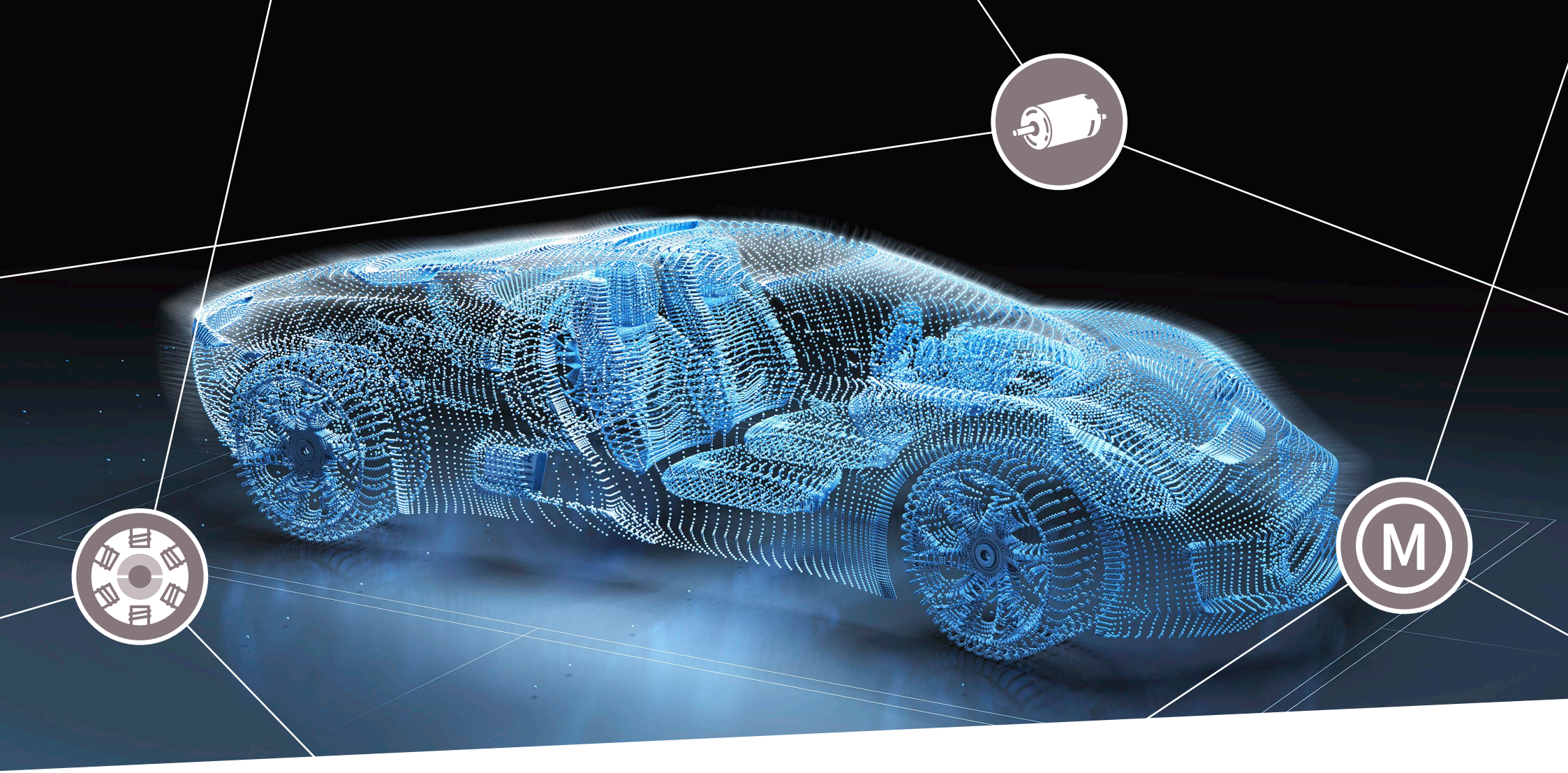

Automotive low-voltage motor control solutions 2021

www.infineon.com/automotivemotorcontrol

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Introduction

Nowadays, the number of electrical motors in cars is growing steadily. The global automotive motor market is projected to grow to USD 25.7 billion by 2025, at a CAGR of 4.8 percent. The rising need for safety features and convenience can be attributed to the ever-growing demand for automotive motors globally.

- In average around 35 motors distributed in an automobile
- About 70 motors present in premium cars
- By 2022, 4.2 billion electrical motors are expected to be built only into cars

Over a long period, mechanical solutions in the automotive industry were state of the art for thermal management applications such as oil pumps, water pumps, fuel pumps and hydraulic pumps. These days, the trend goes to the replacement of mechanical solutions by electrical motors, due to factors such:

- A rising demand for active and passive safety systems which are mandatory due to upcoming legislations. The increased number of safety features such as crash avoidance, driving assistants and autonomous driving also drives the electrical motor market forward.
- CO_2 reduction, which has become a very high priority in the field of transportation, these mechanical pumps were gradually replaced by smart, electrically controlled motors. Instead of continuously using energy from a combustion engine, the electric motors can be switched and speed-controlled on demand.
- In addition the number of pumps and fans needed in a car is increasing due to new applications and new use cases such as battery cooling and e.g. sensor cleaning.

Smart motors are not only used for pumps and fans but also for body and comfort applications like seats, smart closures, wipers and many more. The increasing number of in-cabin comfort functionalities in mid-range cars and premium equipment requires smart solutions.

The above mentioned functionalities in cars show a need for high-tech, reliable, cost-effective, smaller and flexible semiconductor solutions for motor control.

Infineon provides these semiconductor solutions and steadily extends the portfolio of semiconductors needed for smart and modern low-voltage motor control, such as our broad MOTIX™ product portfolio offering dedicated products for different integration levels together with MOSFETs, OPTIREG™ system basis chips, power supplies and transceivers, microcontrollers and sensors.

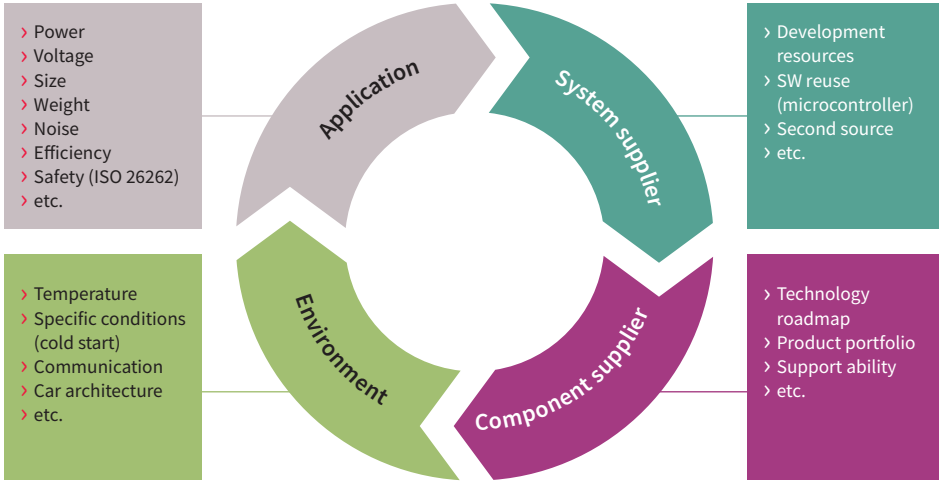
1. Automotive motor control at a glance and Infineon offering

1.1. Motor control architecture and offering depend on multiple criteria

The application and environmental requirements have to be fulfilled with the available components and resources of the component supplier and the supporting ecosystem.

In order to achieve an Automotive Safety Integrity Level (ASIL) according to ISO 26262, Functional Safety is getting ever more important. Infineon has partially outsourced the safety support for AURIX™ microcontrollers to a selection of Preferred Design Houses. In this way, even small- and medium-sized customers can implement support-intensive safety applications.

Image 1: The four main criteria influencing the design

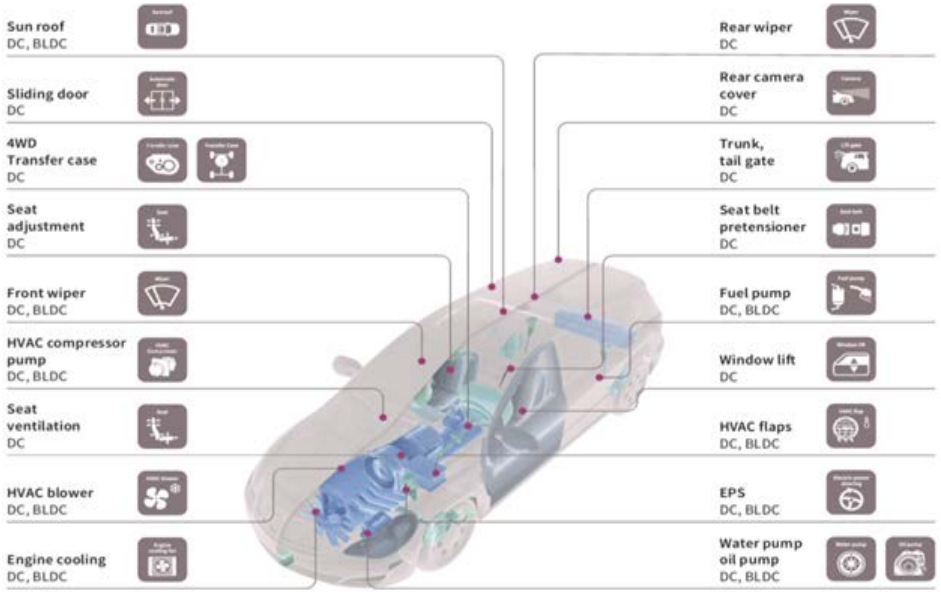


1.2. Infineon offers solutions for all kinds of low-voltage motor control

Whatever you touch in a car, there is an electric motor close by. Brushed DC motors are easy to control and often serve as actuators with an overall short operating time. Torque control down to zero speed is easy to achieve.

Brushless DC (BLDC) motors have less wear but need a complex control algorithm and, therefore, higher computing power than a DC motor drive. BLDC motors are most suitable for applications demanding long-term continuous duty like pumps.

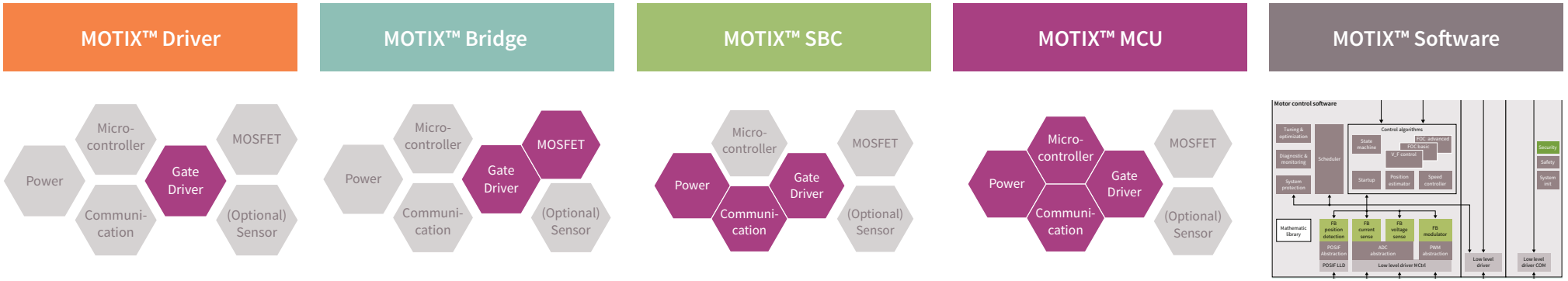
Image 2: Typical applications for DC and BLDC motors in a car



1.3. MOTIX™: Seamless motor control offerings powered by Infineon

Infineon offers four levels of function integration of its hardware: low, medium, medium-high and high. Every level has its own characteristic set of benefits. The following picture serves as a first-decision help in which direction to go for your low-voltage motor control application. In addition we also provide different kinds of software for our MOTIX™ products, please find more information on page 28.

Image 3



MOTIX™ multi MOSFET driver ICs

› TLE92104/8

MOTIX™ motor gate driver ICs

› TLE9180x
› TLE9185

MOTIX™ single half-bridge ICs (NovalithIC™)

› BTNxxxx/IFX007

MOTIX™ multi half-bridge ICs

› TLE94xxx

MOTIX™ full bridge ICs

› TLE9201/IFX9201

MOTIX™ servo and stepper motor ICs

› TLE420x
› TLE8444

MOTIX™ BLDC motor system ICs

› TLE9563/4

MOTIX™ BDC motor system ICs

› TLE9560/1/2

MOTIX™ Embedded Power ICs

› TLE98xx

MOTIX™ motor control software

› eSLx

MOTIX™ diagnostic software

MOTIX™ communication software

MOTIX™ tools

2. MOTIX™ Driver: Low-integrated solutions for high-power motor control

The low-integrated solution with discrete components gives you the flexibility of selecting the optimal device for each function. The result is a tailor-made design that fits the application like a glove. Especially, high-current drives benefit from the use of the latest MOSFETs with the lowest $R_{DS(on)}$ in thermally optimized packages.

