

# RL78/G13, 78K0/Kx2

## Migration Guide from 78K0 to RL78: Clock Generator

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### Introduction

This application note describes how to migrate the clock generator functions from the 78K0/Kx2 to the RL78/G13.

### Target Device

RL78/G13, 78K0/Kx2

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

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## 1. Functions of Clock Generator

Table 1.1 shows the functions of the clock generator in the 78K0/Kx2, and Table 1.2 shows the functions of the clock generator in the RL78/G13.

Table 1.1 Functions of 78K0/Kx2 Clock Generator

Function	Specification
Internal high-speed oscillator	This circuit oscillates a clock of $f_{RH} = 8$ MHz (TYP.). After a reset release, the CPU always starts operating with this internal high-speed oscillation clock.
X1 oscillator	This circuit oscillates a clock of $f_X = 1$ to 20 MHz by connecting a resonator to X1 and X2.
External main system clock input	An external main system clock ( $f_{EXCLK} = 1$ to 20 MHz) can also be supplied from the EXCLK/X2 pin.
Subsystem clock <sup>(Note)</sup>	This circuit oscillates at a frequency of $f_{XT} = 32.768$ kHz by connecting a 32.768 kHz resonator across XT1 and XT2. An external subsystem clock ( $f_{EXCLKS} = 32.768$ kHz) can also be supplied from the EXCLKS/XT2 pin.
Internal low-speed oscillator	This circuit oscillates a clock of $f_{RL} = 240$ kHz (TYP.). After a reset release, the internal low-speed oscillation clock always starts operating. The internal low-speed oscillation clock cannot be used as the CPU clock. The following hardware operates with the internal low-speed oscillation clock. - Watchdog timer - TMH1

Note. The 78K0/KB2 is not provided with a subsystem clock.

Table 1.2 Functions of RL78/G13 Clock Generator

Function	Specification
High-speed on-chip oscillator	The frequency at which to oscillate can be selected from among $f_{IH} = 32, 24, 16, 12, 8, 4,$ or 1 MHz (typ.) by using the option byte (000C2H). After a reset release, the CPU always starts operating with this high-speed on-chip oscillator clock. The frequency specified by using an option byte can be changed by using the high-speed on-chip oscillator frequency select register (HOCODIV).
X1 oscillator	This circuit oscillates a clock of $f_X = 1$ to 20 MHz by connecting a resonator to X1 and X2 pins.
External main system clock input	An external main system clock ( $f_{EX} = 1$ to 20 MHz) can also be supplied from the EXCLK/X2/P122 pin.
Subsystem clock <sup>(Note)</sup>	This circuit oscillates a clock of $f_{XT} = 32.768$ kHz by connecting a 32.768 kHz resonator to XT1 and XT2 pins. An external subsystem clock ( $f_{EXS} = 32.768$ kHz) can also be supplied from the EXCLKS/XT2 pin.
Low-speed On-chip oscillator	This circuit oscillates a clock of $f_{IL} = 15$ kHz (TYP.). The low-speed on-chip oscillator clock cannot be used as the CPU clock. Only the following peripheral hardware runs on the low-speed on-chip oscillator clock. - Watchdog timer - Real-time clock - 12-bit Interval timer

Note. The RL78/G13 products with 40 or more pins are provided with a subsystem clock.

Figure 1.1 shows a block diagram of the clock generator in the 78K0/Kx2, and Figure 1.2 shows a block diagram of the clock generator in the RL78/G13.

After release from the reset state, the 78K0/Kx2 starts operating at the frequency generated by the internal high-speed oscillator, and the RL78/G13 starts operating at the frequency of the high-speed on-chip oscillator clock selected by the option byte.

