

## > Stepping Motor Drivers for Automotive Applications

The annual average growth rate of the Head-Up Display (HUD) market is rapidly growing to 20 %. In 2020, it is estimated to reach 10,000,000 units in the world, and becoming more and more popular. Stepping motors are used for 70% or more of HUDs.

We have developed an automotive stepping motor driver (TB9120FTG) and entered the market for the first time.

The following describes the features of the TB9120FTG compared to competitors.

- Input signal interface: Clock signal

It can output sine-wave current without using high-function microcontrollers or software. (Competitors use SPI interface control.)

- Low ON resistance: 0.7 Ω (typ.)

Lowest value in automotive stepping motor drivers.

- Not required charge pump circuits : Use the combination of upper P-channel FET and lower N-channel FET. (Competitors' products use the combination of upper and lower N-channel FETs.)

- Micro steps: 1/32 step resolution

The finest in automotive stepping motor drivers.

- Package: QFN package (6 mm × 6 mm)

The smallest in automotive stepping motor drivers.

Though TB9120FTG has the optimal specifications for automotive adjustment of the projection position of heads-up displays, it is highly versatile and can be used for various stepping motor applications such as valves.

## Motor drivers for Automotive applications



## > APPLICATIONS

- Concave mirror angle adjustment for head-up displays
- Motorcycle valves
- HVAC valves and dampers

## > FEATURES

## > ADVANTAGES

## > BENEFITS

Microstep driving by clock input	Whereas the mainstream of competitors is SPI interface control, the TB9120FTG uses clock signal input only. Full step to 1/32 step resolution can be supported.	<ul style="list-style-type: none"> <li>• It supports 1/32 step resolution. (contributing to noise and vibration reductions)</li> <li>• Neither high-function microcontrollers nor software are required.</li> </ul>
Stall detection function	When the rotation is abnormal, the detection signal is output by judging to be stalled. Method of detecting an induced voltage, whose temperature and voltage dependence is low, is adopted.	<ul style="list-style-type: none"> <li>• The external simple microcontroller can receive the detection signal and feed it back to the control system.</li> <li>• It is easy to be incorporated to the system design because of its lower dependence of temperature and voltage.</li> </ul>
Low ON resistance	It incorporates DMOSFET with ON resistance of 0.7 Ω. (upper + lower : typ.)	<ul style="list-style-type: none"> <li>• Self-heating is low and thermal design is easy.</li> <li>• Maximum current rating is 1.5 A.</li> </ul>

## > PRODUCT LINEUP

Product number	Voltage (Absolute maximum rating) (V)	Voltage (Operating range) (V)	Current (Absolute maximum rating) (A)	Current (Recommended upper limit) (A)	Step resolution	ON resistance (upper + lower) (Ω)	Operating temperature (°C)	Package	Other functions and features
TB9120FTG	40	4.5 to 7.0 (Note 1) 7.0 to 18.0	1.5	1.0 (Note 2)	Supporting full, half, quarter, 1/8, 1/16, and 1/32 steps.	0.7	-40 to 125	VQFN28 6.0 mm × 6.0 mm Wettable pins with excellent solderability	<ul style="list-style-type: none"> <li>• Constant current PWM control</li> <li>• Mixed decay mode</li> <li>• Stall detection (output a flag signal in detecting stall.)</li> <li>• Output flag function in error detections (over-current detection, thermal shutdown, load open detection)</li> <li>• Standby function (dedicated pin)</li> </ul>

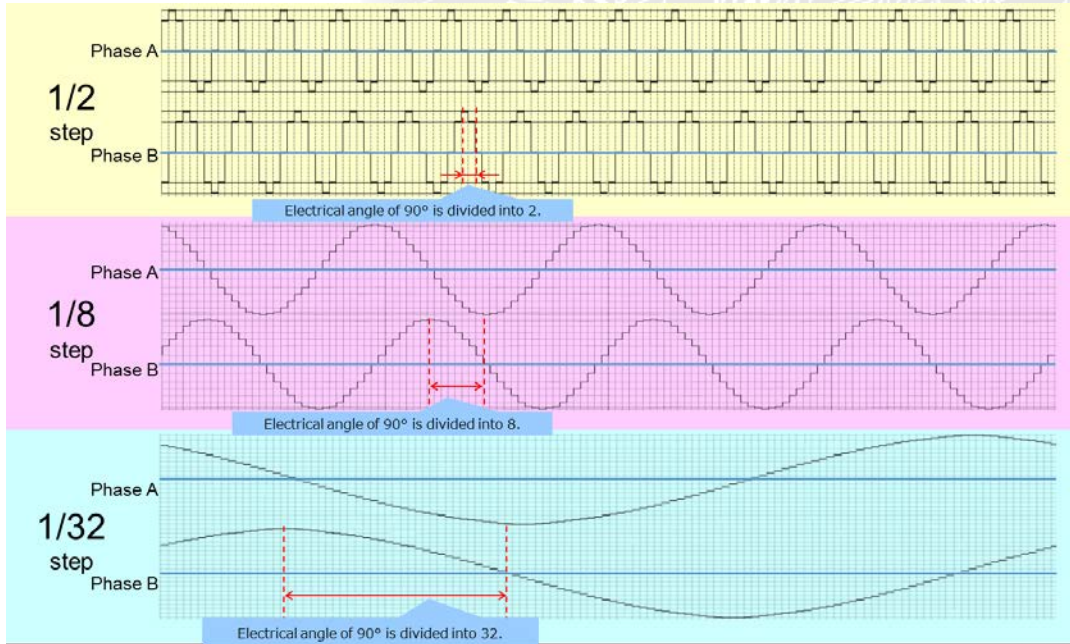
Note 1: In the range of 4.5 to 7.0V, some values of the electrical characteristics are not guaranteed.

