

## White Paper

# New functions of the RL78/G23

## Logic and Event Link Controller (ELCL)

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## Introduction

Logic and Event link controller (ELCL) of the RL78/G23 is added some logic control circuits for Event link controller (ELC) function of RL78/G14 and others. ELC events of some peripheral functions can be linked the other peripheral functions without CPU. New logic circuits are AND, OR, flip-flops and other circuits, therefore when using event link peripheral to the other peripherals, various combinations can be realized without an external circuit and without CPU load. And you can also add new functions to the microcontroller.

This white paper provides some overviews of ELCL, how to use it, and its applications.

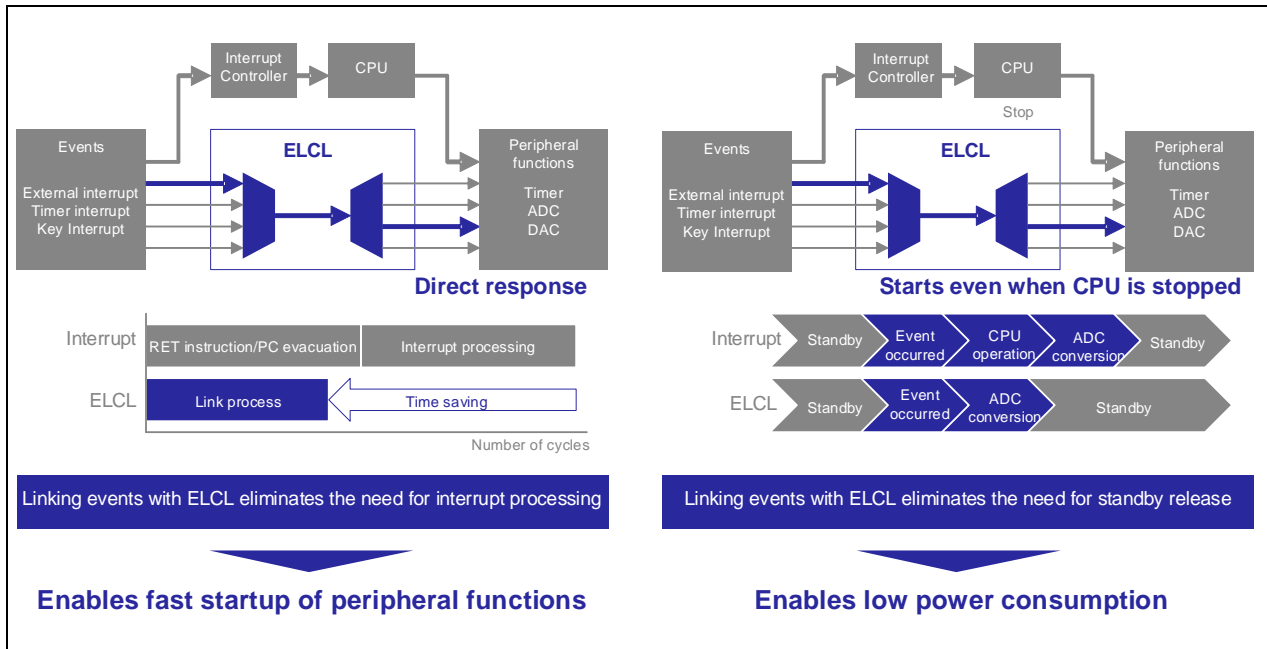
## What is Logic and Event link controller (ELCL)

Explanation the features of ELCL

- Event link controller (ELC) function

ELC function of RL78/G14 and others links event signals output by peripheral functions to other specified peripheral functions through internal circuits directly. ELCL can be used as ELC function.

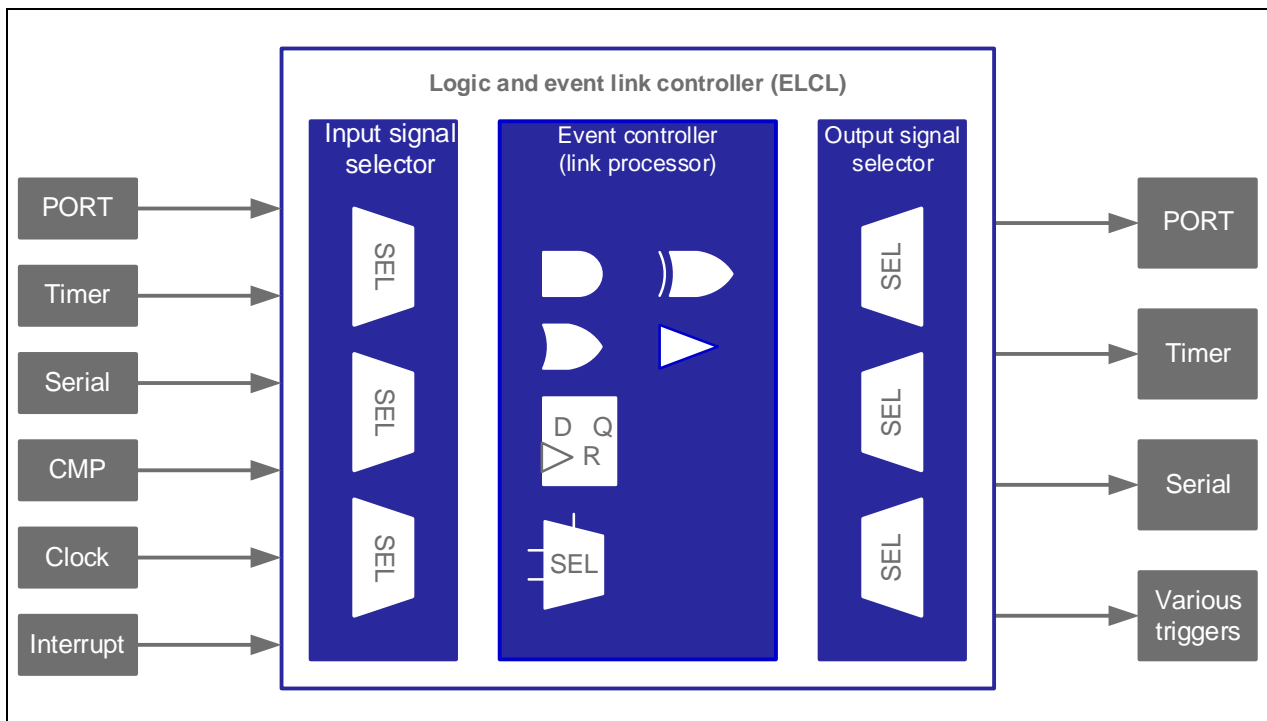
This function is allowing direct communications between peripheral functions without CPU intervention. Therefore, when an event occurs, peripheral functions can be started in short time. And it realizes low power when microcomputer is standby mode, because CPU can be kept standby mode.



**Figure 1. ELC function**

- **Logic functions**

ELCL provides additional logic functions to the traditional ELC functions. The logic function can link the event signals of each peripheral function via the logic circuit such as AND, OR, EX-OR, flip-flop circuits. With this feature can link not only simple combination link but also many combinations with various conditions.



**Figure 2. Logic function**

- Signals inputs of the ELCL can be selected from among up to 99 signals

About ELC function of RL78/G14 and others are can be selected only interrupt signals as event. ELCL can be selected not only interrupt signals but also port input signals, timer output signals, transmit data and clock signals of serial interface and internal clock signals. The following table shows examples of RL78/G23's choices.

