Starts at 11:00 CEST/MESZ 9:00 UTC

Solutions for Ultra-Low Power Angle Sensing

Presenter: Marko Hepp

April 29, 2020

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Marko Hepp

- > 13 Years IC Product Management, Marketing, Support and Sales
- > 10 Year Industrial Automation Software & Systems
- > 27 Years in and for Semiconductor Industry
- Founding Manager of the BiSS interface consortium for the encoder industry
- Electrical Engineer

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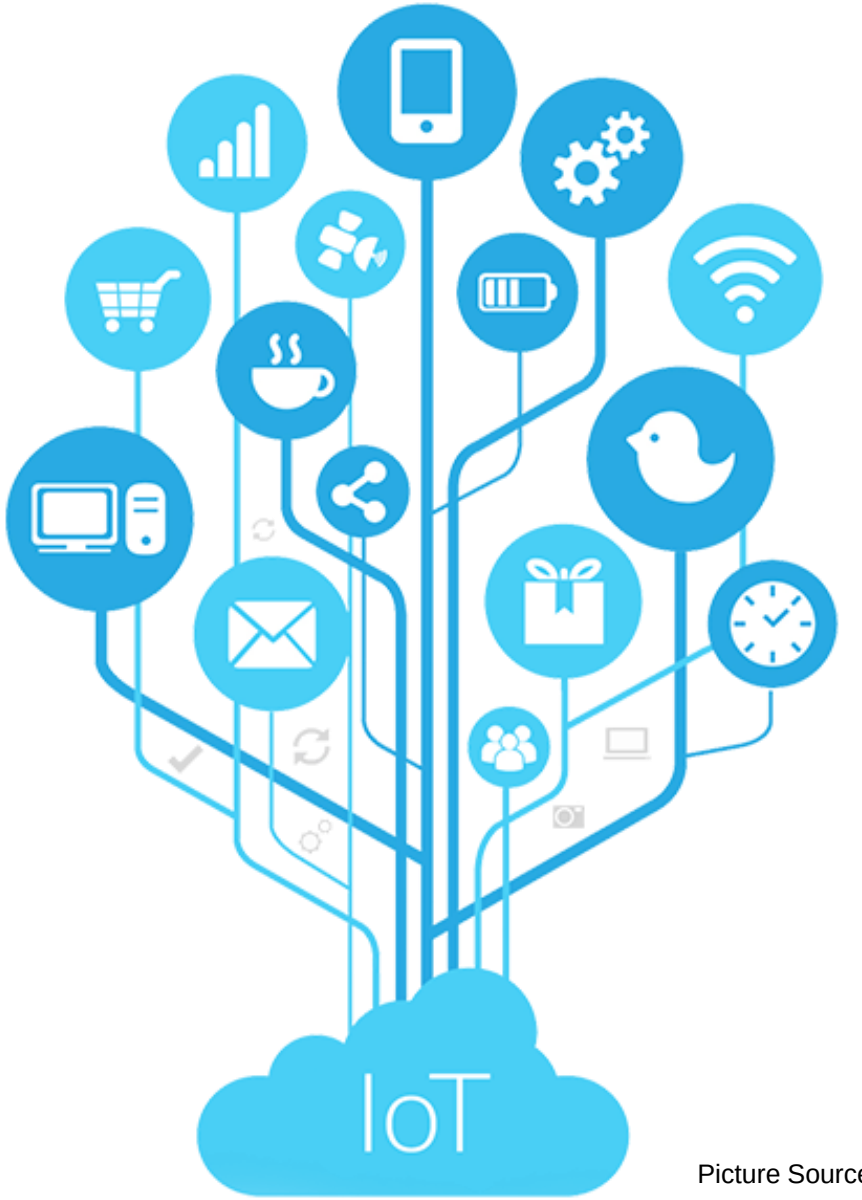
Today's Agenda