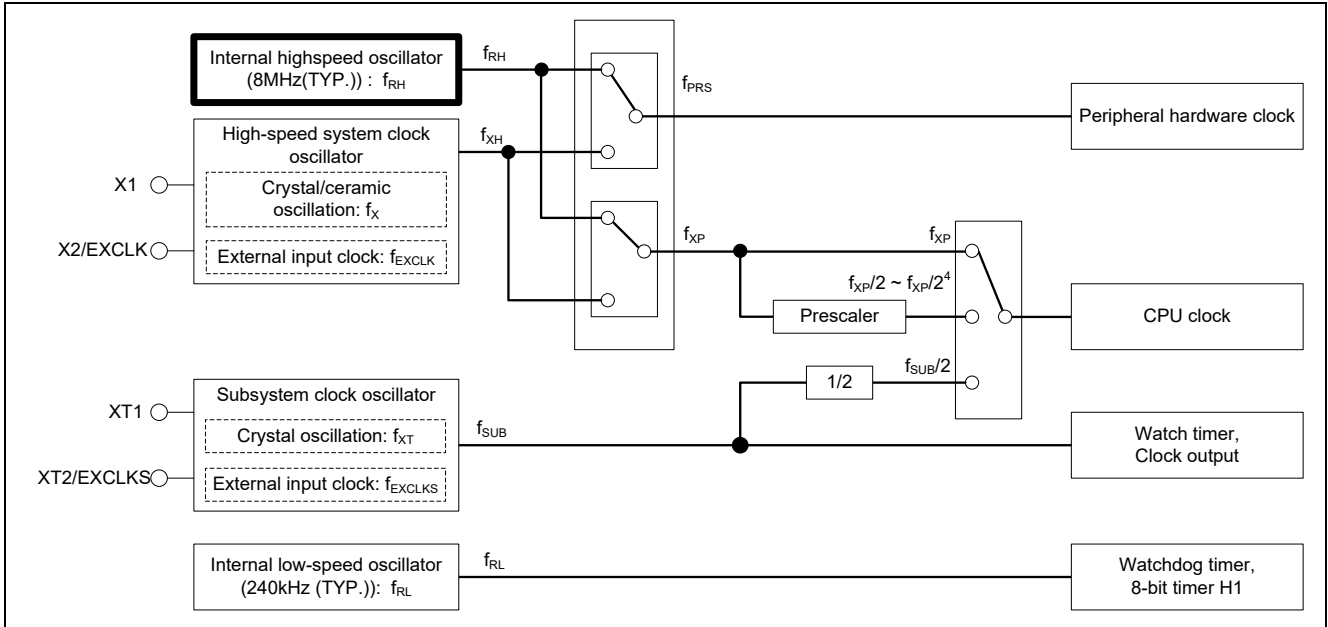


Figure 1.1 Block Diagram of Clock Generator (78K0/Kx2)

