VISHAY PRECISION GROUP

CASE STUDY

Product Group: Vishay Foil Resistors

Precision Resistors in High-Stability MEMS and Quartz Accelerometers for Inertial Navigation Systems

civitanavisystems®

Author Marco Perfetti, Principal Hardware Engineer, Civitanavi Systems Srl

Using Bulk Metal® Z-Foil resistors with TCR of ±0.2 ppm/°C and load-life stability of ±0.005%, Civitanavi was able to create highly stable front-end electronic cards with a single-axis analog MEMS accelerometer or quartz accelerometer onboard for inertial measurement unit (IMU) applications.

Industry/Application Area: Inertial navigation systems for guidance, surveying, and defense applications

Products Used:

- VFCD1505 high-precision Bulk Metal Z-Foil surface-mount voltage divider (10 kΩ / 10 kΩ)
- VSMP1206 ultra-high-precision Bulk Metal Z-Foil surface-mount chip resistors (900 Ω and 350 Ω)

Application 1: MEMS Accelerometers

The Challenge

MEMS accelerometers are the latest generation of open-loop products, and are a major breakthrough towards advanced inertial and high-stability tilt measurements. One problem with MEMS accelerometers offering good bias, scale factors, and axis alignment, however, is their temperature behavior and stability. The MEMS element interfaces with an open-loop circuit that has to be specifically adapted for long-term stability. This integrated interface provides an acceleration-proportional output voltage, as well as a temperature-proportional output for further temperature compensations to be performed at the system level. It operates from a single power supply voltage with a low current consumption, and the output is a ratiometric analog voltage.

The Solution

Civitanavi utilized Vishay Foil Resistors' VFCD1505 Bulk Metal Z-Foil surface-mount voltage divider, which offers the ratio stability and precision needed to ensure the stability of the MEMS accelerometer (Figure 1).