Have a look at gate-drivers, power MOSFETs, voltage regulators for power supply, and transceivers for communication over LIN or CAN, Hall sensors and microcontrollers. Image 4 shows an application example of a 3-phase motor drive using discrete components resulting in a low integration level, while providing the highest flexibility.

2.1 MOTIX™ gate driver ICs for MOSFETs

Our line-up of gate driver ICs for external MOSFETs covers everything you need for brushless DC and brushed DC motors in 12 V and 48 V automotive applications, including protection and diagnostic features to meet ISO 26262.

The trend to advanced driver assistant systems, autonomous driving, challenging regulatory emission targets and the increasing electrification of the drivetrain spur the need for sophisticated electric motor drives in vehicles.

Applications such as HVAC compressors or engine cooling fans will be controlled by variable speed drives in the future. Electric power steering and brake booster will transition from fail safe to fail operational systems with the need for ISO 26262 ASIL D compliance on component level. The introduction of 48 V MHEV will be a game changer for traditional alternators to become integrated starter generators.

www.infineon.com/cms/en/product/power/motor-control-ics/bldc-motor-driver-ics/

At Infineon we have a full range of motor driver ICs to provide the required performance and functional safety for the versatile use that these systems demand. Leveraging more than 15 years' experience and our strong technical resources, we have leading-edge products in place to master the automotive revolution.

Infineon's automotive qualified discrete three phase TLE9180D driver ICs cover high current motor drive applications up to 48 V. The products are ideal for a variety of automotive applications such as electric power steering, brake booster, MHEV starter generator, active roll control, HVAC compressor as well as pumps and fans and where efficiency, a small footprint and monitoring functions are priorities.

Applications	Basic features
› Electric power steering	› Supply range from 5.5 – 60 V
› Electric brake booster	› Powerful driver stage with typ. 2 A output current per channel
› Engine cooling fan	› 0 to 100 percent duty cycle range
› 48 V starter generator	› Integrated current sense amplifier for shunt signal conditioning
› Transfer case	› Extended protection & supervision
› Double clutch transmission	
› Active roll control	
› Water pump	
› Oil pump	

2.1 MOTIX™ gate driver ICs for MOSFETs (cont'd)

Image 4: Application diagram

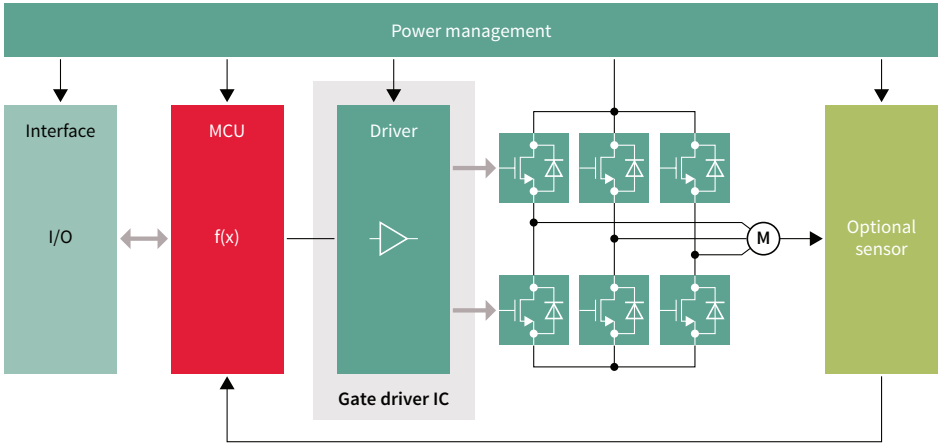
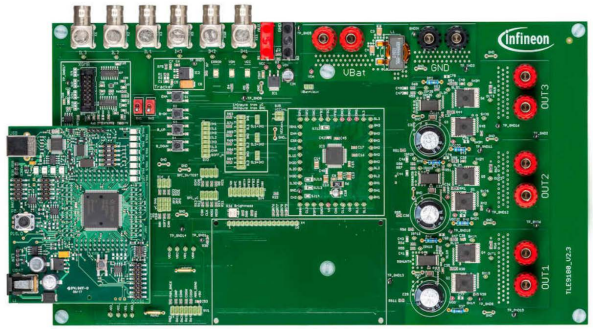


Table 1: Product table

Product name	Description	Package
TLE9180D-21QK	3-phase gate driver IC with 2 current sense amplifier	LQFP-64
TLE9180D-31QK	3-phase gate driver IC with 3 current sense amplifier	LQFP-64
EVAL_TLE9180D-31QK	Evaluation board for TLE9180D-31QK incl GUI for register configuration	–

Image 5: Evalboard



2.2 MOTIX™ multi MOSFET driver

Infineon's TLE9210x is a family of multi MOSFET driver ICs, designed to control up to eight half-bridges (up to 16 n-channel MOSFETs) with one packaged device. MOTIX™ TLE92108 and TLE92104 offer a reliable and cost optimized solution with state of the art diagnostic and protection. The unique adaptive MOSFET control concept enables elimination of end-of-line calibration to MOSFET characteristic spreads and guarantees an optimized balancing between power dissipation and EMC behavior. Outstanding low sleep current, advanced protection and diagnostic make the product family an optimal solution for automotive applications like seat and power lift gate control and various use cases in body control module (BCM) as centralized door lock or washer pumps. Furthermore, an integrated motor brake function increases the reliability and protection for the system.

The devices of the TLE9210x family are pin and software compatible. The product family allows motor cascading: with TLE92108 up to 7 motors can be driven. All products of the TLE9210x family are qualified according to AEC-Q100 and designed to withstand the severe conditions of automotive applications.

System benefits

- Configurable brake mode: preventing damages on ECU level due to intelligent motor braking during manual closing or opening
- Adaptive gate control: providing lower switching losses and EMC optimization due to optimized MOSFET switching
- Pin-to-pin and SW compatible family: enables scalabtility and easy-to-design-in

www.infineon.com/cms/en/product/power/motor-control-ics/brushed-dc-motor-driver-ics/multi-mosfet-driver/

2.2 MOTIX™ multi MOSFET driver (cont'd)

Table 2: Product table

	8-fold MOSFET driver IC		4-fold MOSFET driver IC	
Served application	**TLE92108-232QX**	**TLE92108-231QX**	**TLE92104-232QX**	**TLE92104-131QX**
Power lift gate/Sliding doors	●	–	●	–
Seat	●	●	●	●
General purpose	●	●	●	●
Current sense amplifier	2	2	2	1
PWM inputs	3	3	3	3
Brake mode	●	–	●	–
Adaptive MOSFET control	●	●	●	●

Boards and tools

The application kits contain either one of the multi MOSFET driver ICs of the TLE92104-23QX or the TLE92108-23QX and a typical application circuit, including 4 MOSFET half-bridges to drive up to 4 DC motors or 8 MOSFET half-bridges to drive up to 8 DC motors. It is a simple and easy-to-use tool to evaluate hardware and software functionalities. The application board can be connected via a UIO stick with the computer to evaluate its features via ConfigWizard (a graphical user interface) which can be found in the Infineon Developer Center.

Available boards

› TLE92104-232QX APPKIT
› TLE92108-232QX APPKIT

Image 6: Board

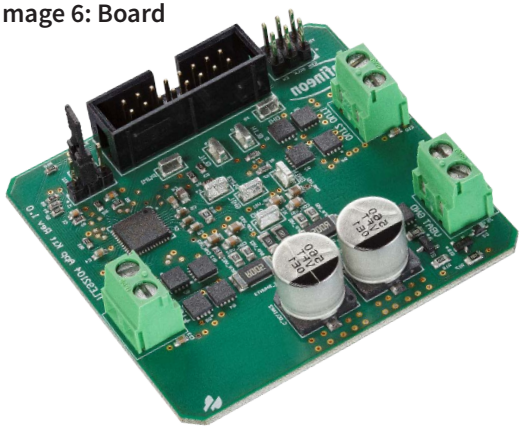
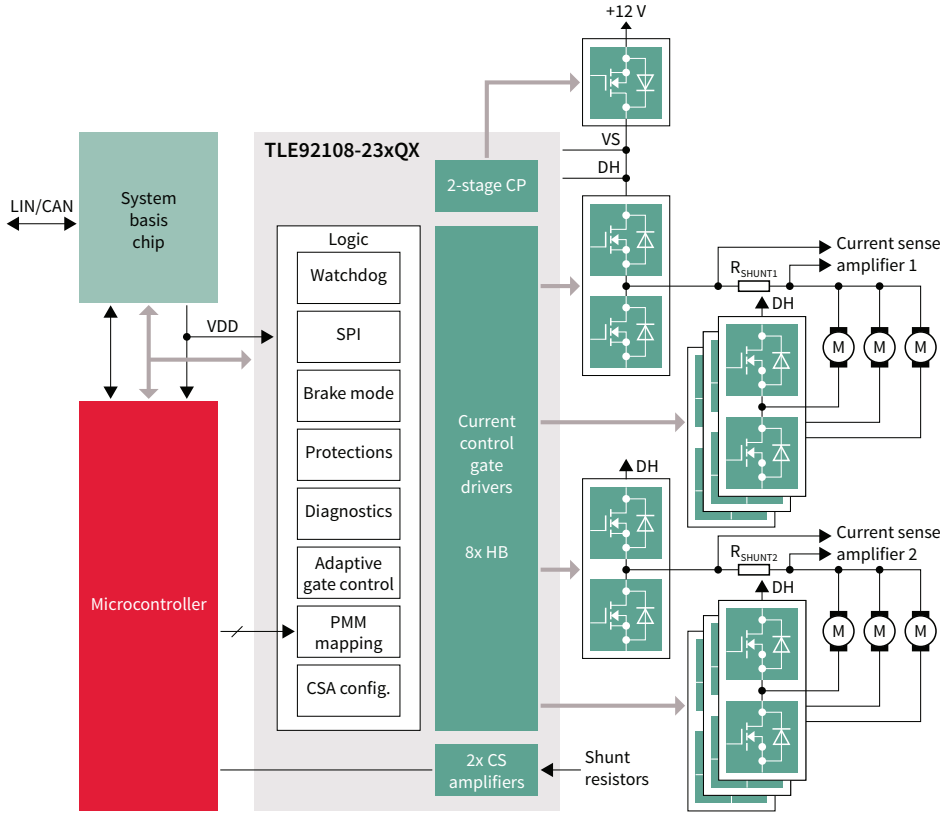


Image 7: Application diagram



www.infineon.com/cms/en/product/power/motor-control-ics/brushed-dc-motor-driver-ics/multi-mosfet-driver/

2.3 MOTIX™ three-phase driver IC

The MOTIX™ TLE9185QX and MOTIX™ TLE9185QX V33 are three-phase driver ICs with integrated power supply and support features in a PG-VQFN-48 power package for motor control in automotive applications.

The BLDC driver ICs provide main functions such as a 3.3 V/5 V low-dropout voltage regulator, three half-bridges for BDLC motor control, one current sense amplifier and one 32-bit SPI interface. The devices include diagnostic and supervision features and are intended to operate with 3.3V /5.0 V microcontrollers.

