

2-system motor control function in a small package (Software Vector Control)

ARM Cortex M4F microcontroller (120MHz) **TMPM4K4FYBUG**

SBK-M4K4B-KIT

TMPM4K4B Brushless DC Motor

Vector Control Development Kit

SBK-M4K4B-KIT

List price: US \$580

1. This kit includes the TMPM4K4B microcontroller evaluation board SBK-M4K4B, inverter board KES-P2, BLDC motor, and power supply. A sample program is already written, so the BLDC motor will rotate using vector control on the day of purchase. A sample program is provided on the attached CD.

The SBK-M4K4B and KES-P2 use a standardized connector (26 pins), and in addition to this product, we also offer a lineup of various microcontroller evaluation boards, microcontroller boards, and inverter boards that have compatible connectors.

2. Use the SBK-M4K4B-KIT to quickly develop products equipped with the TMPM4K4FYBUG!

This kit includes the following boards and required components. Please check.

- TMPM4K4B equipped microcontroller evaluation board SBK-M4K4B (256KB flash ROM installed)
- Inverter Board KES-P2
- 24V brushless DC motor TG611B-R2883, 24V
- Power supply (24V output AC adapter)
- Circuit Diagram
- CD (sample software, application notes)

is included. Because it is an all-in-one kit, you can start evaluating brushless DC motor vector control using the TMPM4K4B immediately after purchase. (Please check the contents of the kit first. If any parts are missing, please contact your dealer or the manufacturer directly.)

The sample programs on the attached CD are compatible with the integrated development environment IAR Embedded Workbench for ARM 9.50.2, the integrated development environment Arm® Keil® MDK 5.40.00, and the integrated development environment SEGGER Embedded Studio 8.12a.