Type	Option
Input pin	P00, P01, P10, P11, P12, P20, P21, P22, P23, P30, P31, P50, P51, P120, P121, P122, P137, P147
Timer	TAU0 channel 0-7 output
Serial interface	SAU0 channel 0-1 transmit data output SAU0 channel 0-1 serial clock output UARTA0 serial clock output, UARTA0 transmit data output 0
Comparator	Comparator detection 0-1
Clock	f <sub>CLK</sub> , f <sub>IHP</sub> , f <sub>IMP</sub> , f <sub>SXP</sub>
Interrupt	INTP0-11 INTTM00-07, INTTM01H, INTTM03H, INTTM10-17, INTTM11H, INTTM13H INTWDTI, INTRTC, INTITL, INTCTSUWR, INTCTSURD, INTCTSUFN INTSR0/INTCSI01/INTIIC01, INTST0/INTCSI00/INTIIC00, INTSR1/INTCSI11/INTIIC11, INTST1/INTCSI10/INTIIC10, INTSR2/INTCSI21/INTIIC21, INTST2/INTCSI20/INTIIC20, INTSR3/INTCSI31/INTIIC31, INTST3/INTCSI30/INTIIC30 INTSRE0-3, INTURE0-1, INTUR0-1, INTUT0-1, INTIICA0-1, INTKR, INTREMC, INTAD, INTSMSE, INTLVI, INTCMP0-1,
Internal signal of ELCL	Output from flip-flop 0 of logic cell block L1 Output from flip-flop 1 of logic cell block L1 Output from flip-flop 1 of logic cell block L2 Output from flip-flop 1 of logic cell block L3

- The destinations of event signals (ELCL outputs) are selected from up to 29 peripheral functions

ELC function are can be used only starting factor (activation trigger) of some peripheral functions. ELCL can be used not only them but also port output signals, timer input signals, receive data and clock signals of serial interface, each peripheral trigger signals. The following table shows an example of RL78/G23's choices.

Type	Option
Output pin	P01, P10, P11, P12, P13, P14, P15, P16, P17, P50, P51, P60, P61
Timer	TAU0 channel 0-1, 5timer input
Serial interface	SAU0 channel 0-1 receive data input SAU0 channel 0-1 serial clock input UARTA0-1 serial clock input
trigger	Event link interrupt (INTELCL), DTC activation trigger, SMS activation trigger, Hardware trigger for A/D converter, Hardware trigger for D/A0,1 converter, CTSU hardware trigger, TML32 operating clock, capture trigger

It is possible to add new functions that combines arbitrary functions with event signals (ELCL input signals) from each peripheral functions to the microcomputer. These new functions will be provided by Renesas as a tool (smart configurator) extension files.

You can easily add new functions to the microcomputer by downloading / importing these extension files.

## Software development by smart configurator

In software development of RL78/G23, you can use the smart configurator. New function of the ELCL is also prepared smart configurator as extension files.

You can easily add new features to RL78/G23 by downloading the extension files for ELCL from the web and importing it smartly. When download the extension files of ELCL and import it into the smart configurator to start the following GUI.

Select the event signal (ELCL input signal), logic combination, and link destination (ELCL output signal) from the pull-down menu on the GUI, and click Code Generation to easily set the code. Peripheral functions linked to ELCL can also be set on the smart configurator, so you can easily add functions.

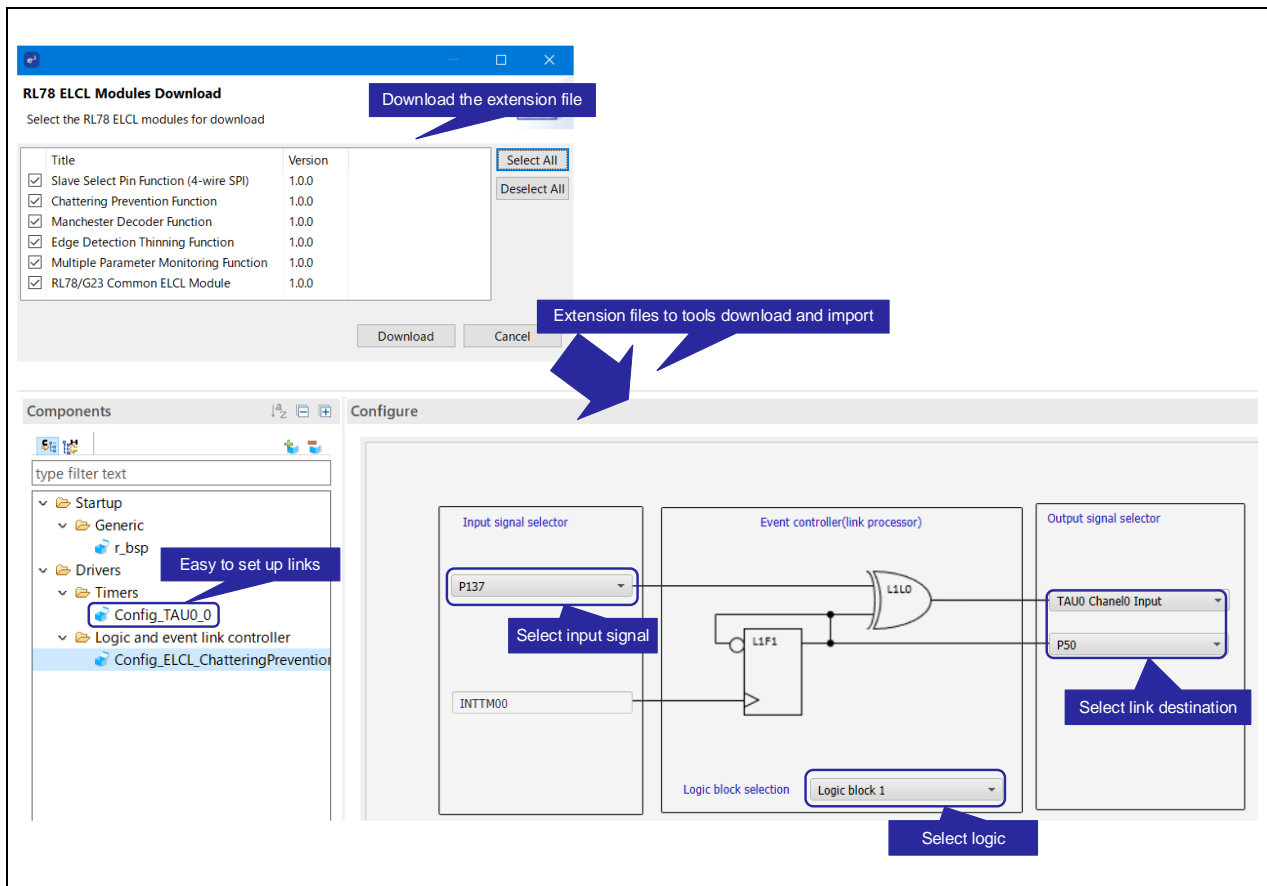










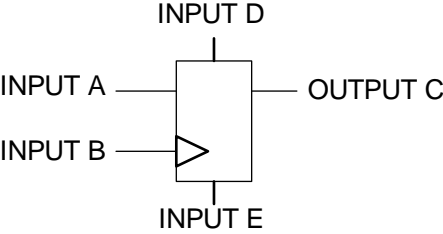
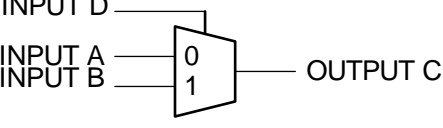
Figure 3 : GUI on Smart Configurator

The following pages explain the extension files on smart configurator prepared by Renesas.

## Logic single function

For the logic functions of ELCL, prepared the following extension files as a single function. INPUT A to E can be selected from port inputs, timers, serial interfaces, comparators, clocks, and interrupts.

OUTPUT C can be selected from port outputs, timers, serial interfaces, and triggers.

