



# MOTOR CONTROL SOLUTIONS BASED ON S32K1 MCUS

The S32K1 family of 32-bit AEC-Q100 qualified MCUs combines a scalable family of Arm® Cortex®-M0-based microcontrollers built on long-lasting features with a comprehensive suite of production-grade tools. S32K1 MCUs are included in NXP's Product Longevity Program, guaranteeing a minimum of 15 years of assured supply.

## S32K1 VALUE PROPOSITION FOR MOTOR CONTROL

### SCALABLE MCU PLATFORM

- Hardware- and Software- compatible MCU family
- 48 MHz Arm Cortex-M0+ core or up to 112 MHz Arm Cortex-M4F core
- Flash memory: from 128 KB up to 2 MB
- QFN, LQFP, MAPBGA packages, from 32 to 176 pin count
- CAN FD, FlexIO, and QSPI Ethernet and serial audio interfaces
- AEC-Q100 qualified:
  - Grade 0 = -40° C to +150° C
  - Grade 1 = -40° C to +125° C
  - Grade 2 = -40° C to +105° C
- Functional Safety compliant: ISO 26262 up to ASIL B
- Cryptographic Services Engine compressed (CSEc) security engine: AES-128 and SHE compliant

### MOTOR CONTROL COVERAGE

- Engineered tools for Brushed DC motors, 3-phase PMSM, and 3-phase BLDC motor control targeting body and chassis
- Dedicated peripherals set for rapid motor control loop implementation: FlexTimer (FTM), TRGMUX, Programmable Delay Block (PDB), Analog to Digital Converter (ADC), and Analog Comparator (CMP)

### COMPREHENSIVE MOTOR CONTROL ECOSYSTEM

- Diverse hardware solutions supporting motor control applications
- S32K1 software ecosystem with production-ready algorithm library:
  - AMMCLIB set
  - FreeMASTER and MCAT tool
  - Model-Based Design Toolbox (MBDT)
- Dedicated technical support and on-line community

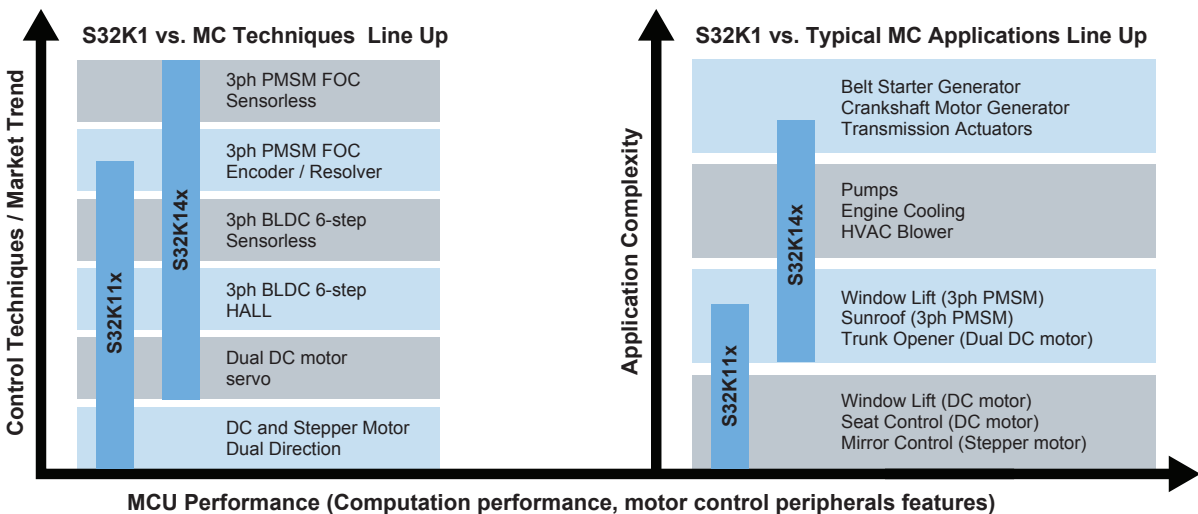


## S32K1 PRODUCT OVERVIEW

S32K1 provides a scalable platform with high hardware and software compatibility to address various motor control techniques and applications.

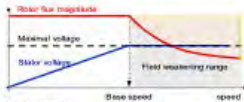
S32K116	S32K118	Common Features	S32K142	S32K144	S32K146	S32K148
Arm® Cortex®-M0+ @ 48 MHz		AEC-Q100	Arm Cortex-M4F @ up to 112 MHz			
128 KB Flash	256 KB Flash	CSEc Security Module	256 KB Flash	512 KB Flash	1 MB Flash	2 MB Flash
17 KB SRAM	24 KB SRAM	ASIL B Compliant	32 KB SRAM	64 KB SRAM	128 KB SRAM	256 KB SRAM
up to 42 I/Os	up to 58 I/Os	Low Power	up to 89 I/Os		up to 128 I/Os	up to 156 I/Os
4 channel eDMA		LPUART, LPSPI, LPIIC, FlexIO	16-channel eDMA			
1 x FlexCAN with 1 x FD		JTAG (K14x only)	2 x FlexCAN with 1 x FD	3 x FlexCAN with 2 x FD	3 x FlexCAN with 2 x FD	3 x FlexCAN with 3 x FD
1x 13-ch. 12-bit ADC	1x 16-ch. 12-bit ADC	TRGMUX	2 x 16-ch. 12-bit ADC		2 x 24-ch. 12-bit ADC	2 x 32-ch. 12-bit ADC
1 x PDB		<b>Motor Control Peripherals</b>	2 x PDB			
2 x 16-bit FTM (16-ch.)			4 x 16-bit FTM (32-ch.)		6 x 16-bit FTM (48-ch.)	8 x 16-bit FTM (64-ch.)
QFN-32	LQFP-64		LQFP-64			LQFP-176
LQFP-48			S32K142LQFP-48		S32K146QFP-144	
			LQFP-100			
			MAPBGA-100			
			IEEE® 1588 Ethernet			
			Quad SPI			
			ETM Trace			
			2 x SAI			

