RX62T Group

Notes on Analog Power Supply Printed Circuit Board Patterns

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Introduction

This application note discusses the layout of the analog power supply lines on printed circuit boards used for RX62T Group microcontroller applications.

Target Device

RX62T Group

This application note also applies to other microcontrollers in the RX Family that have the same A/D converter as the RX62T Group microcontroller. Note, however, that since certain aspects of the functions used may be changed in other devices, the documentation for the device used must be checked carefully before using the information provided in this application note.

Contents

1. Notes on Power Supply Pin Layout

1.1 Separating Digital and Analog Circuits

Digital and analog circuits should be separated as much as possible. In particular, avoid allowing digital signal lines to run close to or to cross analog signal lines so that digital circuit signals do not appear as noise in analog circuits.

The 12-bit A/D converter analog input pins (AN000 to AN003 and AN100 to AN103), the analog reference power supply (VREFH0 and VREFL0), and the analog supply voltage (AVCC0) should be separated from the digital circuits by the analog ground (AVSS0). Furthermore, the analog reference ground (VREFL0) and the analog ground (AVSS0) should be connected to a stabilized ground (VSS) on the board at a single point.

Similarly, the 10-bit A/D converter analog input pins (AN00 to AN11), the analog reference power supply (VREF), and the analog supply voltage (AVCC) should be separated from the digital circuits by the analog ground (AVSS). Furthermore, the analog ground (AVSS) should be connected to a stabilized ground (VSS) on the board at a single point.

To acquire high-quality analog inputs, the analog ground plane and the digital ground plane should be allocated to separate individual layers in the PCB.

The table below lists the setting ranges for the analog pins. If the A/D converters are not used, do not leave any of the following pins open: the AVCC0, AVSS0, VREFH0, and VREFL0 pins for the 12-bit A/D converter and the AVCC, AVSS, and VREF pins for the 10-bit A/D converter.

Table 1 Analog Pin Setting Ranges (3 V Version)

Analog Pin	When an A/D converter is used	When the A/D converter is not used
AVCC0, AVCC	AVCC0 = AVCC = 3.0 V to 3.6 V or 4.0 V to 5.5 V	AVCC0 = AVCC = VCC
AVSS0, AVSS	AVSS0 = AVSS = VSS*1	AVSS0 = AVSS = VSS
VREFH0	VREFH0 = 3.0 V to AVCC0 or 4.0 V to AVCC0	VREFH0 = AVCC0
VREFL0	VREFL0 = AVSS0*1	VREFL0 = AVSS0
AN000 to AN003 AN100 to AN103	VREFL0 ≤ VAN ≤ VREFH0*2	*3
VREF	VREF = 3.0 V to AVCC or 4.0 V to AVCC	VREF = AVCC
AN00 to AN11	AVSS ≤ VAN ≤ VREF*2	*3

Notes: 1. AVSS0, AVSS, and VREFL0 should be connected to a stable ground (VSS) at a single point.
2. VAN: Voltage applied to the analog input pin ANn.
3. Unused pins must be handled as directed in the Hardware Manual for the device used.

Table 2 Analog Pin Setting Ranges (5 V Version)

Analog Pin	When an A/D converter is used	When the A/D converter is not used
AVCC0, AVCC	AVCC0 = AVCC = 4.0 V to 5.5 V	AVCC0 = AVCC = VCC
AVSS0, AVSS	AVSS0 = AVSS = VSS*1	AVSS0 = AVSS = VSS
VREFH0	VREFH0 = 4.0 V to AVCC0	VREFH0 = AVCC0
VREFL0	VREFL0 = AVSS0*1	VREFL0 = AVSS0
AN000 to AN003 AN100 to AN103	VREFL0 ≤ VAN ≤ VREFH0*2	*3
VREF	VREF = 4.0 V to AVCC	VREF = AVCC
AN00 to AN11	AVSS ≤ VAN ≤ VREF*2	*3

Notes: 1. AVSS0, AVSS, and VREFL0 should be connected to a stable ground (VSS) at a single point.
2. VAN: Voltage applied to the analog input pin ANn.
3. Unused pins must be handled as directed in the Hardware Manual for the device used.

