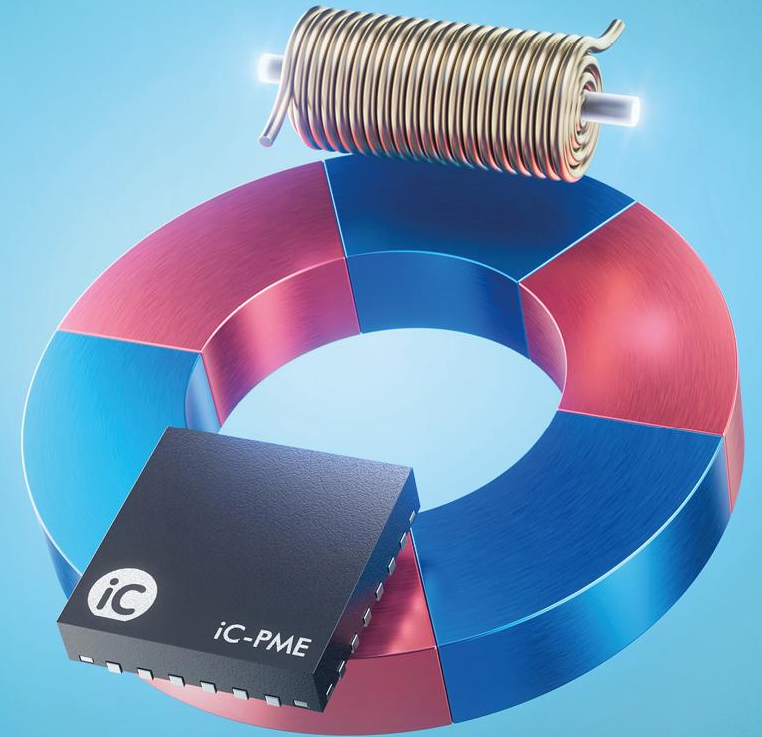


Next Generation Energy Harvesting Multiturn Encoder SoC

MagSense 2026

September 16, 2026, Imaginata, Jena

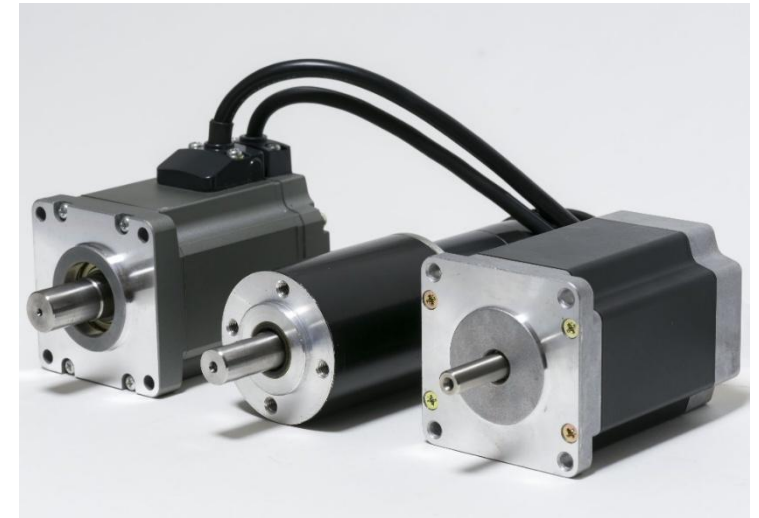


Ball Screw Drives

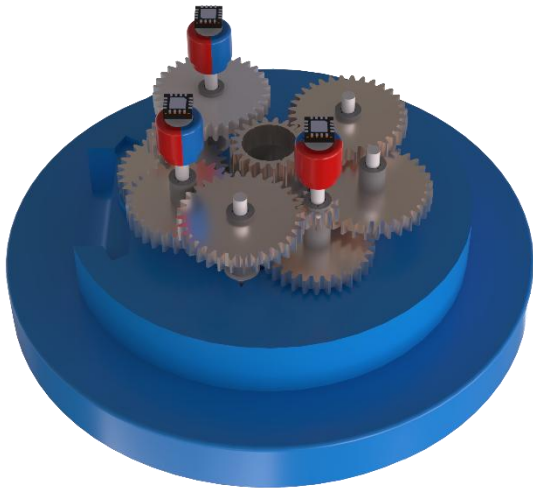


Surasak_Photo/shutterstock

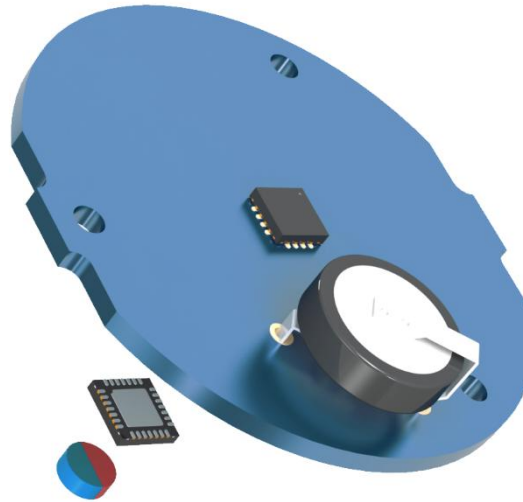
Motor Feedback



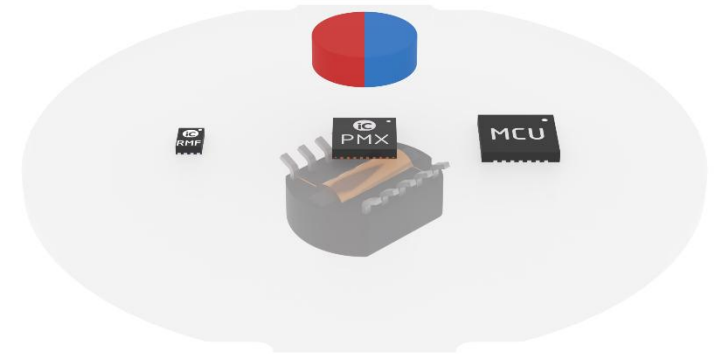
similis/shutterstock



Multiturn Encoder
with Gear Box

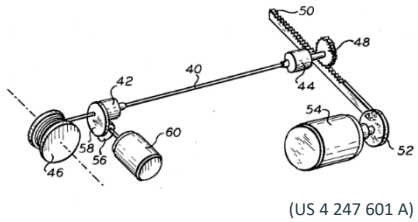


Multiturn Encoder
with Backup Battery



Multiturn Encoder
with Energy Harvesting

Wiegand Wire



1974

2003

2012

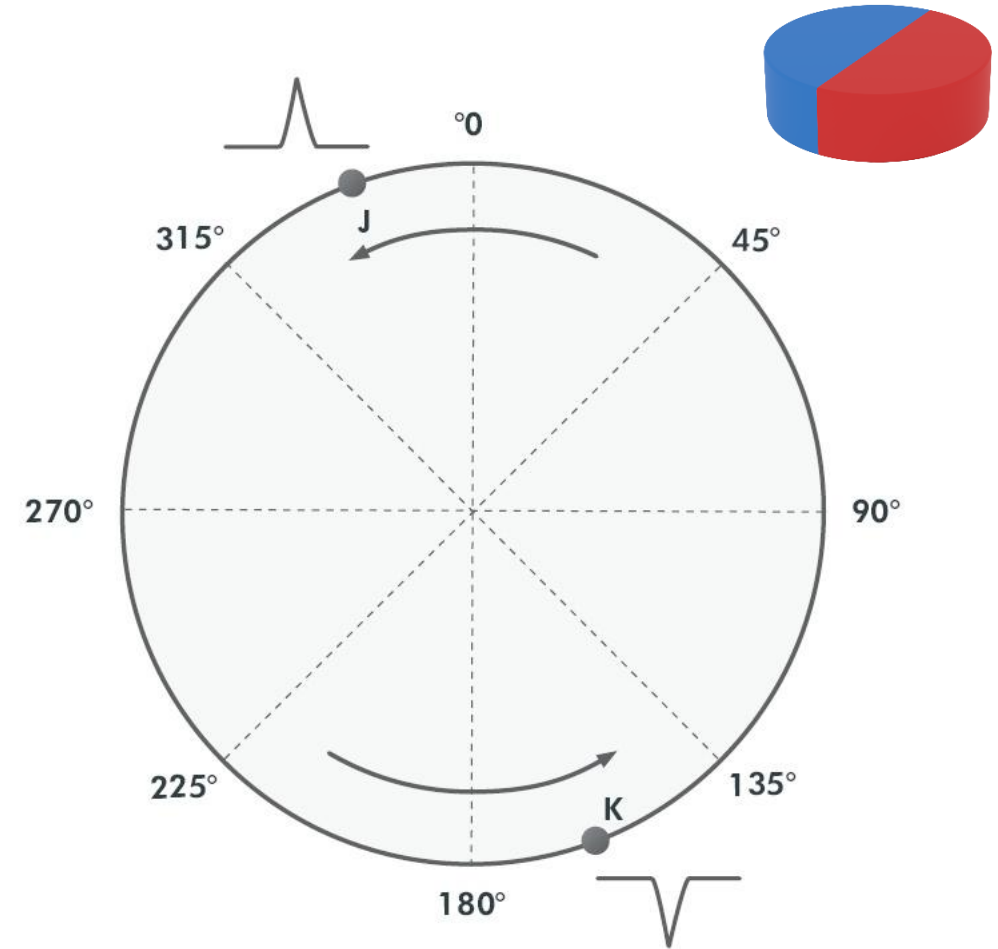
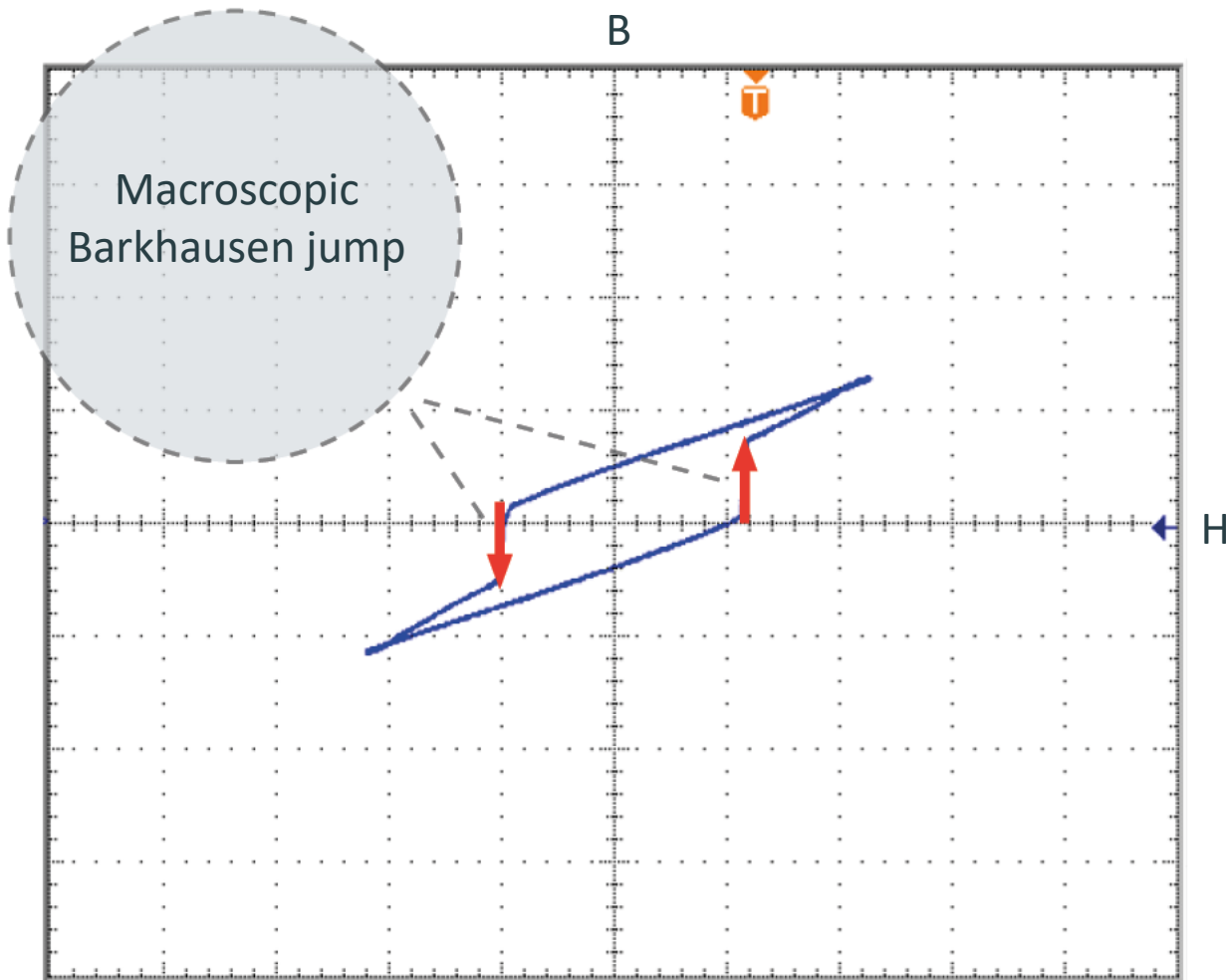
Magnetic Barkhausen effect:

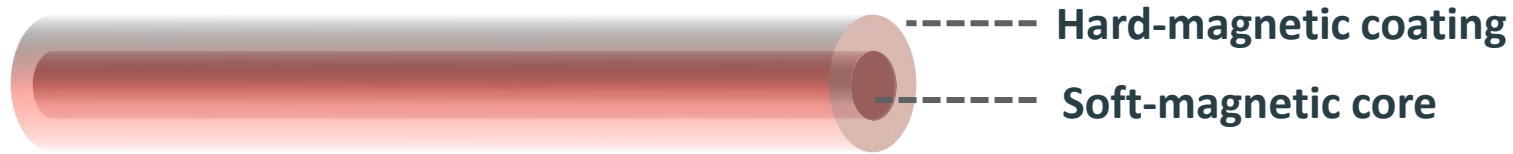
The discontinuous changes in the magnetization of ferromagnetic materials when the magnetic field changes.



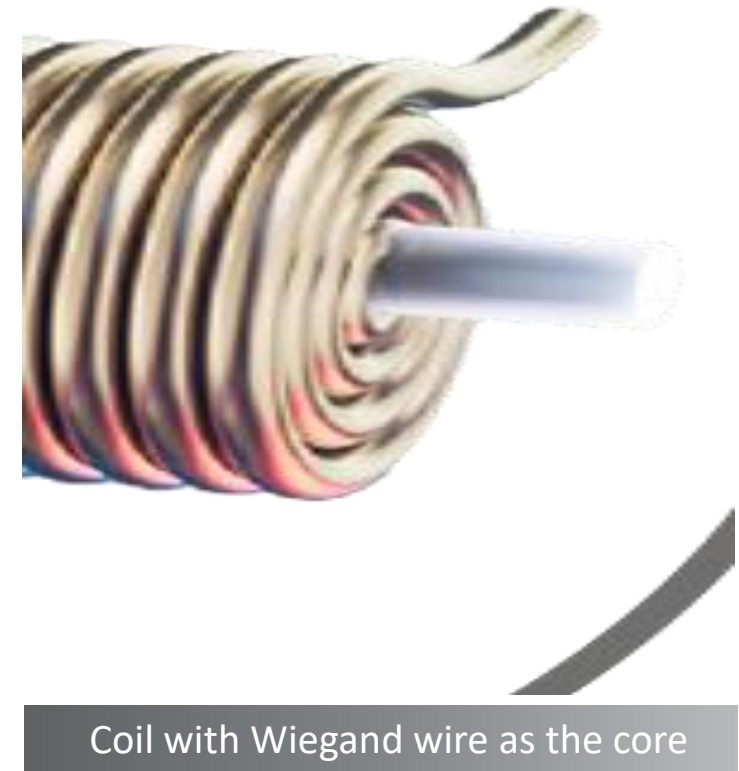
John R. Wiegand

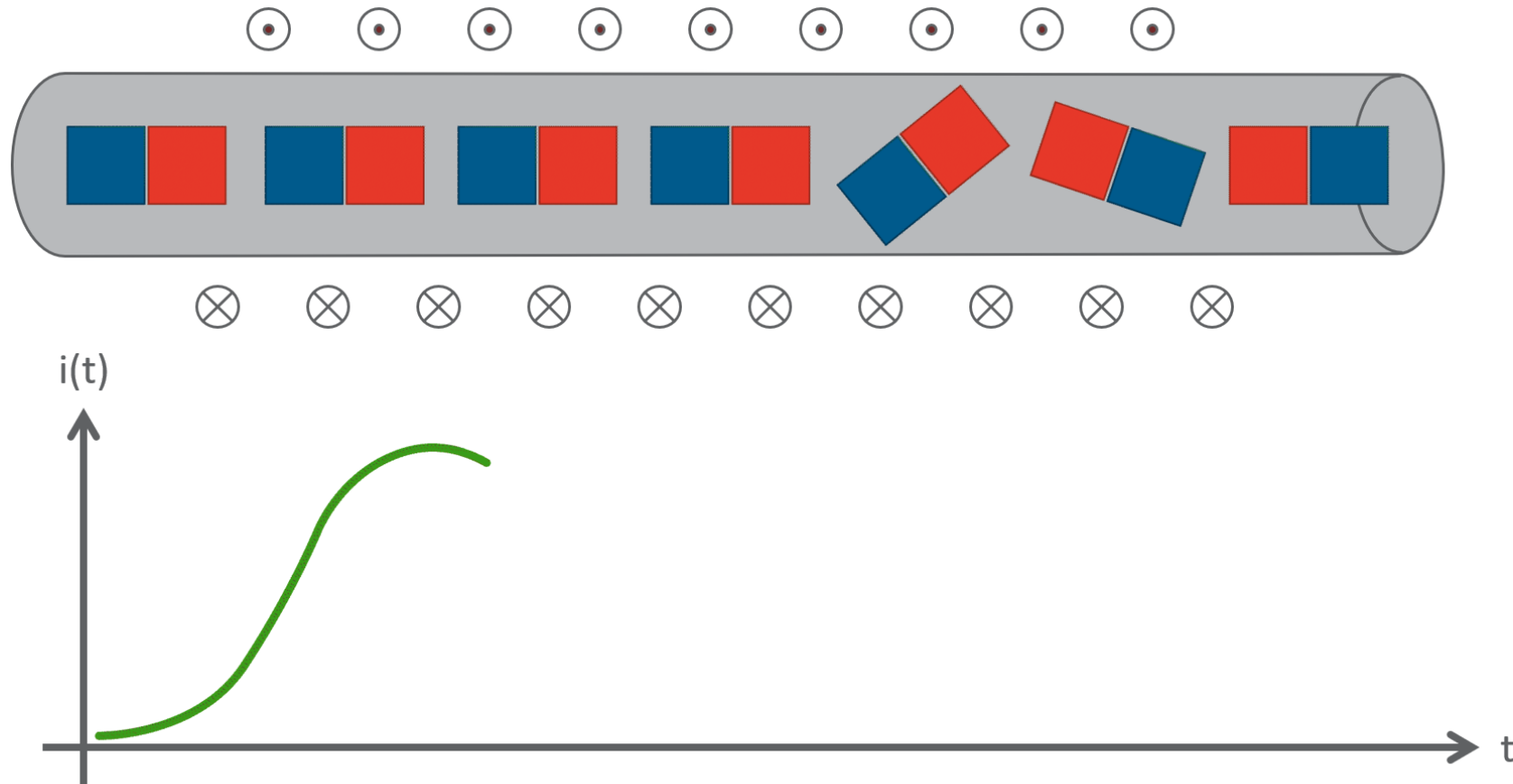
Michael L. Davis, *Machine Design* (2011)



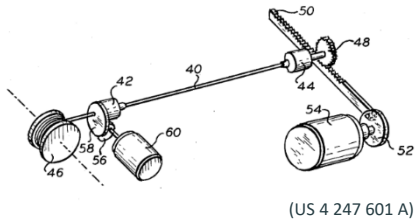


- FeCoV (Iron-Cobalt-Vanadium) alloy
- Mechanical & thermal treatment
- Typical 0.25 mm Ø
- Named after John R. Wiegand





