## Digital Rutronik Forum 2020 Infineon Predictive Maintenance Demo

Tobias Bukowski (Global Marketing Manager Sensors) 23<sup>rd</sup> of June 2020



- restricted -



## Predictive maintenance - background





#### Predictive maintenance Demo - Overview



#### Top View – Functions & interaction points Brake and linear table















## Interaction Point 1: Starting the BLDC motor



#### Control & Actuate – Let's start the motor Infineon's XMC family and ePower solutions





#### XMC4800 running Amazon Free RTOS

- powered by 32-bit ARM® Cortex®-M4
- > Connected via Ethernet to Internet
- Secured Cloud Communication with Security Controller Optiga Trust X

#### XMC1100 Main Controller

- Powered by 32-bit ARM® Cortex®-M0
- CPU at 32MHz
- Programmed via Arduino IDE
- Collecting sensor data & controlling motor Logic

#### **3-Phase BLDC Motor Driver Shield**

- Equipped with TLE9879QXA40 single chip 3-phase motor driver
- > Arduino compatible & handles motor commutation
- Several motor control algorithms (sensorless FOC, Back EMF, hall sensor based block commutation

#### Interaction Point 1: Starting the motor Short glimpse at the dashboard





## XENSIV<sup>™</sup> MEMS microphone IM69D130 Premium audio raw data





## Define the benchmark in speech recognition with IM69D130

#### Noise free audio raw data 69 dB [A] signal to noise ratio

#### Distortion free audio signal capture

<1% total harmonic distortion up to 128 dB SPL

#### **Microphone matching**

<  $\pm 1$  dB sensitivity and <  $\pm 2^{\circ}$  phase response variations

#### **Digital PDM interface**

ultra-low group delay for latency-critical applications (6 µs at 1 kHz)

#### Wide frequency response 28 Hz to 20 kHz



#### Pressing the handle Intenion: Simulates increased shaft friction Breaks motor -> Speed decreases shortly But: motor is controlled for constant speed -> speed increases again

-> current consumption increases









#### TLI4971 – industrial current sensor

- Hall based, magnetic current sensor
- Full scale up to 120A

>

>

 Increased current consumption at same conveyor load can come from motor failure

## Magnetic sensing using HALL technology Core-less vs. core-based





## XENSIV<sup>™</sup> magnetic current sensor TLI4971 Current sensing in industrial applications



חח/

GND

VREF

AOUT

OCD1

OCD2



Variant with UL certification available





#### Size PG- TISON-8: 8x8x1mm

## TLI4971 designed for low power loss

Current path thru the package







Hockey-Stick design allows a maximum on sensitivity by minimal power loss!

#### Key differentiator vs existing products:

- Ultra low insertion resistance
- Optimized thermal management
- Temperature and lifetime performance



## TLI4971 - Application example motor drive

Block diagram motor drive		Current sensor Requirement		TLI4971 solution
Brake chopper Inverter	>	Enabling motor control for smooth operation	>	Highly accurate (<3%) measurement over temperature <b>and</b> lifetime
Driver stage Hall & GMR sensors	>	Protection of output stages against over- current events	>	Two independent output pins for overload detection
	> A m e	Accurate in-phase measurement in harsh environment	>	Stray field robust through differential measurement of magnetic field
	>	Galvanic isolated measurement for high voltage applications	>	Galvanic isolation between current rail and sensor



Name	Picture	Order number	ISAR type
XENSIV <sup>™</sup> magnetic current sensors – programmer <b>Note:</b> can be used with all TLI4971 and TLE4971 evaluation boards!		SP004441438	CUR SENSOR PROGRAMMER
XENSIV <sup>™</sup> magnetic current sensors TLI4971 – evaluation board		SP005343588	TLI4971 EVAL 120A
XENSIV™ magnetic current sensors TLI4971 – S2GO		SP005345472	S2GO_CUR- SENSE_TLI4971
XENSIV™ magnetic current sensors TLI4971 – MS2GO		SP005345474	TLI4971_MS2GO

