Application - Capacitive sensing with XMC1200

XMC™ microcontrollers
July 2016

Agenda

1. Overview
2. Key features
3. Specification
4. System block diagram
5. Hardware overview
6. Software overview
7. Tooling overview
8. Highlight MCU features

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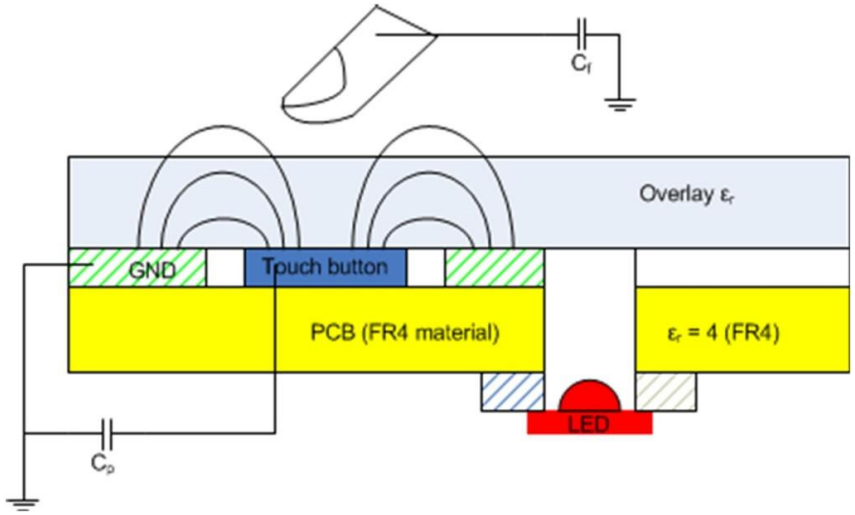
Capacitive sensing
Overview

- The purpose of these slides is to demonstrate how capacitive sensing can be realized with the use of the XMC1200 LEDTS module together with a software algorithm tailored for this device
- Capacitive sensing makes use of change in capacitance when an object, person or substance approaches a metal sensing area
- This change is detected by variations in an oscillator frequency
- The resulting changes are sampled at intervals and processed by a software algorithm in three phases:
  - Capturing
  - Filtering
  - Evaluating

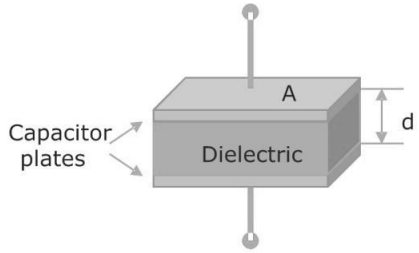
Capacitive sensing Overview

- What is capacitive touch sensing?
  - Touch Pad Controller regularly measures the capacitance of touch pads
  - When the pads are touched, their capacitance increases
  - Touch by a finger forms a parallel capacitance (increase in overall capacitance)



- Parallel-plate capacitor model of the extra capacitance: $C = \varepsilon_0 \varepsilon_r * (A/d)$

- Benefits:
  - Flexible design
  - Can have protective overlay
  - No wear and tear



ε_0 = permittivity of free space
ε_r = relative permittivity of dielectric material
A = area of the plates (~ finger touch area)
d = distance between plates (~ cover thickness)

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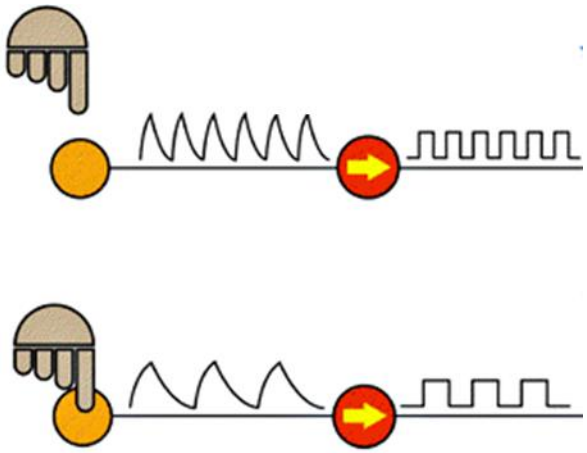
Capacitive sensing
Key features

