

Semiconductor Sensors:

Ch4: Capacitive Sensors Cont.

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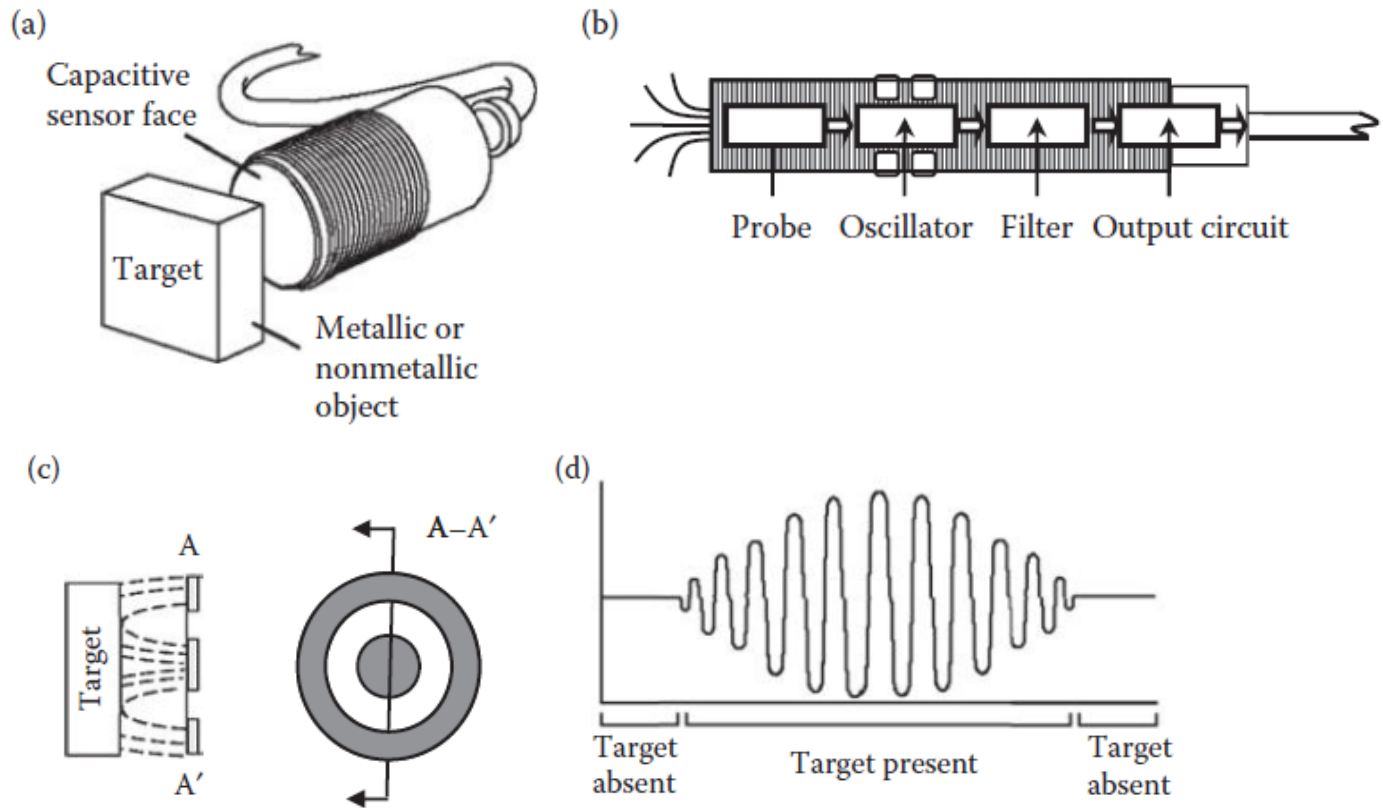
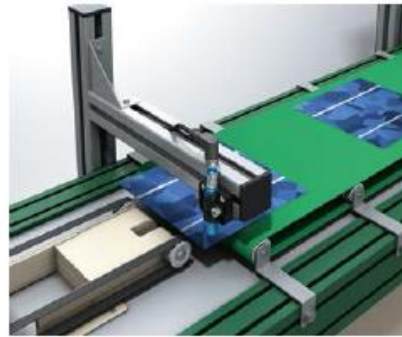


FIGURE 3.29 Example of a capacitive proximity sensor design and sensing. (After Capacitive proximity sensors: Theory of operation, Siemens online course. www.automationmedia.com/Port1050%5CSiemensFreeCourses%5Csnrs_3.pdf.)