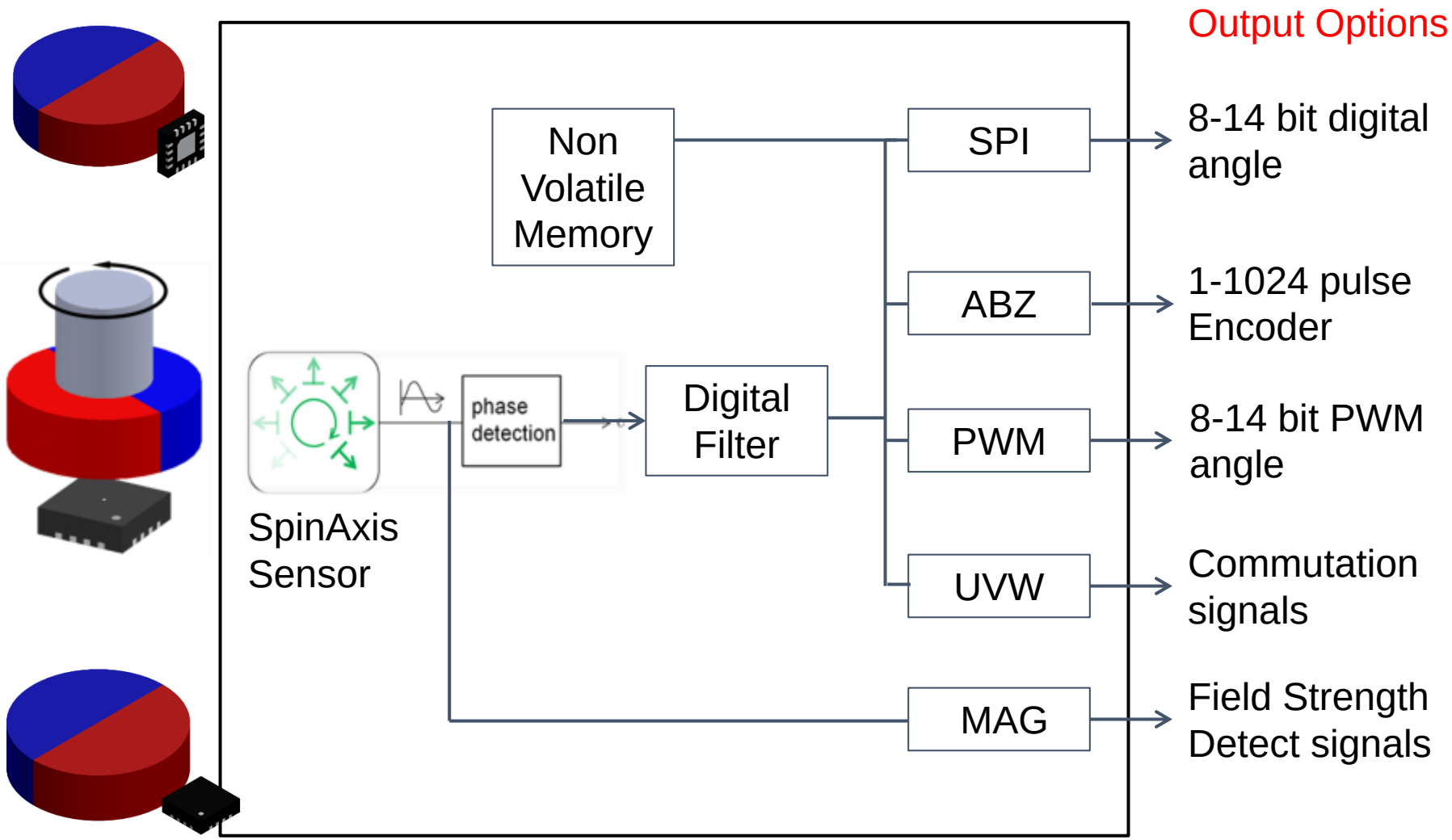
- The Motivation
- Hall Based Position Sensing Systems
- Solutions for Ultra-Low Power Angle Sensing
- How to Accomplish Saving Power in Systems
- Effective Method WOC Wake-On-Change to Save Power
- Systematic Impact
- Open Q&A

The Motivation



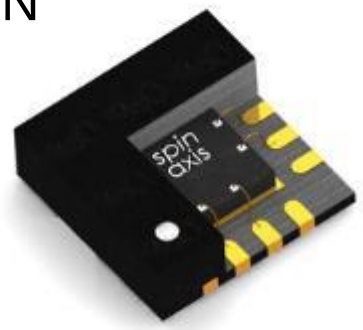
Picture Source: https://de.cleanpng.com/

Angular Sensing with MagAlpha Family



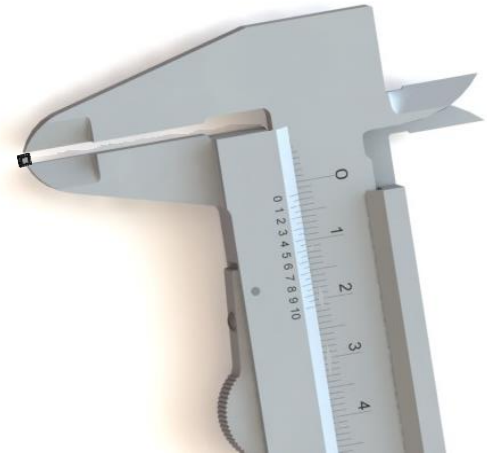
MagAlpha Spinaxis™ Advantages

- Resolution: From 8 to 14 bit (+/-3 Sigma)
- Wide Speed Range: Supports speeds from 0 to 100k rpm or more
- Flexible Magnet Topologies: End and Side of Shaft supported
- Fast angle sensing: 1µs Sampling, 3µs to 10µs latency at any constant speed
- Wide Magnetic Field Range: 15mT to greater than 100mT supported
- Small footprint: 3x3mm2 and 2x2mm2 QFN
- **Ultra Fast Power Up**

