XMC™ in motor control applications
XMC™ microcontrollers
October 2016
Agenda

1. Why XMC™ for motor control?
2. Key microcontroller features
3. Kits and reference design
4. Development tool and software
5. General information
Agenda

1. Why XMC™ for motor control?
2. Key microcontroller features
3. Kits and reference design
4. Development tool and software
5. General information
Why XMC™ for motor control?

› Wide microcontroller portfolio

<table>
<thead>
<tr>
<th>XMC1000</th>
<th>XMC4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARM® Cortex®-M0</td>
<td>ARM® Cortex®-M4</td>
</tr>
<tr>
<td>32 MHz</td>
<td>80 MHz</td>
</tr>
<tr>
<td>48 MHz</td>
<td>120 MHz</td>
</tr>
<tr>
<td>MATH Coprocessor</td>
<td>FPU and DSP instructions</td>
</tr>
</tbody>
</table>
Flash (kB): 16 32 64 128 200 64 128 256 512 1024 2048
Pins: 16 24 28 38 40 64 48 64 100 144 196

› Peripherals tailored for motor control
  - Fast 12-bit ADC
  - Position interfaces for Hall sensors, incremental encoders and resolvers
  - PWM units tailored for sinusoidal and trapezoidal commutation pattern

› Ideal for Field-Oriented Control (FOC)
XMC™ product portfolio - XMC1000 family overview

**ARM® Cortex®-M0**
- Core up to 48 MHz / peripherals up to 96 MHz
- Capture Compare Units (CCU4)
- Up to 4x serial channels
- 12-bit ADC
- Tₐ = -40°C to 105°C

**DC motor control**
- XMC1100
  - Up to 64 kB Flash
  - 16 – 40 pins
  - + 9ch LED control (BCCU)
  - + 3x analog comparators

**XMC1200**
- Up to 200 kB Flash
- 16 – 40 pins

**XMC1300**
- Up to 200 kB Flash
- 16 – 40 pins
- + Math Coprocessor
- + CCU8 PWM timer
- + Hall & encoder I/F

**XMC1400**
- Up to 200 kB Flash
- 40 – 64 pins
- + 2x CAN
- + 2x CCU8
- + Up to 4 serial channels

>70% performance increase

**Low-end motor control**

**Wide supply voltage range 1.8 V – 5.5 V**

**Secure boot loader – ensure IP protection**

**Application specific peripherals**
- MATH Co-processor
- Event Request Unit (ERU)
- High-performance analog comparators
- PWM Timer (CCU8) for motor control
- LED Brightness Color Control Unit (BCCU)

16/28/38 TSSOP – VQFN24/40/64 – TQFP64

Copyright © Infineon Technologies AG 2016. All rights reserved.
**XMC™ product portfolio - XMC4000 family overview**

**ARM® Cortex®-M4** (with FPU)
- CPU frequency up to 144 MHz
- High performance Flash technology
- Timers CCU4, CCU8, POSIF
- USB / up to 6x CAN / up to 6x serial channels
- Up to 4x 12-bit ADC / 2x DAC
- $T_A = -40^\circ C$ to $125^\circ C$

**XMC4400**
- Up to 512 kB Flash / 80 kB RAM
- 64-100 pins
- + 120 MHz core
- + Ethernet
- + ΔΣ demodulator

**XMC4500**
- Up to 1 MB Flash / 160 kB RAM
- 100 – 144 pins
- + EBU
- + SD card

**XMC4700**
- Up to 2 MB Flash / 352 kB RAM
- 100 – 196 pins
- + 144 MHz core
- + 6ch CAN

**XMC4800**
- 256 kB Flash / 128 kB RAM
- 100 pins

**XMC4100/4200**
- Up to 256 kB Flash / 40 kB RAM
- 48-64 pins
- + 120 MHz core
- + Ethernet
- + ΔΣ demodulator

**Mid-range motor control**

48 QFN – 64-144 LQFP – 196 BGA

Long product life cycle (min. 2031)

Extended temperature range - up to $T_A 125 $°C + continues up time of 20 years @$T_J 110^\circ C$

**Application specific peripherals**
- High Resolution PWM (HRPWM)
- Event Request Unit (ERU)
- High-speed analog comparators + slope generation
- PWM Timer (CCU8) for inverter control
- Delta Sigma Demodulator (DSD)

Copyright © Infineon Technologies AG 2016. All rights reserved.
Agenda

1. Why XMC™ for motor control?
2. Key microcontroller features
3. Kits and reference design
4. Development tool and software
5. General information
### Key microcontroller features

#### Peripherals for motor control applications

- ADC
- CCU8
- CCU4
- ARM® Cortex®-M
- MATH
- POSIF
- DSD

#### Highlights

**XMC™** microcontrollers are well suited for various motor control applications and their specific control schemes.

Well tailored and interconnected analog, PWM and sensor interface peripherals are scalable over the entire XMC™ family.

