TI makes SENSE: What is new on TI sensing solutions
Contents

• Inductive (LDC) sensing technology
• Inductive sensing applications
• Capacitive sensing (FDC) technology
• Capacitive sensing application
• Humidity sensing (HDC)
• Ultra Low Power Timers (TPL5x)
Inductive Sensing Technology
Advantages of Inductive Sensing:
- No magnets
- Reliable: contactless
- Insensitive to environmental contaminants (dust, dirt, etc.)
- Micrometer sensitivity
- Low cost sensor (PCB coil)
- Sensor can be remotely located
Resonant Inductive Sensing
Basic Physics

- The E-M field of the sensor intercepts a metal target, generating eddy currents that produce an opposing field.
- Resonance Impedance ($R_p$) and Inductance ($L$) change as a function of the distance $d$ of the target.

$$V_{SENSOR}(d) \approx I_{SENSOR} \cdot R_p(d)$$

$$V_P(d) = L_p \frac{dI_1}{dt} - M(d) \frac{dI_2}{dt}$$
# LDC Functionality

1. Axial Sensing

2. Linear Position Sensing

3. Angular Position Sensing

4. Event Counting

5. Spring Measurement

6. Metal Identification

## Inductive Sensing use cases
L, $R_p$, F vs. Target exposure (lateral sensing, fixed Z)

- These curves represent the characteristic shape of the inductance, $R_p$, and frequency vs the amount of target area exposed to the sensor.
Summary

- The sensor coil generates E-M field that intercepts the target and generates a reverse field opposing the sensor field, reducing the apparent inductance.
- As the target moves, either axially or laterally, the inductance increases or decreases, causing the sensor frequency to decrease or increase.
- Target movement (position), reflected by frequency change, is correlated to either distance (axial) or the area of the target exposed to the sensor.

<table>
<thead>
<tr>
<th>Axial</th>
<th>Lateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D \downarrow \propto F \uparrow$</td>
<td>$A \downarrow \propto F \downarrow$</td>
</tr>
<tr>
<td>$D \downarrow \propto L \downarrow$</td>
<td>$A \downarrow \propto L \uparrow$</td>
</tr>
<tr>
<td>$D \downarrow \propto R_P \downarrow$</td>
<td>$A \downarrow \propto R_P \uparrow$</td>
</tr>
<tr>
<td>$D \downarrow \propto V_{SENSOR} \downarrow$</td>
<td>$A \downarrow \propto V_{SENSOR} \uparrow$</td>
</tr>
</tbody>
</table>
Inductive sensing products
LDC Portfolio at a Glance

Resolution

High
LDC1000 (-Q1)
1-Ch, 5V, SPI
16-bit Rp | 24-bit L
SON-16 (TSSOP16)

Low / Mid
LDC1041/51
1-Ch, 5V, SPI
Mid/low-res LDC

Switch function

LDC161x
2/4-Ch, 3.3V
28-bit L-only
I2C

LDC1101
1-Ch, 1.8V
16-bit Rp | 16-bit L
DFN-10 | SPI

LDC131x
2/4-Ch, 3.3V
12-bit L-only
I2C

LDC08xx
1-Ch, 1.8-3.3V
L-only switch

RTM year

2015 (and earlier)

2016

2017

Next-gen LDC family

New
Existing
Sampling
Preview

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at ti.com/sensing
# LDC1612/4

2-/4-ch, 3.3-V, 28-bit LDCs for Inductive Sensing

## Features

- **Multiple channels:**
  - 2-ch: LDC1612, 4-ch: LDC1614
  - Well matched channels w/ 4.08 ksp/s max. sampling rate
  - Sensor frequency range: 1kHz - 10 MHz
  - Resolution: 28 bits
- **Power consumption:**
  - Active: 540uA/ch (LDC1614)
  - Sleep: 35uA,
  - Shutdown: 200nA
- **Package:**
  - LDC1312: 12-pin WSON
  - LDC1314: 16-pin WQFN

## Benefits

- Up to four channels enables multiple sensors in minimum system size, cost, and power
- Well-matched channels allow for easy compensation of environmental changes and aging
- High resolution enables better end-system performance and efficiency and extended sensing range
- Easy-to-use: sensor just needs to be within 1kHz and 10 MHz, simplifying and accelerating prototyping
- Large sensor frequency range supports very small PCB coils, supporting space-constrained applications

