FAST AND HIGH PRECISION MOTOR CONTROL FOR HIGH PERFORMANCE

MOTOR CONTROL OVERVIEW

Electric motor control is a key functionality of machines installed in industrial manufacturing sites.

Typically, these motors operate synchronously or asynchronously with a three-phase current supplied by the driver unit. This driver unit comes in many types and its capabilities can be as simple as rotating a motor at a certain revolution speed; or as complex as simultaneously controlling of the multiple axis of a robot arm or other complex machinery to enable fast and precise movements along three-dimensional trajectories. They can have additional features like controlling local user interfaces, communicating via industrial buses or Ethernet, predictive maintenance, or functional safety and security against counterfeiting or cyber-attacks. Looking at all these requirements and keeping cost, power consumption and heat dissipation in mind, it becomes obvious that there is no "one size fits all" solution. For the simplest motor drive applications, a standard 16bit MCU can be fully sufficient. But when it comes to high-end applications, typically a superset of the mentioned motor driver functions is required. This becomes a significant cost factor in terms of BOM list, development and certification efforts.

FUNCTIONAL BLOCKS

A motor driver unit as shown in Figure 1 typically consists of these parts:

1
Power input and storage
The single- or three-phase AC mains power is rectified and charges an integrated high voltage capacitor. Optionally, this stage offers additional features like power factor correction (PFC)

2
Three-phase full bridge
This bridge switches the DC voltage individually to the three terminals of the motor. It generates sinusoidal waves by alternating the respective positive or negative outputs.

3
Motor current sensing
The current feedback informs the bridge controller about the operation state of the motor. The motor control software determines load/torque, rotor position and revolution speed from these data.

4
Bridge control
A high frequency, high precision PWM of the bridge controller shapes the motor currents. The motor control algorithms executed on the CPU determine the pulse setup of each motor phase for each new output period. The higher the CPU performance, the more accurate and energy efficient the motor movements.

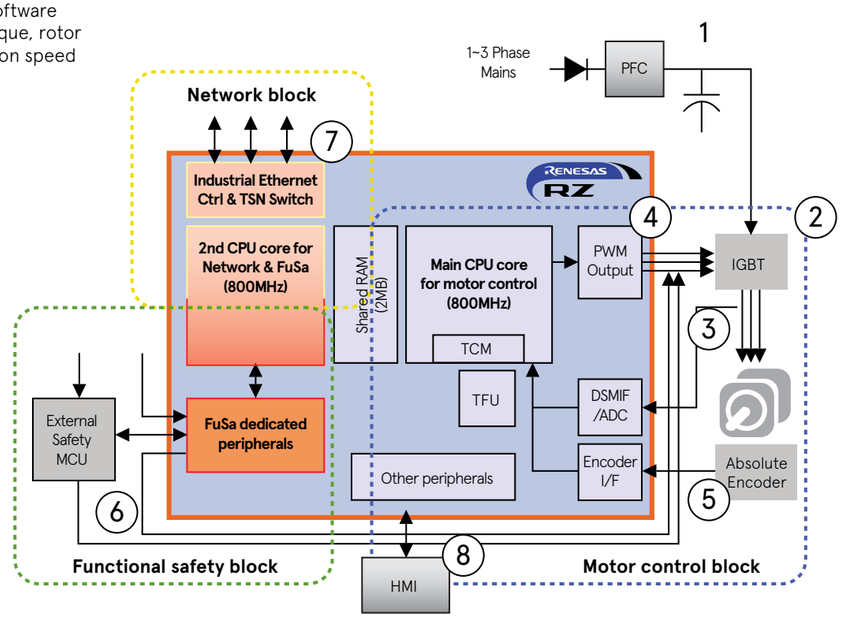
5
Position feedback (optional)
For servo systems, the precise feedback of positions linked to the motor drive is a crucial part of the control loop. Position feedback can be obtained in various ways and interface formats.

6
Functional safety monitoring and shut-off (optional)
Functional safety can be as simple as safe torque off (STO) triggered by the operator of a machine pressing a safe-stop button. In more advanced use cases, the safety system must monitor movements of machines or robots to enable interactive working with humans in production processes or support maintenance and repair by technicians.

7
Industrial bus or Ethernet support (optional)
For remote control of the drive, industrial field buses or industrial Ethernet communication is applied. The control methods range from simple status monitoring and parameter setting through to closed control loops for precise and fast motion control.

8
User interface (optional)
In particular low-end drives without remote control capabilities provide user interfaces to set drives parameters or allow simple actions like start-stop or RPM control of the motor.