Type	Option
pass-through	INPUT A —  — OUTPUT C
NOT	INPUT A —  — OUTPUT C
AND	INPUT A —  — OUTPUT C INPUT B
NAND	INPUT A —  — OUTPUT C INPUT B
OR	INPUT A —  — OUTPUT C INPUT B
NOR	INPUT A —  — OUTPUT C INPUT B
EX-OR	INPUT A —  — OUTPUT C INPUT B
EX-NOR	INPUT A —  — OUTPUT C INPUT B
flip-flop	
selector	

Pass-through or NOT, AND or NAND, OR or NOR, and EX-OR or EX-NOR can be changed by selecting Output C with Positive logic output or Negative logic output (inverted level).  
ELCL of RL78/G23 has 3 input selectors and 6 other logic circuits.

## Application Examples

This section explains how to realize conventional ELC functions, how to realize pin changes for dual-purpose functions, and application examples of combining multiple logics.

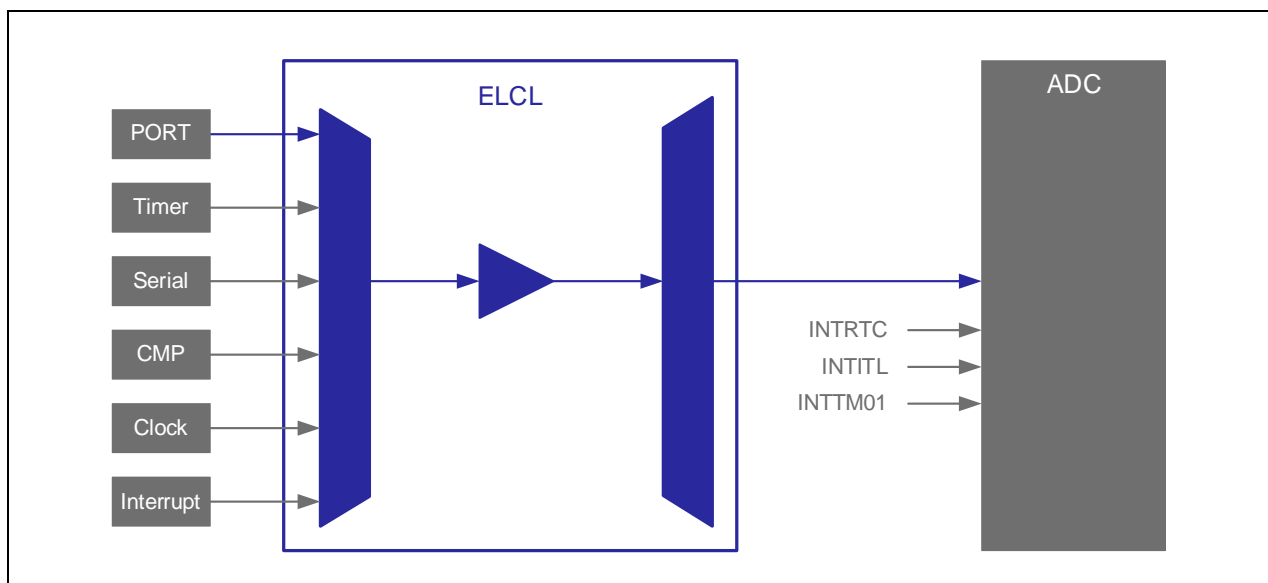
### ELC function

Logic function of the ELCL has pass-through. ELC function can be used by using this logic function. Therefore, the following can be selected in the same function as existing products.

Type	Option	Action after event reception
Timer	Timer input to TAU0 channel 1,5	Delay counter Input pulse interval measurement External event counter
trigger	INTELCL	Interrupt service routing
	DTC activation trigger	DTC activation
	SMS activation trigger	SMS activation
	Hardware trigger for A/D converter	A/D conversion operation
	Hardware trigger for D/A converter0-1	Realtime output
	Hardware trigger for CTSU	Measurement start
	TML32 operating clock, capture trigger	Count clock Capture operation

For example, if you select A/D converter (ADC) hardware trigger as the link destination of ELCL, the image will be as follows. Selecting on the ELCL settings, pins and interrupts can be used as ADC hardware triggers.

This feature can also be easily configured in the smart configurator. It can be realized only selecting "hardware trigger mode" and "Event input from ELCL" by ADC conversion trigger mode.



**Figure 4. Example of ELC function**

## Change the pin of the alternate function

"Pass-through" can be used to change the pin of the alternate function. In ELCL of RL78/G23, the following terminals can be selected from the input options.

Type	Option
Input pin	P00, P01, P10, P11, P12, P20, P21, P22, P23, P30, P31, P50, P51, P120, P121, P122, P137, P147

In the ELCL output options of RL78/G23, the functions equivalent to the alternate function input are as follows.

Peripheral function	Option
Timer	Timer input to TAU0-1, 5 channel
serial interface	SAU0 channel 0-1 receive data input, SAU0 channel 0-1 serial clock input, UARTA0-1 serial clock input

By combining these, you can change the input terminal of the alternate function. For example, select P00 for the input and SAU0 channel 0 serial clock input (SCK00) for the output. And select P01 for the input and SAU0 Channel 0 receive data input (SI00) for the output. Thereby, you can change SCK00 which is a alternate function of P10 to P00, and SI00 of P11 to P01 as shown below.

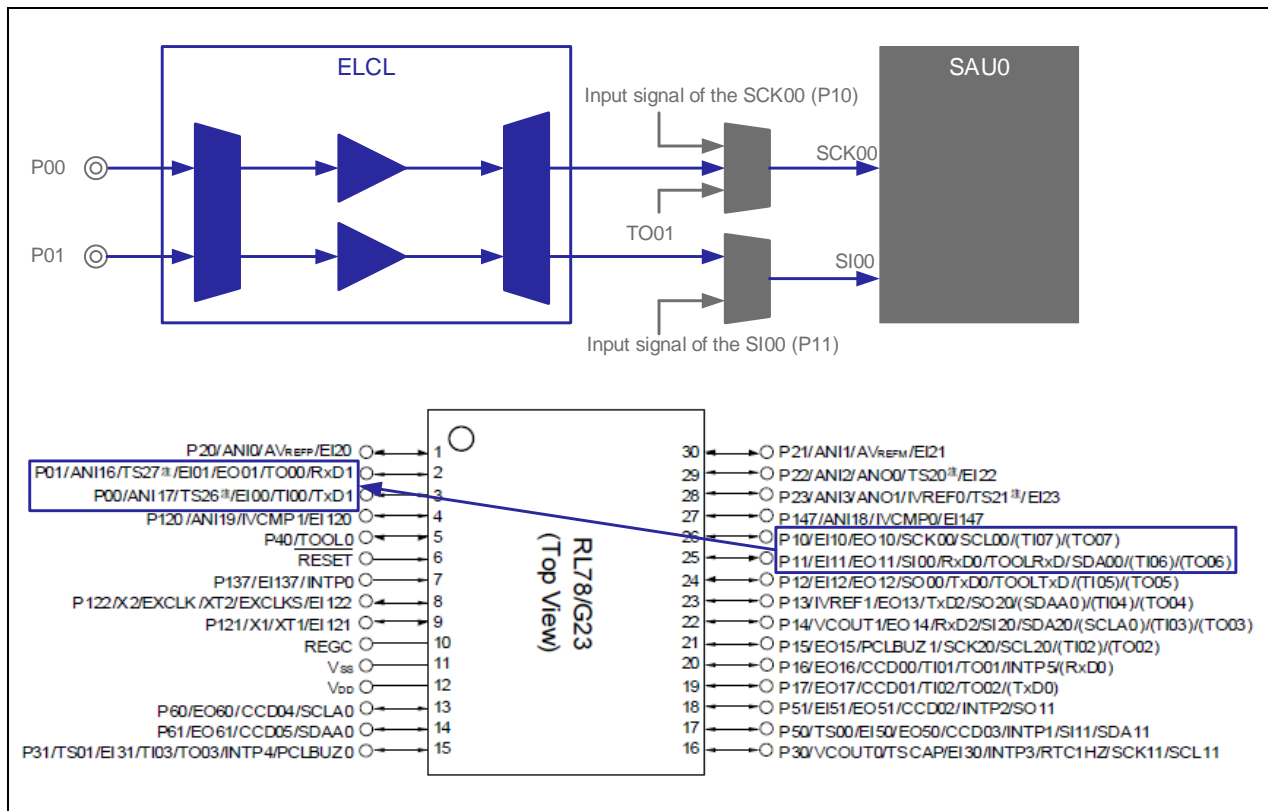


Figure 5. Example of ELCL (Changing input pin)

Next, the terminal change of the output function is explained. In the ELCL input options of RL78/G23, the functions equivalent to the alternate function output are as follows.