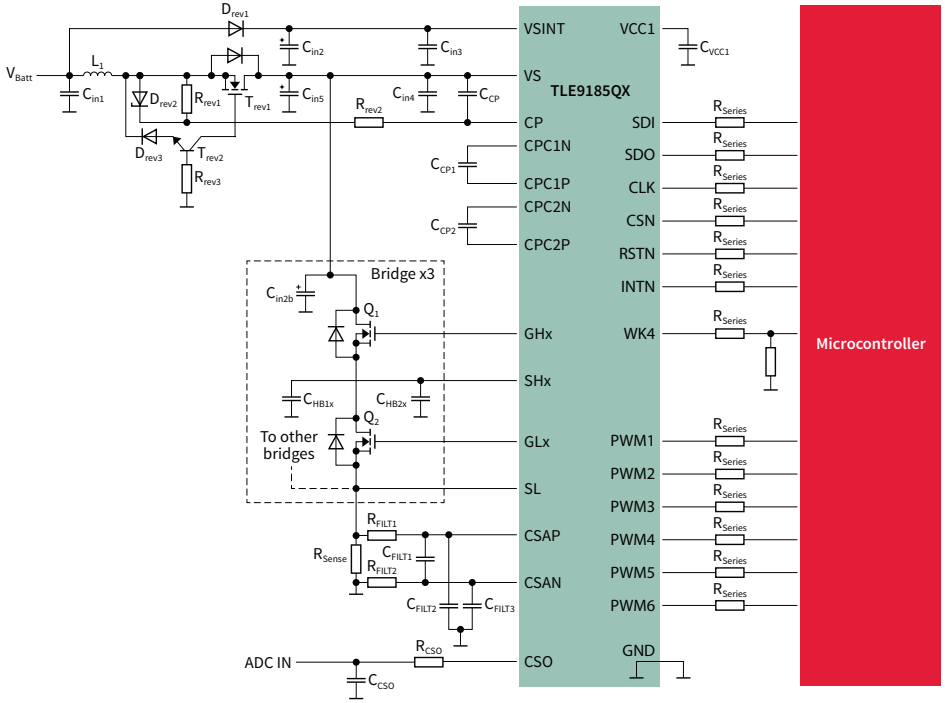
Summary of features

- Low-drop voltage regulator 3.3 V / 5 V, 250 mA for main supply
- Three half-bridge gate drivers for external N-channel MOSFETs
- Adaptive MOSFET gate control
- One low-side capable current sense amplifier (CSA) with configurable gain for protection and diagnosis
- Configurable wake-up sources
- Six PWM inputs with up to 25 kHz PWM frequency
- 32-bit serial peripheral interface (SPI) with cyclic redundancy check (CRC)
- Periodic cyclic wake in normal mode, stop mode and sleep mode
- Drain-source monitoring and open-load detection, configurable time-out and window watchdog
- Overtemperature and short circuit protection features

Applications

- Auxiliary pumps (fuel, water, etc.)
- Blower motor
- Engine cooling fan
- Sunroof module
- Transfer case

Image 8: Application diagram



3. MOTIX™ Bridge: Medium-integrated solutions for motor control: Intelligent motor control ICs

The medium-integrated devices combine gate-drivers with the MOSFET power stage in a single package. A small foot-print on the PCB, diagnostic feedback and protection add to the benefits of the integration.

Infineon's portfolio comprises single half-bridges, multi half-bridges, full- and H-bridges as well as servo and stepper motor ICs.

3.1. MOTIX™ single half-bridge ICs (NovalithIC™)

The integrated motor drivers family NovalithIC™ provides a complete low-ohmic-protected half-bridge in a single package. It can be combined with an additional NovalithIC™ to create an h-bridge or 3-phase bridge as well. The NovalithIC™ family could provide up to 20 kHz PWM while providing overcurrent, overvoltage and overtemperature protection. Other benefits of the NovalithIC™ are

- High reliability
- Current sense
- Small footprint
- High currents
- Scalability due to family concept
- Adjustable slew rate

The NovalithIC™ family offers cost-optimized solutions for protected high- and low-current PWM motor drives with very low board space consumption – scaled to your needs.

Applications

- Fuel pump
- Sunroof
- Electric parking brake
- Fans
- HVAC blower
- Body control module
- Engine cooling fan
- Wiper
- Tail gate
- Sliding door
- Seatbelt pretensioner
- 4WD transfer case
- Door lock
- Cinching latch

Key features & benefits

- Integrated half-bridge
- PWM capability
- Logic-level input: connects directly to MCU
- Current limitation for reduced power dissipation & short-circuit protection
- Adjustable slew rates for optimized EMI
- Current sense capability
- Overtemperature shut down
- Integrated dead-time generation

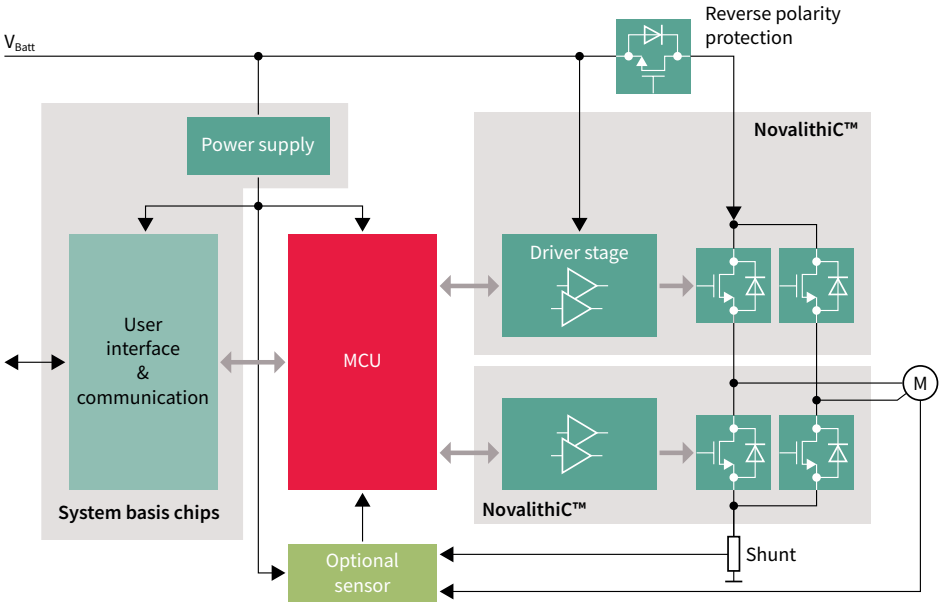
Table 3: Product table

Product name	Path resistance ($R_{DS(on)}$ high side + low side)	Overcurrent detection level	Differential current sense ratio dk_{ILIS}	Package
BTN9990LV	typ. 5.3 mΩ max 9.6 mΩ @ 150°C	Min. 75 A	typ. 50 k	HSOF-7-1 (sTOLL) 7 x 8 x 2.3 mm
BTN9970LV	typ. 9.7 mΩ max 18.1 mΩ @ 150°C	Min. 60 A	typ. 40 k	HSOF-7-1 (sTOLL) 7 x 8 x 2.3 mm
BTN7030-1EPA	Typ. 32 mΩ max 62 mΩ @ 150°C	Min. 14 A	4.3 k	TSDSO-14 5 x 6 x 1.15 mm

www.infineon.com/cms/en/product/power/motor-control-ics/brushed-dc-motor-driver-ics/single-half-bridge-ics/

3.1. MOTIX™ single half-bridge ICs (NovalithIC™) (cont'd)

Image 9: Application diagram



Boards and kits

DC-SHIELD_BTN7030

The motor control shield with BTN7030-1EPA is designed to drive DC motors in combination with an Arduino compatible baseboard.

The shield can be controlled with the general logic IO-Ports of a microcontroller. Either an Arduino Uno R3 or the XMC1100 Boot Kit from Infineon can be used as the master. Another way to control this board is via uIO port using Infineon uIO Stick.

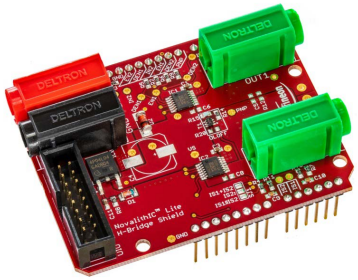


Image 10: DC-Shield BTN7030

DC-SHIELD_BTN9970LV, SP005344739

The board includes two NovalithIC™+ family high current half bridges with integrated driver BTN9970LV and BTN9990LV.

The motor control shield is designed to drive DC motors in combination with an Arduino compatible baseboard. It can be controlled with the general logic IO-ports of a microcontroller. Either an Arduino Uno R3 or the XMC1100 boot kit from Infineon can be used as the controller. Another way to control this board is via uIO port using Infineon uIO stick.

Image 11: DC-Shield BTN9970LV

3.2. MOTIX™ multi half-bridge ICs

TLE94xyz are protected half-bridge drivers designed for automotive motion control applications such as small DC motors for flaps in heating, ventilation and air conditioning (HVAC), as well as mirror adjustment and fold. All devices can drive DC motor loads up to 0.9 A per output in cascaded or parallel operation. They provide diagnosis of short circuit, open load, power supply failure and overtemperature for each half-bridge to ensure safe operation in HVAC or other systems. TLE94xyz offers enhanced EMC performance, which, in combination with the low quiescent current and a small package, makes the products attractive for automotive and other applications.

www.infineon.com/cms/en/product/power/motor-control-ics/brushed-dc-motor-driver-ics/multi-half-bridge-ics/

3.2. MOTIX™ multi half-bridge ICs (cont'd)

Image 12: Application diagram

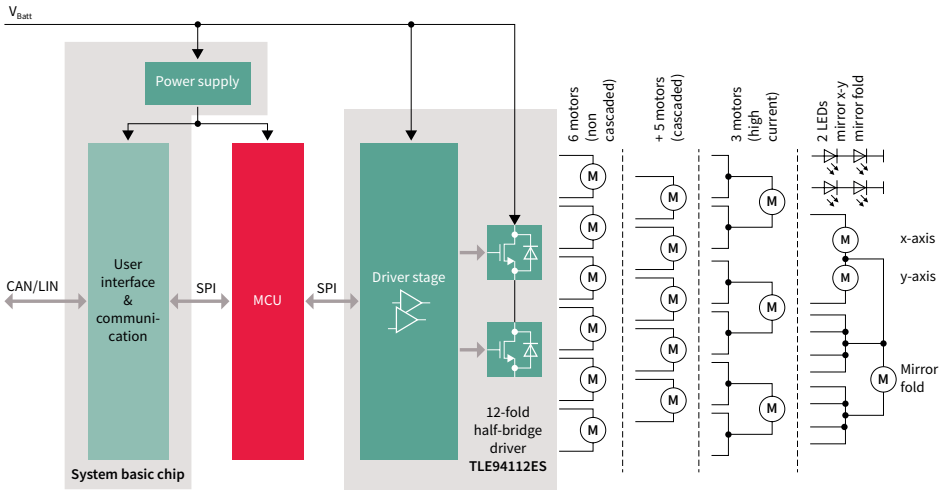
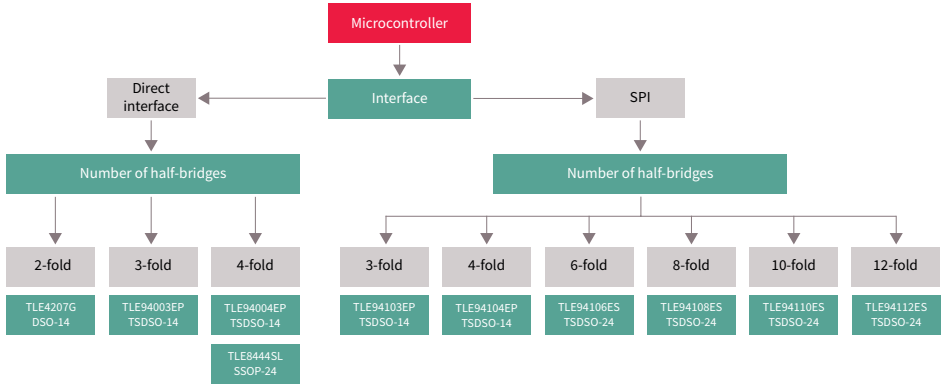


Image 13: Infineon's portfolio of multi half-bridge ICs



Key features & benefits

- 3-, 4-, 6-, 8-, 10-, 12-half-bridges with integrated output stages and PWM
- 6-bit SPI or direct inputs for control and diagnosis
- Voltage supply range: 5.5–20 V
- Adjustable open-load threshold for two outputs
- Variable driving schemes for up to 11 motors
- Diagnosis of each output via SPI
- Device operates down to 5.5 V (supporting start-stop systems of fuel-efficient vehicles)
- OUT 1 and 2 optimized for driving HS loads (e.g., LED)
- Qualified for automotive applications according to AEC-Q100

Applications

- Flap motors in HVAC systems
- Mirror adjustment and fold
- Small DC motors (≤ 0.9 A/output)
- Bi-stable relays

Boards and kits

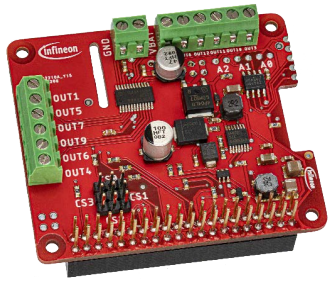
TLE94112ES_RPI_HAT

The Infineon DC motor control HAT with MOTIX™ TLE94112ES complies with Raspberry Pi HAT specification and it provides you with unique evaluation experience. It is equipped with the twelve-fold half-bridge driver TLE94112ES and comes with a ready-to-use software library. The HAT is also equipped with an Infineon TLS4125D0EP V50 synchronous step-down converter which can power the Raspberry Pi.

