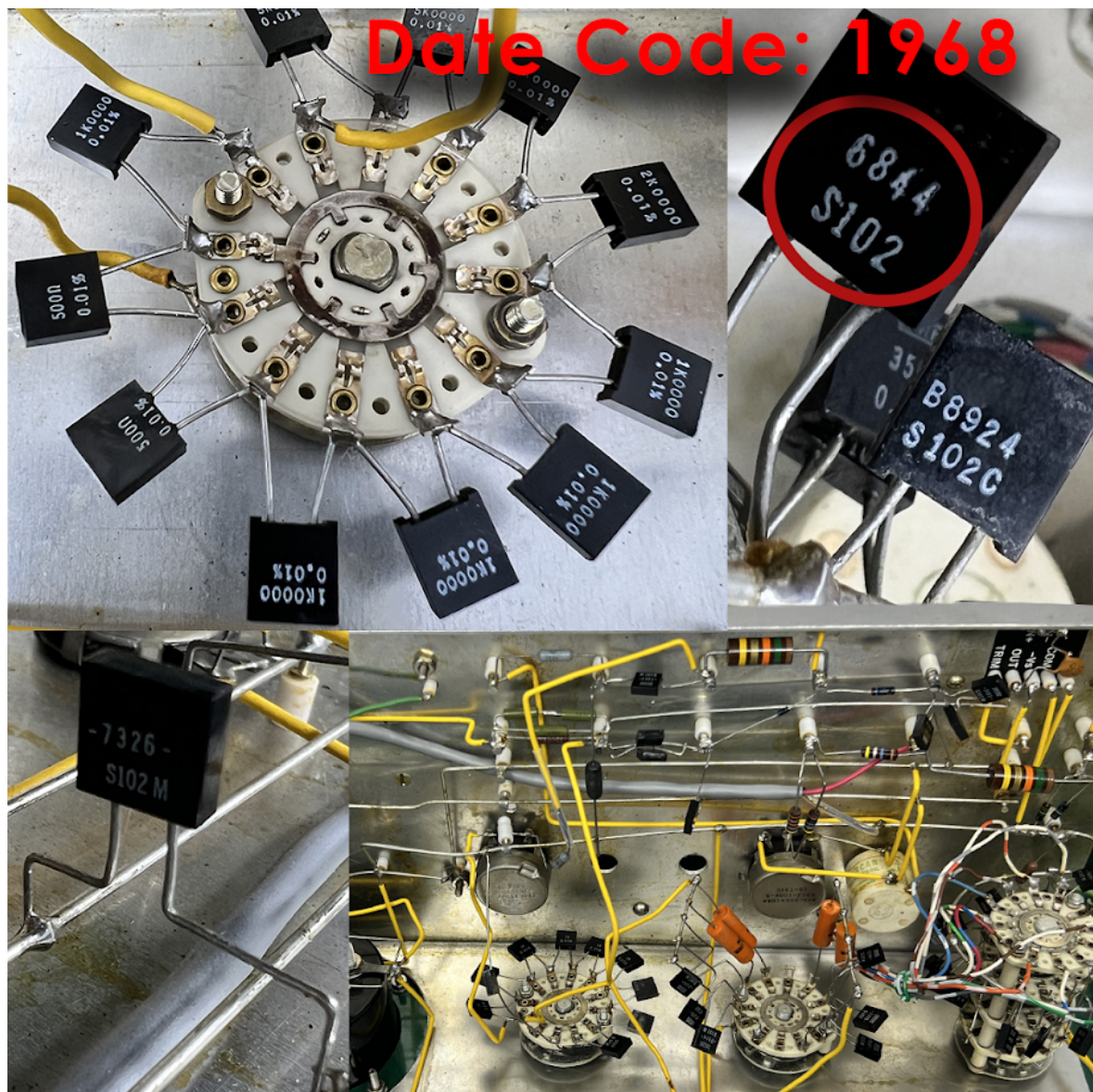


Source: [https://www.linkedin.com/posts/vishay-precision-group\\_they-dont-make-these-resistors-like-they-activity-7449427265274142720-9tMp?utm\\_source=share&utm\\_medium=member\\_desktop&rcm=ACoAAD49EfoBJLW2pXoNMhEA9nRP-w5NZu7IAH0](https://www.linkedin.com/posts/vishay-precision-group_they-dont-make-these-resistors-like-they-activity-7449427265274142720-9tMp?utm_source=share&utm_medium=member_desktop&rcm=ACoAAD49EfoBJLW2pXoNMhEA9nRP-w5NZu7IAH0)

## Precision That Outlived Generations: A Case Study on the Long-Term Reliability of S102C Foil Resistors

In an era where electronics are often designed around rapid product cycles, planned upgrades, and aggressive cost optimization, true long-term reliability has become increasingly rare. Yet every so often, a real-world example emerges that reminds the engineering community what “designed to last” genuinely means.



