

# Infineon Solutions for Transportation

24V to 60V



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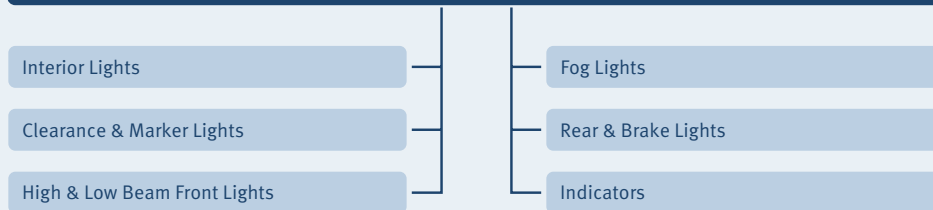
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## 24V – 60V Solutions for Transportation

Large trucks, campers and recreation vehicles are a common sight on today's roads and highways. And ever more people have hobbies requiring the transportation of equipment such as boats, snow mobiles, jet skis or other vehicles. There are many other examples of applications driven by 24V systems. In this brochure, you will find the complete portfolio of Infineon products specifically developed for this attractive and growing market. The products featured here encompass a complete range of microcontrollers, power and sensor devices. The other large market segment addressed in this brochure is that of smaller methods of transportation, examples of which include eScooters and eBikes.

### Application Overview

#### Exterior Truck Applications



#### Interior Truck Applications



# Trucks

## 24V Transport Applications

Infineon has seized the No. 1 spot in automotive power semiconductors by creating innovative power control solutions. Engineers highly value the reliability and versatility designed into these power products and have used them successfully in many automotive and non-automotive applications.

## Innovative Technologies, Advanced Techniques

Infineon leverages various technologies to create these innovations, such as N- and P-Channel MOSFETs, S-Smart power and logic, and Smart Power Technologies (SPT) featuring monolithic analog and digital power. We also use advanced assembly techniques such as chip-by-chip, chip-on-chip and power bond for high-current wire bonding.

## Step up to the Next Generation

By combining these technologies, Infineon produces forward-looking products designed to enable the next generation of innovative 24V solutions. Alongside a broad portfolio of products for 24V applications, we also offer the building blocks for all end-to-end 24V solutions, including voltage regulators, communication ICs, microcontrollers and Hall sensors.



# Construction and Agriculture Vehicles

24V systems are primarily integrated into systems for trucks, as well as for construction and agricultural vehicles. Infineon offers a broad range of power products, microcontrollers and sensors – all of which are qualified to automotive standards and benefit from the Zero Defect Quality Program – for this attractive and growing market.

Take a moment to look at our wide range of 24V products. You are sure to find the perfect solution among them. We look forward to helping you realize your next innovation.



## Sport and Alternative Vehicles

### Sport Vehicles, 24V Transport Applications

In many parts of the world, there is an ever-increasing demand for leisure vehicles. These include boats driven by diesel engines and 24V systems, ranging from small boats to large ships. This brochure is also aimed at applications such as snow mobiles and jet skis, and the broad range of vehicles serving the ever-expanding leisure market.

Infineon has a variety of products for these applications, all of which are based on our excellent quality and technologies. They have been developed to ensure our continued leadership in these markets and applications, and will enable you to design products to address any customer demand.



### Alternative Vehicles, Small Electrical Vehicles

Movement is one of those things that make people smile, bringing enjoyment to a very broad cross-section of society. There are many ways of appreciating movement – from exclusive, fast cars to convenient small electrical vehicles.

The market segment addressed by the range of products featured in this part of the brochure is that of small electrical vehicles. These include electric wheelchairs, golf carts and fork lift trucks, all of which are driven by battery-operated motors. Infineon has a large selection of products that have been developed for this ever-expanding market.



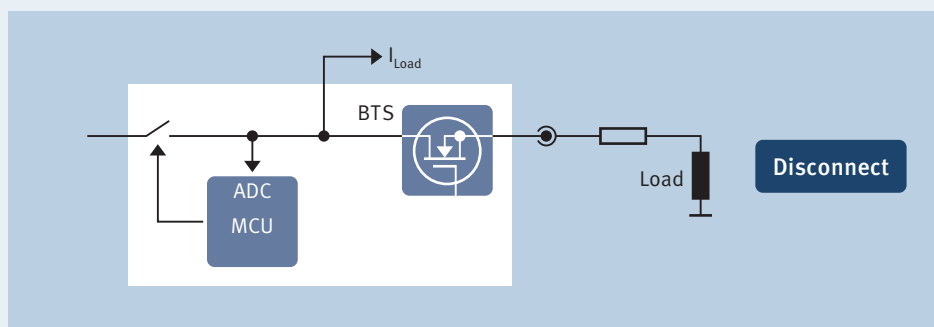
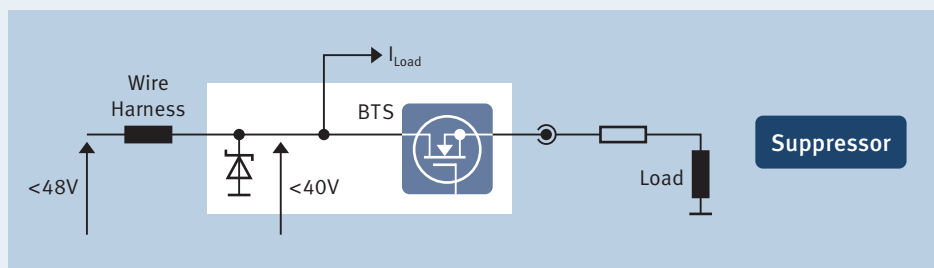
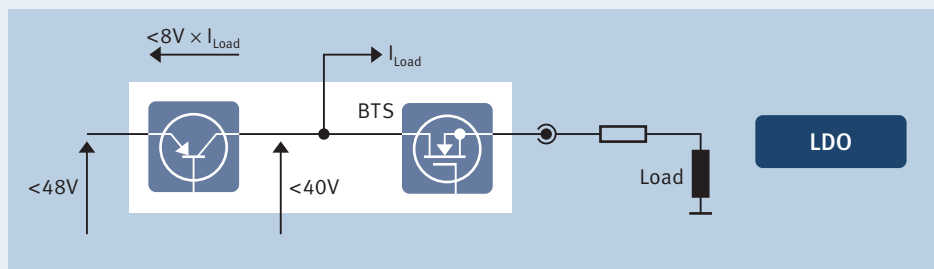
# 24V – 60V Requirements for Transportation Applications

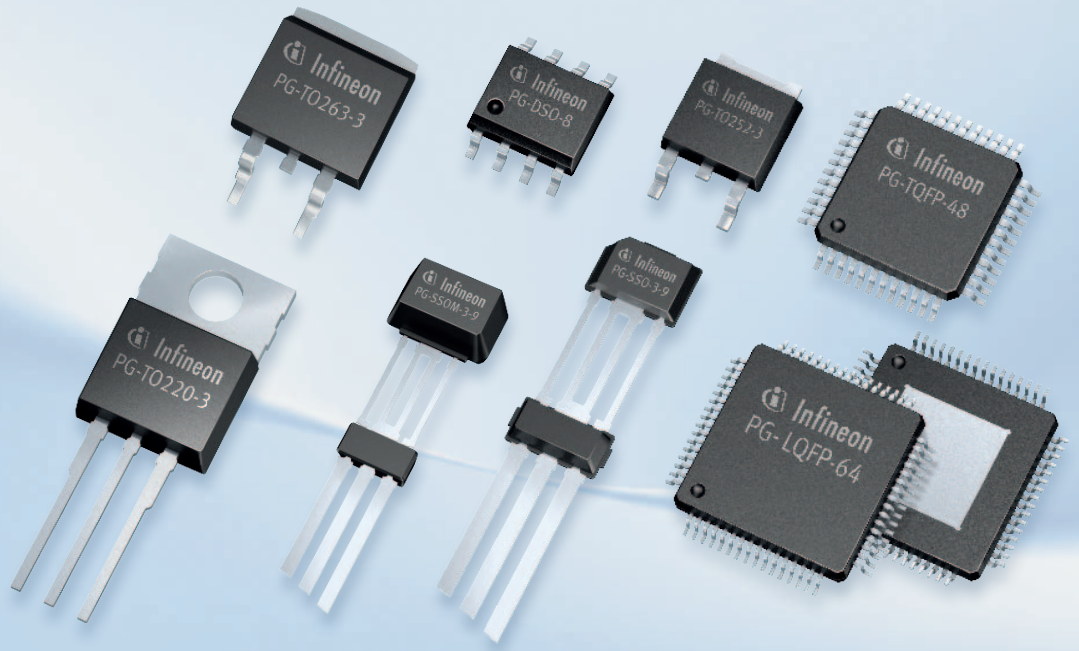
Due to the longer running times, higher mileage and cranking cycles synonymous with the truck business, the associated requirements regarding quality, reliability and robustness are even more demanding.

## Car and Truck Requirements Comparison

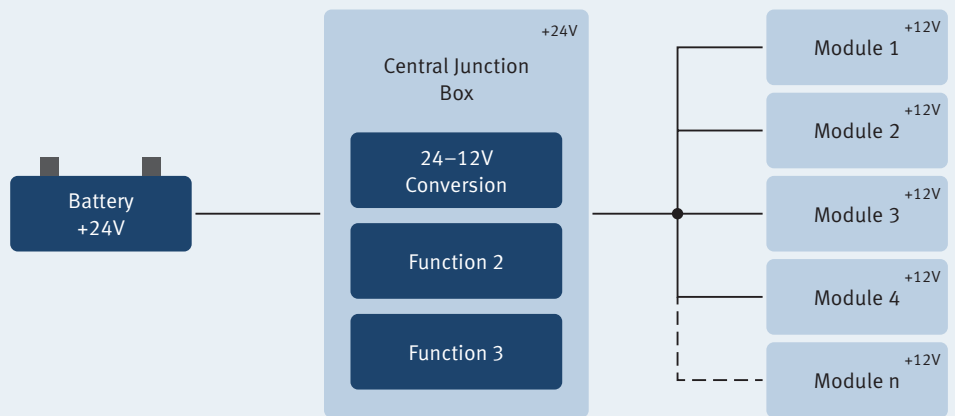
Parameter	Car	Truck
Running time	10,000 hours	50,000 hours
Idle time	76,000 hours	37,000 hours
Distance	250,000 km	2,000,000 km 4,000,000 km trailer
Average speed	25 km/h	40 km/h
Cranking/handbrake	100,000	300,000

## Three Ways of Protecting Electrical Systems against Overvoltage

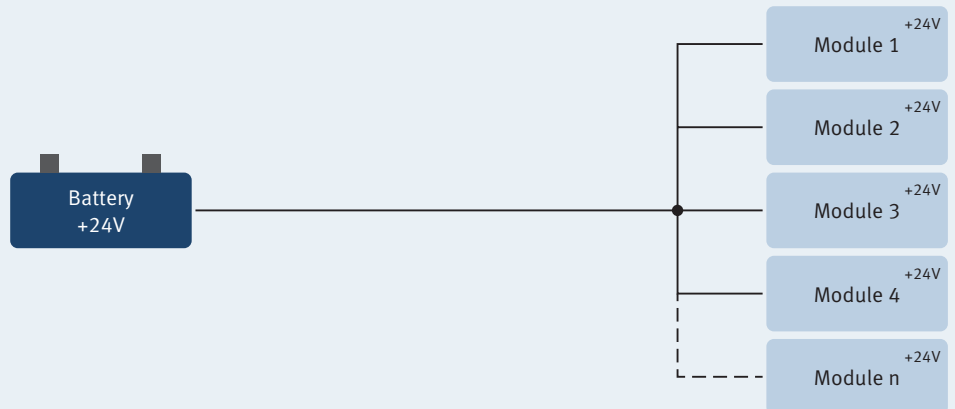




**Centralized Clamping/Overvoltage Protection – Overvoltage Protection via a Central Clamping Device in the Alternator**



**Decentralized Clamping/Overvoltage Protection (for parts < 58V voltage rating) – overvoltage protection in every single module**





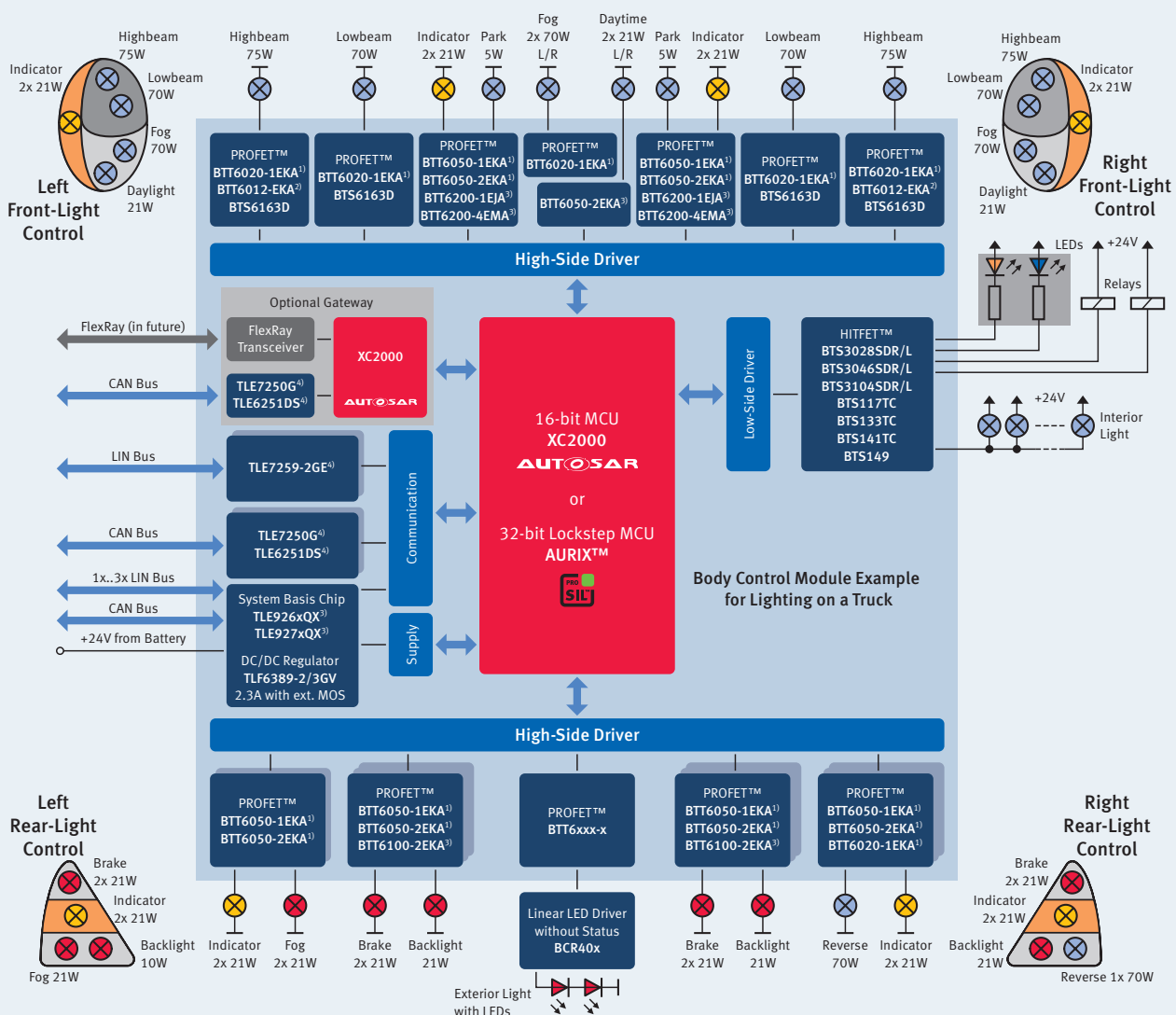


# Truck Body Control Module (BCM) Example for Lighting

The sample diagram below shows a typical central body control module, which is the central computing module for automotive lighting application. It consists of a microcontroller and power switches, as well as supply ICs and network transceivers.

### System Benefits

- 24V complete system solution: power supply, communication, sensors, microcontroller and power switches can be used without external protection.
- PROFET™+ 24V provides excellent diagnostics and protection features, and a high current sense accuracy even for the smallest loads as LEDs.
- 100% pin-to-pin compatibility between the 12V and 24V PROFET™ family.



1) In development, engineering samples available  
 2) In development, samples available soon  
 3) In development, samples available. With external protection against load dump 400ms above 40V. Pre-Regulation is important by using  $R_{th}$  for calculation of power loss for TLE926xQx devices.  
 4) If ECU permanently supplied, need to add external protection against load dump 400ms above 40V.