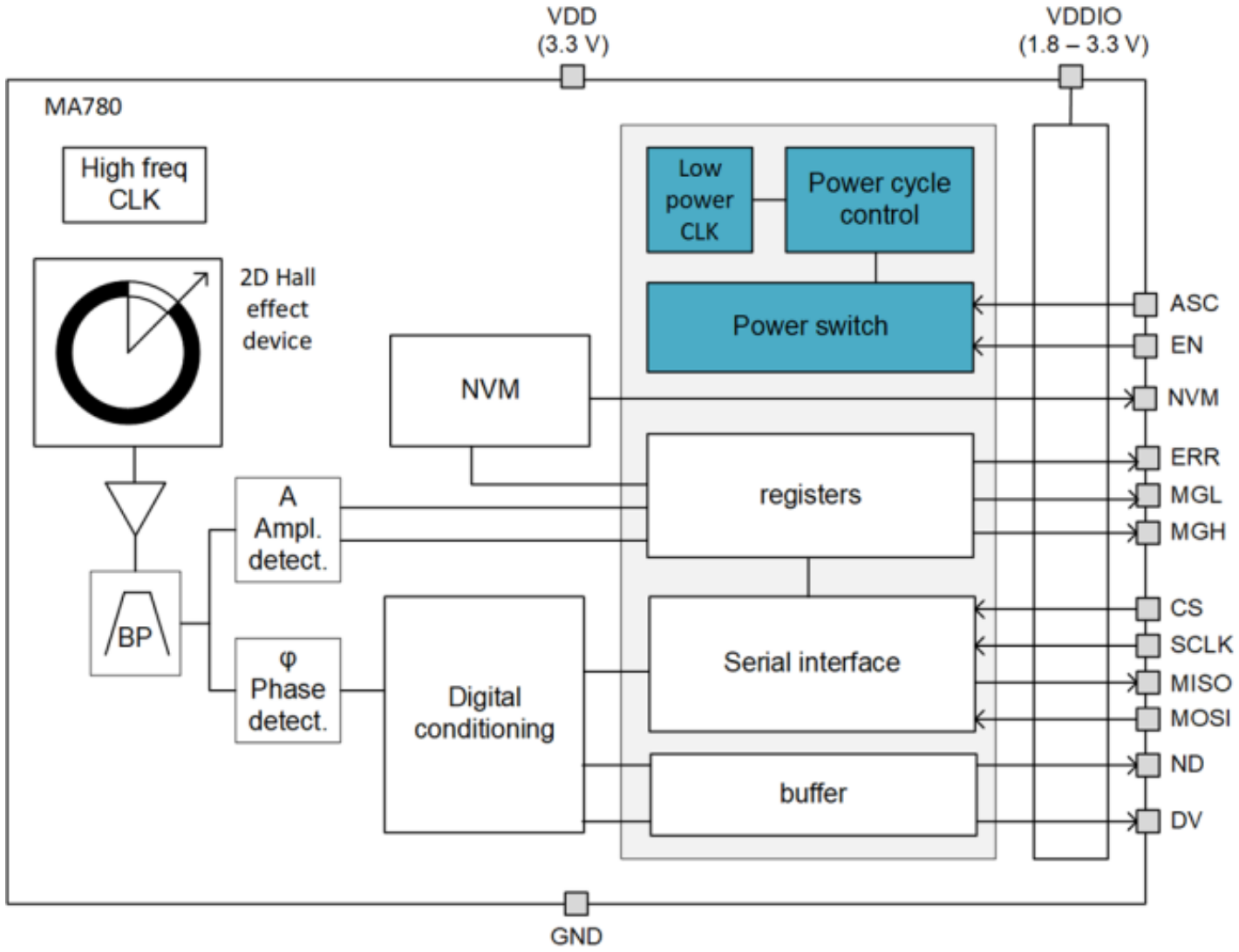


Low Power Sensors: MA780 + MA782

- Resolution: From 8 to 12 bit
- Wide Speed Range: Supports speeds from 0 to 100k rpm
- Fast angle sensing: 1 µs Sampling, on demand,
- Low Latency: 4 µs at any constant speed
- Wide Magnetic Field Range: 15mT to greater than 100mT supported
- Small Footprint: QFN16-3x3mm2 or QFN14-2x2mm2
- **Low Power Consumption Modes and Triggers**



MA780 + 782 Low Power Angle Sensor



Always on
< 1 µA

Only on when
sensor active
10 mA

MA780/782 Low Power Angle Sensor

Wake and sleep provides very low average power in battery applications

- **Power cycling:**
  - **User Controlled**
  - **Automatic Mode (self pulsed)**
  - **WOC (Wake-On-Change)**

- **10 mA when Active**
- **< 1 µA in Idle**
- **< 0.5 µA when Power Off**

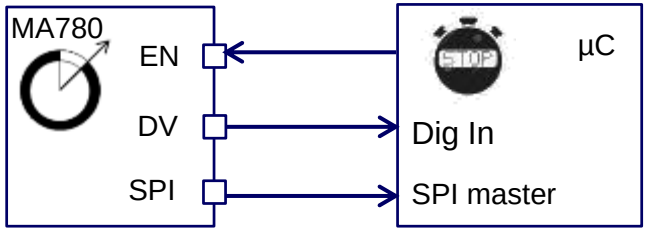
- **3.3 V Supply**
- **IO Supply: 1.8 V to 3.3 V.**

sample rate (Hz)	average current (µA)	
	8 bit	10 bit
1000	500	2900
300	150	870
100	50	290
20	10	60
5	4	16

MA780/782 Low Power Angle Sensor

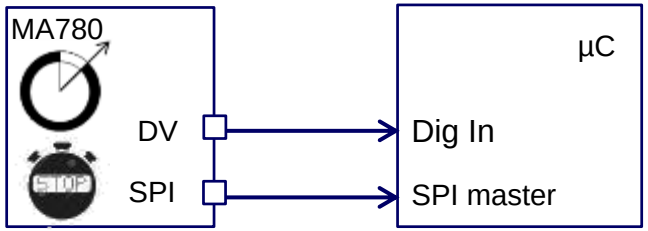
1. User Control Mode

Sensor activity fully user controlled
EN pin to control active / low power
DV = angle data valid