- Hardware provides counts per channel at each time frame interrupt
- Software algorithm processes this number over time:
  - Software Median filter
  - Software averaging filter
  - Software state machine
  - Result output for application use
- Easy configurable low level software
- Non intrusive sensing
- No moving parts
- Aesthetically versatile designs for overlays
- Highly durable compared with electro mechanical buttons
- Cheaper for production

Capacitive sensing
Key features

- R/C oscillator where C is the variable
- Noise immunity
- EFT interference immunity
- RF interference immunity
- Cross talk immunity
- Ageing(drift) immunity
- Easy configurable
- Once set up, transparent to the user
- Low level Sw where only used code will be compiled



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Capacitive sensing Specification

- Capacitive sensing channels: 8 per LEDTS module
- Max counter value:16 bits each channel
- Minimum sense pad area: 80 mm²
- Up to 6 mm capacitive touch sensing distance achievable with glass cover
- Minimum response time:
  - 2 time frames x number of active channels
- Startup delay:
  - Median filter size x number of active channels x 2
- Noise immunity test:
  - 15 ms duration 10 khz burst of 2.5 kV @ 300 ms repetition rate

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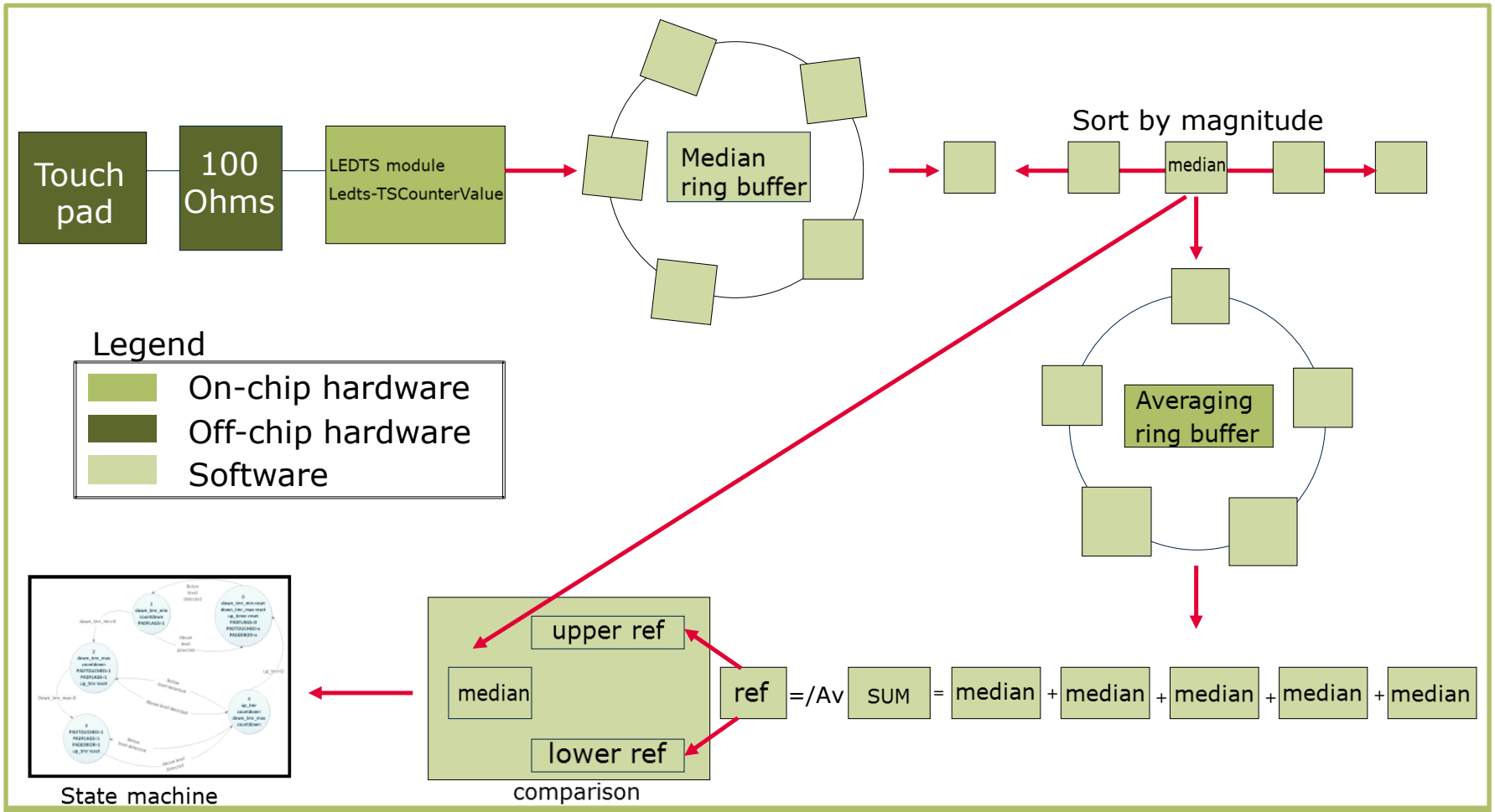
Capacitive sensing
System block diagram