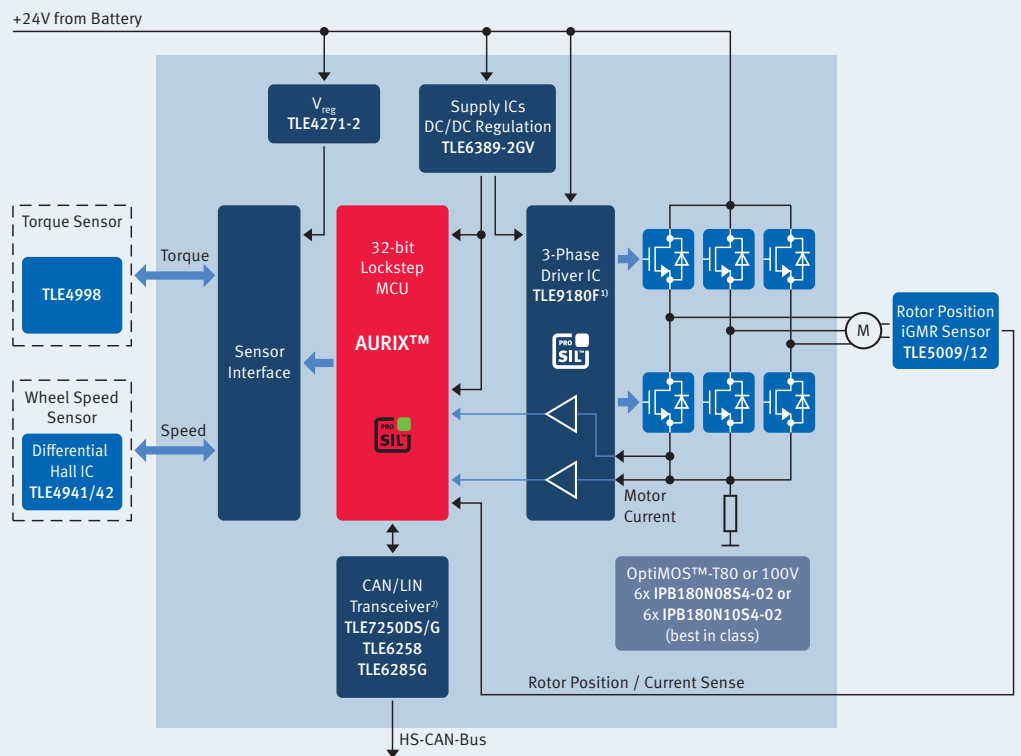


# Brushless DC (BLDC) Motor Control

A 24V complete system solution for a BLDC motor: power supply, sensors, microcontroller, driver (certified ISO26262) and MOSFETs can be used without external protection in a 24V system.

## System Benefits

- For 24V motor control application, Infineon can offer 60, 80 or 100V MOSFETs which can be used according to the application requirements.
- Lowest ohmic MOSFET on the market for higher current capability.
- Integrated MOSFET driver IC TLE9180 with diagnostics, compliant with ISO 26262.
- 24V complete system solution: power supply, communication, sensors, microcontroller and power switches can be used without external protection.



1) Product under development.

2) With external protection against load dump 400ms above 40V.  
Reverse polarity protection is not integrated on this diagram.

## Infineon's PRO-SIL™ Program, Designed to Protect

Infineon's PRO-SIL™ safety program is designed to ease and speed up your automotive and industrial design to comply with the above standards. Across the full certification spectrum from Safety Integrity Levels (SIL) 1 to 4 and Automotive Safety Integrity Levels (ASIL) A to D, our end-to-end PRO-SIL™ approach will help you select the right hardware, software and functional safety concepts to meet your design and compliance needs.

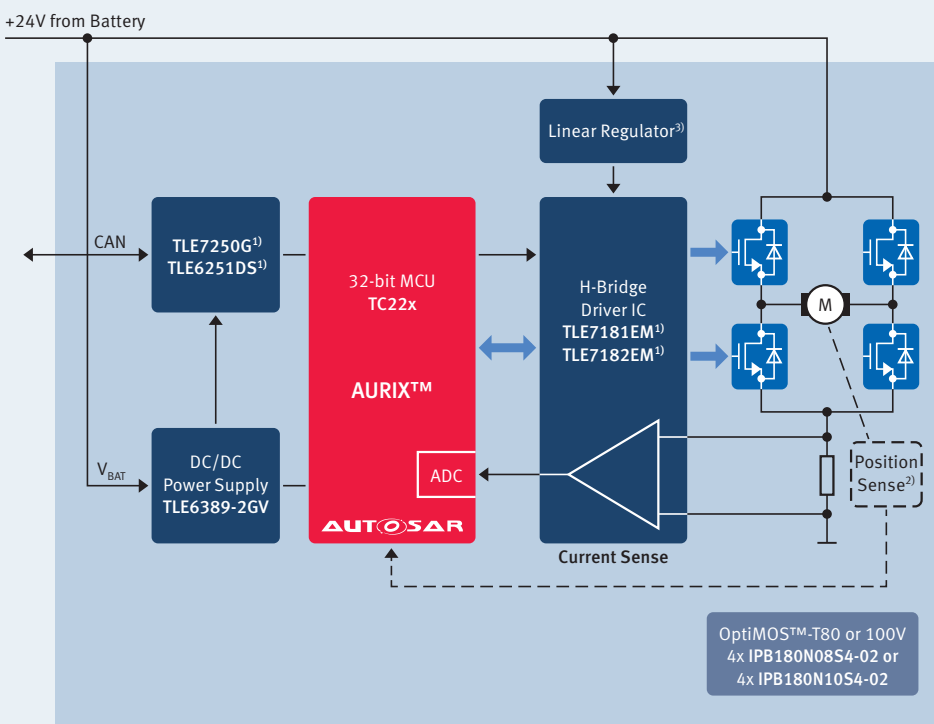
# DC Motor Control

The application below shows a typical system for 2-phase motor control. On one side, the communication interface ensures connection to other ECUs via CAN (TLE7250G or TLE6251DS). The new AURIX™ microcontroller family TC22x will adapt the output signals to control the motor based on the programmed algorithm. Finally, the H-bridge driver devices TLE7182EM or TLE7181EM will control the external MOSFETs (IPB180Nxx S4-02) modifying the speed or direction of the motor.

Furthermore, the TLE6389-2GV can ensure a reliable power supply for the full system. In the case of applications where voltages higher than 40V are expected (i.e. load dump), the maximum ratings and power consumption of the H-bridge supply may need to be analyzed. Depending on the final application, additional feedback paths – such as sensing devices for position control – might be required.

## System Benefits

- For 24V motor control application, Infineon can offer 60, 80 or 100V MOSFETs which can be used according to the application requirements.
- Lowest ohmic MOSFET on the market for higher current capability.
- 24V complete system solution: power supply, communication, sensors, microcontroller and power switches can be used without external protection.



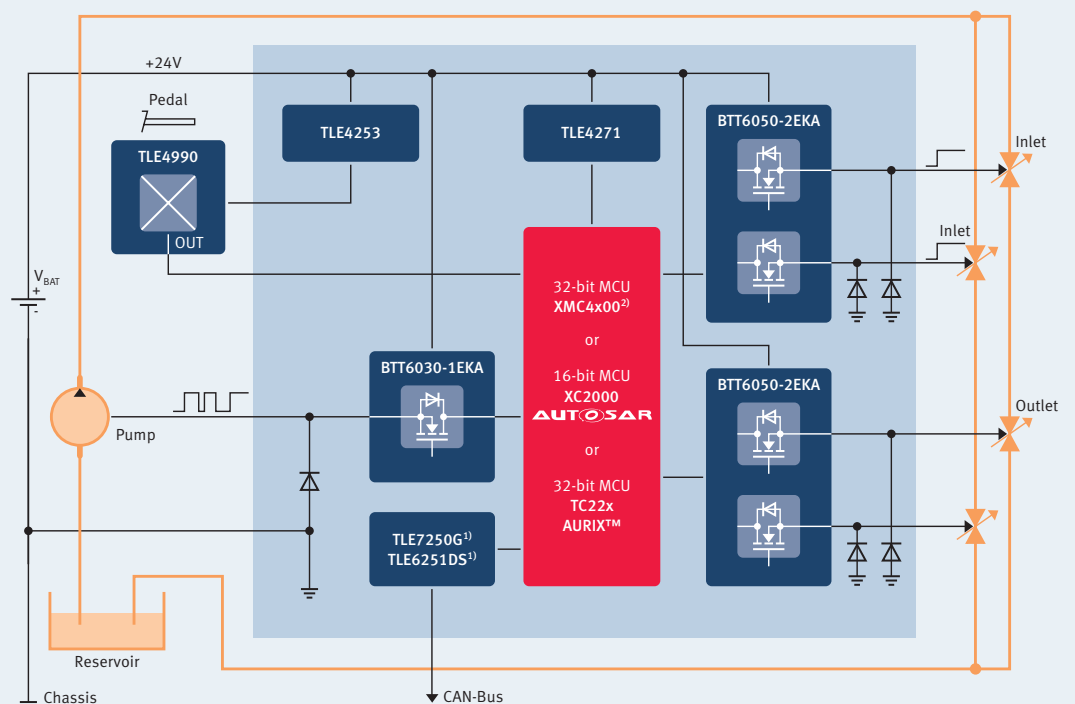
- 1) If ECU permanently supplied, may need to add external protection against load dump 400ms above 40V.
- 2) Position sensing is optional depending on the final application.
- 3) Device may be optional depending on final application requirements (load dump and power dissipation). Reverse polarity protection is not integrated on this diagram. However, it might be required.

# Hydraulic Management System

A 24V complete system solution for hydraulic management systems: power supply, sensors, microcontroller and high-side switches can be used without external protection in a 24V system. Valves and pumps can be driven via linear activation or demand-controlled via PWM signals.

## System Benefits

- Valves and pumps can be driven via linear activation or demand-controlled via PWM signals.
- Quad and dual channels are optimized to reduce costs and space for these applications.
- Pin-to-pin and software compatibility.



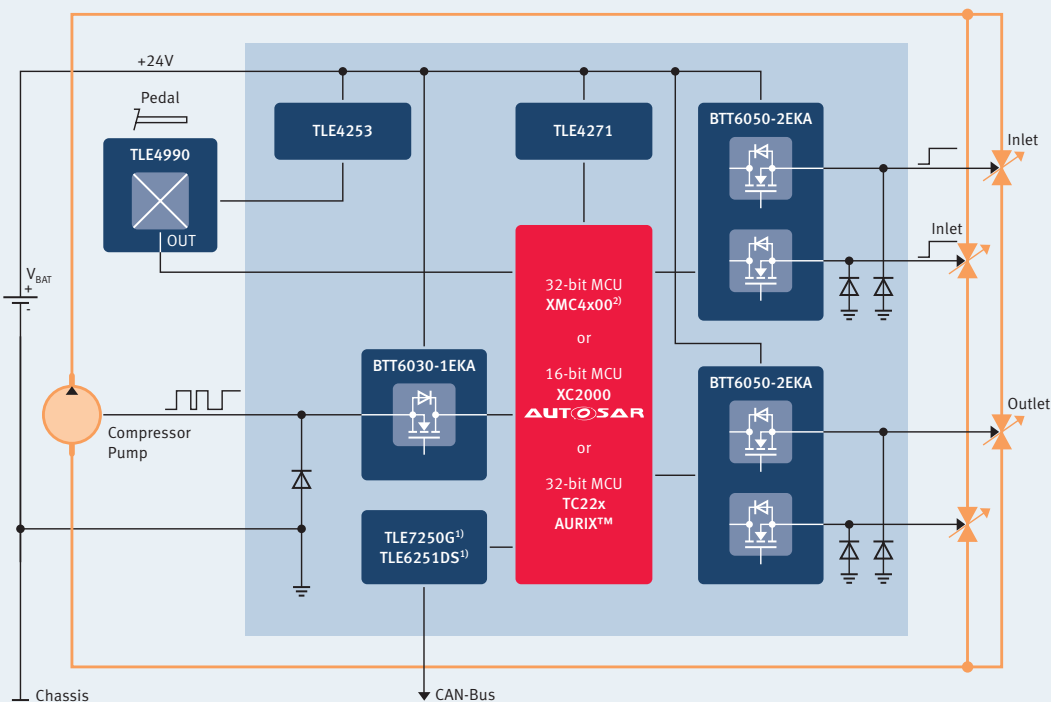
- 1) If ECU permanently supplied, may need to add external protection against load dump 400ms above 40V.
- 2) Not AEC-Q100 qualified

# Pneumatic Management System

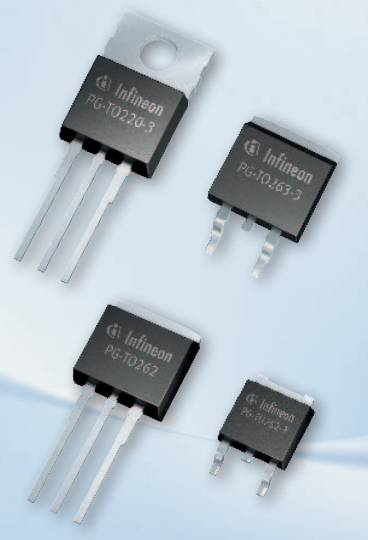
A 24V complete system solution for pneumatic management systems: power supply, sensors, microcontroller and high-side switches can be used without external protection in a 24V system. Valves and pumps can be driven via linear activation or demand-controlled via PWM signals.

## System Benefits

- Valves and pumps can be driven via linear activation or demand-controlled via PWM signals.
- Quad and dual channels are optimized to reduce costs and space for these applications.
- Pin-to-pin and software compatibility.



1) If ECU permanently supplied, may need to add external protection against load dump 400ms above 40V.  
 2) Not AEC-Q100 qualified



# Infineon OptiMOS™ – Benchmark for Automotive MOSFETs

## OptiMOS™ Product Family 60V, 75V and 100V Single N-Channel

We offer a broad product portfolio of OptiMOS™ 60V in trench technology, OptiMOS™ 75V in planar technology and OptiMOS™ 100V in trench technology for various truck applications. Superior performance is guaranteed by our leading MOSFET technology combined with the unsurpassed quality of our robust package.

### Key Features

- OptiMOS™ 60V with
  - $R_{DS(on)}$ : 1.7–30m $\Omega$
  - Packages: PG-TDSON-8 (SuperSO8), PG-TO252, PG-TO263, PG-TO220-3
- OptiMOS™ 75V with
  - $R_{DS(on)}$ : 6.5–50m $\Omega$
  - Packages: PG-TO252, PG-TO263, PG-TO220-3
- OptiMOS™ 100V with
  - $R_{DS(on)}$ : 4.8–31m $\Omega$
  - Packages: PG-TO252, PG-TO263, PG-TO220-3, PGTO262-3

### Key Benefits

- High-current capability up to 180A
- Robust green packages for highest quality and reliability
- Low switching and conduction power losses

### Key Applications

- Daytime running light
- Fuel Injection
- ABS valves

Dual N-Channel OptiMOS™ Product Table

Product Type	Technology	$R_{DS(on)}$ (max.) @ 10V [m $\Omega$ ]/channel	$I_D$ [A]/channel	$R_{\theta(jc)}$ (max.) [K/W]	Package	LL/NL
IPG20N06S4-15	OptiMOS™-T2 60V	15.5	20	3.0	PG-TDSON-8-4	NL
IPG20N06S4L-26	OptiMOS™-T2 60V	26.0	20	4.5	PG-TDSON-8-4	LL
IPG20N06S4L-14	OptiMOS™-T2 60V	13.7	20	3.0	PG-TDSON-8-4	LL
IPG20N06S4L-11	OptiMOS™-T2 60V	11.2	20	2.3	PG-TDSON-8-4	LL
IPG20N06S2L-35	OptiMOS™ 55V	35.0	20	2.3	PG-TDSON-8-4	LL
IPG20N06S2L-50	OptiMOS™ 55V	50.0	20	2.9	PG-TDSON-8-4	LL
IPG20N06S2L-65	OptiMOS™ 55V	65.0	20	3.5	PG-TDSON-8-4	LL

OptiMOS™-T2 80V Product Table

Product Type	Technology	$R_{DS(on)}$ (max.) @ 10V [m $\Omega$ ]/channel	$I_D$ [A]/channel	Package	LL/NL
IPB180N08S4-02	OptiMOS™-T2, SFET4-80V	2.2	180	D <sup>2</sup> PAK	NL
IPB160N08S4-03	OptiMOS™-T2, SFET4-80V	3.1	160	D <sup>2</sup> PAK	NL
IPB140N08S4-04	OptiMOS™-T2, SFET4-80V	4.1	144	D <sup>2</sup> PAK	NL
IPB80N08S4-06	OptiMOS™-T2, SFET4-80V	5.5	80	D <sup>2</sup> PAK	NL
IPP120N08S4-04	OptiMOS™-T2, SFET4-80V	4.2	120	TO220	NL
IPP80N08S4-06	OptiMOS™-T2, SFET4-80V	5.8	80	TO220	NL
IPI80N08S4-06	OptiMOS™-T2, SFET4-80V	5.8	80	TO262	NL
IPD90N08S4-05	OptiMOS™-T2, SFET4-80V	5.3	90	DPAK	NL
IPD50N08S4-13	OptiMOS™-T2, SFET4-80V	13.2	50	DPAK	NL
IPG20N08S4-22	OptiMOS™-T2, SFET4-80V	25.0	20	DualSS08	NL



# HITFET™

## Innovative, Robust and High-Performance Switches

HITFET™ are MOSFETs with embedded protection functions. These devices are ideal for applications from 24V to 60V in which robustness, long life reliability and wide temperature ranges are required.

