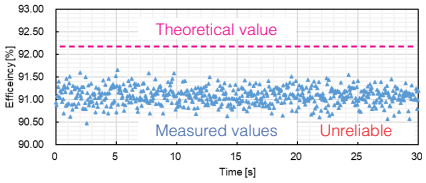
Application Note

To inverter/motor developers focusing on a *0.1%* efficiency improvement

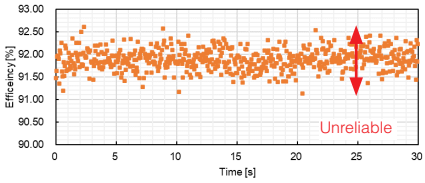
Energy efficiency improvement is a critical issue for achieving a sustainable society, particularly in the context of technologies that drive our daily lives. Inverters and motors are indispensable in various fields, including industrial machinery, transportation, and household appliances. The performance of these inverters and motors running in various facets of our lives directly impacts society's overall energy consumption. To maximize their efficiency and minimize energy conversion losses, repeatable measurements, precise problem identification, and the effective use of measurement data are essential. In this application note, we explore the challenges encountered by industry leaders in their efforts to improve conversion efficiency and present solutions that utilize Hioki's high-precision power analyzers to address these challenges.

1. The challenges faced by industry-leading users

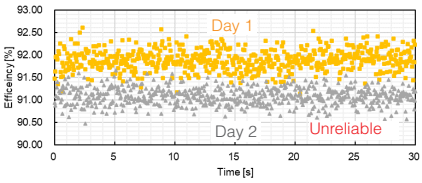
The **discrepancy** between simulation and actual measurement values



The measured values exhibit significant **variability**



The measurement results **differ** depending on the location and day



01 | Measurement inaccuracy

Incorrect pass/fail judgment result in inaccurate simulation-based development.

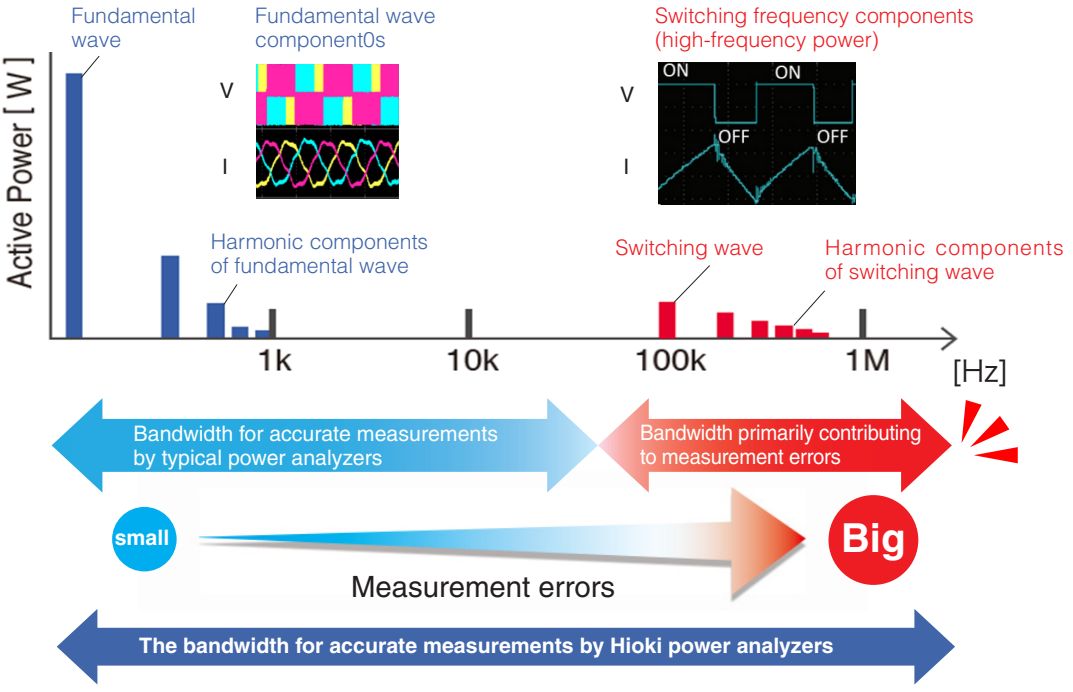
02 | Time-consuming

To minimize variation, lengthy data averaging is necessary. However, this results in a substantial increase in cooling time as motor temperature rises in the process.

