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April 1<sup>st</sup>, 2010  
Renesas Electronics Corporation

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## 7548 Group, 7549 Group

### A/D Converter

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#### 1. Abstract

This document describes the A/D conversion operations of the 7548 and 7549 Groups MCU.

#### 2. Introduction

This document applies to the following MCU:

- Applicable MCU: 7548 and 7549 Groups

Function set ROM data 0 to 2 are used to set peripheral functions by QzROM programming data, but cannot be set by a program. The data set in these areas are enabled since the MCU reset is released. Make sure to set the values matched with a system regardless of peripheral functions which are used or unused.

In this application note, the following values are set:

Function set ROM data 0 FSR0M0 (address FFD816): 100000002

Function set ROM data 1 FSR0M1 (address FFD916): 100000012

Function set ROM data 2 FSR0M2 (address FFDA16): 000010112

### 3. Contents

#### 3.1 A/D Conversion Operation

The A/D converter starts by writing “0” to the AD conversion completion bit. Internal operations during A/D conversion are shown below:

1. The value in the A/D conversion buffer register becomes “00h” when A/D conversion starts.
2. The highest-order bit in the A/D conversion buffer register becomes “1” and comparison voltage  $V_{ref}$  is input to a comparator. Then,  $V_{ref}$  and analog input voltage  $V_{IN}$  are compared.
3. If the comparison result is  $V_{ref} < V_{IN}$ , the highest-order bit in the A/D conversion buffer register is held as “1”. If  $V_{ref} > V_{IN}$ , the highest-order bit becomes “0”.

By performing the above operations to the lowest-order bit in the A/D conversion buffer register, the A/D converter converts an analog value to a digital value. A/D conversion ends in the following time after A/D conversion starts. Then the conversion results are stored in the A/D conversion register (addresses 003516 and 003616). An A/D conversion interrupt request is generated at the same time as the A/D conversion is completed, and the A/D conversion interrupt request bit becomes “1”

Table 3.1 AD Conversion Time

		$\Phi$ SOURCE = XIN, external clock	$\Phi$ SOURCE = HSOCO
AD conversion clock selection bit = 0 $\Phi$ SOURCE/2	$f(\Phi_{AD})$	$f(XIN)/2$	RHSOCO/2
	AD conversion time (example)	$t_c(\Phi_{SOURCE}) \times 122$ (15.25 $\mu$ s)	$t_c(\Phi_{SOURCE}) \times 122$ (30.5 $\mu$ s)
AD conversion clock selection bit = 1 $\Phi$ SOURCE	$f(\Phi_{AD})$	$f(XIN)$	RHSOCO
	AD conversion time (example)	$t_c(\Phi_{SOURCE}) \times 61$ (7.625 $\mu$ s)	$t_c(\Phi_{SOURCE}) \times 61$ (15.25 $\mu$ s)

AD conversion time examples are when  $f(XIN) = 8$  MHz and  $RHSOCO = 4$  MHz.

$f(\Phi_{AD})$  is the AD conversion clock frequency.  $\Phi$ SOURCE/2 or  $\Phi$ SOURCE can be selected for the AD conversion clock.  $t_c(XIN)$  is main clock input cycle time. The A/D converter cannot be used when  $\Phi$ SOURCE is XCIN or the low-speed on-chip oscillator.

Table 3.2 Relational Expression of Vref and A/D Converter Reference Voltage VREF

When n = 0	Vref = 0
When n = 1 to 1023	$V_{ref} = \frac{V_{REF}}{1024} \times n$

n: Value of A/D conversion register (decimal notation)

Table 3.3 Changes of A/D Conversion Buffer Register During A/D Conversion

	Changes in the A/D conversion buffer register <sup>(1)</sup>	Comparison voltage (Vref) value
Conversion starts	0 0 0 0 0 0 0 0 0 0	0
First comparison	1 0 0 0 0 0 0 0 0 0	$\frac{V_{REF}}{2}$
Second comparison	* 1 1 0 0 0 0 0 0 0 0	$\frac{V_{REF}}{2} \pm \frac{V_{REF}}{4}$
Third comparison	* 1 * 2 1 0 0 0 0 0 0	$\frac{V_{REF}}{2} \pm \frac{V_{REF}}{4} \pm \frac{V_{REF}}{8}$
⋮	⋮	⋮
Tenth comparison completed	A/D conversion result * 1 * 2 * 3 * 4 * 5 * 6 * 7 * 8 * 9 * 10	$\frac{V_{REF}}{2} \pm \frac{V_{REF}}{4} \dots \pm \frac{V_{REF}}{1024}$

\*1 to \*10: Comparison results of 1 to 10

Note:

1. The A/D conversion buffer register is in the A/D converter. Changes cannot be seen in the middle of comparisons.

Figure 3.1 shows an A/D Converter Equivalent Circuit and Figure 3.2 shows an A/D Conversion Timing Chart.