### Key Features

- Overcurrent protection
- Overtemperature protection
- Overvoltage protection
- ESD protection
- Diagnostic feedback
- Switching speed controlled by design

### Key Benefits

- Scalable portfolio from 30–550mΩ
- Packages: SO8, SOT223, DPAK, D<sup>2</sup>PAK
- Feature and pin-compatible family concept
- Reputation for quality, reliability and robustness
- Well designed for target application

### Key Applications

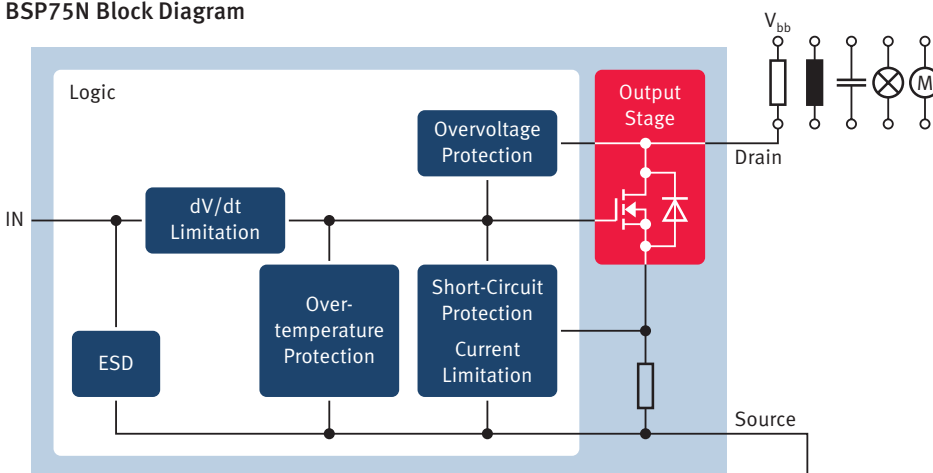
- Relay driver
- Small load driver



HITFET™ – Voltage Class 60V Product Table

Product Type	Channels	V <sub>DS(max.)</sub> [V]	I <sub>D(nom.)</sub> [A]	R <sub>DS(on)</sub> (max.) [mΩ]	I <sub>D(lim)</sub> (min.) [A]	Packages
BTS141TC	1	60	5.1	30	25	PG-T0263-3
BTS3028SDL	1	60	5.0	30	18	PG-T0252-3
BTS3028SDR	1	60	5.0	30	18	PG-T0252-3
BTS133TC	1	60	3.8	50	21	PG-T0263-3
BTS3046SDL	1	60	3.6	50	10	PG-T0252-3
BTS3046SDR	1	60	3.6	50	10	PG-T0252-3
BTS117TC	1	60	3.5	100	7	PG-T0263-3
BTS3104SDL	1	60	2.0	104	6	PG-T0252-3
BTS3104SDR	1	60	2.0	104	6	PG-T0252-3
BTS3408G	2	60	0.55	550	1	PG-DSO-8
BSP75N	1	60	0.7	550	1	PG-SOT223-4

BSP75N Block Diagram





# Multi-Channel Switches for Truck Applications

## Low-Side Switches for Powertrain Applications

Multi-channel low-side switches in Smart Power Technology (SPT) with two to eighteen open-drain DMOS output stages. The products are protected by embedded protection functions and designed for automotive applications. The output stages can be controlled directly by parallel inputs for PWM applications (e.g. gasoline port injection) and by SPI or by Micro Second Channel (MSC). Diagnosis can be read via serial communication or, in the case of some devices, by the external fault pin.

### Key Features

- Overvoltage protection with active clamping
- Undervoltage protection
  - Power-ON reset
  - Undervoltage shutdown
- Overcurrent protection
- Overtemperature shutdown protection
- Electrostatic Discharge (ESD) protection
- Low quiescent current mode
- Direct input control (for PWM)
- Communication interface (Control/Diagnosis)
  - Serial Peripheral Interface (SPI)
  - Micro Second Channel (MSC)
- 2-bit diagnosis feedback (and status flag)

### Key Benefits

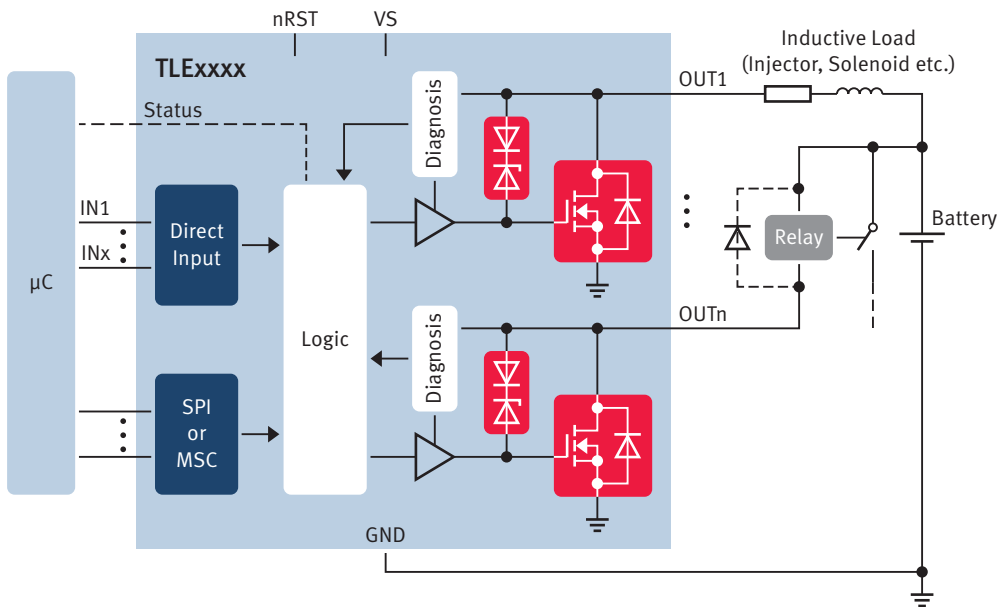
- Dedicated feature-set for engine management application
- Robust design
- Product family to adapt to various system requirements and partitioning



Multi-Channel Low-Side Switches for 24V Systems – Product Table

Product Type	Channels	Electrical Specifications				Interface			Status Flag	Package
		#	R <sub>DS</sub> (typ.) [Ω] @25°C	I <sub>LIM</sub> (min.) [A]	V <sub>CL</sub> (typ.) [V]	Direct Input Pins	SPI	MSC		
TLE8102SG <sup>1)</sup>	2	2x	0.18	5.0 (9.0)	54	2	8-bit		•	PG-DSO-12 (Heat Slug)
TLE6217G	4	2x 2x	0.20 0.35	5.0 3.0	53	4			•	PG-DSO-20 (Heat Slug)
TLE8108EM	8	8x	0.80	0.5	45	4	16-bit			PG-SSOP-24 (Exposed Pad)
TLE8110EE	10	4x 2x 4x	0.30 0.25 0.60	2.6 3.7 1.7	55	10	16-bit			PG-DSO-36 (Exposed Pad)
TLE8718SA <sup>2)</sup>	18	2x 2x 8x 2x 2x 2x	0.15 0.26 0.53 0.35 1.78 0.96	8.0 3.0 2.2 2.2 0.6 0.6	55			LVDS + LVTTTL		PG-DSO-36 (Heat Slug)
TLE6244X	18	6x 6x 2x 4x	0.32 0.30 0.22 0.62	2.2 2.2 3.0 1.1	70 45 45 45	16	16-bit <sup>3)</sup>			PG-MQFP-64 (Heat Slug)

- 1) Embedded current sense
- 2) Available on request
- 3) 1st generation MSC, High-speed down-stream + SPI up-stream





# PROFET™ for 24V Applications

## High-Side Switches Fulfilling 24V Requirements

As part of our successful PROFET™ (ProtectedFET) portfolio, we offer parts which are also suitable for driving loads in 24V applications. The devices come in robust green packages and offer complete protection against harsh environments, such as those required for truck applications. This includes protection against short-circuit through current limitation, as well as overtemperature protection via thermal shutdown. Thanks to overvoltage protection (such as load dump), no additional suppressor diode is needed to protect the device against abnormal voltage events which normally occur in 24V vehicles. In addition to the protection functions, diagnostic information provides the microcontroller with failure reports.

### Key Features

- > 58V voltage rating
- Current limitation
- Protection against loss of battery and GND
- Reverse battery protection
- Short-circuit protection
- Overtemperature protection
- Overvoltage protection
- ESD protection
- (Partially) Proportional load current sense

### Key Benefits

- Real 24V requirements fulfillment
- Benchmark energy robustness
- Vast product portfolio for high and low-current loads
- Integrated protection and diagnostic features
- Current sense with enhanced  $k_{ILIS}$  accuracy with calibration
- Robust green package
- Easy design-in
- Optimized electromagnetic compatibility

	1 Channel	2 Channels	4 Channels	8 Channels
1000mΩ	BTS4140N			
200mΩ	BTS452R/T, BSP752R/T, BSP452, BTS4141N, BTS4142N			BTS4880R
175mΩ	BTS4175SGA			
105mΩ		BTS723GW		
90mΩ			BTS724G	
50mΩ		BTT6050-2EKA		
38mΩ	BTS432E2			
30mΩ		BTS740S2		
20mΩ	BTS6163D, BTS442E2, BTS441RG/TG			
8.5mΩ	BTS5008-1TMA/B			
5mΩ	BTS550			
2.5mΩ	BTS555			



# Multi Half-Bridge Driver ICs for DC Brush Motors

## Voltage Class: 12V/24V

DC brush motor controls that drive low load currents (< 1A) are best implemented using cost-effective and PCB space-saving IC solutions. All Infineon products have protection features implemented and facilitate diagnostics either via a status flag or SPI.

### Key Features

- Product portfolio offers drivers with 2, 4, 6 and 10 half-bridge outputs
- Direct driving and SPI control are possible
- Optimized products for current saving are available
- Overtemperature protection

### Target Applications

- HVAC flap control
- Mirror x-y-adjustment
- Idle speed control
- DC brush motor with maximum currents below 1A

### Key Benefits

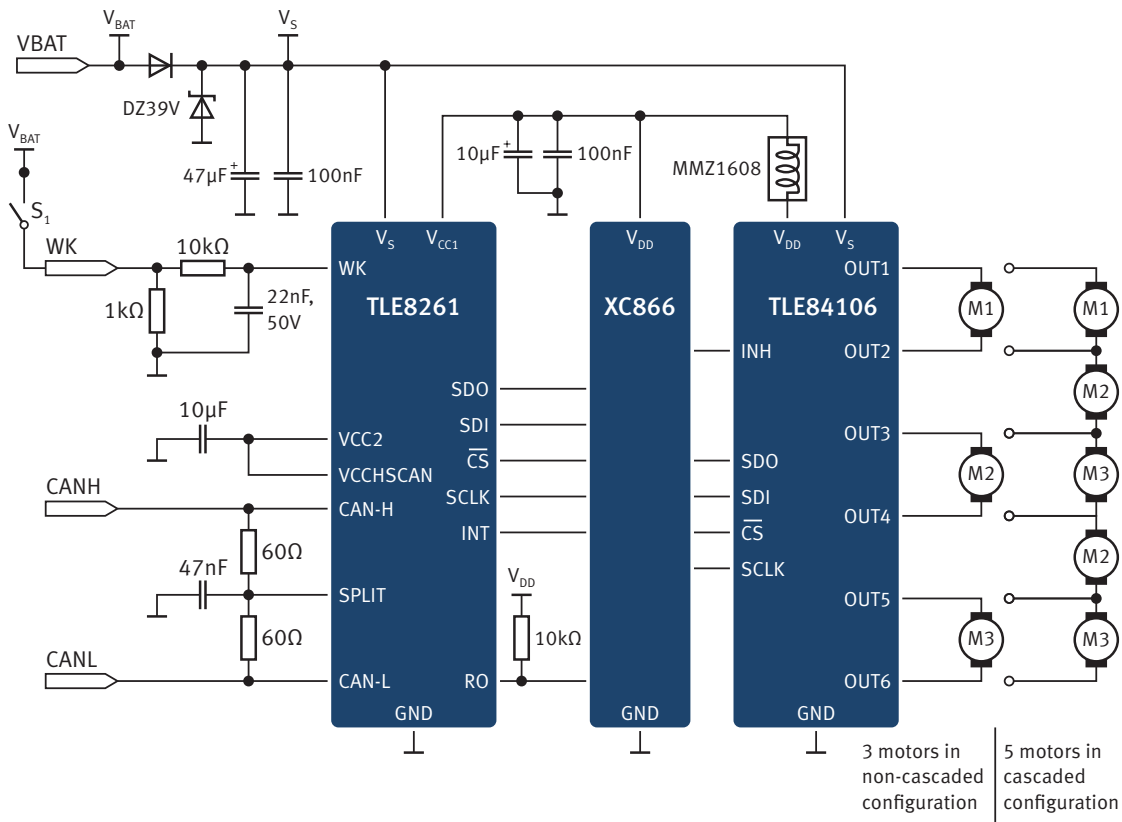
- Scalability for products with family concept (e.g. TLE841xxEL)
- Driver can be adapted to ECU concept (SPI vs. direct driving)
- Longer IC lifetime ensured by thermal shutdown

### Evaluation Boards available for Multi Half-Bridge Driver ICs

- TLE84106EL, TLE84110EL, TLE6208-3G, TLE6208-6G, TLE8444SL

Product Type	$I_{L(NOM)}$ [A]	$I_{L(LIM)}$ [A]	$I_q$ (max.) [μA]	$V_{S(OP)}$ [V]
<b>Multi Half-Bridge Driver IC</b>				
TLE4205G	1 x 1.0	1 x 1.5	100	6–32
TLE4207G	1 x 0.8	1 x 1.5	50	8–18
TLE4208G	2 x 0.8	2 x 1.5	100	8–18
TLE6208-3G	2 x 0.8	2 x 1.0	10	8–40
TLE6208-6G	3 x 0.8	3 x 1.0	12	8–40
TLE8444SL	2 x 0.8	2 x 0.9	5	8–18
TLE84106EL	3 x 0.5	3 x 0.8	4	8–18
TLE84110EL	5 x 0.5	3 x 0.8	4	8–18
<b>Servo Driver</b>				
TLE4206G	8	15	12	8–18
TLE4206-2G	8	15	12	8–18
TLE4206-4G	8	15	12	8–18
TLE4209G	8	15	12	8–18
TLE4209A	8	15	12	8–18

LO = Lockout, OV= Overvoltage, UV= Undervoltage, OT= Overtemperature, SC= Short-Circuit



Protection	Diagnostic Interface	$V_{SAT} (max.) / R_{DS(on)} (max.)$ @ $T_j = 150^\circ C$	Package
SC, OT	None	$V_{SAT\ upper} + V_{SAT\ lower} = 2.7V$ ( $I_{OUT} = 0.6A$ )	PG-DSO-20
SC, OT, OV, UV, LO	Status	$V_{SAT\ upper} + V_{SAT\ lower} = 2.5V$ ( $I_{OUT} = 0.8A$ )	PG-DSO-14
SC, OT, OV, UV, LO	Status flag	$V_{SAT\ upper} + V_{SAT\ lower} = 2.5V$ ( $I_{OUT} = 0.8A$ )	PG-DSO-28
SC, OT, OV, UV, LO	16-bit SPI	4.0Ω path	PG-DSO-14
SC, OT, OV, UV, LO	16-bit SPI	4.0Ω path	PG-DSO-28
SC, OT, OV, UV, LO	Status flag	2.6Ω path	PG-SSOP-24
SC, OT, OV, UV, LO	16-bit SPI	4.0Ω path	PG-SSOP-24 (Exposed Pad)
SC, OT, OV, UV, LO	16-bit SPI	4.0Ω path	PG-SSOP-24 (Exposed Pad)
OT, OV, UV, LO, SC	-	1.2V at 0.4A	PG-DSO-14
OT, OV, UV, LO, SC	-	1.2V at 0.4A	PG-DSO-14
OT, OV, UV, LO, SC	-	1.2V at 0.4A	PG-DSO-14
OT, OV, UV, LO, SC	-	1.2V at 0.4A	PG-DIP-8
OT, OV, UV, LO, SC	-	1.2V at 0.3A	PG-DSO-14





# Driver ICs for Bipolar Stepper Motors

## Voltage Class: 12V/24V

In body electronics, stepper motors are featured in headlight beam leveling and HVAC flap systems. They are also widely used in engine management systems. All drivers offer protection and diagnosis and can be used for small stepper motors up to 1A. Rpm management – where a motor-driven valve in the bypass air inlet controls idling speed – is also a typical application.