1.2 Power Supply Pin Capacitors

Insert a 0.1 µF capacitor between each of the following pairs: between VCC and VSS, between AVCC0 and AVSS0, between VREFH0 and VREFL0, between AVCC and AVSS, and between VREF and AVSS. Furthermore, these noise countermeasures can be improved further by inserting a 0.1 µF capacitor between ACCC0 and VREFL0. Design the layout so that each of these power supply capacitors forms the shortest closed loop possible. The lengths of these lines between capacitor and power supply pin must be made as equal as possible and furthermore, as short as possible. Also, the power supply lines and ground lines should be made as wide as possible.

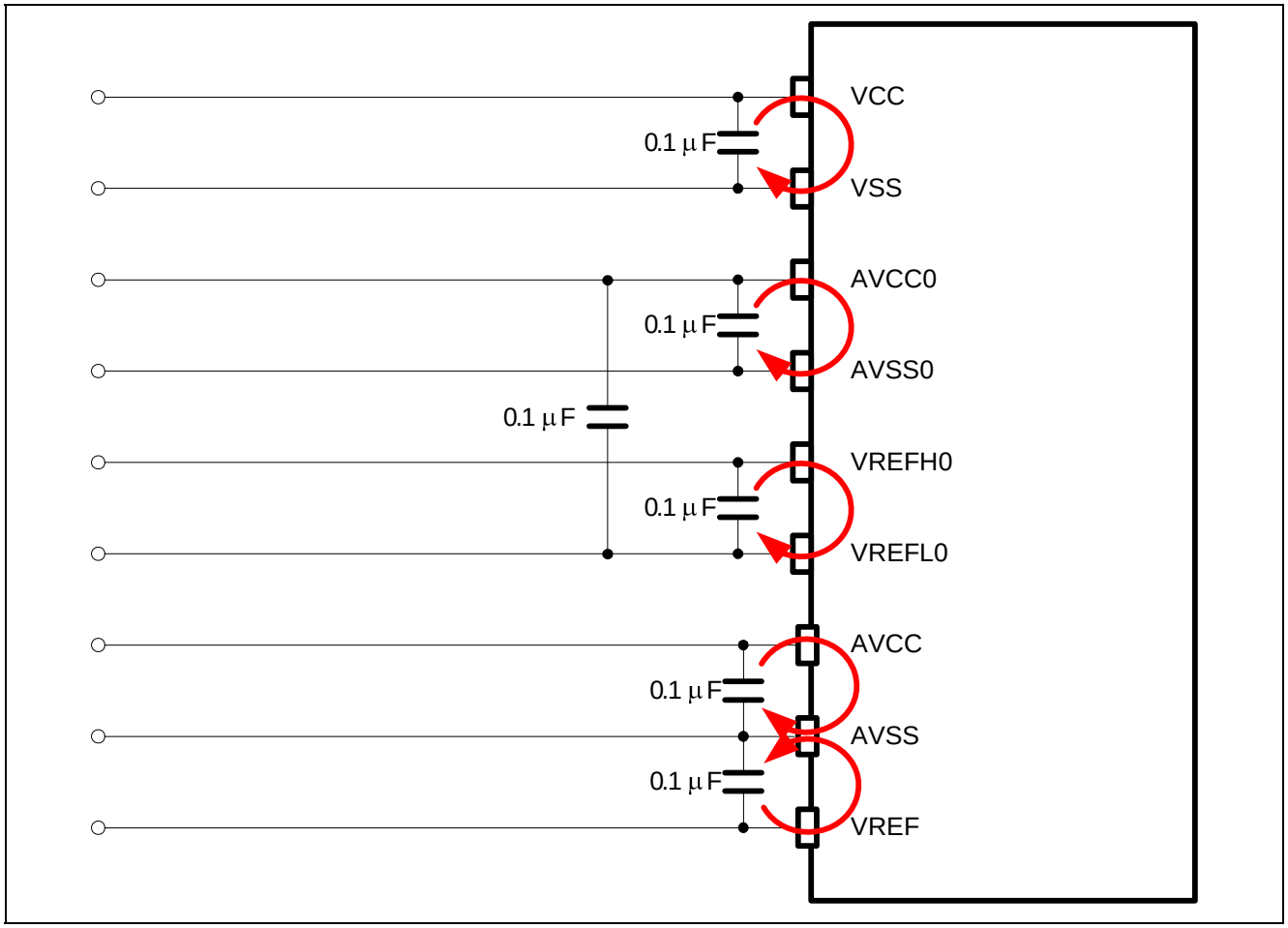


Figure 1 Power Supply Pin Capacitors and Closed Loops

1.3 Power Supply Pin Layout Examples

This section presents examples of analog power supply pin capacitor layouts using 4-layer printed circuit boards.