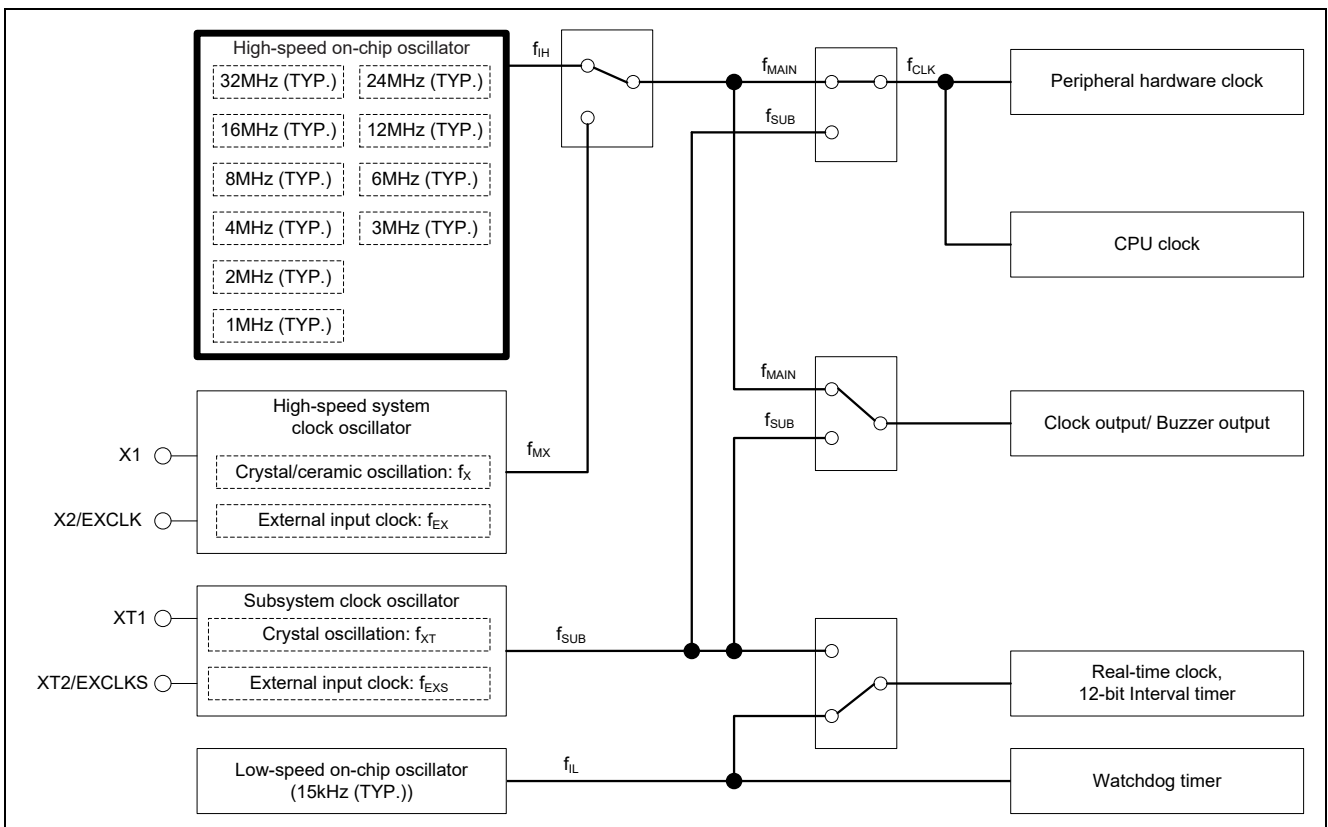


Figure 1.2 Block Diagram of Clock Generator (RL78/G13)

Table 1.3 shows the correspondence of frequency names between the clock generators of the 78K0/Kx2 and the RL78/G13.

Table 1.3 Correspondence of frequency name

78K0/Kx2		RL78/G13	
Name	Symbol	Name	Symbol
X1 clock oscillation frequency	f <sub>X</sub>	X1 clock oscillation frequency	f <sub>X</sub>
Internal high-speed oscillation clock frequency	f <sub>RH</sub>	High-speed on-chip oscillator clock frequency	f <sub>IH</sub>
External main system clock frequency	f <sub>EXCLK</sub>	External main system clock frequency	f <sub>EX</sub>
High-speed system clock frequency	f <sub>XH</sub>	High-speed system clock frequency	f <sub>MX</sub>
Main system clock frequency	f <sub>XP</sub>	Main system clock frequency	f <sub>MAIN</sub>
Peripheral hardware clock frequency	f <sub>PRS</sub>	CPU/peripheral hardware clock frequency	f <sub>CLK</sub>
CPU clock frequency	f <sub>CPU</sub>		
XT1 clock oscillation frequency <sup>(Note1)</sup>	f <sub>XT</sub>	XT1 clock oscillation frequency <sup>(Note)</sup>	f <sub>XT</sub>
External subsystem clock frequency <sup>(Note1)</sup>	f <sub>EXCLKS</sub>	External subsystem clock frequency <sup>(Note2)</sup>	f <sub>EXS</sub>
Subsystem clock frequency <sup>(Note1)</sup>	f <sub>SUB</sub>	Subsystem clock frequency <sup>(Note2)</sup>	f <sub>SUB</sub>
Internal low-speed oscillation clock frequency	f <sub>RL</sub>	Low-speed on-chip oscillator clock frequency	f <sub>IL</sub>

Note1. The 78K0/KB2 is not provided with a subsystem clock.

Note2. The RL78/G13 products with 40 or more pins are provided with a subsystem clock.

## 2. Differences in Function Overview

Table 2.1 summarizes the differences between the clock generator function of the 78K0/Kx2 and the clock generator function of the RL78/G13..

Table 2.1 Differences

Item	78K0/Kx2 Clock Generator (Note1)	RL78/G13 Clock Generator (Note2)
Internal high-speed oscillation clock frequency	8MHz (TYP.)	When FRQSEL3 = 1 Select from 32MHz, 16MHz, 8MHz, 4MHz, 2MHz, 1MHz (TYP.) When FRQSEL3 = 0 Select from 24MHz, 12MHz, 6MHz, 3MHz (TYP.)
X1, X2 pin operation mode	- I/O port mode - X1 oscillation mode - External clock input mode	- Input port mode - X1 oscillation mode - External clock input mode
X1 operating frequency control	When AMPH = 0 $1 \text{ MHz} \leq f_{XH} \leq 10 \text{ MHz}$ When AMPH = 1 $10 \text{ MHz} < f_{XH} \leq 20 \text{ MHz}$	When AMPH = 0 $1 \text{ MHz} \leq f_x \leq 10 \text{ MHz}$ When AMPH = 1 $10 \text{ MHz} < f_x \leq 20 \text{ MHz}$
XT1, XT2 pin operation mode	- I/O port mode - XT1 oscillation mode - External clock input mode	- Input port mode - XT1 oscillation mode - External clock input mode
XT1 oscillator oscillation mode selection	Fixed (cannot be changed)	- Low power consumption oscillation - Normal oscillation - Ultra-low power consumption oscillation
Subsystem clock frequency	32.768kHz (TYP.)	32.768kHz (TYP.)
Internal low-speed oscillation clock frequency	240kHz (TYP.)	15kHz (TYP.)
CPU clock selection	$f_{XP}$ , $f_{XP}/2$ , $f_{XP}/2^2$ , $f_{XP}/2^3$ , $f_{XP}/2^4$	$f_{MAIN}$ , $f_{SUB}$
Peripheral hardware clock selection	$f_{RH}$ , $f_{XH}$	Same frequencies as the CPU clock (Note3)