### Key Features

- Products for 12V and 24V applications are available
- Drivers feature full and half-step modes
- All drivers have integrated overtemperature protection
- Diagnosis possible via status pin

### Key Benefits

- Longer IC lifetime ensured by thermal shutdown
- Failure detection possible

### Target Applications

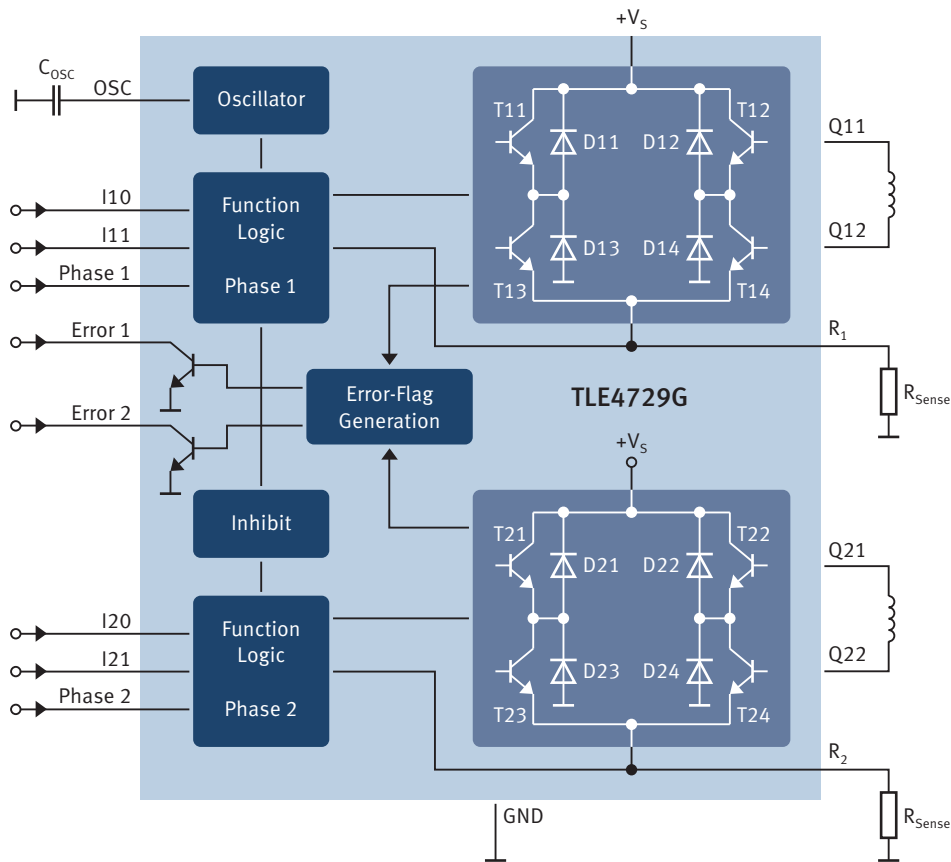
- Bipolar stepper motor driver for up to 1A
- Light adjustment
- Idle speed control for motorbikes or small cars

### Evaluation Boards available for Stepper Driver ICs

- TLE4729 Evaluation Kit V1.0

Product Type	$I_{L(NOM)}$ [A]	$I_{L(LIM)}$ [A]	$I_q$ (max.) [μA]	$V_{S(OP)}$ [V]
Stepper Driver IC				
TCA3727G	2 x 0.75	2 x 1.5	500	5–50
TLE4726G	2 x 0.75	2 x 1.5	500	5–50
TLE4729G	2 x 0.75	4 x 1.5	50	5–16

OL = Open-Load, OT= Overtemperature, SC= Short-Circuit



Protection	Diagnostic Interface	$V_{SAT} (max.) / R_{DS(on)} (max.)$ @ $T_j = 150^\circ C$	Package
OT	Status flag	$V_{SAT\ upper} + V_{SAT\ lower} = 2.4V$ ( $I_{OUT} = 0.75A$ )	PG-DSO-24
OT	Status flag	$V_{SAT\ upper} + V_{SAT\ lower} = 2.4V$ ( $I_{OUT} = 0.75A$ )	PG-DSO-24
OL, OT, SC	Status flag	$V_{SAT\ upper} + V_{SAT\ lower} = 2.4V$ ( $I_{OUT} = 0.75A$ )	PG-DSO-24





## Trilith IC Family – BTM77xxG(P)/BTM78xxK

### Motor Bridge with Protection and Diagnostics (operation up to 42V)

The Trilith IC devices combine two high-side and two low-side switches in one package. They are geared to drive high-current DC motors in an H-bridge configuration but can also be used as single independent switches. All Trilith ICs include overcurrent and overtemperature protection for the high-side switches. With regard to the low-side switches, the user can choose between fast unprotected MOSFETs for PWM applications as well as protected low-side switches for lower frequencies.

Product Type	V <sub>S(op)</sub> [V]	R <sub>DS(on)</sub> (typ.) @ 25°C [mΩ]			I <sub>lim</sub> (typ.) [A]	I <sub>q</sub> (typ.) [μA]	Freq. (typ.) [kHz]	Diagnosis	Protection	Package
		path	high-side	low-side						
BTM7740G	4.8–42	210	110	100	8.0	5	1	OT	OT, SC	PG-DSO-28
BTM7741G	4.8–42	210	110	100	10.0	5	1	OT, OL	OT, SC	PG-DSO-28
BTM7700G	4.8–42	190	110	80	9.5	5	1	OT	OT, SC	PG-DSO-28
BTM7750G	4.8–42	115	70	45	12.0	5	1	OT	OT, SC	PG-DSO-28
BTM7750GP <sup>1)</sup>	4.8–42	115	70	45	12.0	5	1	OT	OT, SC	PG-T0263-15
BTM7751G	4.8–42	115	70	45	14.0	5	1	OT, OL	OT, SC	PG-DSO-28
BTM7710G	4.8–42	110	70	40	15.0	5	1	OT	OT, SC	PG-DSO-28
BTM7710GP <sup>1)</sup>	4.8–42	110	70	40	15.0	5	1	OT	OT, SC	PG-T0263-15
BTM7810K <sup>1)</sup>	5.0–42	40	26	14	42.0	5	1	OT, OL	OT, SC	PG-T0263-15
BTM7811K <sup>1)</sup>	5.0–42	40	26	14	42.0	4	20	OT, OL	OT, SC	PG-T0263-15

1) AEC-grade 3 – T<sub>j</sub> = 110°C  
 UV = Undervoltage (high-side)  
 OT = Overtemperature  
 SC = Short-Circuit  
 OL = Open-Load

Please contact your sales-representative for further information on special peak voltage requirements such as jump-start and load dump.



**Key Features**

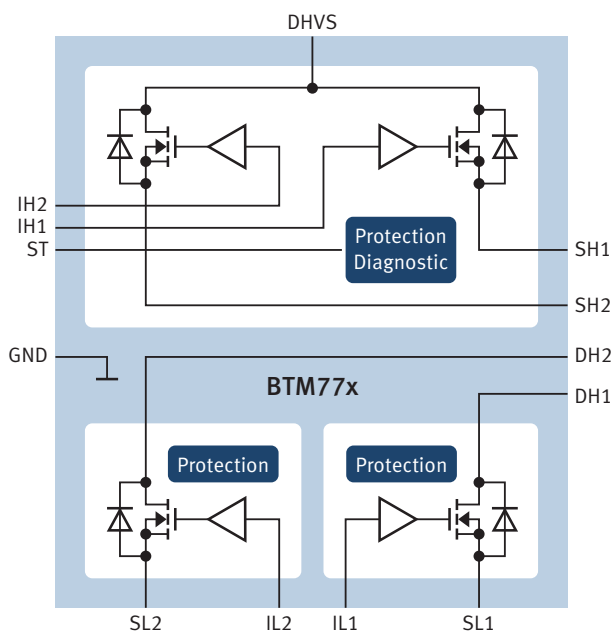
- Quad D-MOS switch driver
- Configurable as quad-switch, dual half-bridge or full-bridge for motor control
- $R_{DS(on)}$  in PG-DSO28 package
  - Path: 110–210m $\Omega$  (typ. at  $T_j = 25^\circ\text{C}$ )
  - 260–500m $\Omega$  (max. at  $T_j = 150^\circ\text{C}$ )
- $R_{DS(on)}$  in PG-TO263-15 package ( $T_{jmax} = 110^\circ\text{C}$ )
  - Path: 40–115m $\Omega$  (typ. at  $T_j = 25^\circ\text{C}$ )
  - 93–265m $\Omega$  (max. at  $T_j = 110^\circ\text{C}$ )
- Peak current up to 42A (typ. at  $25^\circ\text{C}$ )
- Very low quiescent current of 5 $\mu\text{A}$  (typ. at  $25^\circ\text{C}$ )
- Operation up to 42V supply voltage
- PWM frequencies up to 1kHz (limited 20kHz)
- Status flag diagnosis
- Overcurrent limitation
- Overtemperature shutdown with hysteresis
- Short-circuit protection (up to 28V)
- Internal clamp diodes
- Undervoltage shutdown with hysteresis (high-side switch)

**Key Benefits**

- Flexible 4-fold switch (two high and two low-side switches)
- Configurable as easy-to-use DC motor bridge in one package
- High peak current capability
- Scalable portfolio

**Applications**

- Door lock
- Fuel flap lock
- Mirror flap
- Steering wheel lock
- Headrest adjustment





## NovalithIC™ BTN89xxTA

### New Integrated and Protected Half-Bridges with up to 40V Operating Voltage Range

Infineon's NovalithIC™ family has three new members: BTN8946TA, BTN8962TA and BTN8982TA. Based on the same concept as the existing BTN79xxB, the new products offer an extended operating voltage range, up to 40V, a lower  $R_{DS(on)}$ , down to 10mΩ, a faster switching time, down to 250ns, and an improved current sense accuracy, thanks to a new  $k_{ILIS}$  offset calibration method, maintaining pin-to-pin compatibility to all NovalithIC™ family members. These enhanced features and improved specifications allow a significant reduction of power losses and an improvement in relation to EMC emissions, thereby further increasing the already extensive application areas for these products.

#### Key Features

- Integrated half-bridge
- PWM capability combined with active freewheeling
- Switched mode current limitation for reduced power dissipation in overcurrent situation
- Overtemperature shutdown with latch behavior
- Driver circuit with logic level inputs

#### Applications

- Unidirectional DC brush motors
- Bidirectional DC brush motors
- Brushless (BLDC) motors

#### Product Table

Product Type	$V_{S(op)}$ [V]	$R_{(on)}$ path (typ.) [mΩ]	$I_D$ (lim) [A]	$I_q$ (typ.) [μA]	Switch time (typ.) [μs]	Diagnosis	Protect	Packages
BTN8946TA	5.5–40.0	6.7 <sup>1)</sup>	42	7	0.25	OT, OC, CS	UV, OT, OC	PG-T0263-7
BTN8962TA	5.5–40.0	14.2	42	7	0.25	OT, OC, CS	UV, OT, OC	PG-T0263-7
BTN8982TA	5.5–40.0	10.0	70	7	0.25	OT, OC, CS	UV, OT, OC	PG-T0263-7

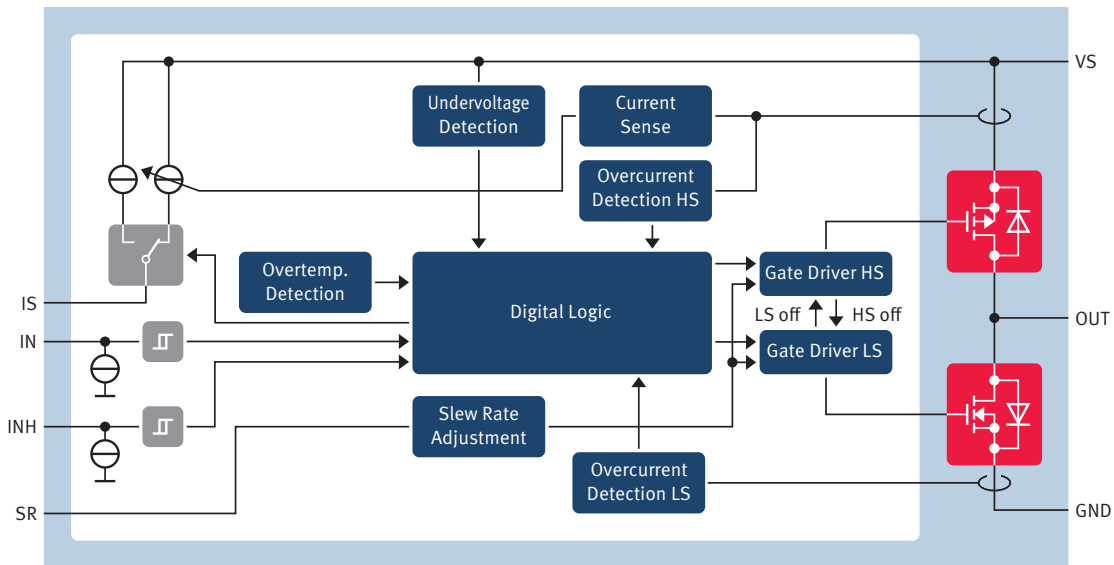
1) HS switch only

OV = Overvoltage  
OC = Overcurrent  
UV = Undervoltage

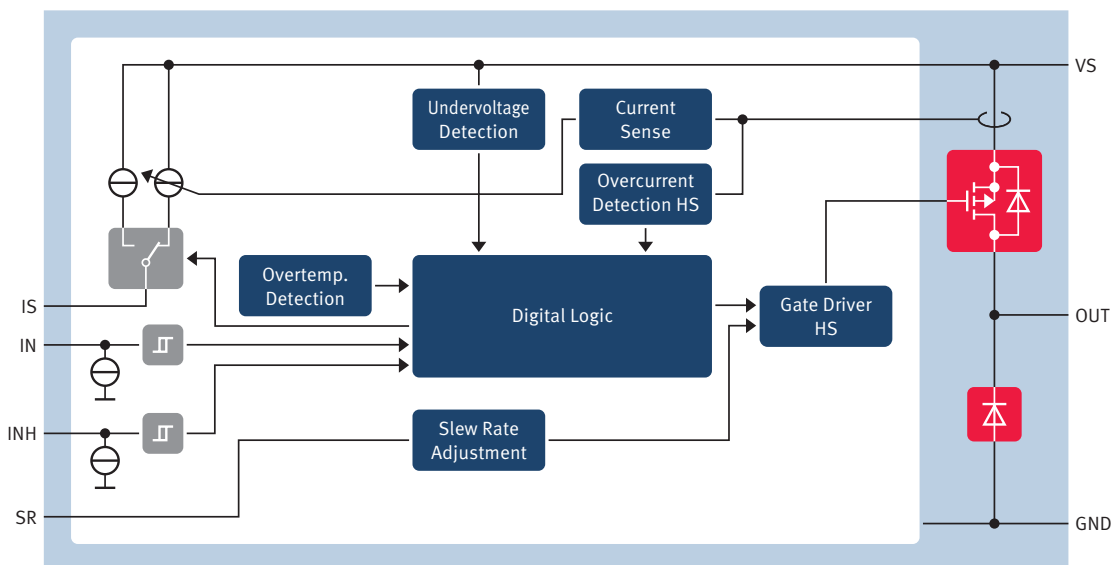
SCL = Smart Clamping  
OT = Overtemperature  
CS = Current-Sense

Please contact your Sales-Representative for further information on special peak voltage requirements such as jump-start and load dump.

BTN8962TA/BTN8982TA Block Diagram



BTN8946TA Block Diagram



# Supply for 24V Applications



## Linear Voltage Regulator, DC/DC Converters

As part of the widest voltage regulator portfolio available in the automotive market, we offer suitable supply devices for 24V applications. The 24V portfolio consists of single-output and dual-output linear voltage regulators and DC/DC converters. They can withstand load dumps of up to 60V without an additional suppressor diode. All devices offer protection in harsh environments against short-circuits, overtemperature etc. All parts come in robust RoHS-compliant packages.

Linear Regulators	
TLE4267	400mA/5V single-output with EN and RES
TLE4270-2	600mA/5V single-output with RES
TLE4271-2	600mA/5V single-output with EN, RES, and WD
TLE4471	System supply 500mA/5V with 2x5V-trackers, EN, RES, and WD
TLE4476	350mA/3.3V and 430mA/5V dual-output with EN
DC/DC Converters	
TLE6368G2	Multiple output system supply for microcontrollers and sensors (e.g. EMS, EPS etc.)
TLE6389-2/-3	Low quiescent current supply (e.g. dashboard)

### Key Features

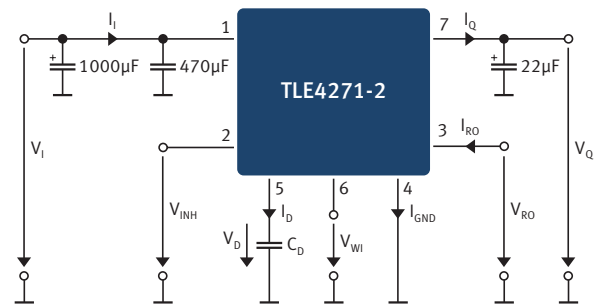
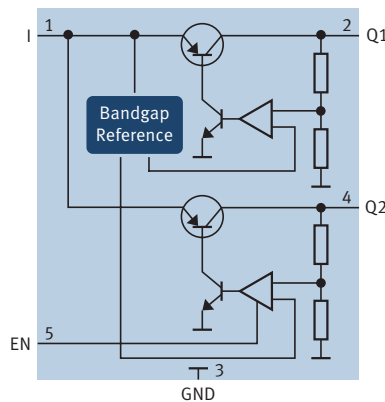
- 60V supply voltage
- Overvoltage protection
- Short-circuit protection
- Current limitation
- Overtemperature protection
- ESD protection

### Applications

- Truck body computer
- Engine management unit
- Sensor supply
- Multilevel system supply (TLE4471xx)
- HVAC
- EPS

### Key Benefits

- Real 24V requirements fulfillment
- AEC-Q100 qualified
- Robust RoHS packages

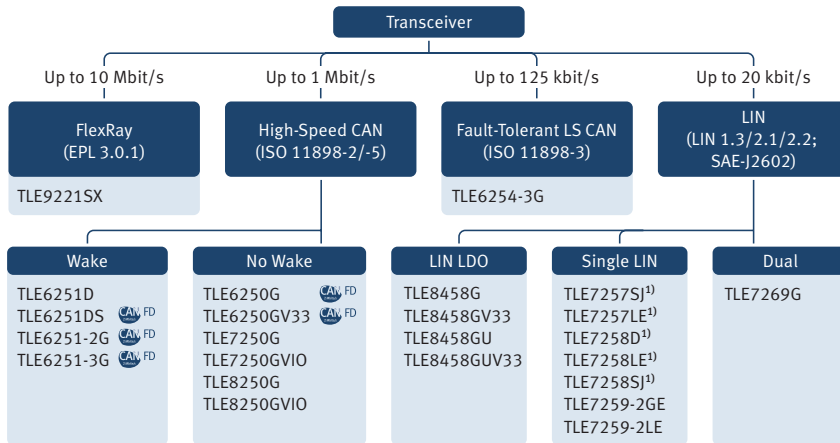


# CAN & LIN Transceivers

## The Perfect Match for In-Vehicle Networking

Transceivers are the link between the protocol unit (the controller) and the physical transmission medium (bus cable). In addition to their driving function (reception/transmission of signals from the bus to ECU), the transceivers also provide a wide range of protective and fault diagnosis functions.