Product Group: Vishay Foil Resistors

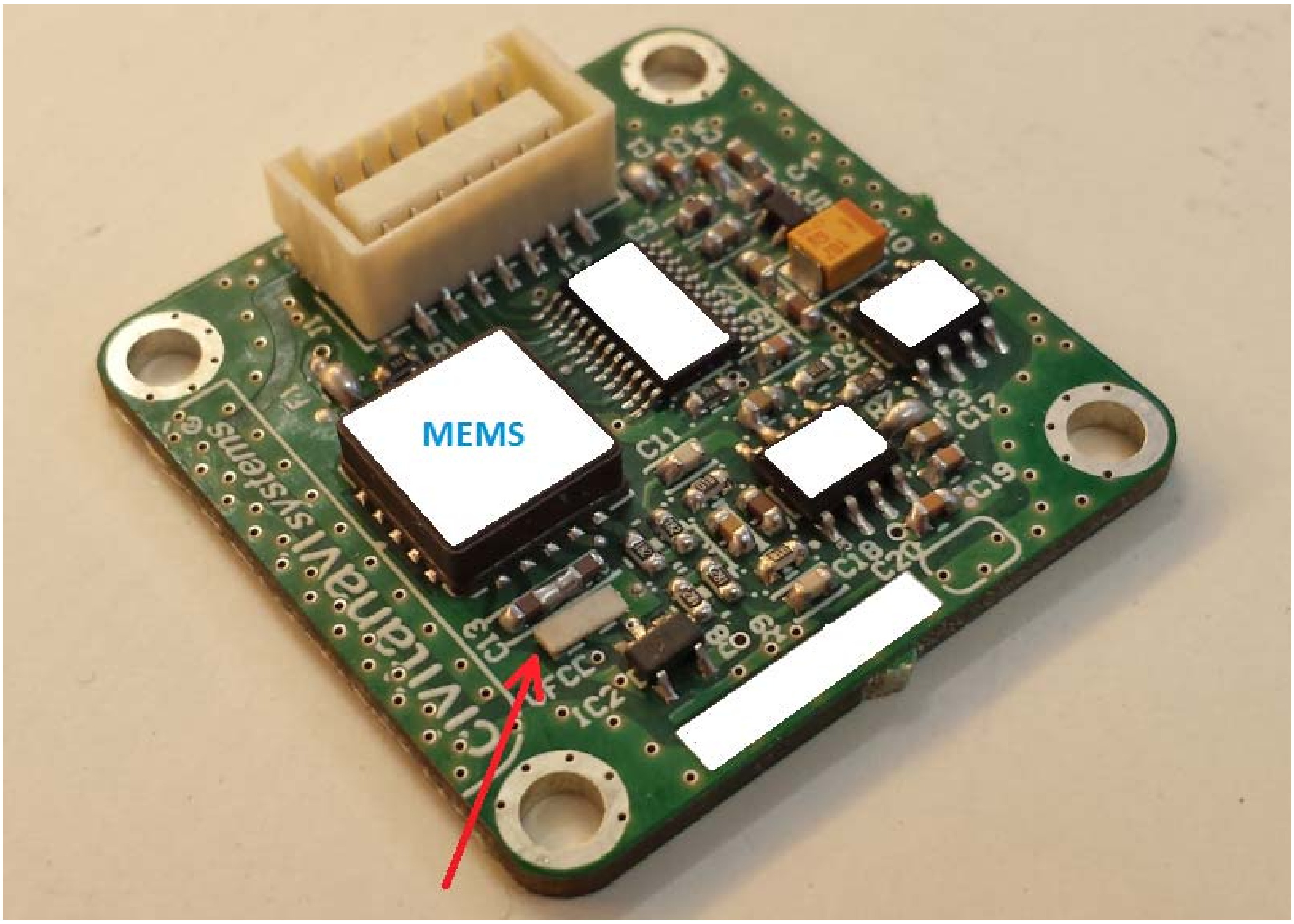

Figure 1: MEMS accelerometer utilizing Bulk Metal Z-Foil VFCD1505 voltage dividers

The User Explains

To ensure the best possible stability of the MEMS accelerometer, the reference voltage of the sensor (VAGND) is generated outside of the package. This node represents the internal reference voltage used in the circuit, and any drift of VAGND will result in an amplified drift of the output signal (VOUT). Therefore, the node's stability must be controlled as precisely as possible, typically within less than 5 µV over the life of the product. One solution for doing this that is implemented in our card is the mounting of an ultra-high-precision resistive divider to generate the external VAGND. The voltage divider is by nature ratiometric and the ratio stability is typically within 2 ppm.

To achieve the required VAGND performance, two precisely matched 10 kΩ resistors are connected in parallel with the two capacitors, as shown in Figure 2.