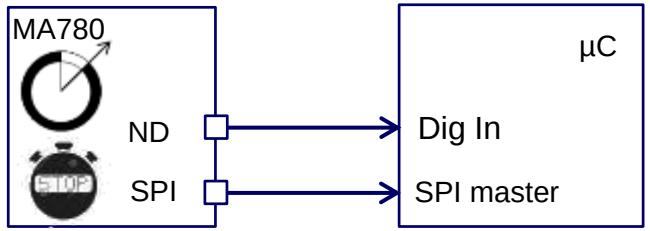
2. Automatic Sample Cycle (ASC)

Independent low power sensor.
Tactive/Tstby time programmable
DV = angle data valid



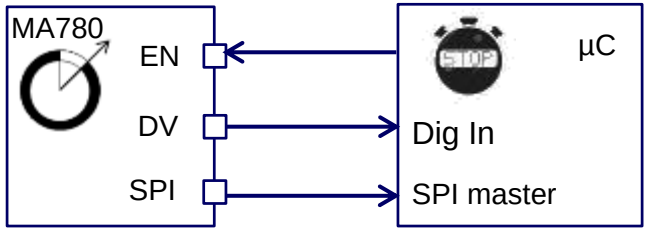
3. WOC Mode

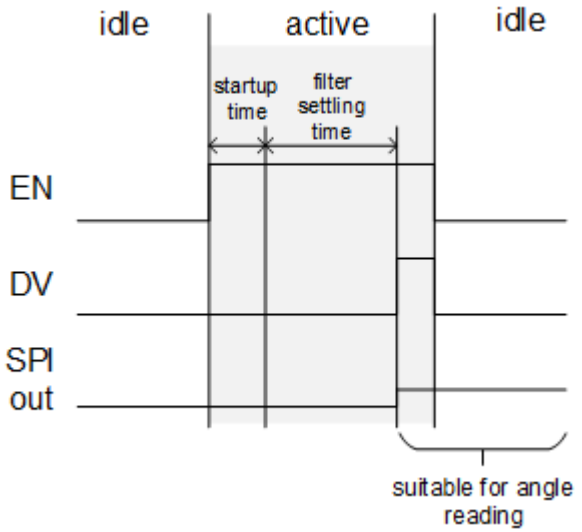
Independent low power sensor.
“Warning on Change of angle”
Flags when angle-REF>THR
(Absolute or relative motion detection)
Only wakes when angle threshold THR is exceed



User Control Mode: External Sensor Control

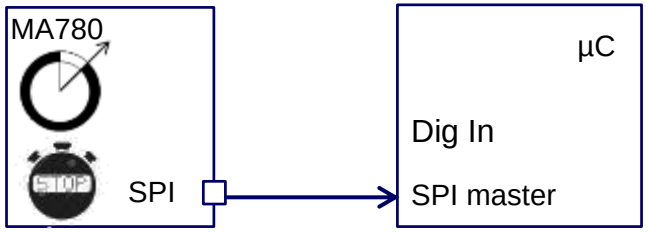
- µC controls Sensor Power/Timing
- Sensor converts Position in Active phase
- Sensor indicates DV (Data Valid) to µC
- Access via SPI
  - Position Data Access in Active and Idle

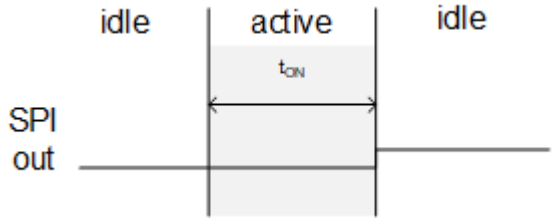




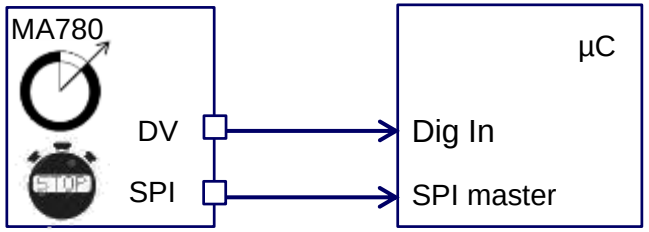
Automatic Sample Cycle (ASC): Sensor Based Timing