## Applications

- Knobs in consumer, appliance, & automotive
- Incremental linear and rotational encoders
- Buttons in home electronics, wearables, & factories
- Keypads, HMI, and POS in factories & appliances
- Metal detection in industrial & consumer
- Flow meters in consumer and appliances

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**What are you sensing?**

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# LDC1312/4

## 2-/4-ch, 3.3-V, 12-bit LDCs for Inductive Sensing

### Features
- **Multiple channels:**
  - 2-ch: LDC1312, 4-ch: LDC1314
- **Well matched channels w/ 13.3 kspms max. sampling rate**
- **Sensor frequency range:** 1kHz - 10 MHz
- **Resolution:** 12 bits
- **Power consumption:**
  - Active: 540uA/ch (LDC1314)
  - Sleep: 35uA,
  - Shutdown: 200nA
- **Package:**
  - LDC1312: 12-pin WSON
  - LDC1314: 16-pin WQFN

### Applications
- Knobs in consumer, appliance, & automotive
- Incremental linear and rotational encoders
- Buttons in home electronics, wearables, & factories
- Keypads, HMI, and POS in factories & appliances
- Metal detection in industrial & consumer
- Flow meters in consumer and appliances

### Benefits
- Up to four channels enables multiple sensors in minimum system size, cost, and power
- Well-matched channels allow for easy compensation of environmental changes and aging
- Easy-to-use: sensor just needs to be within 1kHz and 10 MHz, simplifying and accelerating prototyping
- Large sensor frequency range supports very small PCB coils, supporting space-constrained applications
LDC0851: Product Overview
1.8-3.3V, Temperature Stable Inductive Switch

Features
- Well-matched channels with differential implementation
- **Threshold Accuracy**: \(< 1\% \text{ of coil diameter}
- Average Supply Current: \(< 20\mu\text{A} \text{ @ 10sps}
- No magnets required
- Resistor-set threshold
- Built-in Hysteresis
- Supply Voltage = 1.71V to 3.6V
- Package = 8-pin DFN

Benefits
- Highly reliable over environmental and aging effects (Temperature stable)
- Eliminates factory calibration for lower cost
- Low power for battery powered applications
- Not affected by magnets
- No MCU required to program threshold
- More robust against vibrations in system
- Small package for compact systems

Applications
- Open/Close proximity switches
- ATMs (Automated Teller Machines)
- Home Security and tamper detection
- Simple buttons in industrial and consumer markets
- Printers
- Fan speed, gear/event counting
The reference coil inductance ($L_{\text{REF}}$) is fixed, setting the switching threshold.

The sense coil is exposed to a moving target, causing $L_{\text{SENSE}}$ to vary.

- When $L_{\text{SENSE}} > L_{\text{REF}}$, OUTPUT = High
- When $L_{\text{SENSE}} < L_{\text{REF}}$, Output = Low
LDC Demos

- Event counter (Fan speed, flow meter) – LDC0851
- Incremental Encoder – LDC0851
- Stainless Steel Keypad – LDC1614
- 4x4 Snap Dome Keypad – LDC1312
- 1⁰ Dial – LDC1614
Inductive sensing based event counting
Inductive Sensing solution for Event Counting

**Approach/Capabilities**

- Event counting solutions are used to detect the speed and calculate the position of motors, fans, flow meters, or gears.
- The LDC0851 inductive switch is used to detect presence / absence of metallic target by comparing the dynamic inductance of a sense coil with inductance of a reference coil as the system rotates.
- Sensor and reference coils can be stacked on a 4-layer PCB for systems that are low speed and are space constrained, or arranged side-by-side on a 2-layer PCB for finely spaced gears or fastest rotational speeds.
- Example application: Impeller-based Flow Meter
  - The flow of liquid can be channeled through a small opening to turn an impeller with a metallic surface.
  - A remote PCB coil placed on the outside of the container generates an AC magnetic field which senses when the metallic side of the impeller approaches and triggers the output.
The benefits of Inductive Sensing Event counters

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>No magnets</td>
<td>Noninvasive sensing method that does not require magnets. Water is not exposed to magnets which can be toxic and requires special shielding</td>
</tr>
<tr>
<td>Temperature Stable</td>
<td>Change in temperature will not affect accuracy of reading. Sense and Ref coils see the same temperature.</td>
</tr>
<tr>
<td>Lower power</td>
<td>Meet industry standards on power consumption</td>
</tr>
<tr>
<td>Scalable design</td>
<td>PCB coil determines sensing range</td>
</tr>
<tr>
<td>High sensing speed</td>
<td>Can detect speeds up to 4000 events per second</td>
</tr>
<tr>
<td>Reduced system cost</td>
<td>Magnets not required, any conductor can be used as target. Often, existing gears or screws may be used as targets.</td>
</tr>
</tbody>
</table>
Operating Principles – Side-by-Side Coils

• Sense and reference coils can be placed adjacently with a fixed angular-spacing between them to precisely determine the switch ON and switch OFF points for a given angle.

