To our customers,

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April 1st, 2010
Renesas Electronics Corporation

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Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

User's Manual

8

# 740 Family

## Countermeasures Against Noise

RENESAS 8-BIT SINGLE-CHIP MICROCOMPUTER



Renesas Electronics
www.renesas.com

Rev.1.0 2002.09

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# Preface

The "Countermeasure Against Noise" reference book is a compilation of notes on noise and the countermeasure examples.

The shown countermeasures are effective against noise in theory, however, it is necessary not only to take the measures but to evaluate before actual use.

Additionally, since this book shows an common information to MCUs, it might include information which does not apply to your system or MCU, such as a pin not existing in your MCU.

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# 1. Shortest Wiring Length

The wiring on a printed circuit board can function as an antenna which feeds noise into the microcomputer.
The shorter the total wiring length (by mm unit), the less the possibility of noise insertion into a microcomputer.

## 1.1 Package

Select the smallest possible package to make the total wiring length short.

● **Reason**

The wiring length depends on a microcomputer package. Use of a small package, for example QFP and not DIP, makes the total wiring length short to reduce influence of noise.

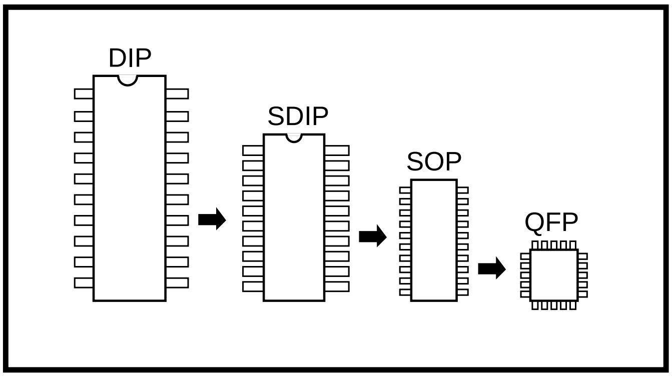


**Fig. 1 Selection of packages**

## 1.2 Wiring for $\overline{\text{RESET}}$ input pin

Make the length of wiring which is connected to the $\overline{\text{RESET}}$ input pin as short as possible. Especially, connect a capacitor across the $\overline{\text{RESET}}$ input pin and the Vss pin with the shortest possible wiring (within 20 mm).

● **Reason**

The width of a pulse input into the $\overline{\text{RESET}}$ pin is determined by the timing necessary conditions. If noise having a shorter pulse width than the standard is input to the $\overline{\text{RESET}}$ input pin, the reset is released before the internal state of the microcomputer is completely initialized. This may cause a program runaway.

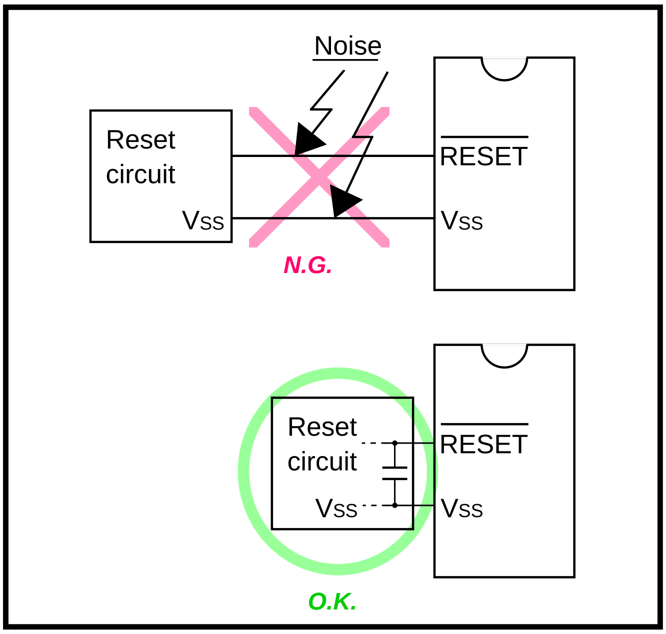


**Fig. 2 Wiring for the $\overline{\text{RESET}}$ input pin**

### 1.3 Wiring for clock input/output pins

- Make the length of wiring which is connected to clock I/O pins as short as possible.
- Make the length of wiring (within 20mm) across the grounding lead of a capacitor which is connected to an oscillator and the Vss pin of a microcomputer as short as possible.
- Separate the Vss pattern only for oscillation from other Vss patterns.