Simplest usage

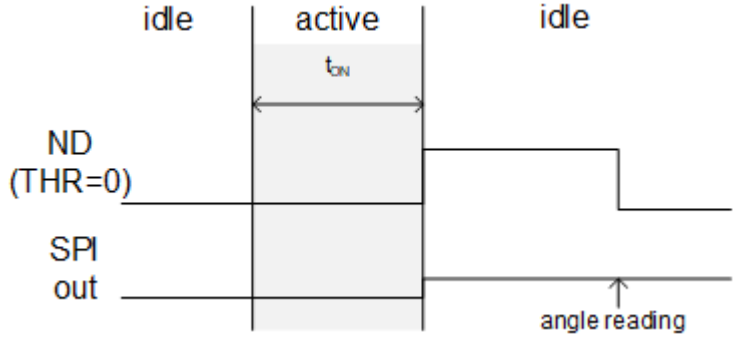




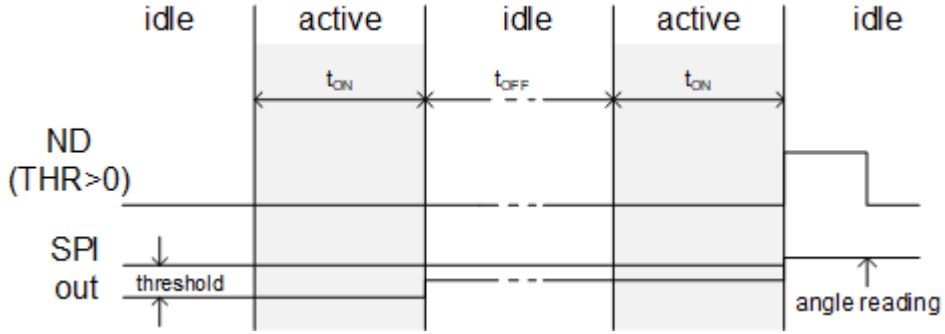
Reading the New Data (ND) output



zero threshold:

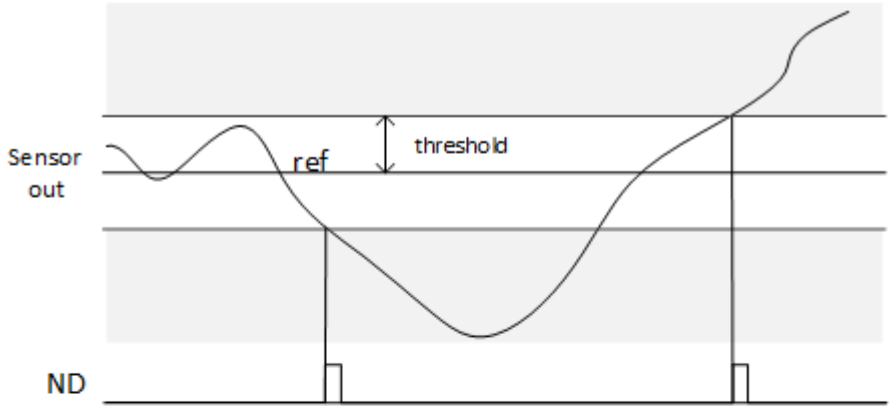


Non zero threshold:

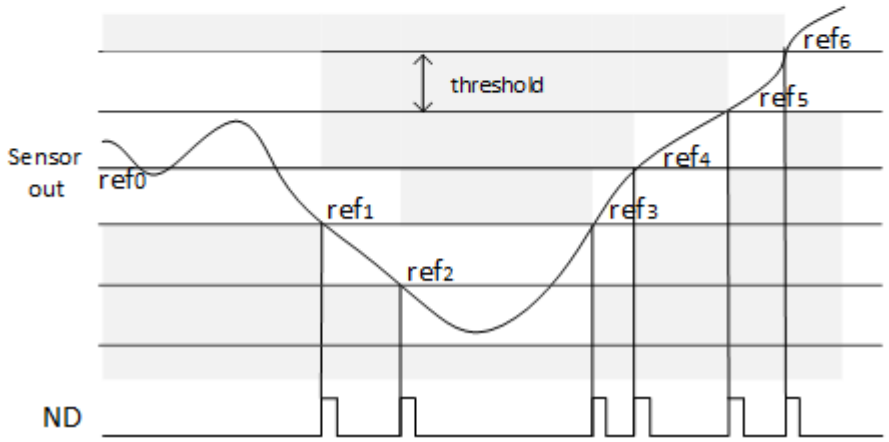


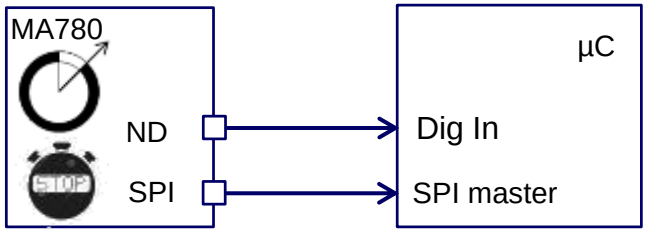
Wake-On-Change (WOC): Sensor Based Motion Detection