Note 2: The upper output current is limited according to the ambient temperature and the heat dissipation of the board.

### RESTRICTIONS ON PRODUCT USE

- Toshiba Corporation and its subsidiaries and affiliates are collectively referred to as "TOSHIBA".
- Hardware, software and systems described in this document are collectively referred to as "Product".
- TOSHIBA reserves the right to make changes to the information in this document and related Product without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.
- PRODUCT IS NEITHER INTENDED NOR WARRANTED FOR USE IN EQUIPMENTS OR SYSTEMS THAT REQUIRE EXTRAORDINARILY HIGH LEVELS OF QUALITY AND/OR RELIABILITY, AND/OR A MALFUNCTION OR FAILURE OF WHICH MAY CAUSE LOSS OF HUMAN LIFE, BODILY INJURY, SERIOUS PROPERTY DAMAGE AND/OR SERIOUS PUBLIC IMPACT ("UNINTENDED USE"). Except for specific applications as expressly stated in this document, Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. IF YOU USE PRODUCT FOR UNINTENDED USE, TOSHIBA ASSUMES NO LIABILITY FOR PRODUCT. For details, please contact your TOSHIBA sales representative.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. TOSHIBA ASSUMES NO LIABILITY FOR DAMAGES OR LOSSES OCCURRING AS A RESULT OF NONCOMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS.

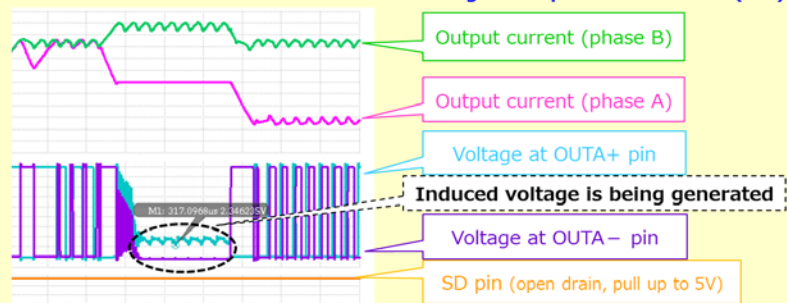
## > ADVANTAGE: Micro step drive



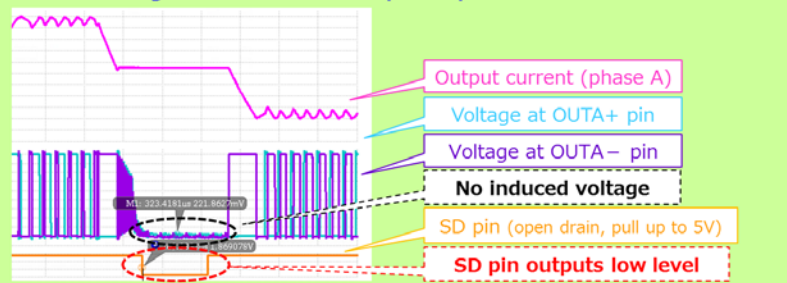
The above figure shows an example of output current waveforms of the 2-phase stepping motor. Waveforms of half step, 1/8 step, and 1/32 step resolution are shown in order from the top. It can support up to 1/32 step resolution (micro steps), which is the finest in automotive stepping motor drivers, contributing to noise and vibration reductions.

## > ADVANTAGE : Stall detection

(1) Without stall detection: Normal motor rotation with induced voltage → SD pin is in HIZ state (5 V)



(2) With stall detection: Induced voltage is not detected → SD pin outputs low level



When the rotation is abnormal, the detection signal is output by judging to be stalled.

The external simple microcontroller can receive the detection signal and feed it back to the control system.

As an example, it can determine the original position of the motor at the initial startup of the system, contributing to cost reduction by eliminating the mechanical switches for detection and their routing wires.

For stall detection method, some competitors' products monitor PWM frequency changes. However, this method has a significant dependence of temperature and voltage because the PWM chopping current changes easily due to them. On the other hand, the TB9120FTG has a method of detecting motor's induced voltage, resulting in lower dependence of temperature and voltage and easier system design.