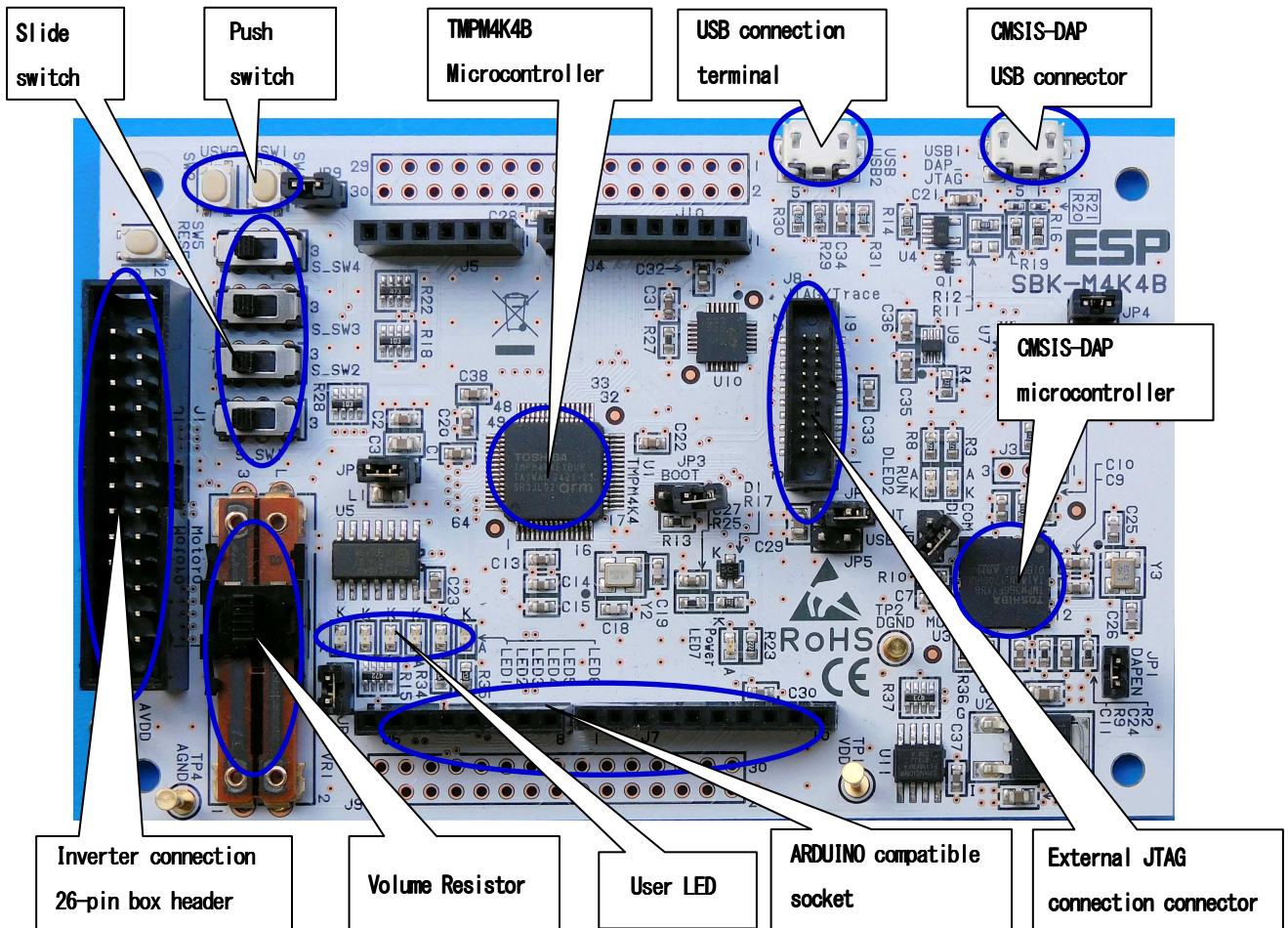
This development kit SBK-M4K4B-KIT is

- Includes inverter board KES-P2 that supports 24V/3A (Position detection supports 3 shunts/1 shunt.)
- Equipped with a high-performance 12-bit DAC, it can display waveforms of various control data and register contents inside the microcontroller.
- The CMSIS-DAP debugger circuit installed on the board enables debugging of C language source code. (The CMSIS-DAP debugger circuit is a standard specification recommended by ARM.)

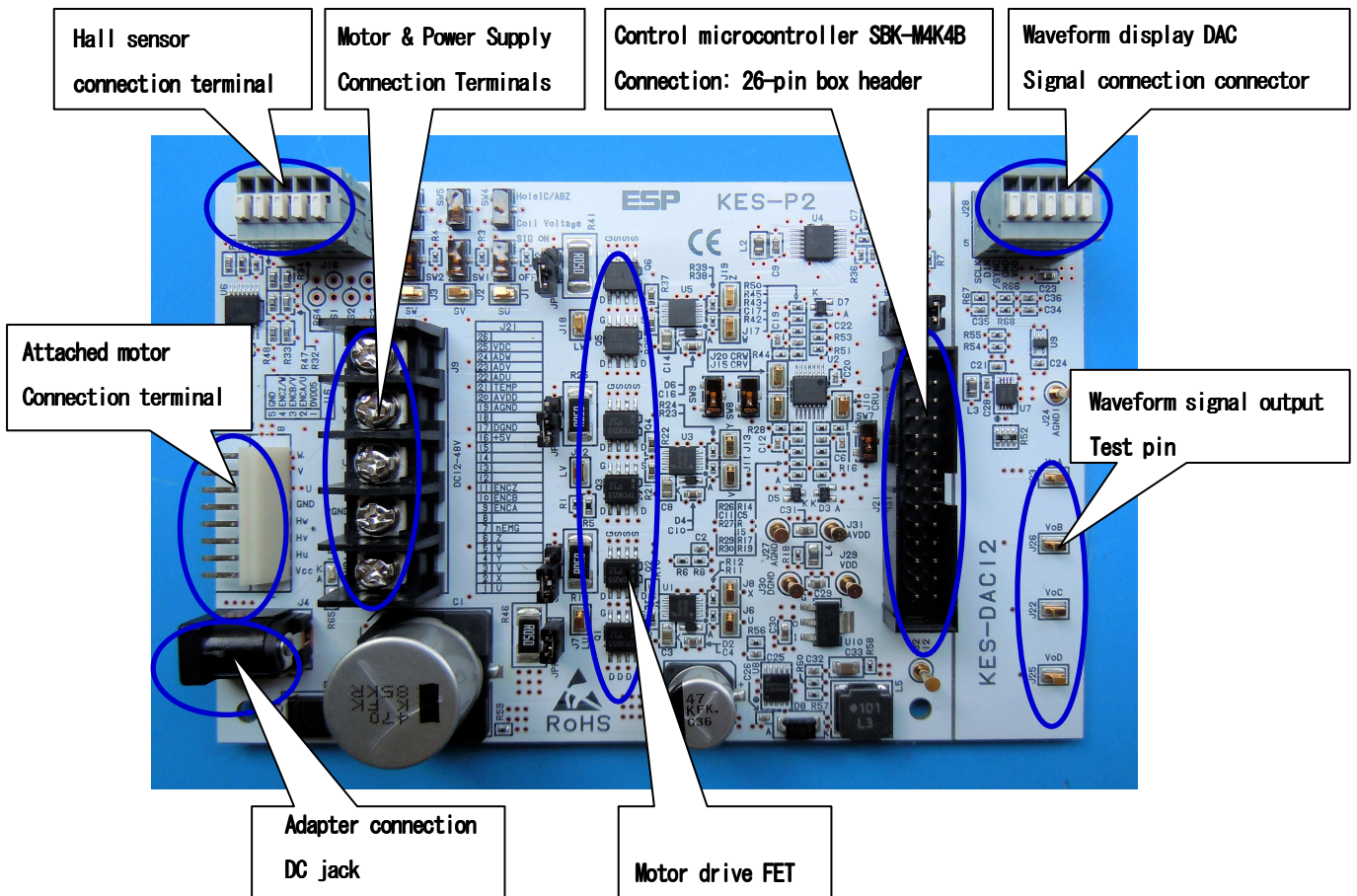
It has many features that help speed up development, such as:



3. Full view of the TPM4K4B microcontroller evaluation board SBK-M4K4B



4. Full view of the inverter board KES-P2



5. Checking the operation of the kit

The TMPM4K4B vector control development kit SBK-M4K4B-KIT is shipped with a sample program for the 3-shunt system.

The kit includes a brushless DC motor TG611B-R2883 (Toshiba custom model number) for drive tests, so be sure to first check its operation using the following procedure.

- ① Connect the brushless DC motor included in the kit to the header connector (J14) of the KES-P2.
- ② Connect the AC adapter (24V, 2.7A) included with the kit.
- ③ Set the motor ch0 operation slide switch (S_SW1) to ON (start, right →).
- ④ Set the RPM Up/Down selector slide switch (S_SW4) to off (Up, left ←).
- ⑤ Press the rotation speed adjustment push switch (USW1). Each press increases the rotation speed by 10Hz.
- ⑥ Set the rotation speed Up/Down selector slide switch (S_SW4) to on (Down, right →) and press the rotation speed adjustment push switch (USW1). Each press will decrease the rotation speed by 10Hz.

【If the motor does not rotate properly, it may be due to some initial defect or damage during transportation. Please contact us.】

For details on how to use the software, please refer to “4.4 User Interface” in the TMPM4K4B Motor Sample Software Application Note on the CD.

【Notes on using the board】

- ① Be sure to check the jumper settings.
- ② If the control method of the sample software does not match the jumper settings on the board, it will not work. When changing the control method, be sure to match the software settings with the jumper settings.
- ③ When checking operation over a long period of time, please be careful of semiconductor temperature rise.
- ④ Please refrain from checking operation beyond the rated limits.
- ⑤ When using the same motor, the maximum rotation speed will be different when driven at a standard 24V voltage and at other voltages (e.g., 20V). This is a voltage issue, not a control issue.

6. Development Tools

The sample software provided on the attached CD is compatible with the following development tools.

IAR Embedded Workbench for ARM 9.50.2

Keil μ Vision MDK-Lite 5.39.0.0

Segger Embedded Studio 8.10b

Tools are supplied by each tool vendor. Each tool is available in a free evaluation version for evaluation and educational purposes only. IAR Embedded Workbench for ARM is available for a limited 14-day period, while Keil μ Vision MDK and Segger Embedded Studio 8.18 are available for unlimited use.

In both cases, you will need to purchase a legitimate licensed version for commercial use in product development. For details, please contact the respective tool vendor.

For instructions on how to start a sample program project using each tool, please refer to “4.2 How to Start a Project” in the TMPM4K4B Motor Sample Software Application Note on the attached CD.