The board surfaces are allocated as follows: the top surface is the component plane, layer 2 is the ground plane, layer 3 is the power supply plane, and the back surface is the solder plane. After capacitor decoupling, each of the AVCC0, VREFH0, AVSS0, VREFL0, AVCC, VREF, and AVSS pins should be connected to the corresponding power supply plane. Although this example only shows the analog power supply pins, similar decoupling should also be used between VCC and VSS.

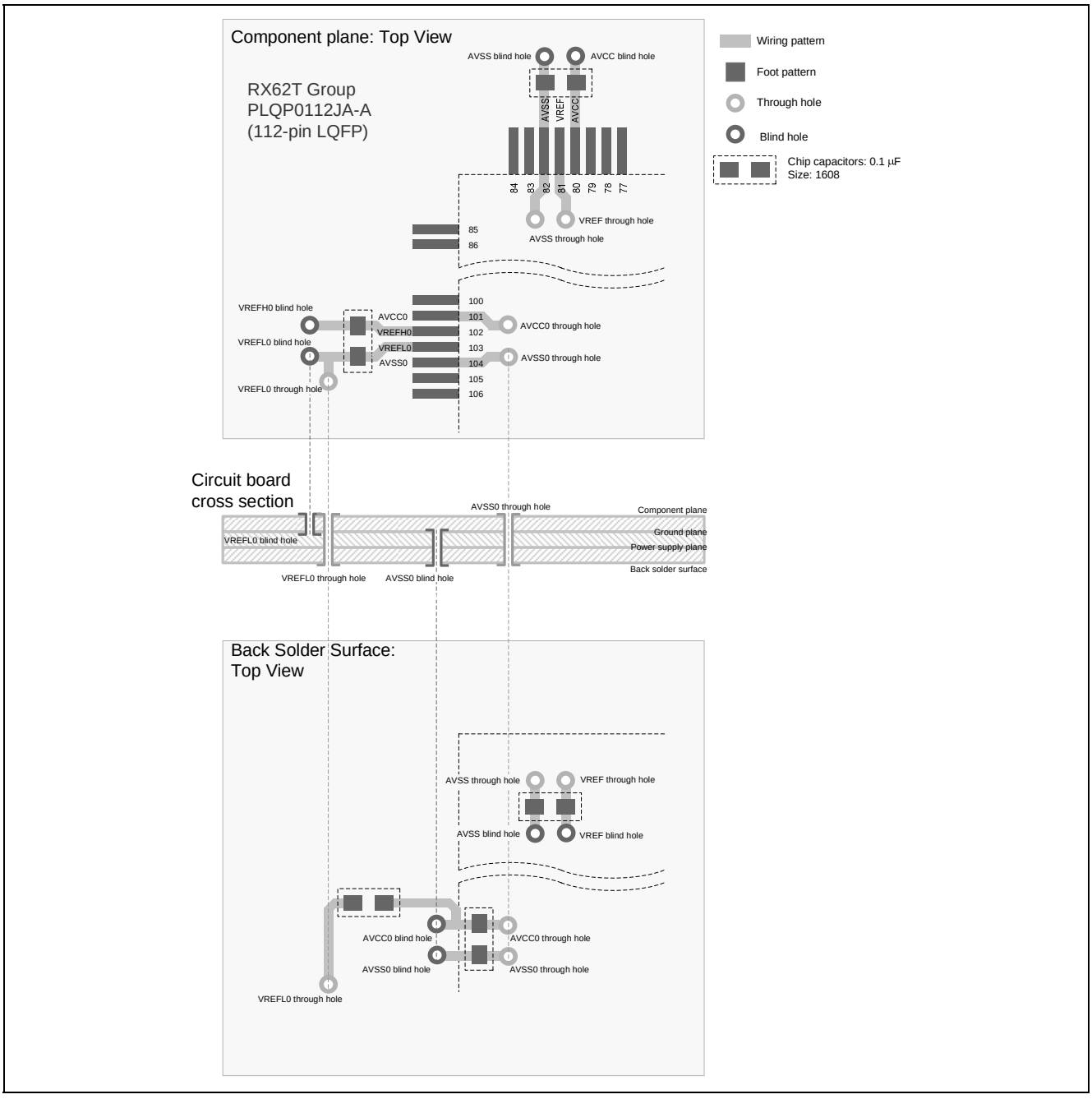


Figure 2 RX62T 112-Pin LQFP Package Power Supply Pin Capacitor Layout Example

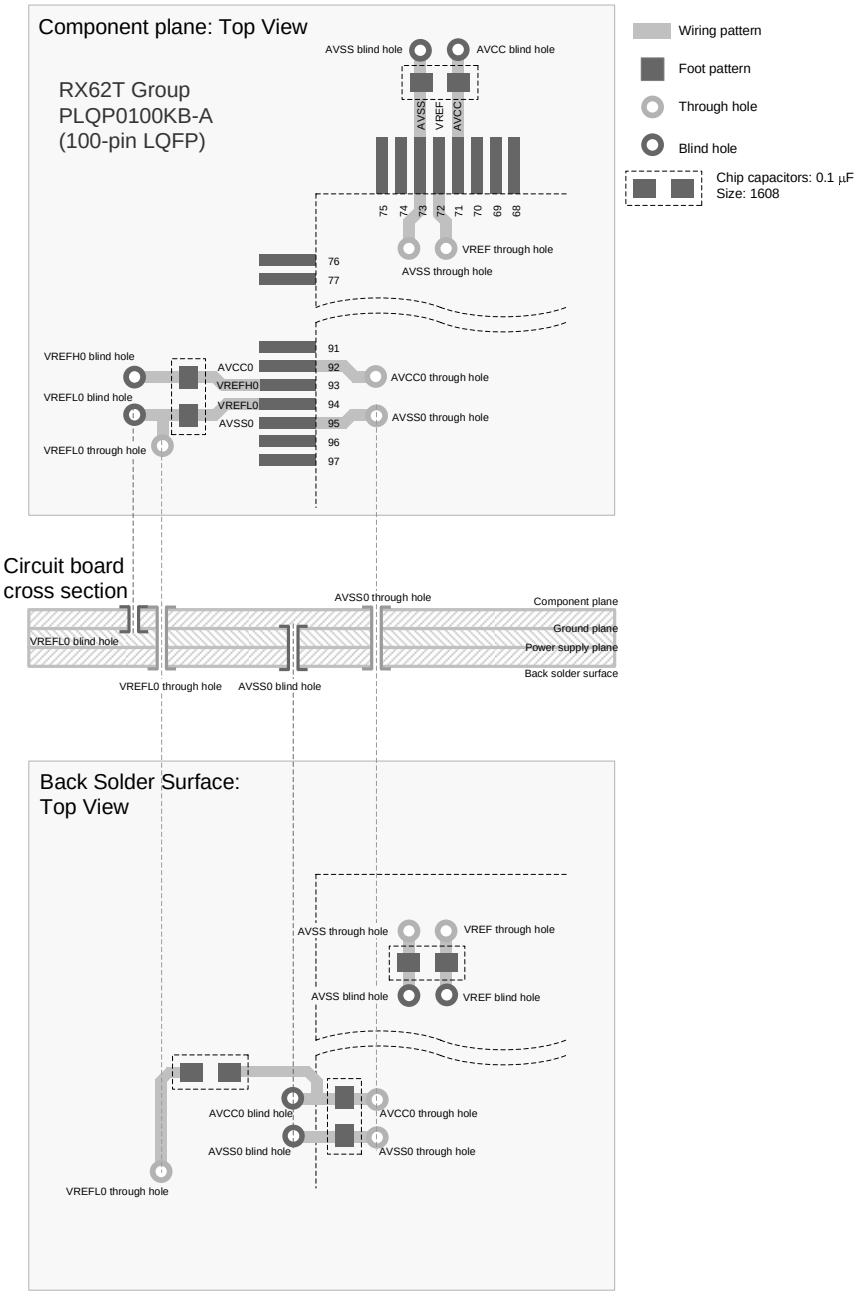


Figure 3 RX62T 100-Pin LQFP Package Power Supply Pin Capacitor Layout Example

