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The Performance Comparison of 6-pin photocoupler with base connection pin and Renesas 4-pin photocouplers used in digital mode

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Introduction

This paper intends to compare the performance of a 6-pin photo-transistor coupler vs. Renesas 4-pin photo-transistor coupler in the digital mode. The CNY17-3, a 6-pin photo-transistor coupler made by a few opto manufacturers is used as a reference in the writing of this paper.

In general, the purpose of using a 6-pin photo-transistor coupler with the base connection is to improve the switching time of the device. The improvement is implemented by biasing the base of the phototransistor with a resistor, generally, in the range of 100K or greater connected from its base to ground. However, if the switching speed is not critical, many users would leave the base connection pin of a photo-transistor coupler unconnected or unused.

Noise Issue

Unfortunately, in a noisy environment, the circuit may become susceptible to noise when a 6-pin photo-transistor coupler with the base connection is left unused. When the base connection pin is not used, it would act as an antenna and allow noise current to enter the base of the phototransistor. As a result, the noise current would appear at its output and its amplitude is multiplied by a factor of current transfer ratio (CTR). The fix to the noise problem is to add a LC circuit to the unused base connection pin to suppress EMI noise, which means adding cost and components to the BOM.

PCB Board Saving

In addition, some applications where the PCB board space is a premium, the 6-pin optocoupler would take more space compared to 4-pin optocoupler.

As a comparison of the PCB area taken by a 4-pin DIP vs. 6-pin Dip, the table below shows that the 4-pin DIP package would save PCB board space by roughly a factor of 2.

	PS25xxL-1 (SMT)	CNY-17X (SMT)
Package	4-pin DIP	6-pin DIP
Package Dimensions (Max) in mm²	47.72	91.57

How Renesas Addresses The Problems

To address the above issues and different requirements of a photocoupler with transistor output, Renesas has offered a range of products in 4-pin optocouplers for a general purpose application where the switching time is not crucial to a fast switching device where the applications require higher data rate.

For example, the PS2501A-1 is commonly used in the application where the switching time is not crucial. However, for faster switching time requirements, Renesas offers PS2513-1 and the new PS2514-1 to meet the needs. The new PS2514-1 incorporates an internal bias at the base of the phototransistor. As a result, the new PS2514-1 has a faster switching time without the need of adding an extra external resistor to bias the base of the phototransistor and it minimizes the EMI susceptibility as experienced with 6-pin photocoupler with its base connection exposed. In addition, the PS2514-1 offers PCB board saving as mentioned above.

The following pages shows the comparison table and figures for the purpose of reference to show the performance of Renesas photocouplers in reference to 6-pin photocoupler on the switching time.

Comparison Table (*)

Saturated Switching Time	Test Conditions	Symbols	PS2501A-1-Q (CTR = 140%) ⁽³⁾	PS2513-1 (CTR = 116%) ⁽³⁾	PS2514-1 (CTR = 100%) ⁽³⁾	CNY17-3 ⁽¹⁾ (CTR = 158%) ⁽³⁾	CNY17-3 ⁽²⁾ (CTR = 76%) ⁽³⁾	Units
Rise Time / Fall Time (Figure 1.0)	RL = 5.1KΩ, IF = 5 mA, VCC = 5.0 V, Freq = 1.0 KHz, DC = 50%, Ta = 25C	tr/tf	2.6 /36.4	2.0/12.6	3.0/6.0	6.4/123.6	5.6/3.6	μs

Notes:

(*): For reference only.

(1): The base of the phototransistor is not used.

(2): The base of the phototransistor is connected with a 200KΩ resistor to ground.