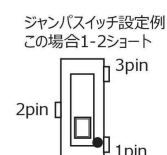
7. Jumper settings for the SBK-M4K4B microcontroller evaluation board

The jumper setting specifications for the microcontroller evaluation board SBK-M4KK4B are as follows: Be sure to match the software settings with the hardware settings before use.

| Jumper Name | Terminal name (Silk marking) | function | open | short | Initial state 3-shunt sensorless External amplifier KES-P2 connection |
|-------------------|---------------------------------|---|--|-------------------------------------|--|
| JP1 | DAPEN | Uses onboard ICE (Short if using the on-board CMSIS-DAP) | Unused | use | short |
| JP2 | DnBOOT | M366-BOOT mode setting (Normally, leave this open.) | Prohibited | permission | open |
| JP3 | BOOT | M4KN-BOOT mode setting (Normally, leave this open.) | Prohibited | permission | open |
| JP4 | LVSFT | Level shift circuit enabled (Short when using CMSIS-DAP) | Prohibited | permission | short |
| JP5 JP6 JP7 | USB OBJT 5VIN | Microcomputer 5V power supply source selection Be sure to set JP5, JP6, and JP7 as shown in the table.(Only one jumper should be shorted.) | Power supply source JP5 JP6 JP7 | USB2 (USB) short open open | USB1 (DAP) open short open |
| JP8 | (VDD-AVDD) | Digital/analog 5V power supply separation | separation | common | common |
| JP9 | (GND-AGND) | Digital/analog GND separation | separation | common | common |

8. Jumper settings for the inverter board KES-P2

The jumper setting specifications for the inverter board KES-P2 are as follows: For the settings of jumper switches SW1 to SW9, see the diagram on the right.



【Control Method Selection】

| Control method selection | JP | Sensorless Vector (initial) | Sensorless square wave | Hall IC square wave | Hall IC Vector | remarks |
|--|-------------------|--------------------------------|---------------------------|------------------------|-------------------|---|
| Motor position signal output to J21 (MIL26)/Open | SW1 SW2 SW3 | 2-3 Short | 1-2 Short | 1-2 Short | 1-2 Short | SW1, 2, 3 open/short the external position signal and microcomputer port. |
| Induced voltage/Hall IC sensor signal selection | SW4 SW5 SW6 | 2-3 Short | 2-3 Short | 1-2 Short | 1-2 Short | SW4, 5, and 6 switch the Hall IC (ABZ) and coil voltage. |

【Internal/external amplifier selection】

When combined with SBK-M4K4B, the built-in amplifier cannot be used.

| Control Method | JP | External AMP (initial) | Internal AMP | remarks |
|------------------------------------|-------------------|------------------------|--------------|---|
| Built-in/external AMP selection | SW7 SW8 SW9 | 1-2 Short | 2-3 Short | Be sure to match the settings on the software side.*The built-in amplifier cannot be used in combination with the SBK-M4KN. |

【Control Method Selection】

| Control Method | JP | Initial settings (initial) | remarks |
|---------------------|-----|-------------------------------|--|
| Digital power short | JP1 | short | Switch between short and open according to the specifications of the control board. |
| Analog power short | JP2 | short | |
| Analog GND short | JP3 | short | |

【Selecting the location detection method】

| Position detection | JPR | 3-shunt system(initial) | 1 shunt system | |
|---------------------|------|-------------------------|----------------|--|
| 3/1 shunt switching | JPR1 | open | short | Be sure to match the settings on the software side. |
| | JPR2 | open | short | |
| | JPR3 | open | short | |
| | JPR4 | short | open | |

9. Motor control software operation specifications

When running the sample software using the microcontroller evaluation board SBK-M4K4B and the general-purpose inverter board KES-P2, please set it according to the following operating specifications. (See the application note for details)

【Slide switch settings】

| SW name | item | Hi (off) setting (default setting) | Lo (on) setting |
|---------|-------------------------------------|------------------------------------|-----------------|
| S_SW1 | Motor ch0 operation | Stop | Start |
| S_SW2 | Motor ch1 operation | Stop | Start |
| S_SW3 | Rotation speed/DAC operation target | ch0 | ch1 |
| S_SW4 | Rotation speed Up/Down | Down | Up |

【Rotation speed control method】 (Press the push switch USW1 on the microcomputer board SBK-M4K4B to increase or decrease the rotation speed.)

| S_SW4 Settings | USW1 Push | Limit |
|----------------|--------------------------|------------|
| Hi (off): Up | Rotation speed 10-z up | MAX[100-z] |
| Lo (on): Down | Rotation speed 10-z down | MIN[0-z] |

10. Please note the following when using this kit:

This kit is a development platform to support the development of brushless DC motor vector control systems using TMPM4K4B (Toshiba). This is a tool that reduces the time and cost of prototyping for developers in the first step of development, and improves development efficiency.