### Selection Tree for Automotive Transceivers

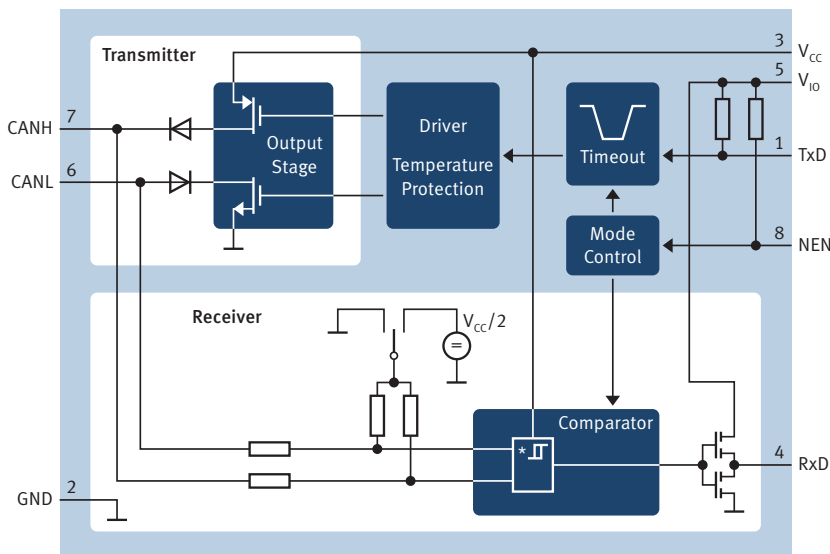


1) in development

### Key Features and Key Benefits

- Excellent EMC
- Outstanding ESD robustness
- Highest quality standard
- Broad product portfolio and family concept
- Low quiescent current requirement

### Block Diagram Example of a High-Speed CAN: TLE7250GVIO



## Make Your Application Wireless

Infineon offers a comprehensive and complementary product portfolio of transmitter, receiver and transceiver products for the major sub-1GHz frequency bands. This means you can always find the right product with the best cost/feature ratio for all the different application requirements from consumer to automotive.

Our portfolio extends from a high number of standard ASK/FSK transmitter, receiver and transceiver products with different feature sets and operating temperature ranges up to the highly integrated and feature-rich SmartLEWIS™ family. SmartLEWIS™ stands for Smart Low Energy Wireless Systems and its family members for the next generation of wireless control products that have the highest level of integration and functionality for reducing system complexity and current consumption in an intelligent way.

- The SmartLEWIS™ TX is a multi-channel and multi-band transmitter with selectable output power.
- The SmartLEWIS™ MCU products are multi-band transmitters with an embedded 8051 microcontroller, on-chip memory and many exciting peripherals, thereby realizing a highly-efficient single chip for remote control applications.
- The SmartLEWIS™ RX products have an integrated digital baseband, enabling autonomous receive functionality without the need to wake up the microcontroller and thereby minimizing the system current consumption. Furthermore, multi-protocol handling enables these devices to receive signals from different applications.
- The SmartLEWIS™ RX+ products feature enhanced sensitivity and a reduced bill-of-material compared to their SmartLEWIS™ RX predecessors while keeping the high level of functionality.
- The SmartLEWIS™ TRX is a multi-channel transceiver with the highest functionality, high sensitivity and selectable output power.

### Applications

- Remote Keyless Entry (RKE)
- Tire pressure monitoring
- Replacement of wireline connections
- Any kind of wireless low data rate application

### Key Benefits

- Complementary product portfolio for sub-1GHz RF
- Lowest current consumption
- Best range
- High automotive proven quality
- Comprehensive documentation and easy-to-use development tooling



	Product Type	Description
Transmitter	TDK510x/F	ASK/FSK Transmitter family for low power (2–5dBm), temperature range -40 ... 125°C
	TDK511x F	ASK/FSK Transmitter family for high power (10dBm), temperature range -40 ... 125°C
	TDA7100	ASK/FSK Transmitter family for low power (2–5dBm), temperature range -20 ... 70°C
	TDA711x/F	ASK/FSK Transmitter family for high power (10dBm), temperature range -40 ... 85°C
SmartLEWIS™ TX	TDA5150	ASK/FSK Transmitter, multi-channel, multi-band, multi-power, temperature range -40 ... 85°C
SmartLEWIS™ MCU	PMA5105	ASK/FSK Transmitter with embedded 8051 microcontroller, temperature range -40 ... 125°C
	PMA5110	ASK/FSK Transmitter with embedded 8051 microcontroller and 125kHz LF receiver, temperature range -40 ... 125°C
	PMA7105	ASK/FSK Transmitter with embedded 8051 microcontroller, temperature range -40 ... 85°C
	PMA7106	ASK/FSK Transmitter with embedded 8051 microcontroller and 10-bit ADC, Temperature range -40 ... 85°C
	PMA7107	ASK/FSK Transmitter with embedded 8051 microcontroller and 125kHz LF receiver, temperature range -40 ... 85°C
	PMA7110	ASK/FSK Transmitter with embedded 8051 microcontroller, 10-bit ADC and 125kHz LF receiver, temperature range -40 ... 85°C
Receiver	TDA520x	ASK Receiver family, temperature range -40 ... 85°C
	TDA521x	ASK/FSK Receiver family, temperature range -40 ... 105°C
	TDA522x	ASK/FSK Receiver family with switchable peak detector, temperature range -40 ... 105°C
	TDA7200	ASK/FSK Receiver family with switchable peak detector, temperature range -20 ... 70°C
	TDA7210/V	ASK/FSK Receiver family, temperature range -40 ... 85°C, TSSOP and VQFN package
SmartLEWIS™ RX	TDA5230/31	Receiver family with digital baseband processing, multi-channel, Temperature range -40–105°C
SmartLEWIS™ RX+	TDA5225	High Sensitivity Receiver, multi-channel, temperature range -40 ... 105°C
	TDA5235	High Sensitivity Receiver with digital baseband processing, single channel, Temperature range -40 ... 105°C
	TDA5240	High Sensitivity Receiver with digital baseband processing, multi-channel, Temperature range -40 ... 105°C
Transceiver	TDA525x	ASK/FSK Transceiver family, single-channel, temperature range -40 ... 85°C
	TDA7255V	ASK/FSK Transceiver family, single-channel, VQFN package, temperature range -40 ... 85°C
SmartLEWIS™ TRX	TDA5340	High Sensitivity Transceiver with digital baseband processing, multi-channel, Temperature range -40 ... 110°C



# Evaluation Kits/Demo Boards

## Standard Transmitter + Receiver Boards/Kits

Board/Kit Type	RX/TX/MCU	Frequency [MHz]	Output Power [dBm]	Modulation	Order Code
TDK5101-TDA5211_315_5	TX, RX	315	5	FSK (ASK)	SP000444584
TDK5101-TDA5221_315_5	TX, RX	315	5	FSK (ASK)	SP000278818
TDK5101F-TDA5221_315_5	TX, RX	315	5	FSK (ASK)	SP000078497
TDK5111-TDA5221_315_10	TX, RX	315	10	FSK (ASK)	SP000278820
TDK5111F-TDA5211_315_10	TX, RX	315	10	FSK (ASK)	SP000086723
TDK5100-TDA5220_434_5	TX, RX	434	5	FSK (ASK)	SP000278816
TDK5100F-TDA5220_434_5	TX, RX	434	5	FSK (ASK)	SP000078498
TDK5100F_434_5 BOARD	TX	434	5	FSK (ASK)	SP000078510
TDA7100-TDA7200_434_5	TX, RX	434	5	FSK (ASK)	SP000307373
PMAFOB_TDA7210V_434_KIT	TX+MCU, RX+MCU	434	5	FSK (ASK)	SP000873416
TDK5110-TDA5220_434_10	TX, RX	434	10	FSK (ASK)	SP000278821
TDK5110F_434_10 BOARD	TX	434	10	FSK (ASK)	SP000278798
TDK5110F-TDA5210_434_10	TX, RX	434	10	FSK (ASK)	SP000086722
TDA7110F-TDA7210V_434_10	TX, RX	434	10	FSK (ASK)	SP000745284
TDA7110F_7210_MODULES	TX, RX	434	10	ASK	SP000977506
TDK5100-TDA5210_868_5	TX, RX	868	5	FSK (ASK)	SP000078505
TDK5110-TDA5220_868_10	TX, RX	868	10	FSK (ASK)	SP000278822
TDK5116F-TDA5220_868_10	TX, RX	868	10	FSK (ASK)	SP000278819
TDA7110-TDA7210_868_10	TX, RX	868	10	FSK (ASK)	SP000546902
TDA7116F-TDA7210V_868_10	TX, RX	868	10	FSK (ASK)	SP000745290
TDA5102-TDA5212_915_5	TX, RX	915	5	FSK (ASK)	SP000278814

Standard TX and RX boards are configured for FSK modulation by default. To modify the boards from FSK to ASK, refer to the app note entitled "How to convert standard tooling from FSK to ASK".

## SmartLEWIS™ TX Boards/Kits

Board/Kit Type	RX/TX/MCU	Frequency [MHz]	Output Power [dBm]	Modulation	Order Code
TDA5150_315_5 BOARD	TX	315	5	ASK/FSK	SP000356305
TDA5150_434_5 BOARD	TX	434	5	ASK/FSK	SP000356301
TDA5150_434_10 BOARD	TX	434	10	ASK/FSK	SP000356304
TDA5150_868_10 BOARD	TX	868	10	ASK/FSK	SP000356303
TDA5150_915_10 BOARD	TX	915	10	ASK/FSK	SP000356302
TDA5150 SIB BOARD	Interface	Universal			SP000357842

A full TDA5150 evaluation kit comprises the TDA5150 RF board with the required frequency plus the TDA5150 system interface board (TDA5150 SIB board), which must be ordered separately.

## SmartLEWIS™ MCU Boards/Kits

Board/Kit Type	RX/TX/MCU	Frequency [MHz]	Output Power [dBm]	Modulation	Order Code
PMA Starter Kit					
PMAx110-315-5-USB-RF KIT	TX + MCU	315	5	ASK/FSK	SP000409138
PMAx110-434-5-USB-RF KIT	TX + MCU	434	5	ASK/FSK	SP000409140
PMAx110-868-10-USB-RF KIT	TX + MCU	868	10	ASK/FSK	SP000426622
PMA Evaluation Kit <sup>1)</sup>					
PMA5110-315-5 BOARD	TX + MCU	315	5	ASK/FSK	SP000409122
PMA5110-434-5 BOARD	TX + MCU	434	5	ASK/FSK	SP000409126
PMA5110-868-10 BOARD	TX + MCU	868	10	ASK/FSK	SP000409132
SmartLEWIS™ SIB BOARD	Interface	Universal			SP000409156
PMAfob Demonstrator					
PMAFOB-DEMO KIT <sup>2)</sup>	TX + MCU, RX	434	5	ASK/FSK	SP000643642
PMAFOB_TDA7210V_434_KIT <sup>3)</sup>	TX+MCU, RX+MCU	434	5	ASK/FSK	SP000873416

1) A full PMA evaluation kit comprises the PMA RF board with the required frequency plus the system interface board (SmartLEWIS™ SIB board), which must be ordered separately.

2) RKE and home automation demonstrator: PMA keyfob and TDA5230 evaluation board

3) Remote Control Demonstrator: PMA keyfob in combination with TDA7210V + MCU receiver board



## SmartLEWIS™ RX Boards/Kits

Board/Kit Type	RX/TX/MCU	Frequency [MHz]	Output Power [dBm]	Modulation	Order Code
TDA5231_315_5_BOARD	RX	315		ASK/FSK	SP000278813
TDA5230_434_5_BOARD	RX	434		ASK/FSK	SP000278811
TDA5230-434-USB-UWLINK	RX	434		ASK/FSK	SP000559072
TDA5230_868_5_BOARD	RX	868		ASK/FSK	SP000278812

## SmartLEWIS™ RX+ Boards/Kits

Board/Kit Type	RX/TX/MCU	Frequency [MHz]	Output Power [dBm]	Modulation	Order Code
TDA5240_315_5_BOARD	RX	315		ASK/FSK	SP000535296
TDA5235_315_5_BOARD	RX	315		ASK/FSK	SP000640510
TDA5225_315_5_BOARD	RX	315		ASK/FSK	SP000643648
TDA5240_434_5_BOARD	RX	434		ASK/FSK	SP000535300
TDA5235_434_5_BOARD	RX	434		ASK/FSK	SP000640514
TDA5225_434_5_BOARD	RX	434		ASK/FSK	SP000643654
TDA5240_868_5_BOARD	RX	868		ASK/FSK	SP000535304
TDA5235_868_5_BOARD	RX	868		ASK/FSK	SP000640518
TDA5225_868_5_BOARD	RX	868		ASK/FSK	SP000643658
TDA5240_915_5_BOARD	RX	915		ASK/FSK	SP000799568
TDA5235_915_5_BOARD	RX	915		ASK/FSK	SP000799564
TDA5225_915_5_BOARD	RX	915		ASK/FSK	SP000775162
SmartLEWIS™ SIB BOARD	Interface	Universal			SP000409156

A full TDA5240/35/25 evaluation kit comprises the RF board with the required frequency and the system interface board (SmartLEWIS™ SIB Board), which must be ordered separately.

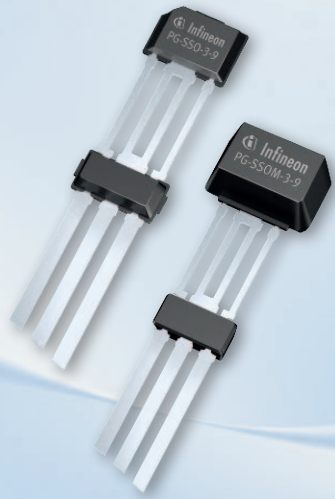
## Standard Transceiver Boards/Kits

Board/Kit Type	RX/TX/MCU	Frequency [MHz]	Output Power [dBm]	Modulation	Order Code
TDA5251-TDA5251_315 Kit	TRX	315	5	ASK/FSK	SP000078507
TDA5255-TDA5255_434 Kit	TRX	434	5	ASK/FSK	SP000015023
TDA7255V_TDA7255V_434_10	TRX	434	10	ASK/FSK	SP000745294
TDA5250-TDA5250_868 Kit	TRX	868	5	ASK/FSK	SP000486986
TDA5252-TDA5252_915 Kit	TRX	915	5	ASK/FSK	SP000434768

## SmartLEWIS™ TRX Boards/Kits

Board/Kit Type	RX/TX/MCU	Frequency [MHz]	Output Power [dBm]	Modulation	Order Code
TDA5340_315_BOARD	TRX	315	10	ASK/FSK	SP000926798
TDA5340_434_BOARD	TRX	434	10	ASK/FSK	SP000926802
TDA5340_470_BOARD	TRX	470	10	ASK/FSK	SP000997724
TDA5340_868_BOARD	TRX	868	13	ASK/FSK	SP000926808
TDA5340_915_BOARD	TRX	915	13	ASK/FSK	SP000926812

The evaluation board includes one TDA5340 RF board and one UWLINK interface board. You do not need to order a separate interface board. If you want to establish a wireless connection, you will have to order two evaluation boards.



