New Gen 1-coil DC motor smart driver

Nov, 2020

Melexis
INSPIRED ENGINEERING

Outline

- Experience Matters
- 1-coil fandrivers introduction
  - Overview
    - 2-/3-wire fans
    - 4-wire fans
  - 1-coil vs 3-phase
- Smart Fandriver solutions
  - Melexis MLX90411 introduction
  - Melexis performance / USP
    - Open loop vs closed loop
    - Softswitching
      - 1/16 vs Supersoft: Torque vs vibrations, and 2/16 as compromise
    - Robustness & quality
- More Success with the new MLX90411
- Programming 90411
- Other Fandriver solution: Expanding into higher power

Experience Matters

- Gen 1 - US168
- Gen 2 - MLX90287/90297
- Gen 3 - MLX90411/12

IC solutions for your applications

IT (VGA, CPU))

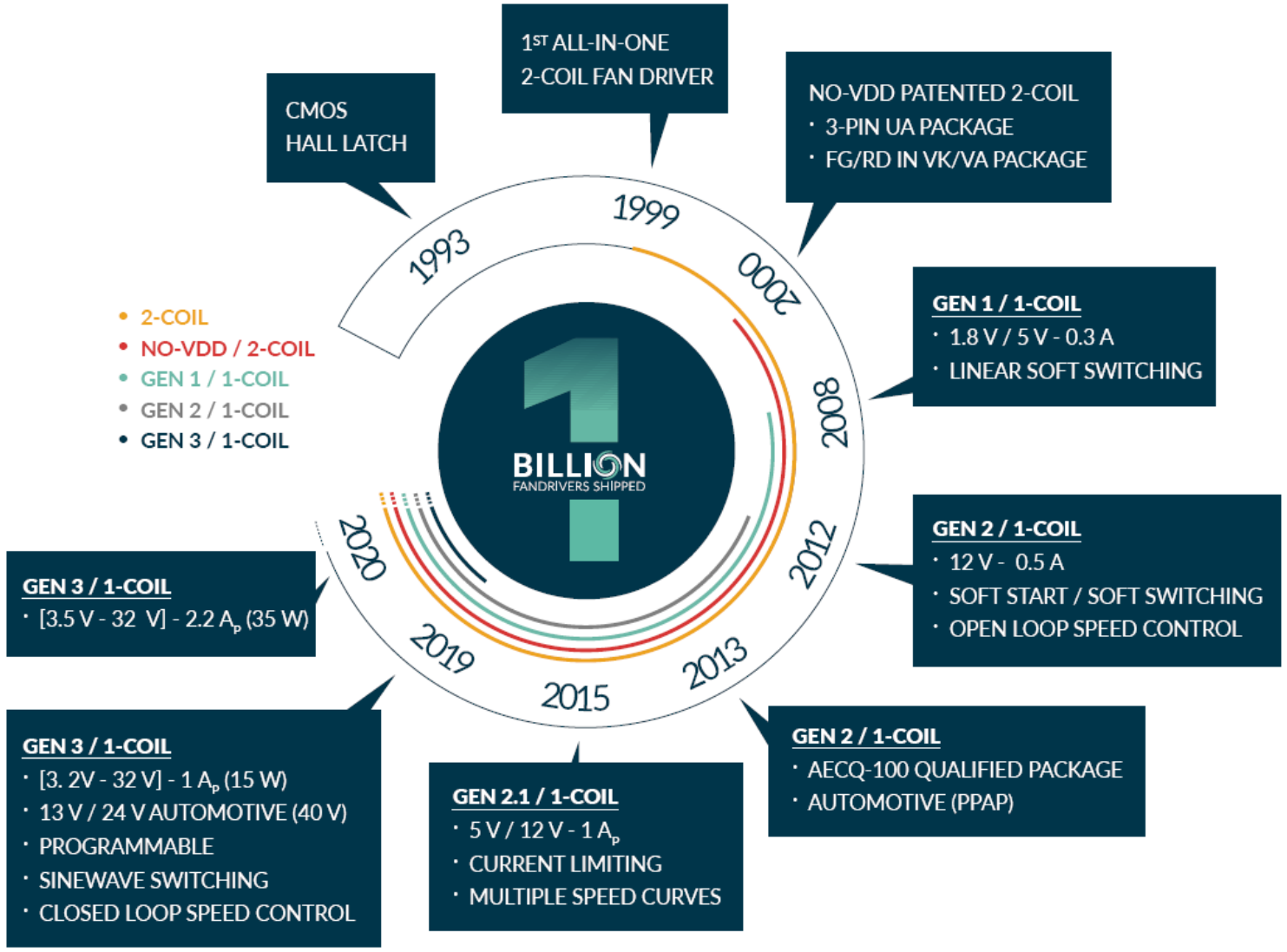
Office Appliance

Home Appliance

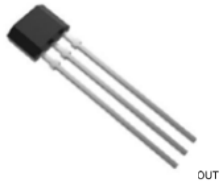
Li-ion portable

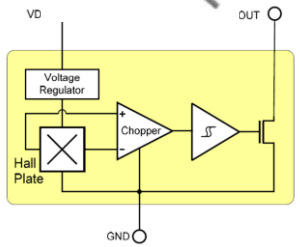
Industrial

Automotive



25+ years of Innovation in fan control





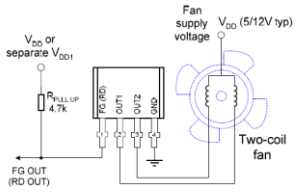
Latch&Switch, UA

1992

NO-VDD 2-coil fandriver:

12V/24V 1um

VK/VA with FG/RD output



2000

Gen-I 1-coil fandriver

5V, 0.35um, UTDFN6

Fixed speed

Linear Soft Switching

2008

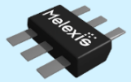
Gen-II 1-coil fandriver

12V 0.35um, SO8 Straight leads

Open Loop Speed Control

Soft start / Soft Switching

2012



Gen-III 1-coil fandriver

40V 0.18um, SOT/DFN (integr. Hall)

Closed Loop speed, Sine, Adaptive

35W Industrial/ Home appliance

20W Automotive, ASIL A

2019

2021

Gen IV 1-coil fandriver

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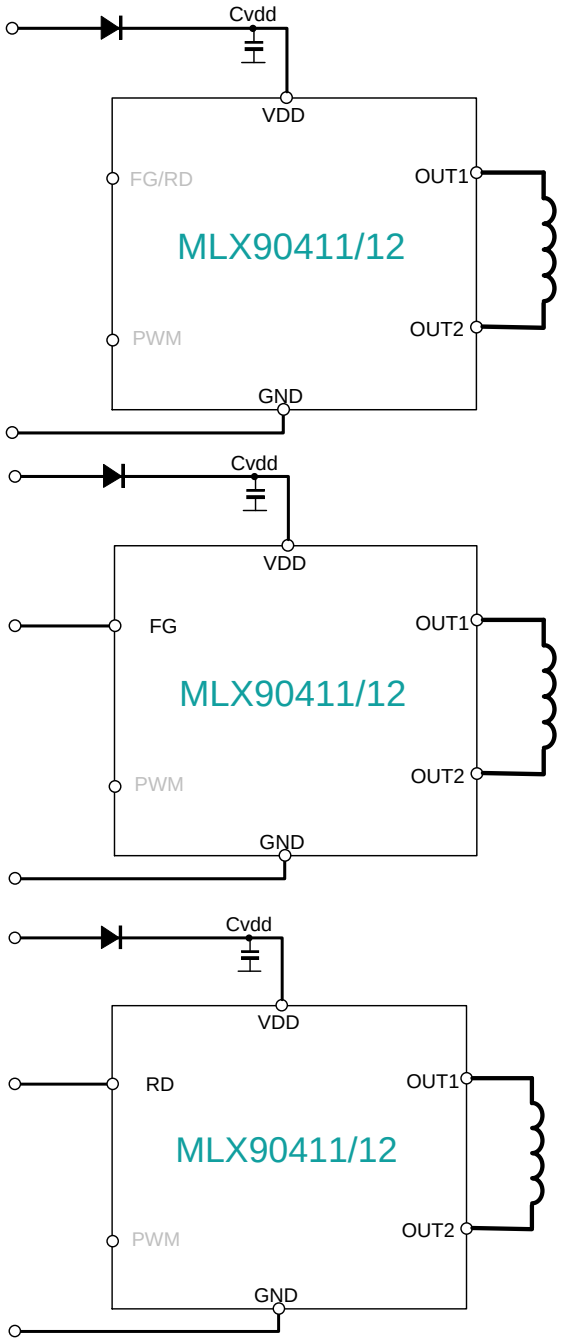
Overview: 2-/3-wire fan