It is entirely possible that hardware damage or destruction may occur when changing parameter settings or when running a new program developed by the user. Please be aware of this point and use the service accordingly. To avoid damage to the hardware, turn off the power immediately if you notice any abnormalities.

11. Purpose of this kit and disclaimer

This kit is a development platform to support the development of brushless DC motor vector control systems using the ARM Cortex M4 microprocessor TMPM4KN (Toshiba) with vector engine. This product has been prepared to assist in the development of products incorporating the TMPM4KN, but Toshiba Electronic Devices & Storage Corporation and ESP Planning Co., Ltd. assume no responsibility for the results obtained.

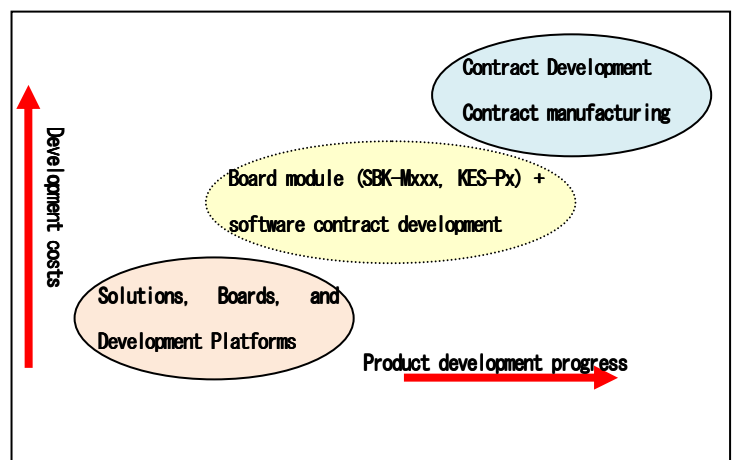
12. For customers developing brushless DC motor control equipment • • • Three levels of support available

We offer the following three types of services for developing brushless DC motor control devices.

The “Brushless DC Motor Vector Control Development Kit” provides the evaluation boards (SBK-Mxxx, KES-Px), motors, and sample programs required for the first stage of development, and is a tool for learning how to evaluate basic motor control algorithms and tune parameters.

We have been providing contract development and contract manufacturing as the development menu closest to the finished product.

As a complementary solution, we are currently proposing a combination of board modules (SBK-Mxxx, KES-Px) that correspond to the motors and power supplies that our customers want to control, plus software development. We look forward to hearing from you. (Free consultation)



**Included
Materials**

Combining an inverter board and a motor control microcomputer board...

We support our customers in developing various BLDC motor-equipped devices.

The right diagram shows the hardware configuration for vector control of a BLDC motor. The minimum required connection signals between the motor control microcomputer circuit and the inverter circuit are:

- Gate drive signal (digital signal) 6
- Current detection signal (analog signal) 1 to 3
- Other control signals (analog/digital signals) several

It is summarized as follows.

Therefore, as shown in Table 1, the signal layout has been standardized to a 26-pin box header. As a result, we have expanded our lineup of motor control boards and inverter boards, making it possible to facilitate the development of various applications for our users. The connection signals between the microcontroller board SBK-M4KN and the inverter board KES-P2 also follow this signal layout.

The photos on the next page are of products currently available or in development.

- Inverter Board KES-Px series
- Microcontroller board with debugger (CMSIS) SBK-Mxxxx
- CPU stand-alone microcomputer board CPB-Mxxxx

The lineup on Table 2 shows the part numbers and specifications.

The left column of the photo shows the lineup of various inverter boards (KES-Pxxx series). Table 2(a) provides an overview.

The microcontroller board in the center row of the photo is an SBK board (SBK-Mxxx series) with on-board debugging functionality (JTAG/SWD) the CMSIS-DAP standard. Table 2(b) is SBK-board.

