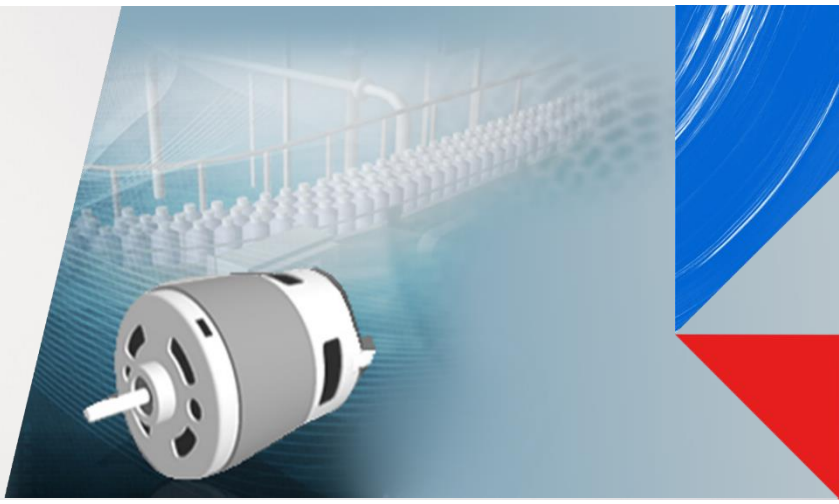
Vector Engine



Toshiba's Original Motor Control Technology

Toshiba's original Vector Engine (VE) is a high performant coprocessor executing the complex operations required for Field Oriented Control (FOC). It frees up valuable computational resources, allowing the processor core to take care of other tasks such as Power Factor Correction (PFC), sensing operations, or system communication. Especially when controlling multiple motors, the Vector Engine notably reduces FOC execution time. The Vector Engine also comes with a flexible scheduler allowing the user to optimize the interaction between the Vector Engine and the software running on the main processor core.

Applications

- Industrial motors
- Pumps
- E-bikes
- Washing machines
- Refrigerators
- Fans

Features

- Co-processor exclusively for motor control calculation
- Various scheduling schemes
- Predefined calculation tasks

Advantages

- 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.
- The vector engine has Toshiba's original scheduling function which configures the tasks and their combinations.
- The impact of development environment and compiler options is reduced.

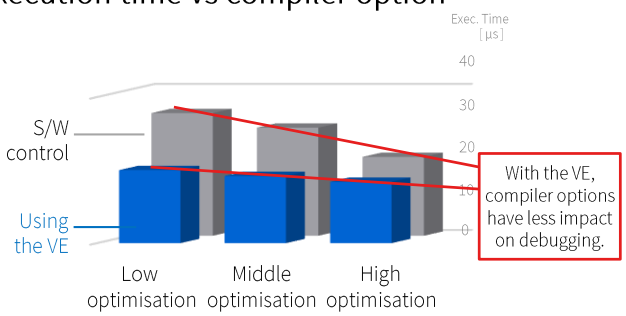
Benefits

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

Reduction of development effort

Since some vector control calculations are 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.

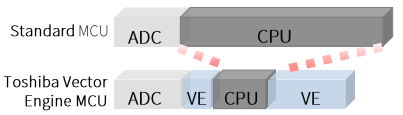
Execution time vs compiler option



Reduced motor control processing time

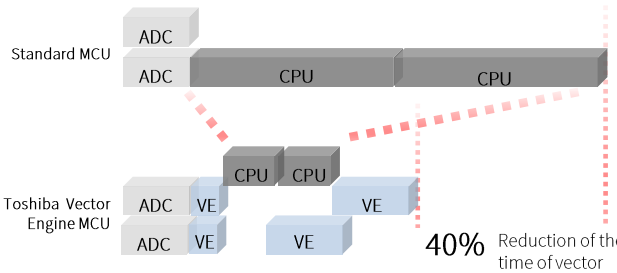
Typical calculations for vector control are handled by the vector engine. Thus, the CPU utilization of the software is decreased. This reduction improves overall system performance, because the CPU can release resources to other tasks like PFC, sensor processing, or system communication. Especially when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



72% Reduction of the CPU execution time is achieved.

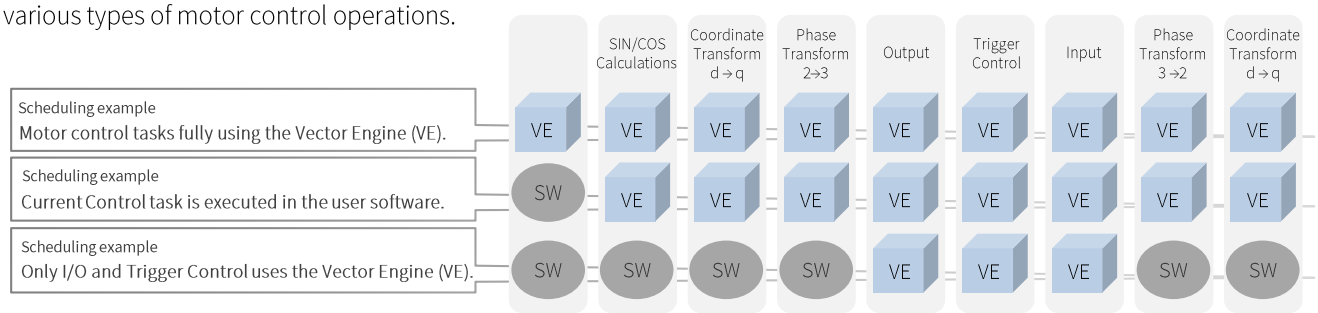
Controlling two motors



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.



Product line-up

		M4KH	M4KL / M4ML		M4KM / M4MM	M4KN / M4MN	
Processor core	CPU	Arm® Cortex®-M4F (with FPU)					
	Max. Freq.	160 MHz					
System	Code Flash	128 / 256 KB					
	Data Flash	32 KB					
	SRAM	24 KB					
Analog	12-bit ADC (unit / ch / conv.)	2 / 6,2 / 1.0 us	3 / 8,3,3 / 1.0 us		3 / 8,5,4 / 1.0 us	1 / 11,5,6 / 1.0 us	
	Operation Amplifier (units)	3	3		3	3	
Motor control	Vector Engine (type)	A-VE+	A-VE+		A-VE+	A-VE+	
	PMD (unit × type)	1 × A-PMD	3 × A-PMD		3 × A-PMD	3 × A-PMD	
	Encoder Input (unit / type)	-	1 × A-ENC32		2 × A-ENC32	3 × A-ENC32	
Interfaces	IO Pins	31	51		67	87	
	UART / I2C / SPI / SIO	3 / 1 / 1 / 1	3 / 2 / 2 / 2		4 / 2 / 2 / 2	4 / 2 / 2 / 2	
	CAN	-	- / 1		- / 1	- / 1	
Package	Type / Pins	LQFP 44	LQFP 64	LQFP 64	LQFP 80	LQFP 100	QFP 100
	Dimension (W×L) [mm]	10×10	10×10	14×14	12×12	14×14	14×20
	Pitch [mm]	0.80	0.50	0.80	0.50	0.50	0.65
Operating conditions	Power Supply	4.5 V – 5.5 V (without ADC: 2.7 V – 5.5 V)					
	Operating Temperature	-40°C – 105°C					