1. 2-wire: No feedback
2. 3-wire: FG
3. 3-wire: RD

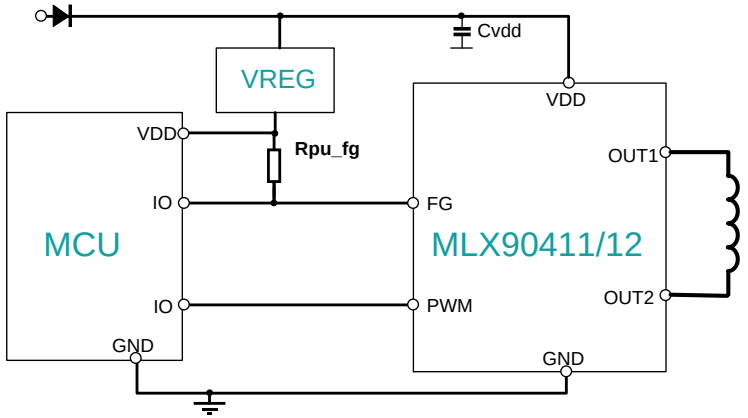
- Open loop speed
  - Dcout=100%
  - Dcoutmax preprogrammed inside MLX90411/12
- Fixed Closed loop speed
  - Preprogrammed inside MLX90411/12

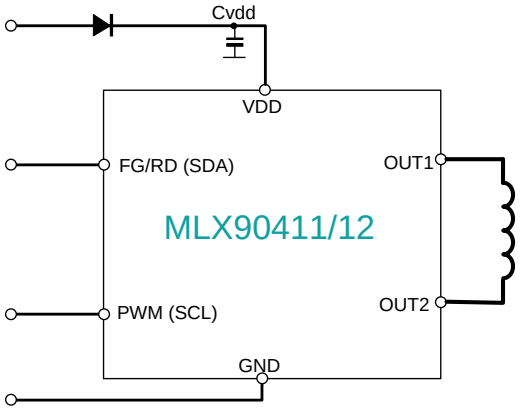


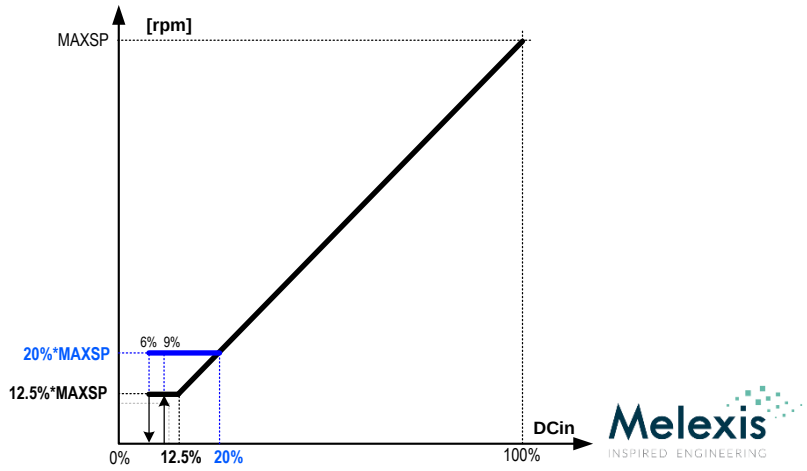
Overview: 4-wire fan

- PWM input is used to set target speed

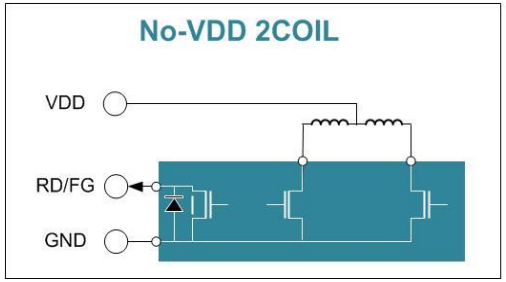
1. Speed ctrl loop is Closed in MCU
   - PWM input is used to set Dcout[%]
   - FG is used to monitor speed, and adjust PWM
2. Speed ctrl loop is Closed in MLX90411/12
   - Max Closed loop speed target is programmed inside 90411/12
   - PWM input is used to set % of Maxspeed
   - FG is for diagnostics only
3. Open loop
   - PWM input only sets Dcout[%]
   - In case of increased backpressure, fanspeed will increase

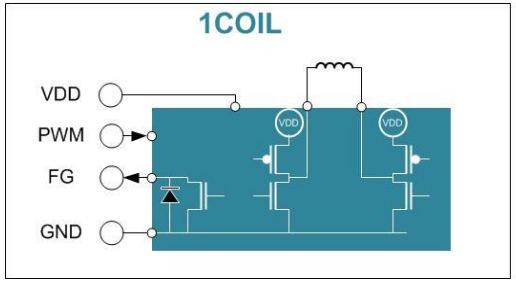


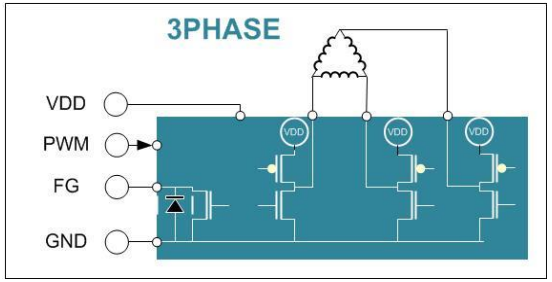




1-coil vs 3-phase







	2-COIL	1-COIL	3-PHASE
Fan Connector	Only 2-/3-wire fans	2/3/4-wire fans	2/3/4-wire fans
Fan BOM cost/power	Medium	Low	High / Very High
Fandriver IC cost	Low	Medium	High / Very High
Noise	High	Medium / Low	Low / Very Low

