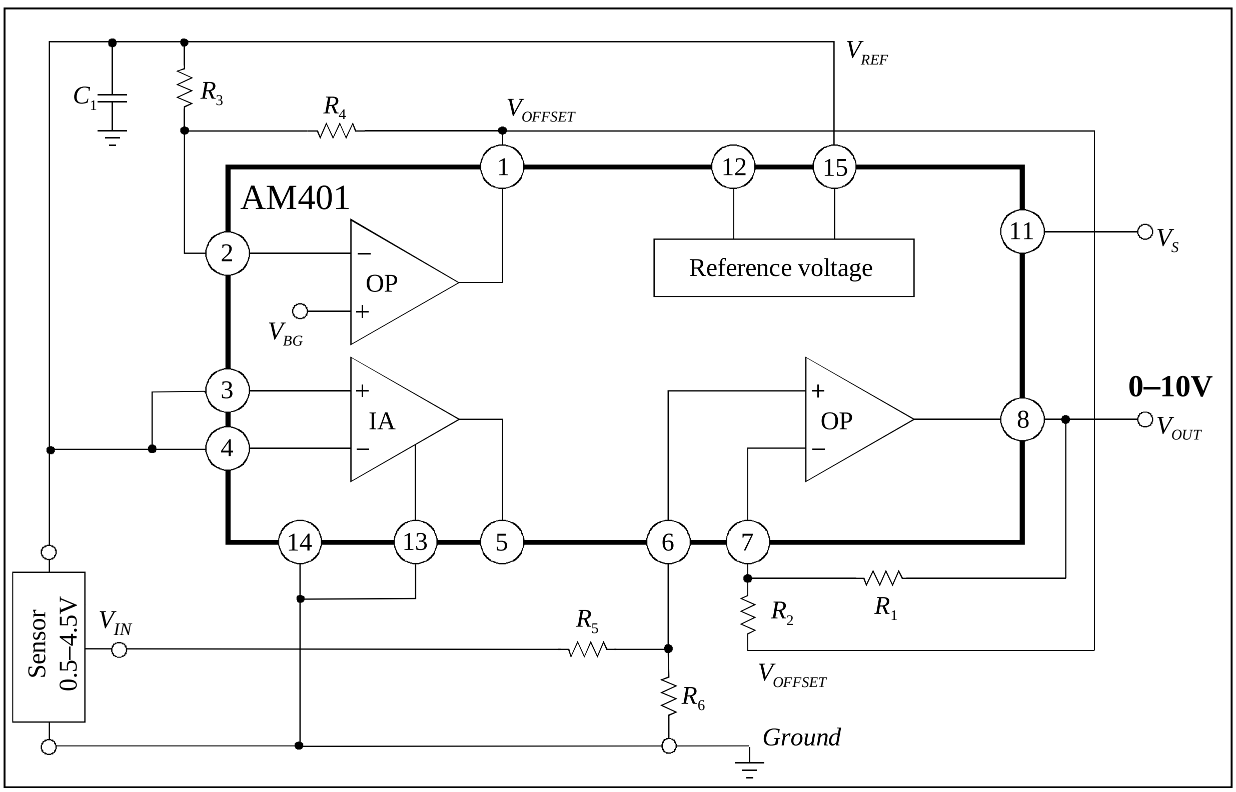

Figure 4: AM401's design concept makes more complicated applications possible