Product Group: Vishay Foil Resistors

Control and Data Acquisition for Cable Relaxation Testing (CREEP)

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Using Bulk Metal® Z-Foil resistors and arrays from Vishay Foil Resistors (VFR), Pacam Electronica was able to create ultra-stable measuring equipment for the acquisition of data during cable relaxation testing (CREEP).

Industry/Application Area: Measurement equipment

Products Used:

- Z201 Bulk Metal Z-Foil 40 Ω resistor
- SMNZ Bulk Metal Z-Foil 10 KΩ and 100 Ω surface-mount four-resistor networks

The Challenge

Pacam Electronica's objective was the creation of ultra-stable measuring equipment to be used in independent testing laboratories for quality control of power transmission cables, whose tensile strength and mechanical behavior over time must be known. The system would offer closed-loop control via a servomotor and a load cell for the acquisition of data during cable relaxation testing (CREEP). The purpose of the test is to measure how the wire is deformed under constant tension. The initial length of the cable would be 25 m, and it would be subjected to a constant tension of 40 kN for three months.

The force applied would decrease as the cable lengthens over time, so the exertion of a corrective action would be needed to maintain a constant applied tension. This would be achieved by the servomotor, which would rotate the preloaded nut. This in turn would cause the inner spindle to increase the tension to the programmed value of 40 kN. The entire test stand would be located in a closed tunnel with an external air conditioning system to maintain temperature stability.

In designing the equipment, a primary challenge was that in order to characterize the behavior of a cable with precision, it would be vital for the applied tension to be accurately known, constant in time, and independent of weather conditions. This meant that drifts due to thermal changes and the aging of components had to be minimized.

The Solution

To provide the high stability Pacam Electronica required, the system's amplification circuit is designed without adjustment potentiometers, and in its most critical part, VFR's Bulk Metal Z-Foil Z201 resistors and SMNZ arrays are used. A 40 Ω Z201 resistor determines the gain amplification, ensuring there are no drifts and avoiding errors. Similarly, 10 KΩ and 100 Ω SMNZ four-resistor networks are being used for the feedback resistors. This helps to maintain ultra-stable amplification, and with the resistors having very close tolerances, also ensures a high common mode rejection, which decreases the parasitic interference input from the shielded cable used for connection to the load cell. The two arrays are also used for calibrating signals, as high thermal and temporal stability is crucial in maintaining a constant signal reference.

The User Explains

To ensure system stability, in addition to using a load cell of known quality - like the Tedea-Huntleigh load cell used in this project - we have designed an AC amplifier to minimize the effects of parasitic thermoelectric junctions (any union between two different metals, such as welded joints between the component connection and tin, and between tin and copper for printed circuit tracks). Potential alternating drifts caused by these thermoelectric junctions move very slowly, so they are not amplified and therefore do not alter the reading signal of the force applied.

For operational amplifiers, we are using bipolar devices with high open loop gain and very low noise. The analog conditioner is separated from the rest of the system to minimize switching noise coupling from the digital section.