Peripheral function	Option
Timer	Output from TAU0 channel 0-7
serial interface	Transmit data output from SAU0 channel 0-1 Serial clock output from SAU0 channel 0-1 Serial clock output from UAR0A0, Transmit data output 0 from UAR0A0

In ELCL of RL78/G23, the following pins can be selected from the output options.

Type	Option
Output pin	P01, P10, P11, P12, P13, P14, P15, P16, P17, P50, P51, P60, P61

By combining these, you can change the output pin of the alternate function. For example, select Timer output from TAU0 channel 0 (TO00) for the input and P51 for the output. Thereby, you can change TO00 which is a alternate function of P01 to P51.

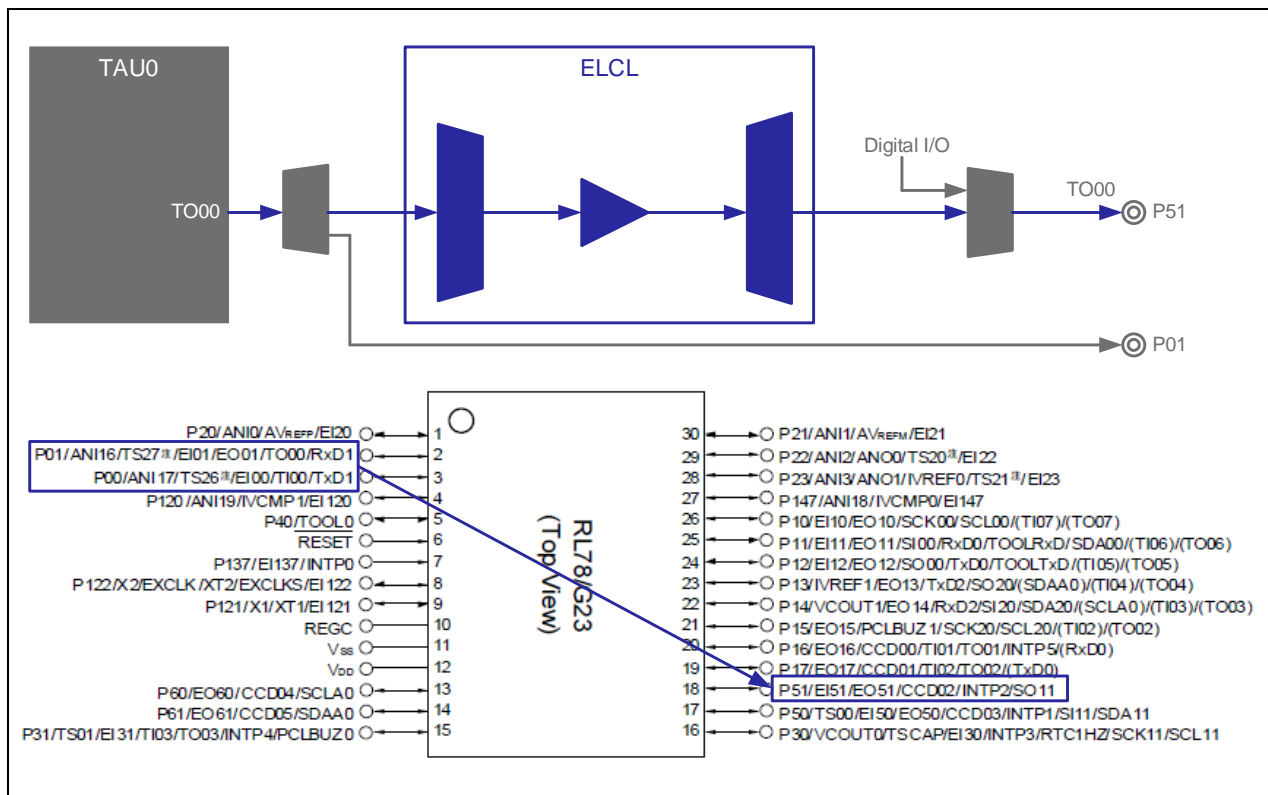


Figure 6. Example of ELCL (Changing output pin)

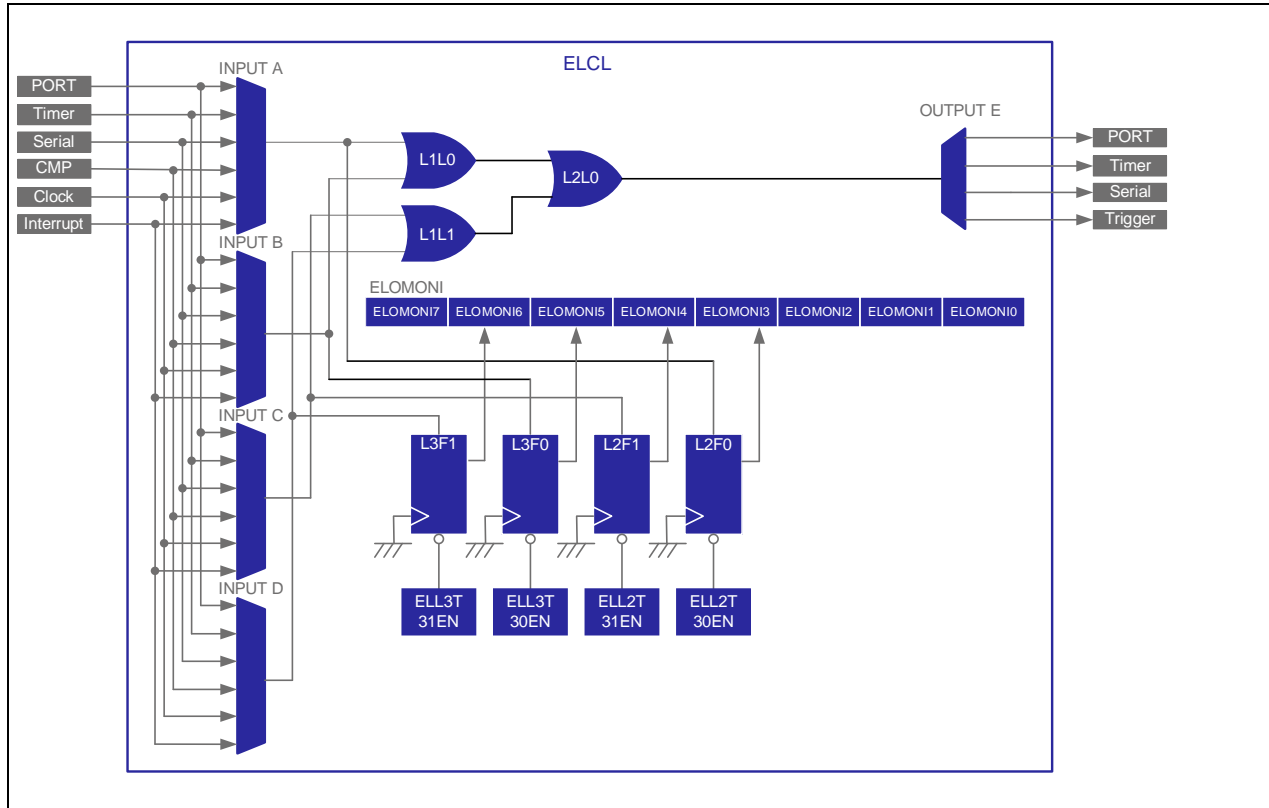
With ELCL in this way, you can easily change the alternate function to another pin.