#### Key feature

- Dedicated motor control peripherals for various control schemes and sensors
- Interconnected analog, PWM and sensor interface peripherals
- ARM® Cortex®-M CPU portfolio range from M0 with MATH to M4 with FPU

#### Customer benefits

- Select and configure the peripherals with respect to the specific requirements
- Autonomous peripherals ensure precise control for high energy efficiency
- Easy cost and performance balancing within the entire XMC™ portfolio

---

Copyright © Infineon Technologies AG 2016. All rights reserved.
Dedicated motor control peripherals for various control schemes and sensors

**Feature rich peripherals**
with dedicated motor control features allow optimization of the system behaviour with respect to the specific application’s requirements

- BLDC control with Hall sensors
- FOC control with encoder
- FOC control with resolver
Interconnected analog, PWM and sensor interface peripherals

Sensor interface peripherals

PWM peripherals

Interconnect matrix

Analog peripherals

Copyright © Infineon Technologies AG 2016. All rights reserved.
XMC™ ARM® Cortex®-M0 - with MATH coprocessor

› XMC1300 series with 16 to 40 pins
  - 32-bit ARM® Cortex®-M0 core running at 32 MHz
  - MATH coprocessor running at 64 MHz
    - 7x faster division compared to other Cortex®-M0 devices
    - 38x faster sine, cosine and arctangent calculations
    - High resolution Park/Inverse Park Transforms at 24-bit in less than 1 μs
  - PWM units clocked at 64 MHz for precise modulation

› XMC1400 series with 40 to 64 pins
  - 32-bit ARM® Cortex®-M0 core running at 48 MHz
  - MATH coprocessor running at 96 MHz
  - PWM units clocked at 96 MHz for precise modulation
  - CAN bus connectivity
XMC™ ARM® Cortex®-M4
- with FPU and EtherCAT®

› XMC4000 Series with 48 to 196 pins
  - 32-bit ARM® Cortex®-M4 core with FPU running at 80 MHz to 144 MHz
  - DSP instruction set with saturation and MAC instructions
  - Wide temperature range from -40°C to 125°C

› As a highlight, XMC4300 and XMC4800 are the first-ever highly integrated ARM® Cortex®-M based microcontrollers with EtherCAT® integrated
  - Bringing real-time Ethernet communication into an unrivaled level
    - Ease of implementation
    - Cost effectiveness
Agenda

1. Why XMC™ for motor control?
2. Key microcontroller features
3. Kits and reference design
4. Development tool and software
5. General information
## XMC™ motor control application kits - for DC motors

<table>
<thead>
<tr>
<th>Development boards</th>
<th>Order number</th>
<th>Kit/ref design</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC motor control shield with BTN8982TA for Arduino</td>
<td><strong>DC-MOTORCONT R_BTN8982</strong></td>
<td>Kit</td>
</tr>
<tr>
<td>24 V protected switch shield with BTT6030-2EKA and BTT6020-1EKA for Arduino</td>
<td><strong>24V_SHIELD_BTT 6030</strong></td>
<td>Kit</td>
</tr>
<tr>
<td>H-bridge kit 2GO</td>
<td><strong>HBRIDGEKIT2GO TOBO1</strong></td>
<td>Kit</td>
</tr>
</tbody>
</table>

Copyright © Infineon Technologies AG 2016. All rights reserved.
## Development boards

<table>
<thead>
<tr>
<th>Development boards</th>
<th>Order number</th>
<th>Kit/ref design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>XMC1000 motor control application kit</strong></td>
<td><strong>KIT_XMC1X_AK_MOTOR_001</strong></td>
<td>Kit</td>
</tr>
<tr>
<td><strong>XMC1300 boot kit</strong></td>
<td><strong>KIT_XMC13_BOOT_001</strong></td>
<td>Kit</td>
</tr>
<tr>
<td><strong>XMC1400 boot kit</strong></td>
<td><strong>KIT_XMC14_BOOT_001</strong></td>
<td>Kit</td>
</tr>
<tr>
<td><strong>XMC4400 motor control application kit</strong></td>
<td><strong>KIT_XMC44_AE3_001</strong></td>
<td>Kit</td>
</tr>
</tbody>
</table>
## Development boards