Figure 1: Typical setup of a motor driver unit



SOLUTIONS

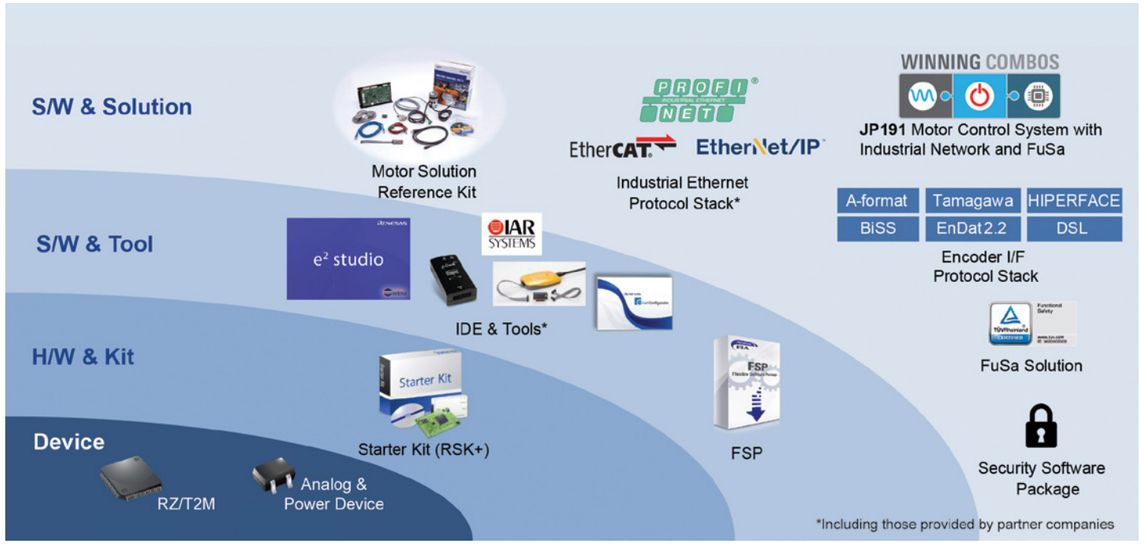
For high-end servo applications, which need to cover a rich feature set, the BOM list tends to be long and costly. The most effective way to counter this is by integrating all required functions into a single chip solution like the new Renesas RZ/T2M servo motor control device. Beyond a significantly shorter BOM list, this integrated solution comes with many more advantages:

- Scalable hardware platform allowing application software reuse
- Powerful Cortex R52 ARM CPU core with Tightly Coupled Memory (TCM) supporting hard real-time processing
- Trigonometric Function Unit (TFU) to accelerate complex mathematical algorithms
- Matured, feature-rich set of peripheral IP for PWM generation, Delta-Sigma I/F, SAR-ADC, digital encoder I/F etc.
- 3-port multi-protocol Ethernet network including Time Sensitive Networking (TSN) support
- Software ecosystem consisting of matured peripheral drivers, software stacks and application samples
- Pre-certified functional safety platform software
- Pre-certified industrial network stacks
- Embedded security for anti-counterfeiting and secure network communication
- Configurable absolute encoder interfaces for future prove encoder support
- Sample applications and demo boards to start evaluating out of the box
- Long term availability as part of the PLP program

The more extensive the feature set of the silicon device, the more likely it can cover today's and future requirements.

For efficient developments with low schedule risk, the completeness of the development environment is crucial. The Renesas RZ/T2M device comes with a rich set of tools and software solutions (see Fig. 2), helping application developers in all aspects of his project.

Figure 2: Development environment



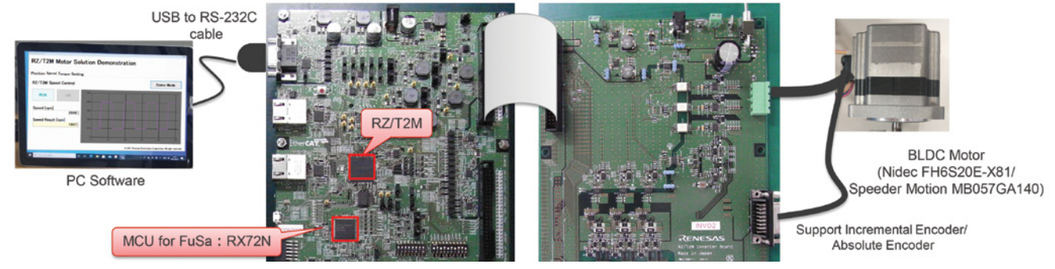


Figure 3: Servo motor control reference application with functional safety

As every solution has its pros and cons, a thorough evaluation of different offers is the key for successful and sustainable product developments with minimized risk. Availability of hardware and software as sample applications is essential to swiftly compare different solutions, confirm their suitability, and feature coverage.

As implementation concepts and detailed feature sets differ, there is no single reference for a complex application like a servo drive. However, a feature rich sample application (see Figure 3) can provide coverage of today's and future requirements and, when used as a template for companies' own developments, minimizing their risk and schedule.

FURTHER READING

To learn more about Renesas Motor Control System with Industrial Network and Functional Safety Solutions,

CLICK HERE