From the next pages are explanations of the new functions that can be realized by combining multiple logics.



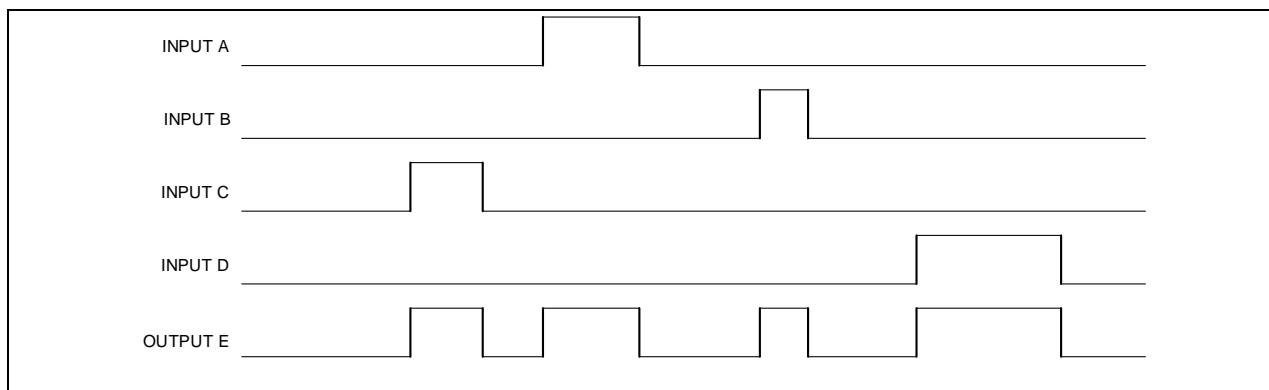
## ELCL Multiple parameter monitoring

You can monitor multiple input signals (parameters) by using ELCL. Up to four input signals can be link as “OR” and generating monitoring results.



**Figure 7. ELCL Configuration**

Link the four input signals (INPUT A, INPUT B, INPUT C, INPUT D) to the three ORs (L1L0, L1L1, L2L0), and link the generated signal to OUTPUT E. In addition, link the four input signals to the flip-flops (L2F0, L2F1, L3F0, L3F1), and link the output of the flip-flops to the monitor register (ELOMONI). Thereby it is possible to confirm the state of the input signal by reading the monitor register.

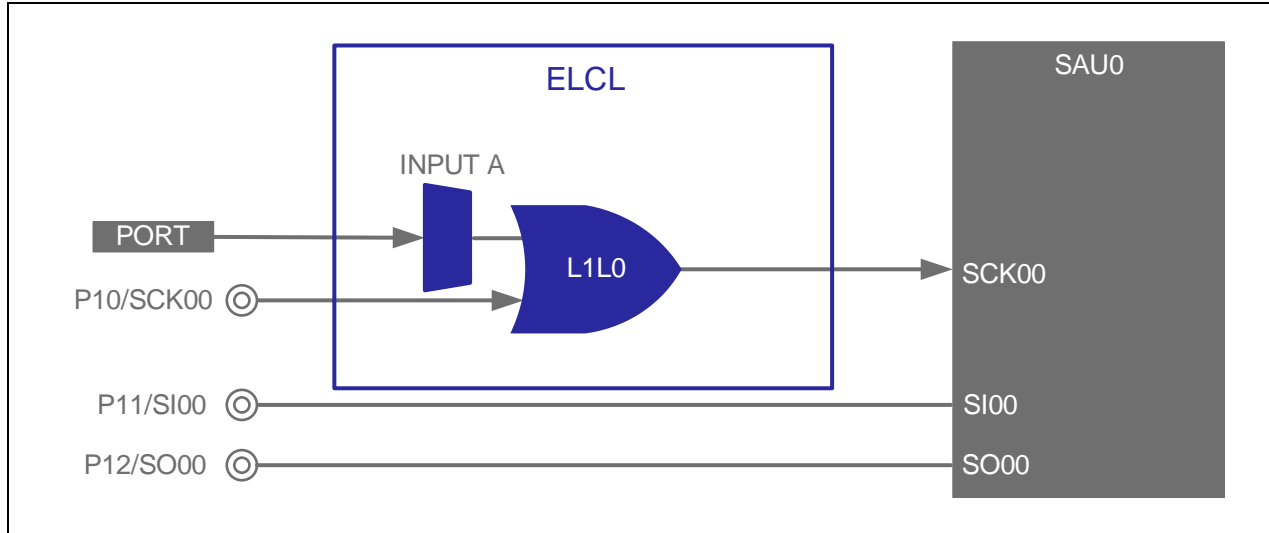


**Figure 8. Timing chart**

In detail, please see RL78/G23 application note “ELCL Multiple Parameter Monitoring Function (R01AN5615)”.

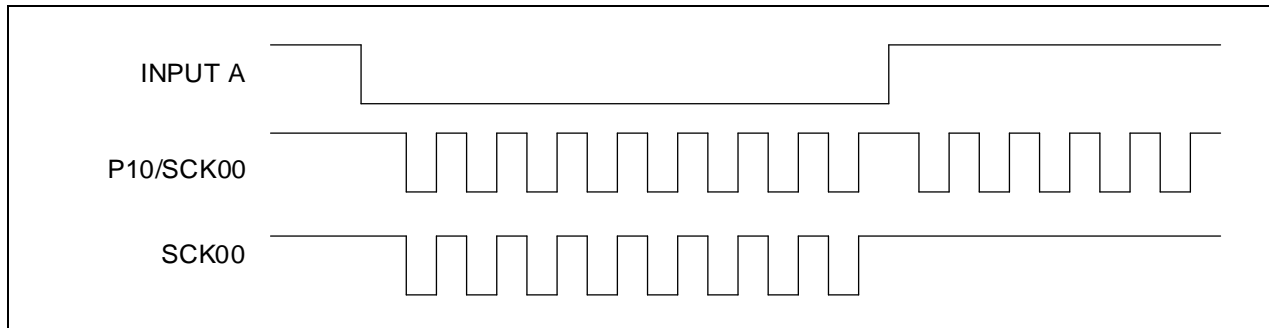
## **ELCL slave select pin function (for 4-wire SPI)**

You can generate 4-wire SPI by using ELCL. This function is to add slave selection (SS) to the slave receive mode of a serial array unit's (SAU) 3-wire serial I/O (CSI) and achieve 4-wire SPI (Serial Peripheral Interface) communication.



**Figure 9. System Configuration of ELCL**

Input slave select signal (SS) to a PORT and "OR" with the SCK00 signal. The SCK00 input is masked while INPUT A = 1. Thereby SAU0 can receive only for the period of INPUT A = 0.



**Figure 10. Timing chart**

This function extension file has same function as the single function "OR", but the selectable input signal and output destination options are limited, and it specializes in realizing the slave select function.

In detail, please see RL78/G23 application note "ELCL Slave Select Pin Function for 4-wire SPI (R01AN5614)".

## ELCL Edge Detection Thinning Function

This function thins out the edge detection of the input signal and enables the input signal once every two times. For example, if a valid edge is detected twice on a port, trigger for A/D converter once and A/D conversion operation can be executed.