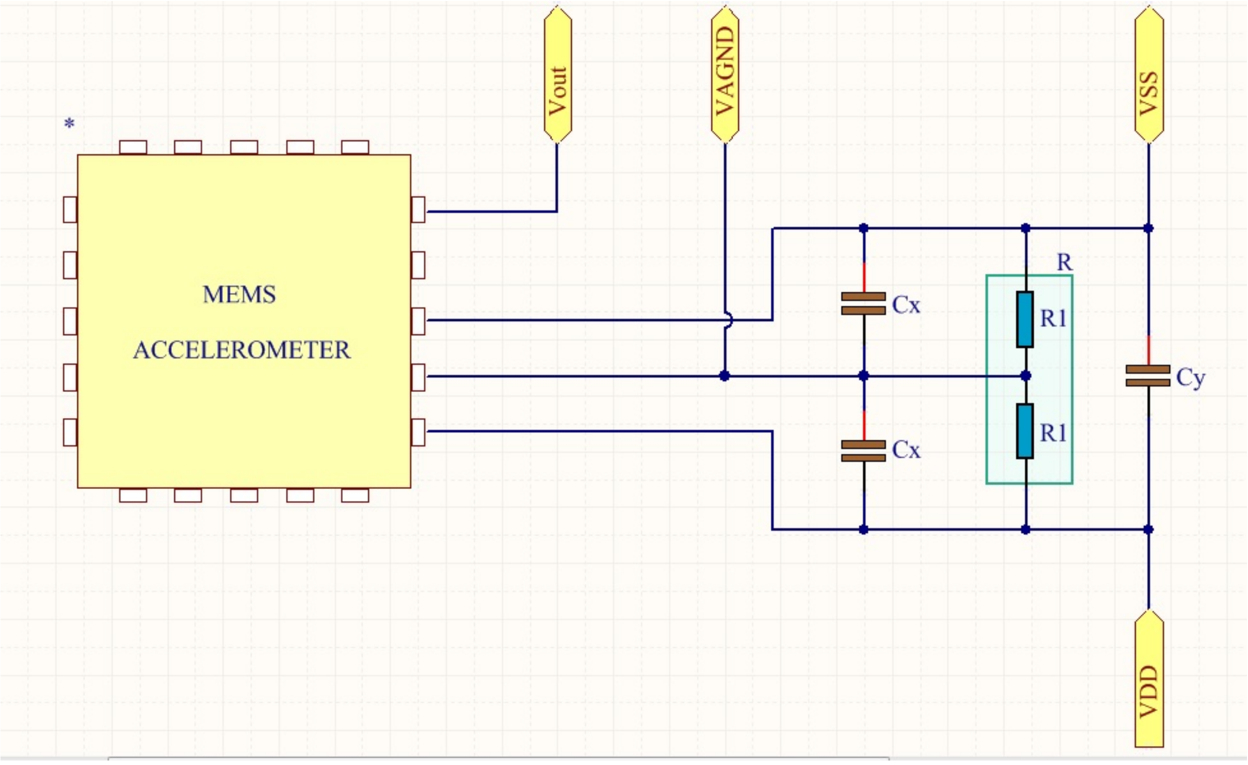

Figure 2: Precision resistors and capacitors connected in parallel to generate the external VAGND.

Both capacitors and resistors have to be mounted as closely as possible. For the resistors, we selected VFR's VFCD1505 Bulk Metal Z-Foil voltage divider, which offers the two high-precision resistors in one package.

Application 2: Quartz Accelerometers

The Challenge

Quartz accelerometers are used in commercial applications, such as strap-down inertial navigation systems for aircraft, marine vessels, land vehicles, and others. The excellent performance of these accelerometers is achieved owing to proven quartz flexure technology. In creating its quartz accelerometer, Civitanavi's goal was to improve the stability of the device and the accuracy of its signal, without decreasing the dynamic range.

The Solution

Civitanavi utilized Vishay Foil Resistors' VSMP1206 Bulk Metal Z-Foil surface-mount chip resistors, which offers the stability and precision required by the quartz accelerometer (Figure 3).