Solar and electronics industries:
Detection of solar wafers

The CM12 capacitive proximity sensor is



Woodworking machines:
Detection of wood

The CM18 capacitive proximity sensor



Plastics industry:
Detection of various media

The CM30 capacitive proximity sensor

Features

Housing	Cylindrical thread design
Thread size	M12 x 1
Sensing range S_n	8 mm
Safe sensing range S_s	5.76 mm

Supply voltage	10 V DC ... 36 V
Ripple ¹⁾	≤ 10 %
Voltage drop ²⁾	≤ 2.5 V DC
Current consumption ³⁾	≤ 12 mA
Time delay before availability	≤ 120 ms
Hysteresis	3 % ... 20 %
Repeatability ^{4) 5)}	≤ 5 %

Reduction factors

Note	The values are reference values which may vary
Metal	1
Water	1
PVC	Approx. 0.4
Oil	Approx. 0.25
Glass	0.6
Ceramics	0.5
Alcohol	0.7
Wood	0.2 ... 0.7

کاربردهای حسگرهای خازنی

۲- فشارسنج خازنی:

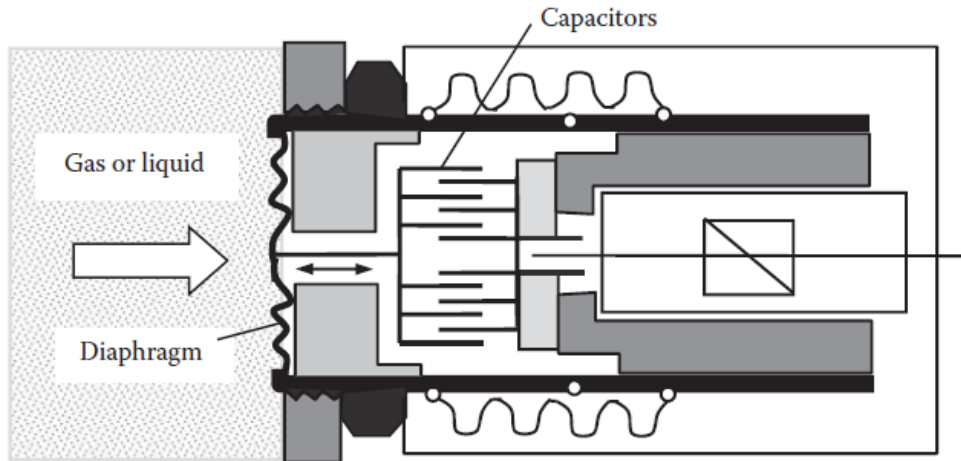
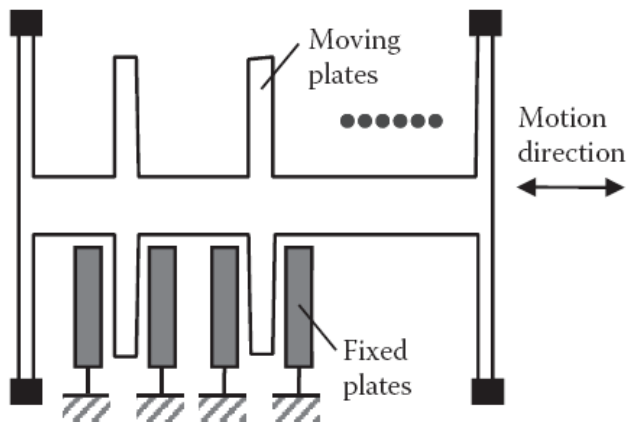
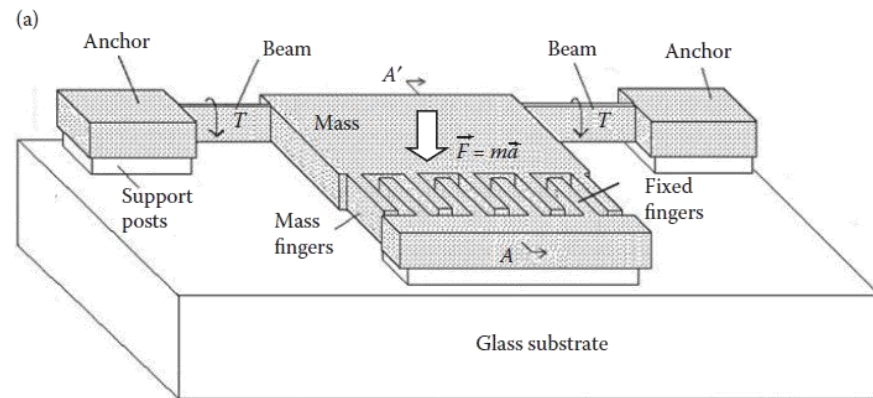