• Good for systems that have fine gear-to-gear spacing or require fastest rotational speeds (up to 4000 events per second)
Incremental Encoders using Inductive Switching
Incremental Encoder Knob solution

- Uses two LDC0851 Inductive Switches
- Measures position (angle) and direction
- Robust operation even with interference from environmental factors such as:
  - Temperature
  - Dirt & Dust
  - Moisture/humidity
  - Vibration
- Scalable – can support from 4 steps/rotation to 64+
  - Scales in multiples of 4 steps
  - Minimum knob size increases with number of steps
- Suitable for human interface and motor rotation applications
The benefits of LDC0851 Encoder Knob

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contactless</td>
<td>LDC Technology does not require any contact between target and sensor to perform measurements</td>
</tr>
<tr>
<td>Robust even in challenging environments</td>
<td>Temperature, humidity, dust, dirt do not affect the measured sensor inductance</td>
</tr>
<tr>
<td></td>
<td>Systems can be optimized for rugged applications</td>
</tr>
<tr>
<td>No calibration required</td>
<td>Repeatable response for mechanically stable design</td>
</tr>
<tr>
<td>Sensors can be placed remote from LDC0851</td>
<td>Intrinsic feature of LDC technology</td>
</tr>
<tr>
<td>Simple physical knob design</td>
<td>Knob only needs to maintain fixed target distance from sensor</td>
</tr>
<tr>
<td>Simple interface</td>
<td>Grey-code output of 2 devices provides simple robust operation</td>
</tr>
</tbody>
</table>
System solution

- 2 LDC0851 devices are used to monitor a quadrature positioned set of sensors.
- Simple power supply requirements
- Works with wide range of MCUs

![Diagram showing the system solution with LDC0851 devices, sensors, and microcontroller connections.](image-url)
Touch-on-metal keypads
Touch-on-Metal (ToM) keypad solutions - Overview

• Based on the principle of axial sensing
• Relies on deflection of button surface, no electrical contact required.
• The ability to detect as little as 5 micrometers of movement enables this solution to be used with thick metal panels (aluminum, stainless steel).
• Not affected by magnets, liquids, dust or dirt.
• Narrowband, L-C resonator sensor is inherently immune to interference.
# The benefits of Touch-on-metal buttons

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher reliability</td>
<td>Contactless, no moving parts.</td>
</tr>
<tr>
<td>Accommodates rugged environments</td>
<td>Keypad can be environmentally sealed against dust, dirt, moisture</td>
</tr>
</tbody>
</table>
| Reduced system cost           | • No need to cut holes/openings for buttons. Can use monolithic material (e.g., stainless steal panel) for interface, lowering machining costs.  
• Fewer parts to assemble  
• Button sensors are simple PCB coils.                                                                                                                                                     |
| Flexible                      | • Multiple thresholds can be used for multi-function buttons  
• Glove-friendly                                                                                                                   |
Angle and Rotation sensing
Rotational Sensing - Overview

- Target moves laterally with respect to the sensor coil(s).
- Z-axis is fixed.
- The amount of target exposure modulates the inductance measured by the LDC.
- Z-axis stability is important.
- Max rotation rate is determined by sample rate and desired accuracy.
# Benefits of Inductive-based rotation sensing

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher reliability</td>
<td>Contactless</td>
</tr>
<tr>
<td>Accommodates rugged environments</td>
<td>Not affected by dust, dirt, moisture, or DC magnetic fields</td>
</tr>
<tr>
<td>High resolution</td>
<td>• Continuous, monolithic target supports fine angular resolution</td>
</tr>
<tr>
<td>Low cost</td>
<td>• Cheap PCB sensor coils</td>
</tr>
<tr>
<td></td>
<td>• Simple PCB-based target</td>
</tr>
</tbody>
</table>
Capacitive Sensing technology
**FDC Portfolio**

- **Automotive**
  - FDC1004Q
    - 4-ch, 10-MSOP
    - 0.5fF res
    - 3.3V, I2C