TLE94112ES_SHIELD

The DC motor shield is a small evaluation board equipped with MOTIX™ TLE94112ES for use with Arduino. The TLE94112ES is capable to drive up to 6 small DC motors in parallel mode or up to 11 DC motors in cascaded mode. All outputs can drive up to 0.9 A. The outputs can be used stand-alone or combined to increase driving capability up to 3.6 A.

Image 14: Shield TLE94112ES



3.3. MOTIX™ full bridge ICs

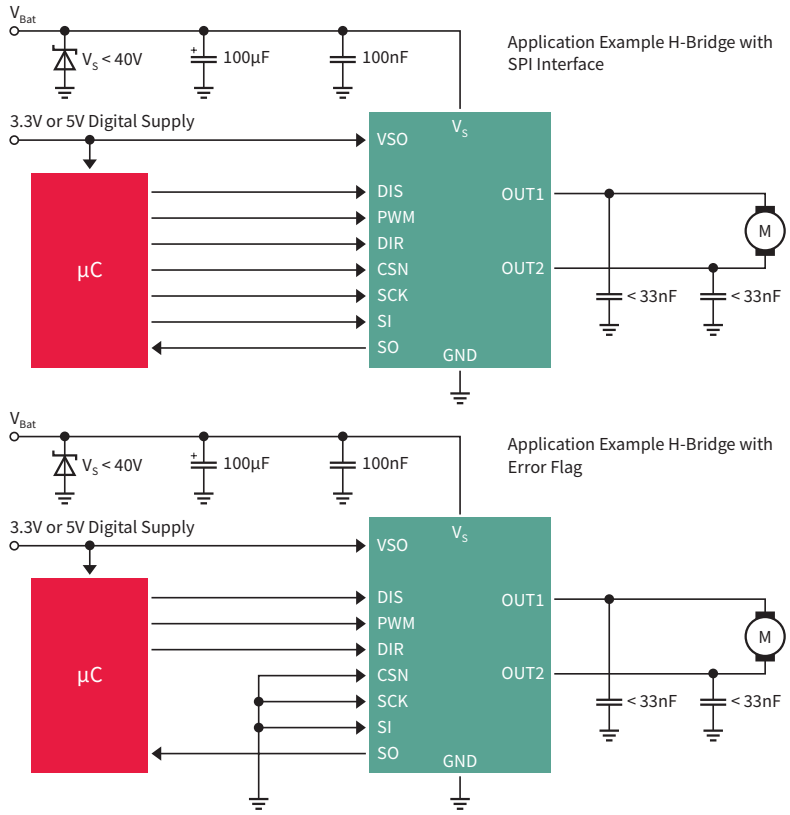
Infineon offers also full bridge drivers for operation voltages up to 42 V. The integrated bridges provide optimized diagnostic and protection as for example overtemperature (OT), overcurrent (OV) and short circuit (SC) protection and they are designed for the control of small DC motors and inductive loads. Infineon offers a dedicated device for automotive applications, MOTIX™ TLE9201SG, which is a 6 A H-bridge qualified according to AEC-Q100 and fulfills high quality and reliability standards for automotive applications like exhaust gas recirculation (EGR), idle speed control, swirl and tumble flaps or water pumps. This product offers the flexibility between choosing SPI for detailed diagnostic or simple error flag.

For industrial applications such as home appliance and building automation, power tools battery management and medical applications the MOTIX™ IFX9201SG is the right fit.

Key features & benefits

- $R_{DS(on)}$ (typ.) < 100 mΩ per switch
- Operation voltage: 4.5 V to 28 V
- Fully 3.3/5.5 V compatible logic inputs
- Low standby current
- Short circuit and overtemperature protection
- VS undervoltage protection
- Open load detection in ON and OFF state
- Detailed SPI diagnosis or simple error flag
- Qualified according automotive standard AEC-Q100
- Green product (RoHS compliant)
- Small package saves board space
- Includes over current and over temperature protection
- Simple design with few external components
- SPI enables for easy diagnosis

Image 15: Block diagram



Applications

- Exhaust Gas Recirculation (EGR)
- Variable Geometry Turbo (VGT)
- Idle speed sontrol
- Swirl and tumble flaps
- Variable intake manifold
- Turbo charger waste gate
- Auxiliary water pumps
- Industrial DC motor applications

3.4. MOTIX™ servo and stepper motor drivers ICs

Infineon offers dedicated drivers for DC motors in servo control applications as well as drivers for stepper motors.

MOTIX™ servo driver ICs: TLE4209G and TLE4206-2G are protected H-bridge drivers with an integrated closed loop control circuitry are available from Infineon. The drivers are optimized for use in head light beam control applications.

Key benefits

- Amplification and angle shift can be adjusted with external resistors
- Range input to protect reference potentiometer against short circuit

Applications

- Vertical light leveling using servo motors
- Applications with small servo motors

MOTX™ stepper motor driver ICs: Infineon's solution for driving stepper motors consists is the TLE8444SL which is capable to drive bipolar stepper motors in half-step mode.

Key benefits

- Small package helps to save PCB area
- Improved diagnosis for over- and under voltage-lockout and open load detection improve system reliability and performance
- The device also supports stepper motor applications

Applications

- DC motors in automotive and industrial applications
- Stepper motors in automotive and industrial applications (e.g. Idle speed control for small cars or motor bike)

4. MOTIX™ SBC: Medium-high integrated solutions

Infineon's MOTIX™ motor system IC is the world first IC to combine DC and BLDC motor control with integrated power supply, CAN FD & LIN functionality. The family features multi MOSFET driver in brushed DC 2x or 4x half bridges pre-driver as well as a 3-phase BLDC pre-driver configuration. The IC is complemented with a low-dropout voltage regulator of up to 250 mA, CAN FD (5 Mbit/s) and LIN transceiver as well as well as high-side switches (7 Ω typ.), wake inputs and supervision features.

Image 16: Application diagram TLE9560/1/2 for DC motor control

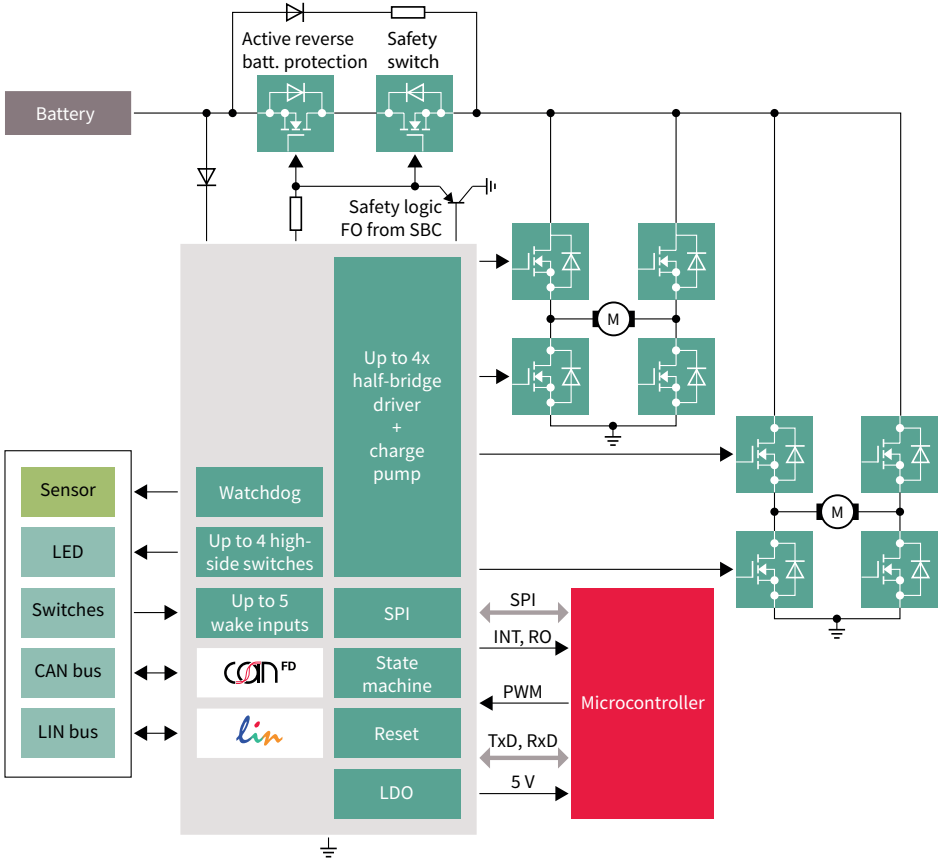
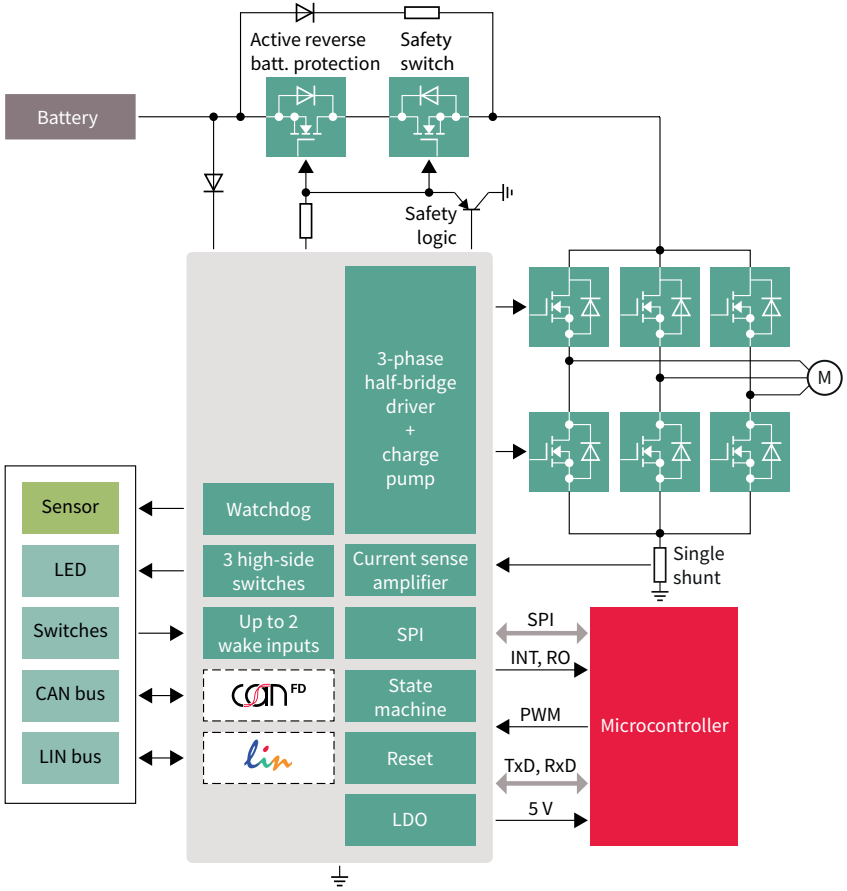


Image 17: Application diagram TLE9563/4 for BLDC motor control



Key features

- 2x/4x half-bridge drivers or 3ph driver with up to 6 PWM inputs
- 5 V LDO V_{CC1} up to 250 mA
- Adaptive MOSFET control
- 100 mA/150 mA constant gate charge current
- CAN FD up to 5 Mbps acc. ISO 11898-2:2016
- CAN PN FD Tolerant with “-3” variants
- LIN2.2B/J2602
- Up to 5 HV wake inputs
- Up to 4 protected HS Switches
- Window and Timeout Watchdog

Key applications

DC motor control

- Power lift gate
- Seat control module
- Sunroof module
- HVAC flaps
- Electric parking actuator
- Steering column lock
- Reversible seat belt

BLDC motor control

- Pumps
- Fans
- Sunroof
- Transfer case

System benefits

- Patented principle: optimized MOSFET switching provides lower switching losses and EMC optimization
- Preventing damages on ECU level due to intelligent motor braking, when closing/opening manually
- Peerless scalability within the motor system IC family and half bridges to reduce time-to-market
- First IC with integrated half-bridge driver, power supply and communication interface in the market

Tools and boards

These evaluation boards come with either one DC motor control IC of MOTIX™ TLE9562-3QX or one BLDC motor control IC of MOTIX™ TLE9563-3QX. The purpose of these boards is to provide a quick evaluation solution for customers’ lab assessments. The evaluation board offers a unique two in one solution. It can connected via a uIO stick with the computer to evaluate its features via ConfigWizard (a graphical user interface) which can be found in the Infineon Developer Center. In addition, the evaluation board features an Arduino Shield interface for rapid prototyping.