System block diagram: Capacitive sensing

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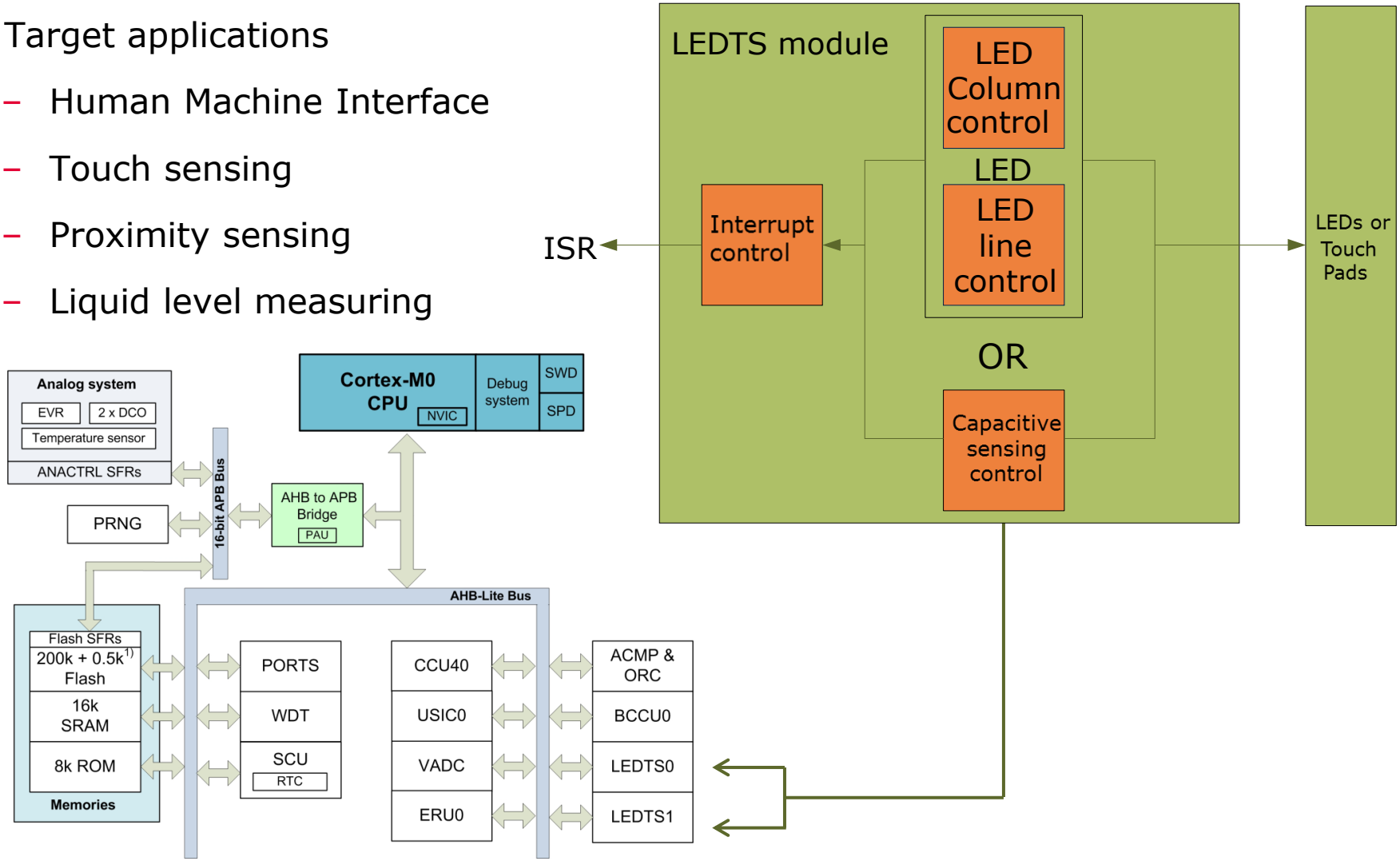
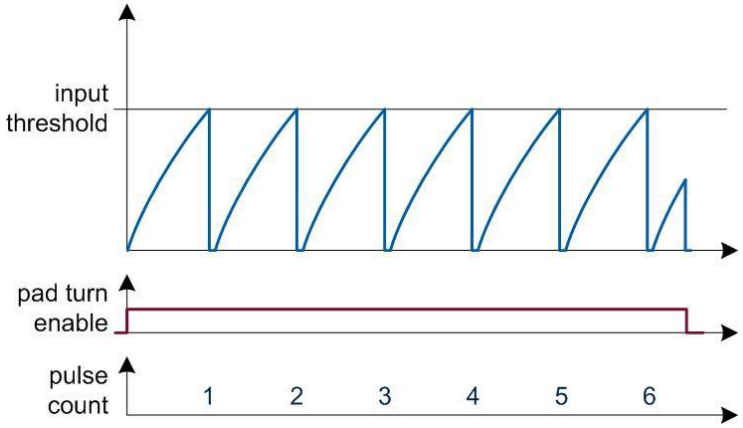
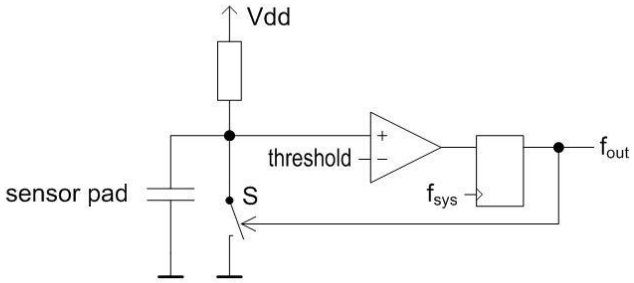
Capacitive sensing Hardware overview

- Target applications
  - Human Machine Interface
  - Touch sensing
  - Proximity sensing
  - Liquid level measuring