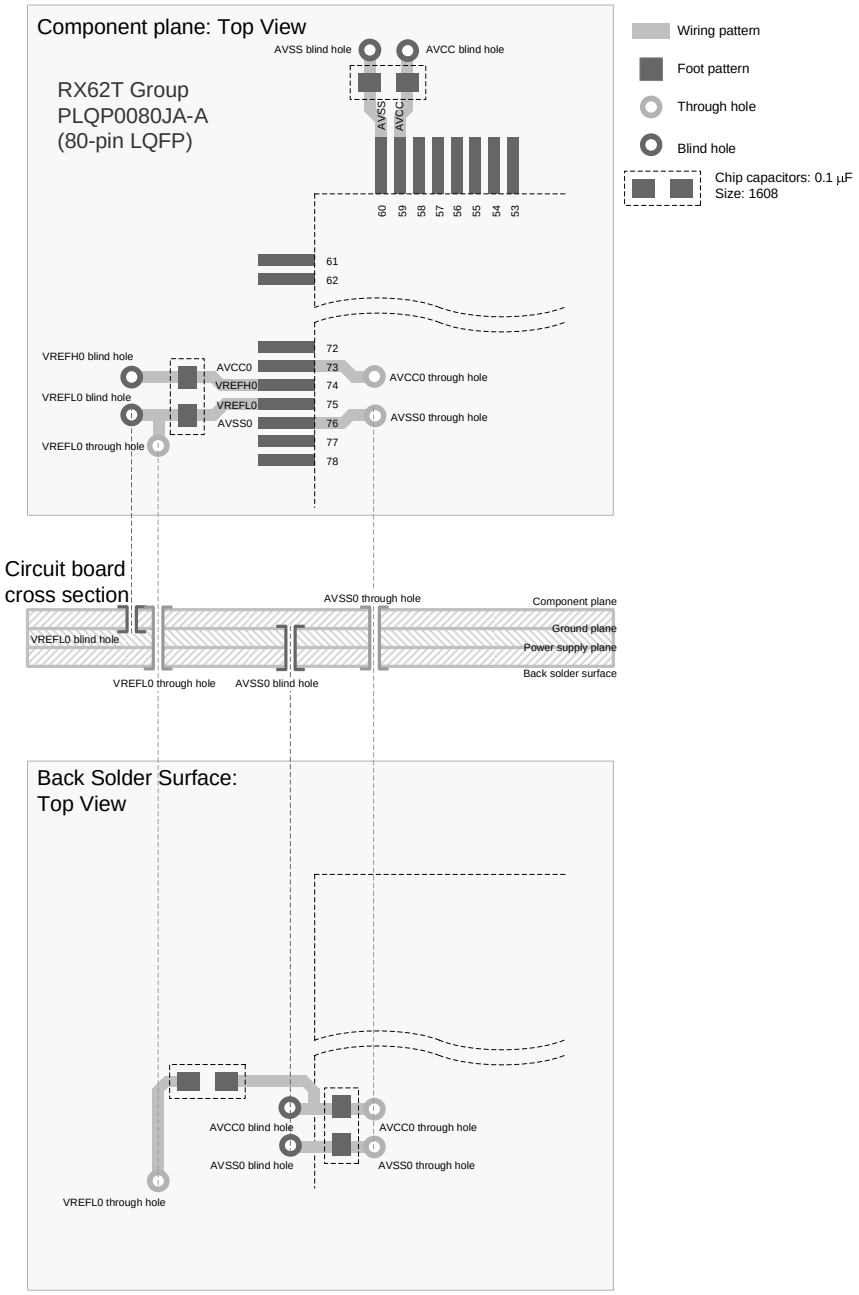


Figure 4 RX62T 80-Pin LQFP Package Power Supply Pin Capacitor Layout Example

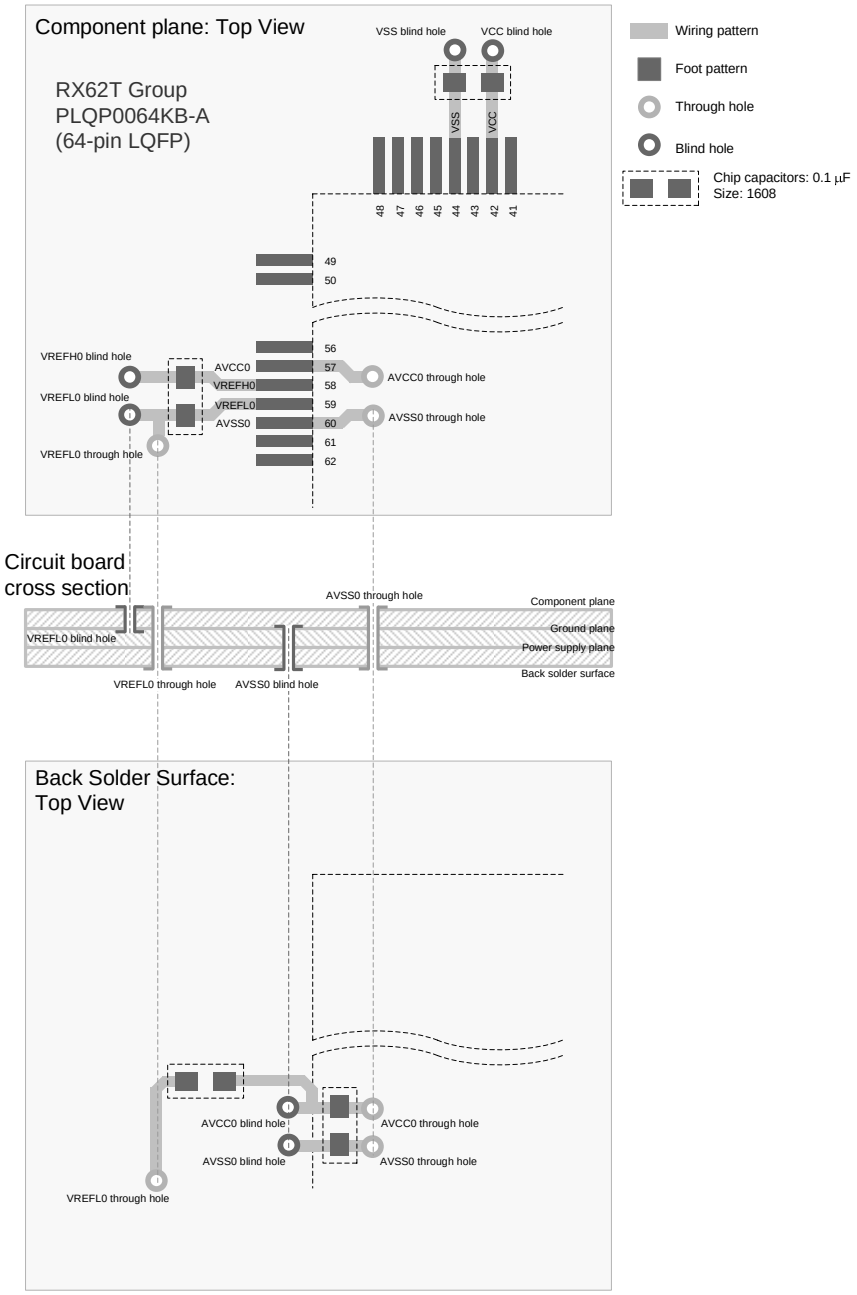
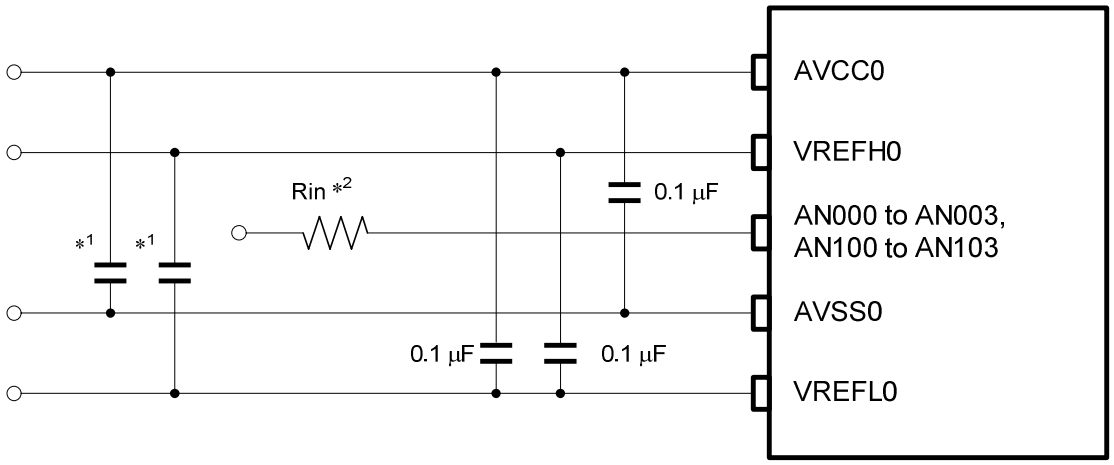