- **White Goods**
- **Printer**
- **Medical**
- **Industrial**
  - FDC1004
    - 4-ch, 10-QFN
    - 0.5fF res
    - 3.3V, I2C

- **2016**
  - FDC2214/2Q
    - 4/2-ch, 16/12-QFN
    - EMI-Robust
  - FDC2114/2Q
  - FDC2214/2
  - FDC2114/2
  - FDC2214/2
  - FDC2114/2

- **Definition**
- **Planned**
- **Sampling**
- **Released**
FDC2112/4
2-/4-ch, 3.3-V, 12-bit FDCs for Capacitive Sensing

Features

- Number of channels / Packages:
  - 2 (FDC2x12) / 12-pin QFN
  - 4 (FDC2x14) / 16-pin QFN
- Maximum Input Capacitance: 250nF (@10kHz with 1mH inductor)
- Maximum output rate (one channel): 13.3ksps (FDC211x)
- Resolution: 12-bit
- Sensor excitation frequency: 10kHz to 10MHz
- Supply voltage: 2.7V to 3.6V
- Power consumption:
  - Active: 2.1mA
  - Low-Power Sleep Mode: 35uA
  - Shutdown: 200nA
- Interface: I2C

Applications

- Human proximity detection up to 50cm
- Object proximity/obstacle detection up to 50cm

Benefits

- Two and four channels enables multiple sensors in minimum system size and cost
- EMI-resistant architecture
- High excitation rate
- High output data rate
- Large maximum input cap value

[Diagram of FDC2114]
FDC221x versus Traditional Cap-to-Digital

**Traditional Cap-to-Digital**

- Charge-Based Measurement
  - Wideband input / antenna
  - Noise aliased in-band after sampling
    - Highly susceptible to noise

- Oscillation-Based Measurement
  - High-Q narrowband bandpass filter
  - Strong noise rejection
    - Immune to noise

**Example:**
- Switched-cap
- Time-based/Discharge
Noise Reception in Cap-to-Digital Converters

Excitation rate  →  CDC input bandwidth

Input noise

Noise folds due to CDC input sampling

Folded input noise reduces resolution

Traditional Cap-to-Digital

FDC2xxx

Excitation rate

Input noise

All noise filtered out by LC tank

All noise filtered out, maximizing resolution

Texas Instruments
Demos

• Proximity EVM
• Competitive noise demo
FDC2214 (Noise-Immune Capacitive Sensing Solution for Proximity Sensing)
FDC2214PROXSEN-EVM solution for Capacitive (Proximity) Sensing - Overview

• Proximity sensing and capacitive touch buttons
  – Bezel sensor configuration (proximity)
• Complete standalone system
  – 4-channel FDC2214
  – MSP430FR5969
  – Battery powered
  – Firmware and adaptive algorithm included on MSP430 for data processing
• Dedicated colored LEDs light up once the device detects a target in close proximity to the board or detects a touch on the buttons
## Resonant-based Cap sensing with the FDC2214

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise immune</td>
<td>Narrowband architecture eliminates unwanted noise and interferences</td>
</tr>
<tr>
<td>Fast excitation rate</td>
<td>Up to 10 MHz excitation rate allows for sensing of conductive liquids</td>
</tr>
<tr>
<td>High capacitive sensing range</td>
<td>250 nF input range tolerates system stray capacitances</td>
</tr>
<tr>
<td>Fast sample rate</td>
<td>Up to 13.3 kmps sample rate enables the sensing of moving targets</td>
</tr>
<tr>
<td>High resolution</td>
<td>28-bit resolution provides excellent sensivity</td>
</tr>
</tbody>
</table>

![FDC2214 Diagram](image-url)
System solution – signal-to-noise

Each peak represents the response from a hand coming within 5 cm of a circular sensor that is 0.8 inches in diameter.

Traditional Cap-Switch Solution (Orange)
FDC2214 (Blue)
## Capacitive sensing End-equipment

### Capacitive sensing using FDC2214

<table>
<thead>
<tr>
<th>Proximity sensing</th>
<th>Liquid sensing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Noise-immune Proximity &amp; Gesture</strong></td>
<td><strong>Liquid level sensing</strong></td>
</tr>
<tr>
<td>Detect presence, simple gestures</td>
<td>Detect all liquids including soap, ink</td>
</tr>
<tr>
<td>Markets</td>
<td>Markets</td>
</tr>
<tr>
<td>- White goods</td>
<td>- White goods</td>
</tr>
<tr>
<td>- Industrial</td>
<td>- Automotive</td>
</tr>
<tr>
<td>- Automotive</td>
<td>- Medical</td>
</tr>
<tr>
<td>- Personal electronics</td>
<td>- Printer</td>
</tr>
</tbody>
</table>