## Interaction Point 2: Overcurrent Protection Prevent motor from severe damage





#### TLE4966G – Double Hall switch Rotational speed and direction







## XENSIV<sup>™</sup> magnetic hall switches



#### Overview

- > Based on Hall-technology
- > Detects the strength of a magnetic field
- > Is used for proximity as well as rotational speed and direction detection
- > Available for consumer, industrial and automotive applications

## TLE4966– Family of Double Hall Latches Rotational speed and direction measurement





#### **Technical features**

#### Highlights

- Direction detection and speed due to two integrated Hall sensor elements
- > Excellent sensitivity and stability of the magnetic switching points
- **Operation** even from **unregulated power supply** plus **reverse battery protection** (-18V)
- Sensors for **horizonta**l (TLE4966) and **vertical** (TLE4966V) **sensing** for mounting flexibility

TLE4966		TLE4966V-1G		
>	Horizontal sensing	>	Vertical Hall for In-Plane Sensing	
>	2.7V to 24V operating supply voltage	>	3.5V to 32V operating supply voltage	
		>	Overvoltage capability up to 42V without external resistor	
		>	Low current consumption	
>	PG SSO-4-1 and PG-TSOP6	>	PG-TSOP6	









#### Interaction Point 3: Out-of-shaft vs end-of-shaft Simulating anomaly in two differing modes of angle calculation





### Interaction point 3 – linear table Simulating anomaly in two differing modes of angle calculation







#### TLE5014SP

Digital GMR Angle Sensor End-of-Shaft configuration Detects rotation of fast spinning motor shaft Can be used for motor commutation



## Infineon XENSIV<sup>TM</sup> – Angle sensor portfolio



## TLE5014: GMR, digital angle sensors

#### TLE5014 – Characteristics

- > Easy-to-use plug & play sensors: pre-configured and pre-calibrated
- > Offering high flexibility:
  - Available as single and dual die products
  - 12bit digital interface with protocol options PWM, SENT, SPC, SPI
  - E<sup>2</sup>PROM and look-up table for customer configuration and calibration
- > High angle accuracy: max. 1.0° over temperature and lifetime
- > High voltage capability up to 26 V
- > Fully compliant development according ISO26262
  - developed acc. ASIL-D level
  - sensor reaching ASIL-C metrics

#### TLE5014 – Products

TLE5014 C16	TLE5014 C16D	TLE5014 P16	TLE5014 P16D	TLE5014 S16	TLE5014 S16D	TLE5014 SP16	TLE5014 SP16D	
S	PC	P\	PWM		NT	SPI		
Single die	Dual die	Single die	Dual die	Single die	Dual die	Single die	Dual die	
NEW - IN PRODUCTION					NEW - IN PRODUCTION			







RoHS

## TLE5014SP(D) SPI interface for high dynamic applications



## Optimal for angle sensing for motor commutation



#### Highlights

- Fully compliant sensor developed according ASIL-D with ASIL-C metric
- 3-pin SPI with access to
  - Sin/cos raw values
  - Calculated angle (15 bits)
  - Diagnostic information
- > SPI Data rate: 8MHz
- Internal update rate: 25µs
- > Signal delay: ~ 60µs
- 3.3V and 5V versions
- Accuracy < 1°



#### TLE493D-W2B6 - Out-of-Shaft configuration 3D magnetic sensor with wake-up functionality



## TLE493D-W2B6

3D Magnetic Sensor Out-of-Shaft configuration Detects rotation of slowly spinning conveyor shaft

#### **Calculation of angle error for predictive maintenance**

Difference between End-of-Shaft and Out-of-Shaft angle can be used for predictive maintenance Detects failures of motor gear and shaft misalignments (e.g. a wobbling or unbalanced shaft)



## XENSIV<sup>™</sup> 3D magnetic sensors



## Overview

- Based on Hall-technology
- Detects the strength of a magnetic field in all three dimensions, i.e. x-, y- and z-axis
- In addition able to detect linear movements & the angular position of a rotating magnetic field
- > Is available for consumer, industrial and automotive applications