The microcontroller board in the right column is a low-cost CPU board (CPB-Mxxx series) equipped with only a CPU, JTAG connector, and a BOX connector for connecting the inverter board. An overview is provided in Table 2(c).

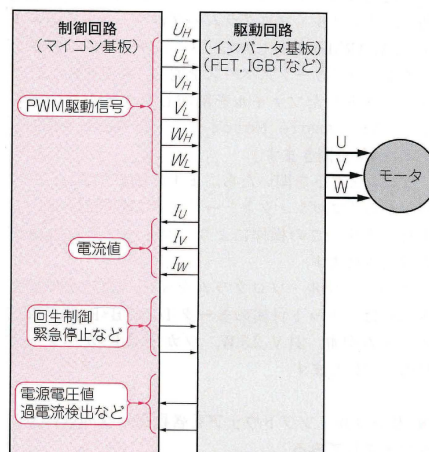


表1. インバータ基板とマイコン基板的接続信号対応表

| ピン番号 | 信号名 | 機能 | 信号種別 |
|------|--------------|-------------------|--------|
| 1 | U | ゲート駆動信号 UHigh | デジタル値 |
| 2 | X | ゲート駆動信号 Ulow | |
| 3 | V | ゲート駆動信号 Vhigh | |
| 4 | Y | ゲート駆動信号 Vlow | |
| 5 | W | ゲート駆動信号 Whigh | |
| 6 | Z | ゲート駆動信号 Wlow | |
| 7 | nEMG | 過電流検出(Emergency) | |
| 8 | nOVV | 過電圧(Over Voltage) | |
| 9 | ENCA | エンコーダ信号 A | |
| 10 | ENCB | エンコーダ信号 B | |
| 11 | ENGZ | エンコーダ信号 Z | |
| 12 | — | 予備 | |
| 13 | — | 予備 | |
| 14 | — | 予備 | |
| 15 | Relay/ENABLE | 駆動電源ON(リレー) | 電源 |
| 16 | +5V | デジタル電源(+5V) | |
| 17 | DGND | デジタル・グランド | アナログ電源 |
| 18 | — | 予備 | |
| 19 | AGND | アナログ・グランド | アナログ値 |
| 20 | AVDD | アナログ電源(+5V) | |
| 21 | TEMP | FET温度 | |
| 22 | ADU | U相電流検出値 | |
| 23 | ADV | V相電流検出値 | |
| 24 | ADW | W相電流検出値 | |
| 25 | VDC | 電源電圧値 | |
| 26 | — | 予備 | |

表2(a). インバータ基板

| 基板名 | 駆動電源電圧 DC V | 駆動電流 (MAX) A | ゲート駆動 素子 | 駆動FET | 電流検出方式 | 電流検出 素子(仕様) | 回生電圧 保護回路 | 備考 |
|-------------|----------------|-----------------|-------------|-------------------------|---------|----------------|--------------|-------------------------|
| KES-P2 | 12~48 | 3 | LM5109ASD | TPC8053-H(東芝)×6 | 1/3シャント | 抵抗(50mΩ 2W) | 無 | ガラエポ4層基板 4チャンネルDAC基板 |
| KES-PF | 12~70 | 50 | LM5109ASD | TPH2R608NH(東芝)×6 | 2センサ | ホール素子型(50A) | 有 | ガラエポ4層基板 |
| KES-PX | 12~60 | 70 | DRV8323RH | IPT012N08N5(Infineon)×6 | 3シャント | 抵抗(2mΩ 10W) | 有 | アルミ2層基板 |
| KES-PM150 | 12~95 | 100 | DRV8323RH | TPH3R70APL(東芝)×12 | 3シャント | ホール素子型(150A) | 有 | ガラエポ4層基板 |
| KES-PH(開発中) | AC100/220V | 5 | TPD4207F | パワーFET(TPD4207F) | 3シャント | 抵抗(100mΩ 3W) | 無 | ガラエポ4層基板 |

表2(b). マイコン(SBK)基板

| 基板名 | 駆動電源電圧 DC V | マイコン | オンボード デバッグ機能 | スライド・ボリューム | スライドスイッチ | プッシュスイッチ |
|----------|----------------|--------------|-----------------|------------|----------|----------|
| SBK-M4KN | 5 | TMPM4KNFYAFG | CMSISDAP搭載 | 有 | 4 | 3 |
| SBK-M4K4 | 5 | TMPM4K4FYAUG | CMSISDAP搭載 | 有 | 4 | 3 |

By combining an inverter board with an SBK (Solution Board Kit) board (SBK-Mxxx series) equipped with on-board JTAG, we can support our customers in developing various BLDC motor-equipped devices. Table 3 is a list of microcontroller boards and inverter kits currently available.

