RL78/G14, H8/36109

Migration Guide from H8 to RL78: 14-Bit PWM

Introduction

This application note describes how to migrate the 14-bit PWM of the H8/36109 to the timer array unit (TAU) of the RL78/G14 (100-pin package).

Target Device

RL78/G14, H8/36109

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Contents

1. Functions of 14-bit PWM of H8/36109 and Timer Array Unit of RL78/G14

Table 1.1 shows the functions of the 14-bit PWM of H8/36109, and Table 1.2 shows the functions of the timer array unit (TAU) of RL78/G14.

Table 1.1 Function of 14-bit PWM

Function	Explanation
14-bit PWM	Outputs PWM waveform of the pulse division method.

Table 1.2 Functions of Timer Array Unit

Function	Explanation
Interval timer	Each timer of a unit can be used as a reference timer that generates an interrupt (INTTMmn) at fixed intervals.
Square wave output	A toggle operation is performed each time INTTMmn interrupt is generated and a square wave with a duty factor of 50% is output from a timer output pin (TOmn).
External event counter	Each timer of a unit can be used as an event counter that generates an interrupt when the number of the valid edges of a signal input to the timer input pin (TImn) has reached a specific value.
Divider	A clock input from a timer input pin (TI00) is divided and output from an output pin (TO00).
Input pulse interval measurement	Counting is started by the valid edge of a pulse signal input to a timer input pin (TImn). The count value of the timer is captured at the valid edge of the next pulse. In this way, the interval of the input pulse can be measured.
Measurement of high-/low-level width of input signal	Counting is started by a single edge of the signal input to the timer input pin (TImn), and the count value is captured at the other edge. In this way, the high-level or low-level width of the input signal can be measured.
Delay counter	Counting is started at the valid edge of the signal input to the timer input pin (TImn), and an interrupt is generated after any delay period.
One-shot pulse output	Two channels are used as a set to generate a one-shot pulse with a specified output timing and a specified pulse width.
PWM output	Two channels are used as a set to generate a pulse with a specified period and a specified duty factor.
Multiple PWM output	By extending the PWM function and using one master channel and two or more slave channels, up to seven types of PWM signals that have a specific period and a specified duty factor can be generated.

The 14-bit PWM of the H8/36109 outputs PWM waveform of pulse division method. A single conversion period has 64 pulses.

Figure 1.1 shows a block diagram of the 14-bit PWM.

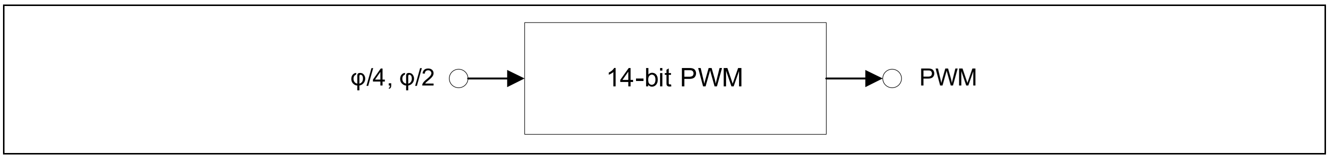

Figure 1.1 Block diagram of the 14-bit PWM

The timer array unit (TAU) incorporated in the RL78/G14 has four 16-bit timers. Each 16-bit timer is called a channel and can be used as an independent timer. In addition, two or more channels can be combined to serve as a higher-accuracy timer.

Each channel has one timer counter register, one timer data register, one input pin, and one output pin.

Figure 1.2 shows a block diagram of the timer array unit (TAU).