- Fixed Reference



- Auto Updated Reference*



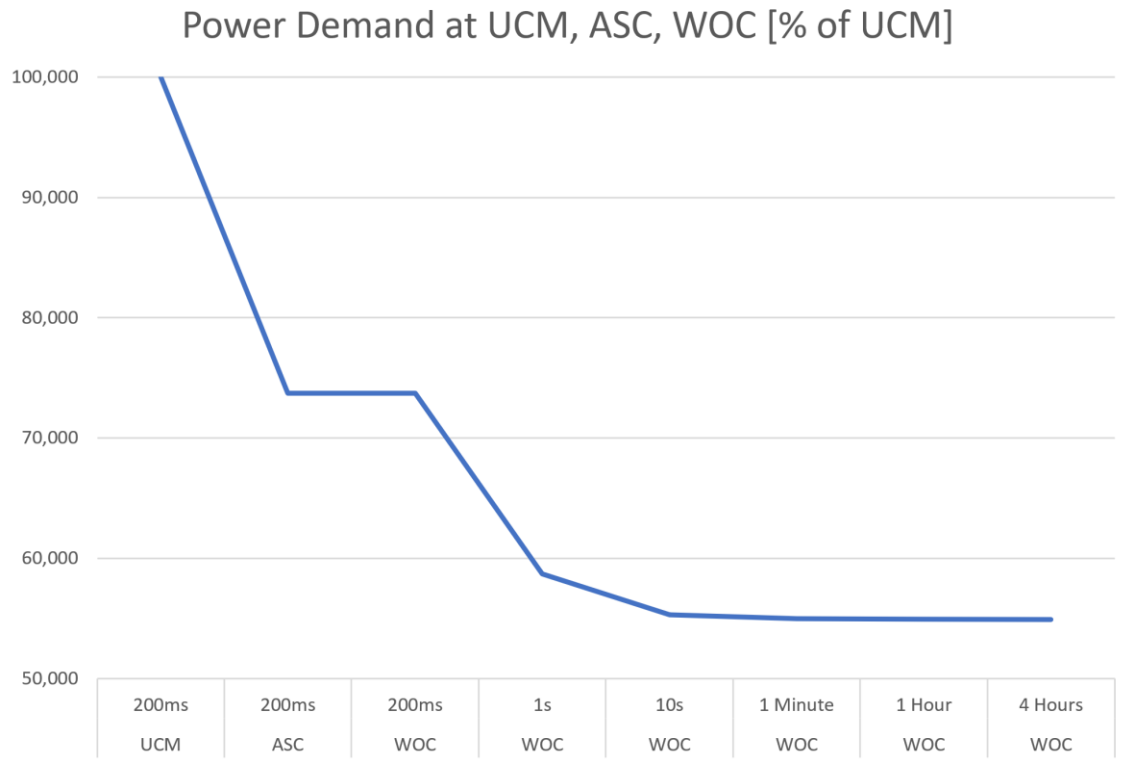


Comparing Modes

Typical HMI Conditions:

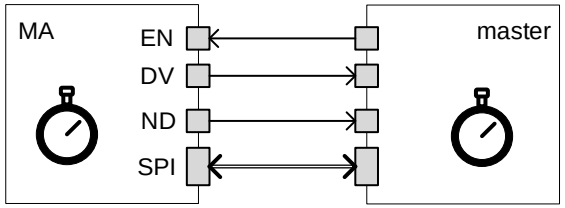
- Sensor Cycle: 5 Hz = 200 ms
- Sensor MA782: Active = 10 mA @ 36 µs; Idle = 1 µA
- µC ESP32: Active = 35 mA @ UCM 70 µs, ASC 25 µs, WOC 25 µs ; Sleep = 10 µA

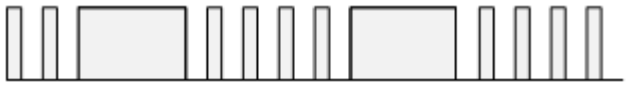
Mode	Time of Interaction	Power Demand
UCM	200 ms	100,000 %
ASC	200 ms	73,716 %
WOC	200 ms	73,716 %
WOC	1 s	58,693 %
WOC	10s	55,313 %
WOC	1 Minute	55,000 %
WOC	1 Hour	54,938 %
WOC	4 Hours	54,937 %