## S32K1 MOTOR CONTROL LINE-UP

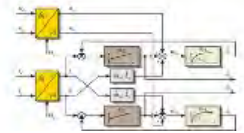


# S32K1 MOTOR CONTROL SOFTWARE ECOSYSTEM

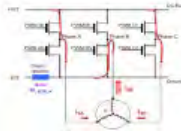
## Field-weakening



## Sensorless PMSM



## Single-shut I meas.



## ATO

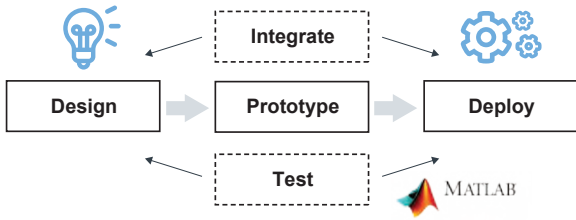


## AUTOMOTIVE MATH AND MOTOR CONTROL LIBRARY (AMMCLIB) SET

- Precompiled software library including NXP-patented control math algorithms
- Automotive production-ready software (SPICE Level 3, CMMI and ISO 9001/TS 16949)
- Delivered as bit-accurate models for MATLAB®/Simulink® and C code
- Single API across NXP MCUs, simple migration across platforms

## MODEL-BASED DESIGN TOOLBOX (MBDT)

- Model-based design environment in MATLAB/Simulink for motor control software on S32K MCUs
- Automatic code generation for S32K1xx peripherals and applications prototyping
- Extensive online community and tutorials available
- Model-based design approach helps to save R&D time and test efforts



## FREEMASTER (LITE)

- Real-time data visualization tool for debugging and tuning embedded algorithm during development
- Graphs, tabular grids, and web views embedded directly in the desktop application
- FreeMASTER Lite supports JSON RPC protocol and is able to run on Windows® or Linux® host PC, enabling custom UI on web browsers



## MOTOR CONTROL APPLICATION TUNING (MCAT)




- HTML-based graphical user interface tool, plug-in to FreeMASTER and fully compliant with AMMCLlib set API
- Real-time tuning and updating of control parameters

## S32K1 ADDITIONAL SOFTWARE

- S32 Design Studio IDE: Eclipse, GCC, and debugger
- Production-grade S32 Software Development Kit (S32 SDK): SPICE Level 3 compliant, MISRA tested
- NXP AUTOSAR® MCAL (QM and ISO 26262 compliant) and OS
- Security firmware – NXP provided
- Core Self-Test Library for functional safety applications
- Production-grade ASIL compliant Real Time Drivers (RTD) support
- Third-party ecosystem support to reduce time-to-market



# S32K1 MOTOR CONTROL HARDWARE TOOLS

3-Phase Low-Power Motor Control Development Kits		3-Phase High-Power Motor Control Development Board	
	MCSPT1AK116	MCSPT1AK144	MCSXTE2BK142
			
<b>PRODUCTS</b>			
<b>MCU</b>	S32K116	S32K144	S32K142
<b>Analog</b>	UJA1169 – Mini high-speed system basis chip GD3000 – MOSFET gate driver for 3-phase motor		TJA1021 – LIN PHY TJA1043 – CAN PHY GD3000 – MOSFET gate Driver for 3-phase motor
<b>HARDWARE</b>			
<b>Motor</b>	3-phase BLDC motor with Hall sensor 24 VDC, 9000 RPM, 95 W	3-phase BLDC motor with Hall sensor 24 VDC, 4000 RPM, 40 W	N/A
<b>Power</b>	Up to 100 W		Up to 800 W
<b>Voltage</b>	12 V (10-18 V)		12/24 V (10-36 V)
<b>Current sensing</b>	Single-, dual-, and triple-shunt		
<b>Position sensing</b>	Hall, encoder		
<b>Communication</b>	CAN (FD), LIN, UART, PWM		
<b>MOTOR CONTROL SOFTWARE APPLICATION</b>			
<b>PMSM FOC</b>	3-phase field-oriented control (FOC) with field weakening (FW) Sensor (Encoder) or sensorless control (back-EMF observer) Single-shunt and dual-shunt current sensing and 3-phase stator current reconstruction		
<b>BLDC Six-step</b>	3-phase 6-step commutation control Sensor (Hall) or sensorless control based on back-EMF zero-cross detection method		
<b>TOOLS</b>			
<b>Integrated development environment</b>	S32 Design Studio for Arm®		
<b>MCU peripherals settings and control</b>	S32K1 SDK and software configuration tool		
<b>Motor control library</b>	Automotive Math and Motor Control Library		
<b>Visualization and motor control tuning</b>	FreeMASTER and Motor Control Application Tuning (MCAT)		