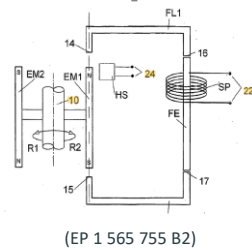
Wiegand Wire



1974

2003

2012



Mehnert & Theil Position Detector

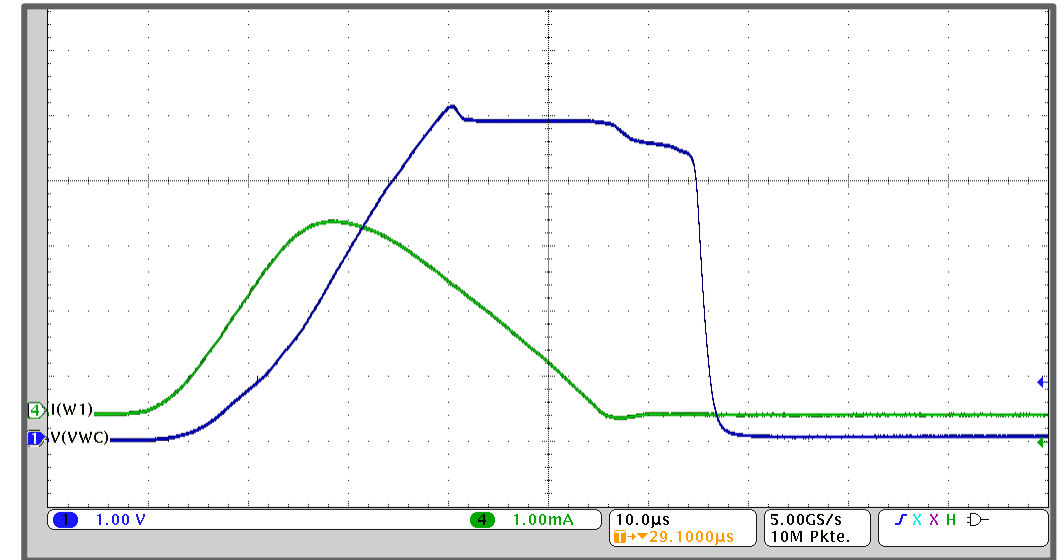
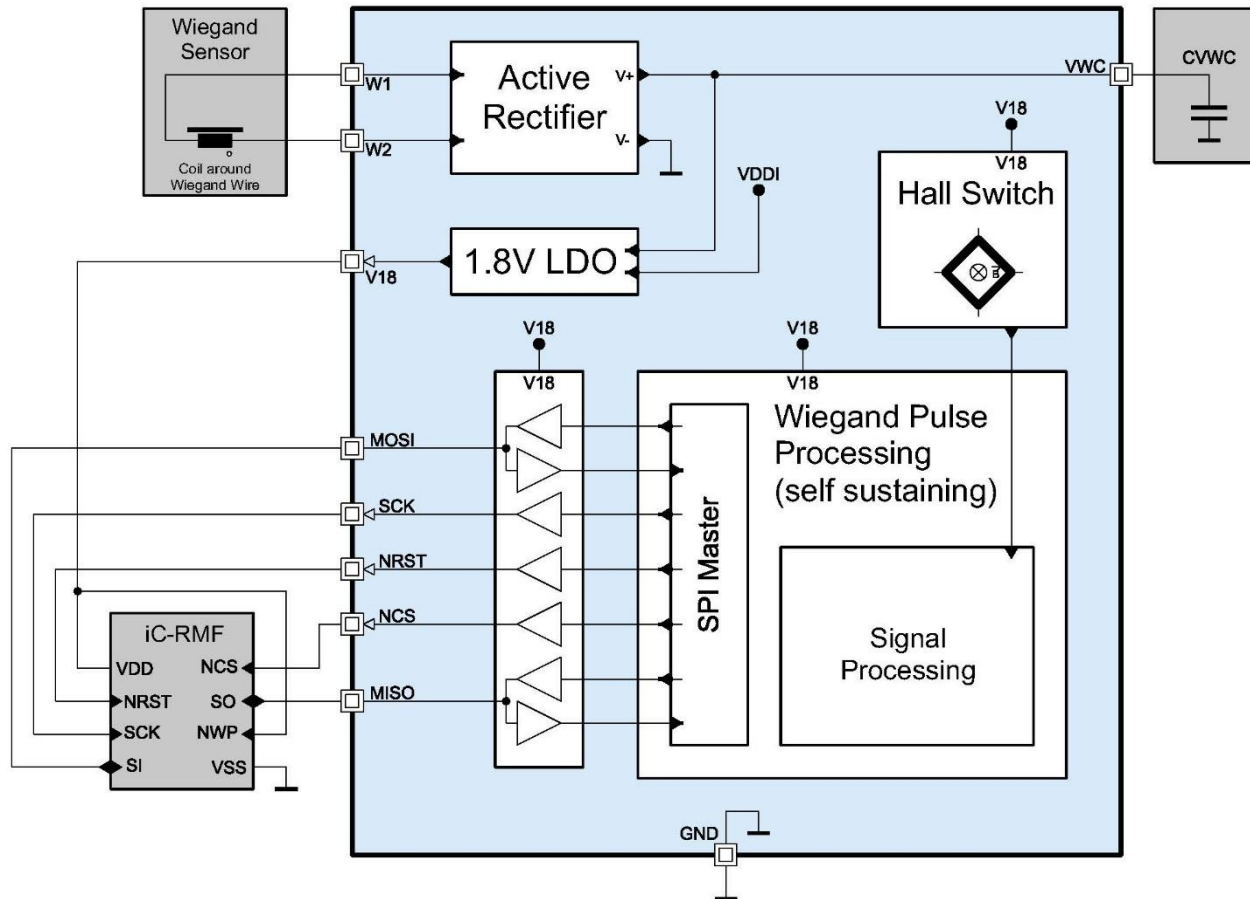
Research by the inventors, Dr. Walter Mehnert and Dr. Thomas Theil

System Design:

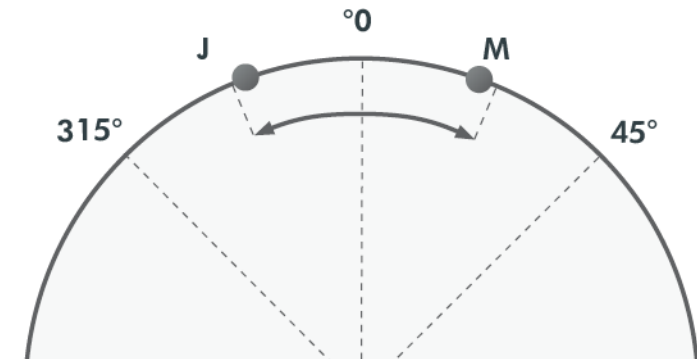
- Power generation for revolution counting using Wiegand wire
- FRAM as a memory for the count value
- Basic system: one Wiegand sensor, two Wiegand pulses per revolution
- Evaluation electronics for Wiegand pulses, counting direction and FRAM interface

Challenge solved:

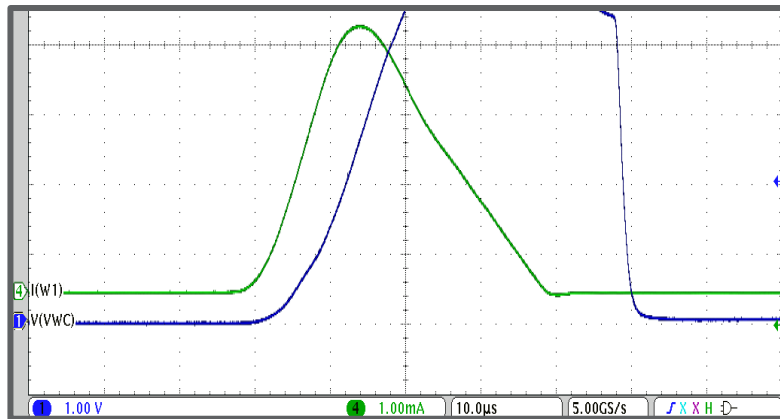
Power-on procedure for synchronizing the Wiegand sensor system with a singleturn sensor:
Modulating the magnetic field at the Wiegand sensor using an externally supplied current ramp
(EP 1 565 755 B2)



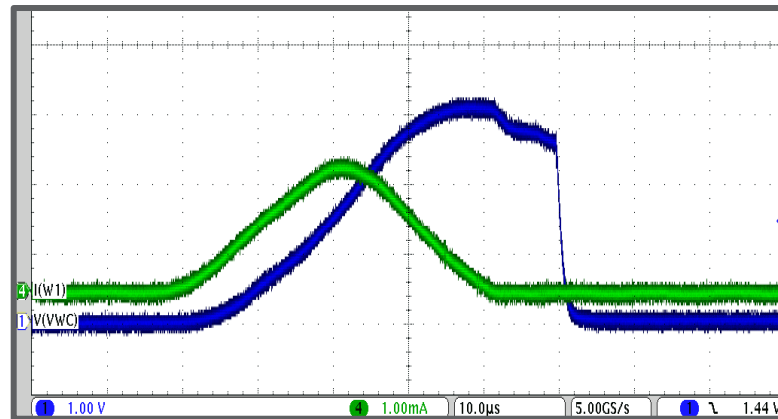
- Counting revolutions without external power
- Harvesting energy from low-speed motion
- Energy management within the chip
- Counting up to 43 bit



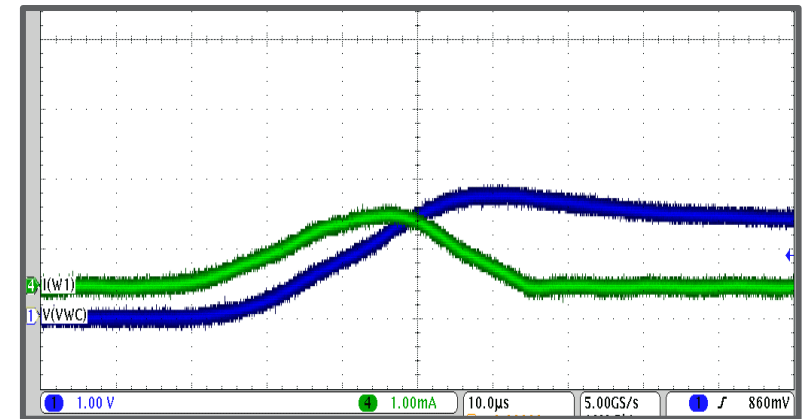
Runt pulse due to rotation reversal:

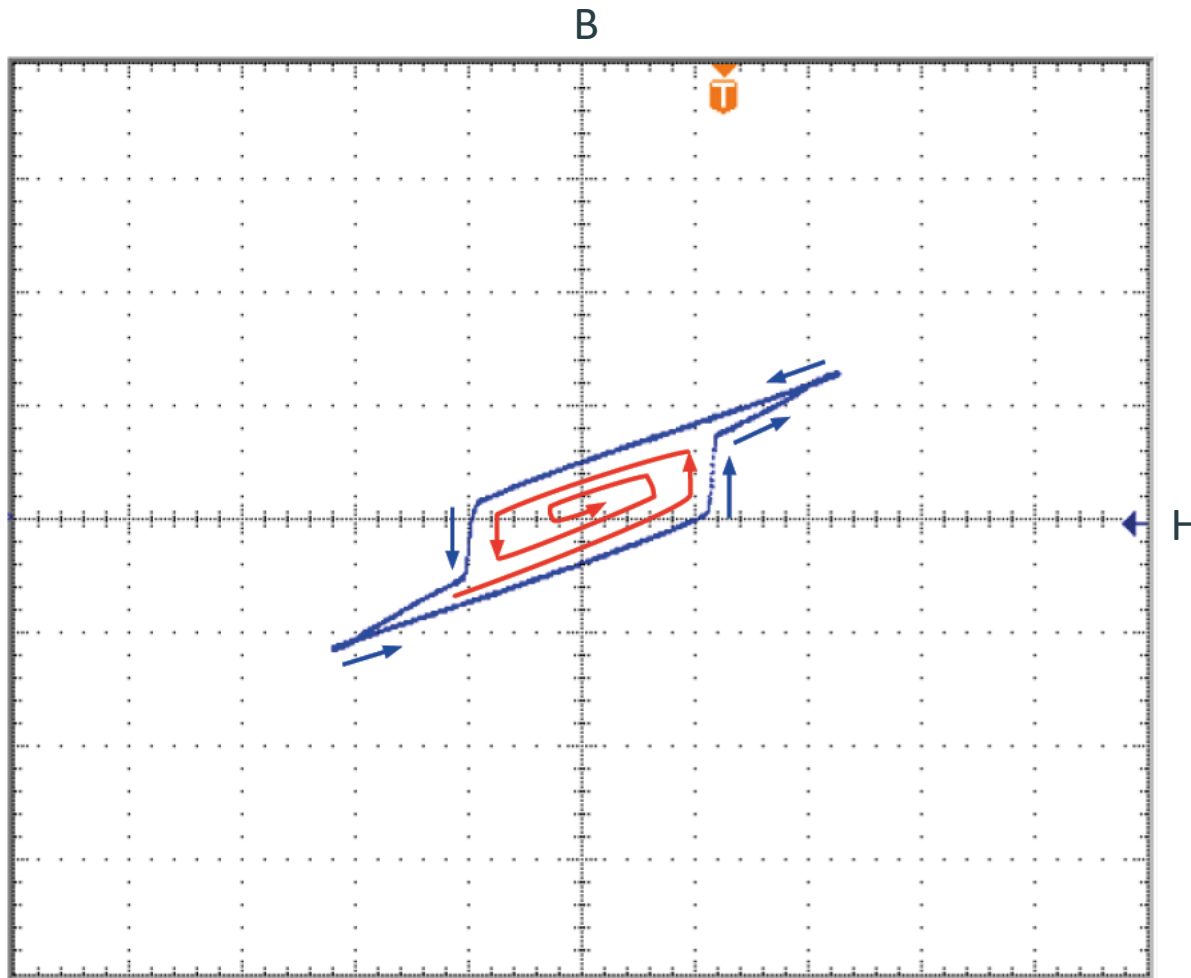


Normal pulse



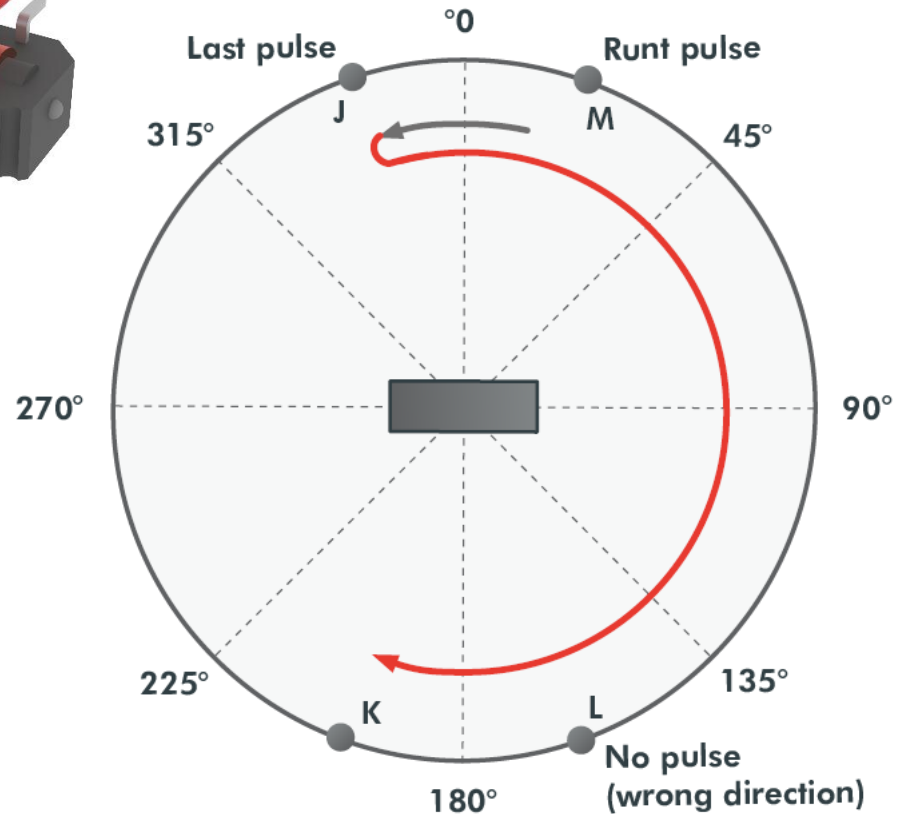
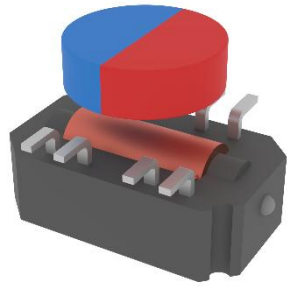
Runt pulse





Change in rotation direction:

- Reverse operation
- Possible lack of preliminary magnetization of the Wiegand sensor



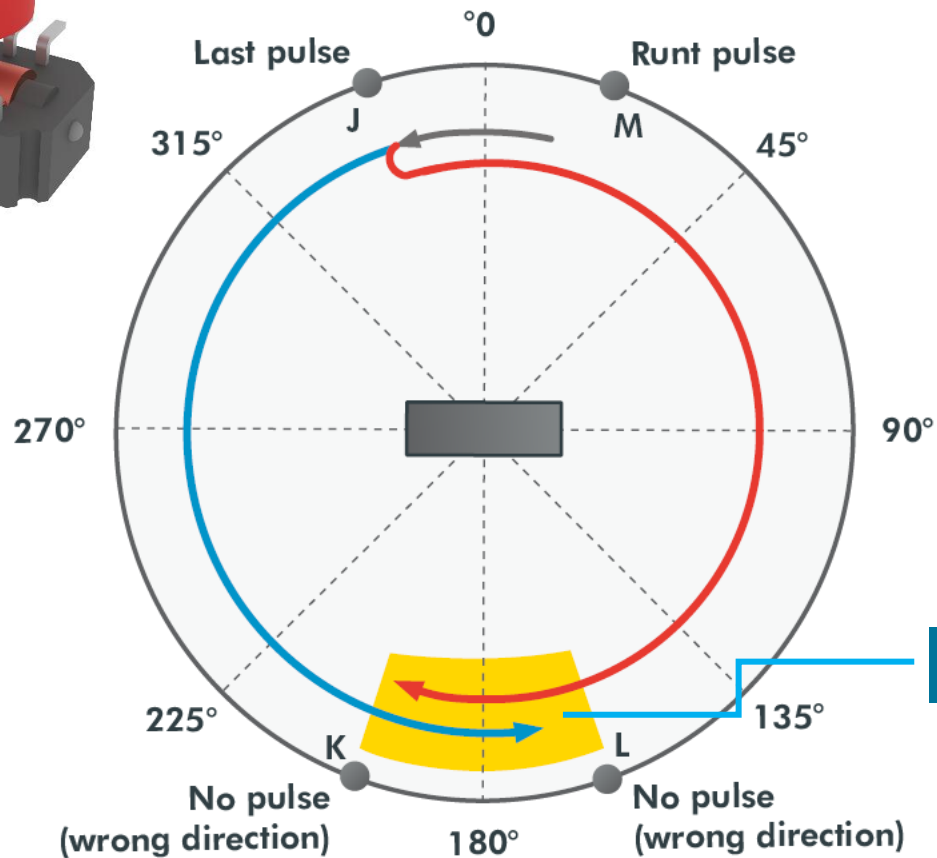
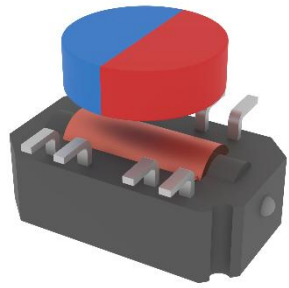
Rotation reversal immediately after pulse J

1. Pulse M can be a Runt pulse (is not counted)
2. Pulse K follows pulse J

→ Exception handling required

Autocorrection in the FRAM:

Multiturn Counter Operation							
Condition	Last Pulse		Current Pulse		CNT		
	PP	DIR	PP	DIR			
CW Rotation	L	0	1	J	1	1	-1
CCW to CW after M	M	0	0	J	1	1	-1
CCW to CW after M (Runt)	M	0	0	L	0	1	-1
CCW to CW after K (Runt)	K	1	0	J	1	1	-1
CCW Rotation	K	1	0	M	0	0	+1
CW to CCW after J	J	1	1	M	0	0	+1
CW to CCW after J (Runt)	J	1	1	K	1	0	+1
CW to CCW after L (Runt)	L	0	1	M	0	0	+1
Others							+0



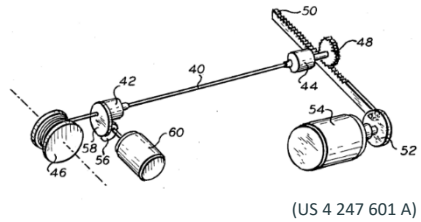
Pulse detected at J $\rightarrow MT_F = MT_F - 1$ recorded

1. ST is between K und 0°
 $\rightarrow$ MT correct
2. ST is between 0° und L
 $\rightarrow MT = MT_F + 1$
3. ST is between L und K
 $\rightarrow$ Additional information required

Worst case: Direction of rotation unknown

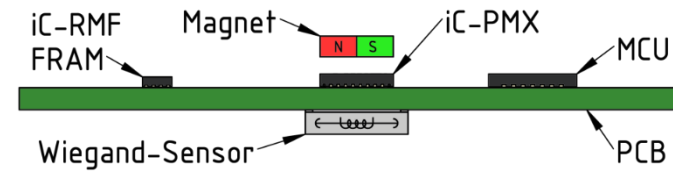
iC-PMX: Inductive triggering of a Wiegand pulse (Patent EP 1 565 755 B2)

Wiegand Wire



1974

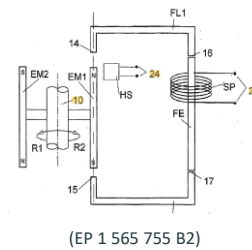
Multiturn Counter



2012

TODAY?