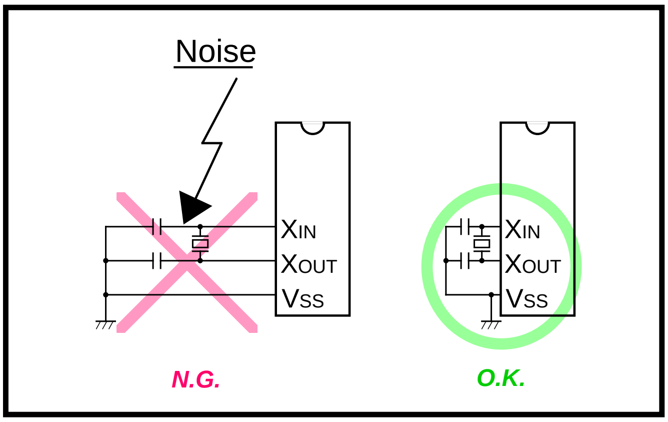


**Fig. 3 Wiring for clock I/O pins**

● **Reason**

If noise enters clock I/O pins, clock waveforms may be deformed. This may cause a program failure or program runaway. Also, if a potential difference is caused by the noise between the Vss level of a microcomputer and the Vss level of an oscillator, the correct clock will not be input in the microcomputer.

### 1.4 Wiring to CNVss pin

Connect the CNVss pin to the Vss pin with the shortest possible wiring.

● **Reason**

The processor mode of a microcomputer is influenced by a potential at the CNVss pin. If a potential difference is caused by the noise between pins CNVss and Vss, the processor mode may become unstable. This may cause a microcomputer malfunction or a program runaway.

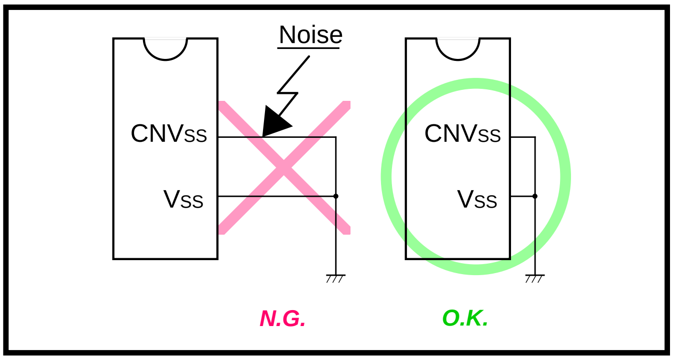


**Fig. 4 Wiring for CNVss pin**

### 1.5 Wiring to VPP pin of One Time PROM version, EPROM version, and Flash memory version

● When the VPP pin is also used as the CNVss pin*1

Connect an approximately 5 kΩ resistor to the VPP pin the shortest possible in series and also to the Vss pin. When not connecting the resistor, make the length of wiring between the VPP pin and the Vss pin the shortest possible (refer to **countermeasure example 1 of Figure 5**)

● When the VPP pin is also used as any other pin than the CNVss*2

Connect an approximately 5 kΩ resistor to the VPP pin the shortest possible in series. When not connecting the resistor, make the length of wiring for the VPP pin the shortest possible (refer to **countermeasure examples 2 and 3 of Figure 5.**)

*1 When a microcomputer has the CNVss pin, the VPP pin is also used as the CNVss pin.

*2 When a microcomputer does not have the CNVss pin, the VPP pin is also as the input pin adjacent to the RESET input pin.

Note: Even when a circuit which included an approximately 5 kΩ resistor is used in the Mask ROM version, the microcomputer operates correctly.

**● Reason**

The VPP pin of the One Time PROM, the EPROM version, and the flash memory version is the power source input pin for the built-in memory. When programming in the built-in memory, the impedance of the VPP pin is low to allow the electric current for writing flow into the memory. Because of this, noise can enter easily. If noise enters the VPP pin, abnormal instruction codes or data are read from the built-in memory, which may cause a program runaway.