PRODUCTS							
	Industrial	& Consumer		<b>~</b>	Automotiv	'e	
> TLV493D-A1B6 > TLI493D-A2B6 > TLI493D-W2BW JESD47 Qualified Products			> TLE493D-A2B6 > TLE493D-W2B6 A0- AEC-Q100 Qualified Products				
How to read 3D-Sense	ors nome	nclature?					
TLE Qualification:	49 ↓	3D ↓ Sensor Product Number	- A Variant	1 V Generat	ion Interface	6 - A0 V V Package	
TLE: Automotive     10       TLI: Industrial     49       TLV: Consumer (Value)	9: Hall	<b>3D</b> : 3D technology - using three hall plates	(Common Use) W: Wake-Up	1: 1 <sup>st</sup> generation 2: 2 <sup>nd</sup> generation	3D sensor 3D sensor B: I <sup>2</sup> C Protocol	W: WLB A0-A3	
<b>KEY FEATURES</b>	AND B	ENEFITS					
TLV493D-A1B6		TLI493D-A2B6	TLE493D-	-W2BW Ax	TLE493D-A2B6	TLE493D-W2B6 Ax	
Reduced update frequency and field range	y   • Ir   a	ncreased update frequency nd field range	Small WLB p     Wake-up upo	oackage	Variable update frequencies     and power modes	Wake-up upon magnetic field     mode	
<ul><li>Power down mode (7nA)</li><li>Low current consumption</li></ul>	• P   • C	ower down mode (7nA) omponent reduction	mode     Power down	mode (7nA)	<ul><li>Power down mode (7nA)</li><li>Integrated temperature</li></ul>	<ul> <li>Power down mode (7nA)</li> <li>Integrated temperature</li> </ul>	
<ul> <li>Integrated temperature sensing</li> </ul>	· s	ensor address read back	Integrated te	mperature	sensing	<ul> <li>sensing</li> <li>ISO ready</li> </ul>	
USE CASES							
Internet of things       Major Home Appliance         Image: Appliance       Service         Image: Appliance       Image: Appliance         Image: Appliance							
A global support structure with 3D magnetic sensor experts that can address customer's requirements							





#### **Unique Characteristics**

- Possibility to connect up to 4 sensors (A0 A3) to one I<sup>2</sup>C bus system
- Specific addressing done via the sensor variants A0 A3
- Technically same sensor, but preconfigured with "individual startup ID"
- Four different orderable address types (Individual OPN for A0, A1, A2, A3, A4)
- For functional safety critical applications a separate bus for each sensor is highly recommended





#### Figure 15 Static or Dynamic Wake Up Threshold Operation of the TLE493D-W2B6

## Interaction Point 3: Linear table Simulating wobbling - Moving sensor away





### XENSIV<sup>™</sup> Evaluation Tool Environment 2GO Kits and Shield2Go



#### Shield2Go

- > Comprise one board with one single Infineon IC
- > Comes with solderless connectors
- > The **Software** for the Shield2Go is based on **Arduino**



2GO Kits

USB connection for fast evaluation

Cortex<sup>™</sup>-M0 CPU.

Ob board debugging

One Infineon sensor IC combined with an ARM®



Software

Graphical User interface (GUI)

Arduino library

#### Add on coponents

Joystick - Rotation knob – Linear slider – Out of shaft adapter – Drill trigger – Mini Control



>

>

>

### The backbone of Shield2Go Unleash your creativity





2020-06-23 restricted



## XENSIV<sup>™</sup> Shield2Go – Portfolio overview



# Unleash your creativity – How is that looking like?



#### Shield2Go + Infineon XMC<sup>™</sup> 2Go



XMC<sup>™</sup> 2Go stacked with the TLV493D 3DSense Shield2Go and rotate knob

#### Shield2Go + My IoT Adapter + XMC<sup>™</sup> bootkit



Stacked XMC1100 Boot Kit with My IoT Adapter and Shield2Go

#### Online Simulation tools – fast and easy Simulation for Hall switches, 3D magnetic and angle sensors





One widget for three simulation tools – the guide to identify the most suitable Infineon sensor IC combined with the best-fit magnet

https://www.infineon.com/cms/en/product/sensor/#!simulation

### Sensor Product Portfolio Various sensors for plenty of applications





![](_page_42_Picture_0.jpeg)

## Part of your life. Part of tomorrow.