2003



Mehnert & Theil
Position Detector



AMA
Innovation Award

Near-field sensors instead of far-field sensors

3A: Wiegand sensor without magnetic flux conductor

3B: Conventional Wiegand sensor with ferrite beads, good far-field operation

3C: Wiegand sensor with integrated magnetic flux conductor; enables good near-field detection

FIG. 3A

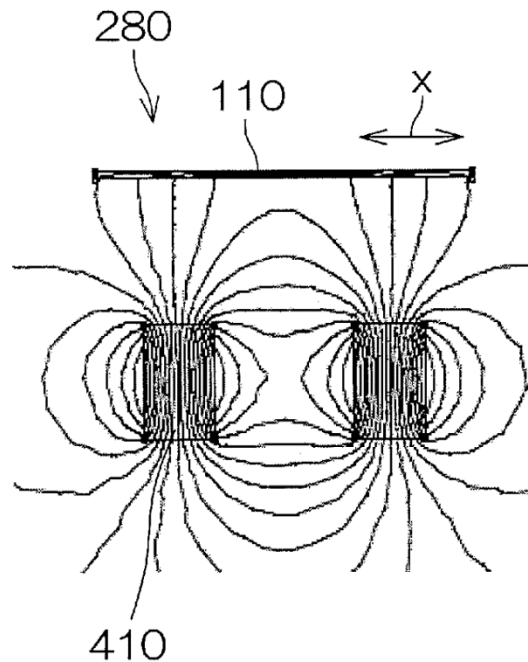


FIG. 3B

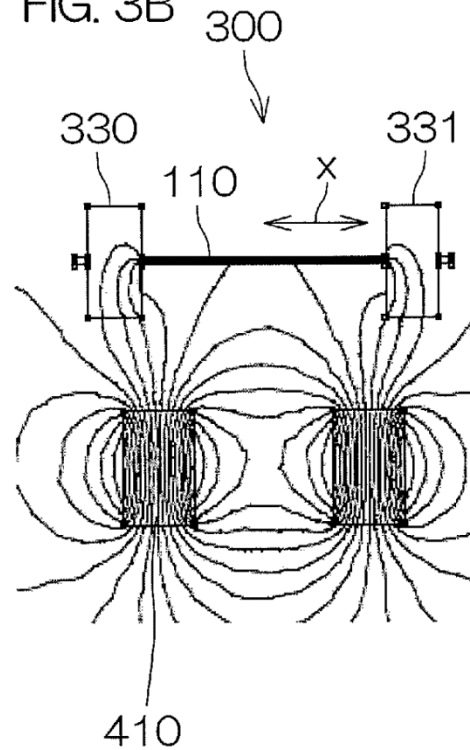
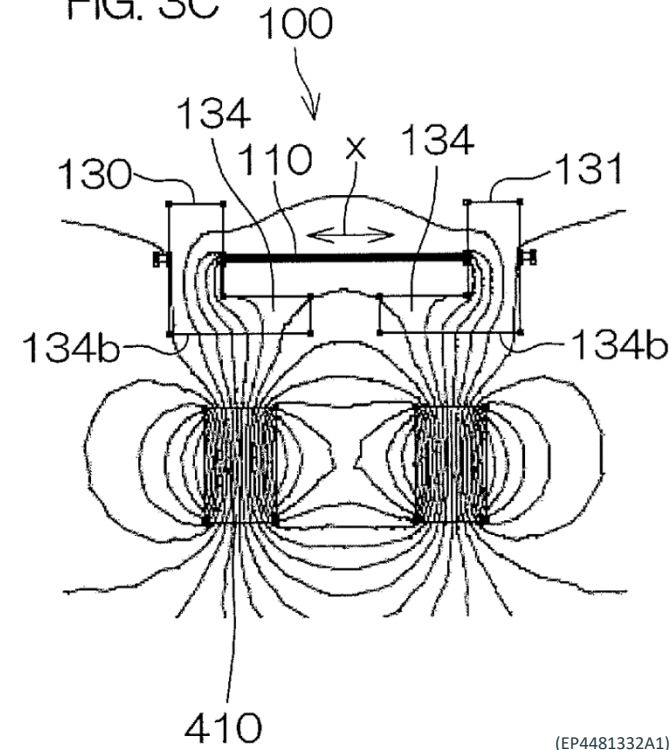