03 | Reproducibility

Without data reproducibility, correct design improvement assessment is hindered, preventing high-quality outcomes.

2. What is the reason? When examining the inverter voltage and current waveforms...



In inverter development, accurate measurement of **high-frequency power** is key

HIOKI

application_PW8001_0.1% efficiency improvement_E1_251M

Application Note

3. Attention !! The solution only Hioki can provide

Hioki: Uniquely Tailoring Power Analyzers and Current Sensors for Optimal Performance

Hioki's power analyzers are used with a lineup of dedicated current sensors. Because both are developed in-house, you can achieve highly repeatable measurements that are not possible by other brands without this advantage. Pursuing efficiency improvement in inverters requires highly repeatable measurement of high-frequency power. By utilizing fine-tuned frequency characteristics of the sensors, our power analyzer can perform unparalleled phase correction, making remarkably stable measurements and delivering accuracy and reproducibility.

Power Analyzers PW8001

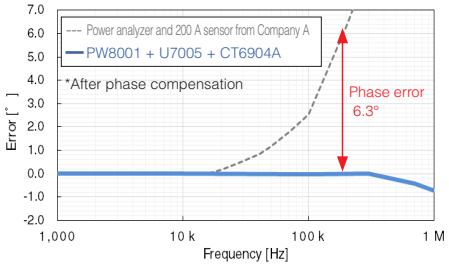
Accuracy: 0.03% (50/60 Hz)
Bandwidth: DC to 5 MHz
Automatic phase correction for our current sensors

High-accuracy current sensors

Rated Current: 2 to 2000 A
Bandwidth: DC to 10 MHz
World-class accuracy & bandwidth
High noise immunity and reproducibility

4. Explanation 3 reasons why PW8001 can accurately measure high-frequency power

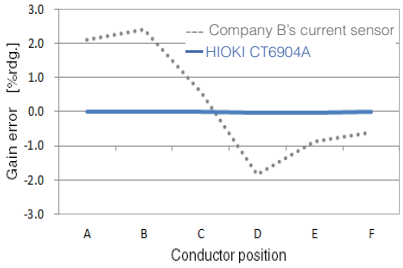
Comparison of phase error



Effect of aliasing

	Fs Sampling frequency		BW Analog bandwidth
Typical power analyzers **Fs < 2BW**	10 MS/s	=	10 MHz
	Error and variability due to aliasing are present		
PW8001 **Fs ≧ 2BW**	15 MS/s	>	5 MHz
	Error and variability due to aliasing are absent		

Effect of conductor position (100 kHz)



PW8001 +  U7005 +  CT6904A

CT6904A
*Deviation from center

1 Accuracy

Typical power analyzers

Accurate measurement of high-frequency power is not possible due to significant phase errors at high frequencies,.

Hioki's PW8001 and current sensors

Precise high-frequency phase correction is uniquely possible because we develop current sensors in-house, enabling us to fully understand their characteristics.

2 Stability

Typical power analyzers

Aliasing error occurs due to insufficient sampling frequency (Fs) relative to analog bandwidth (BW).

Hioki's PW8001

We achieve simultaneous wideband measurements up to 5 MHz and prevent aliasing by employing a high-speed 15 MHz sampling A/D converter.