A recent post by VPG, conceptualised by Yuval, showcased exactly such a case. The post highlighted a measurement instrument originally built in the early 1980s that continues to operate today without measurable performance degradation. At the core of its analog

amplifier stage are S102C foil resistors manufactured in 1968 and 1973 — components that have now remained stable for more than 55 years. (surface mount equivalents: SMR1DZ and SMR3DZ)

For engineers working in precision instrumentation, aerospace, medical electronics, metrology, industrial automation, and high-end calibration systems, this example represents more than nostalgia. It provides a practical lesson in how material science, resistor physics, and disciplined engineering design can create systems whose reliability spans generations.

This case study explores why these resistors continue to perform, what makes foil technology unique, and what modern engineering teams can learn from this extraordinary demonstration of component longevity.

## **Background: The Role of Precision Resistors in Analog Systems**

Precision resistors are foundational to high-performance electronic systems. They define gain, linearity, calibration accuracy, temperature stability, and signal integrity in analog circuits. Even small resistance drift over time can introduce cumulative errors that compromise system performance.

In applications such as:

- Measurement instrumentation
- Bridge completion circuits
- Calibration equipment
- Aerospace controls
- Medical diagnostics
- Precision amplifiers
- Weighing and metrology systems

resistor stability directly affects operational reliability and measurement confidence.

Traditionally, many resistor technologies experience aging due to:

- Thermal stress
- Humidity exposure
- Mechanical strain
- Oxidation
- Material migration
- Power cycling
- Electrostatic discharge (ESD)
- Environmental contamination

Over decades, these mechanisms can cause measurable drift, requiring recalibration, redesign, or complete replacement of equipment.

What makes the S102C example remarkable is that none of these expected long-term degradation behaviors appear to have significantly impacted performance.

## The Discovery: A 55-Year Reliability Benchmark

The instrument featured in the post was built during the early 1980s and remains operational today. More importantly, the amplifier section containing S102C foil resistors reportedly shows no measurable drift within the application.

The resistors themselves were dated 1968 and 1973, meaning they have remained stable for over half a century.

This is not simply a case of components “still functioning.” Many old electronic systems can technically power on while operating far outside original specifications. The distinction here is that the resistors continue to maintain precision performance characteristics.

This level of longevity fundamentally changes how engineers think about lifecycle reliability.

Rather than designing around replacement intervals, recalibration cycles, or drift compensation, the original designers selected components whose inherent physics minimized degradation from the beginning.

As one industry professional commented on the post:

**“Longevity like this is the true measure of engineering quality.”**

That observation captures the essence of the case.

## Why Foil Resistor Technology Matters?

The extraordinary stability of S102C resistors is rooted in foil resistor technology itself.

Unlike conventional thick-film or wirewound resistor designs, precision foil resistors use a specially engineered metal foil bonded to a stable substrate. This structure allows extremely tight control over critical parameters including:

- Temperature coefficient of resistance (TCR)
- Load life stability: to  $\pm 0.005\%$  at  $70^{\circ}\text{C}$ , 2000 h at rated power
- Current Noise:  $0.010\ \mu\text{VRMS/V}$  of applied voltage ( $< -40\ \text{dB}$ )
- Non hot spot design
- Electrostatic discharge (ESD) at least to 25 kV
- Thermal EMF  $< 0.1\ \mu\text{V}/^{\circ}\text{C}$
- Rise time: 1 ns effectively no ringing
- Thermal stabilization time  $< 1\ \text{s}$
- Power coefficient “ $\Delta R$  due to self heating”: 5 ppm at rated power
- Non inductive:  $< 0.08\ \mu\text{H}$
- Short time overload:  $\leq 0.005\%$
- Voltage coefficient  $< 0.1\ \text{ppm/V}$

The technology was specifically developed for ultra-precision applications where even microscopic instability can create significant measurement errors.

## **Key Advantages of Foil Resistors**

### **1. Extremely Low Temperature Coefficient**

Temperature changes are among the biggest causes of resistance variation. Foil resistors are engineered to minimize thermal expansion mismatches, dramatically reducing temperature-induced drift.

This enables stable operation across varying environmental conditions.