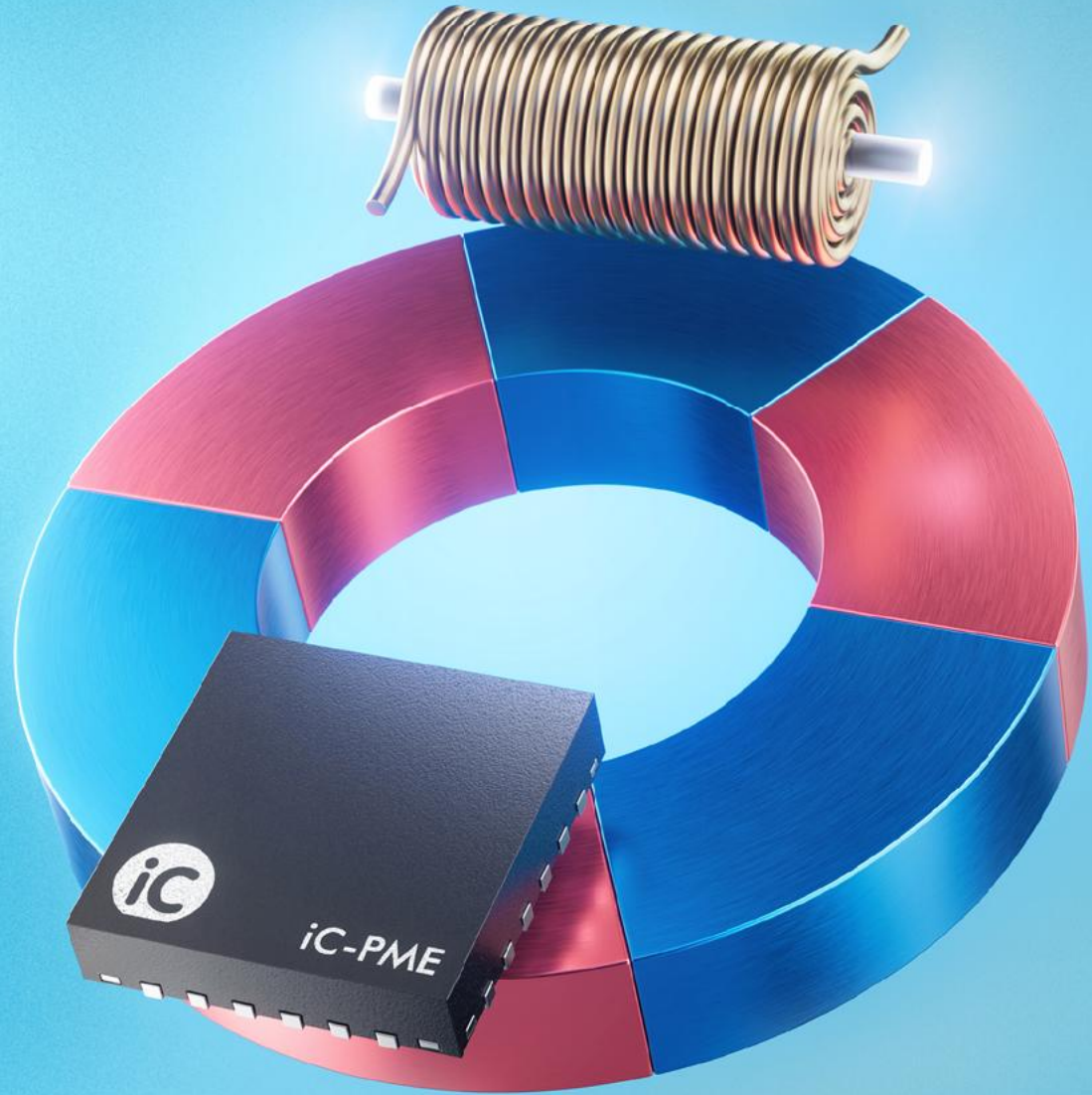
FIG. 3C

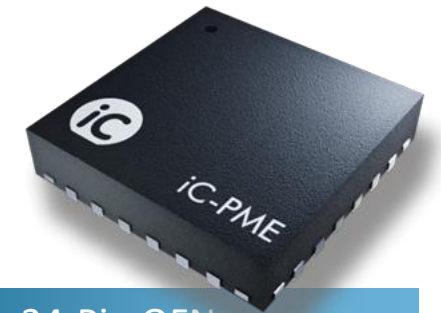
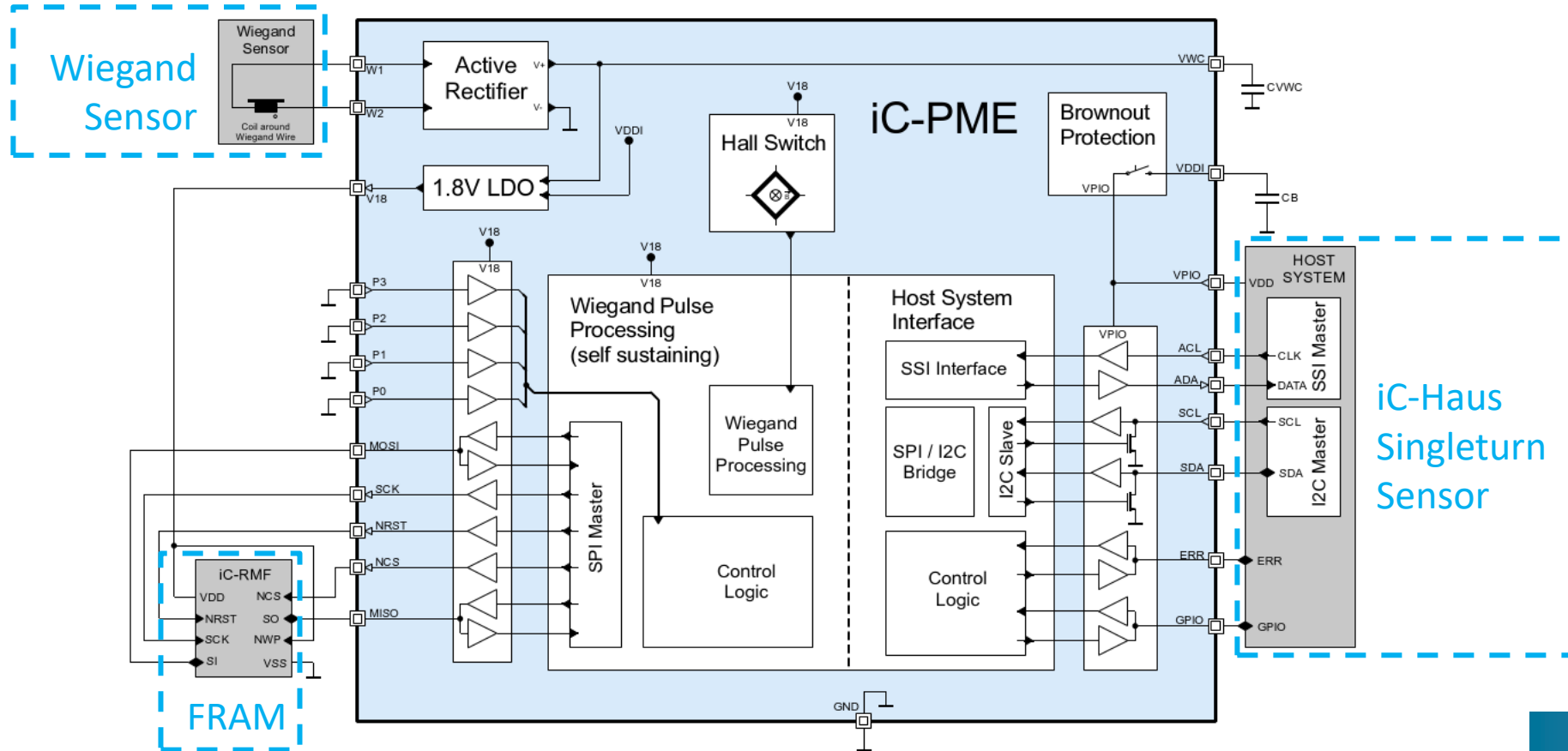


(EP4481332A1)

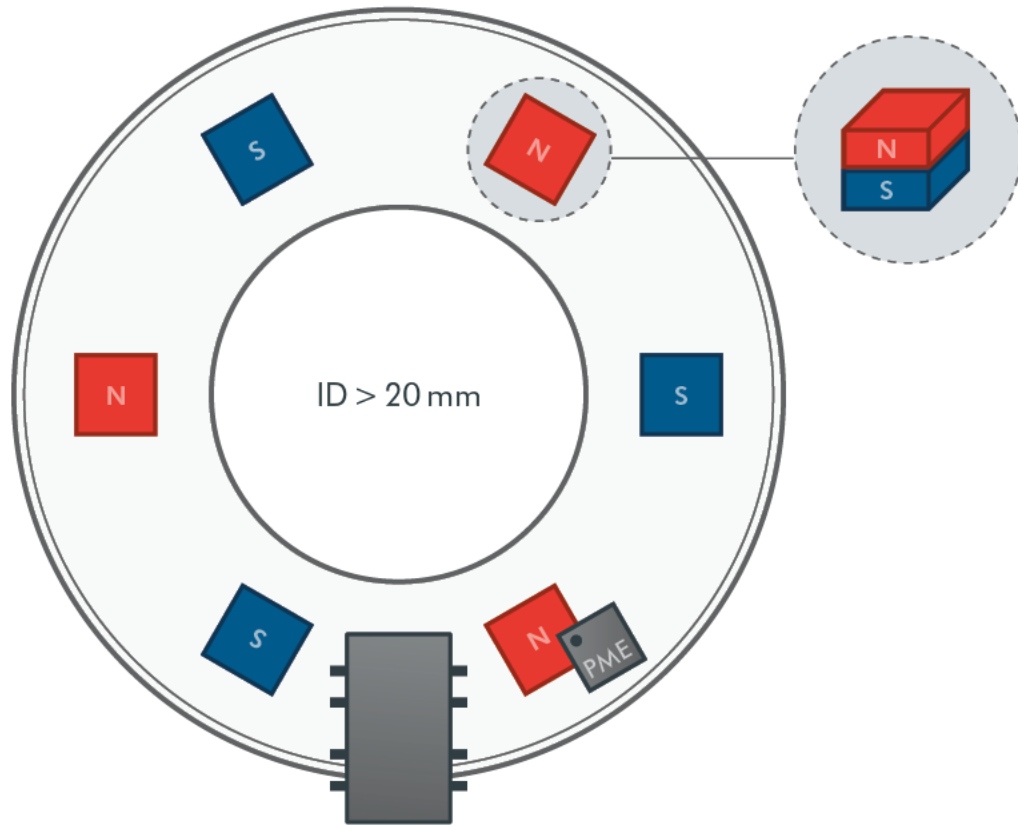
iC-PME Energy Harvesting Multiturn Counter

NEW!

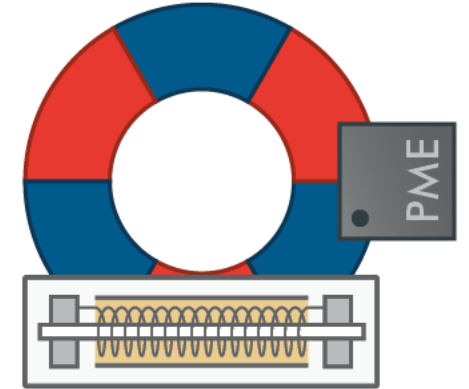
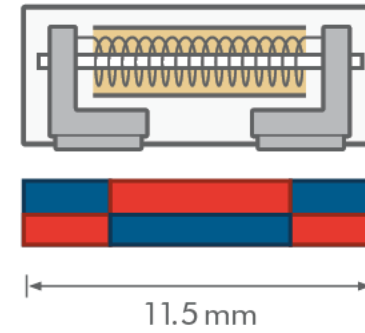




24-Pin QFN
4.0 mm x 4.0 mm x 0.9 mm
2.7 V to 5.5 V operation within
-40°C to 125°C



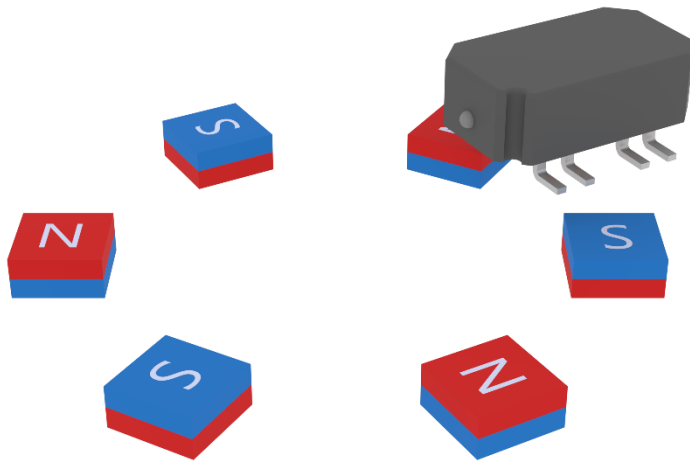
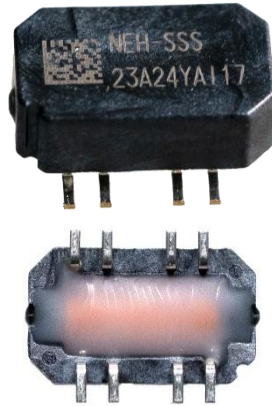
Scalable pole wheel with discrete magnets



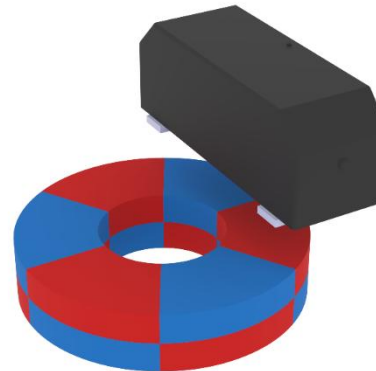
Miniature pole wheel

FlexCount® adjustable period count per revolution:

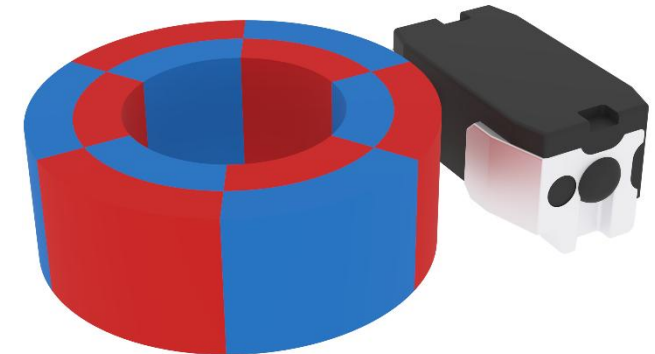
- Encoder application: 3 to 16 pole pairs
- Counter application: 1 to 16 pole pairs



