TOSHIBA
Leading Innovation >>>

GLYN High-Tech Distribution

MICROCONTROLLER

> VECTOR ENGINE
Toshiba's Original Motor Control Technology

The latest trend in motor control technology is vector control, but for this complicated high-speed calculation and high-level software, development is needed. The Toshiba original vector engine accomplishes easy and low-cost vector control. The vector engine is a co-processor exclusively for motor control. The vector engine executes the typical calculations including transformation of the three-phase motor current to a two-phase and transformation/inverse transformation of the rotational co-ordinates. These functions help to reduce CPU utilization while user-specified functions like position estimation and speed control are still executed in software. Thus the vector engine keeps a high level of flexibility while providing high performance motor control processing.

TX03 Series TX04 Series TXZ3 Series TXZ4 Series

ARM® Core-Based Microcontrollers
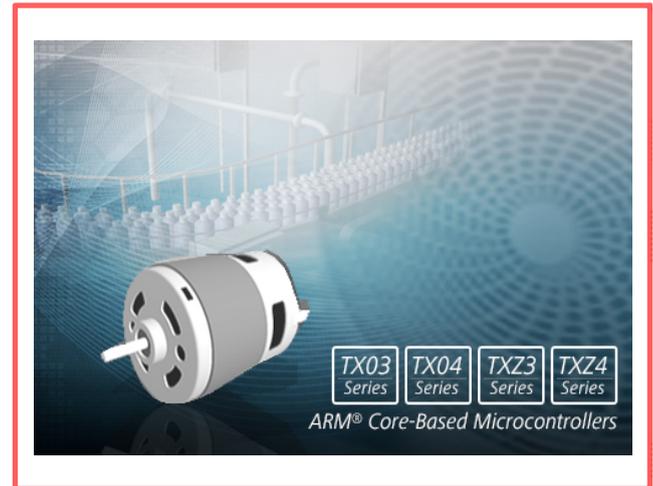
> APPLICATIONS

- Industrial Motors
- Pumps
- E-bikes
- Washing Machines
- Refrigerators
- Fans

> FEATURES

FEATURES	ADVANTAGES
Co-processor exclusive for motor control calculation	Reduction of the CPU overhead. Since the motor control process time is reduced, a commanding share of the CPU held by the software is decreased by 72% when two motors are operating.
Various scheduling schemes	The vector engine has Toshiba's original scheduling function which configures the tasks and their combinations.
Predefined calculation tasks	The impact of development environment and compiler options is reduced.

> BENEFITS

- Total system performance is improved by releasing resources of the CPU to other tasks like Power Factor Correction, sensor processing or communication
- Quiet and low-vibration operation is possible with high speed PWM frequency
- Software development effort and debugging time is reduced
- High speed rotation of up to 100.000rpm and more
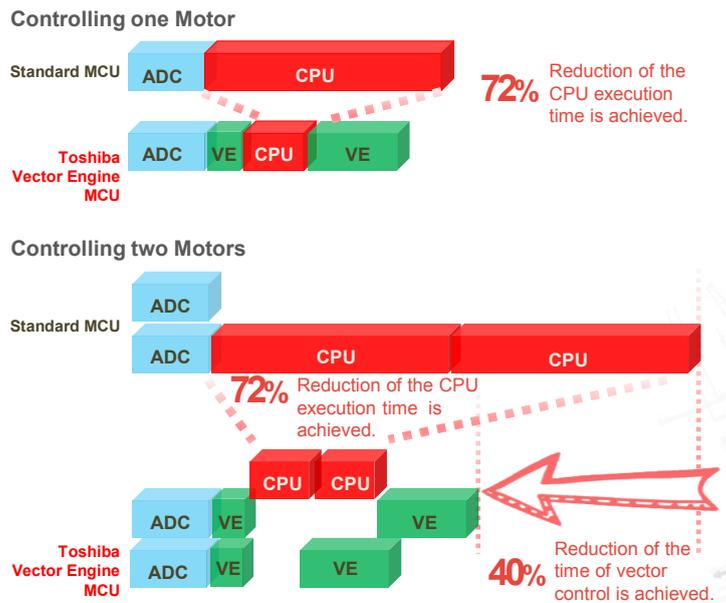
> PRODUCT LINEUP

Part Number	ROM Size (KB)	RAM Size (KB)	PMD* (ch)	Package	Features
TMPM370FYFG	256	10	2	LQFP100 (14 x 14 mm)	Various analogue circuits integrated. System cost can be reduced
TMPM370FYDFG	256	10	2	QFP100 (14 x 20 mm)	
TMPM372FWUG	128	6	1	LQFP64(10 x 10 mm)	Small scale pin package
TMPM373FWDUG	128	6	1	LQFP48(7 x 7 mm)	
TMPM374FWUG	128	6	1	LQFP44(10 x 10 mm)	
TMPM375FSDMG	64	4	1	SSOP30(5.6 x 10 mm)	
TMPM376FDFG	512	32	2	LQFP100 (14 x 14 mm)	Built-in I^{2}C
TMPM376FDDFG	512	32	2	QFP100 (14 x 20 mm)	
TMPM37AFSQG	64	4	1	VQFN32 (5 x 5 mm)	Pre-driver for 3-phase sine wave drive
TMPM470FYFG	256	18	2	LQFP100 (14 x 14 mm)	ARM® Cortex®-M4F core @120MHz
TMPM470FZFG	384	34	2		
TMPM470FDFG	512	34	2		
TMPM475FYFG	256	18	2		ARM® Cortex®-M4F core @120MHz CAN-bus controller
TMPM475FZFG	384	34	2		
TMPM475FDFG	512	34	2		