Image 18: MOTIX™ BLDC shield TLE9563-3QX

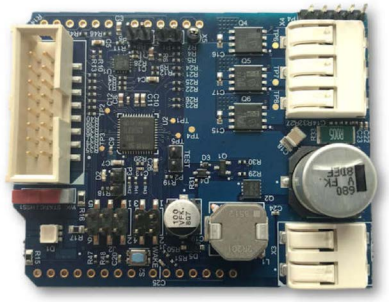
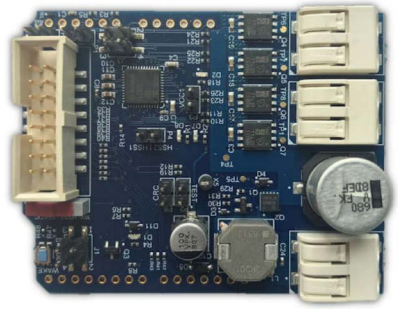


Image 19: MOTIX™ DC shield with TLE9562-3QX



Links

www.infineon.com/cms/en/product/power/motor-control-ics/bldc-motor-driver-ics/bldc-motor-system-ics/

www.infineon.com/cms/en/product/power/motor-control-ics/brushed-dc-motor-driver-ics/dc-motor-system-ics/

5. MOTIX™ MCU: High-integrated solutions

MOTIX™ MCU provides an unmatched level of integration with Arm® Cortex®-M CPU, power supply, transceiver and motor driver for < 1 kW BDC and BLDC motor control in body, comfort and thermal management applications.

5.1. MOTIX™ Embedded Power ICs — System-on-Chip motor control

MOTIX™ Embedded Power ICs are specifically designed to enable mechatronic motor control solutions for a range of motor control applications in which a small package form factor and a minimum number of external components are essential. Such applications include window lift, sunroof, wiper, fuel pump, HVAC blower, engine cooling fan, water and oil pump.

Produced on Infineon's first-in-industry automotive-qualified smart power technology, the MOTIX™ Embedded Power System-on-Chip (SoC) solutions offer the highest level of integration of all functions required to sense, control and actuate a motor on one single die. These functions include an Arm® Cortex®-M microcontroller, non-volatile flash memory, analog and mixed signal peripherals, communication interfaces along with driving stages needed for either relay, half-bridge or full-bridge DC and BLDC motor applications.

www.infineon.com/cms/en/product/microcontroller/embedded-power-ics-system-on-chip-/

Table 4: Selection table for MOTIX™ TLE98xx with LIN communication

Criteria	TLE984x	TLE9845	TLE9850/1	TLE985x	TLE986x	TLE987x
Controller	Arm® Cortex®-M0				Arm® Cortex®-M3	
Core frequency	25/40 MHz	40 MHz			24–40 MHz	
Flash size	36–64 KB	48 KB	48/64 KB	48–96 KB	36–256 KB	
Driver stage	Relay	Half-bridge		H-bridge		B6-bridge
		PN FET	NN FET	N FET		N FET
HV monitor inputs	4 – 5	5	4		0-1	
Junction temperature levels	150°C	150°C	150°C & 175°C	150°C & 175°C	150°C & 175°C	
Package	VQFN-48-31		VQFN-48-29 VQFN-48-31	VQFN-48-29 VQFN-48-31	VQFN-48-29 VQFN-48-31 TQFP-48-10	

Key features & benefits

- Enable cost and board improvements – the chip comes in a compact VQFN-48/TQFP-48 package with 7 x 7 mm footprint that enables PCB space saving. The MOTIX™ Embedded Power IC families allow driving of relays and MOSFETs at V_{Batt} > 6 V without external components, providing very cost effective solution on a system level. Extensive diagnostics and protections features are embedded within the system-on-chip
- Intelligent power saving modes including stop and sleep mode and energy management for external sensors (on demand)
- Support multiple and flexible designs with minimal effort – all MOTIX™ Embedded Power ICs are software compatible, maximizing a single design through scalability.

5.1. MOTIX™ Embedded Power ICs — System-on-Chip motor control (cont'd)

Applications

- Window lift
- Sunroof
- Wiper
- Fuel pump
- Oil pump
- Water pump
- HVAC blower

Tools and software

Infineon MOTIX™ Embedded Power ICs are supported by a complete development tool chain provided by Infineon and third-party vendors. For more details, please check Chapter 7.

For each MOTIX™ Embedded Power IC family we offer evaluation boards to evaluate all functions and peripherals providing access to all device I/Os. In addition, evaluation and applications kits are available which are space- and cost-optimized to demonstrate near-application solutions.

BLDC shield TLE9879

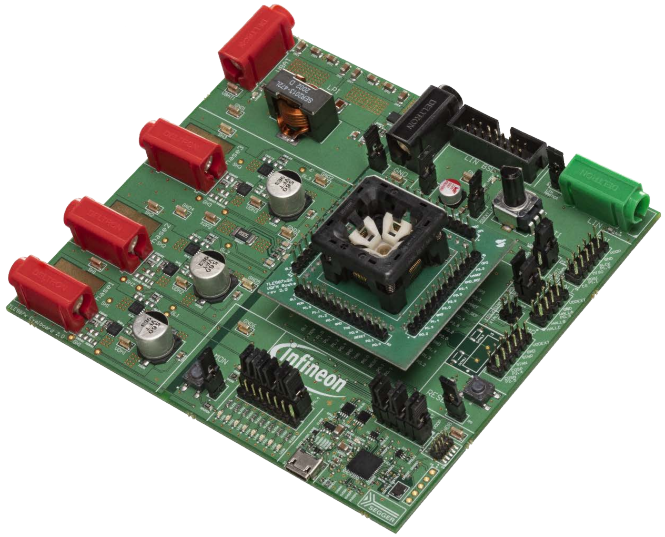
BLDC Shield for Arduino with TLE9879QXA40 is designed to drive BLDC motors in combination with an Arduino compatible baseboard. The shield is flashed with several motor control algorithms (sensorless FOC, hall sensor-based block commutation). The shield is controlled from the baseboard via SPI.

www.infineon.com/cms/en/product/microcontroller/embedded-power-ics-system-on-chip-/

Evaluation board for TLE987x VQFN/TQFP version

The TLE987X EVALB_VQFN and EVALB_TQFP offer complete evaluation of all functions and peripherals of the TLE987x product family and allows direct connection to a BLDC motor via MOSFETs in B6-Bridge configuration, it includes: B6-Bridge for BLDC motor drive, UART and LIN for communication, direct access to all device I/Os and an onboard debugger.

Image 20: Evaluation board



Links

www.infineon.com/cms/en/product/evaluation-boards/tle987x-evalb_vqfn/

www.infineon.com/cms/en/product/evaluation-boards/tle987x-evalb_tqfp/

6. Complementary devices

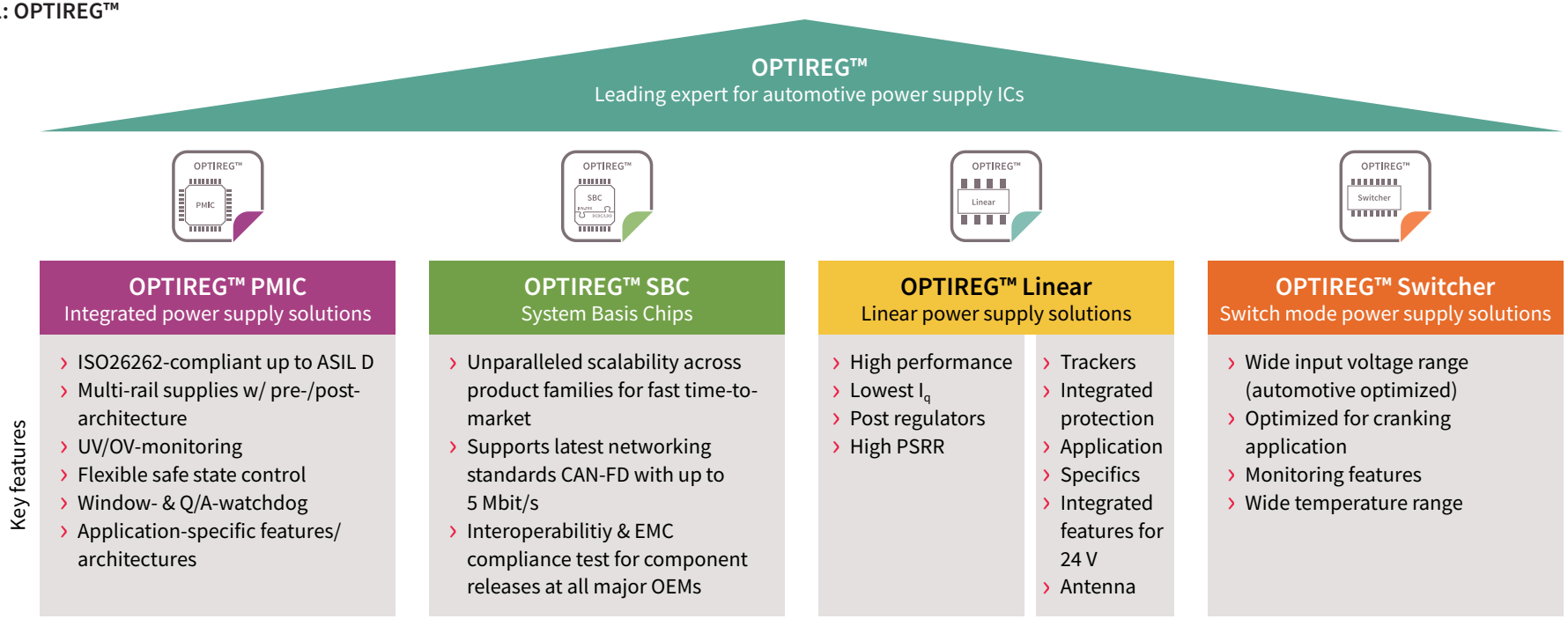
6.1 OPTIREG™ power supply ICs – unregulated input, optimally regulated output

In automotive ECUs, microcontrollers and other electronic system components have to be supplied by a stable and reliable voltage that is lower than the battery voltage (e.g., 3.3 V or 5 V) and works over the entire temperature range (from –40°C to 150°C). Dependable power supply guarantees smooth functionality.

As the market leader in power semiconductor solutions for automotive applications, we created the OPTIREG™ Power Supply IC portfolio to meet today's and tomorrow's design challenges. This OPTIREG™ family is the broadest dedicated power IC portfolio for automotive applications currently available in the market.

With the most comprehensive portfolio in the market, OPTIREG™ offers the perfect fit for every design challenge, scaling from discrete to fully integrated system solutions (supplying sensors, microcontrollers, actuators and network ICs). Giving customers unprecedented choice, OPTIREG™ covers everything from linear voltage regulators to DC-DCs and power management ICs; from tiny (TSNP) to thermally optimized (D^2PAK) packages; and power ranges from 25 mA to several amps.

Image 21: OPTIREG™



6.1.1 OPTIREG™ Linear – power supply solutions

Infineon offers you a comprehensive high performance portfolio of linear voltage regulators fitting in a broad range of automotive applications. All our devices are especially designed for use in harsh automotive environments and are offered in the highest quality level and long–term reliability.

Our portfolio implements many automotive specific product features such: reset, watchdog, early warning help to solve almost all design challenges in the application.

Table 5: Product overview linear voltage regulators & DC/DC converter

Product name	Operating voltage (min.) [V]	Operating voltage (max.) [V]	Output voltage type	Accuracy [%]	Output current (max.) [mA]	Regulator type	Package
TLS115B0/D0	4.0	40	adj.	0.1	150	Linear → Tracker	DSO-8/ TSON-9
TLE4250-2	4.0	40	adj.	0.5	50	Linear → Tracker	SCT595-5
TLS820F0	3.0	40	3.3, 5.0 V	2.0	200	Linear → High perfornce regulators	SSOP-14
TLS850D0/-F0	3.0	40	3.3, 5.0 V	2.0	500	Linear → High perfornce regulators	TO263-7/ TO252-5
TLE4473G V55-2	5.6	42	5.0 V	2.5/2.0	300	Linear → Multiple output	DSO-12

www.infineon.com/optireg-linear

6.1.2 OPTIREG™ SBC – system basis chips

An SBC is an integrated component that combines common system features required on automotive ECUs such as: communication transceivers, voltage regulators, diagnostics and supervision functions, switches and wake inputs.

