ENERGY HARVESTING: MAGNETIC PULSE GENERATOR USING THE WIEGAND EFFECT

Visit Our Booth 341 In Hall 5
COMPANY HISTORY

- 1918 Founded by Franz Baumgartner
- 1939 Established Relay Manufacturer
- 1963 "Brush" Absolute Rotary Encoder
- 1973 Absolute Optical Rotary Encoder
- 1999 Start Magnetic Encoder Development

**2004 First Wiegand Sensor Design**
- 2006 Magnetic Encoder with Wiegand MT
- 2013 Acquisition of Wiegand Technology and Production Lines
- 2013 High Precision Magnetic Technology
- 2014 Wiegand Technology Center
- 2015 Start Wiegand Sensor Production
- 2016 Launch of Magnetic Motor Feedback Kits
WIEGAND EFFECT

- Non-linear Magnetic Effect
- FeCoV Alloy (Vicalloy) Wire
- Annealing & Coldworking Leads to Hard Magnetic Shell & Soft Magnetic Core
- Large Hysteresis
- „Macroscopic Barkhausen Effect“
WIEGAND EFFECT

Magnetization and external field

Pulse

A

B

C

D

E

F
WIEGAND EFFECT

- Symmetric Switching Induced by Permanent Magnet
- Pulse Independent of Field Strength and Change Rate
- Typically 2-10V Peak, 10-20us Width
APPLICATIONS

Wiegand Sensor as Pulse Generator
- Rate / Position Sensor
- Access Control Cards
- Flow Meters
- Event Trigger

Wiegand Sensor as Power & Pulse Generator
- Rotary Encoders
- Water Meters
- Event Trigger and Storing of Results
ENERGY HARVESTING - DYNAMO

Rotating Magnet And Coil

Maxwell – Faraday Equation

$$\nabla \times \mathbf{E}(\mathbf{r}, t) = -\frac{\partial \mathbf{B}(\mathbf{r}, t)}{\partial t}$$

Example:
Dynamo

No Power at Standstill

Rotational Speed
ENERGY HARVESTING – WIEGAND SENSOR

Rotating Magnet and Coil
with Wiegand Wire Inside

Only 2 States of Magnetization

Voltage

Voltage

Pulse Energy

Constant Pulse Energy

Rotational Speed

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ENERGY HARVESTING MULTI TURN ENCODER

- Fully functional without external power (VDD)
- Operated when connected to external power (VDD)

Diagram:
- Magnet
- Wiegand Module
- Pulse from Wiegand Sensor
- Counter Asic
  - High Resol. Hall (ST)
  - Low End Hall Sensor
- Rectifier
- Digital Control
  - VDD powered
- Control Logic
  - Self Sustaining
- MCU
- FRAM
- Permanent Storage
- Direction of rotation detection
- Monitoring of Wiegand signal

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KIT ENCODER & WIEGAND COMPONENTS
WIEGAND SENSORS

- Proven Design for Encoders since 2005
- Pulse Energy 120 to 200nJ
- Pulse Peak 6.5-7V typ. (5.3V min)
- Optimized for Various Magnet Systems
- Versions for Water Meters Under Development

UTS

5 mm Wire – Seating Plane Distance
High Power
Component Placing Below Sensor Possible

WFS

2.5 mm Wire – Seating Plane Distance
Component Placing Below Sensor
Flat and Compact Design

UFS

2.5 mm Wire – Seating Plane Distance
High Power
Flat Design
CHALLENGES

- Pulse Energy Has Large Standard Deviation
- Selection Process
- Current Rectifier Has Low Efficiency
OPTIMIZATION FOR ENERGY HARVESTING

- Re-engineer Wire Process
  - Optimization of Alloy
  - Wire Dimensions
  - Wire Processing
- Optimization of Magnet System
- Power Sensor Concept (10-100x Energy per Pulse)
- Implementation of Better Rectifier, Lower Power Electronics
WIEGAND PRODUCTION

- Currently up to 2 Million Sensors Annually
- 100k Sensors for In-house Use
- 1 Mio Sensors for Encoder/MF Manufacturers

- 8 Lines (Gen1 and 2) in House
- Bit Test with Rotating Magnet and Standard Load
- 1000 Pulses (Av & Stdev) and Slew Rate
- Good/Bad Criteria Selectable
- Additional Spot Sample Test of Each Batch in a Final Sensor Setup
WIEGAND PULSE USAGE IN KIT ENCODER

Components Used for Kit Encoder

- Magnetic Bottom Shield
- Magnet
- Carrier with Printed Circuit Board
- Magnetic Housing
WIEGAND PULSE USAGE IN KIT ENCODER

Components Used for Kit Encoder
WIEGAND PULSE USAGE IN KIT ENCODER
CONCLUSION

- Wiegand Harvesting Proven in Metering and Position Sensing
- Ultra Low Cost Designs provide Another Option for General Energy Harvesting Applications
- Feasible for Wireless Transmission without Rechargeable Battery/Supercap

Experience the WIEGAND Effect on Your Own on our Booth Hall 5-341 in a Live Demonstration!