### Detection Features

#### Proximity sensing
- **Collision avoidance**
  - Markets
  - Industrial
  - Automotive
  - Detect object in path of motion

#### Liquid sensing
- **Ice/snow/rain detection**
  - Markets
  - White goods
  - Industrial
  - Automotive
  - Detect leaks, rain/fog, ice buildup
Resource links

- **TI Designs**
  - Noise-immune Capacitive Proximity Sensor System ([TIDA-00466](#))
  - Capacitive-based Liquid Level Sensing Sensor ([TIDA-00317](#))
- **Application Notes**
  - Power Reduction Techniques ([SNOA943](#))
  - Capacitive Proximity Sensing ([SNOA940](#))
  - Derivative Integration Algorithm ([SNOA939](#))
  - Capacitive Sensing: Direct vs Remote Liquid-Level Sensing ([SNOA935A](#))
- **Tools**
  - FDC211x/FDC221x Current Consumption Estimator
- **Learn about all TI sensing solutions**
  - [www.ti.com/sensing](http://www.ti.com/sensing)
- **Capacitive sensing E2E forum**
  - [http://e2e.ti.com/support(sensor/capacitive-sensing/default.aspx](http://e2e.ti.com/support/sensor/capacitive-sensing/default.aspx)
HDC1080 Humidity Sensor
TI’s Humidity Sensing Solution

Sensing Element Diagram

Device Block Diagram

Moisture

Polyimide

Metal

$\varepsilon_r$

Capacitance-to-digital converter

Calibration & Temp Compensation

I2C

Temp

EEPROM
## HDC1080 Humidity & Temperature Sensor

### Features
- **Relative Humidity Range**: 0% to 100%
- **Humidity Accuracy**: ±2%
- **Supply Current (Measuring)**: 190μA
- **Avg Supply Current (@1sps)**: 1.3μA
- **Temperature Accuracy**: ±0.2ºC
- **Temperature Range (Operating)**: -20ºC to +85ºC
- **Temperature Range (Functional)**: -40ºC to +125ºC
- **Operating Voltage**: 3V to 5V
- **Package**: 6 pin DFN (3mm x 3mm)

### Benefits
- Completely integrated humidity and temperature IC provides guaranteed performance
- Fully calibrated sensor enables quick time-to-market
- Very low power consumption
- Small package size supports compact designs

### Applications
- HVAC
- White goods (dryer, fridge, microwave, dishwasher)
- Printers
- Handheld Meters
- Camera Defog
- Smart Thermostats and Room Monitors
- Medical Devices

---

![Diagram of HDC1080 components](image)
Register Map

<table>
<thead>
<tr>
<th>Pointer</th>
<th>Name</th>
<th>Reset Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00</td>
<td>Temperature</td>
<td>0x0000</td>
<td>Temperature measurement output</td>
</tr>
<tr>
<td>0x01</td>
<td>Humidity</td>
<td>0x0000</td>
<td>Relative Humidity Measurement output</td>
</tr>
<tr>
<td>0x02</td>
<td>Configuration</td>
<td>0x1000</td>
<td>HDC1080 configuration and status</td>
</tr>
<tr>
<td>0xFB</td>
<td>Serial ID [40:25]</td>
<td>device dependent</td>
<td>First 2 bytes of serial ID of the part</td>
</tr>
<tr>
<td>0xFC</td>
<td>Serial ID [25:9]</td>
<td>device dependent</td>
<td>Mid 2 bytes of serial ID of the part</td>
</tr>
<tr>
<td>0xFD</td>
<td>Serial ID [8:0]</td>
<td>device dependent</td>
<td>Last bits of the serial ID of the part</td>
</tr>
<tr>
<td>0xFE</td>
<td>Manufacturer ID</td>
<td>0x5449</td>
<td>ID of Texas Instruments</td>
</tr>
<tr>
<td>0xFF</td>
<td>Device ID</td>
<td>0x1050</td>
<td>ID of HDC1080 device</td>
</tr>
</tbody>
</table>

Simple to use:
- Two 16-bit output registers for T and RH measurements
- One 16-bit configuration and status register
## Sensing Solutions GUI

![GUI Screenshot]