FIGURE 3.23 Capacitive pressure sensor with area variation. (Modified based on original drawing from VEGA Technique, France.)

۳- شتاب سنج خازنی:



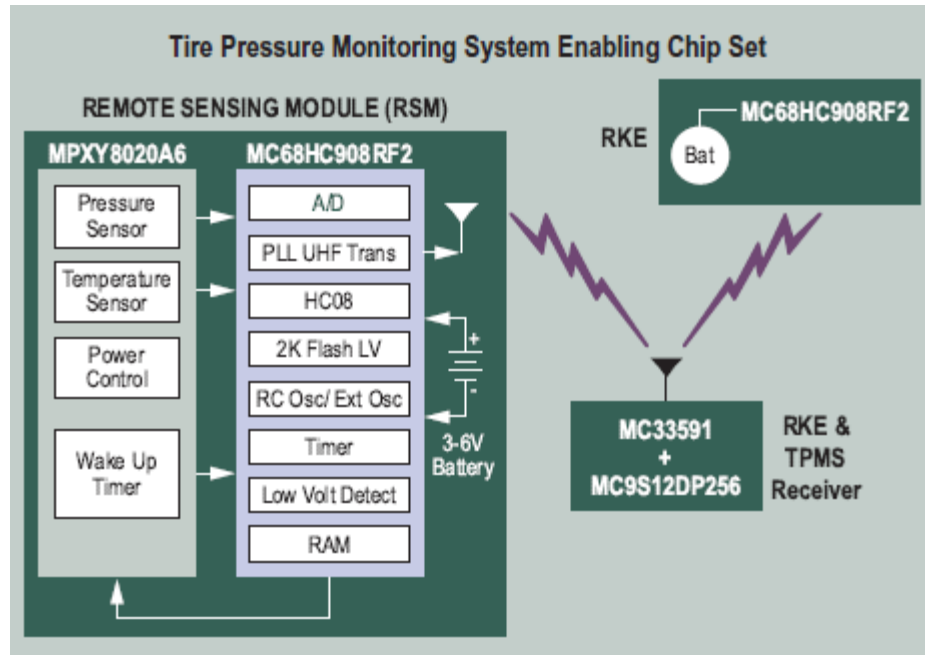
A multiplate capacitive sensor.



TIRE PRESSURE MONITORING SENSOR

Motorola introduces the MPXY8000 series family of tire pressure monitoring sensors that are comprised of a capacitive pressure sensing element, a temperature-sensing element, and an interface circuit with wake-up feature, all on a single chip. This chip is housed in Motorola's SSOP (super small outline package) package. The SSOP's size and enhanced media protection make it the perfect package solution for Tire Pressure Monitoring System (TPMS) remote sensing modules, mounted on valve stems or wheel wells.

