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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

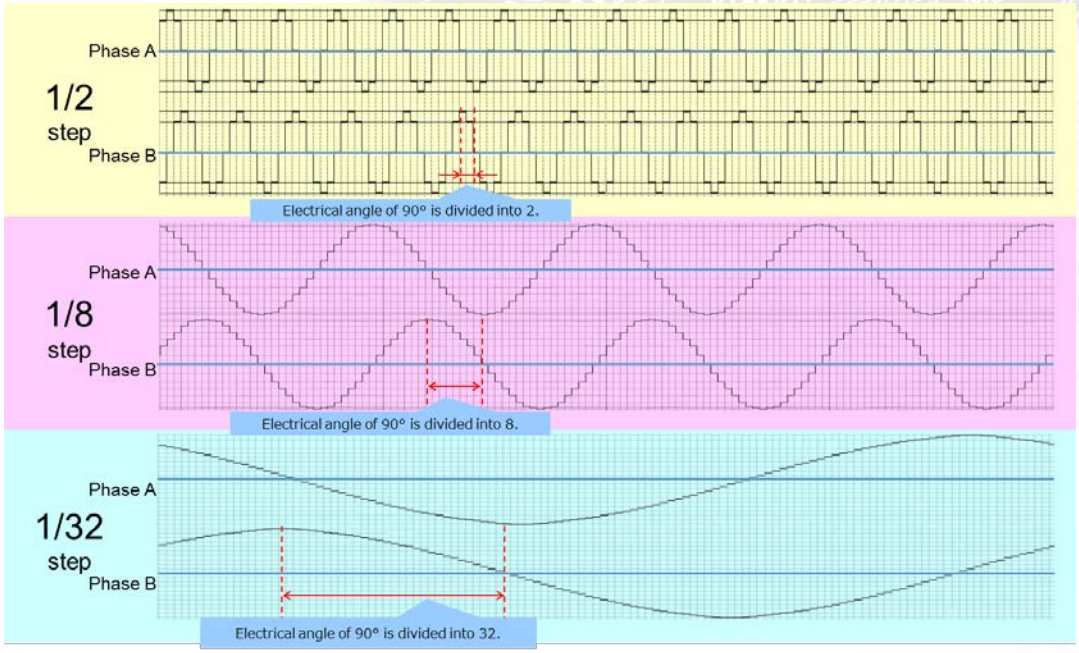
FEATURES	ADVANTAGES	BENEFITS
Microstep driving by clock input	Whereas the mainstream of competitors is SPI interface control, the TB9120FTG uses clock signal input only. Full step to 1/32 step resolution can be supported.	・ It supports 1/32 step resolution. (contributing to noise and vibration reductions) ・ Neither high-function microcontrollers nor software are required.
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.	・ The external simple microcontroller can receive the detection signal and feed it back to the control system. ・ It is easy to be incorporated to the system design because of its lower dependence of temperature and voltage.
Low ON resistance	It incorporates DMOSFET with ON resistance of 0.7 Ω. (upper + lower : typ.)	・ Self-heating is low and thermal design is easy. ・ Maximum current rating is 1.5 A.

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 (℃)	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	・Constant current PWM control ・Mixed decay mode ・Stall detection (output a flag signal in detecting stall.) ・Output flag function in error detections (over-current detection, thermal shutdown, load open detection) ・Standby function (dedicated pin)

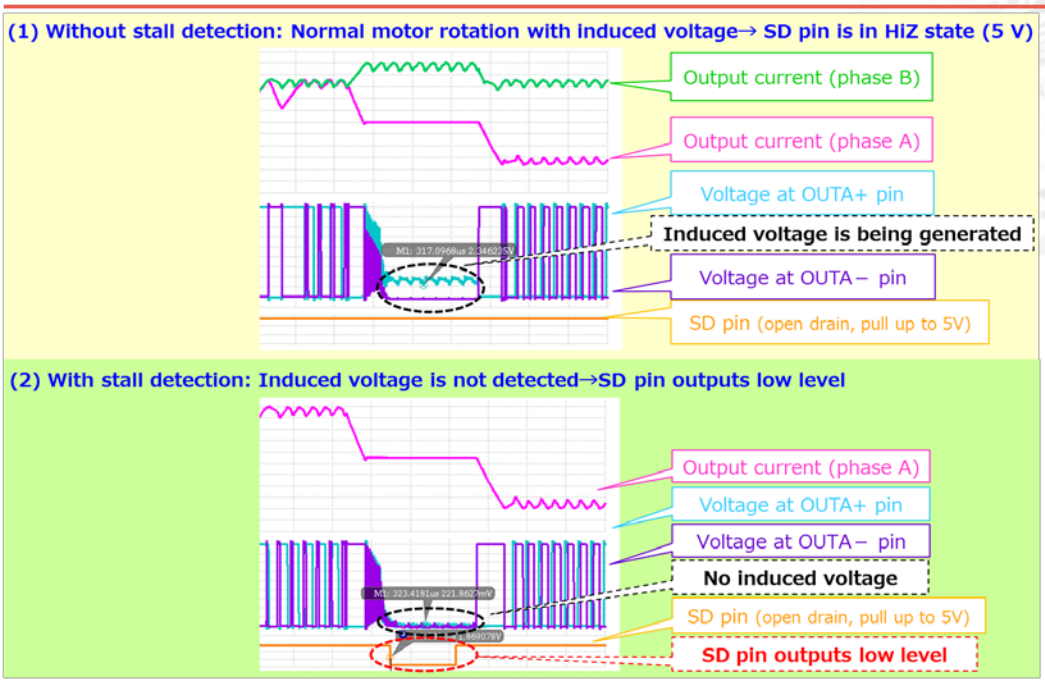
Note 1: In the range of 4.5 to 7.0V, some values of the electrical characteristics are not guaranteed.
Note 2: The upper output current is limited according to the ambient temperature and the heat dissipation of the board.

> 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



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.