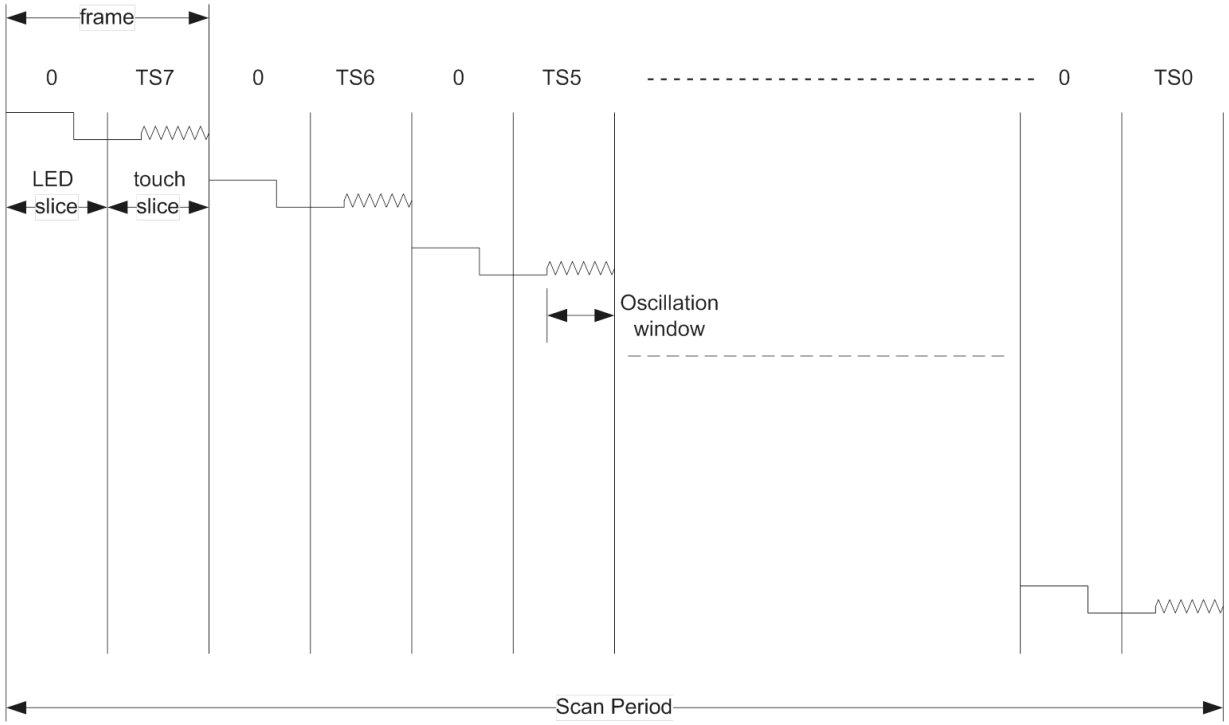
Capacitive sensing
Hardware overview





- What is the relaxation oscillator topology?
  - A simple circuit generates oscillations on the sensor pad
  - The number of oscillations is monitored in an adjustable time window (called the oscillation window)
  - The output frequency depends on the pad capacitance
  - The higher the capacitance the lower the frequency and the lower the number of pulses -> if the pad is touched, the number of pulses becomes lower
- Benefits:
  - HW needed for charging and discharging is already available in the device
  - No need for extra HW to be designed

Capacitive sensing
Hardware overview



- Adjustable time slice
- Adjustable oscillation window(touch slice)
  - Counts are taken during this window