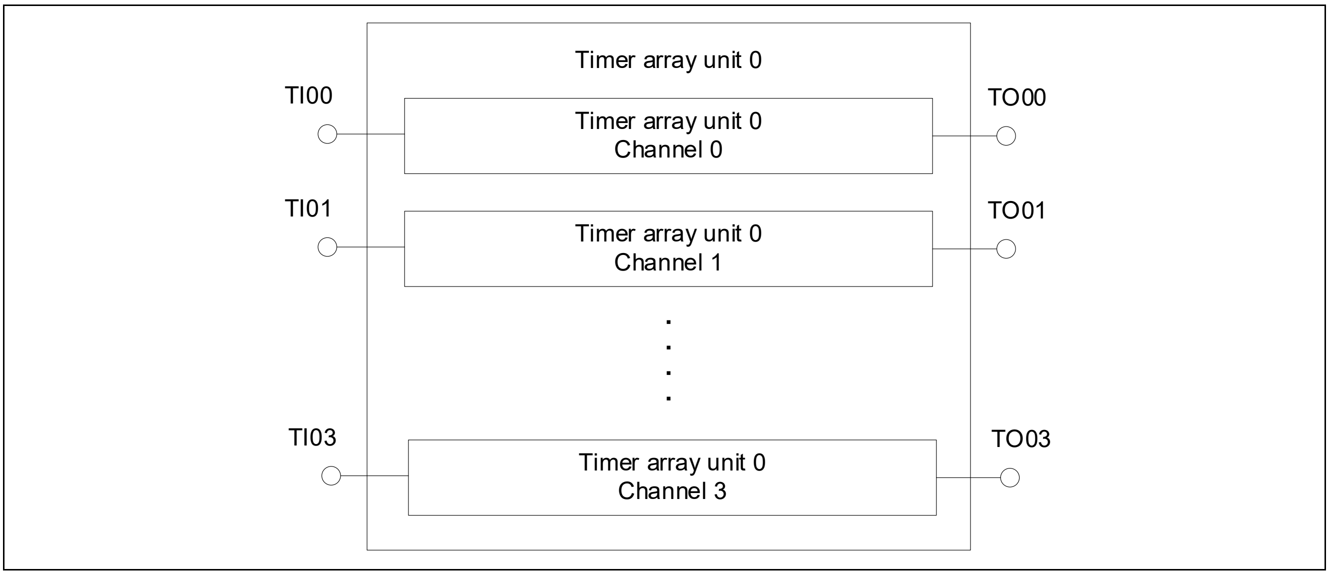

Figure 1.2 Block Diagram of Timer Array Unit

Table 1.3 shows the TAU functions corresponding to the14-bit PWM.

Table 1.3 Correspondence between Functions

H8/36109 14-bit PWM	RL78/G14 Timer Array Unit (TAU)
PWM	PWM output

The timer array unit (TAU) can implement the functions equivalent to those provided in the 14-bit PWM by using each channel independently or a combination of multiple channels simultaneously.

14-bit PWM corresponds to the PWM output of the TAU.

2. Summary of Differences between Functions

Table 2.1 summarizes the differences between the functions of 14-bit PWM and TAU.

Table 2.1 Summary of Differences between Functions

Item	H8/36109 14-bit PWM	RL78/G14 Timer Array Unit (TAU)
Count clock	φ/4, φ/2	f_{TCLK} (f_{CLK}, to $f_{CLK}/2^{15}$), f_{SUB}(Note), f_{IL}(Note)
Operation Mode	PWM	- Interval timer - Square wave output - External event counter - Frequency divider - Input pulse interval measurement - Input signal high-/low-level width measurement - Delay counter - One-shot pulse output function - PWM output - Multiple PWM output
PWM output	Pulse division method (a single period divided by 64 and output)	Pulse width modulation method (pulse width specified for each period)
Shared pin	P11/PWM	Unit 0: P00 / TI00, P01 / TO00, P16 / TI01 / TO01 P17 / TI02 / TO02, P31 / TI03 / TO03 Unit 1: TI10 / TO10 / P64, TI11 / TO11 / P65 TI12 / TO12 / P66, TI13 / TO13 / P67
Interrupt source	None	Compare match / Input capture, Overflow, Underflow

Note. Channel 1 only

2.1 Differences between 14-bit PWM

The 14-bit PWM of the H8/36109 correspond to the PWM function of the TAU of the RL78/G14. Table 2.2 shows the differences between 14-bit PWM.

Table 2.2 Differences between 14-bit PWM

Item	H8/36109 14-bit PWM	RL78/G14 Timer Array Unit (TAU) PWM output
Control of 14-bit PWM input clock supply	Setting the MSTPWM bit in the MSTCR2 register to 0 (Initial value)	Setting the TAU1EN (Note1) bit or TAU0EN bit in the PER0 register to 1
Count clock	φ/4, φ/2	f_{TCLK} ($f_{CLK,}$ ~ $f_{CLK}/2^{15}$), f_{SUB}(Note2), f_{IL}(Note2)
Pulse Output with Arbitrary Duty Cycle	Single conversion period: 16384/φ (PWCR0=0), 32768/φ (PWCR0=1) Total high-level width during this period (T_H): T_H = (Data value in PWDRU and PWDRL+64) x tφ/2 Period: Single conversion period / 64 = tf1 tf1 = tf2 = tf3 =…= tf64 Total high-level width during this period: T_H = tH1 + tH2 + tH3 + ... + tH64	Period: - Period of count clock × {Set value of TDRmn (Master) + 1} Pulse width: - When TOLm = 0 (active high) Period of count clock × {Set value of TDRmp (Slave)} - When TOLm = 1 (active low) Period of count clock × [{Set value of TDRmn (Master) + 1} - {Set value of TDRmp (Slave)}]
Count start condition	Writing byte data first to PWDRL and then to PWDRU	Setting the TSmn bit in the TSm register to 1
Count stop condition	Setting the MSTPWM bit in the MSTCR2 register to 1	Setting the TTmn bit in the TTm register to 1
Interrupt request generation timing	None	- When count operation starts (master) - When TCRmn reaches 0000H and then the next count clock pulse (f_{MCK}) is generated (master) - When TCRmp reaches 0000H and then the next count clock pulse (f_{MCK}) is generated (slave)