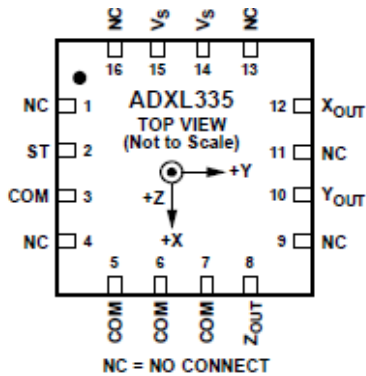
Device	Maximum Operating Pressure (kPa)	Full Scale Span Output	Sensitivity (kPa/bit)	Maximum Pressure Accuracy (-20°C to +70°C)	Temperature Accuracy (-40°C to +125°C)	Supply Voltage Range (V)
MPXY8010	450	8-bit Digital	2.5	± 7.5 kPa	± 4°C	2.1 to 3.3
MPXY8020	637	8-bit Digital	2.5	± 7.5 kPa	± 4°C	2.1 to 3.6
MPXY8030	900	8-bit Digital	5.0	± 15 kPa	± 4°C	2.1 to 3.3
MPXY8040	1275	8-bit Digital	5.0	± 15 kPa	± 4°C	2.1 to 3.6



The ADXL335 is a complete 3-axis acceleration measurement system. The sensor is a polysilicon surface-micromachined structure built on top of a silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor that consists of independent fixed plates and plates attached to the moving mass. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration.

APPLICATIONS

- Cost sensitive, low power, motion- and tilt-sensing applications
- Mobile devices
- Gaming systems
- Disk drive protection
- Image stabilization
- Sports and health devices



FUNCTIONAL BLOCK DIAGRAM

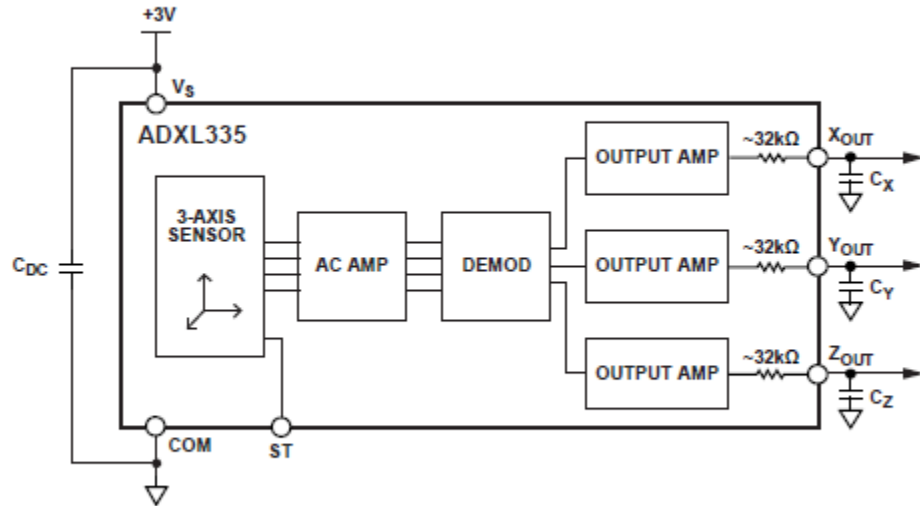


Figure 1.

SPECIFICATIONS

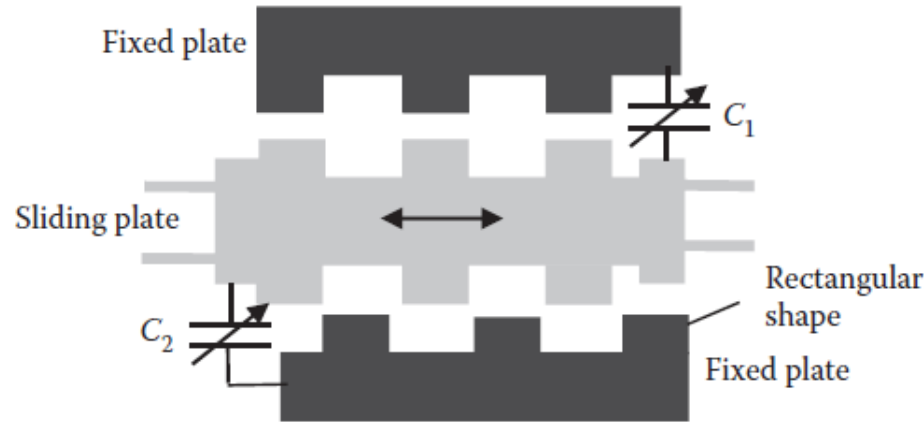
$T_A = 25^\circ\text{C}$, $V_S = 3\text{ V}$, $C_X = C_Y = C_Z = 0.1\ \mu\text{F}$, acceleration = 0 g, unless otherwise noted. All minimum and maximum specifications are guaranteed. Typical specifications are not guaranteed.