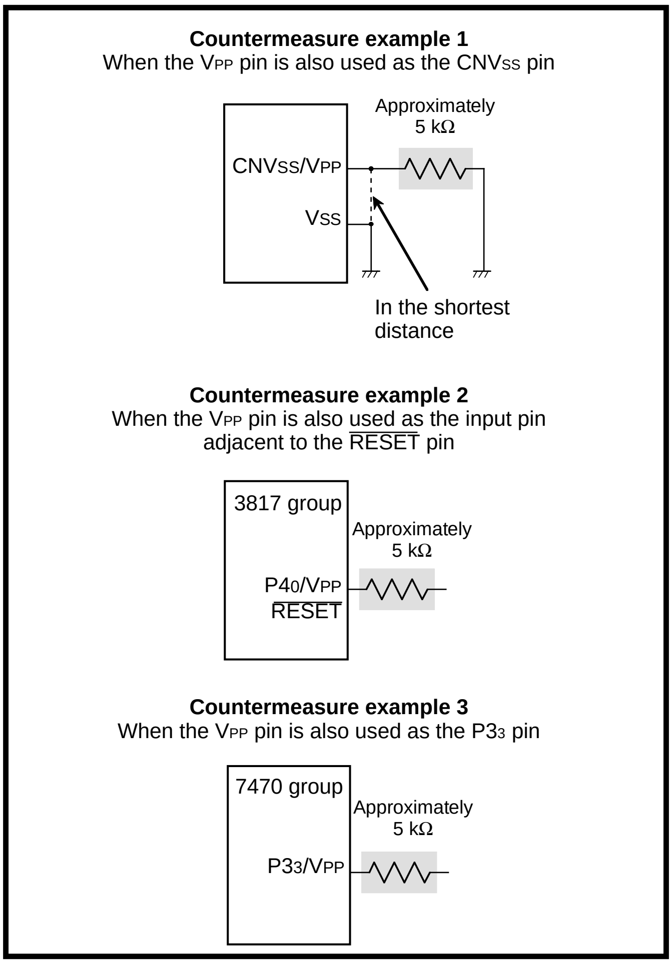


**Fig. 5 Wiring for the VPP pin of the One Time PROM version, the EPROM version, and the Flash memory version**

## 2. Connection of Bypass Capacitor across VSS Line and VCC Line

In order to stabilize the system operation and avoid the latch-up, connect an approximately 0.1 μF bypass capacitor across the VSS line and the VCC line as follows:

- Connect a bypass capacitor across the VSS pin and the VCC pin at equal length.
- Connect a bypass capacitor across the VSS pin and the VCC pin with the shortest possible wiring.
- Use lines with a larger diameter than other signal lines for VSS line and VCC line.
- Connect the power source wiring via a bypass capacitor to the VSS pin and the VCC pin.

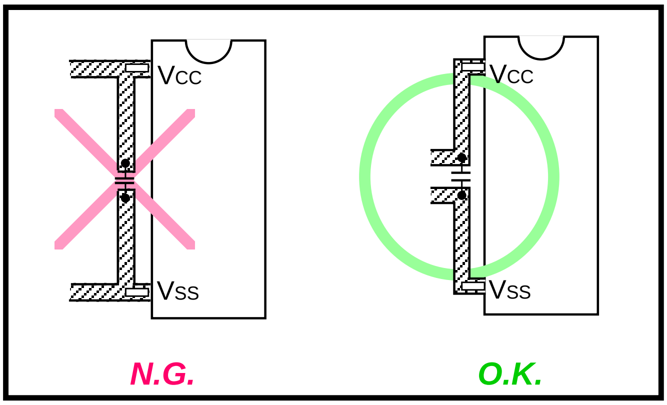


**Fig. 6 Bypass capacitor across the VSS line and the VCC line**

## 3. Wiring to Analog Input Pins

• Connect an approximately 100 Ω to 1 kΩ resistor to an analog signal line which is connected to an analog input pin in series. Besides, connect the resistor to the microcomputer as close as possible.
• Connect an approximately 1000 pF capacitor across the Vss pin and the analog input pin. Besides, connect the capacitor to the Vss pin as close as possible. Also, connect the capacitor across the analog input pin and the Vss pin at equal length.

● **Reason**

Signals which is input in an analog input pin (such as an A-D converter/comparator input pin) are usually output signals from sensor. The sensor which detects a change of event is installed far from the printed circuit board with a microcomputer, the wiring to an analog input pin is longer necessarily. This long wiring functions as an antenna which feeds noise into the microcomputer, which causes noise to an analog input pin. If a capacitor between an analog input pin and the Vss pin is grounded at a position far away from the Vss pin, noise on the GND line may enter a microcomputer through the capacitor.