### **2. Exceptional Long-Term Stability**

The defining feature demonstrated in this case study is long-term drift performance.

Foil resistors exhibit remarkably low aging effects because their materials and construction methods are optimized for mechanical and thermal stability over extended periods.

### **3. Low Noise Characteristics**

In precision analog circuits, electrical noise can corrupt measurements and reduce system accuracy. Foil technology inherently produces lower excess noise compared to many other resistor technologies.

### **4. Superior Environmental Resistance**

Humidity, vibration, oxidation, and contamination are major causes of resistor degradation. Foil resistors are specifically designed to resist these failure mechanisms.

### **5. Predictable Reliability**

Many modern low-cost components may initially meet specification requirements but degrade unpredictably over time. Foil resistors are valued because their behavior remains consistent across decades.

This is why one commenter accurately stated:

**“This is why foil remains the benchmark for precision.”**

## **Engineering Philosophy: Physics Over Shortcuts**

One of the most compelling lines from the original post stated:

**“This is what happens when resistor design is driven by physics, not shortcuts.”**

That sentence reflects a broader engineering philosophy increasingly relevant in modern manufacturing environments.

Today's electronics industry often prioritizes:

- Cost reduction
- Miniaturization
- Faster production cycles
- Component consolidation
- Shorter product lifespans

While these objectives support market competitiveness, they can sometimes compromise long-term reliability.

The S102C case demonstrates the opposite philosophy:

- Stable materials
- Conservative design margins
- Proven manufacturing methods
- Long-term performance prioritization
- Reliability-focused engineering discipline

In mission-critical systems, this philosophy delivers enormous lifecycle advantages.

## **Business Impact of Long-Term Stability**

The value of ultra-stable components extends far beyond engineering elegance.

### **Reduced Maintenance Costs**

Systems requiring fewer recalibrations reduce operational downtime and maintenance expenses.

### **Extended Equipment Life**

Long-lasting components delay costly equipment replacement cycles.

### **Improved Measurement Confidence**

Stable analog systems produce more consistent results over time, improving quality assurance and operational trust.

### **Lower Total Cost of Ownership**

While premium precision components may cost more initially, their long-term reliability often produces lower lifecycle costs.

### **Stronger Brand Reputation**

Manufacturers known for durable, dependable systems build stronger customer confidence and market credibility.

This explains why precision foil resistors became trusted standards across industries where failure or drift is unacceptable.

As another commenter noted:

**“Built right once. Still right 55 years later.”**

## Relevance to Modern Industries

The lessons from this case remain highly relevant today, especially in sectors where precision and reliability are inseparable.

### Aerospace and Defense

Systems may remain operational for decades and require absolute reliability under extreme conditions.

### Medical Electronics

Precision drift can directly affect diagnostic accuracy and patient safety.

### Industrial Automation

Stable instrumentation reduces production variability and calibration interruptions.

### Metrology and Calibration

National standards laboratories and calibration facilities depend on ultra-stable reference components.

### Weighing and Sensor Systems

Bridge completion, load-cell calibration, and precision signal conditioning demand minimal drift over long operating periods.

One comment specifically highlighted:

**“S102C is the best as bridge completion and for shunt calibration.”**

That statement reflects the continued practical importance of foil resistors in high-accuracy measurement ecosystems.

## Lessons for Today’s Engineers

This case study offers several enduring lessons for engineering teams and product designers.

## **1. Reliability Begins at the Material Level**

Long-term stability cannot be added later through software correction alone. Material science and component architecture matter deeply.

## **2. Precision Is About Consistency Over Time**

Initial accuracy is only part of the equation. True precision means remaining accurate after years — or decades — of operation.

## **3. Engineering Discipline Outlasts Trends**

Technologies optimized around sound physical principles often outperform newer alternatives focused solely on cost or speed.

## **4. Lifecycle Thinking Creates Better Systems**

Designing for decades rather than quarters produces more sustainable and reliable products.

## **5. Proven Technologies Still Matter**

Innovation is important, but some foundational technologies remain industry benchmarks because they solved core engineering challenges exceptionally well.

## **Conclusion**

The story of S102C foil resistors continuing to perform accurately after more than 55 years is more than a fascinating engineering anecdote. It is a powerful demonstration of what becomes possible when precision design is guided by physics, discipline, and long-term thinking rather than short-term optimization.

In a world increasingly focused on rapid iteration and disposable technology, this example stands as a reminder that true engineering excellence is measured not only by performance at launch, but by performance decades later.

Some components simply survive.

Others quietly prove they were engineered correctly from the very beginning.