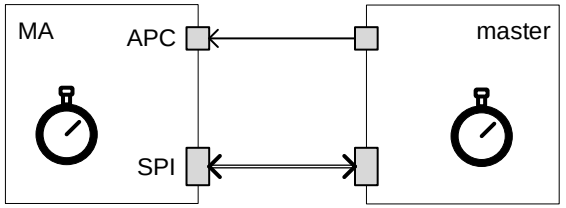
Mixing Modes

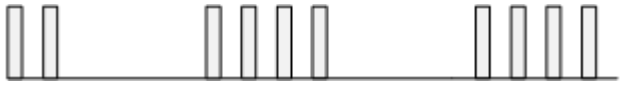
ASC - Active





ASC - Idle





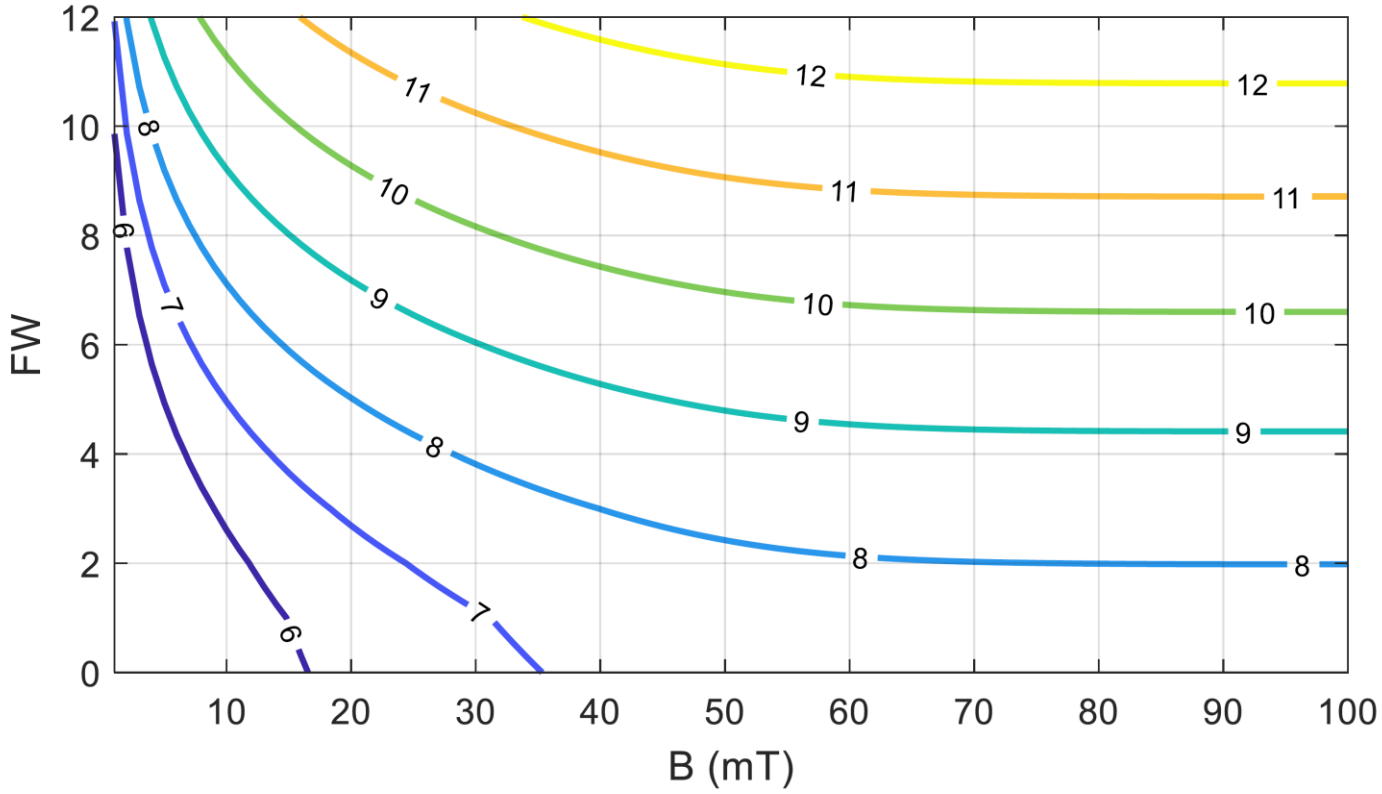
MA780/782 Ultra-Low Power Applications

Battery powered devices like dials, smart thermostats, smart locks, ...