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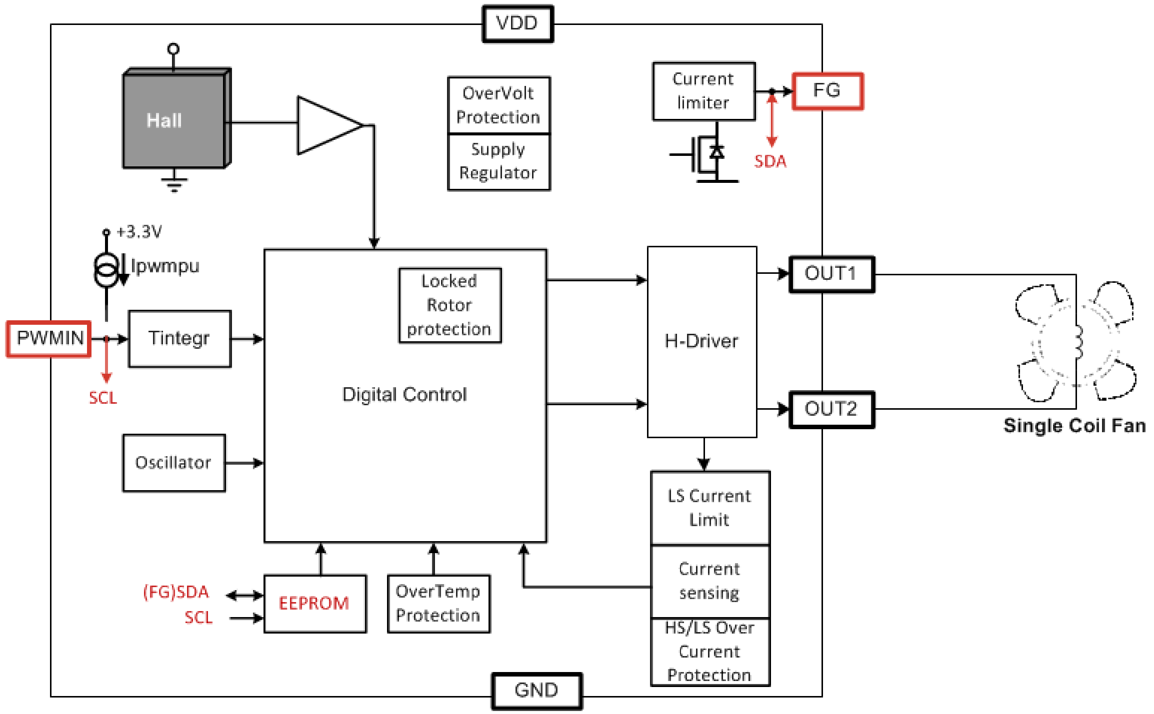
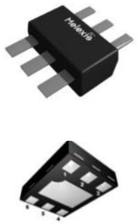
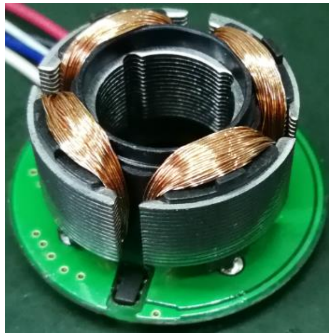
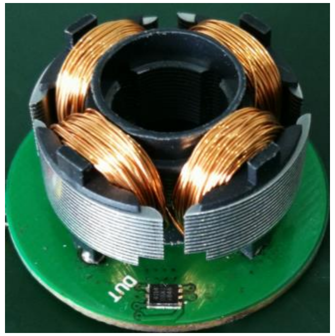
MLX90411 introduction

- Operating range: 5V, 12V and 24V, 28V applications
- [3.2, 32]V operating range, Tj = [-40, 150]C
- RDSon = 1.6 Ohm [4, 30]V
- Irms up to 600mA (1A peak)
- Closed loop speed range: [250~45,000]rpm (2pp motor), +/-5% (max) tolerance
- Accurate Built-in Current limit (+/-10%)
- OverVoltage/OverTemperature/ShortCircuit protections
- Adaptive commutation control for optimal performance on any motor type
- I2C interface for EEPROM configuration options:
  - Low EMI or Low acoustic noise
  - High torque /Low noise, or Ultra-Low acoustic noise
  - Start up options
  - FG/RD output options
  - Closed loop speed control
- Package options:
  - Straight leads SOT23-6L
  - UTDFN6   2.5x2x0.4









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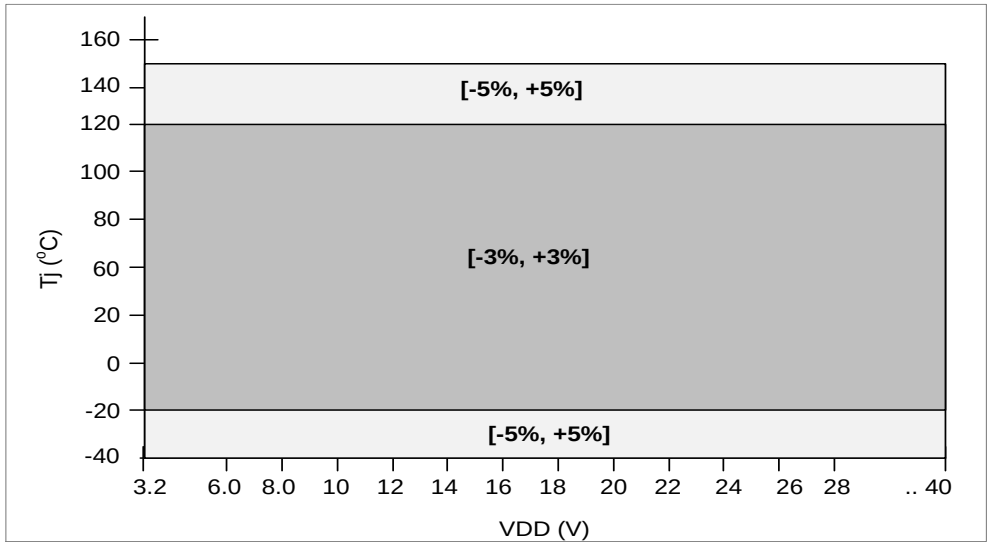
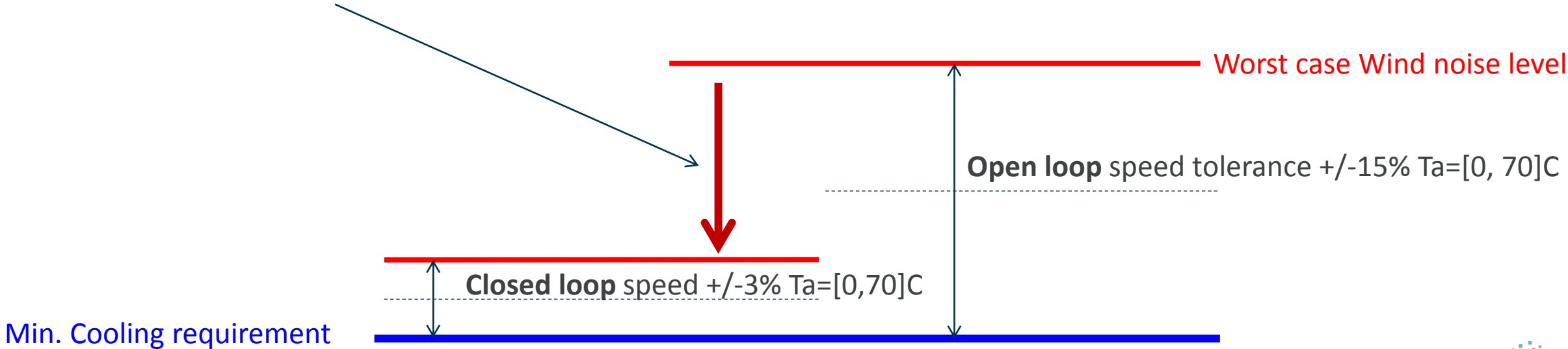
Closed loop speed control tolerance (consumer)

- Closed loop Speed control accuracy is mainly defined by RC-oscillator tolerance
  - +/-1% @ 25C
  - +/-3% @ Tj = [-20, 120C] (~ Ta=[-20, 85]C)



- RCO Tolerance << open loop fan tolerance

⇒ **Lower wind noise!**



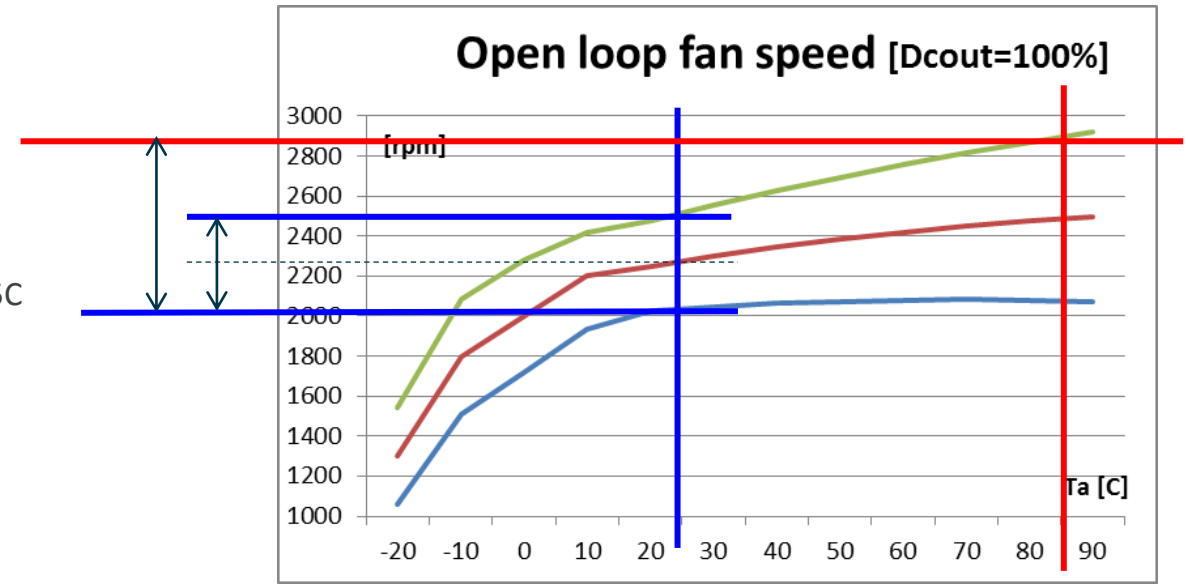
Example CASE: min rpm = 2000 @ 25C

1. **Open loop solution:**

+900rpm fan production tolerance (+/-22%)

