# A Test Device Module of the Step Motor Driver for HANARO CAR Operation

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## 1. Introduction

Recently, the control computer system of HANARO, HCCS, has been successfully replaced with up-to-date RTP control systems. Because the previous supplier was no longer able to support technical services, it was necessary to follow up the rapidly changing modern digital technology trend owing to the aging problem. The brand-new control system is reliable and has advantages compared with the old control system, and the installed system covers all functional operations of old system [1]. Nevertheless, packaged RTP systems do not include a step motor or driver, and it is necessary to develop a proper test device to check the step motor and driver without using the RTP system. In particular, the operation of a CAR (Control Absorber Rod) requires many complicated procedures. Occasionally, it takes significant time to prepare for a field test [2].

In this work, a test device module for a step motor diver is shown to emulate a HANARO CAR operation, and the test device system architecture, operational principle, and experiment results are presented. A commercial 8-bit $\mu$-processor is applied to implement the device [3].

## 2. Development of a test device module

### *2.1 Features*

The implemented device was designed to do the same operation of the HCCS (HANARO Control Computer System) with a hand-held size. The interface of the module matches with that of the CAR device, and the control signals are updated every 200 [ms]. Fig. 1 shows a block diagram of the test device for CAR operation, and the summarized features are as follows:

- Compatible interface with HANARO CAR system
- Processor: 8-bit (Atmega128)
- Cycle time: 200 [ms] (timer-based interrupt)
- Power supply: 5 VDC (from the driver)
- Step range: 0 ~ ±15 or ±60 [steps/cycle]
- Resolution: 1.8 [degree/step]
- Module size: 12 x 12 [$cm^2$]
- Monitoring step error (±3 steps/cycle)
- Driver fault detection
- Digital inputs (or step numbers) with push buttons
- Visual inspection by external LEDs

### *2.2 Counting Technique of Step Number*

To ensure a stable operation, the step number should be counted from the encoder signals. The encoder signals can be considered as a combination of multiple-pulses. Fig. 2.(a) shows the typical waveforms of the encoder signals, and Fig. 2.(b) shows the corresponding state diagram. In the forward direction, the phase of encoder signal B is -90 degrees. However, compared with the phase of encoder signal A in the reverse direction, the phase of encoder signal B is +90 degrees. It should be noted that each state has a recursive property which is shown in Fig. 2.(b). One step means that the completion of one circulation, which implies the state changes, (00→10→11→01→00) or (00→01→11→10→00). Thus, the $\mu$-processor can count the step numbers from a state variation of the encoder signals.

### *2.3 Experiment Results*

The fabricated test device module is shown in Fig. 3. Fig. 4.(a) and (b) show the measured encoder signals of the driver operating at 15 and 60 steps, respectively. The step motor driver is identical to that of HCCS, and both results satisfy a 200 ms cycle time. From those encoder signals, the step number is counted and compared with digital inputs from push buttons, and thus the system can check whether the status of the system is valid or not. In addition, a user can confirm its operation through external LEDs.

## 3. Conclusions

A portable test device for HANARO CAR operation is presented. An 8-bit $\mu$-controller is used to emulate a HANARO CAR operation. The digital interface, as well as the functional operation, of the test device module matches that of the currently used driver. This device can be used to check the functional validity of the step motor and driver.

## REFERENCES

[1] Im Yun-Taek *et al*., Analysis of Software Functions in the HANARO Control Computer System, KAERI/TR-5537/2014.
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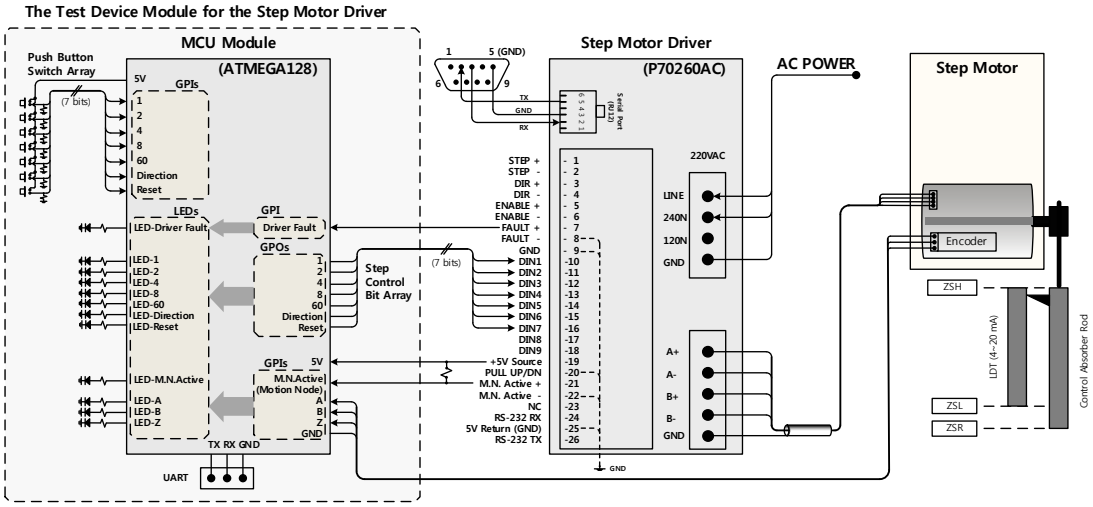


Fig. 1. Block diagram of the test device module for CAR operation.


(a) (b)

Fig. 2. (a) Typical encoder signal waveforms and (b) state diagram of the encoder signals

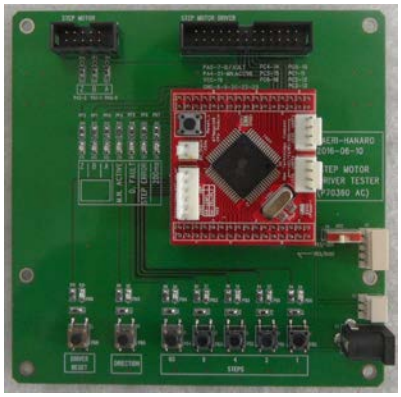

Fig. 3. Test device module for the step motor driver.


(a) (b)

Fig. 4. Measured encoder signals (a) at 15 and (b) 60 steps.