Table 6: Product overview system basis chips & power management ICs

Product name	Transmission rate (max.) [MBit/s]	Voltage regulator output (V_{CC1})	Voltage regulator output (V_{CC2})	Voltage regulator output (V_{CC3})	Output drivers	Quiescent current	Standby current	Package
TLE9261x	5	5 V or 3.3 V/ 250 mA	5 V/ 100 mA	5 V or 3.3 V/ up to 400 mA	4 x High-Side Switch 150 mA	15 µA (typ) Sleep mode	44 µA (typ) Stop mode	VQFN-48
TLE9262x	5	5 V or 3.3 V/ 250 mA	5 V/ 100 mA	5 V or 3.3 V/ up to 400 mA	4 x High-Side Switch 150 mA	15 µA (typ) Sleep mode	44 µA (typ) Stop mode	VQFN-48
TLE9263x	5	5 V or 3.3 V/ 250 mA	5 V/ 100 mA	5 V or 3.3 V/ up to 400 mA	4 x High-Side Switch 150 mA	15 µA (typ) Sleep mode	44 µA (typ) Stop mode	VQFN-48

www.infineon.com/optireg-sbc

6.2. User Interface and communications: automotive transceivers

Infineon offers a broad product portfolio of automotive transceivers — all of which are perfectly suited and designed to withstand the harsh automotive environment — for the various automotive bus segments. Different transceiver types are used in accordance with the respective vehicle network architecture and the related ECU supply path. Infineon transceivers ensure reliable communication and help minimize the current consumption and associated CO_2 emissions at the vehicle level. Thanks to their high performance, ruggedness and reliable communication, Infineon's transceiver products offer the ultimate in value.

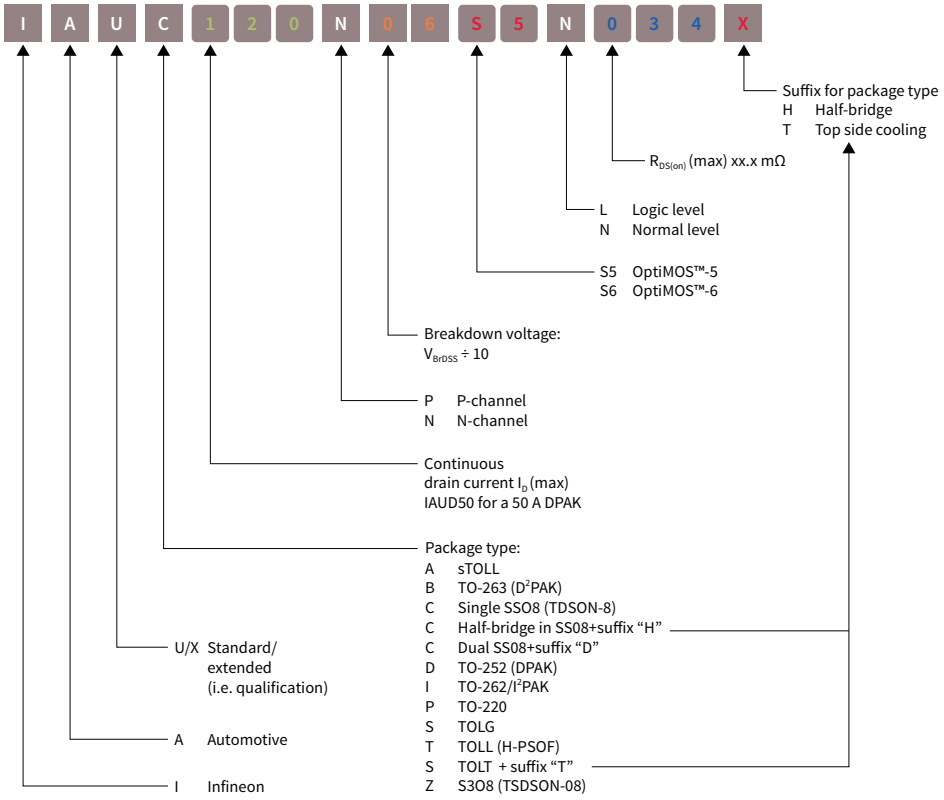
Table 7: Product overview CAN-FD transceivers/ LIN transceivers

Product name	Family	Quiescent current	Bus wake-up capability	Additional features	Package
TLE935x	CAN FD 5MBit/s	< 18 µA @ 5 V standby	No	NEN, Vio	DSO-8
TLE9251x	CAN FD 5MBit/s	< 15 µA @ 5 V standby	Yes	STB, Vio	DSO-8
TLE9250x	CAN FD 5MBit/s	< 15 µA @ 5 V standby	No	NEN, Vio	TSON-8
TLE725x	LIN	< 10 µA sleep mode	Yes	INH, EN	DSO-8
TLE7268x	LIN	< 20 µA sleep mode	Yes	Multiple channel, 2x LIN trx, INH, EN	DSO-14
TLE8457x	LIN	< 10 µA sleep mode	Yes	5.0 V output VREG, EN, RESET	TSON-8

6.3. MOSFETs

Infineon offers a wide portfolio of automotive MOSFETs in a variety of packages to target all automotive applications. You can find the smallest S3O8 (3 x 3 mm^2) package, an integration of two MOSFETs in a half-bridge configuration in the SSO8-HB (5 x 6 mm^2) package, but also the standard single SSO8 (5 x 6 mm^2) or the standard single sTOLL (7 x 8mm^2) for high power and even the highest power density in a 10 x 15 mm^2 TOLL or TOLT (top side cooling) package for your applications need, for example.

Image 22: Automotive MOSFET naming system



Key features and benefits

- Best-in-class $R_{DS(on)}$ performance for increased system efficiency
- Lowest switching and conduction power losses for increased thermal system reliability
- Benchmark for quality and reliability
- Wide voltage range from 24 V to 300 V for N-Channel FET, and from 20 V to 150 V for P-Channel FET
- Robust green package for easy process handling
- Diversified package portfolio caters to customers' needs for
  - Package size minimization (down to 11 mm² in S3O8)
  - High current capability (up to 300 A in TOLx)
  - Top side cooled package for high power density designs
  - Integrated half-bridge for motor control applications

S3O8 Single (TSDSON-8)	SSO8 Half-Bridge (TDSON-8)	SSO8 Dual (TDSON-8)	SSO8 Single (TDSON-8)
			
3 x 3 mm²	5 x 6 mm²	5 x 6 mm²	5 x 6 mm²

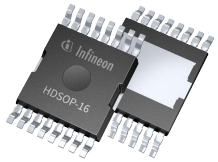
sTOLL Single (HSOF-5)	TOLL Single (HSOF-8)	TOLG Single (HSOG-8)	TOLT Single (HDSOP-16)
			
7 x 8 mm²	10 x 12 mm²	10 x 12 mm²	10 x 15 mm²

Table 8: 40 V, 60 V, 80 V & 100 V single N-channel MOSFET overview in S3O8 package

Product type	Technology	$R_{DS(on)}$ @ 10 V [mΩ]	I_D [A]	Normal/ Logic level	V_{DS} (max) [V]
IPZ40N04S5L-3R6	OptiMOS™ 5	3.6	40	LL	40
IAUZ40N06S5N050	OptiMOS™ 5	5.0	40	NL	60
IAUZ40N08S5N100	OptiMOS™ 5	10.0	40	NL	80
IAUZ20N08S5L300	OptiMOS™ 5	30.0	20	LL	80
IAUZ40N10S5L120	OptiMOS™ 5	12.0	30	LL	100

Two MOSFET in the S3O8 package with the size of 3 x 3 mm, take less space than a single 5 x 6 device. With a current capability of up to 40 A, they can be used in several automotive applications, such as motor drives of up to 250 W, LED car lighting or 48 V fans.

Table 9: 40 V, 60 V, 80 V & 100 V single N-channel MOSFET overview in single SSO8 package

Product type	Technology	$R_{DS(on)}$ @ 10 V [mΩ]	I_D [A]	Normal/ Logic level	V_{DS} (max) [V]
IAUC120N04S6L005	OptiMOS™ 6	0.55	120	LL	40
IAUC120N06S5N017	OptiMOS™ 5	1.70	120	NL	60
IAUC41N06S5N102	OptiMOS™ 5	10.20	41	NL	60
IAUC28N08S5L230	OptiMOS™ 5	23.00	28	LL	80
IAUC26N10S5L245	OptiMOS™ 5	24.50	26	LL	100

The single 5 x 6 mm² package offers a wide portfolio in 40 V, 60 V 80 V and 100 V automotive MOSFETs for a variety of applications.

Table 10: 40 V dual N-channel MOSFET in half-bridge configuration in SSO8 package

Product type	Technology	$R_{DS(on)}$ @ 10 V [mΩ]	I_D [A]	Normal/ Logic level	V_{DS} (max) [V]
IAUC60N04S6L030H	OptiMOS™ 6	3.0	60	LL	40
IAUC60N04S6N031H	OptiMOS™ 6	3.1	60	NL	40
IAUC60N04S6N050H	OptiMOS™ 6	5.0	60	NL	40
IAUC45N04S6L063H	OptiMOS™ 6	6.3	45	LL	40
IAUC45N04S6N070H	OptiMOS™ 6	7.0	45	NL	40

The new and innovative half-bridge enables easier routing and space saving for motor drive applications with a current capability of up to 60 A. PCBs for window lift, seat adjustment, body control module or electric parking brake are only a view examples where you can save area in your design.

Table 11: 40 V, 80 V & 100 V N-channel MOSFET in sTOLL package

Product type	Technology	$R_{DS(on)}$ @ 10 V [mΩ]	I_D [A]	Normal/ Logic level	V_{DS} (max) [V]
IAUA250N04S6N005	OptiMOS™ 5	0.55	250	NL	40
IAUA250N04S6N007E	OptiMOS™ 6	0.70	250	NL	40
IAUA120N04S5N014	OptiMOS™ 5	1.40	120	NL	40
IAUA250N08S5N018	OptiMOS™ 5	1.80	250	NL	80
IAUA170N10S5N031	OptiMOS™ 5	3.10	170	NL	100

The sTOLL is Infineon's high power leadless package in 7 x 8 mm², offering high current capability of 250 A and a footprint of 56 mm² which is even smaller than the DPAK (65 mm²). In combination with the leading OptiMOS™ power MOS technology, sTOLL offers best in class power density and power efficiency at Infineon's well known quality level for robust automotive packages.

Table 12: 40 V, 80 V & 100 V N-channel MOSFET in TOLL package

Product type	Technology	$R_{DS(on)}$ @ 10 V [mΩ]	I_D [A]	Normal/ Logic level	V_{DS} (max) [V]
IPLU300N04S4-R8	OptiMOS™ T2	0.77	300	NL	40
IPLU300N04S4-1R1	OptiMOS™ T2	1.15	300	NL	40
IAUT300N08S5N011	OptiMOS™ 5	1.10	300	NL	80
IAUT300N10S5N014	OptiMOS™ 5	1.40	300	NL	100
IAUT260N10S5N019	OptiMOS™ 5	1.90	260	NL	100

The 10 x 12 mm² TOLL package is suitable for applications where excellent thermal performance is required. Available in 40 V, 80 V and 100 V they are suitable for DC-DC applications, battery disconnect switches and other application with high current requirements.

Table 13: 80 V & 100 V N-channel MOSFET in top-side-cooled TOLT package

Product type	Technology	$R_{DS(on)}$ @ 10 V [mΩ]	I_D [A]	Normal/ Logic level	V_{DS} (max) [V]
IAUS300N08S5N011T	OptiMOS™ 5	1.1	300	NL	80
IAUS300N08S5N012T	OptiMOS™ 5	1.2	300	NL	80
IAUS300N08S5N014T	OptiMOS™ 5	1.4	300	NL	80
IAUS300N10S5N015T	OptiMOS™ 5	1.5	300	NL	100
IAUS260N10S5N019T	OptiMOS™ 5	1.9	260	NL	100

Top side cooling is an alternative to the conventional cooling towards the substrate commonly used. Infineon's TOLT package, with the drain exposed at the top, reduces the heat path by eliminating the PCB and solder interconnect from the heat path. This has a huge impact on the MOSFET performance. The TOLT package available for 80 V and 100 V is perfectly suited for high power 48 V applications.

Table 14: 80 V & 100 V N-channel MOSFET in TOLG package

Product type	Technology	$R_{DS(on)}$ @ 10 V [mΩ]	I_D [A]	Normal/ Logic level	V_{DS} (max) [V]
IAUS300N08S5N011	OptiMOS™ 5	1.1	300	NL	80
IAUS300N08S5N012	OptiMOS™ 5	1.2	300	NL	80
IAUS200N08S5N023	OptiMOS™ 5	2.3	200	NL	80
IAUS165N08S5N029	OptiMOS™ 5	1.5	165	NL	80
IAUS300N10S5N014	OptiMOS™ 5	1.4	300	NL	100

The TOLG (10 x 12 mm²) package is recommended for Al core IMS and Cu based substrates. It is pin-to-pin compatible with the TOLL package and suitable for parallel placement. It offers minimized conduction and lowest switching losses with Infineon's benchmark OptiMOS™ 5 technology.

