Very Low Level DC Voltage Measurement Technique by DC-AC Conversion

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1. Objective
Accurate and fast testing
- very small offset voltage of operational amplifier
- with Automatic Test Equipment (ATE)

- Testing Requirements
  • μV-order DC voltage
  • Fast
- Proposed Method
  FFT-Based DC-AC Conversion

2. Background
Problems for μV-order DC Voltage Testing

1. Noise at Test Environment
2. Test Time
3. Thermo-Electromotive Force (EMF)

\[ V_{emf} = V1 - V2 = (T1 - T2) \times 30 \mu V \]

3. Proposed Method
Accurate and fast testing
very small offset voltage
of operational amplifier
with Automatic Test Equipment (ATE)

- Testing Requirements
  • μV-order DC voltage
  • Fast
- Proposed Method
  FFT-Based DC-AC Conversion

4. DC-AC Conversion Circuit

FFT-Based DC-AC Conversion

\[ V(t) = \frac{2A}{\pi} \sin(\omega t) + \frac{1}{3} \sin(3\omega t) + \frac{1}{5} \sin(5\omega t) + \cdots \]

5. Multi-Site Testing

Configuration & Operation

Measurement Result

Sampling Rate: 100kHz, Sample: 10k, Averaging: 100, Frequency Resolution: 10Hz

Expected FFT Result

Measurement Result

Multi-site measurement as low as 0.2 μV is possible

6. Conclusion

Solved Problems

1. Noise at Test Environment
Testing is NOT affected by system noises
2. Test Time Reduction
Testing method is applicable to multi-site testing
3. Electromotive force (EMF) Countermeasure
Keep temperature difference less than 0.1 °C for μV-order testing

Proposed FFT-based DC-AC conversion is applicable for μV-order DC test using ATE

7. References