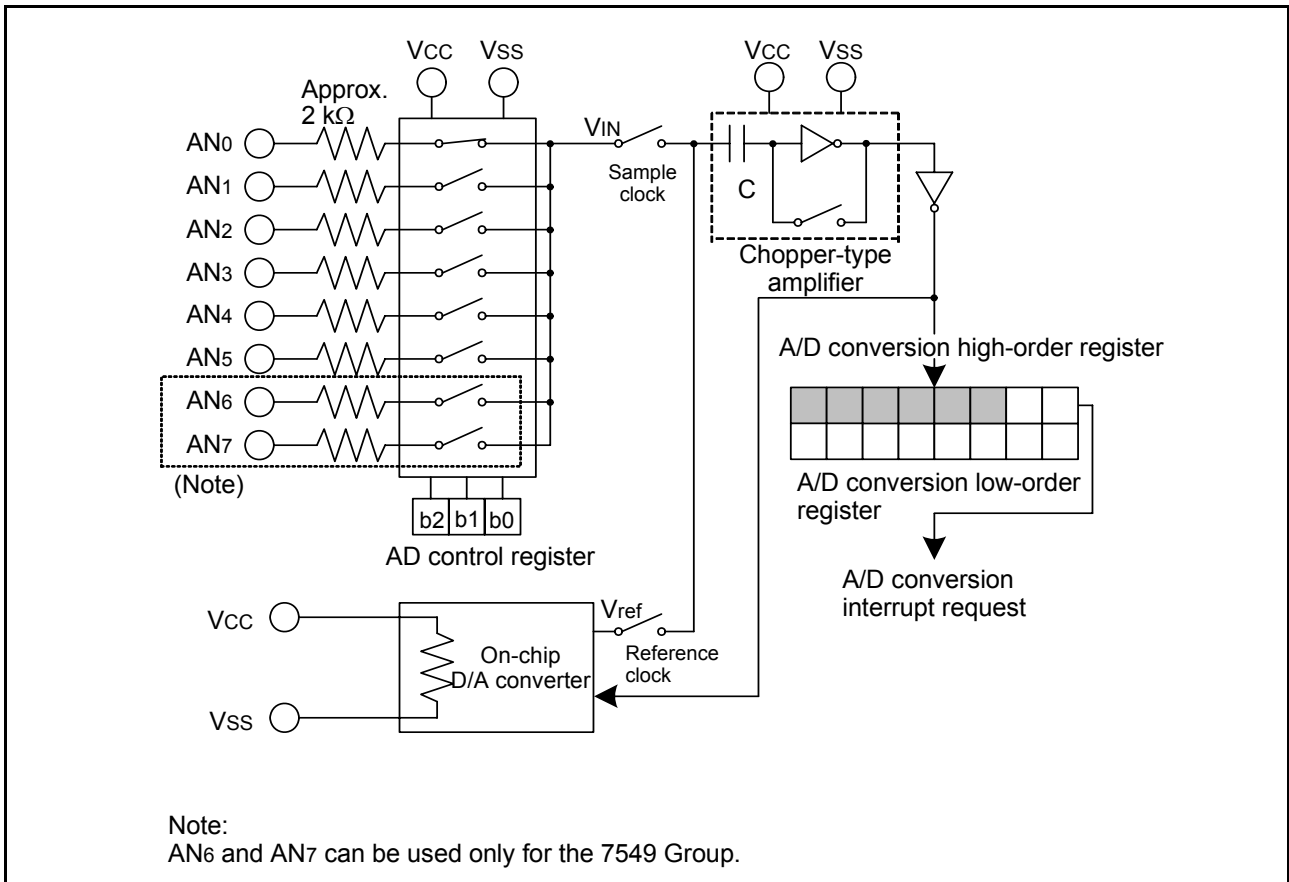


Figure 3.1 A/D Converter Equivalent Circuit

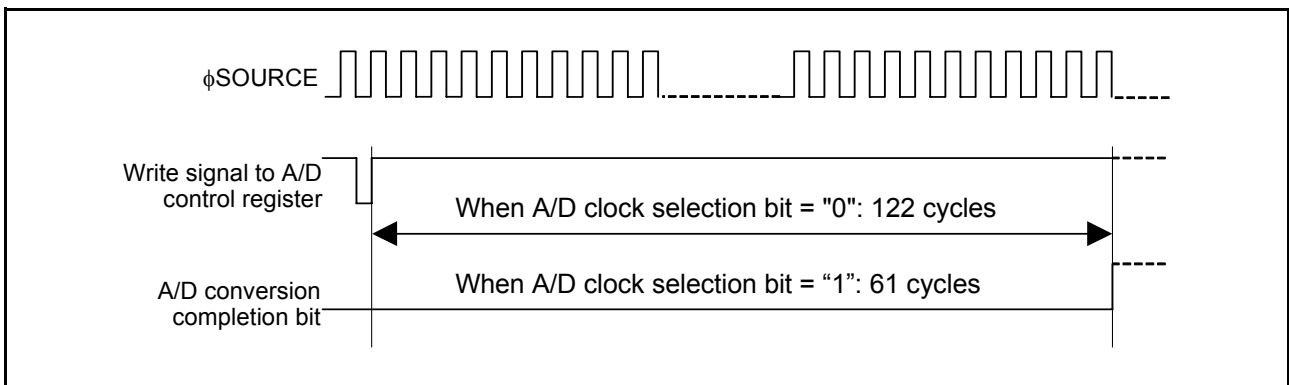


Figure 3.2 A/D Conversion Timing Chart

#### 4. Reference Document

Datasheet

7548 Group Datasheet

7549 Group Datasheet

Use the most recent version of the document on the Renesas Technology Web site.

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REVISION HISTORY	7548 Group, 7549 Group A/D Converter
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		Page	Summary
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