<table>
<thead>
<tr>
<th>Description</th>
<th>Order number</th>
<th>Kit/ref design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>24 V, 250 W motor drive power card for XMC1000 and XMC4000</strong></td>
<td>(coming soon)</td>
<td>Kit</td>
</tr>
</tbody>
</table>
## XMC™ motor control application kits - for high voltage AC motors (1/2)

<table>
<thead>
<tr>
<th>Development boards</th>
<th>Order number</th>
<th>Kit/ref design</th>
</tr>
</thead>
<tbody>
<tr>
<td>XMC™ 750 Watt motor control application kit</td>
<td>KIT_XMC750WATT_MC_AK_V1</td>
<td>Kit</td>
</tr>
<tr>
<td>XMC1300 drive card</td>
<td>KIT_XMC1300_D_C_V1</td>
<td>Kit</td>
</tr>
<tr>
<td>XMC4400 drive card</td>
<td>KIT_XMC4400_D_C_V1</td>
<td>Kit</td>
</tr>
<tr>
<td>Development boards</td>
<td>Order number</td>
<td>Kit/ref design</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------------</td>
<td>----------------</td>
</tr>
<tr>
<td>iMOTION™ modular application design kit (MADK)</td>
<td>EVALM11302056 5DTOBO1 EVALM11302058 4DTOBO1 EVALM11302364 5ATOBO1 EVALM11302368 4ATOBO1</td>
<td>Kit</td>
</tr>
</tbody>
</table>
## XMC™ motor control reference designs and system demonstrators

<table>
<thead>
<tr>
<th>System solution</th>
<th>Order number</th>
<th>Kit/ ref design</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BLDC power tool reference design</strong>&lt;br&gt;1 kW / 20 V\text{DC}</td>
<td>On request <a href="#">OPN: EVALSSO81 KWBLDCTOBO1</a></td>
<td>Kit / Ref design</td>
</tr>
<tr>
<td><strong>40mm server fan reference design</strong>&lt;br&gt;with XMC1302 in VQFN24 package</td>
<td>-</td>
<td>Ref design</td>
</tr>
<tr>
<td><strong>Modular 3-phase motor drive</strong>&lt;br&gt;100 W / 230 V\text{AC}</td>
<td>-</td>
<td>Ref design</td>
</tr>
<tr>
<td><strong>Multi-axis drive and motion control with XMC4400</strong></td>
<td>-</td>
<td>demo</td>
</tr>
</tbody>
</table>
DC motor control shield with BTN8982TA for Arduino

Key features:
› Compatible with Arduino Uno R3 and XMC1100 boot kit from Infineon
› Capable of high frequency PWM, e.g. 30 kHz
› Diagnosis with current sense
› Protection e.g. against over-temperature and overcurrent

Customer benefits:
› Rapid prototyping of DC motor control in half and full bridge configuration
› Precise control and small current ripples
› Easy overload detection and current limitation by software control
› Robust design platform without hesitation
24 V protected switch shield with BTT6030-2EKA and BTT6020-1EKA for Arduino

Key features:
› Compatible with Arduino microcontroller boards and XMC™ microcontroller kits using the Arduino form factor (e.g.: XMC1100 boot kit)
› 8 V - 36 V input voltage (max. 5V - 48 V), current up to 5 A per channel
› Capable of PWM up to 400 Hz
› Driver circuit with logic level inputs

Customer benefits:
› Fast and inexpensive prototyping of 24 V load driving, e.g.: motors
› Load diagnosis with current sense capability
› Over temperature shut down with latch behaviour
H-bridge kit 2GO

Key features:
› Control of DC motors or other inductive loads up to 6 A or up to 36 V of supply
› General purpose H-bridge IFX9201 combined with XMC1100
› Outputs can be pulse width modulated at frequencies up to 20 kHz
› SPI enables for easy diagnosis

Customer benefits:
› Rapid prototyping of DC motor control in half and full bridge configuration
› Simple design with few external components
› Easy protection of over current and over temperature
XMC1000 motor control application kit

Key features:

› Robust 12 V - 24 V 3-phase inverter for maximum 3 A
› Multiple position sensing interfaces
  - Quadrature encoder interface
  - Hall sensor interface
› Seamless connection to the XMC1300 or XMC1400 boot kits

Customer benefits:

› Rapid prototyping of PMSM and BLDC motor control schemes with various position and current feedback sensors
› This modular system allows users to evaluate the XMC1302 or XMC1404 microcontrollers with respect to motor control feature set and performance

Include motor 24 V PMSM with hall sensors
XMC4400 motor control application kit

Key features:

› Robust 3-phase 24 V inverter for nominal dc-link current 5 A (max. 7.5 A)
› Multiple position sensing interfaces
  - Inductive resolver interface
  - Quadrature encoder interface
  - Hall sensor interface
› Seamless connection to XMC4000 CPU boards (e.g. CPU_44A-V2, CPU_45A-V2)

Customer benefits:

› Rapid prototyping of PMSM and BLDC motor control schemes with various position and current feedback sensors
› This modular system allows to evaluate any XMC4000 microcontroller with respect to motor control feature set and performance

Include motor
24 V PMSM with Hall sensors and encoder

Copyright © Infineon Technologies AG 2016. All rights reserved.
24 V, 250 W motor drive power card for XMC1000 and XMC4000

Key features:
› Robust 16 V - 42 V (60 V max) 3-phase motor drive bridge, equipped with 6x BSC014N06N OptiMOS™ 80 V, 1.4 mΩ
› Half-bridge gate driver 2EDL05N06PF EiceDRIVER™ in SO8 package with SOI technology
› Seamless connection to XMC1000 and XMC4000 drive cards

Customer benefits:
› Rapid prototyping of PMSM and BLDC motor control from low to middle-range power
› Allows evaluation of XMC1000 and XMC4000 in the same ecosystem
› Flexible to adopt many different control algorithms
XMC™ 750 watt motor control application kit

Key features:
- Include two XMC™ drive cards with galvanic isolation to target device
- 3-phase inverter and analog or digital PFC
- Support with various sense & control techniques (including shunt, resolver, Hall sensors for FOC)

Customer benefits:
- Gives jumpstart into evaluation of XMC™ microcontroller and motor control performance
- Allows evaluation of XMC1000 as well as XMC4000 in the same ecosystem
- Robust and non-hazardous control via standard tools for debugging, data analysis and control

Key features:
- Ready to use 750 W power inverter with PFC with wide supply range (115 V\textsubscript{AC} to 230 V\textsubscript{AC}) and nominal 3 A motor current
- XMC1300 and XMC4400 drive cards included
- Isolated debug interface providing Cortex®-SWD channel and COM-port (UART) channel
XMC™ drive cards with galvanic isolation

- On-board J-Link Lite debugger with galvanic isolation to target device
- Flexible and modular with clearly defined interfaces
- Isolated debug interfaces
  - SWD
  - UART
  - CAN (if applicable)
- Other interfaces
  - Hall Sensors
  - Encoder
  - UART/SPI/I2C
  - Others
iMOTION™ modular application design kit - introduction

- Compact and modular 3-phase motor drive system solution platform with scalable controller and IPM inverter board options
- Designed for sensorless or sensored motor control
- Spin your motor in less than 1 hour thanks to provided motor control software and easy-to-use GUI for parametrization and tuning
iMOTION™ modular application design kit - available kits and boards overview (1/2)

Controller boards

- **EVAL-M1-099M**
  - IRMCK099 control card
  - SP001591856

- **EVAL-M1-1302**
  - XMC1302 control card
  - SP001591894

Individual board

- **EVAL-M1-1302_36-84A**
  - XMC1302 control card + Powerstage based on IRSM836-084MA, µIPM™, 250 V
  - SP001592044

- **EVAL-M1-1302_36-45A**
  - XMC1302 control card + Powerstage based on IRSM836-045MA, µIPM™, 500 V
  - SP001592034

- **EVAL-M1-1302_05-84D**
  - XMC1302 control card + Powerstage based on IRSM505-084DA2, µIPM™-DIP, 250 V
  - SP001591814

- **EVAL-M1-1302_05-65D**
  - XMC1302 control card + Powerstage based on IRSM505-065DA2, µIPM™-DIP, 500 V
  - SP001591902