- Motor needs to be designed with typical 2500 rpm @ Ta=25C

⇒ 2900 rpm max @ Ta=85C => max windnoise level

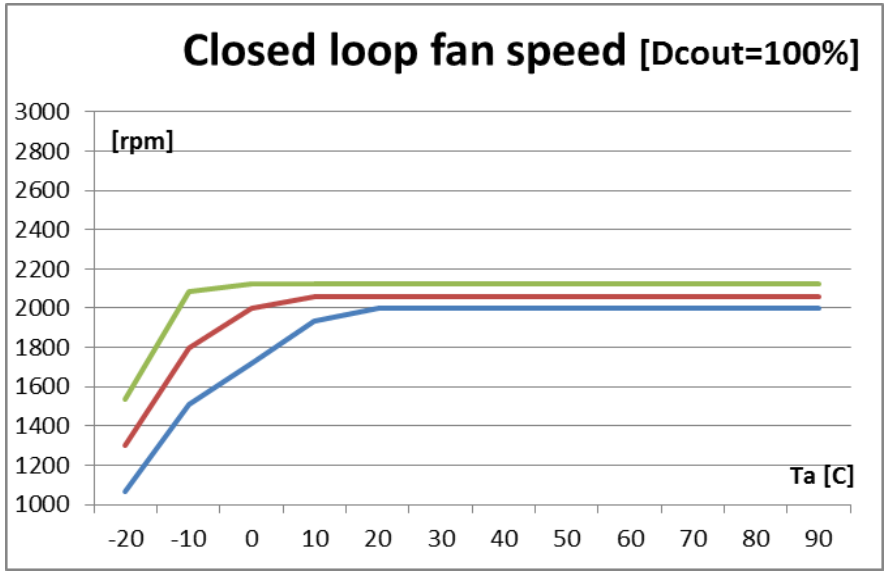


2. **Closed loop speed control:**

+120rpm tolerance of 90411 Oscillator (+/-3%)

- Program 2060 rpm in MLX90411 EEPROM

⇒ 2120 rpm max @ 85C (+6%):



⇒ **CONCLUSION: Worst case windnoise**

⇒ with **Closed loop** is **780rpm (39%)** lower compared to **open loop**

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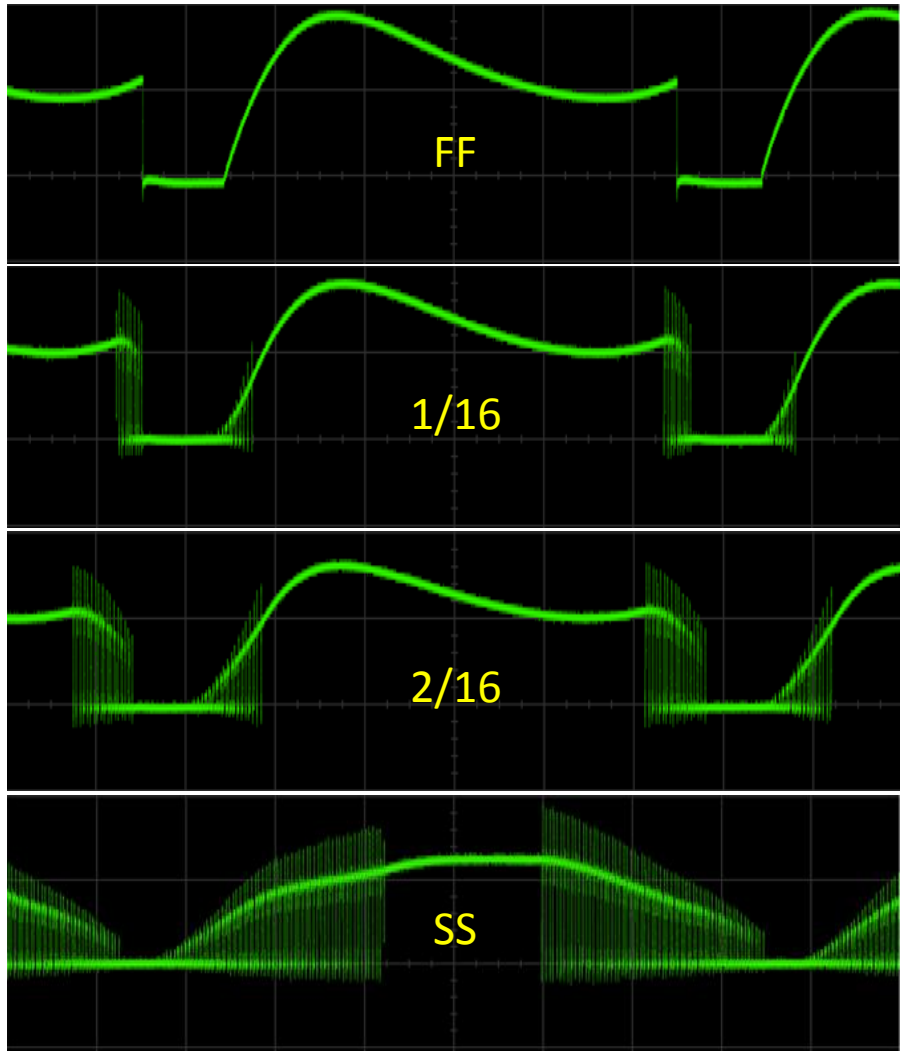
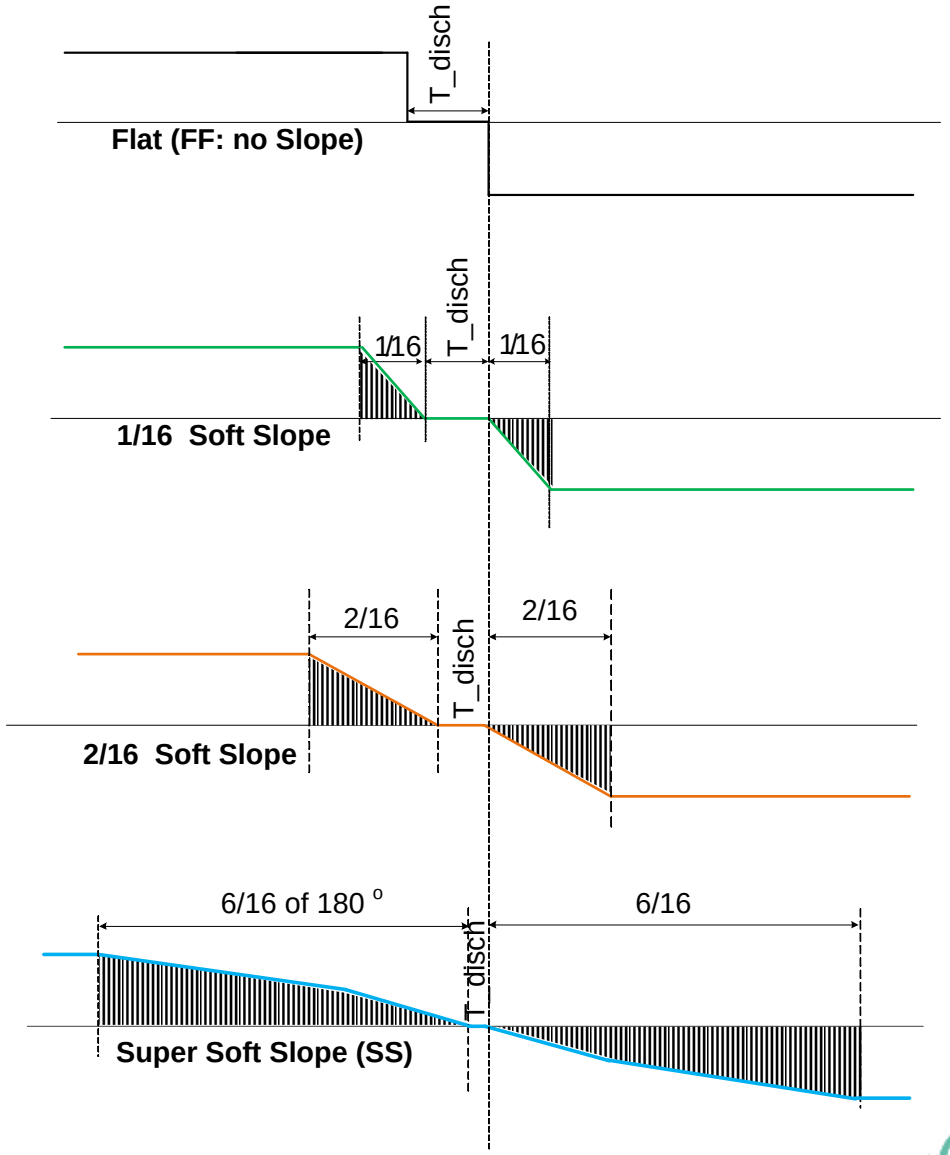
MLX90411: Commutation options OVERVIEW