Wake and check for movement every few milliseconds

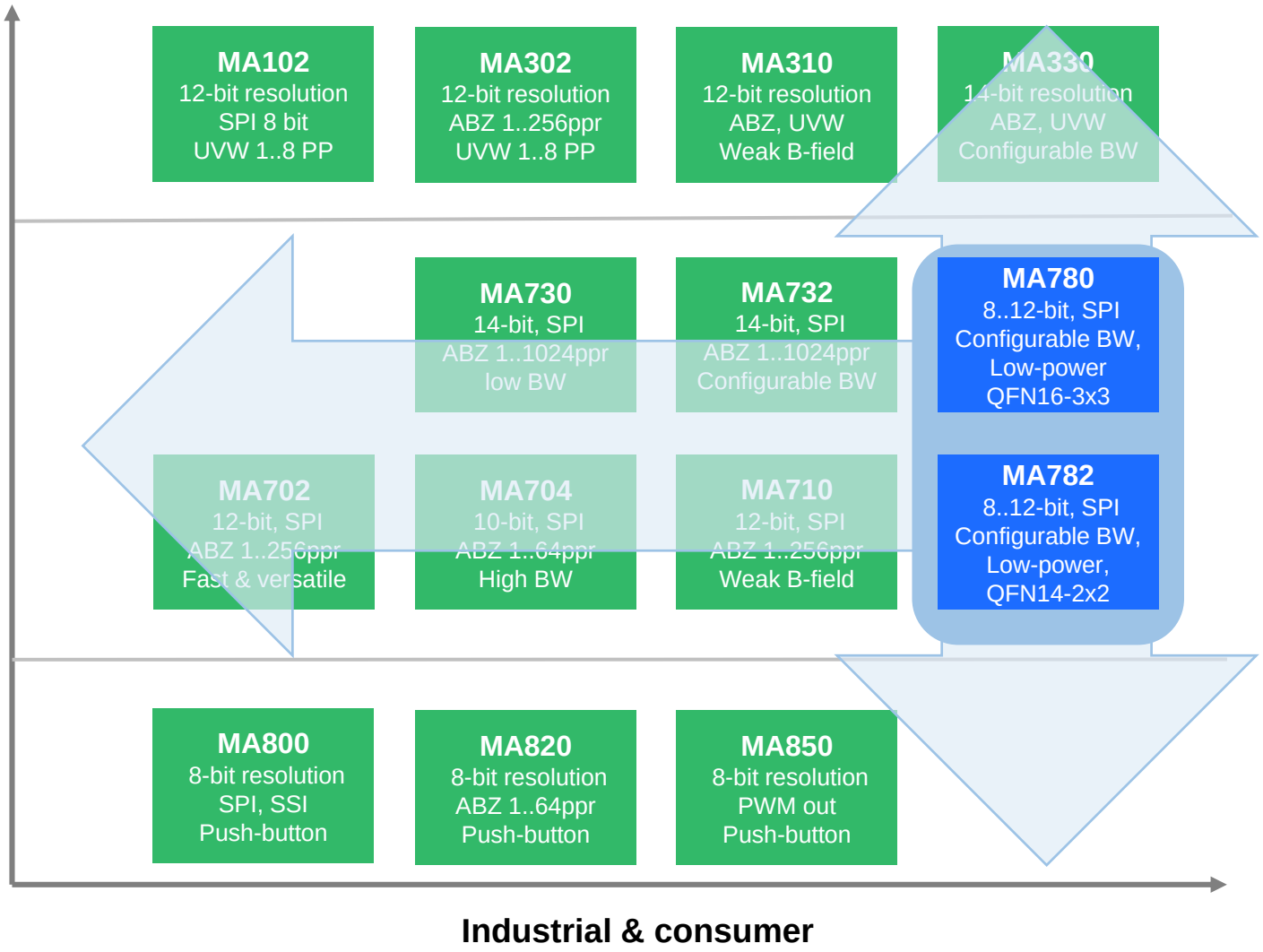
Resolution and Adjustable Filter Window

Window size FW(0:3)	Time constant τ [µs]	Filter settling time [µs]
0	1	1
1	2	3
2	4	7
3	8	15
4	16	31
5	32	63
6	64	127
7	128	255
8	256	511
9	512	1023
10	1024	2047
11	2048	4095
12	4096	8191
13	8192	16383
14	16384	32767
15	32768	65535



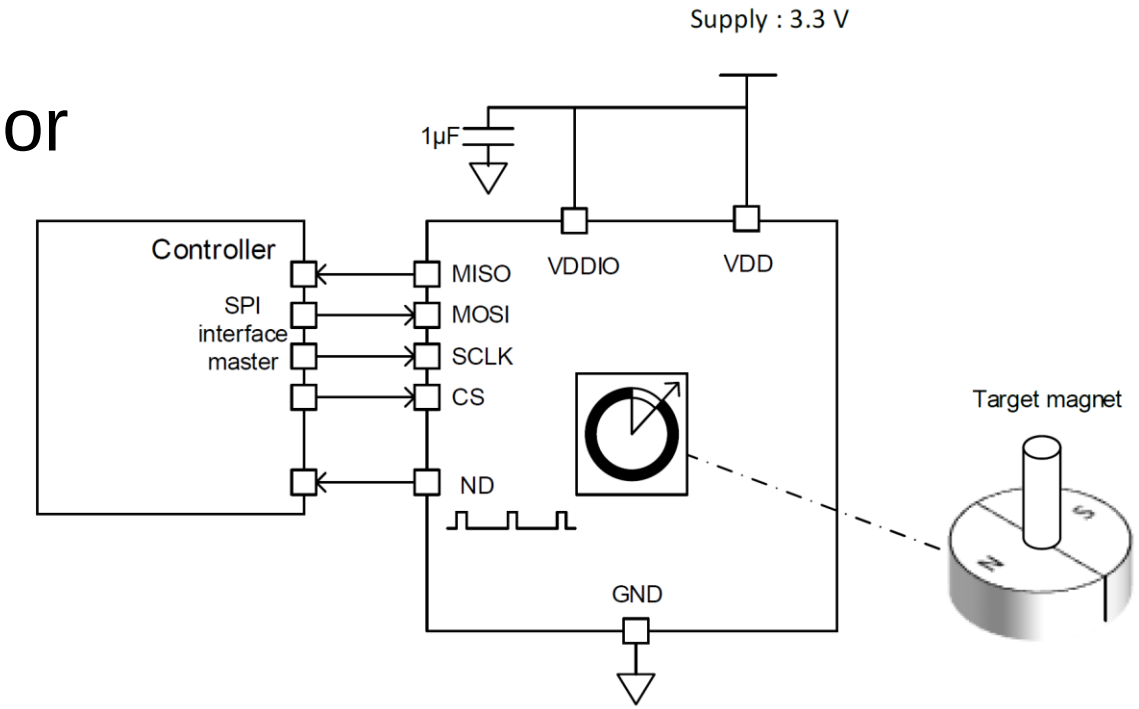
Sensor Application Range

- **Wide Application Range**
  - Up to 12 bit Resolution
  - Up to 100k RPM
  - High Bandwidth SPI
- **Trade Off**
  - Not enough pins for classic *Real Time Demanding* interfaces: ABZ, UVW, PWM
  - embedded system Structure Required

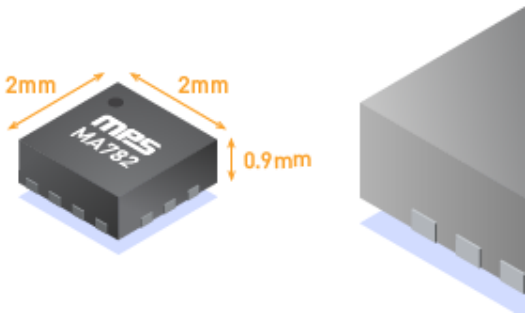


Enabling Ultra-Low Power System Architecture

- Ultra-Low Power capable Sensor
  - Wide Configuration Range
  - Wide Operation Range
  - Wide Performance Range
- System Structure Flexibility
  - Roles of Master and Slave
  - Time + Event based Operation



World's Smallest
Absolute ICEncoder®



Summary

- Growing Low Power Applications
- Hall Based Position Sensing Systems
- Available Solutions for Ultra-Low Power Angle Sensing
- Effective Saving Power
- Combining multiple modes for User Interaction and Motion Control
- System Structure and Design
- Open Q&A