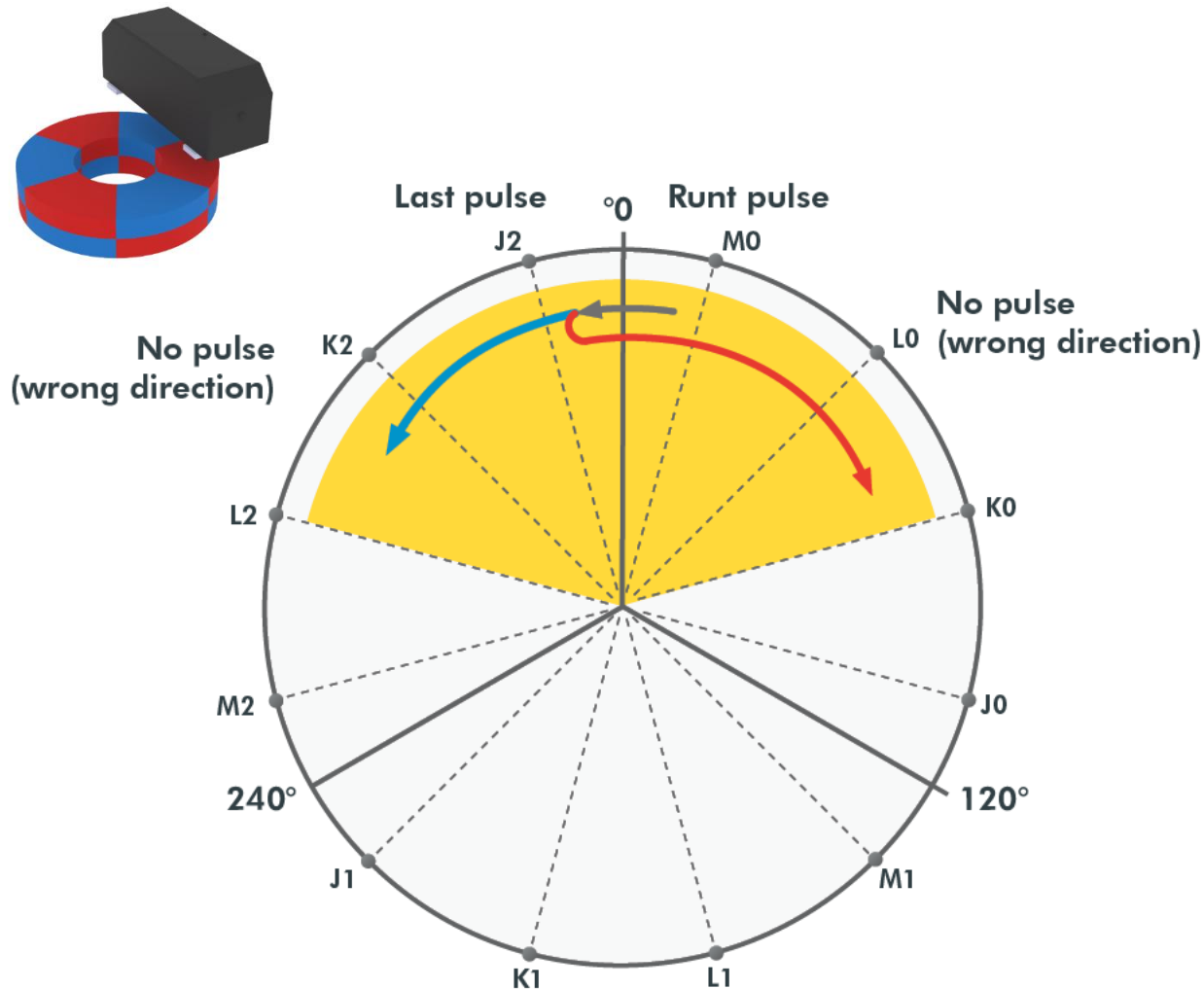
WS NEH-SSS



WS DK01



WS VTS



Pulse detected at J2: $MT = MT - 1$

1. ST is between L2 und 0°
→ MT correct
2. ST is between 0° und K0
→ $MT = MT + 1$
3. ST cannot be between K0 and L2
→ no ambiguous position exists;
simple synchronization possible

Advantages of 3 Pole Pairs

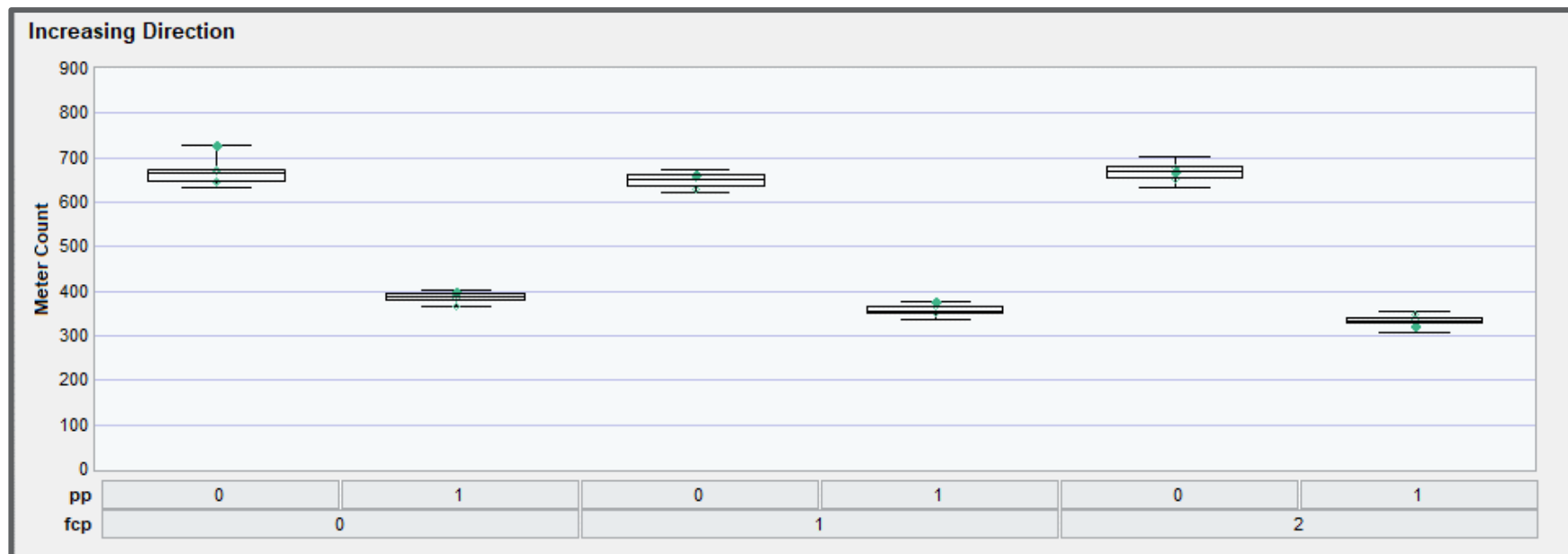
- Hollow shaft application
- Assembly tolerances
- Robustness
- Wide synchronization range