6.4. XENSIV™ – Magnetic sensors for motor control

Exceptionally precise thanks to industry-leading magnetic technologies

Infineon offers a broad portfolio of dedicated position sensor products for motor control applications, which are not only leading from a technical point of view, but which offer considerable advantages on the system cost and quality side. The portfolio ranges from Hall latches to angle sensors and 3D Hall sensors offering flexibility in choosing the most appropriate measuring principle and the best fitting mounting position of the sensor. Infineon magnetic position sensors allow for small and robust designs providing precise information on the position of the rotor for motor control which considerably improves the overall system performance

6.4.1 Hall latches

Our XENSIV™ TLE/TLI/TLV496x-xM/L family of hall switches saves energy and enables designers to create precise and compact systems.

The 5 V high-precision automotive/industrial hall-effect sensor (TLE/TLI4963-xM) and the up to 32 V energy-efficient automotive/industrial/consumer hall switch (TLE/TLI/TLV4961-xM/L) are the perfect fit for motor control applications.

Table 15: Product overview

Product name	Type	Operating point B_{OP} [mT]	Release point B_{RP} [mT]	Hysteresis ΔB_{HY} [mT]	Automotive	Industrial	Consumer	Package
TLE4961-1M/L	Latch	2.0	-2.0	4.0	●	●	●	SOT23/ SSO-3-2
TLE4961-2M	Latch	5.0	-5.0	10.0	●	●	●	SOT23
TLE4961-3M/L	Latch	7.5	-7.5	15.0	●	●	●	SOT23/ SSO-3-2
TLE4961-4M	Latch	10.0	-10.0	20.0	●	●	●	SOT23
TLE4961-5M	Latch	15.0	-15.0	30.0	●	●	●	SOT23

6.4.2 3D Hall sensors

Infineon 3D magnetic sensors can be used for out of shaft rotation in order to detect motor position. The XENSIV™ sensor TLE/TLI/TLV493D-X2B6/W's features include a sensor address read-back feature for additional communication verification, a half range mode focusing to half of the magnetic range, ensuring higher accuracy, and an angular mode (for x and y readout only). The 3D sensor family with an enhanced dynamic wake-up feature was developed. Four pre-programmed address options (A0-A3) are available, enabling for a fast start-up initialization when used in I^2C bus configurations.

Table 16: Product overview

Product name	Temperature range	Qualific.	Linear magnetic range	Resolution	I_{DD}	Update rate	Package
TLI493D-A2B6	-40 … 105°C	JESD47	±160 mT (min) ±100 mT (min)	7.7 or 15.4 LSB12/mT	7 nA – 3.3 mA	10 Hz – 8.4 kHz	TSOP6
TLE493D-W2B6 A0 TLE493D-W2B6 A1 TLE493D-W2B6 A2 TLE493D-W2B6 A3	-40 … 125°C	AEC-Q100	±160 mT (min) ±100 mT (min)	130 µT/LSB (65 µT/LSB)[1)]	7 nA – 3.3 mA	0.05 Hz – 8.4 kHz	TSOP6

1) Half range mode

6.4.3 Angle sensors based on integrated Magneto Resistive (ixMR) technologies

The Infineon family of angle sensors detect the orientation of an applied magnetic field by measuring sine and cosine angle components with monolithically integrated magneto resistive elements.

Infineon's iGMR sensors are ideal for applications with a wide angle range, such as BLDC motor or steering sensors. They are pre-calibrated and ready-to-use. Different levels of signal processing integration enable designers to optimize system partitioning.

Our iAMR sensors are ideal for applications with the highest accuracy requirements, as they offer best performance over temperature, lifetime and magnetic field range.

XENSIV™ TLE5501 is a fast analogue TMR-based angle sensors dedicated to automotive applications.

Table 17: Product overview

Product name	Technology	Die configuration	Sin/cos output	Angle output	Second interface	Accuracy	ISO 26262	Package
TLE5011	GMR	Single die	SSC (SPI)	–	–	1.6°	Ready	DSO-8
TLI5012B	GMR	Single die	SSC (SPI)	SSC (SPI)	PWM/IIF/ SPC/HSM	1.9°	QM	DSO-8
TLE5501	TMR	Single die	Analog sin/cos	–	–	1.0°	Compliant	DSO-8

Their fields of use for Infineon angle sensors range from steering angle applications with the highest functional safety requirements to motors for wipers, pumps and actuators and electric motors in general. They are also ready to be used in industrial and consumer applications like robotics or gimbal.

Your compact guide to the vast and innovative world of XENSIV™ sensors – www.infineon.com/xensiv-selectionguide

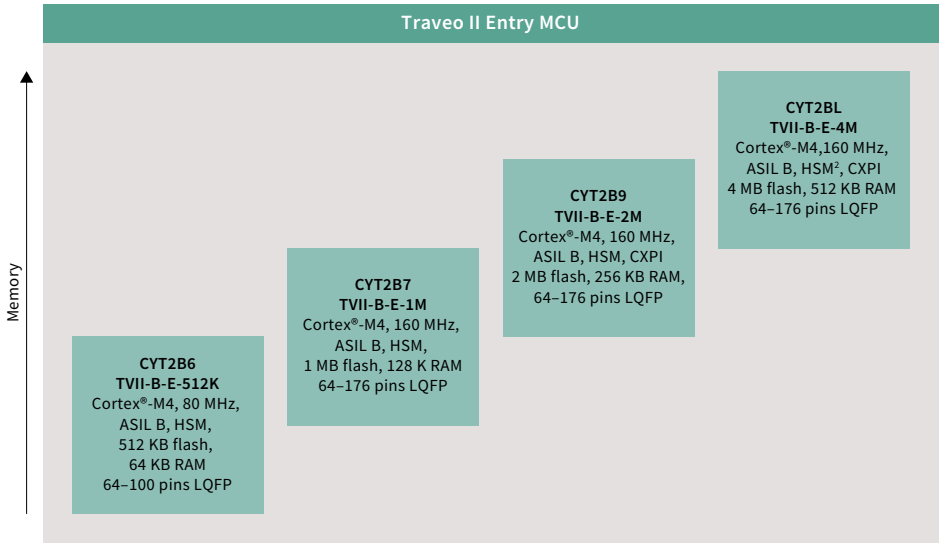
Find your sensor: www.infineon.com/fastfinder

6.5. TRAVEO™ II Entry MCU (based on 32-bit Arm® Cortex® M4F)

The TRAVEO™ II Entry MCU family is designed for automotive body electronics applications and offers cutting-edge performance, safety, and security features. With processing power and network connectivity built into a single Arm® Cortex®-M4F, this family of microcontrollers has enhanced performance up to 1500 DMIPS. This family also provides the scalability across memory size and pin count and the IP compatibility enable customers to design and develop their system with a single-platform MCU solution. TRAVEO™ II MCUs come with optimized software platform that is available with AUTOSAR MCAL (Microcontroller Abstraction Layer) and HSM Performance Library.

The TRAVEO™ II Entry MCU family consists of four sub-families, which scale up to 4 MB Flash/512 KB RAM: CYT2B6, CYT2B7, CYT2B9 and CYT2BL. All sub-families offer cutting-edge features like dual-bank flash support for SOTA, embedded HSM and advanced timer units for motor control.

Image 23: TRAVEO™ II Entry MCU



6.6. AURIX™ 32-bit microcontroller for Motor Control applications

AURIX™ for high-performance, multicore and safety-demanding applications
The AURIX™ 32-bit microcontroller family is based on the Infineon TriCore™ high-performance core concept and provides a highly scalable family from single core to multicore.

The AURIX™ family enables the highest integrated safe memory sizes (SRAM up to 6.9 MB and flash memory up to 16 MB) and all memory is protected by hardware Error Correction Code (ECC). The devices reach more than 600 DMIPS at clock rates of up to 6x 300 MHz and combine MCU and DSP instructions with an integrated FPU.

The integrated peripheral set is primarily targeted toward motor control and power conversion, providing high-performance ADCs, DS ADCs and a full set of diverse high-performance timers. This is one of the very few in the industry that is able to drive the upcoming three-level inverter topologies. Furthermore, the AURIX™ family supports the latest connectivity, such as Ethernet, CAN FD, FlexRay and multiple other high-speed interfaces.

Key features

- Dedicated peripheral set: LIN, CAN, CAN-FD, SPI, FlexRay, Ethernet
- Advanced timer unit for totally flexible PWM generation and hardware input capture
- ISO 26262 conformance to support safety requirements up to ASIL D
- Redundant flexible 12-bit ADC
- Innovative supply concept leads to best-in-class power consumption
- Safety and development support by Infineon's preferred design houses, see list on www.infineon.com/pdh

Product recommendation: AURIX™ TC38x
www.infineon.com/cms/en/product/microcontroller/32-bit-tricore-microcontroller/32-bit-tricore-aurix-tc3xx/aurix-family-tc38xqp/

Table 18: 32-bit TriCore™ AURIX™

Product type	Max clock frequency [MHz]	Program memory [KByte]	SRAM (incl. cache) [KByte]	Cores/lockstep	Number of ADC channels	External bus interface	CAN/CAN FD nodes	Communication interfaces	Temperature ranges	Packages	Additional features/ remarks
AURIX™ TC2xx family											
TC237LP	200	2000	192	1/1	24	No	6	2x ASCLIN, 4x QSPI, 4x SENT, FlexRay, CAN FD	K	LFBGA-292	EVR, WUT, HSM
TC234LP	200	2000	192	1/1	24	No	6	2x ASCLIN, 4x QSPI, 4x SENT, FlexRay, CAN FD	K	TQFP-144	EVR, WUT, HSM
AURIX™ TC3xx family											
TC387QP	300	10 000 flash	1 568	4/2	124	No	3/3x4	12x CAN FD, 2x FlexRay, 24x LINs, 5x QSPI, 2x I^2C, 25x SENT, 5x PSI, 1x HSSL, 3x MSC	-40°C to 125°C	LFBGA-292	HSM compliant eVita full Ethernet
TC389QP	300	10 000 flash	1 568	4/2	124	No	3/3x4	12x CAN FD, 2x FlexRay, 24x LINs, 5x QSPI, 2x I^2C, 25x SENT, 5x PSI, 1x HSSL, 3x MSC	-40°C to 125°C	FBGA-516	HSM compliant eVita full Ethernet

7. Support & Services

7.1 Infineon Developer Center

All Infineon tools in one place. The Infineon Developer Center is available both as online and as desktop application for easy discovery, download and installation of Infineon tools. Furthermore, you can register your evaluation kits and boards there for an easy and guided start and to receive additional documentation. You can also share your projects with your colleagues and/or our support interfaces.
Please follow the link: https://softwaretools.infineon.com/welcome

Development tools & software for MOTIX™
Infineon MOTIX™ products are supported by several tools to support the design in process, e.g. for MOTIX™ MCU, also known as Embedded Power ICs a complete development tool chain provided by Infineon and third party vendors is available. The tool chain includes compilers, debuggers, evaluation boards, LIN low level drivers and configuration tools as well as variety of example software code.

- MOTIX™ Config Wizard for several MOTIX™ product families
- Power dissipation tool
- Micro inspector Pro for MOTIX™ MCU
- Boot strap loader support via µIO stick
- Application notes
- User manual
- Trainings and eLearnings

7.2 Reference designs

We do not only offer dedicated evaluation kits and boards for the whole MOTIX™ portfolio but also dedicated reference designs for specific applications. With Infineon reference designs we help to reduce time to market by providing a proven chipset for specific applications including EMC tests and detailed documentation. With state of the art components, a minimal BOM and a reduced PCB size can be achieved and therefore cost competitive solutions are offered.

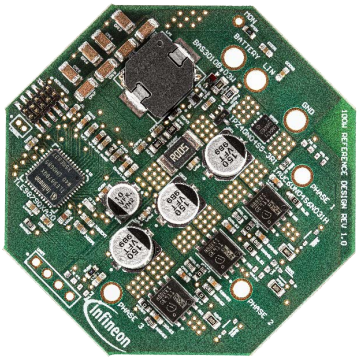
The reference designs are optimized in terms of EMC and thermal behavior. Moreover, it includes comprehensive support material including layout and schematic files (Altium), EMC tests, thermal analysis and detailed documentation.

7.2.1 100 W auxiliary water pump

This reference design is developed for 3-phase automotive auxiliary water pumps in thermal management systems up to 140 W. It is a reference for EMC and thermal performance and comes at the same time with an optimized BOM and PCB size (55 x 55 mm).

It features MOTIX™ TLE9879QXW40 which integrates an industry standard Arm® Cortex®-M3 core along with LIN transceiver, bridge driver and power supply, enabling the implementation of advanced motor control algorithms such as sensorless field-oriented control (FOC) and IAUC60N04S6N031H, a 40 V MOSFET in 5x6 SSO8 package, using Infineon's leading OptiMOS™-6 technology. It offers cost efficiency for low and mid power drive applications. Moreover, it provides sizably reduced PCB size due to enhanced routing for bridge applications.