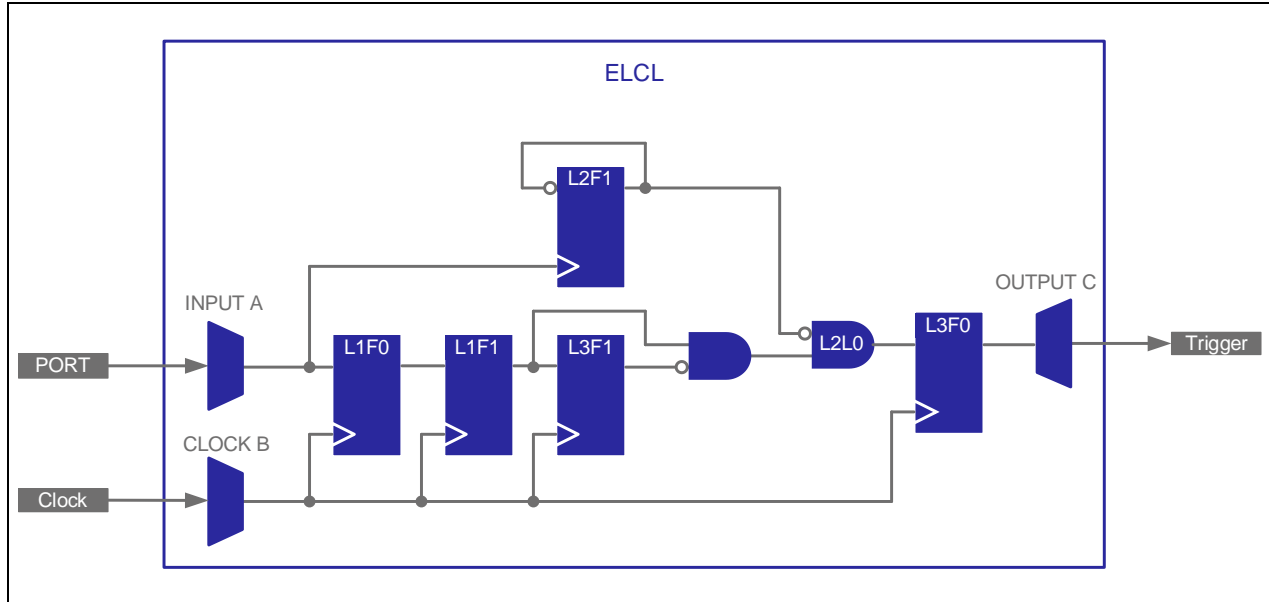


Figure 11. System Configuration of ELCL

The external input signal is INPUT A, the clock that creates the thinning interval is CLOCK B, and the thinned output signal is OUTPUT C. By combining "flip-flop" and "AND circuit" as above, edge detection of the input signal from INPUT A is masked the first time and enabled the second time.

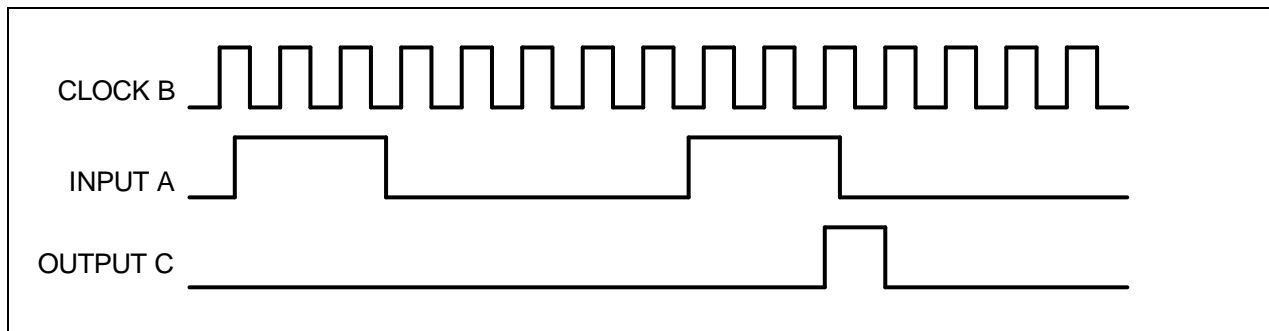


Figure 12. Timing chart

In detail, please see RL78/G23 application note "RL78/G23 ELCL Edge Detection Thinning Function (R01AN5613)".

## ELCL Chattering Prevention

In the case of a switch with mechanical settings such as a button switch, the phenomenon (chattering) in which the contacts repeatedly turn on/off occurs when the switch is turned on/off. Therefore, in the embedded system, chattering prevention control is performed for the signal of the button switch to prevent malfunction so that the operation of pressing the button once and the operation of pressing it multiple times are not mistaken.

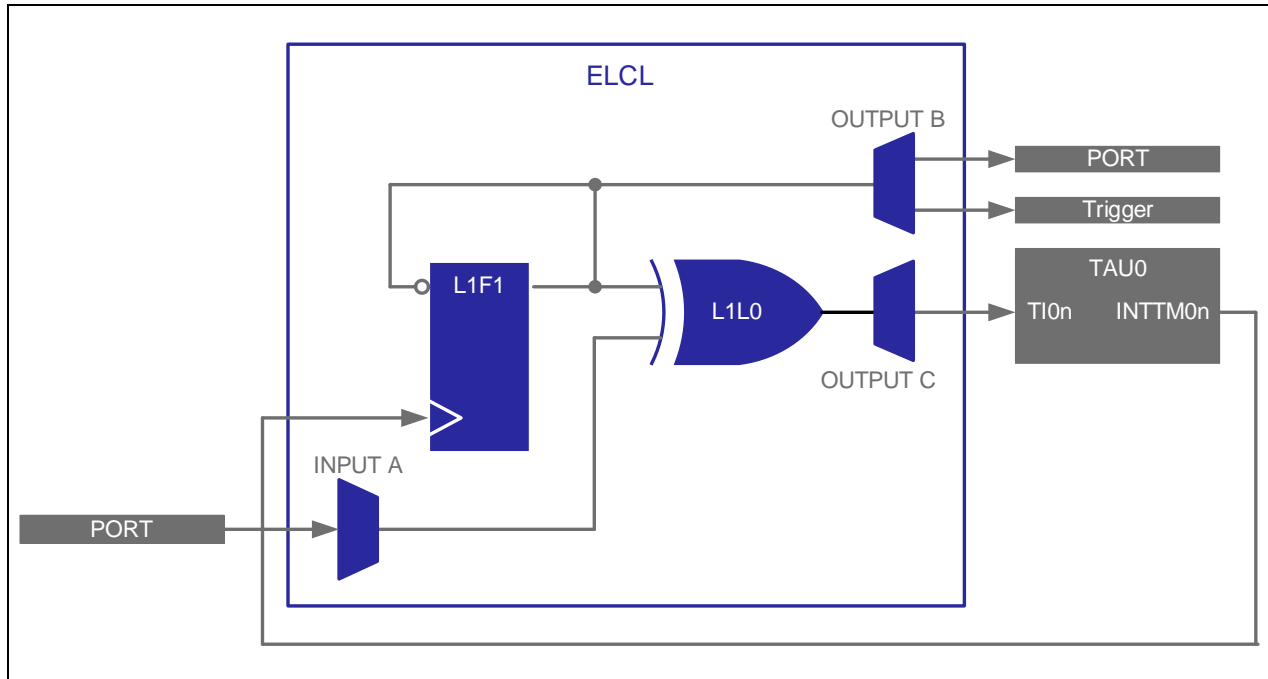


Figure 13. System Configuration of ELCL

The input signal from the external switch is INPUT A, and the output signal from the chattering prevention circuit is OUTPUT B. Use the delay count function of TAU0 to control the chattering prevention period.