Diagnosis

- 2 Output Pins (ERR, GPIO)
- Status Flags via I2C interface

Monitoring

- Energy surplus measurement, separately for each Wiegand pulse

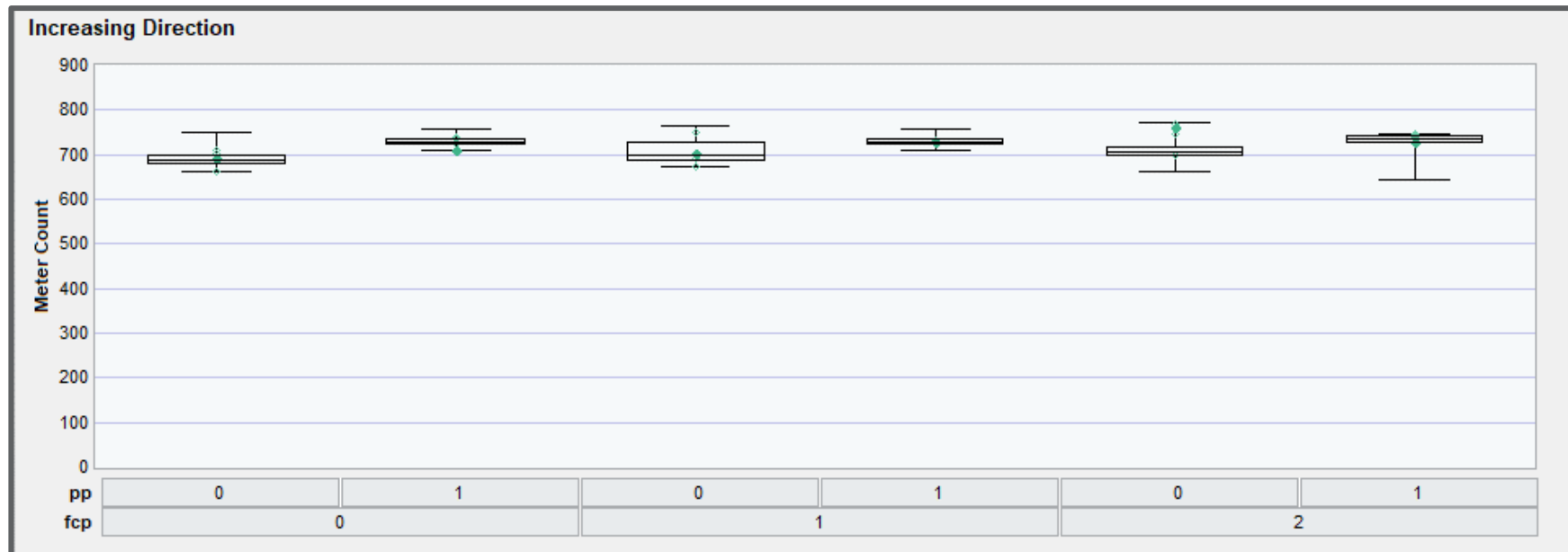


Diagnosis

- 2 Output Pins (ERR, GPIO)
- Status Flags via I2C interface

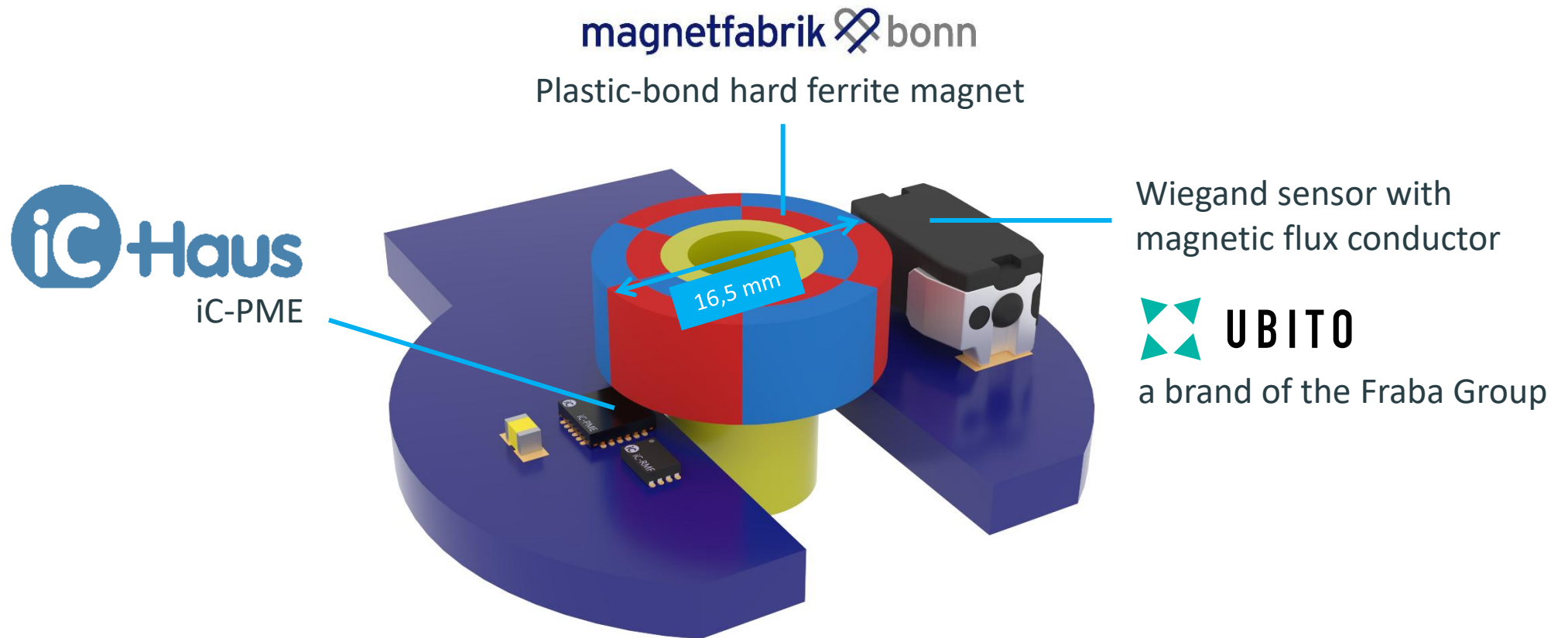
Monitoring

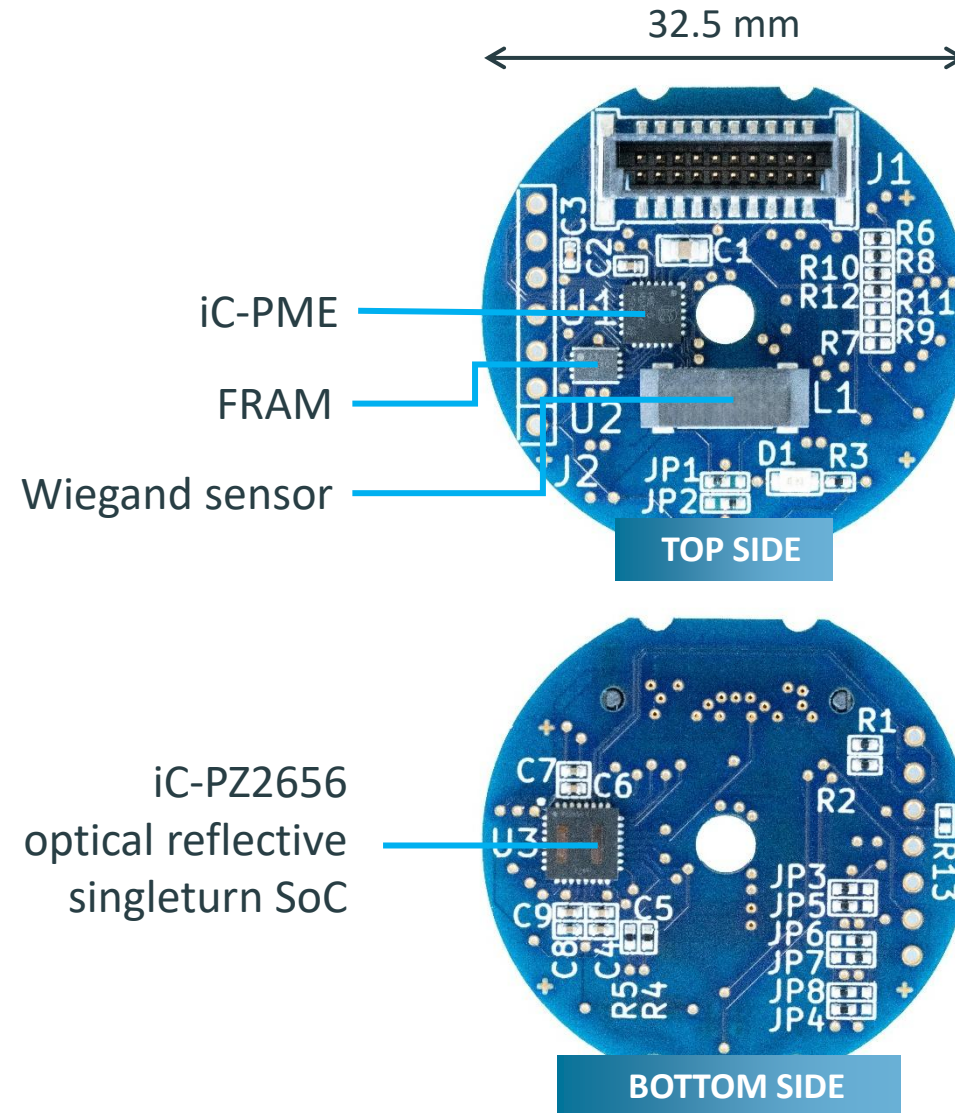
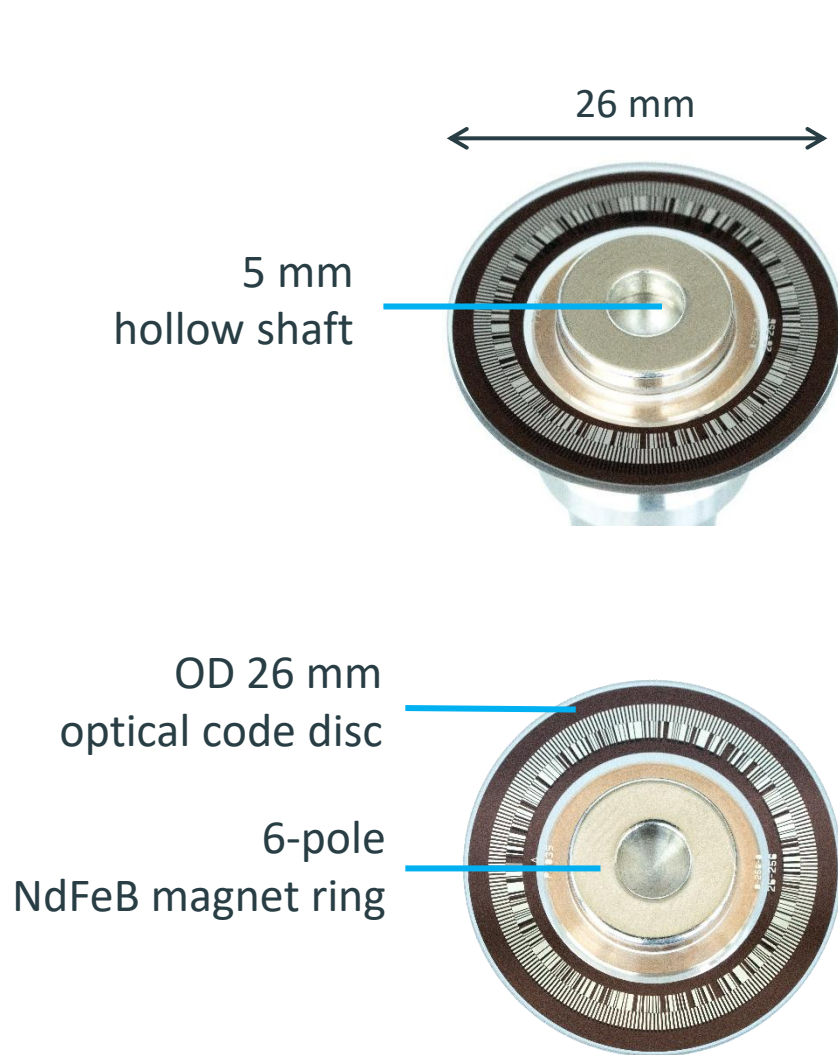
- Energy surplus measurement, separately for each Wiegand pulse



Synergy powered by

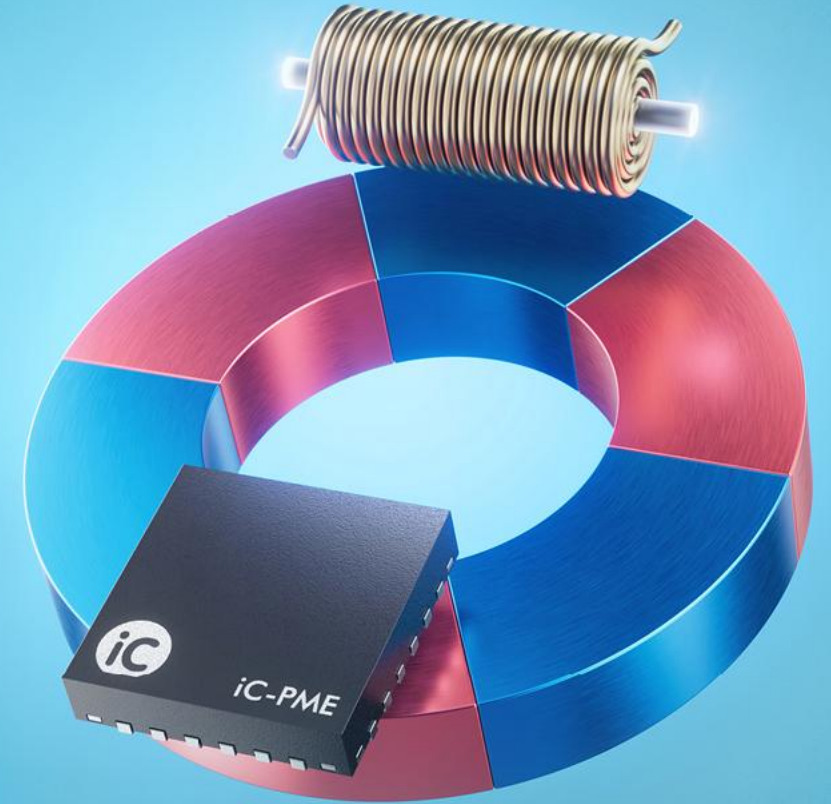
| I | N | N | O | M | A | G |





Innovations

- Greater flexibility in size (off-axis, small and large diameters)
- Easy startup
- Optimized energy efficiency
- Plug and play interface to iC-Haus singleturn iCs
- Self-test of the energy harvester
- Internal measurement of the energy surplus of Wiegand pulses
- Integrated monitoring and diagnosis
- Improved estimation of system tolerances
- Simplified encoder production and final testing



THANK YOU!



Dr. Steffen Klupsch

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www.ichaus.de