Note1. 80 and 100-pin products only.

Note2. Channel 1 only

Remark. For RL78/G14, m: Unit number (m = 0, 1), n: Channel number (n = 0, 2),
p: Slave channel number (n = 0: p = 1, 2, 3; n = 2: p = 3)

3. Comparison between Registers

Table 3.1 and Table 3.2 compares the registers for the H8/36109 14-bit PWM and the registers for the RL78/G14 Timer Array Unit.

Table 3.1 Comparison between Registers (1/2)

Item	H8/36109 14-bit PWM	RL78/G14 Timer Array Unit (TAU)
Control of 14-bit PWM input clock supply	MSTCR2 register MSTPWM bit	None
Control of timer array unit input clock	None	PER0 register TAU1EN bit (Note), TAU0EN bit
Clock select	PWCR register PWCR0 bit	TPSm register TMRmn register CKSmn1 bit, CKSmn0 bit
PWM data register U, L	PWDRU register PWDRL register	None
Timer count register	None	TCRmn register
Timer data register	None	TDRmn register
Selection of count clock (f_{TCLK}) of channel n	None	TMRmn register CCSmn bit
Selection between using channel n independently or simultaneously with another channel (as a slave or master)	None	TMRmn register MASTERmn bit
Selection of 8 or 16-bit timer operation for channels 1 and 3	None	TMRmn register SPLITmn bit
Setting of start trigger or capture trigger of channel n	None	TMRmn register STSmn2 - STSmn0 bit
Selection of TImn pin input valid edge	None	TMRmn register CISmn1 bit, CISmn0 bit
Operation mode of channel n	None	TMRmn register MDmn3 - MDmn1 bit
Setting of starting counting and interrupt	None	TMRmn register MDmn0 bit
Counter overflow status of channel n	None	TSRmn register OVF bit
Indication of operation enable/stop status of channel n	None	TEm register
Operation enable (start) trigger of channel n	None	TSm register TSmn bit
Operation stop trigger of channel n	None	TTm register

Note. 80 and 100-pin products only.

Remark. For RL78/G14, m: Unit number (m = 0, 1), n: Channel number (n = 0, 2),
p: Slave channel number (n = 0: p = 1, 2, 3; n = 2: p = 3)

Table 3.2 Comparison between Registers (2/2)

Item	H8/36109 14-bit PWM	RL78/G14 Timer Array Unit (TAU)
Selection of timer input used with channel 0	None	TIS0 register TIS04 bit
Selection of timer input used with channel 1	None	TIS0 register TIS02 - TIS00 bit
Timer output enable/disable of channel n	None	TOEm register TOEm3 - TOEm0 bit
Timer output of channel n	None	TOm register TOmn bit
Control of timer output level of channel n	None	TOLm register TOLmn bit
Control of timer output mode of channel n	None	TOMm register TOMmn bit
Input switch control register	None	ISC register SSIE00 bit ISC1 bit, ISC0 bit
Noise filter enable register	None	NFEN1 register, NFEN2 register

Remark. For RL78/G14, m: Unit number (m = 0, 1), n: Channel number (n = 0, 2),
p: Slave channel number (n = 0: p = 1, 2, 3; n = 2: p = 3)

4. Sample Code for Timer Array Unit

The sample code for the timer Array Unit is explained in the following application notes.

- RL78/G13 Timer Array Unit (PWM Output) CC-RL (R01AN2589)

5. Documents for Reference

User's Manual:

- RL78/G14 User's Manual: Hardware (R01UH0186)
- H8/36109 Group User's Manual: Hardware (R01UH0294)

The latest versions can be downloaded from the Renesas Electronics website.

Technical Update/Technical News:

The latest information can be downloaded from the Renesas Electronics website.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Feb. 28, 2020	-	First edition issued

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit 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. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time 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 time 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 time 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 time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance 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 the 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.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is 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. Additionally, 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.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of 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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