Inverter boards

- **EVAL-M1-36-84A**
  - µIPM™ power board IRSM836-084MA 250 V
  - SP001592062

- **EVAL-M1-36-45A**
  - µIPM™ power board IRSM836-045MA 500 V
  - SP001592052

- **EVAL-M1-05-84D**
  - µIPM™-DIP power board IRSM505-084DA2 250 V
  - SP001591850

- **EVAL-M1-05-65D**
  - µIPM™-DIP power board IRSM505-065DA2 500 V
  - SP001591474

Kits

More iMOTION™ MADK controller and inverter boards coming soon...
For more details about individual board (control cards and µIPM™-based inverters), please check the additional documentation on [www.infineon.com/MADK](http://www.infineon.com/MADK)
Reference design / demo
- BLDC power tool 1 kW / 20 V$_{DC}$

Key Infineon components:
- Microcontroller:
  - XMC1302 in TSSOP38
- Power stage:
  - OptiMOS™ 1.05 mΩ / 40 V
    - BSC010N04LSI
  - EiceDRIVER™ 2EDL05N06PF

Key features:
- 3-phase BLDC motor driver (6 V-24 V, 50 A continuous, 200 A peak) with Hall sensor based block commutation on XMC1302
- Synchronous PMW transitions
- Motor model based speed control
- MOSFET driver voltage boost control
- Over current, over load, over temperature protection

Customer benefits:
- Precise and efficient control of power tool motor with best in class OptiMOS™ power MOSFETs
- Minimized power losses
- Best tool performance
- Extended supply voltage range
- Maximum robustness by dedicated hardware and software features
Reference design / demo
- 40 mm server fan with XMC1302 VQFN24

Key features:
› 3-phase motor driver (12 V, 1 A) with sensorless FOC based on XMC1302 in VQFN24
› Smooth start-up control of sinusoidal output voltage and closed loop speed control up to 25000 rpm
› Lock detection, over current protection, reverse polarity protection
› Control interface: PWM speed input / FG speed output

Key Infineon components:
- Microcontroller:
  - XMC1302 in VQFN24
- Power:
  - OptiMOS™ P + N channel BSL308C
  - 5 V LDO IFX20001MBV50

Customer benefits:
› Maximum energy efficiency at lowest bill of material cost and smallest form factor
› Minimum audible noise at low speed and maximum performance at high speed
› Reliable operation under all circumstances
› Compatible to many fan control ASICs
Reference design / demo - modular 3-phase motor drive

**Highlights:**
› Modular concept:
  - Power supply for 325 V, 15 V and 5 V
  - Inverter card: 100 W with fast reverse conducting IGBT (DPAK)
  - XMC1300 drive card
› Applications:
  - Fridge compressor
  - Pump
  - Fan

**Key features and benefits:**
› Easy performance comparison of different IGBTs, MOSFETs and IPMs
› Fast adaptation to continuously growing IGBT, MOSFET and IPM portfolio
› Easy performance comparison of different XMC™ microcontrollers
› Software evaluation and development platform
System demonstrator with XMC4400 multi-axis drive and motion control

- Demonstrator for system integration of HMI, PLC, CAN and XMC4000
- Multi-axis motion control
  - Manual movement
  - Homing
  - Positioning
  - Hand-wheel ("electrical shaft")
- XMC4400 dual motor control
  - Torque, speed & position loop
  - FOC with encoder

XMC4400 tasks
- Dual FOC with torque, speed and position loop at 20 kHz cycle
- Dual shunt current measurement with hardware synchronized ADC channels
- CAN communication for speed and position control with PLC as well as parameter handling

Software is based on DAVE™ 3 motor control APPs with only a few lines of user code
Agenda

1. Why XMC™ for motor control?
2. Key microcontroller features
3. Kits and reference design
4. Development tool and software
5. General information
Development tools and software
DAVE™ - software development made easy

From evaluation to production

Third parties
Hand-in-hand with third party tools

XMC™ Lib
Low-level driver library/ APIs for peripherals

DAVE™ Apps
Graphical-configurable application-oriented software components

Examples
XMC™ Lib and DAVE™ Apps composed to create more complex applications

DAVE™ SDK
Modify, enhance, and develop DAVE™ Apps

DAVE™
Professional free-of-charge IDE

XMC™ 32-bit industrial microcontroller portfolio

Copyright © Infineon Technologies AG 2016. All rights reserved.
µC/Probe™ XMC™

› µC/Probe™ XMC™ - Windows based application that allows you to read and write the memory of XMC™ microcontrollers during run-time in a non-intrusive way and with a graphical dashboard to fine-tune your application