*PMD: Programmable Motor Driver
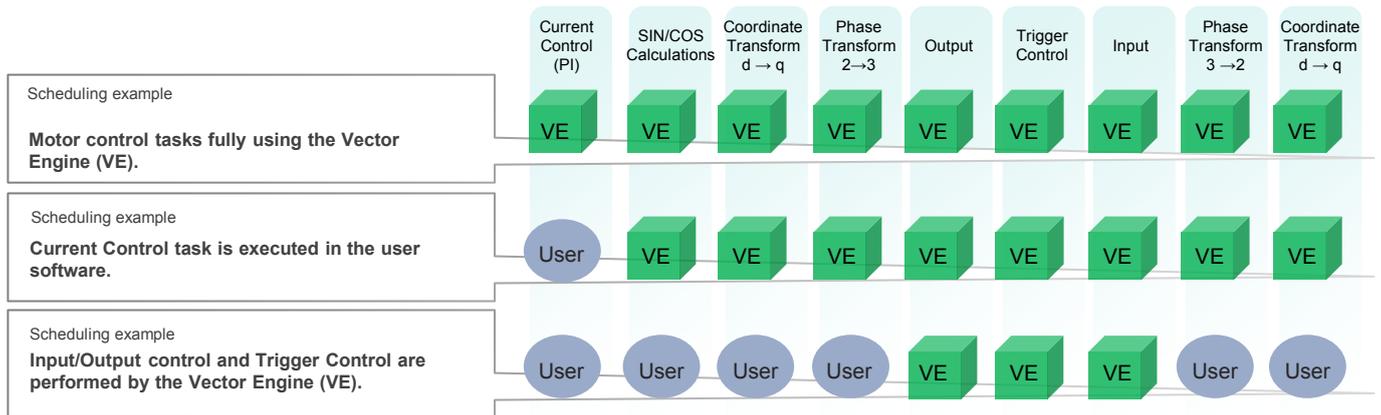
REDUCED MOTOR CONTROL PROCESSING TIME

Typical calculations for vector control are handled by the vector engine. Thus the CPU utilization of the software is decreased. This reduction improves overall system performance, because the CPU can release resources to other tasks like PFC, sensor processing or system communication.

Especially when two motors are controlled, the vector engine notably reduces CPU processing time. In case of vector control of two motors by software, the clock speed of the CPU must be increased for the processing. This will lead to increased power consumption of the MCU which has an impact on the power supply, power dissipation, EMC and system cost. With Toshiba's vector engine the calculations for two channels are performed in parallel and the CPU clock doesn't need to be increased.
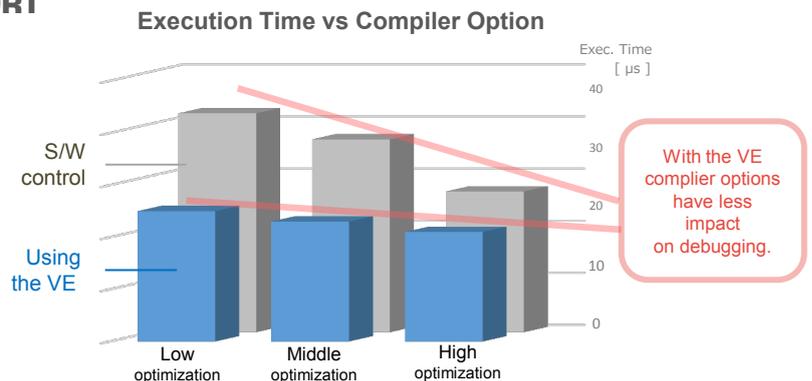
Controlling one Motor

Standard MCU: ADC | CPU

Toshiba Vector Engine MCU: ADC | VE | CPU | VE

72% Reduction of the CPU execution time is achieved.

Controlling two Motors

Standard MCU: ADC / ADC | CPU | CPU

72% Reduction of the CPU execution time is achieved.

Toshiba Vector Engine MCU: CPU CPU / ADC VE / ADC VE / VE / VE

40% Reduction of the time of vector control is achieved.

FLEXIBLE SCHEDULING OF VECTOR ENGINE TASKS

Position estimation and speed control depend on system configuration and therefore these tasks are left to software processing. The vector engine handles the typical calculation including transformation from a three-phase motor current to a two-phase and the transformation of the rotational coordinates. The tasks of the vector engine are configured by a scheduler. This scheduler offers up to 16 combination types which gives the user a high level of flexibility and supports various types of motor control operations.

	Current Control (PI)	SIN/COS Calculations	Coordinate Transform d → q	Phase Transform 2→3	Output	Trigger Control	Input	Phase Transform 3→2	Coordinate Transform d → q
Scheduling example — **Motor control tasks fully using the Vector Engine (VE).**	VE	VE	VE	VE	VE	VE	VE	VE	VE
Scheduling example — **Current Control task is executed in the user software.**	User	VE	VE	VE	VE	VE	VE	VE	VE
Scheduling example — **Input/Output control and Trigger Control are performed by the Vector Engine (VE).**	User	User	User	User	VE	VE	VE	User	User

REDUCTION OF DEVELOPMENT EFFORT

Since the vector control calculation is handled by the vector engine, the size of program code is reduced. Therefore the amount software to be complied is reduced. This makes the execution time independent from compiler performance and optimization options.

Execution Time vs Compiler Option

Exec. Time [μs]

S/W control

Using the VE

Low optimization | Middle optimization | High optimization

With the VE complier options have less impact on debugging.

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