Table 1.

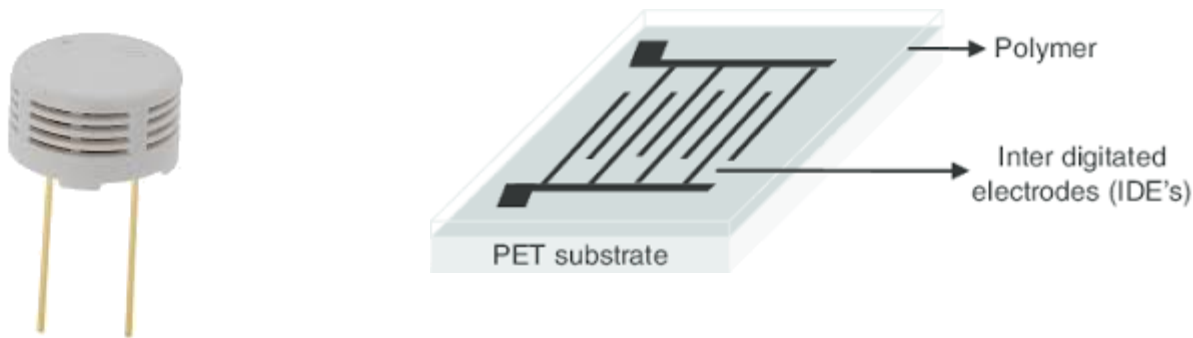
Parameter	Conditions	Min	Typ	Max	Unit
SENSOR INPUT	Each axis				
Measurement Range		± 3	± 3.6		g
Nonlinearity	% of full scale		± 0.3		%
Package Alignment Error			± 1		Degrees
Interaxis Alignment Error			± 0.1		Degrees
Cross-Axis Sensitivity ¹			± 1		%
SENSITIVITY (RATIOMETRIC) ²	Each axis				
Sensitivity at X_{OUT} , Y_{OUT} , Z_{OUT}	$V_S = 3\text{ V}$	270	300	330	mV/g
Sensitivity Change Due to Temperature ³	$V_S = 3\text{ V}$		± 0.01		%/ $^\circ\text{C}$
ZERO g BIAS LEVEL (RATIOMETRIC)					
0 g Voltage at X_{OUT} , Y_{OUT}	$V_S = 3\text{ V}$	1.35	1.5	1.65	V
0 g Voltage at Z_{OUT}	$V_S = 3\text{ V}$	1.2	1.5	1.8	V
0 g Offset vs. Temperature			± 1		mg/ $^\circ\text{C}$
NOISE PERFORMANCE					
Noise Density X_{OUT} , Y_{OUT}			150		$\mu\text{g}/\sqrt{\text{Hz}}$ rms
Noise Density Z_{OUT}			300		$\mu\text{g}/\sqrt{\text{Hz}}$ rms

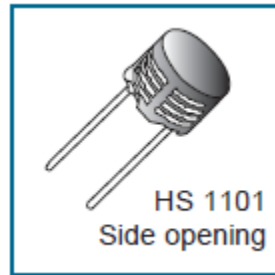
کاربردهای حسگرهای خازنی

۴- مکان سنج خازنی:

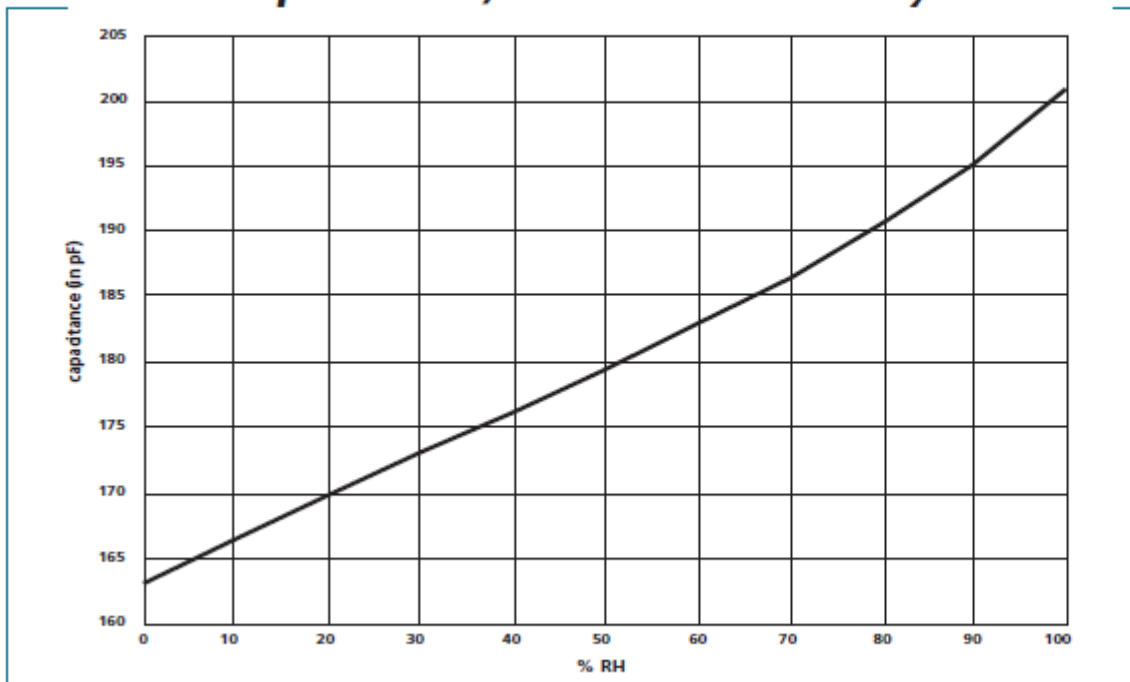


۵- رطوبت سنج خازنی:





**Typical response curve
of HS 1100/HS 1101 in humidity**



Calibration data are traceable to NIST standards through CETIAT laboratory.

Measurement frequency : 10kHz
Ta = 25°C

$$\text{Polynomial response : } C(\text{pF}) = C@55\% * (1.2510^{-7} RH^3 - 1.3610^{-5} RH^2 + 2.1910^{-3} RH + 9.010^{-1})$$

CHARACTERISTICS

TEMPERATURE IN °C

(Ta = 25°C, measurement frequency @ 10kHz unless otherwise noted)

Characteristics	Symbol	Min.	Typ.	Max.	Unit.
Humidity measuring range	RH	1		99	%
Supply voltage	Vs		5	10	V
Nominal capacitance @ 55% RH*	C	177	180	183	pF
Temperature coefficient	Tcc		0.04		pF/°C
Averaged Sensitivity from 33% to 75% RH	$\Delta C/\%RH$		0.34		pF/%RH
Leakage current (Vcc = 5 Volts)	Ix		1		nA
Recovery time after 150 hours of condensation	tr		10		s
Humidity Hysteresis			+/-1.5		%
Long term stability			0.5		%RH/yr
Response time (33 to 76 % RH, still air @ 63%)	ta		5		s
Deviation to typical response curve (10% to 90% RH)			+/-2		% RH

** Tighter specification available on request*



FIGURE 3.33 A capacitive chemical sensor.

A capacitive chemical sensor, as shown in Figure 3.33, is often composed of two electrodes separated by a chemically sensitive polymer that can absorb specific chemicals (analytes) [21]. Upon analyte absorption, the polymer swells and increases not only the distance between the two electrodes but also the polymer's dielectric permittivity. Both change the capacitance of the sensor that can be electrically detected and measured.

۷- حسگر سطح مایع خازنی:

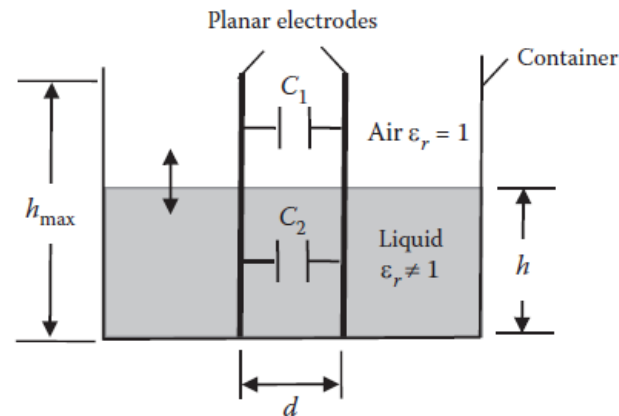


FIGURE 3.34 A capacitive level sensor.