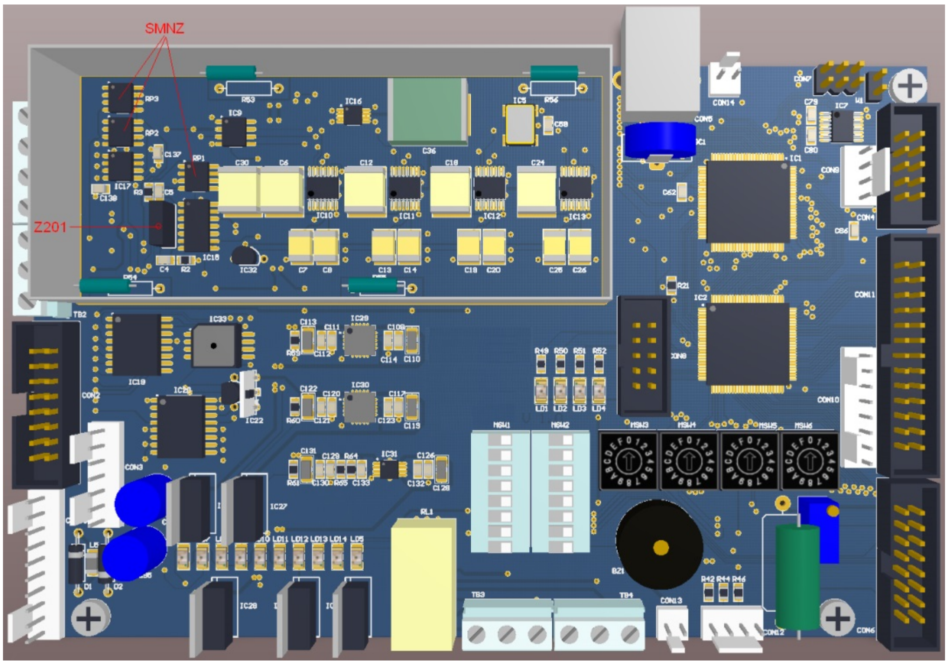

Figure 1: 3D rendering of the PCB highlighting the Z201 resistor and SMNZ array

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Figure 1 shows a 3D representation of the PCB design - VFR's Bulk Metal Z-Foil components are marked in red. These components assure analog system stability. The actual implementation of these components is shown in Figures 2a and 2b. Figure 2a shows the Z201 resistor, which ensures the stability of the amplification. Figure 2b shows three SMNZ arrays that maintain a high common mode rejection and stable reference signals for system calibration.

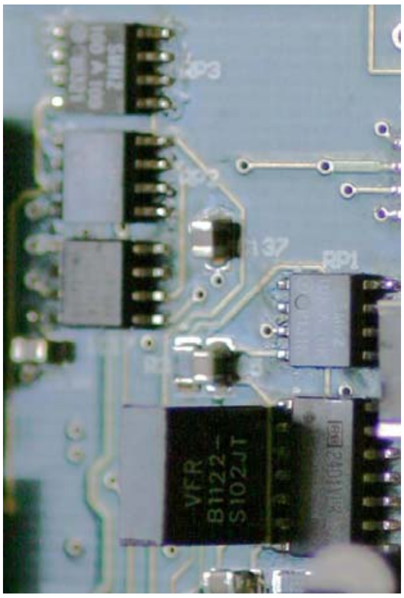

Figure 2a: Z201 resistor on PCB

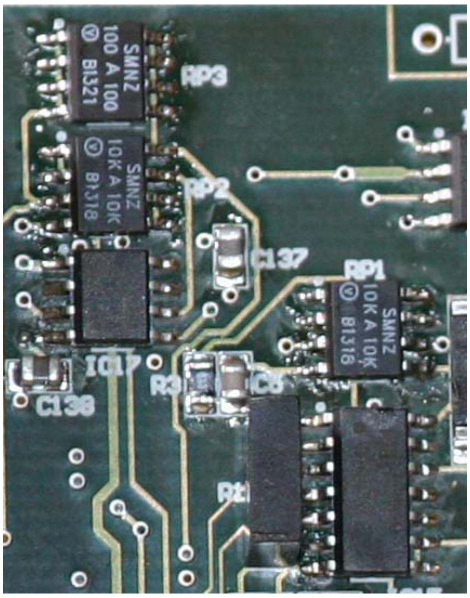

Figure 2b: SMNZ arrays on PCB

A 32-bit microcontroller is responsible for the overall management of the system, and a large-capacity, non-volatile memory in magnetic technology (MRAM) is used for storing data acquired during the test. A real-time clock with back-up power through a super capacitor serves for the time reference of the data acquired. The system communicates with a PC operator interface via RS-485, as this allows for relatively long distances. To keep electrical noise at low levels, linear voltage regulators with very low noise are used for the analog part of the system.

"Vishay Foil Resistors' Bulk Metal® Z-Foil resistors have demonstrated excellent stability have made it possible to realize ultra-stable measurement and control equipment."

Acknowledgments**:**

I want to thank to Vishay Precision Group for delivering the Bulk Metal Z-Foil resistors and arrays necessary for the assembly of the two prototypes. I'd especially like to thank David Gazit for his invaluable cooperation in realizing this system, and Yuval Hernik for his excellent technical articles. It was in these articles that I discovered the amazing benefits of these resistors, without which it would not have been possible to achieve the required stability.

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