### Configuration Table

<table>
<thead>
<tr>
<th>Register</th>
<th>Address</th>
<th>Current Value</th>
<th>Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEMPERATURE</td>
<td>0x00</td>
<td>0x6604</td>
<td>0 0 1 1 0 0 1 1 0 0 0 0 0 0 1 0 0</td>
</tr>
<tr>
<td>HUMIDITY</td>
<td>0x01</td>
<td>0x5528</td>
<td>0 0 1 0 1 0 1 0 1 0 0 1 0 1 0 0 0</td>
</tr>
<tr>
<td>CONFIGURATION</td>
<td>0x02</td>
<td>0x1000</td>
<td>0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>SERIAL_ID_39_24</td>
<td>0xFB</td>
<td>0x0256</td>
<td>0 0 0 0 0 0 0 1 0 0 1 0 1 0 1 1 0</td>
</tr>
<tr>
<td>SERIAL_ID_23_8</td>
<td>0xFC</td>
<td>0x10a1</td>
<td>1 1 1 1 0 0 0 0 1 0 1 0 0 0 0 0 1</td>
</tr>
<tr>
<td>SERIAL_ID_7_0</td>
<td>0xFD</td>
<td>0x7600</td>
<td>0 1 1 1 0 1 1 0 0 0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>MANUFACTURER_ID</td>
<td>0xFE</td>
<td>0x5449</td>
<td>0 1 0 1 0 1 0 0 0 1 0 0 1 0 0 1</td>
</tr>
<tr>
<td>DEVICE_ID</td>
<td>0xFF</td>
<td>0x1050</td>
<td>0 0 0 1 0 0 0 0 0 0 1 0 1 0 0 0 0</td>
</tr>
</tbody>
</table>

- **Battery voltage**: 2.8V
- **Status**: Connected, Register loading complete

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**What are you sensing?** Find your solution now at [sensing.empa.ethz.ch](http://sensing.empa.ethz.ch)
Ultra Low Power Timers: TPL5xxx
Ultra Low Power Timer Overview

- In several applications, the microcontroller or the transceiver devices sleep for most of their operating life (e.g., IoT Sensor Nodes, smoke detectors, etc).

- These devices have low power or sleep mode that are not very efficient.

- Ultra Low Power Timer devices were designed to reduce power consumption during the sleep operating phase and periodically wake up the system.
Ultra Low Power Timer Overview

- Two family of Ultra Low Power Timer are available

**Ultra Low Power Timer TPL5010**
Programmable Ultra Low Power Timer with Watchdog Function

- **35nA Power Consumption**

**Ultra Low Power Timer TPL5110**
Programmable Ultra Low Power Timer for Systems Power Gating

- **35nA Power Consumption**

Microcontroller can be put in **deep sleep** (internal oscillator switched off) and wake up periodically.

Microcontroller (system) **power supply is gated** and switched On periodically.
### Key Ultra Low Power Timer Applications

<table>
<thead>
<tr>
<th>IoT</th>
<th>Home appliance</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Sensor Node" /></td>
<td><img src="image" alt="Smoke detector" /></td>
</tr>
<tr>
<td><img src="image" alt="WiFi node" /></td>
<td><img src="image" alt="Shock detector" /></td>
</tr>
<tr>
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<td><img src="image" alt="TPMS" /></td>
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IoT Internet of Things: system

IoT system: high level description

Sensor Node
IoT Internet of Things: Sensor Node

- Sensor Node description
  - Power supply (LDO, boost, battery)
  - Sensors
  - Communication (ZigBee, 6LoWPAN)
Humidity & Temperature Sensing Node for Star Networks Enabling 10+ year Coin Cell Battery Life

**TI Designs Number: TIDA-00374**

### Solution Features
- HDC1000 humidity and temp digital sensing
- Detect relative humidity from 0 – 100% ±3% accuracy
- Detect temp. at ±0.2°C (nominal) over 5°C to 60°C
- Configurable sleep time
- Power management partitioning for extremely low power consumption

### Solution Benefits
- Small, integrated solution size due to the integrated sensor and radio SoC
- Long Battery Lifetime: Designing for 10+ years off a single CR2032 coin cell battery

### Tools & Resources
- "<TIDA-00374 Tools Folder>"
- "<User Guide>"
- **Design Files:** Schematics, BOM, Gerbers, Software, and more
- **Device Datasheets:**
  - HDC1000
  - TPL5110
  - TS5A3160
  - CC2x

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![Diagram of Circuit Board Components](image-url)
Thank You!
Questions?