(3): CTR test conditions: IF = 5mA, VCE = 5V

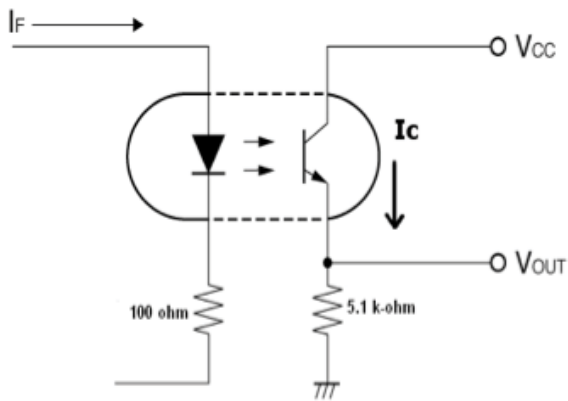


Fig 1: Switching Time Test Circuit

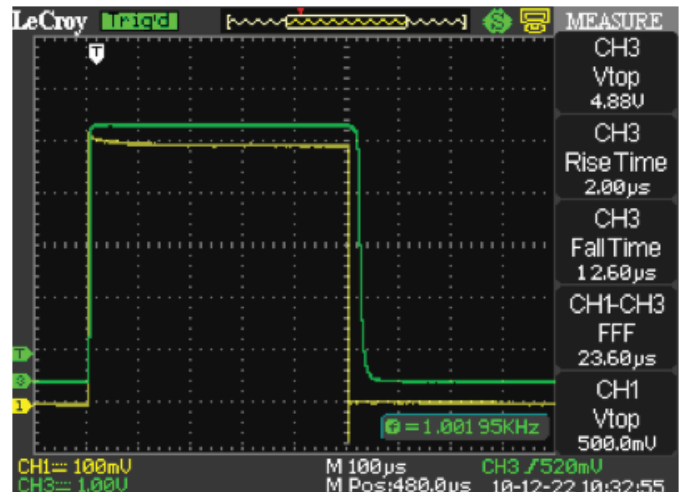


Fig 3: Switching Time for PS2513-1

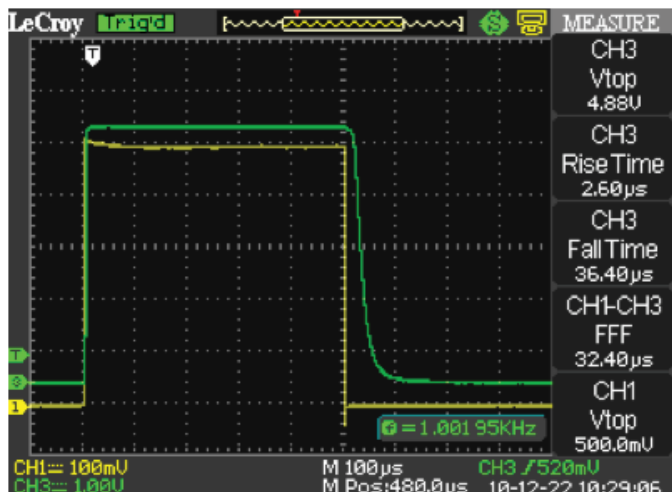


Fig 2: Switching Time for PS2501A-1-Q

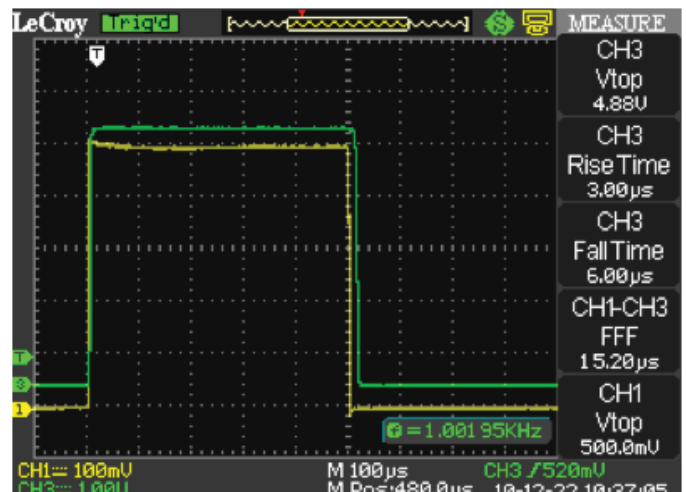


Fig 4: Switching Time for PS2514-1

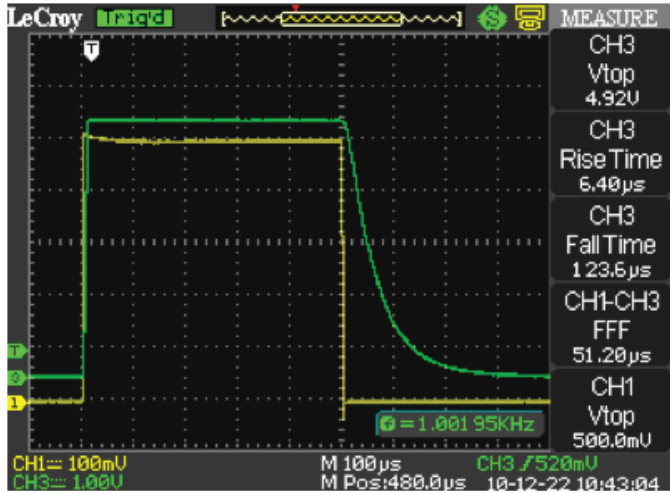


Fig 5: Switching Time for CNY17-3 (1)

Note (1): The base of the phototransistor is not used.

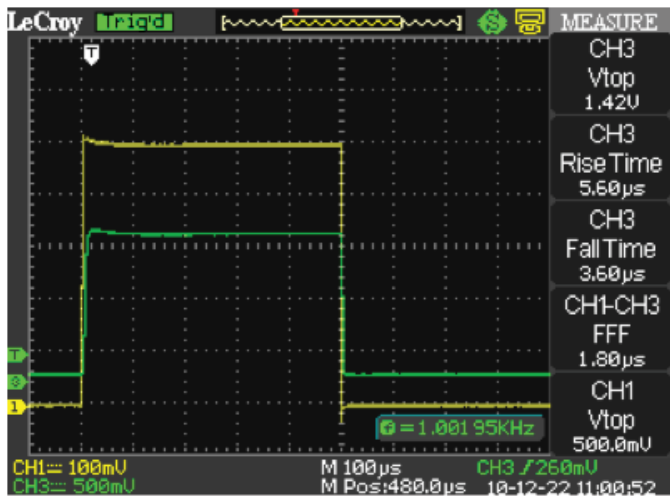


Fig 6: Switching Time for CNY17-3 (2)

Note (2): The base of the phototransistor is connected with a 200KΩ resistor to ground.

Conclusion

Renesas offers a range of phototransistors that can meet the market needs: From the common general purpose, PS2501A-1 to the PS2513-1-A and PS2514-1-A which would not only provide faster switching time but it also reduces the component count and board space in comparison to the 6-pin photocoupler in high speed application.

For more info about Renesas range of photocoupler products, applications, please visit CEL website at www.cel.com.