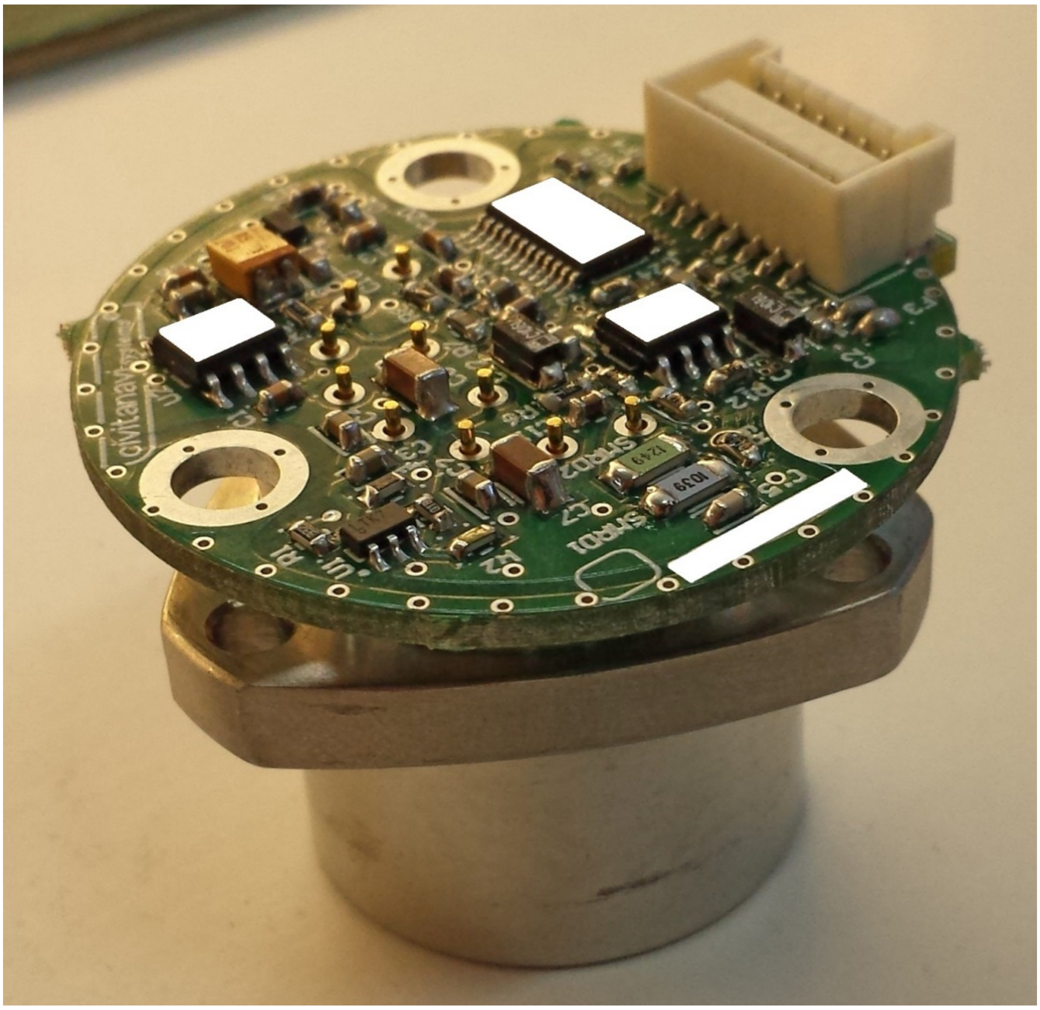

Figure 3: Quartz accelerometer utilizing Bulk Metal Z-Foil VSMP1206 chip resistors

The User Explains

The current output of an accelerometer is proportional (by scale factor) to the input acceleration along the input axis. In our case, we required an output voltage signal for ADC conversion, and we use a sampling resistance connected between the output and ground (R1+R2). This resistor value is determined by the acceleration input range selected and by the input power supply. In our quartz accelerometer, we have split the sampling resistance into two components for interfacing with the ADC circuit, as shown in Figure 4.

For improved stability and signal resolution, we selected VFR's 900 Ω and 350 Ω VSMP1206 Bulk Metal Z-Foil resistors.

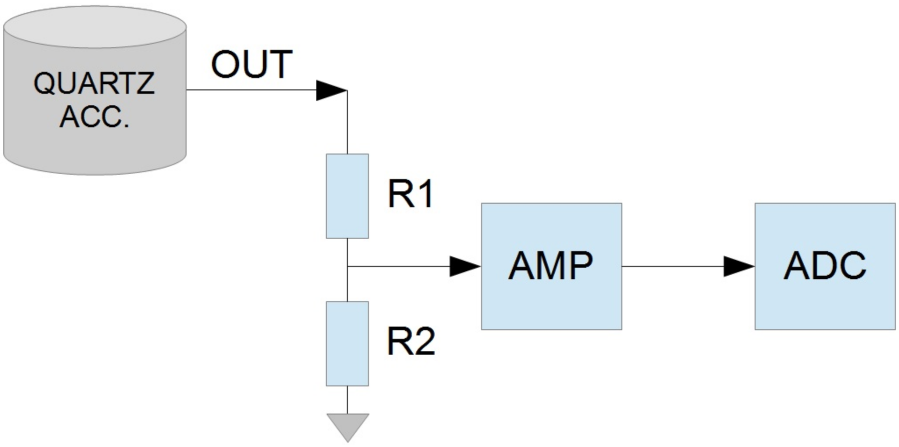

Figure 4: The sampling resistance is split for interfacing with the ADC circuit

"In our MEMS and quartz accelerometer applications, the best solutions for improving stability and scaling signals without losing resolution and accuracy are Bulk Metal Z-Foil resistors from Vishay Foil Resistors."

Acknowledgments**:**

Civitanavi Systems provides solutions for inertial navigation systems and sensors used in guidance, surveying, and defense application. For more information on the company, please visit http://www.civitanavi.com.

Contact Information

Civitanavi Systems Srl
Via Custoza, 20
62012 Civitanova Marche (MC) - Italy
Tel/Fax: +39.0733.773648
skype: civitanavi.mperfetti
Email: mperfetti@civitanavi.com
Web: www.civitanavi.com

Vishay Precision Group, Inc. (VPG)
Vishay Foil Resistors
foil@vishaypg.com

Click here for your regional VFR contact.