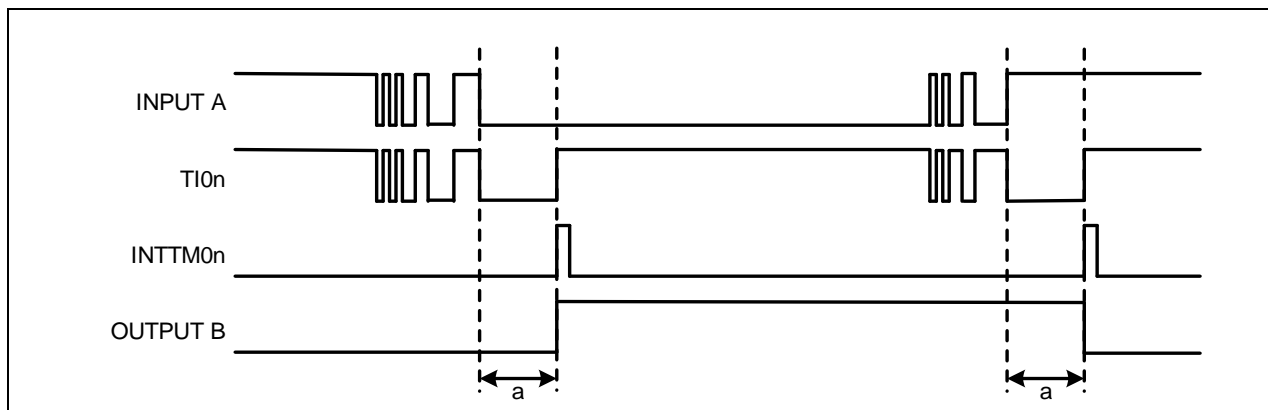
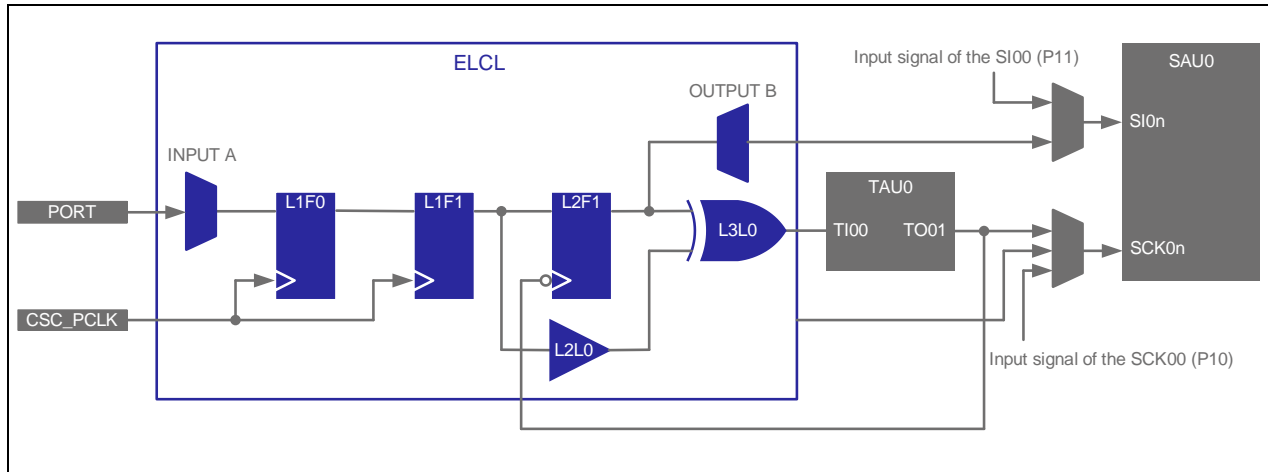


Figure 14. Timing chart

In detail, please see RL78/G23 application note “RL78/G23 ELCL Chattering Prevention Function (R01AN5612)”.

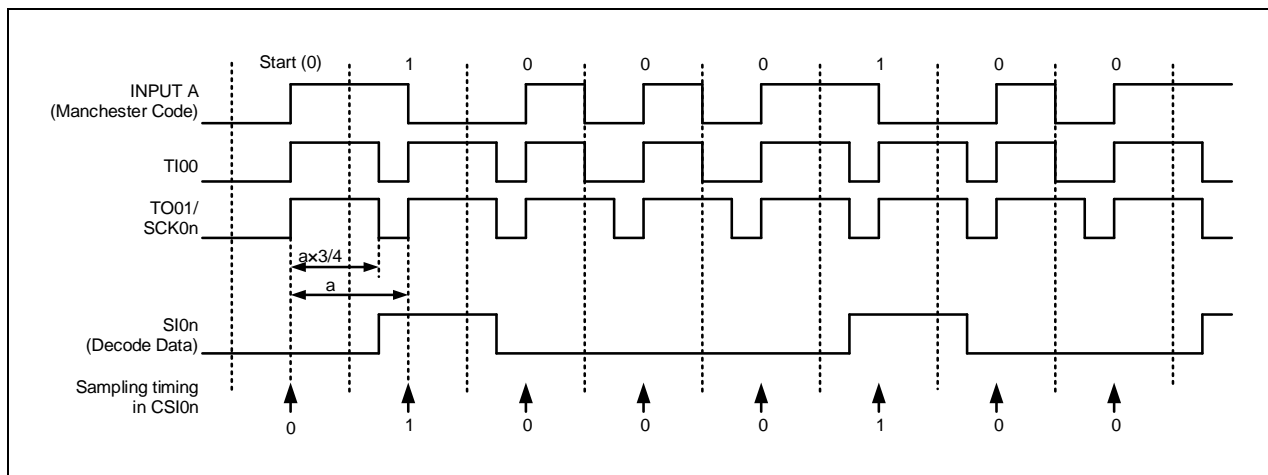
## ELCL Manchester Decoder

This function realize the Manchester code decoding of the G.E.Thomas method. Following figure shows the Manchester code decoding system configuration using ELCL. The Manchester code received by INPUT A and the clock line are to the data line. The clock line is connected to SCK0n of Serial Array Unit 0 (SAU0) via channels 0 and 1 of Timer Array Unit 0 (TAU0) and the data line is connected to SI0n of SAU0.



**Figure 15. System configuration of the Manchester code decoding**

The TAU0 channel is used by setting it to the one-shot pulse output function, and the SAU is used by setting it to the continuous transfer mode. The period  $a$  for SCK0n is generated by TAU0. It set TDR00 (delay) and TDR01 (one-shot pulse width) so that the change timings of the Manchester code, SCK0n cycle, and TAU0 do not overlap. Thereby it encodes the Manchester code to a serial signal and receives it.



**Figure 16. Timing chart**

In detail, please see RL78/G23 application note “RL78/G23 (R01AN5616)”.

## ELCL Manchester Decoder

This function realize Manchester code encoding of the G.E.Thomas method. SO0n, SCK0n of 3-wire Serial SPI and by using ELCL, the Manchester code encoding is realized. Following figure shows the Manchester code encoding system configuration using ELCL.

