Capacitive detection of liquid in micro-canals

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An on-line method to detect liquid and its dielectric properties in micro-canals.
The detection is performed using a capacitive measurement method.
A low-cost electronic circuit enables the detection of capacitance changes as low as 50 aF.

Basic principle
In this capacitive sensing system, one common electrode is directly placed under the two mono-mode 50 um step-index fibers.
The other electrodes of sensing capacitors \( C_x \) and \( C_{ref} \) are half circle of a metal pipe, which can fit just around the step-index fibers. The offset capacitor \( C_0 \) is a shielded wire without any connection to the electrode.
The capacitance is affected by the dielectric between its electrodes.

Measurement set up
The system is comprised of the capacitive sensing element, one UTI chip, a microcontroller and a PC.
The UTI in mode 1 or 4 is used to measure three such capacitances with one common electrode,
- one dielectric capacitor
- one reference capacitor
- one offset capacitor
One measurement cycle consists of three phases

Universal Transducer Interface (UTI):
\[ T_x = K C_x + T_{off} \]

Microcontroller:
- To measure the output signal of the UTI.
- To control the mode function of the UTI.
- To communicate with the PC.

The program, LabView, in the PC will implement the calculation of the measurements based on the three-signal auto-calibration method.
These calculations are presented by
\[ C_x = C_{ref} \left( \frac{N_{Cl} - N_{C0}}{N_{Cref} - N_{C0}} \right) \]
Meanwhile, the results are displayed on a graphical display.