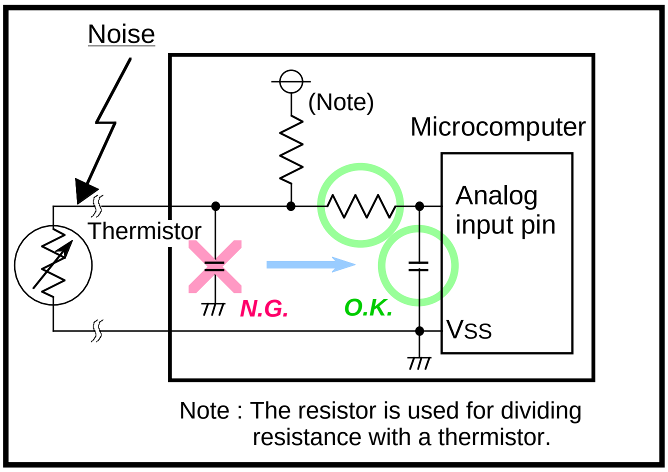


**Fig. 7 Analog signal line and a resistor and a capacitor**

## 4. Oscillator Concerns

Take care to prevent an oscillator that generates clocks for a microcomputer operation from being affected by other signals.

### 4.1 Keeping oscillator away from large current signal lines

Install a microcomputer (and especially an oscillator) as far as possible from signal lines where a current larger than the tolerance of current value flows.

● **Reason**

In the system using a microcomputer, there are signal lines for controlling motors, LEDs, and thermal heads or others. When a large current flows through those signal lines, strong noise occurs because of mutual inductance.

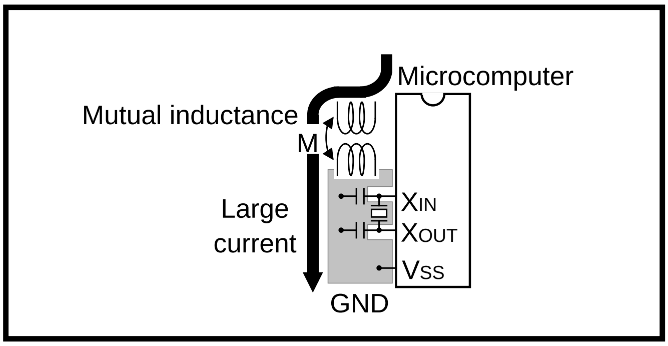


**Fig. 8 Wiring for a large current signal line**

### 4.2 Installing oscillator away from signal lines where potential levels change frequently

Install an oscillator and a connecting pattern of an oscillator away from signal lines where potential levels change frequently. Also, do not cross such signal lines over the clock lines or the signal lines which are sensitive to noise.

● **Reason**

Signal lines where potential levels change frequently (such as the CNTR pin signal line) may affect other lines at signal rising edge or falling edge. If such lines cross over a clock line, clock waveforms may be deformed, which causes a microcomputer failure or a program runaway.

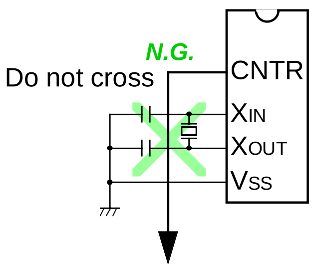


**Fig. 9 Wiring to a signal line where potential levels change frequently**

### 4.3 Oscillator protection using Vss pattern

As for a two-sided printed circuit board, print a Vss pattern on the underside (soldering side) of the position (on the component side) where an oscillator is mounted.
Connect the Vss pattern to the microcomputer Vss pin with the shortest possible wiring. Besides, separate this Vss pattern from other Vss patterns.

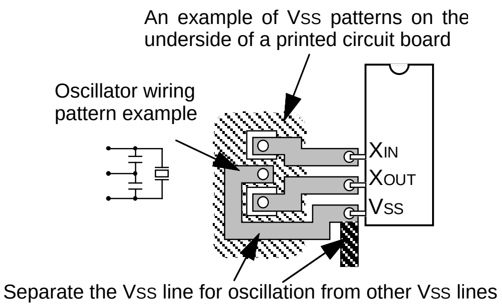


**Fig. 10 Vss pattern on the underside of an oscillator**

## 5. Setup For I/O Ports

Setup I/O ports using hardware and software as follows:
<Hardware>
- Connect a resistor of 100 Ω or more to an I/O port in series.