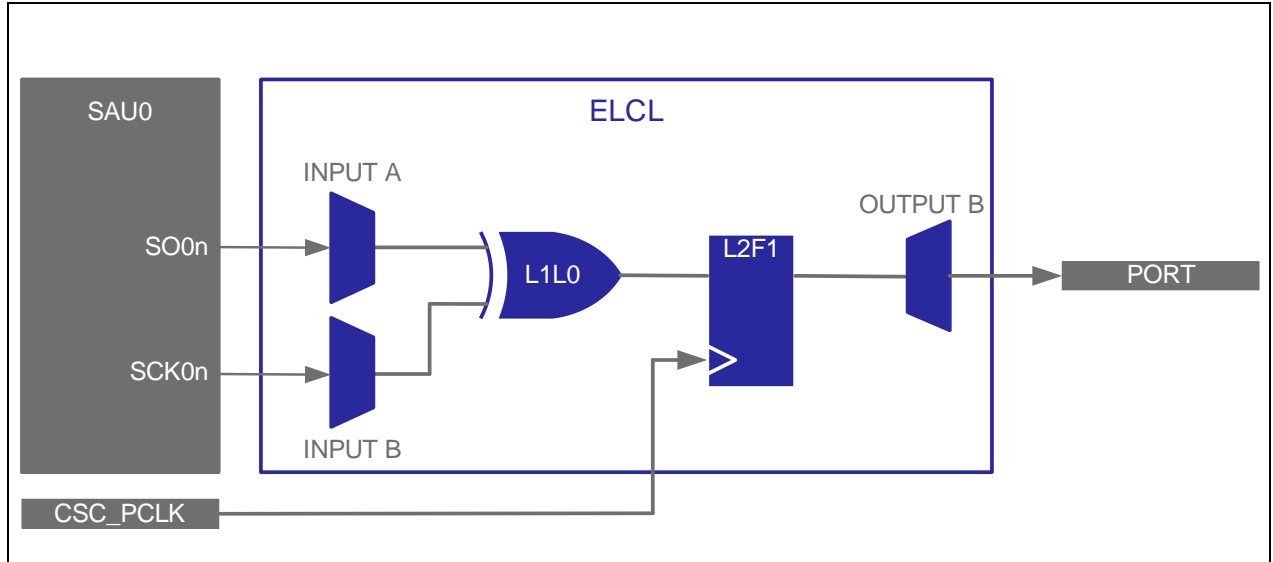


Figure 17. System configuration of the Manchester code encoding

Input SCKn and SO0n of SAU0 to ELCL and using EX-OR function, to synchronize with CSC\_PCLK with a flip-flop. SAU0 is used by setting continuous transfer mode. Thereby it encodes the serial signal to the Manchester code and transfer it.

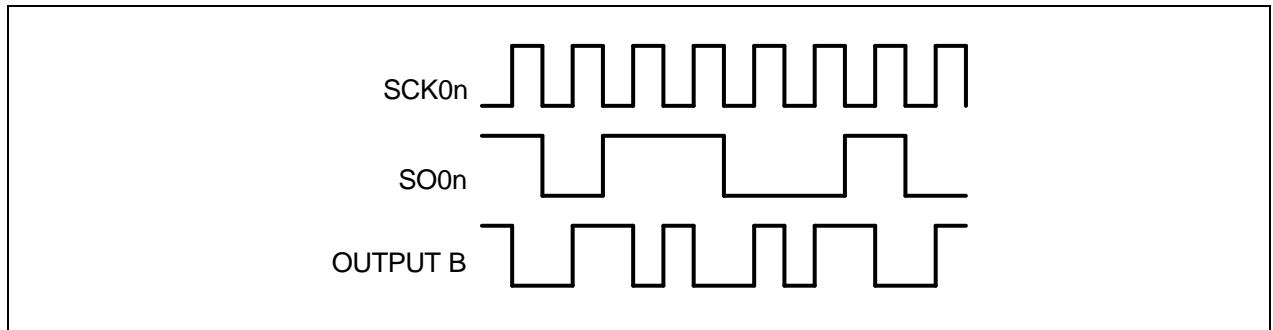
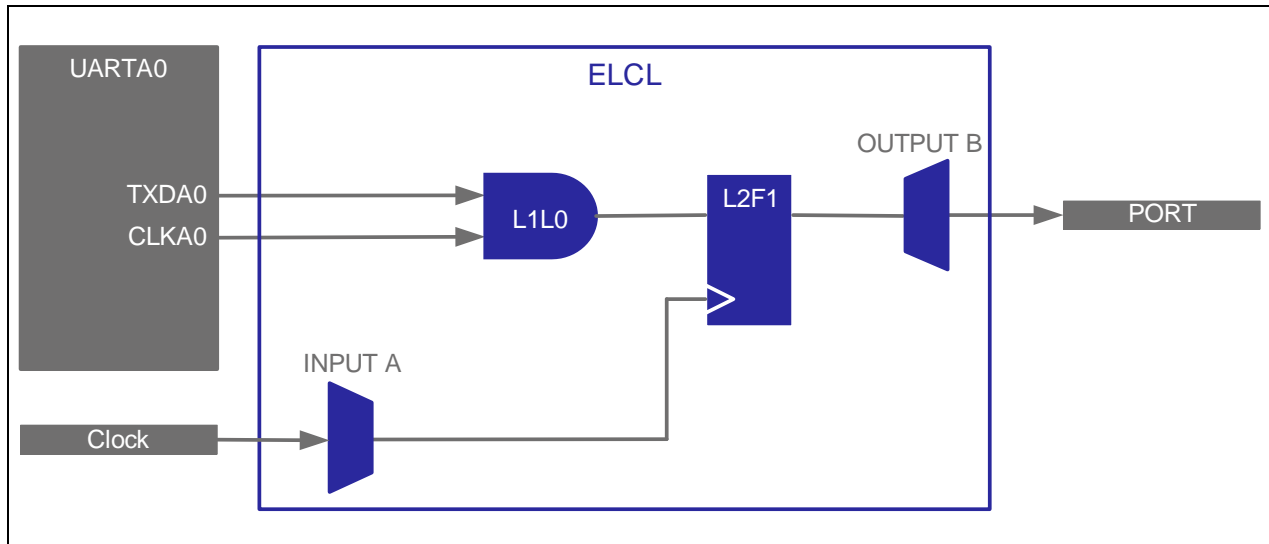


Figure 18. Timing chart

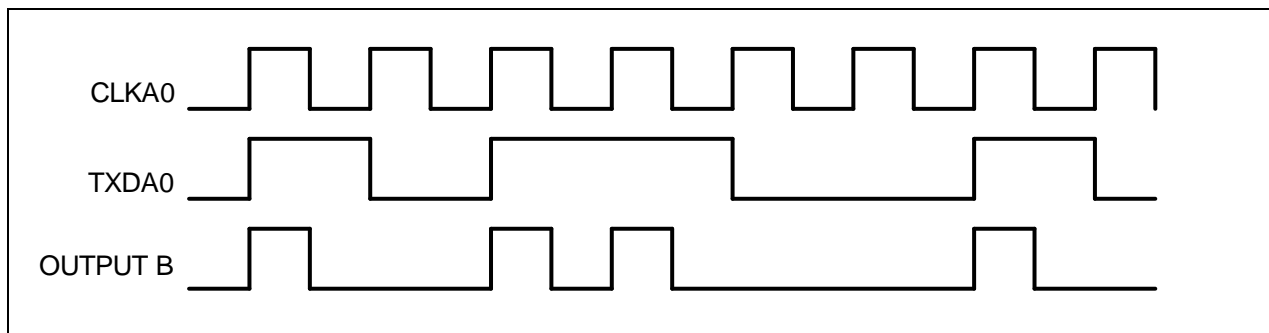
## ELCL NRZ to RZ encode

This function realize encoding from data output of NRZ (Non Return to Zero) to RZ (Return to Zero).



**Figure 19. System configuration of encoding from NRZ to RZ**

Input CLKA0 and TXDA0 of UARTA to ELCL and using AND function, to synchronize with the Clock with a flip-flop.  
Thereby it encodes the data output of NRZ to RZ.



**Figure 20. Timing chart**

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## Conclusion

"Logic and Event Link Controller" is one of the new features implemented in RL78/G23. In addition to the conventional Event Link function, the logic function can be set to meet the detailed requirements of the user.

And also, in order to easily design each functions, we will provide extension files for "Smart Configurator" and Application Notes.

## Learn More

1. [RL78/G23 User's Manual Hardware 16-Bit Single-Chip Microcontrollers](#)
2. [Smart Configurator](#) The utility for combining Renesas drivers easily
3. Application Note RL78/G23 ELCL Multiple Parameter Monitoring Function (R01AN5615)
4. Application Note RL78/G23 ELCL Slave Select Pin Function (for 4-wire SPI) (R01AN5614)
5. Application Note RL78/G23 ELCL Edge Detection Thinning Function (R01AN5613)
6. Application Note RL78/G23 ELCL Chattering Prevention Function (R01AN5612)
7. Application Note RL78/G23 ELCL Manchester Decoder Function (R01AN5616)

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