## Three-wire Speed Sensors TLE492x and TLE4957

### Self-calibrating, Highly-sensitive Hall Sensor

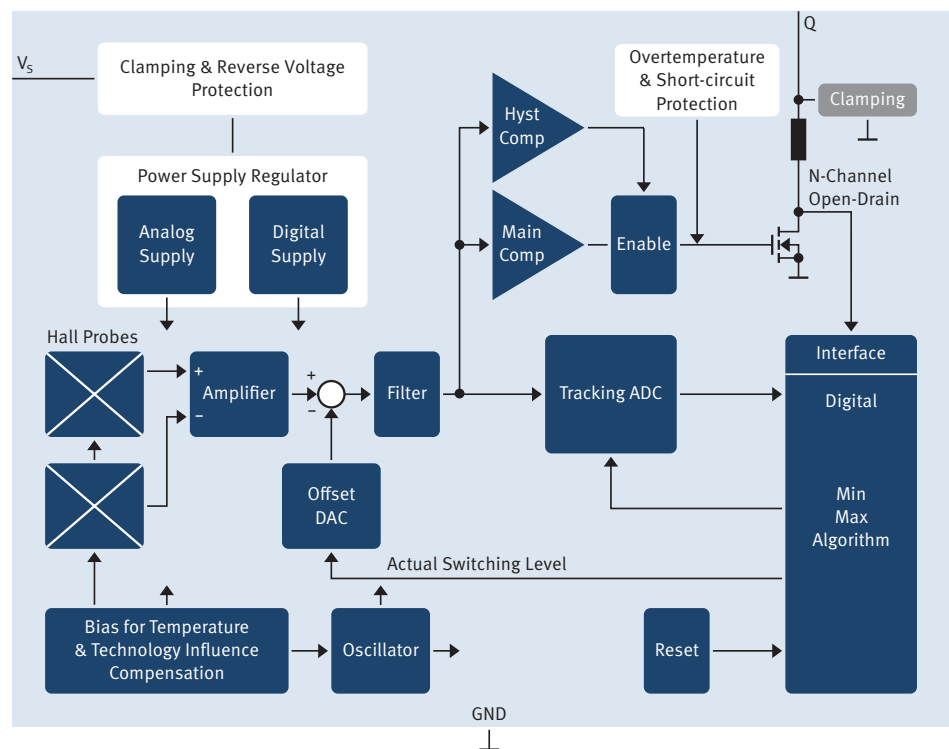
The TLE492x family and TLE4957 are active Hall sensors suited to detecting the motion and position of ferromagnetic and permanent magnet structures. An additional self-calibrating module has been implemented to achieve optimum accuracy during normal running operation. It comes in a 3-pin package for the supply voltage and an open-drain output. Package options with integrated back-bias magnets (iBB) for easier use and design are also available.

#### Key Features








- Advanced performance via dynamic self-calibration principle
- No external components required for operation
- 0.001kHz low cut-off frequency
- Fast start-up time (2<sup>nd</sup> edge detection)
- Low voltage supply (3.3V)
- Output short-circuit, reverse-polarity and overtemperature protected
- Digital output signal (voltage interface)
- High sensitivity ( $B_{\min} < 1.5\text{mT}$ )
- Low jitter typ.  $\pm 0.11\%$  at 10mT
- Module style package with two integrated 47nF capacitors between  $V_s$  and GND
- Availability of integrated back-bias magnet package options

#### Key Applications

- Speed and position (i.e. crankshaft)
- Transmission speed
- Speedometer



## Overview of Powertrain Speed Sensors

	Icon/Description	TLE4921	TLE4923	TLE4924	TLE4926	TLE4927	TLE4928	TLE4951 <sup>3)</sup>	TLE4953	TLE4954 <sup>3)</sup>	TLE4957
Automotive	Wheel Speed		yes								
	Camshaft			yes		yes					
	Crankshaft	yes		yes	yes	yes	yes				yes
	Transmission	yes		yes		yes	yes	yes	yes	yes	yes
Industrial		yes		yes		yes		yes		yes	yes
Sensor Technology		Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall	Diff. Hall
Direction Information Available								yes	yes	yes	
Vibration Suppression Algorithm Included								yes	yes	yes	yes
Type of Hysteresis <sup>1)</sup>		V	V	V	H	H	H	V	V	V	V/H
		F	F	A/F	F	A	F	A	A	A	A
Interface <sup>2)</sup>	# of pins	4	3	3	3	3	3	2	2	2	3
	Interface	V	C	V	V	V	V	C	C	C	V
	Protocol	S	S	S	S	S	S	P	P	P	S
Package without Integrated Capacitor		yes	yes				yes		yes		
Package with Integrated Capacitor				yes	yes	yes	yes	yes	yes	yes	yes
iBB-Package								yes		yes	

1) H = Hidden; V = Visible; F = Fixed; A = Adaptive; P = Programmable

2) C = Current; V = Voltage Interface; S = Single Pulse; P = PWM Protocol; A = AK-Protocol

3) To be released in 2013





## TLE496x Family in an SOT23 Package

### Hall Switches for Contactless Position Detection, Index Counting and BLDC Commutation

Designed with new technology, the family offers high-voltage capabilities with very small current consumption. The products can be operated from unregulated power supplies, thereby offering our customers a unique freedom of system design.

The superior overvoltage of up to 42V makes additional resistors redundant. This allows the reduction of external, passive protection components which reduces system PCB space, along with design and inspection costs.

With the typical current consumption of 1.6mA, the family offers a reduction of over 50% compared to similar products and is therefore ideally suited for upcoming energy-sensitive systems.

Aimed at the automotive market with high quality requirements, both strong ESD functionality and a high stability of magnetic thresholds over temperature and lifetime have been realized.

#### Key Features

- 3.0V to 32V operating supply voltage
- Operation from unregulated power supply
- Reverse polarity protection (-18V)
- Overvoltage capability up to 42V without external resistor
- Small current consumption (1.6mA)
- Output short-circuit & overtemperature protection
- Active error compensation
- High stability of magnetic thresholds
- High ESD performance
- Small SMD package (SOT23)

#### Key Applications

- BLDC (commutation)
- Window lifter (index counting)
- Power closing (index counting)
- Gear stick (position detection)
- Seat belt (position detection)

#### Key Benefits

- Low current consumption
- High resistance to mechanical stress due to active error compensation
- High repeatability of magnetic thresholds
- Small package enables very compact system size

### TLE496x Family in smallest SOT23 Package – Portfolio Overview

Product Type	Type	Magnetic Sensitivity [mT]	Availability
TLE4961-1M	Latch	±2.0	In production
TLE4961-3M	Latch	±7.5	In production
TLE4964-1M	Unipolar	12.5/18.0	In production
TLE4964-2M	Unipolar	22.5/28.0	In production
TLE4964-3M	Unipolar	9.5/12.5	In production
TLE4968-1M	Bipolar	±1.0	Q3 2013
TLE4964-5M	Unipolar	5.0/7.5	In production
TLE4961-2M	Latch	±5.0	In production
TLE4961-4M	Latch	±10.0	Q3 2013
TLE4964-6M	Unipolar	2.5/3.5	Q3 2013
TLE4961-5M	Latch	±15.0	Q3 2013
TLE4964-4M	Unipolar	8.5/10.0	Q3 2013





# Angle Sensors

## iGMR Sensors

Infineon's iGMR sensors are the ideal choices for applications with a wide angle range, such as BLDC motor or steering sensors. The sensors are pre-calibrated and ready to use. A different level of signal-processing integration allows the optimization of system partitioning.

## iAMR Sensors

Infineon's iAMR sensors are particularly well suited for applications with a small angle range, such as wipers, pedals and flaps. Their excellent accuracy can also be beneficial to some BLDC applications where 180° information is sufficient.

### Applications

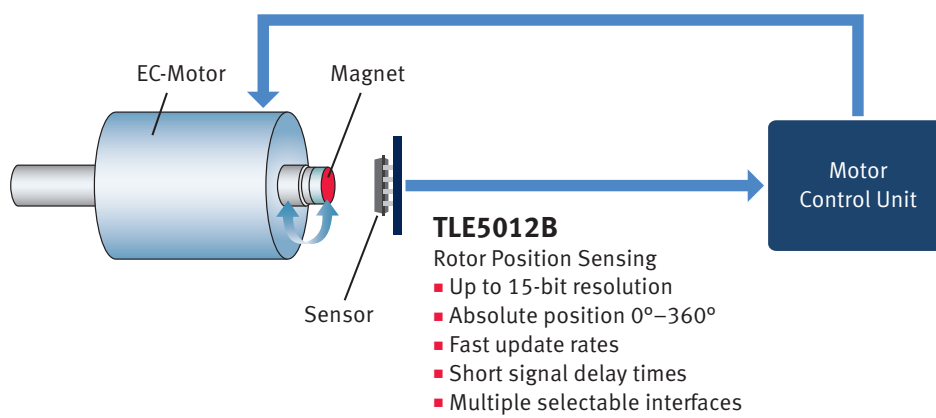
- Steering angle
- Brushless DC motor commutation (e.g. Electric Power Steering (EPS))
- Rotary switch
- General angular sensing
- Incremental or absolute magnetic encoder
- Contactless angle measurement
- Wiper positioning
- Rotational position measurement

### Key Features

- Integrated GMR (iGMR) technology
- Full 0° to 360° angle measurement
- Pre-calibrated sensors
- High angle resolution
- Fast update rates
- Multiple interfaces available
  - SPI-compatible synchronous serial communication (SSC). Bidirectional up to 8Mbit/s
  - Pulse Width Modulation (PWM)
  - Hall Switch Mode (HSM) for motor commutation
  - Incremental interface (IIF)
  - Analog differential or single-ended
- Integrated angle calculation with CORDIC algorithm
- Temperature compensation and auto-calibration algorithm
- Diagnoses function for sensor elements and circuitry with PRO-SIL™ support
- Automotive-qualified: -40 ... 150°C (junction temperature)
- ESD > 2kV (HBM)
- Green package with lead-free (Pb-free) plating

Product Type	Sin/Cos Output	Angle Output	Second Interface	Accuracy
TLE5009	Analog			2.3°
TLE5011	SPC (SPI)			1.6°
TLE5012B	SPC (SPI)	SPC (SPI)	PWM/IIF/SPC/HCM	1.0°
TLE5109	Analog			0.9°

### TLE5012B Acting as a Rotor Position Sensor



**iGMR iAMR**

AEC  
Qualified





## SP37

### Tire Pressure Sensor for Tire Pressure Monitoring System (TPMS)

The SP37 is a highly integrated device which performs all necessary functions for a Tire Pressure Monitoring System (TPMS) wheel module suited for high-volume applications. The device contains the sensing elements, the microcontroller, the LF receiver, the RF transmitter and more in a single package requiring only few external components to complete a TPMS module.

The SP37 measures pressure, radial acceleration, temperature and supply voltage, and is compliant to the RoHS standard with a green package.

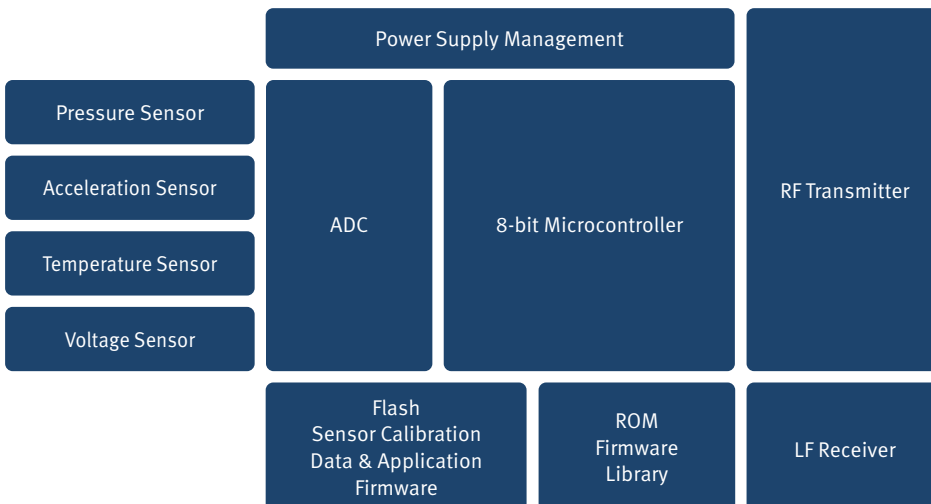
Measurable pressures vary from light vehicle to heavy truck applications offered by a variety of product variants with different pressure ranges (100–450kPa, 100–900kPa and 100–1300kPa).

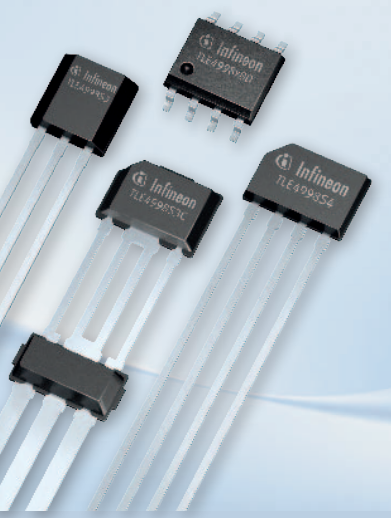
#### Key Features

- Pressure sensor
- Radial acceleration sensor
- Temperature sensor
- Supply voltage sensor
- Embedded 8051-compatible 8-bit microcontroller
- 6KB on-chip FLASH memory
- 256Byte RAM
- 315 and 434MHz FSK/ASK
- RF transmitter
- Selectable output power of 5 or 8dBm
- 125kHz ASK high-sensitivity LF receiver
- Advanced power control/wake-up system to minimize battery consumption
- Ultra-low standby current of  $< 0.7\mu\text{A}$
- Supply voltage range of 1.9–3.6V
- Operating temperature range of  $-40 \dots 125^\circ\text{C}$
- PG-DSOSP-14-6 package
- RoHS-compliant, green package



Product Type	Pressure Range	Key Benefits
SP370-25-106-0	100–450kPa	<ul style="list-style-type: none"> <li>■ Single-pressure</li> <li>■ Field-programmable via LF</li> <li>■ RF data rate up to 20kbit/s</li> </ul>
SP370-25-116-0	100–900kPa	<ul style="list-style-type: none"> <li>■ Automatic pressure</li> <li>■ Field-programmable via LF</li> <li>■ RF data rate up to 20kbit/s</li> </ul>
SP370-23-156-0	100–1300kPa	<ul style="list-style-type: none"> <li>■ Single-pressure</li> <li>■ RF data rate up to 10kbit/s</li> </ul>
SP270-25-256-0	SP27 100–1300kPa (Non-TPMS Product)	<ul style="list-style-type: none"> <li>■ Without accelerometer sensing</li> <li>■ Without wireless communication capabilities (RF and LF)</li> </ul>





# Linear Hall Sensor Family

## Programmable Analog and Digital Linear Hall Sensor Family

Our family of TLE499x linear Hall ICs is tailored to the needs of highly accurate angular and linear position detection and current measurement applications. Each product measures the vertical component of a magnetic field and outputs a signal that is directly proportional to the magnetic field. These programmable linear Hall sensors come with different interface options: TLE4997 features radiometric analog output while TLE4998P comes with pulse width modulation (PWM), TLE4998S with single edge nibble transmission (SENT) and TLE4998C with short PWM codes (SPC). These high-precision 12-bit resolution linear Hall sensors feature EEPROM memory for flexible programming across a wide range of parameters.

Thanks to digital signal processing based on a 20-bit DSP architecture plus digital temperature compensation, these sensors deliver outstanding temperature stability compared to similar compensation methods. TLE4998 also includes stress compensation to withstand stress effects from the package, such as moisture, thereby ensuring best-in-class accuracy over the device's lifetime.

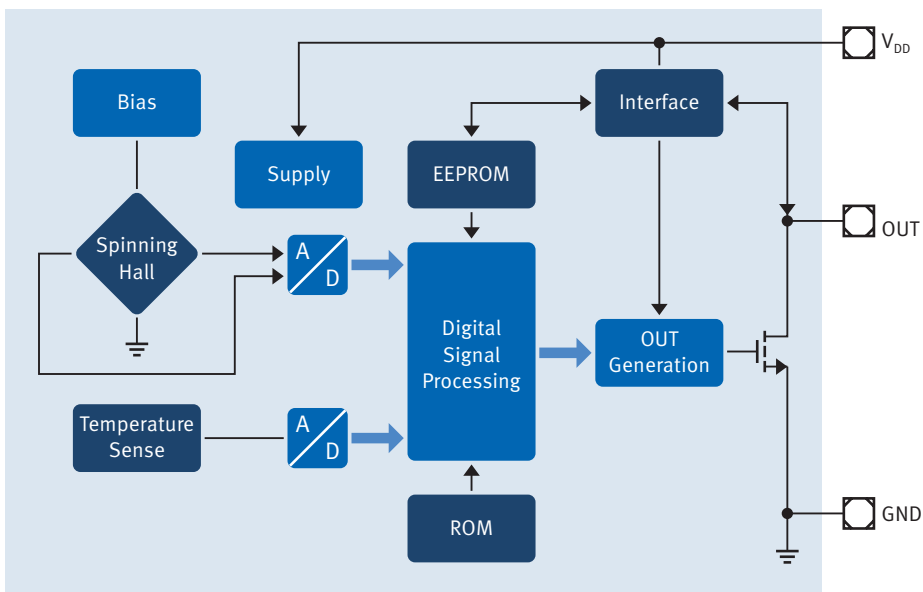
### Key Features

- 20-bit digital signal processing
- 12-bit overall resolution at wide output range
- 3 magnetic ranges:  $\pm 50/100/200\text{mT}$
- Programmable transfer function (gain, offset), clamping, bandwidth and temperature characteristic
- Digital temperature compensation
- Exceptionally low drift of offset and output signal
- High immunity against EMC, ESD and mechanical stress (stress compensation)
- On-board diagnosis
- Wide temperature range:  $-40^{\circ}\text{C}$  to  $150^{\circ}\text{C}$
- Analog and various digital interface options available (PWM – Pulse Width Modulation, SENT – Single Edge Nibble Transmission, SPC – Short PWM Codes, Single and Dual-Die SMD package)

### Key Applications

- Suspension control
- Detecting gear stick/lever positions
- Detecting liquid levels in fuel tanks
- Battery management
- Motor control
- Detecting linear and angular position
- Detecting pedal and throttle position
- Steering torque measurement
- Headlight leveling
- High-current sensing
- Seat position and occupant detection

Product Type	Program-mable	Number of Pins	Sensitivity	Magnetic Offset	Supply Voltage (extended range)	Package
TLE4997	EEPROM	3	$\pm 12.5$ to $\pm 300$ mV/mT	$< \pm 400$ $\mu$ T	5V $\pm 10\%$ (7V)	PG-SSO-3-10 PG-TDSO-8
TLE4998P	EEPROM	3/4	$\pm 0.2$ to $\pm 6\%$ /mT	$< \pm 400$ $\mu$ T	5V $\pm 10\%$ (16V)	PG-SSO-3-10 PG-SSO-4-1 PG-SSO-3-9 (2 Capacitors) PG-TDSO-8
TLE4998S	EEPROM	3/4	$\pm 8.2$ to $\pm 245$ LSB/mT	$< \pm 400$ $\mu$ T	5V $\pm 10\%$ (16V)	PG-SSO-3-10 PG-SSO-4-1 PG-SSO-3-9 (2 Capacitors) PG-TDSO-8
TLE4998C	EEPROM	3/4	$\pm 8.2$ to $\pm 245$ LSB/mT	$< \pm 400$ $\mu$ T	5V $\pm 10\%$ (16V)	PG-SSO-3-10 PG-SSO-4-1 PG-SSO-3-9 (2 Capacitors) PG-TDSO-8



## Integrated Pressure Sensor ICs

Our integrated pressure sensor family uses unique multiple surface micro-machined capacitive sensor cell arrays that support powerful self-diagnosis features, such as the mechanical and electrical verification of sensor functionality. Monolithic integration onto a single chip enables state-of-the-art production using a standard automotive-qualified BiCMOS process. Sophisticated sensor cell design combined with fully digital signal conditioning and processing based on high-volume production flows ensures superior quality over the entire lifecycle.