<Software>
- As for an input port, read data several times by a program for checking whether input levels are equal or not.
- As for an output port, since the output data may reverse because of noise, rewrite data to its data register at fixed periods.
- Rewrite data to direction registers and pull-up control registers (only the product having it) at fixed periods.

When a direction register is set for input port again at fixed periods, a several-nanosecond short pulse may be output from this port. If this is undesirable, connect a capacitor to this port to remove the noise pulse.

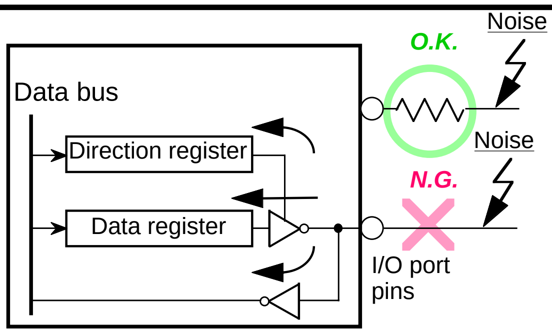


**Fig. 11 Setup for I/O ports**

## 6. Providing of Watchdog Timer Function by Software

If a microcomputer runs away because of noise or others, it can be detected by a software watchdog timer and the microcomputer can be reset to normal operation. This is equal to or more effective than program runaway detection by a hardware watchdog timer. The following shows an example of a watchdog timer provided by software.
In the following example, to reset a microcomputer to normal operation, the main routine detects errors of the interrupt processing routine and the interrupt processing routine detects errors of the main routine.
This example assumes that interrupt processing is repeated multiple times in a single main routine processing.

<The main routine>
- Assigns a single byte of RAM to a software watchdog timer (SWDT) and writes the initial value N in the SWDT once at each execution of the main routine. The initial value N should satisfy the following condition:
  N+1 ≥ (Counts of interrupt processing executed in each main routine)
  As the main routine execution cycle may change because of an interrupt processing or others, the initial value N should have a margin.

- Watches the operation of the interrupt processing routine by comparing the SWDT contents with counts of interrupt processing after the initial value N has been set.
- Detects that the interrupt processing routine has failed and determines to branch to the program initialization routine for recovery processing in the following case:
  If the SWDT contents do not change after interrupt processing.

<The interrupt processing routine>
- Decrements the SWDT contents by 1 at each interrupt processing.
- Determines that the main routine operates normally when the SWDT contents are reset to the initial value N at almost fixed cycles (at the fixed interrupt processing count).
- Detects that the main routine has failed and determines to branch to the program initialization routine for recovery processing in the following case:
  If the SWDT contents are not initialized to the initial value N but continued to decrement and if they reach 0 or less.

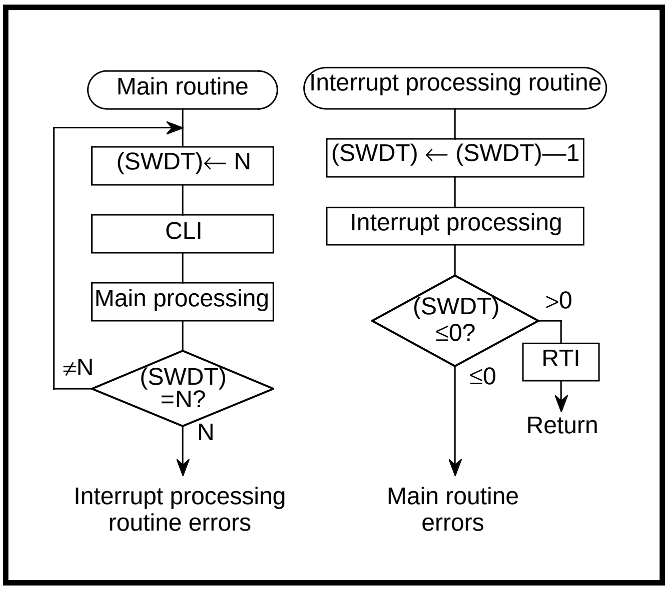


**Fig. 12 Watchdog timer by software**

***MEMORANDUM***

**MITSUBISHI SEMICONDUCTORS**
**740 Family COUNTERMEASURES AGAINST NOISE Rev. 1.0**

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