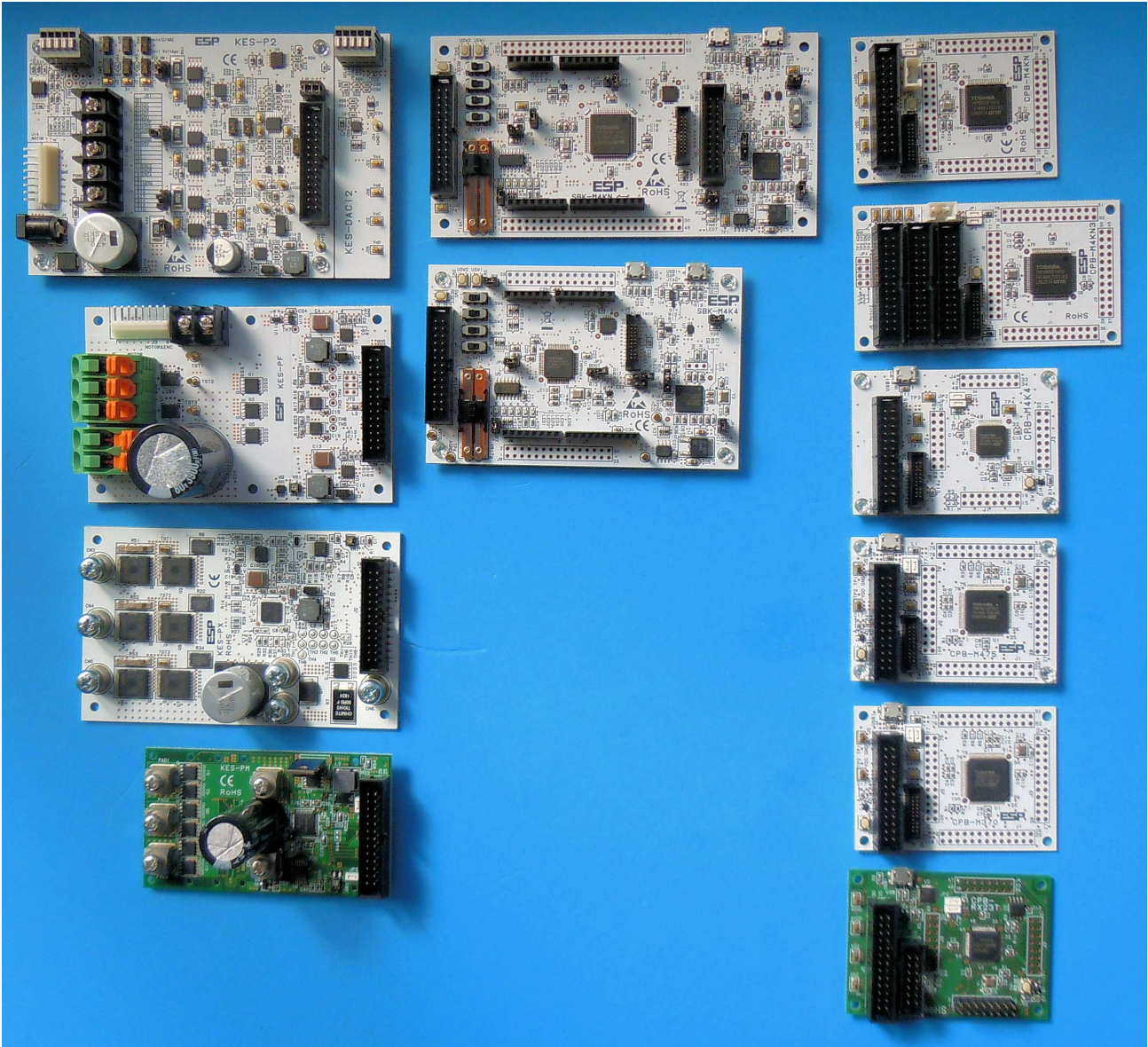
Sample software provided: (W) Toshiba website, (D) Through a Toshiba distributor, (S) The difference is included in the kit on CD.