These pressure sensors are ideal for a wide range of applications in the automotive and industrial sectors. The analog and digital interfaces of our pressure sensors provide customers with a high degree of design flexibility and enable manufacturers to meet evolving market demands.

Our digital interface portfolio ranges from PSI5 for safety products (such as side crash detection and pedestrian protection systems) to SPI for automotive powertrain and body applications (such as Barometric Air Pressure (BAP), fuel vapor and seat comfort systems) all the way up to I<sup>2</sup>C and SENT with SPC functionality for upcoming engine management products (such as MAP, Turbo MAP (with NTC) and secondary air valves).

Product Type	Pressure Range [kPa]	Max. Accuracy [kPa]	Max. Operating Temperature [°C]
KP23x	40–115	1.0	125
KP236N6165	60–165	1.0	125
KP21x	10–115	1.0	140
KP22x	10–400	2.5	140
KP253	60–165	1.0	125
KP254	40–115	1.5	125
KP256	60–165	1.0	125

### Key Applications

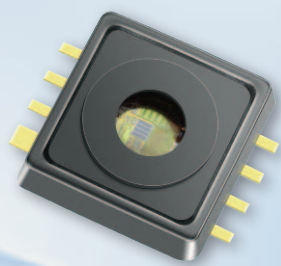
- BAP
- Seat comfort systems
- Fuel vapor
- Idle stop

## KP21x/KP22x

### Analog Manifold Air Pressure Sensor IC Family (MAP + Turbo MAP)

#### Features

- Manifold air pressure measurement – MAP and Turbo MAP
- Excellent accuracy of up to 1.0kPa over a large temperature range
- Ratiometric analog voltage output proportional to the applied pressure



- Output signal fully compensated across pressure and temperature ranges
- Pressure range from 10 to 400kPa
- Temperature range from -40 ... 140°C
- Output clamping (optional)
- Complete product family available with multiple transfer function
- Reverse polarity protection
- Green SMD package

## KP23x

### Analog Barometric Air Pressure (BAP) Sensor IC Family

#### Features

- Absolute air pressure measurement
- Excellent accuracy of 1.0kPa over a large temperature range
- Ratiometric analog voltage output proportional to the applied pressure
- Output signal fully compensated across pressure and temperature ranges
- Pressure range from 40 to 115kPa
- Temperature range from -40 ... 125°C
- Serial service interface
- Open Bond Detection for supply and GND (OBD)
- Self-diagnosis routines
- Inverse polarity protection
- Green SMD package

## KP25x

### SPI Digital Barometric Air Pressure Sensor IC Family

#### Features

- SPI – digital interface
- Absolute air pressure measurement
- Excellent accuracy of 1.0kPa over a large temperature range
- Output signal fully compensated across pressure and temperature ranges
- Pressure range from 40 to 165kPa
- Temperature range -40 ... 125°C
- Self-diagnosis routines & diagnosis codes
- Reverse polarity protection
- Diagnosis checks during operation
- Green SMD package

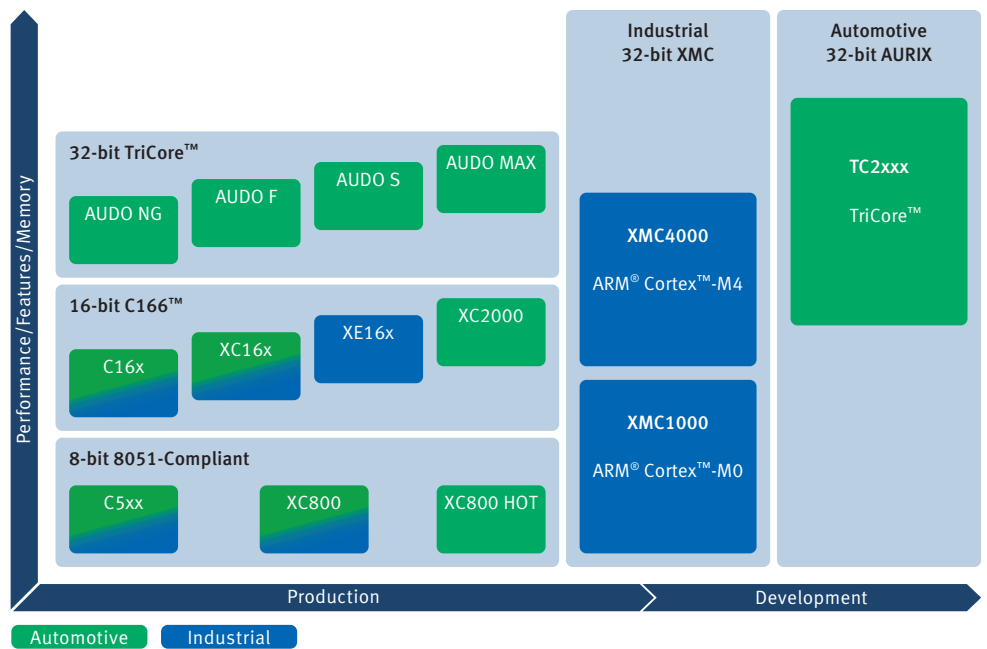


# The Perfect Microcontroller Family for Your 24V – 60V Applications

We offer a broad portfolio of 8-bit to 32-bit microcontrollers suitable for any kind of sub-application in the transportation area.

## Highest Quality Microcontroller Portfolio Drives Your Ideas to Business

- Leading real-time performance
- Outstanding peripherals
- Complete portfolio
- Superior quality
- Ease-of-use and expert support



## 32-bit Microcontrollers – TriCore™ Family

The Infineon TriCore™ family is optimized for 3-phase motor control applications in the industrial and automotive segments, including Permanent Magnet Synchronous Motors (PMSM) and AC Induction Motors (ACIM).

### Application Segments

#### Industrial

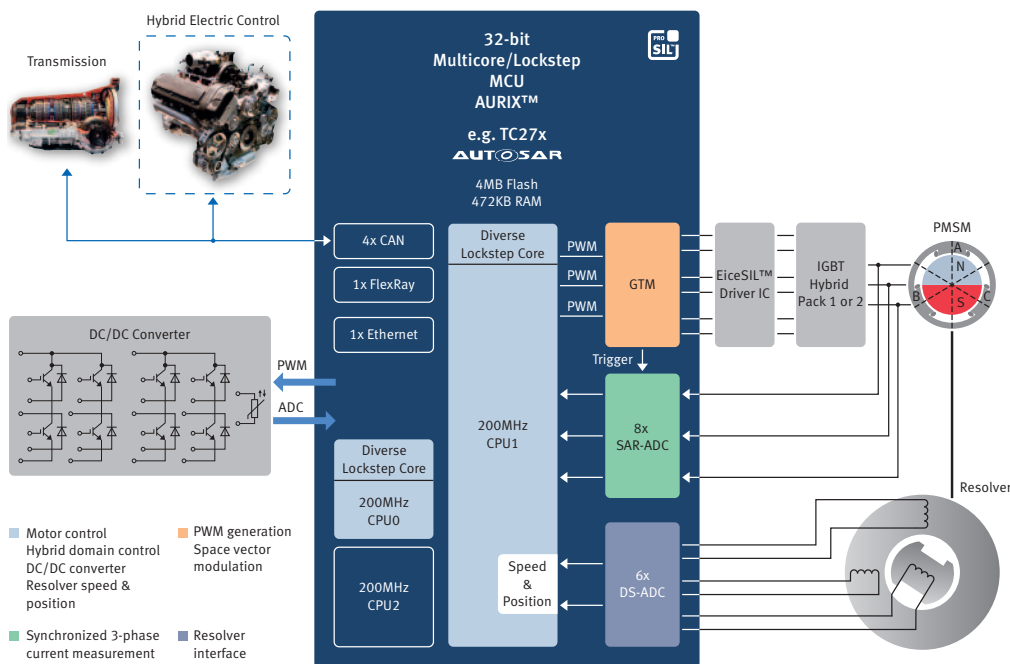
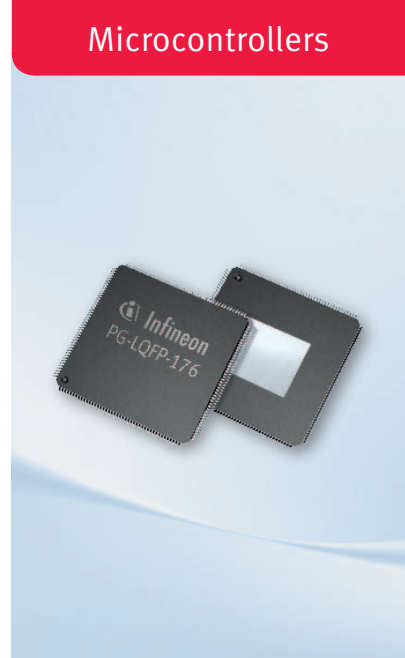
- AC Servo drives
- PLC
- Mobile controllers
- Process control

#### Automotive

- Steering (e.g. EPS)
- Electric propulsion for hybrid and electric vehicles

### Product Benefits

- High performance speeds up your motor control algorithm
- TriCore™ DSP instruction set for multiple motor control algorithms (e.g. Park, Clarke, Space vector modulation)
- Software library for Field-Oriented Control (“e-motor module”) facilitates fast implementation
- Supports safety-critical systems in achieving IEC 61508/ISO 26262 compliance
- Free tool chain: [www.infineon.com/davebench](http://www.infineon.com/davebench)



## XMC Family – 32-bit Industrial Microcontrollers Based on ARM® Cortex™

### XMC1000 Microcontroller Family – 8-bit Price for 32-bit Performance

The XMC1000 product family integrates the ARM® Cortex™-M0 core into a leading-edge 65nm manufacturing process to overcome the limitations of today's 8-bit designs. The XMC1000 is a full member of the XMC family which was introduced in early 2012 and uses the same peripherals, such as timers, A/D converters or those for serial communication. As is the case with XMC4000 products, the DAVE™ development environment is available as a free download for SW development.

Within its market segment, the XMC1000 offer the largest spectrum of Flash memory variants from 8KB to 200KB. Three product series cover a range of application fields. The XMC1100 series is tailored for an easy entry into the XMC world. The XMC1200 features peripherals for LED lighting and HMI designs, while the XMC1300 series addresses the needs of real-time control applications in the field of motor control or digital power conversion.

#### Key Features

- 32-bit ARM® Cortex™-M0, 32MHz
- 8KB to 200KB Flash memory – the most scalable Flash portfolio in the low-end segment
- AES 128-bit secure loader for SW IP protection
- Patented LED color control engine
- Leading-edge XMC mixed signal and timer peripherals
- IEC 60730 Class B-compliant
- Peripherals for touch and LED display control
- 64MHz MATH co-processor for advanced control loops (CORDIC / DIVIDE)
- Extended temperature range up to 105°C

#### Application Fields

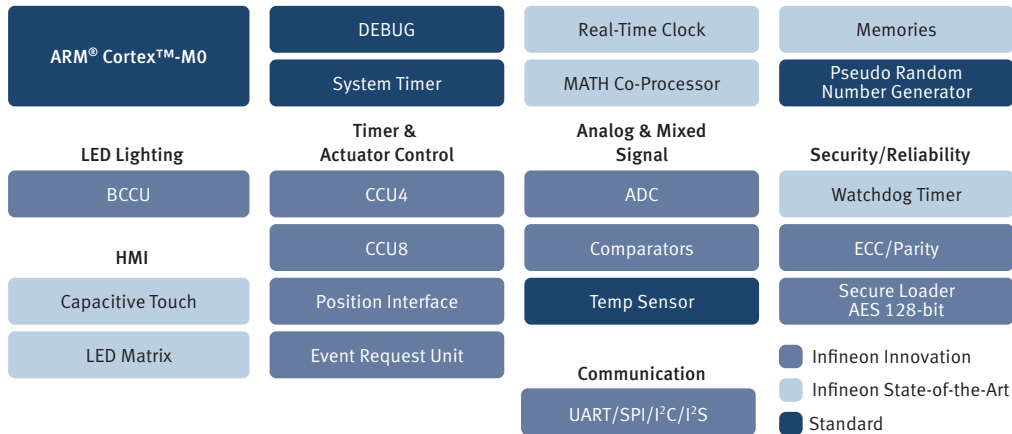
- Motor control
- LED lighting
- Digital power conversion
- Smart sensors
- Touch control
- LED displays
- General purpose

#### Packages

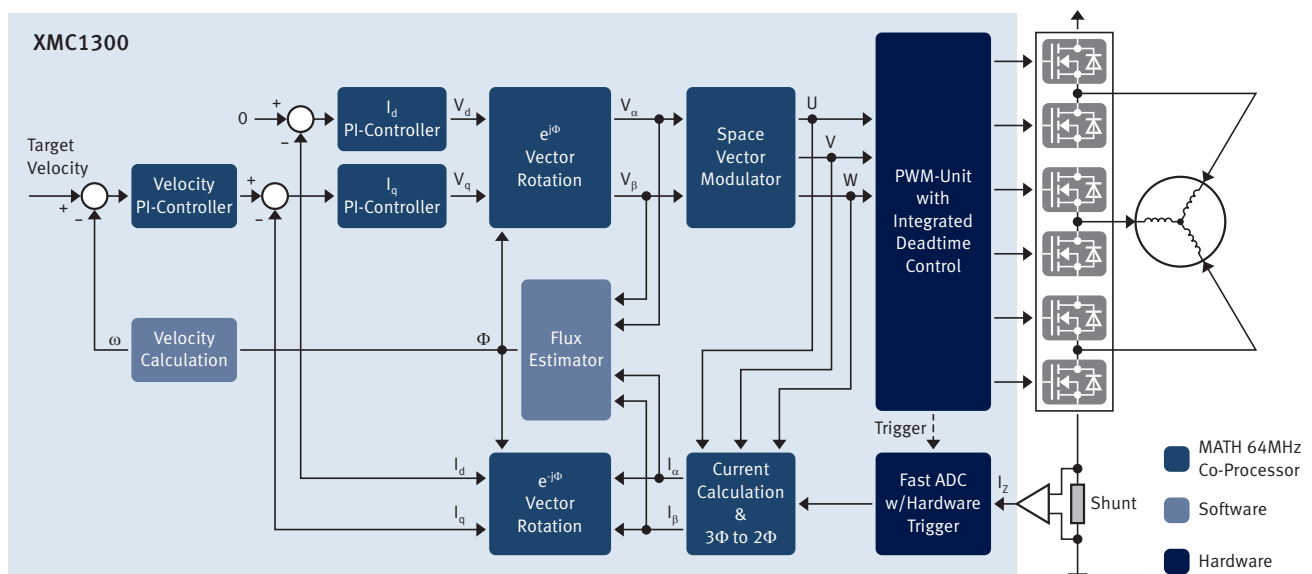
- TSSOP 16-pin, 28-pin, 38-pin



**XMC1100 Functional Block**



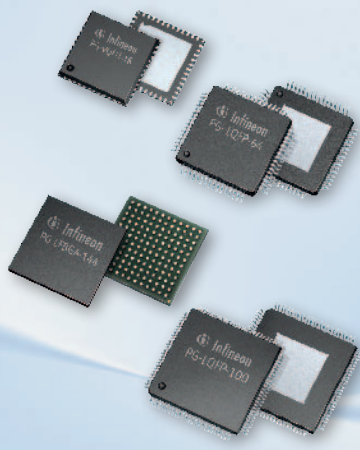
**XMC1300 Motor Control Scheme**



**XMC1000 Product Series**

		XMC1100	XMC1200	XMC1300
System Performance	Core	ARM® Cortex™-M0		
	CPU Frequency	32MHz		
	Co-Processor			MATH <sup>1)</sup>
	Flash Size	8–64KB	16–200KB	8–200KB
	RAM Size	16KB	16KB	16KB
Timers	POSIF			1x
	CCU4 (4ch)	1x	1x	1x
	CCU8 (4ch)			1x
Signal Processing	ADC 12-bit	1x	1x (2x S&H)	1x (2x S&H)
	Comparator		Up to 3x	3x
Communication	Serial Channels (UART, SPI, I <sup>2</sup> C, I <sup>2</sup> S)	2 Channels	2 Channels	2 Channels
Application-Specific	Touch Control/LED Display Matrix		✓ <sup>2)</sup>	
	LED Dimming & Color Control		✓ <sup>3)</sup>	✓ <sup>1)</sup>