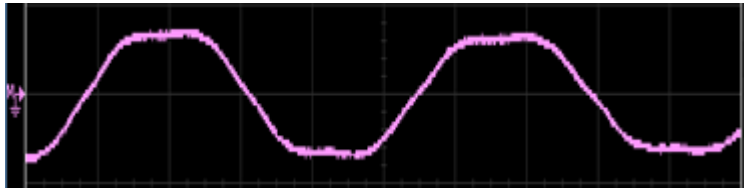


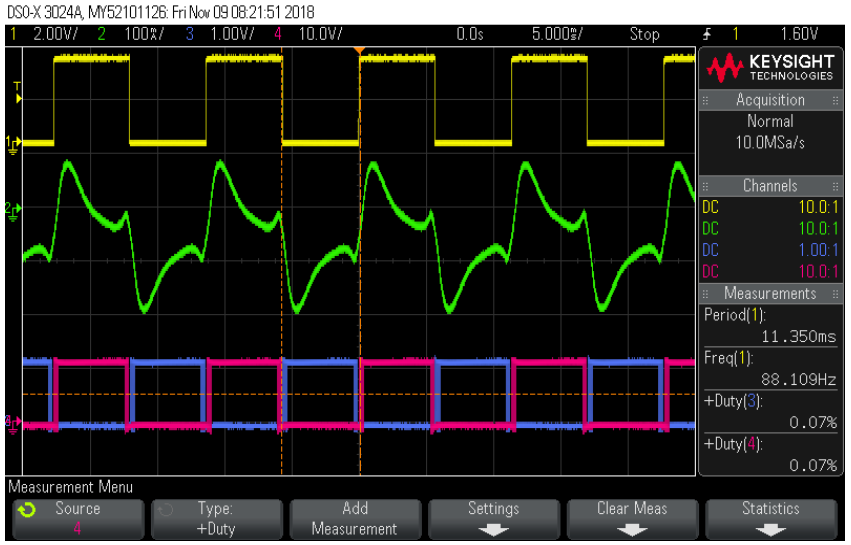
Optimal combinations between driver & motor

Highest torque

=> MLX90411 -**1/16 Soft with lead angle**

=> Applied on Trapezoidal-BEMF motor

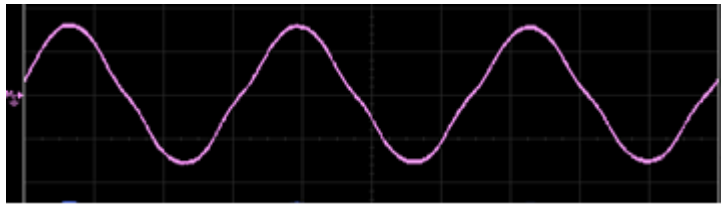


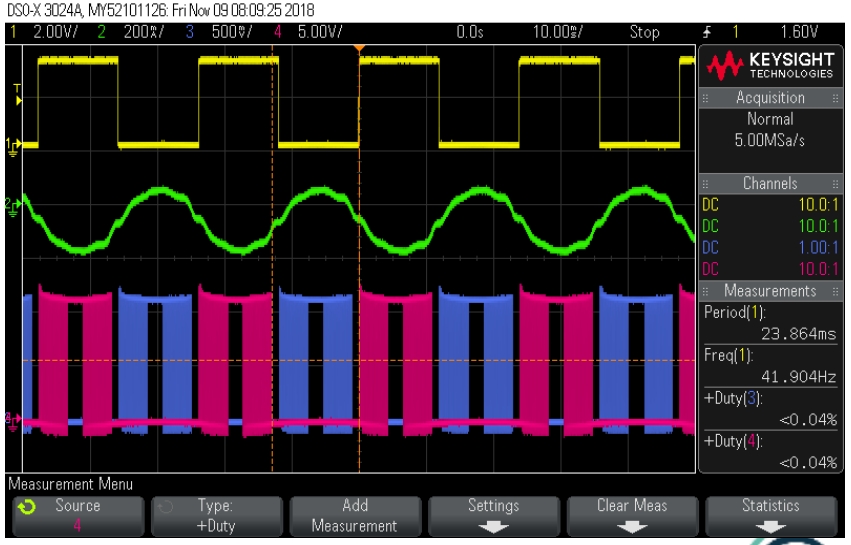


Lowest torque ripple (lowest noise)