۸- حسگر قطره خازنی:

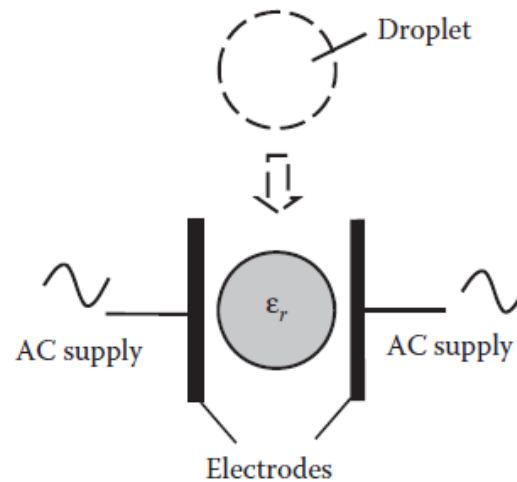


FIGURE 3.35 A capacitive droplet detector.

کاربردهای حسگرهای خازنی

۹- صفحه لمسی خازنی:

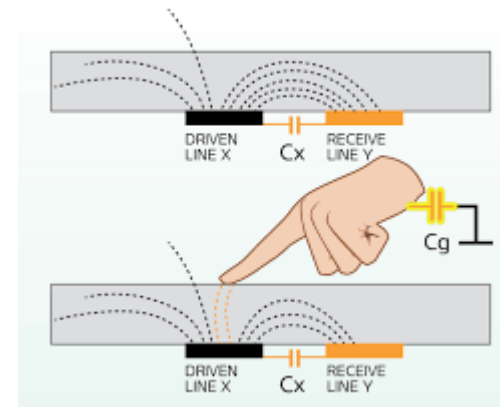
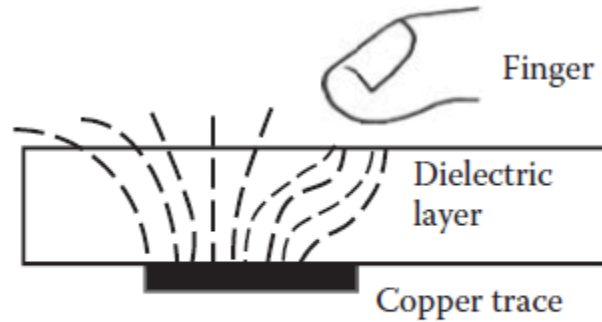


FIGURE 3.37 A parallel-plate capacitive touch sensor.

۱۰- حسگر اثر انگشت خازنی:

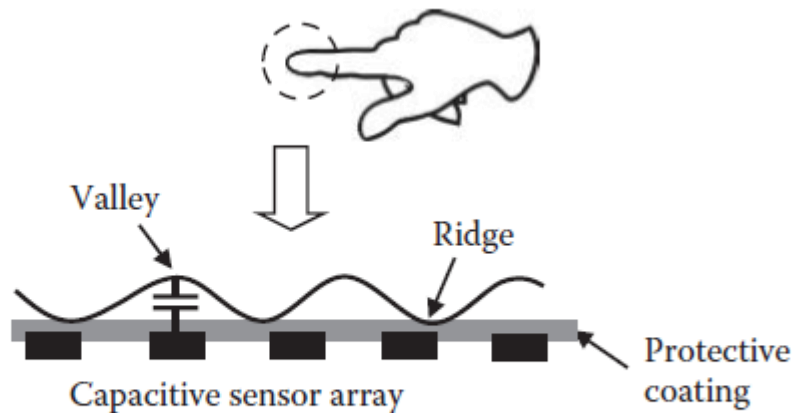


FIGURE 3.54 A capacitive fingerprint sensor.