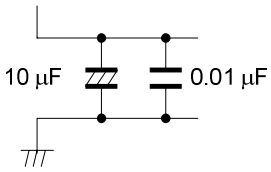
Figure 5 RX62T 64-Pin LQFP Package Power Supply Pin Capacitor Layout Example

1.4 Reducing Noise in Power Supply Lines

The 10 µF and 0.01 µF (values provided for reference purposes) capacitors shown in the circuit diagrams in the Hardware Manual for each microcontroller product are included as bypass capacitors for the analog power supply lines. The actual capacitances and layout details for these capacitors must be analyzed in conjunction with the end product or system characteristics (for example locating them near the power supply itself).

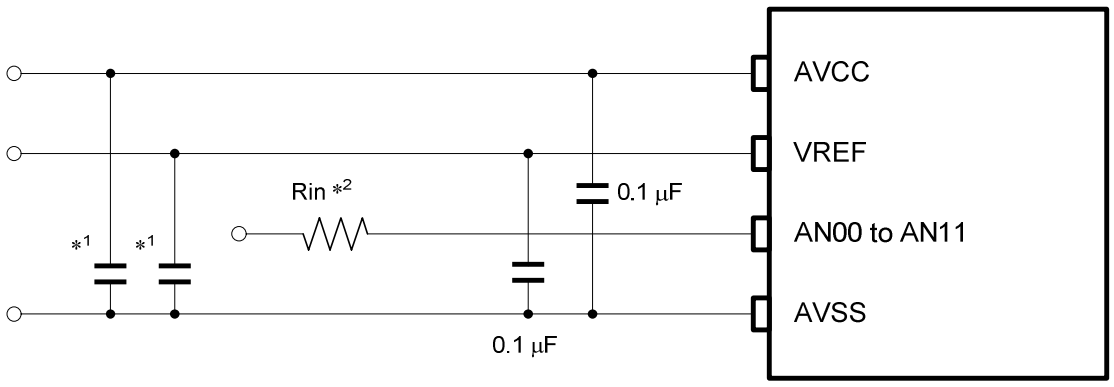


Notes: 1. The capacitance values indicated are for reference purposes only.

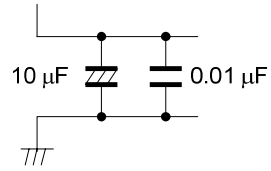


2. Rin: Signal source impedance

Figure 6 Reducing Noise in Power Supply Lines (12-bit A/D converter)



Notes: 1. The capacitance values indicated are for reference purposes only.



2. Rin: Signal source impedance

Figure 7 Reducing Noise in Power Supply Lines (10-bit A/D converter)

2. Reference Documents

- Hardware Manual
  RX62T Group User's Manual: Hardware Rev.1.10
  (The latest version can be downloaded from the Renesas Electronics Web site.)
- Technical Updates
  (The latest information can be downloaded from the Renesas Electronics Web site.)

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Sep.27.11	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of an MPU or MCU in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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Renesas Electronics America Inc.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-585-100, Fax: +44-1628-585-900

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-65030, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
1 harbourFront Avenue, #06-10, keppel Bay Tower, Singapore 098632
Tel: +65-6213-0200, Fax: +65-6278-8001

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics Korea Co., Ltd.
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141

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