=> MLX90411- **6/16 Super-soft**

⇒Applied on Sinewave-BEMF motor



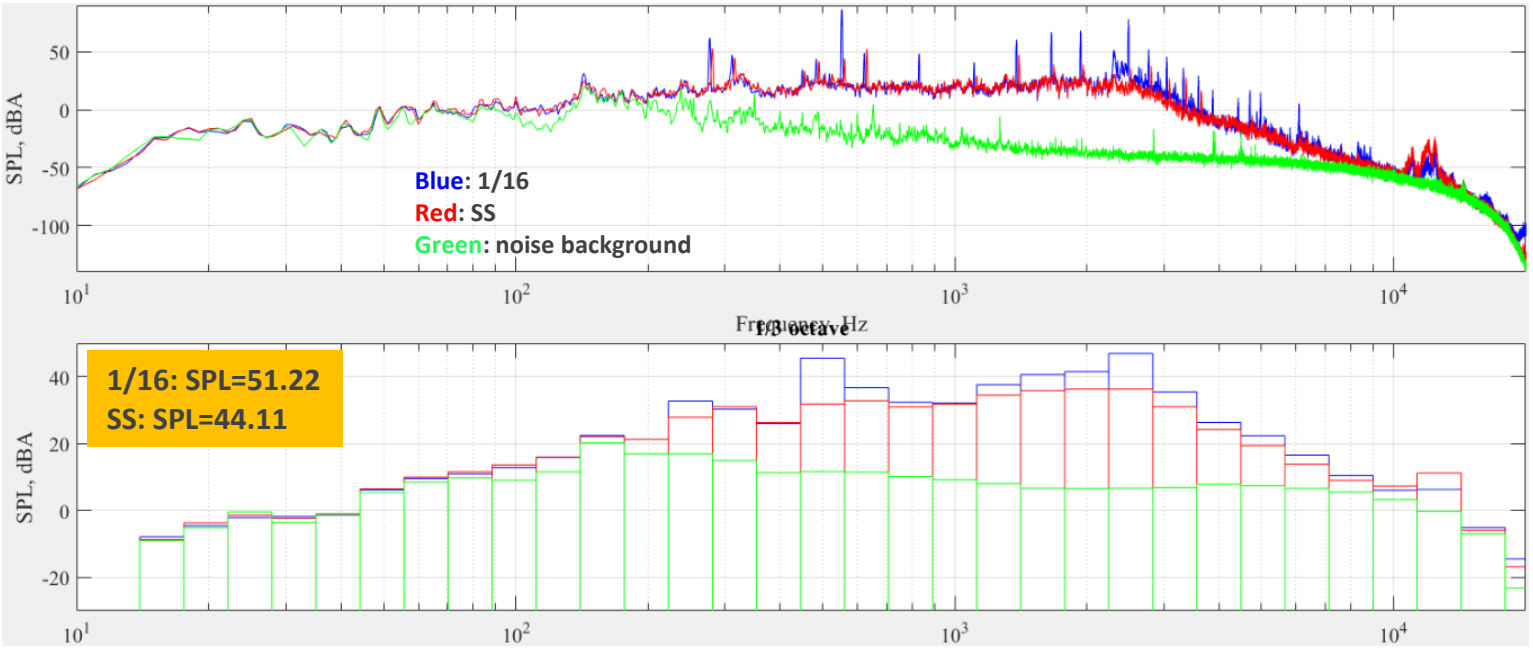


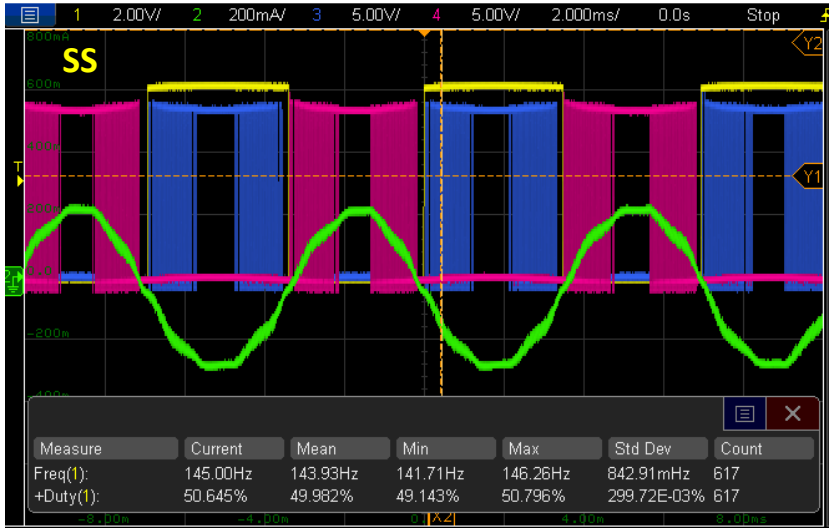
MLX90411: Soft-Switching highlights

- **NEW!** Super-Soft slope for lowest acoustic noise
  - With sinewave magnetized rotor

⇒ The same 2160rpm fan

⇒ 7dB reduction on SPL with SS driving





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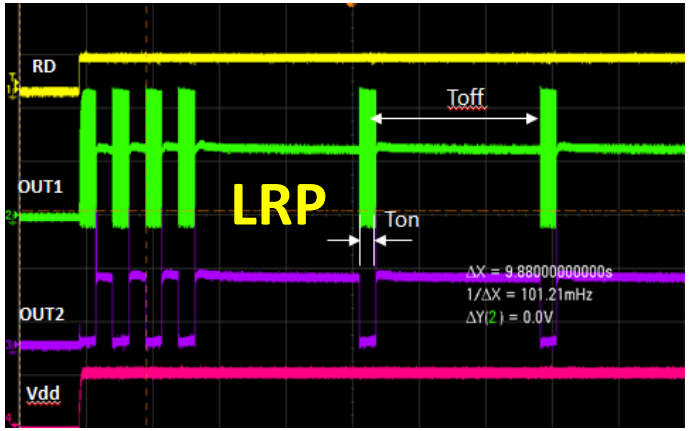
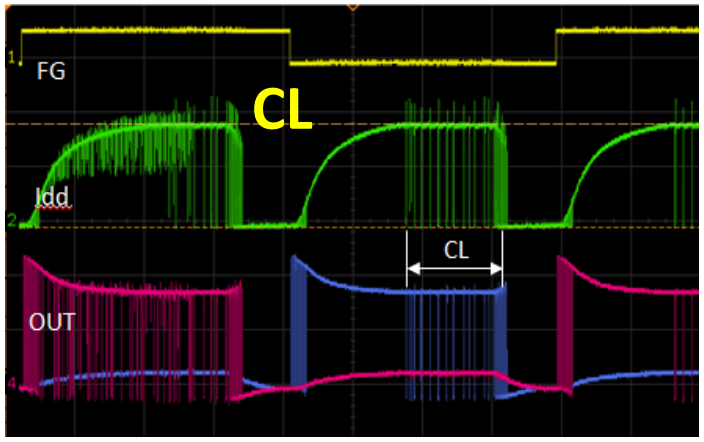
Robustness – Complete protections



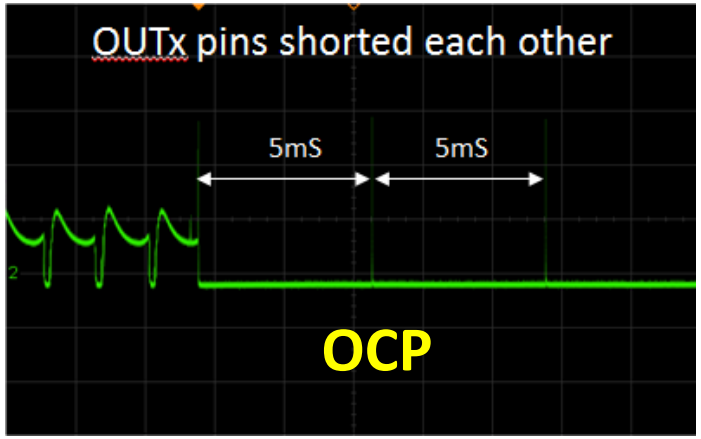
Locked Rotor

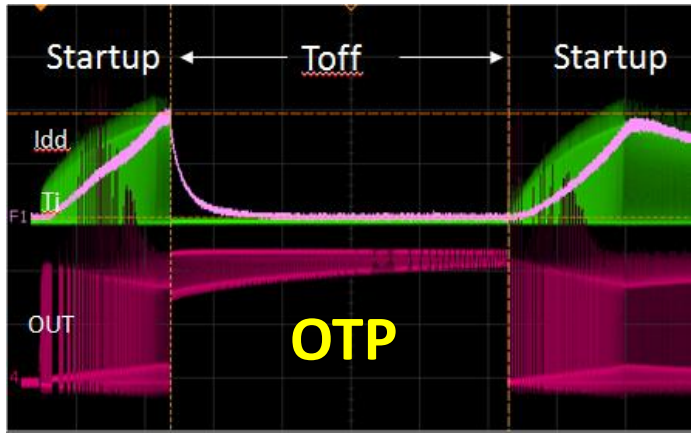
Current over limit



Short pins

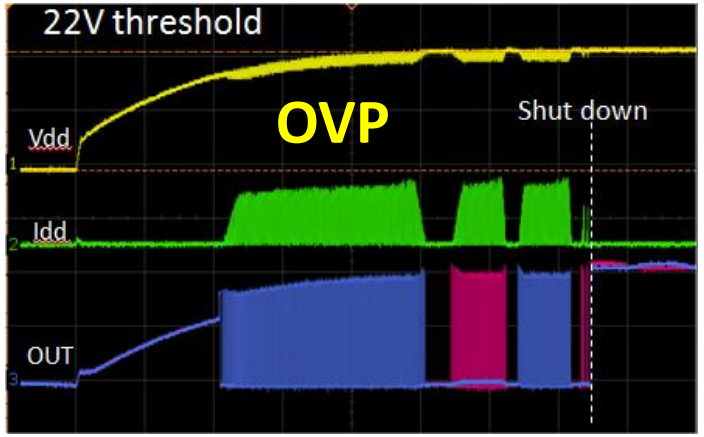
Short circuit





Over temp

Over voltage



Melexis
INSPIRED ENGINEERING

Quality

- ESD up to 10kV
- Market reference EOS performance
- 100% full test
  - Stable production tolerances
- Automotive grade designed packages
  - Stable production quality
  - Tj = 150°C capable, allowing high current from small package footprint