3 Reproducibility

Typical current sensors

Conductor position changes measurement values, especially at higher frequencies

Hioki's current sensors

Measurements are unaffected by conductor position thanks to unique techniques in coil winding arrangements and shielding

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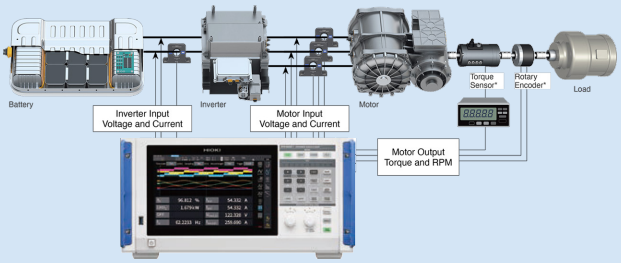
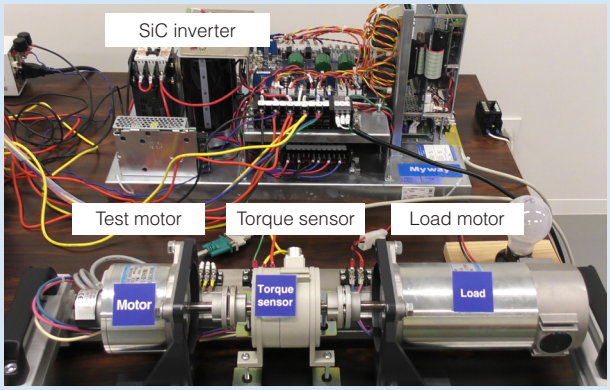
5. Efficiency measurement results of SiC inverters

Schematic diagram of the test



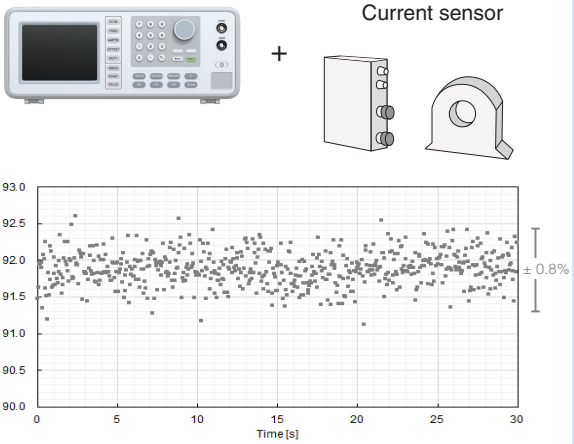


Measurement Condition

Switching frequency: 50 kHz
Motor speed: 1000 rpm
Wiring: 3P3W

Company A

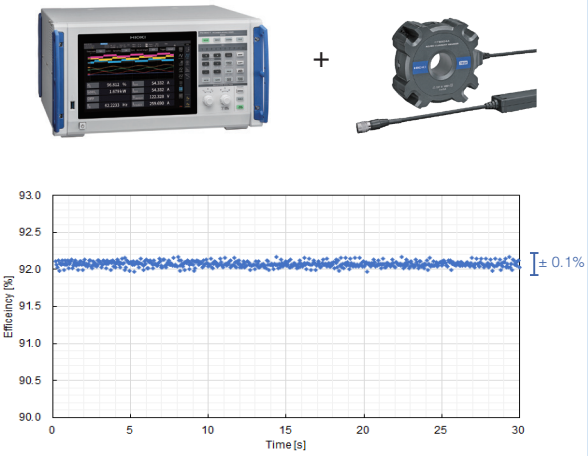
Power analyzer + Current sensor element or Current sensor



× Large variability

Hioki

PW8001 + U7005 + CT6904A (500 A rated)



✓ High stability and reproducibility

For more details

PW8001 introduction

https://www.hioki.com/global/products/power-meters/power-analyzer/id_412384

Technical paper

https://www.hioki.com/us-en/download/31462

PW8001 introduction video

https://www.youtube.com/watch?v=Sr7W8Da2efY&t=7s

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