

Absolute Accuracy: 3% uncalibrated, 1% with single calibration

**Applications:**

- Study process variation (within-chip, chip-to-chip, run-to-run) of on-chip capacitors
- Measure on-chip calibration capacitors
- Measure interconnect parasitics

**Example:**

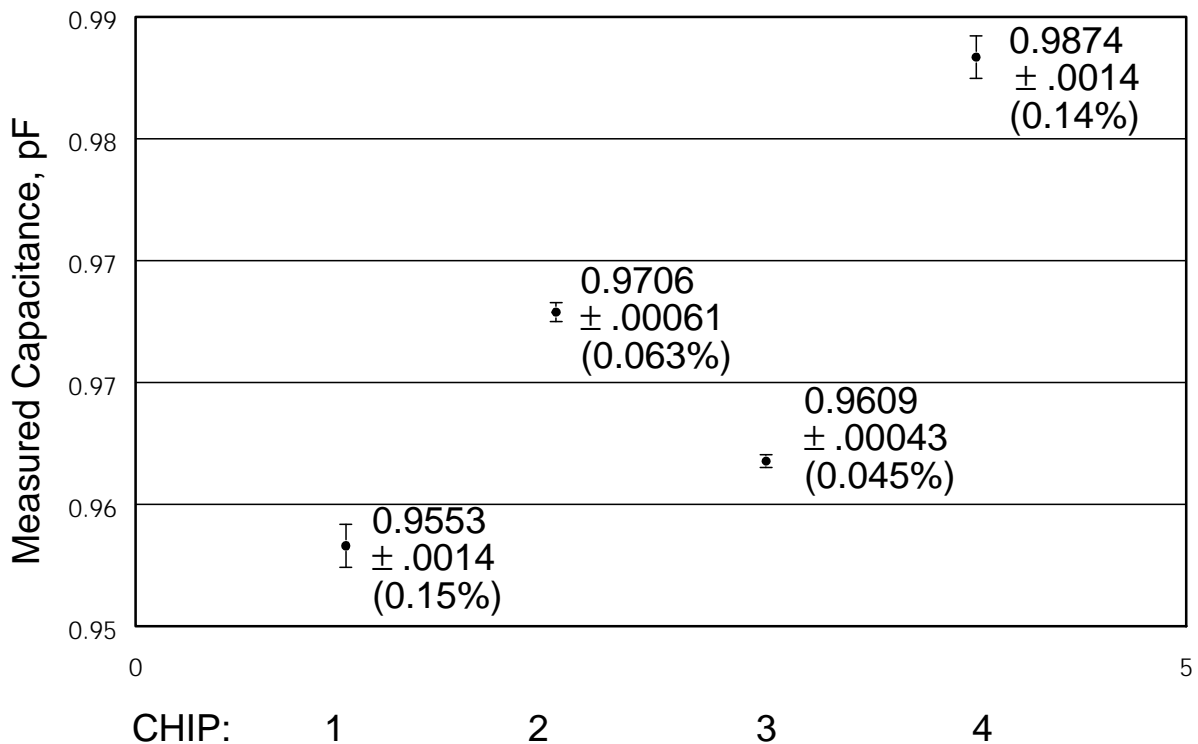
Array of 8 on-chip capacitors

Nominal value: **0.959 pF**

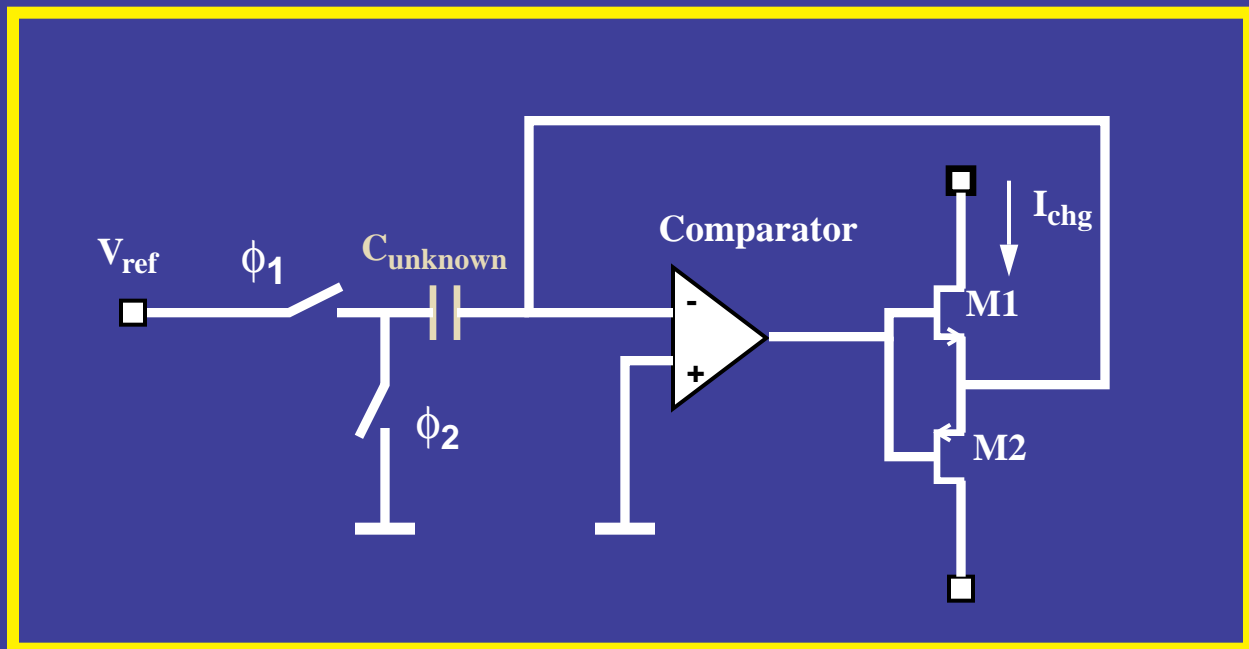
Measured value (ave. of 32 caps. on 4 chips): **0.963 pF**

On-chip variation (one s): **0.10%**

Chip-to-chip variation: **1.50%**



## Precision Capacitance Measurement Circuit



The left side of  $C_{unknown}$  is alternately connected to  $V_{ref}$  and ground at a frequency  $f_{ck}$ . The charging current  $I_{chg}$  through M1 is measured.

- **Capacitance:** 
$$C = \frac{I_{chg}}{(V_{ref} + V_{\epsilon}) \cdot f_{ck}}$$

- **Error:** 
$$\frac{\Delta C}{C} = \frac{V_{\epsilon}}{V_{ref}} \approx \frac{V_{DD}}{V_{ref} G_A}; \text{ (GA = gain of comparator)}$$

- **Insensitive to:**

- comparator offset voltage
- parasitic capacitance
- switch charge injection