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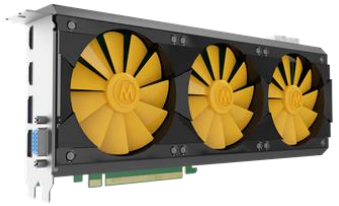
Target Applications < 15W



VGA card GPU fan

Desktop: CPU/PSU/System fan

Sensor fan
(PM2.5 particle , …)

Depilator

Water spreader or pump in Evaporative cooler, & Air Conditioner

Printers fan

Refrigerator fans

Microwave fan

Air purifier fan

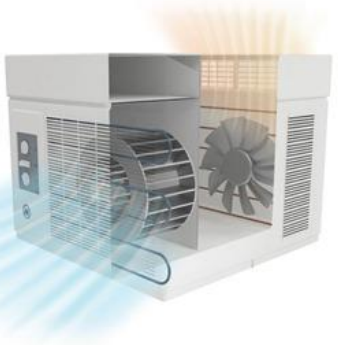
Drone GPU fan

Melexis

Target Applications < 50W

Interior Unit Airconditioner

Mobile airconditioner



Window Air conditoner

Hot air oven

Dish washer Dryer fan

Cloths Dryer fan

Deskfan / Standing fan

Robot cleaner

Robot lawn mower

Generic pump

Toilet pump

Drain pumps
In Condenser Dryer
In Washing machine
In Dish washer

Automotive Interior fan applications

Camera GPU fan

Multimedia – GPU fan

Display GPU fan

Domain Controller/
Server fan

HVAC:
- Thermistor fan
- Air Quality fan
  - PM 2.5
  - Air purifier
  - Fragrance
  - CO_2, NO_x

SENSOR

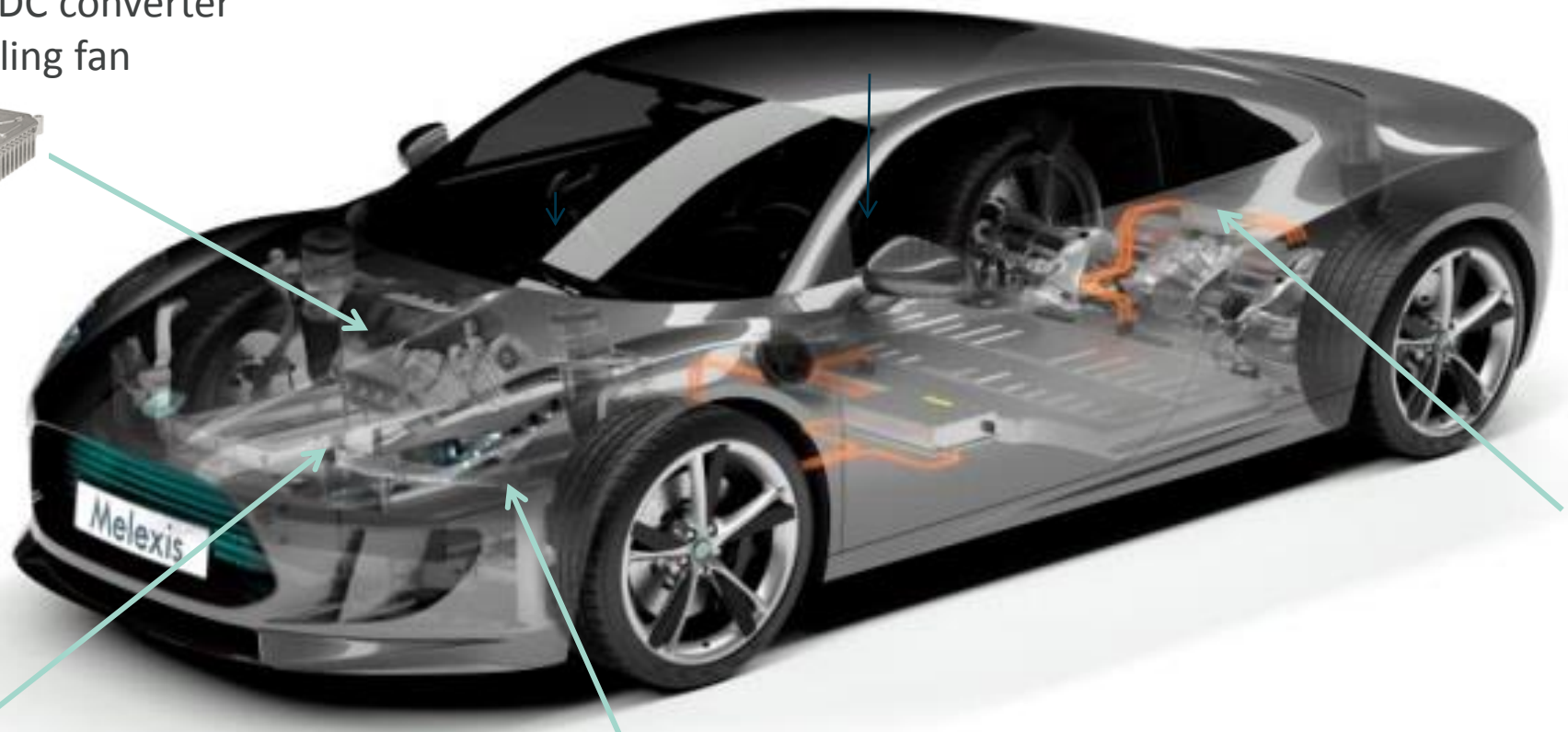
Seat ventilation fan
Seat massage
air pump

Cell phone
Wireless charger

Melexis

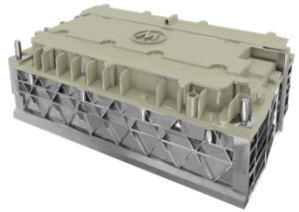
Automotive Powertrain/Exterior small motor applications