Note1. The 78K0/KB2 is not provided with a subsystem clock.

Note2. The RL78/G13 products with 40 or more pins are provided with a subsystem clock.

Note3. Except the real-time clock, 12-bit interval timer, clock output/buzzer output, and watchdog timer.

In the 78K0/Kx2, separate clocks can be supplied to the CPU and peripheral hardware — that is, when the internal high-speed oscillation clock ( $f_{RH}$ ) is selected as the CPU clock, the high-speed system clock ( $f_{XH}$ ) can be selected as the peripheral hardware clock.

In contrast, the same clock is supplied to the CPU and peripheral hardware in the RL78/G13. When the CPU clock is changed, the peripheral hardware clock is also changed (except the real-time clock, 12-bit interval timer, clock output/buzzer output, and watchdog timer). Before changing the CPU or peripheral hardware clock, be sure to stop the peripheral functions.

### 3. Register Compatibilities

Table 3.1 shows the compatibilities of the registers in the clock generator between the 78K0/Kx2 and the RL78/G13.

Table 3.1 Register Compatibilities

Item	78K0/Kx2 <sup>(Note1)</sup>	RL78/G13 <sup>(Note2)</sup>
X1, X2 pin operation mode	OSCCTL register EXCLK bit, OSCSEL bit	CMC register EXCLK bit, OSCSEL bit
X1 operating frequency control	OSCCTL register AMPH bit	CMC register AMPH bit
XT1, XT2 pin Operation Mode	OSCCTL register EXCLKS bit, OSCSELS bit PCC register XTSTART bit	CMC register EXCLKS bit, OSCSELS bit
XT1 oscillator oscillation mode selection	None	CMC register AMPHS1 bit, AMPHS0 bit
Selection of clock supplied to main system clock and peripheral hardware	MCM register XSEL bit, MCM0 bit	CKC register CSS bit MCM0 bit
CPU Clock Selection	PCC register CSS bit PCC2 bit - PCC0 bit	
CPU Clock Status	PCC register CLS bit	CKC register CLS bit
Main system clock status	MCM register MCS bit	CKC register MCS bit
Status of internal high-speed oscillator	RCM register RSTS bit	None
Internal low-speed oscillator oscillating/stopped	RCM register LSRSTOP bit	None
Internal high-speed oscillator oscillating/stopped	RCM register RSTOP bit	CSC register HIOSTOP bit
Control of high-speed system clock operation	MOC register MSTOP bit	CSC register MSTOP bit
Subsystem clock operation control	None	CSC register XTSTOP bit
Oscillation stabilization time select register	OSTS register	OSTS register
Oscillation stabilization time counter status register	OSTC register	OSTC register
Peripheral enable register	None	PER0 register
Subsystem clock supply mode control register	None	OSMC register
High-speed on-chip oscillator frequency select register	None	HOCODIV register
High-speed on-chip oscillator trimming register	None	HIOTRM register

Note1. The 78K0/KB2 is not provided with a subsystem clock.

Note2. The RL78/G13 products with 40 or more pins are provided with a subsystem clock.

#### 4. Sample Code for Clock Generator

Sample codes for the clock generator are explained in the following application notes.

- RL78/G13 CPU Clock Changing and Standby Settings (C Language) CC-RL (R01AN3128)
- RL78/G13 CPU Clock Changing and Standby Settings (Assembly) CC-RL (R01AN2912)
- RL78/G13 High-speed On-chip Oscillator (HOCO) Clock Frequency Correction CC-RL (R01AN2833)

#### 5. Reference Documents

User's Manual:

- RL78/G13 User's Manual: Hardware (R01UH0146)
- 78K0/Kx2 User's Manual: Hardware (R01UH0008)

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	2019.05.08	-	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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## Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,  
Koto-ku, Tokyo 135-0061, Japan  
[www.renesas.com](http://www.renesas.com)

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