1) Not valid for all variants of this product series  
 2) Only for XMC1201 sub-series  
 3) Only for XMC1202 sub-series

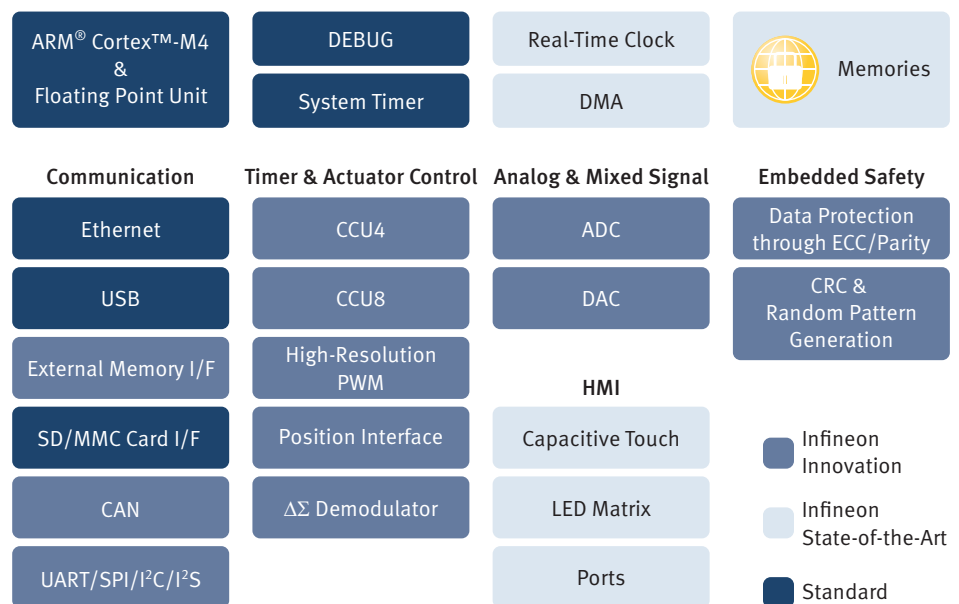


## XMC4000 Microcontroller Family

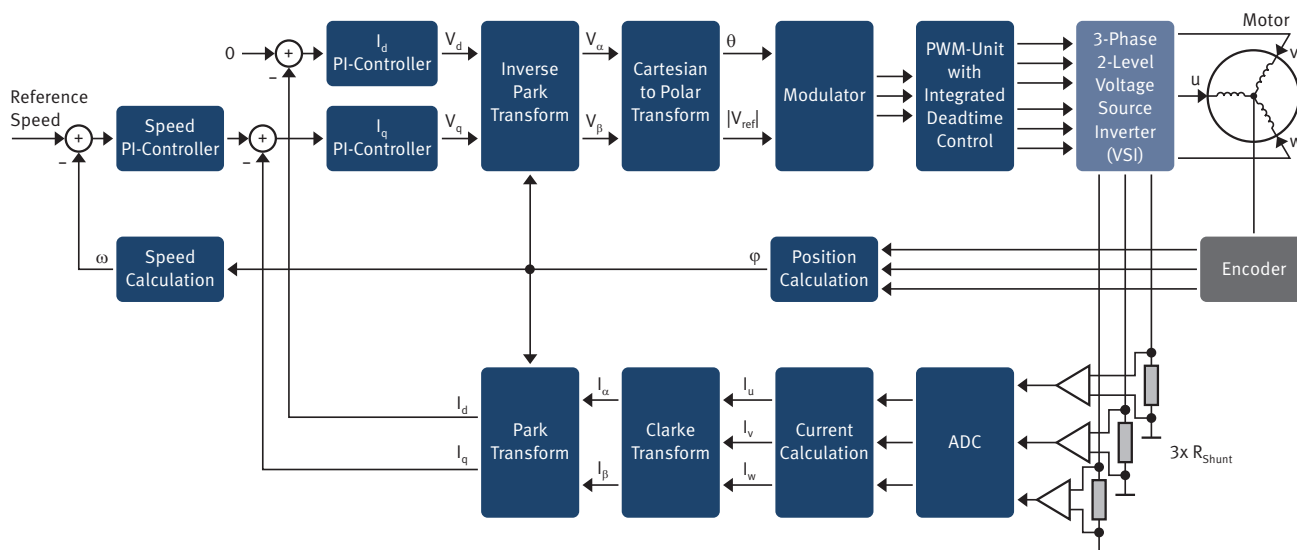
The XMC4000 family marks a cornerstone in microcontroller design for real-time critical systems. With the XMC4000, Infineon combines its leading-edge peripheral set with an industry-standard ARM® Cortex™-M4 core. Featuring Infineon’s highly advanced peripheral set – configurable to specific applications and designed to minimize the load on the CPU – the XMC4000 provides the horsepower for running the most sophisticated algorithms for today’s industrial control solutions. Family members even operate in high-temperature environments of up to 125°C, granting you access to their exceptional performance in all corners of your system.

All microcontrollers in the XMC4000 family offer a number of options with respect to CPU frequency, memory density, peripheral functions and number of I/Os. They are SW-compatible and offer pin-compatibility to their neighbor series for one particular package. Starting with the XMC4500 series with a mid to high-end feature set, the latest releases – the XMC4400, 4200 and 4100 – offer additional mid to lower-end feature/cost options and the most advanced high-resolution PWM module, reaching a resolution of 150ps.

### XMC4000 Functional Blocks



XMC4000 Motor Control Scheme



XMC4000 Product Series

		XMC4100	XMC4200	XMC4400	XMC4500
System Performance	Core	ARM® Cortex™-M4			
	CPU Frequency (at 125°C)	80MHz	80MHz	120MHz	120MHz
	Co-Processor	Floating Point Unit			
	Flash Size	128KB	256KB	512KB	1MB
	RAM Size	20KB	40KB	80KB	160KB
	Cache	4KB	4KB	4KB	4KB
Timers	POSIF	1x	1x	2x	2x
	CCU4 (4ch)	2x	2x	4x	4x
	CCU8 (4ch)	1x	1x	2x	2x
	High-Resolution PWM (150ps) Channels	4x	4x	4x	
Signal Processing	ADC 12-bit	2x	2x	4x	4x
	ΔΣ Demodulator			4x	4x
	DAC	2x	2x	2x	2x
Communication	IEEE 1588 Ethernet MAC			1x	1x
	USB	FS DEV	FS DEV	FS OTG	FS OTG
	SDIO/SD/MMC				✓
	Serial Channels (UART, SPI, I <sup>2</sup> C, I <sup>2</sup> S)	4x	4x	4x	6x
	Ext. Memory I/F				✓
	CAN	2x	2x	2x	3x
Application-Specific	Touch Control / LED Display Matrix	✓	✓	✓	✓



## 16-bit Microcontrollers – XC2000/XE166 Family

The highly scalable XC2000/XE166 family is ideal for a wide range of motor control designs, including applications based on DC brushed control, DC servo control, AC induction scalar-slip control, BLDC commutated control, permanent magnet AC field-oriented control and AC induction field-oriented control.

### Application Segments

#### Industrial

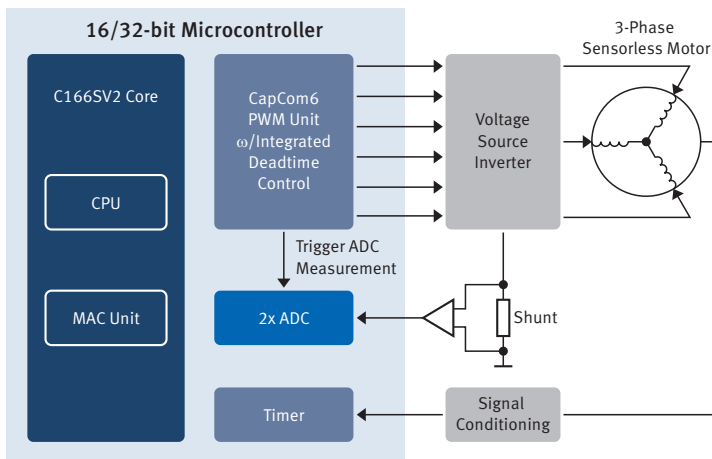
- Inverters
- Elevators
- Spindle drives
- PLC, Servo, CNC

#### Automotive

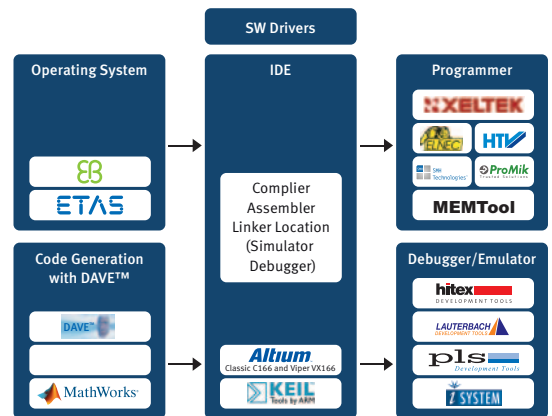
- Steering (e.g. EPS)
- Heating, ventilation, air-conditioning (e.g. HVAC) control systems
- Pumps

### Product Benefits

- Reduced BOM cost – the XE166/XC2000 family offers up to 4 PWM units with separate time bases for the combined control of two motors and the PFC algorithm on one chip
- High performance speeds up your motor control algorithm
- Two independent ADC units are triggered by the PWM timers
- The MAC unit provides DSP functionality via seamless integration into the CPU instruction set
- Supports safety-critical systems in achieving IEC 61508/ISO 26262 compliance
- Free tool chain: [www.infineon.com/davebench](http://www.infineon.com/davebench)



### Free Tool Chain



## 8-bit Microcontrollers – XC800 Family

The feature-rich XC800 microcontroller with its optimized peripheral set supports highly cost-efficient solutions in the industrial and automotive segments.

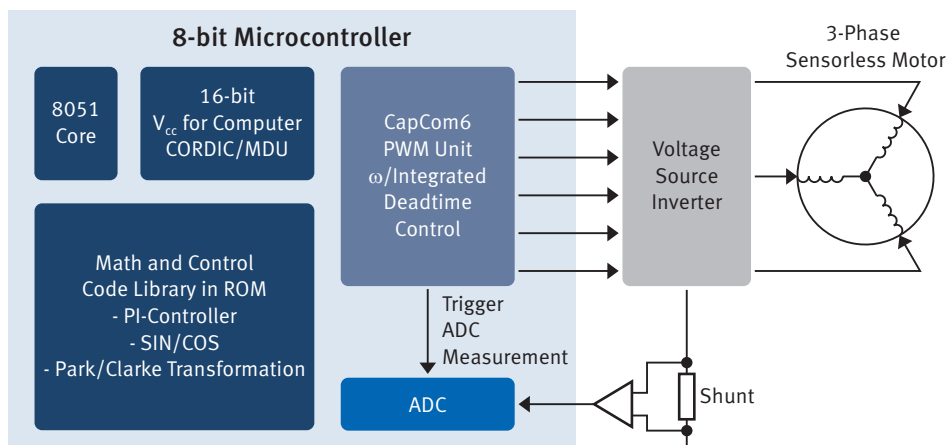
### Application Segments

- Home appliances
- Fans
- eBikes
- Pumps
- Stepper gauges
- Valve control

### Product Benefits

- Up to 50% system cost savings - Field-Oriented Control (FOC) at lowest cost
- Portfolio from 2KB to 64KB Flash and from 16-pin to 64-pin package options, qualified
- AEC-Q100 and up to an ambient temperature of 150°C
- Optimized peripherals and code library in ROM for Field-Oriented Control
- Two PWM units with separate time bases for combining motor control and power factor correction algorithms on one chip
- For use in IEC 60730/Class B-certified applications
- Low-cost stepper motor drive
- Free tool chain: [www.infineon.com/davebench](http://www.infineon.com/davebench)

### Sensorless Field-Oriented Control for 3-Phase Motor e.g. PMSM Motor









### Free Tool Chain

- DAVE™ – Infineon's latest embedded software solution
- Free XC800 Compiler
  - Complete Keil tool chain
  - Up to 64k code
  - 3-month support

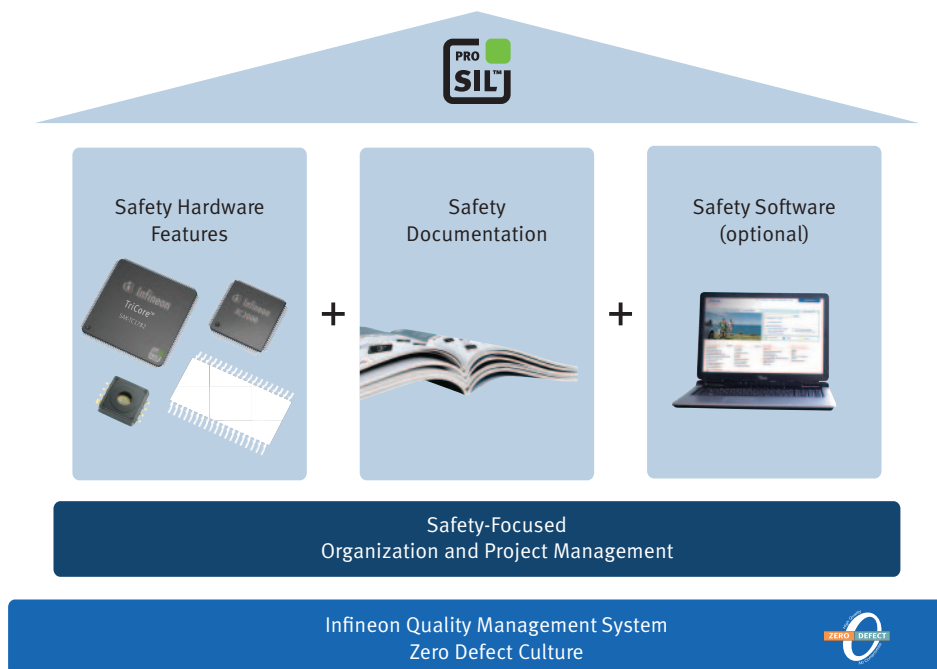


## Support Tools

Board Name	Products	Description	Order No.
 TLE5011 Evalkit	TLE5011  Angle sensor	The kit consists of a PGSISI box and an evaluation board and allows evaluation of an integrated Giant Magneto Resistance (iGMR) angle sensor. The evaluation board (PCB) with an angle sensor and rotating magnet is available separately (without PGSISI box).	TLE5011 Evalkit SP000634330 TLE5011 Evalboard (PCB) SP000634322
 TLE5012 Evalkit	TLE5012  Angle sensor	The kit consists of a PGSISI box and an evaluation board and allows evaluation of an integrated Giant Magneto Resistance (iGMR) angle sensor. The evaluation board (PCB) with an angle sensor and rotating magnet is available separately (without PGSISI box).	TLE5012 Evalkit SP000634334 TLE5012 Evalboard (PCB) SP000634326
 SP37 development kit	SP37  Tire pressure sensor	The SP37 development kit enables evaluation of the entire feature-set of the tire pressure sensor SP37, such as RF transmitter and LF receiver functionality. Furthermore, it also allows software development and in-circuit debugging. The development kit includes the required evaluation hardware, SP37 devices, an integrated software development environment, documentation and a selection of sample software.	SP37-315-8 DEVELOP KIT SP000518282 (with 315MHz transmitter) SP37-434-8 DEVELOP KIT SP000518286 (with 434MHz transmitter)
 Triple half-bridge driver	TLE6208-3G  Multi half-bridge driver	Designed specifically for automotive (mirror adjustment drive) and industrial motion control applications. The IC contains 3 half-bridge outputs. It provides access to all inputs and outputs with standard 4mm jacks.	Demoboard TLE6208-3G SP000427042
 Hex half-bridge driver	TLE6208-6G  Multi half-bridge driver	Designed specifically for automotive (climate control flap drive) and industrial motion control applications. The IC contains 6 HSS channels and 6 LSS channels and can be used as a freely configurable switch, half-bridge or H-bridge driver. It provides access to all inputs and outputs with standard 4mm jacks.	Demoboard TLE6208-6G SP000427044
 Buck converter	TLE6389-2GV  DC/DC converter	Multi-purpose buck controller for external PMOS switch, 5V or adjustable output voltage, maximum of 2.3A output current, low quiescent current.	Demoboard TLE6389-2GV SP000427060

## DAVE™ – Digital Application Virtual Engineer

DAVE™ is a tool that helps engineers program Infineon microcontrollers. It provides intelligent wizards that configure chips to specific requirements and automatically generate C-code with appropriate driver functions for all on-chip peripherals and interrupt controls. DAVE™ interacts directly with the IDEs from leading tool suppliers and with Infineon’s free DAVE™ Bench tool chain. The DAVE™ mother system and DIP file for the microcontroller in question are needed to use DAVE™.



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