DC/DC converter
Cooling fan



Charger station
Cooling fan

Battery Cooling fan
On-Board charger



Auxiliary pumps

LED headlamp fan

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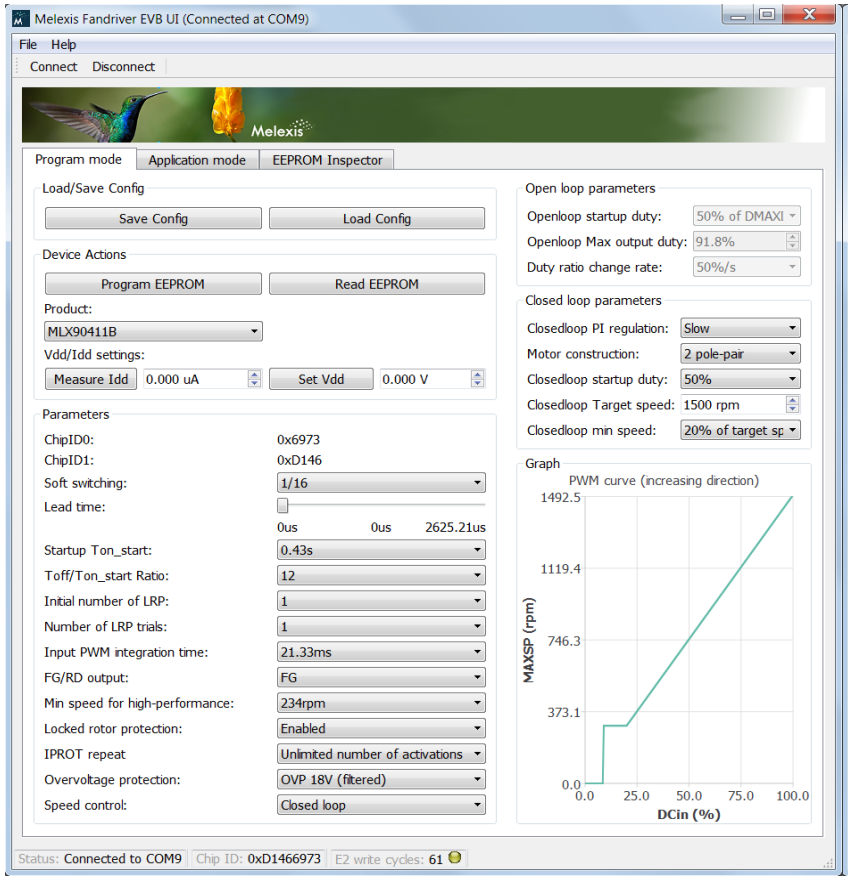
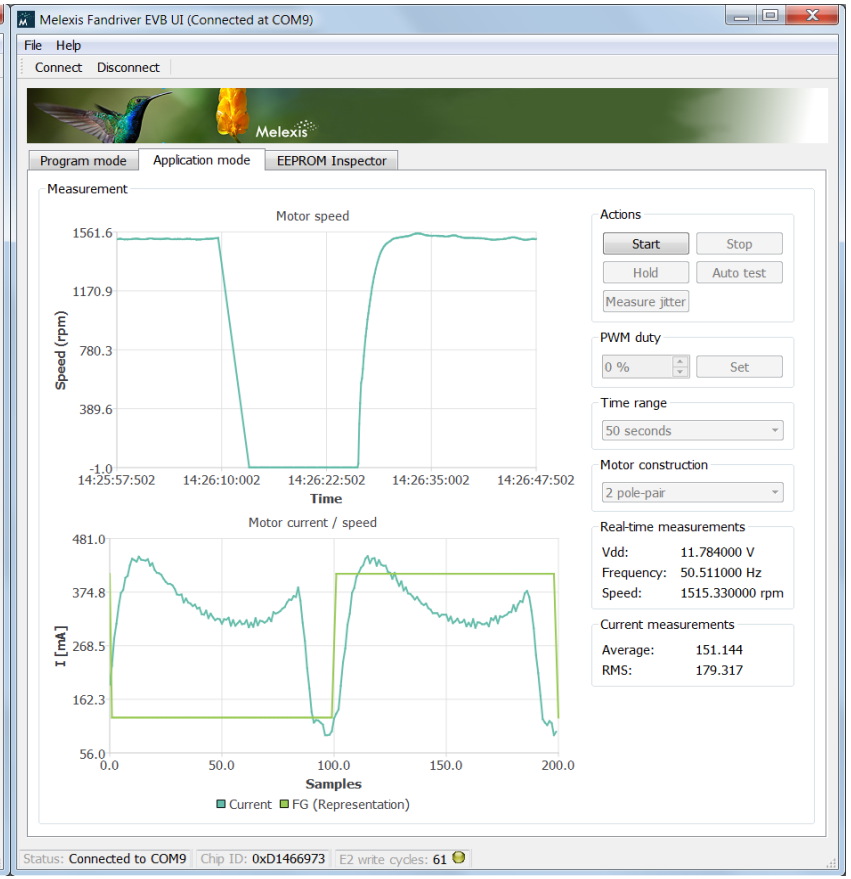
EVB1 for fandriver: configuring EEPROM using GUI

Applicable for MLX90411A, MLX90411B, MLX90412

EEPROM configuration

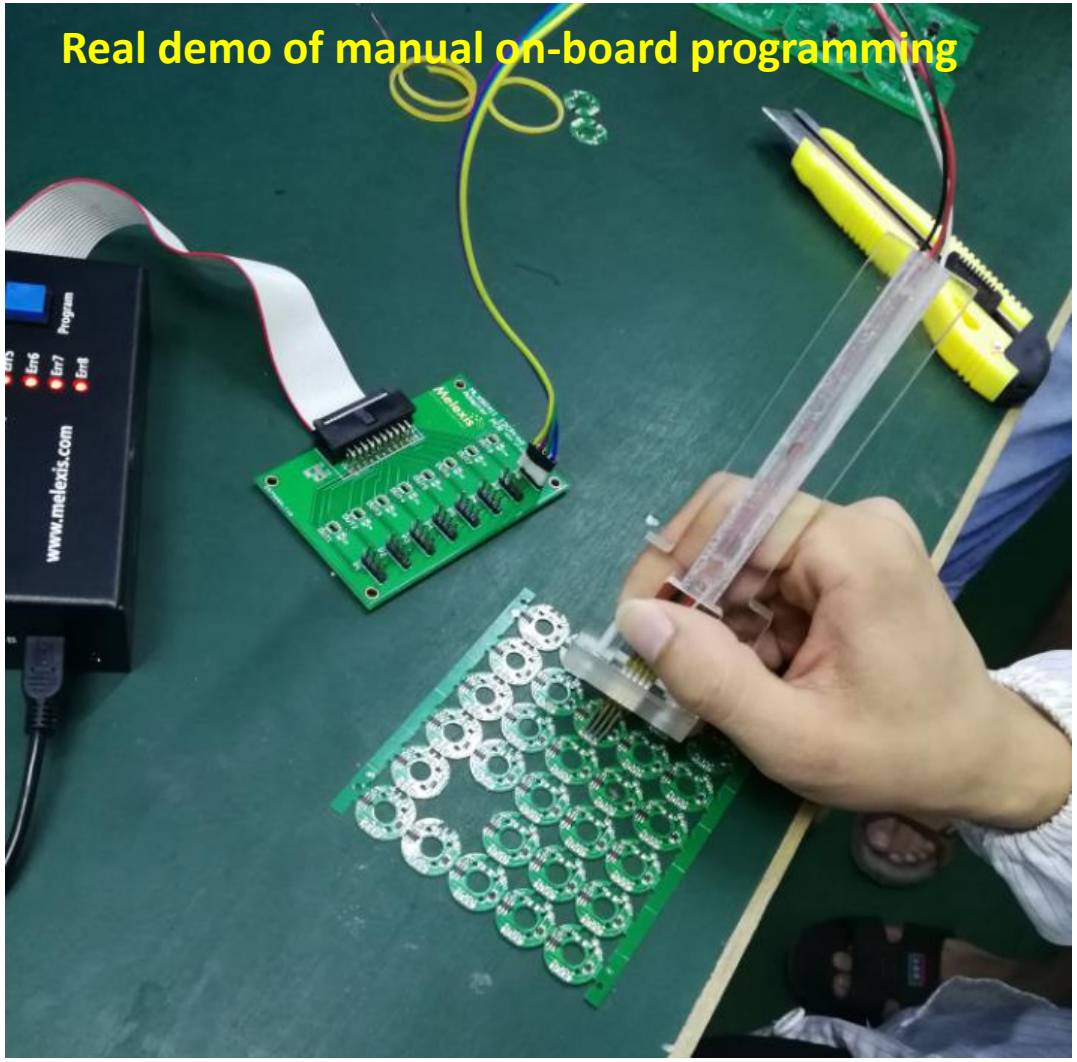


On-line motor running



ProgrammerA: for manual programming by operator

8 devices in parallel, all loggings stored on SD memory card



Outline

- Experience Matters
- 1-coil fandrivers introduction
  - Overview
    - 2-/3-wire fans
    - 4-wire fans
  - 1-coil vs 3-phase
- Smart Fandriver solutions
  - Melexis MLX90411 introduction
  - Melexis performance / USP
    - Open loop vs closed loop
    - Softswitching
      - 1/16 vs Supersoft: Torque vs vibrations, and 2/16 as compromise
    - Robustness & quality
- More Success with the new MLX90411
- Programming 90411
- Other Fandriver solution: Expanding into higher power

MLX90411-predriver: up to 60W

For even more powerful applications.

Hot air oven

Dishwasher Dryer fan

Clothes Dryer fan

Dryer/washer Combo
1 or 2 fans
+ 1 or 2 pumps

Drain pump

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