Image 24: Board

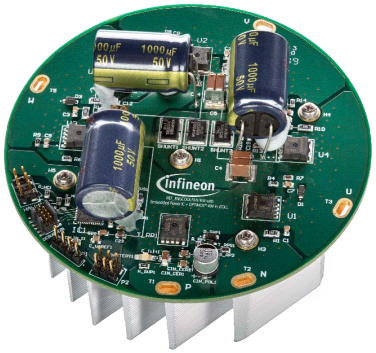


7.2.2 Engine cooling fan

The reference design is an automotive 3-phase motor drive for an engine cooling fan application using MOSFETs with a gate charge > 100 µC. It presents the current capability via the first worldwide integrated bridge driver capable to drive 1 kW motors at 12 V.

The main component used in the reference is MOTIX™ TLE9879QXW40, which is a single chip 3-phase motor driver, System-on-Chip solution. It integrates the industry standard Arm® Cortex®-M3 core along with LIN transceiver, bridge driver and power supply, enabling the implementation of advanced motor control algorithms such as sensor-less field-oriented control (FOC). This device is accomplished by IAUA250N04S6N007, an OptiMOS™-6 40V MOSFET in high-power leadless sTOLL package, providing higher current capability in smaller form factor of 7 x 8 mm^2 without sacrificing thermal performance. In combination with OptiMOS™-6 40V power MOS technology, sTOLL offers best in class power density and power efficiency at Infineon's well known quality level for robust automotive packages.

Image 25: Board



7.2.3 Central door lock

The reference design describes a detailed implementation of a central door lock application where the control of all lock motors occurs from a central location such as a body control module. It is shown how proper protection and diagnosis of external MOSFETs is ensured using the multiple MOSFET driver MOTIX™ TLE92108-232QX in combination with OptiMOS™-6 half-bridge MOSFETs. The multiple MOSFET driver is controlled by Traveo™ II CYT4BF series microcontroller, which is especially designed for body control modules. The TLE9471ES system basis chip (SBC) is used to power the microcontroller and provides a CAN transceiver for communication.

7.2.4 Window lift

A reference design for window lift application (using brushed DC motors and H-bridge MOSFET configuration) aims to minimize the overall number of components. It combines MOTIX™ TLE9855QX with the integrated half-bridge IAUC60N04S6N031H (OptiMOS™-6 40V MOSFET in SSO8 package) and the high precision Hall-effect sensor TLE4966G (providing rotational speed and direction detection).

7.3 Software offering

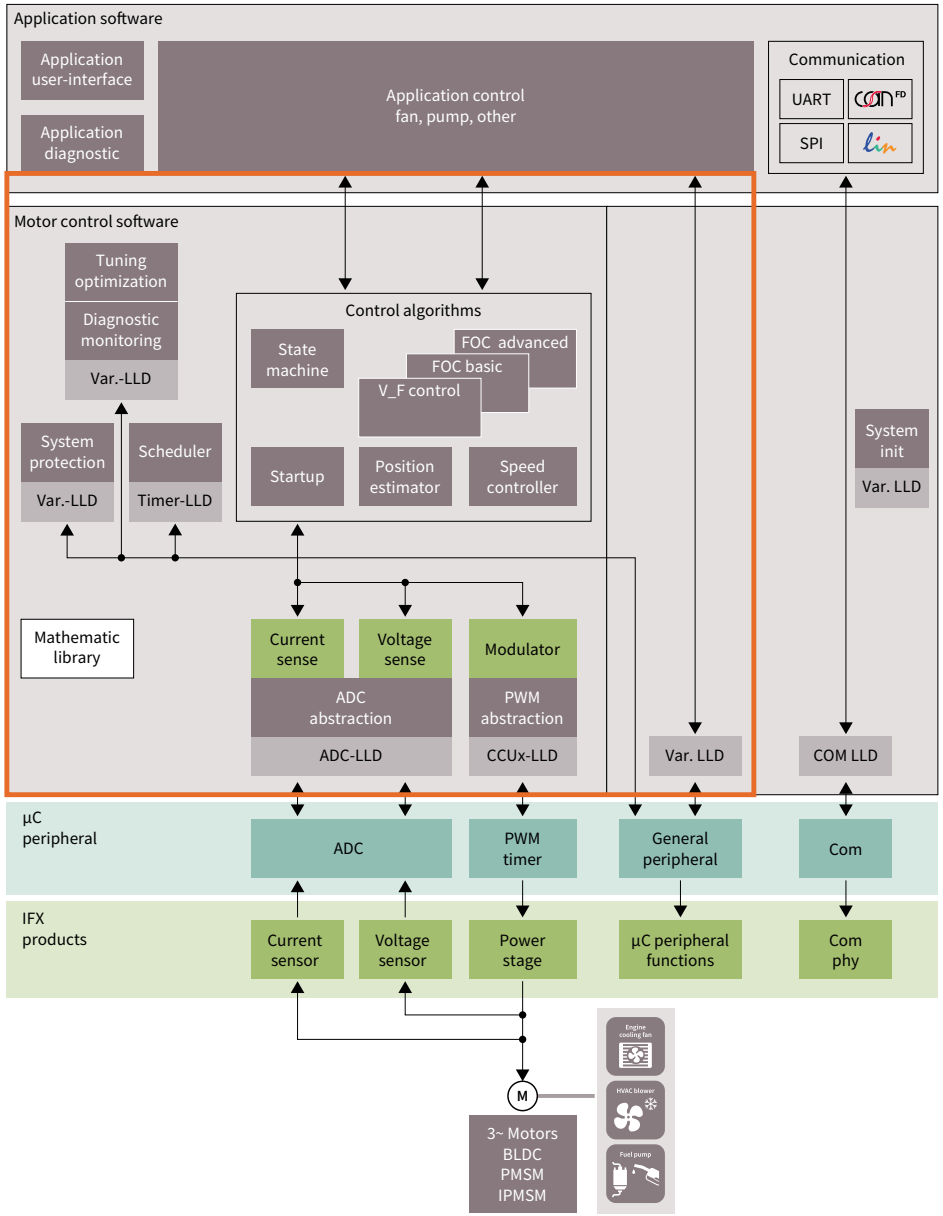
Infineon has a new professional motor control offering for BLDC driven automotive applications improving customer time to market based on software and tools.

7.3.1 TLE98xx motor control software

Key features	
› Sensorless FOC 3-phase (I)PMSM and BLDC motors	› Supported by Embedded Power System Development Kit
› Single-shunt current measurement scheme	› Interface to PC-tools for easy configuration & parameter optimization
› Modularized software architecture & Platform allows scalable software solutions on TLE98xx	› MISRA C: 2012 compliant (A-SPICE level 1 target)
› Support of Multiple Compilers (Arm® Compiler 5 & 6)	› Production Ready Quality (ensured by automated testing including test coverage report)

Infineon's motor control software is available as free-of-charge ECO version to demonstrate the device performance and as BASIC version which is production-ready and process-compliant.

Image 26: Application diagram

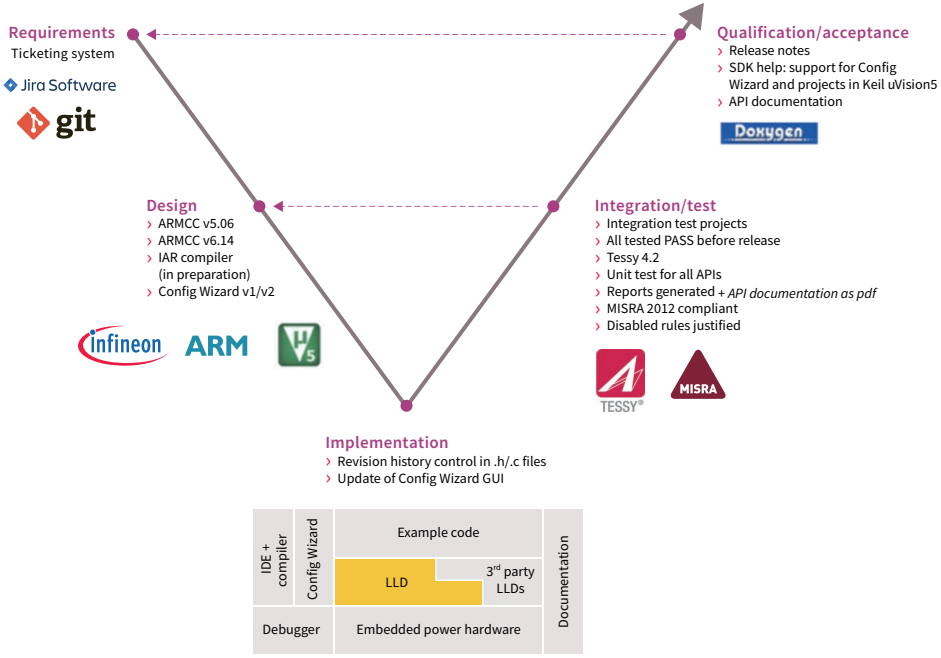


7.3.2 Documentation for low level driver

Infineon low level drivers contain a file pair (c./.h file) per module to allow the initialization and the configuration of the module during runtime via the provided APIs. The documentation package includes not only the source code, API documentation and release notes but also the MISRA exceptions reports, unit test reports and an integration test report, which show that all tests are PASS before release.

Communication low level drivers (LIN, CAN) are provided by IHR, Vector, etc. (COM LDD).

Image 26: Application diagram



7.3.3 Traveo™ II AUTOSAR 4.2.2 MCAL software

Traveo™ II supports all relevant versions of AUTOSAR MCAL, including optional microcontroller modules such as core test, flash test, RAM test, flash EEPROM emulation.

Please follow the link:
www.hitex.com/tools-components/software-components/mcal-and-complex-drivers/traveo-autosar-software-mcal

7.3.4 Traveo™ II HSM performance library

Developed in automotive SPICE QM process and compliant to MISRA C:2012 with AMD1 and SEI CERT C 2016, Traveo™ II II HSM performance library supports the lean implementation to achieve highest AES and CMAC performance.

Please follow the link:
www.hitex.com/tools-components/software-components/embedded-security/traveo-ii-hsm-performance-library

7.4 Design-in support

On the dedicated product pages a variety of different simulation models are available. The models help to understand the behavior of specific features of the device better. Simulation models are available for PSPICE, Saber, SIMetrix and orCAD for e.g. CSA, charge pump, several configurations of a bridge driver (uni-directional, bi-directional, full-bridge, half-bridge, etc.) and IBIS (Input/output buffer information specification).

A well established partner network around the globe supports our customers during the design-in. Based on customer needs they support with their engineering and development services. For more information please visit:
www.infineon.com/cms/en/product/microcontroller/embedded-power-ics-system-on-chip-/#!partners

7.4.1 Design-in support with MOTEON

MOTEON is an Infineon Preferred Design House (PDH) in EMEA and your engineering service provider for motor control software and system solutions. We provide our customers the technical support for MCTRL software and mechatronic system conception and realization. From the selection of the right controller up to tools and components, MOTEON accompanies the development process from the beginning. With our premium services we support a wide range of Arm®-based microcontrollers.

MOTEON is an expert for motor control system solutions

- Long-term expertise for Arm®-based microcontrollers
- Expertise in mechatronics, system concept & modeling, embedded software as well as tools & testing
- Years of electronic motor know how
- Development according to automotive standards

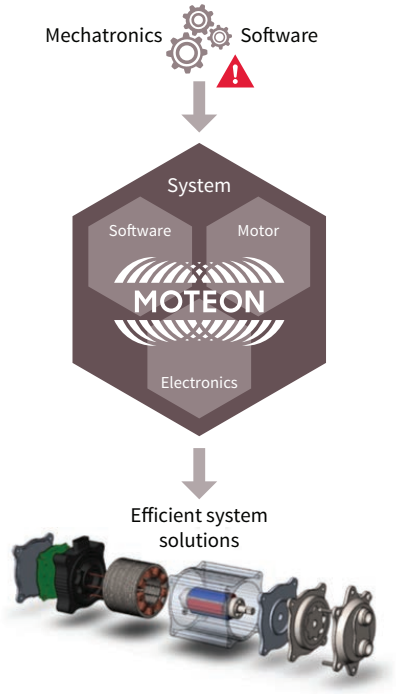


Image 27: MOTEON graphic

MOTEON is an expert in reducing future product costs by optimizing the design in the early concept phase. Whether you want to make your existing system more efficient or develop a new system from scratch, we are at your side with our many years of expertise and our competent partner network.

Image 28: Service offering

Software and motor control ecosystem	Professional motor control offering based on software and tools
Training and consulting	Customized support and expertise to enable motor control design
Prototyping, initialization and customization	Prototyping and proof of concept for customized motor drive solution
Full system development	System solution engineering leveraging into series production

For further information about our services scan the QR Code or follow the link to get directly to our website! Feel free to contact us!

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