| 表2(c). マイコン(CPU)基板 | | |
|--------------------|----------------|--------------|
| 基板名 | 駆動電源電圧 DC V | マイコン |
| CPB-M4KN | 5 | TMPM4KNFYAFG |
| CPB-M4KN3 | 5 | TMPM4KNFYAFG |
| CPB-M4K4 | 5 | TMPM4K4FYAUG |
| CPB-M475 | 5 | TMPM475FYFG |
| CPB-M370 | 5 | TMPM370FYFG |
| CPB-RX23T | 5 | R5F523T5ADFM |

| 表3. マイコン基板&インバータ・キット一覧 | | | |
|------------------------|-----------------|-----------------|------------------|
| マイコン基板 インバータ | SBK-M4KN | SBK-M4K4 | CPB-RX23T |
| KES-P2 | SBK-M4KN-KIT(D) | SBK-M4K4-KIT(W) | |
| KES-PF | | | |
| KES-PX | | | |
| KES-PM150 | SBK-M4KN-PKT(S) | SBK-M4K4-PKT(S) | CPB-RX23T-PKT(S) |
| KES-PH(開発中) | | | |

photograph. Currently available (or under development) board modules

Inverter board (KES-Px) Debugger-equipped microcontroller board (SBK-Mxxx) CPU stand-alone board (CPB-Mxxx)



Materials SBK-M4KN10-KIT included motor (TG-611) specifications

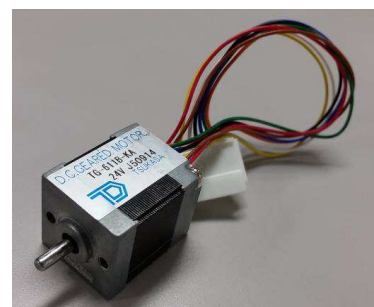
Manufacturer: Tsukasa Electric

Model name: TG-611 (output: 3.5W)

Toshiba custom model number: TG611B-R2883, 24V

size: 22mm□

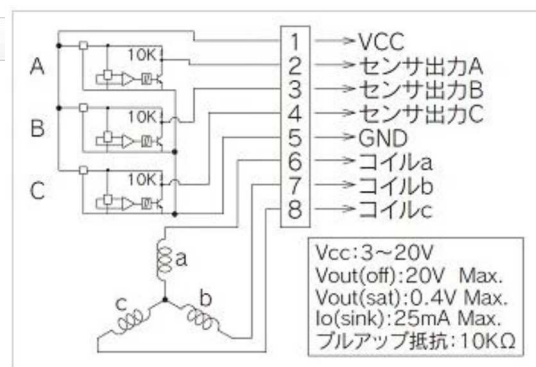
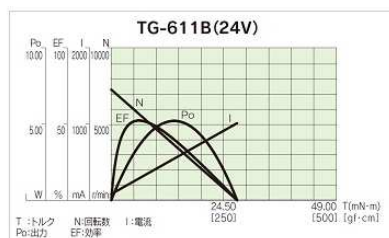
Number of poles: 4 poles



モーター単体仕様

| 機種名 | 定格電圧 (V) | 無負荷 回転数 (r/min) | 無負荷 電流 (mA) | 定格トルク | | 定格 回転数 (r/min) | 定格 電流 (mA) | 回転方向 | 質量 (g) | 備考 |
|---------|-------------|-----------------------|-------------------|--------|---------|----------------------|------------------|------|-----------|----|
| | | | | (mN·m) | (gf·cm) | | | | | |
| TG-611B | 24 | 7260 | 80 | 5.88 | 60 | 5700 | 280 | 両方向 | 61 | |

モーター単体負荷特性図



Control signal waveform output DAC board connection diagram

| DAC board KES—DAC12 | | SBK-M4xN10 board J7 | |
|---------------------|-------------|---------------------|-------------|
| number | Signal Name | number | Signal Name |
| 1 | DVDD | 1 | DVDD |
| 2 | GND | 2 | GND |
| 3 | TSPI1RXD | 3 | TSPI1RXD |
| 4 | TSPI1TXD | 4 | TSPI1TXD |
| 5 | TSPI1CLK | 5 | TSPI1CLK |

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