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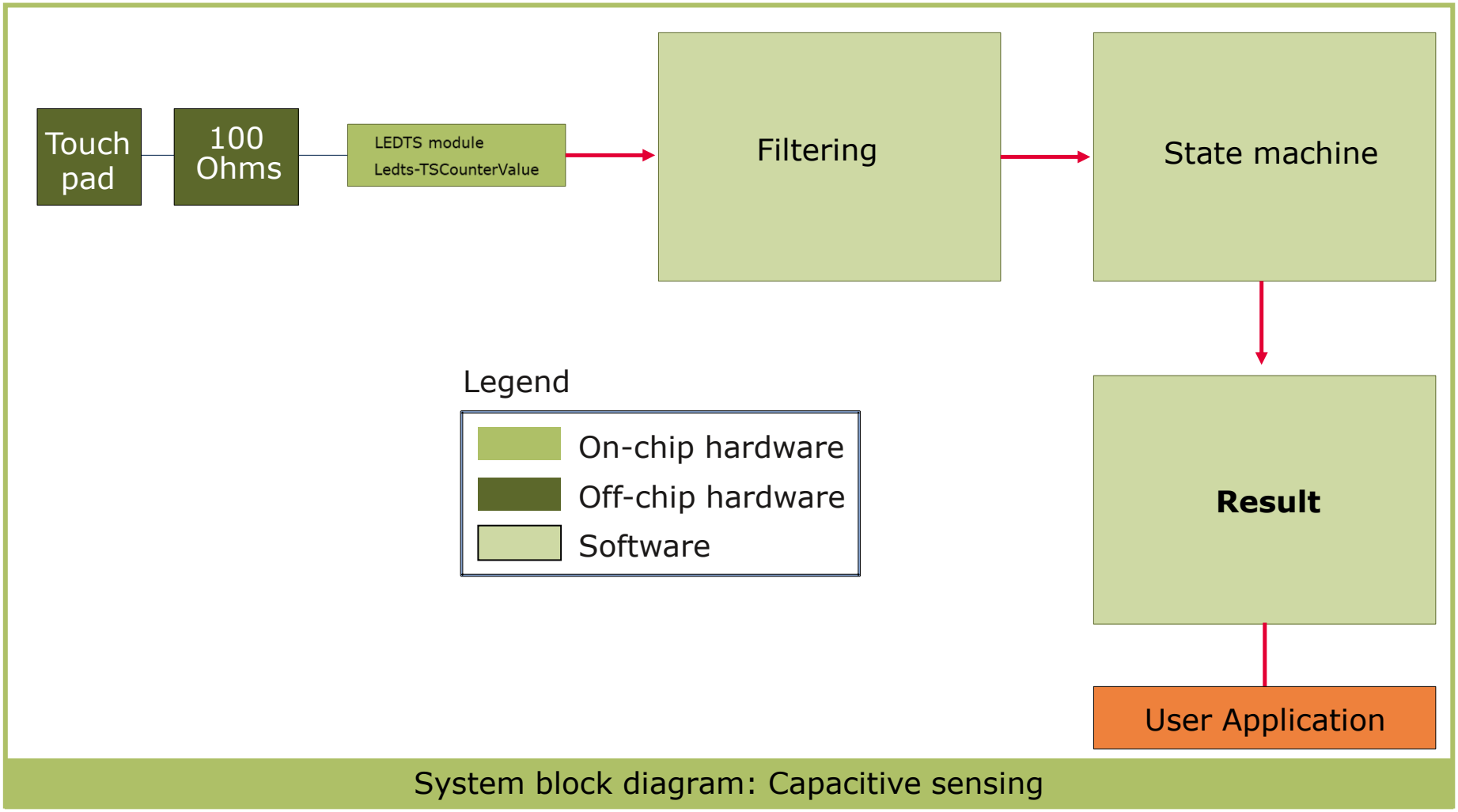
Capacitive sensing
Software block diagram



System block diagram: Capacitive sensing

Capacitive sensing
Software overview

- Raw *countervalue* is median filtered then averaged
- Median is used as the signal, average is the **ref**erence level
- State machine
  - State 0: not touched, idle
  - State 1: touched but not confirmed
  - State 2: confirmed touch
  - State 3: confirmed longer than normal touch
  - State 4: intermediate state between:
    - state 2 and 0
    - state 3 and 0
- Output
  - The user only needs this:
    - The result