› Examples - motor control GUI
XMC™ Flasher

XMC™ Flasher - programming tool for on-chip flash programming of XMC™ microcontrollers
Motor control example projects

- Users can download DAVE™ 4 motor control example projects from [Infineon website](http://www.infineon.com), e.g.:

<table>
<thead>
<tr>
<th>Project</th>
<th>Description</th>
<th>Target MCU</th>
<th>Version</th>
<th>Last Update</th>
<th>Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLDC_SCALAR_HALL_XMC13</td>
<td>This example project controls 3-phase BLDC motor with 3 hall sensor feedback using block commutation control algorithm. This is configured for Infineon low voltage motor control kit KIT_XMC1X_AK_MOTOR_001 with Maxon motor part number 267121</td>
<td>XMC1300</td>
<td>1.0.0</td>
<td>2016-05-25</td>
<td>DAVE™</td>
</tr>
<tr>
<td>PMSM_FOCAMPLE_XMC13</td>
<td>This example demonstrates permanent magnet synchronous motor control using sensorless FOC algorithm. Speed of the motor is changed by potentiometer value</td>
<td>XMC1300</td>
<td>4.2.6</td>
<td>2016-04-28</td>
<td>DAVE™</td>
</tr>
<tr>
<td>PMSM_FOCAMPLE_XMC44</td>
<td>This example demonstrates speed control of motor using V/f with smooth transition to FOC closed loop start up technique. Speed of the motor is changed by potentiometer input value</td>
<td>XMC4400</td>
<td>4.2.6</td>
<td>2016-04-28</td>
<td>DAVE™</td>
</tr>
</tbody>
</table>
Agenda

1. Why XMC™ for motor control?
2. Key microcontroller features
3. Kits and reference design
4. Development tool and software
5. General information
## Support material:

<table>
<thead>
<tr>
<th>Collaterals and Brochures</th>
<th>Technical Material</th>
<th>Videos</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>‣ Product Briefs</td>
<td>‣ Application Notes</td>
<td>‣ Technical Videos</td>
<td>‣ Forums</td>
</tr>
<tr>
<td>‣ Selection Guides</td>
<td>‣ Technical Articles</td>
<td>‣ Product Information Videos</td>
<td>‣ Product Support</td>
</tr>
<tr>
<td>‣ Application Brochures</td>
<td>‣ Simulation Models</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‣ Presentations</td>
<td>‣ Datasheets, MCDS Files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>‣ Press Releases, Ads</td>
<td>‣ PCB Design Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[<a href="http://www.infineon.com/XMC">www.infineon.com/XMC</a>]</td>
<td>[<a href="http://www.infineon.com/XMC">www.infineon.com/XMC</a>]</td>
<td>[Infineon Media Center, XMC Mediathek]</td>
<td>[Infineon Forums, Technical Assistance Center (TAC)]</td>
</tr>
</tbody>
</table>
Glossary abbreviations (1/2)

› AC  Alternating Current
› ADC  Analog-to-Digital Converter
› BEMF  Back Electromotive Force
› BLDC  Brushless DC Motor
› CAN  Controller Area Network
› CPU  Central Processing Unit
› DAC  Digital-to-Analog Converter
› DAVE™  Digital Application Virtual Engineer
› DC  Direct Current
› DSD  Delta Sigma (ΔΣ) Demodulator
› DSP  Digital Signal Processor
› FOC  Field-Oriented Control
Glossary abbreviations (2/2)

› FPU Floating Point Unit
› GUI Graphical User Interface
› HMI Human-Machine Interface
› IPM Intelligent Power Modules
› MADK Modular Application Design Kit
› MOSFET Metal-Oxide-Semiconductor Field-Effect Transistor
› PLC Programmable Logic Controller
› PMSM Permanent Magnet Synchronous Motor
› POSIF Position Interface
› PWM Pulse Width Modulation
› RAM Random-Access Memory
› XMC™ Cross-Market Microcontrollers
Disclaimer

The information given in this training materials is given as a hint for the implementation of the Infineon Technologies component only and shall not be regarded as any description or warranty of a certain functionality, condition or quality of the Infineon Technologies component.

Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind (including without limitation warranties of non-infringement of intellectual property rights of any third party) with respect to any and all information given in this training material.
Part of your life. Part of tomorrow.