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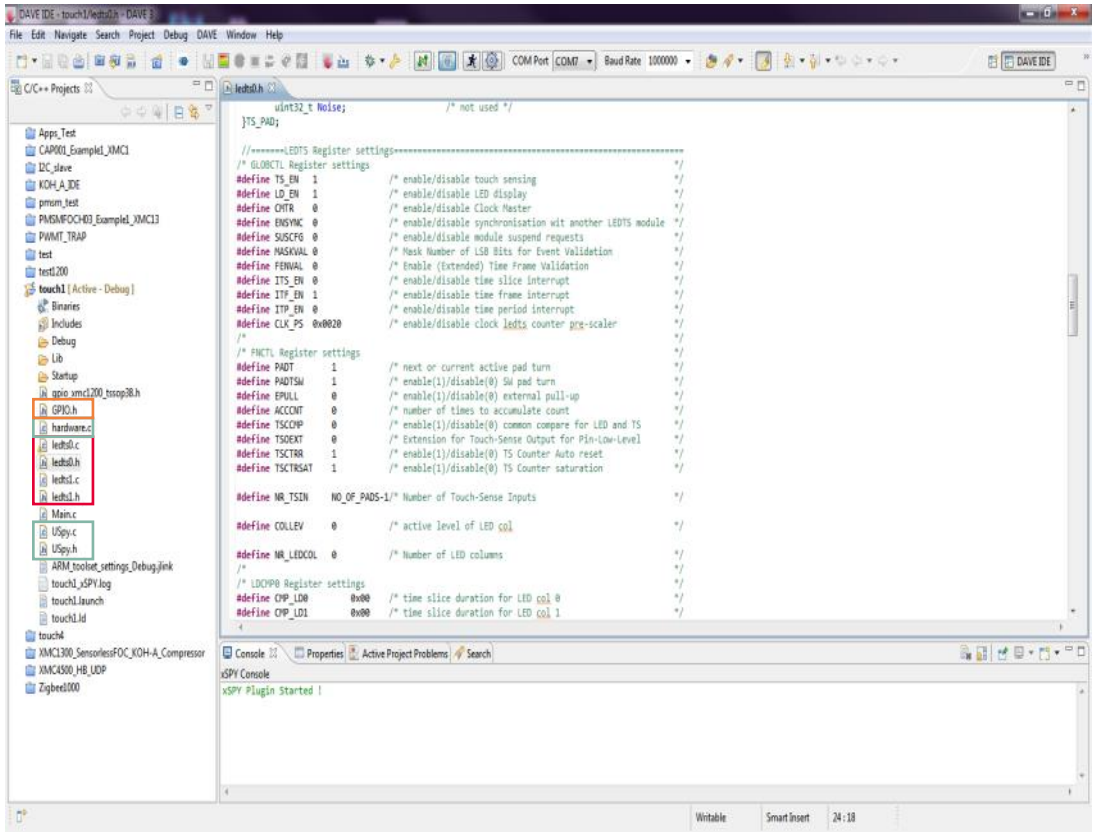
Capacitive sensing
Tooling overview

- DAVE™ 3.1 upwards
- Software files in 'C'
  - ledts(n).c
  - ledts(n).h
- Configuration in ledts(n).h
- For aiding configuration and debugging
  - DAVE™ debugger
  - Uspy
    - Uspy.c
    - Uspy.h
    - Uspy.exe



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Capacitive sensing
Highlight MCU features

- XMC1200
  - 2 x LEDTS capacitive sensing module
  - High current pads for LED driving
  - SPI communication to facilitate cascading of devices for more sensing channels

- These device variants support capacitive sensing
  - XMC1201-TO38 2 LEDTS modules (2x8 channels)
  - XMC1201-QO40 2 LEDTS modules (2x8 channels)

General information

- Where to buy a kit?
  - www.infineon.com/xmc-dev

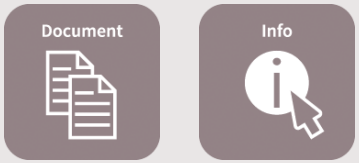
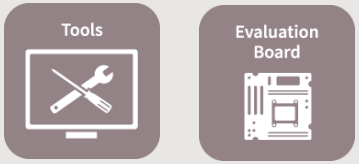
- For latest updates, please refer to:

  www.infineon.com/xmc1000

- For support:

  http://www.infineonforums.com/

Support material

Collaterals and Brochures 	› Product Briefs › Selection Guides › Application Brochures › Presentations › Press Releases, Ads	› www.infineon.com/XMC
Technical Material 	› Application Notes › Technical Articles › Simulation Models › Datasheets, MCDS Files › PCB Design Data	› www.infineon.com/XMC › Kits and Boards › DAVE™ › Software and Tool Ecosystem
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