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RENESAS TECHNICAL UPDATE

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Product Category	MPU/MCU		Document No.	TN-RH8-B0580A/E	Rev.	1.00
Title	RH850/U2Cx RI3C Ext Pull up resistor description		Information Category	Technical Notification		
Applicable Product	RH850/U2C8-EVA, U2C8, U2C4, U2C2	Lot No. All	Reference Document	R01UH1018EJ0100 (User's Manual: Hardware)		

[Overview]

RI3C does not have a pull-up control function, so when it operates as an I3C master, it cannot control the pull-up of the I3C bus. As a result, it cannot start communication because it cannot detect the "bus free" (SDA = SCL = high level) state defined in the MIPI I3C protocol.

No problem when operating as an I3C slave. And the I2C mode is not affected by this issue.

[Applicable Product]

RH850 / U2C8-EVA, U2C8, U2C4, U2C2

[Phenomenon]

MIPI I3C protocol requests that I3C Master should control the Pull-up resistors on the I3C bus (SDA: Data line, SCL: Clock line). The SDA needs to switch between three states, and the SCL between two states.

R-I3C has no Pull-up control function during Master mode, so it cannot control the Pull-up resistors on the I3C bus.

During the communication, the I3C Master switches between pull-up and no pull-up states. If there is no pull-up between the master and slave, the I3C bus is unstable and I3C master mode does not work*. I3C slave mode is available.

*) Communication cannot start because " Bus Free " (SDA=SCL=high level) is not detected.

The difference between expected and RI3C SDA/SCL pin states are shown in Table 1. Mismatch Between Expected and RI3C SDA/SCL Pin States.

The difference between the SDA pin state in the I3C master: No Drive with High-Keeper (HK) Pull-Up, or Open-Drain with Open Drain (OD) Pull-Up. In this situation, a Pull-Up state is expected, but in RI3C the pin state will be Hi-Z.

The difference between SCL pin state in the I3C Master: No Drive with High-Keeper (HK) Pull-Up. A Pull-Up state is expected in this case, but in RI3C, the pin state will be Hi-Z.

To achieve a Pull-Up state on the SDA/SCL pins, external pull-up resistors need to be added.

Table 1. Mismatch Between Expected and RI3C SDA/SCL Pin States

Mode	I3C Bus State	IO Buffer State	Expected pin state		RI3C pin state	
			SDA	SCL	SDA	SCL
I3C Master	No Pull-Up (High-Z)	Open-Drain	-	-	-	-
		Push-pull	Hi-Z	Hi-Z	Hi-Z	Hi-Z
		No drive	Hi-Z	Hi-Z	Hi-Z	Hi-Z
	High-Keeper (HK) Pull-Up	Open-Drain	-	-	-	-
		Push-pull	-	-	-	-
		No drive	HK Pull-up	HK Pull-up	**Hi-Z**	**Hi-Z**
	Open Drain (OD) Pull-Up	Open-Drain	OD Pull-up	-	**Hi-Z**	-
		Push-pull	-	-	-	-
		No drive	-	-	-	-
I3C Slave	No Pull-Up (High-Z)	Open-Drain	Hi-Z	-	Hi-Z	-
		Push-pull	Hi-Z	Hi-Z	Hi-Z	Hi-Z
		No drive	Hi-Z	Hi-Z	Hi-Z	Hi-Z

Note: - is unused state.

[Change point]

The following description will be added in the User's Manual.

[Additional Description]

Section 21 I3C Bus Interface (RI3C)

21.4.6 Usage Notes [I2C/I3C common]

21.4.7.3 Restrictions that require an external pull-up resistor when communicating with I3C [I3C master]

When using Master mode, please implement Pull-up resistors outside of the chip (OD Pull-up for SDA, HK Pull-up for SCL).

Note: MIPI I3C protocol accepts use of common Pull-up resistor for HK Pull-up and OD Pull-up. The impact is an increased current consumption.

Case1) When using both Master and Slave modes

Please implement Pull-up resistors w/ switch and control it by chip GPIO.

In Master mode, turn the Pull-up resistor ON using GPIO. In Slave mode, turn the Pull-up resistor OFF using GPIO. Also, in the case of not using I3C (DeepSTOP mode. etc.), turn the Pull-up resistor OFF using GPIO to reduce the current consumption of the Pull-up resistor. Figure 1 shows an example of a Pull-up resistor control circuit, and Figure 2 shows an example of the GPIO control flow. Regarding GPIO control, please refer to **2.6 Port Setting Flow Example** in *RH850/U2C Group User's Manual: Hardware*.

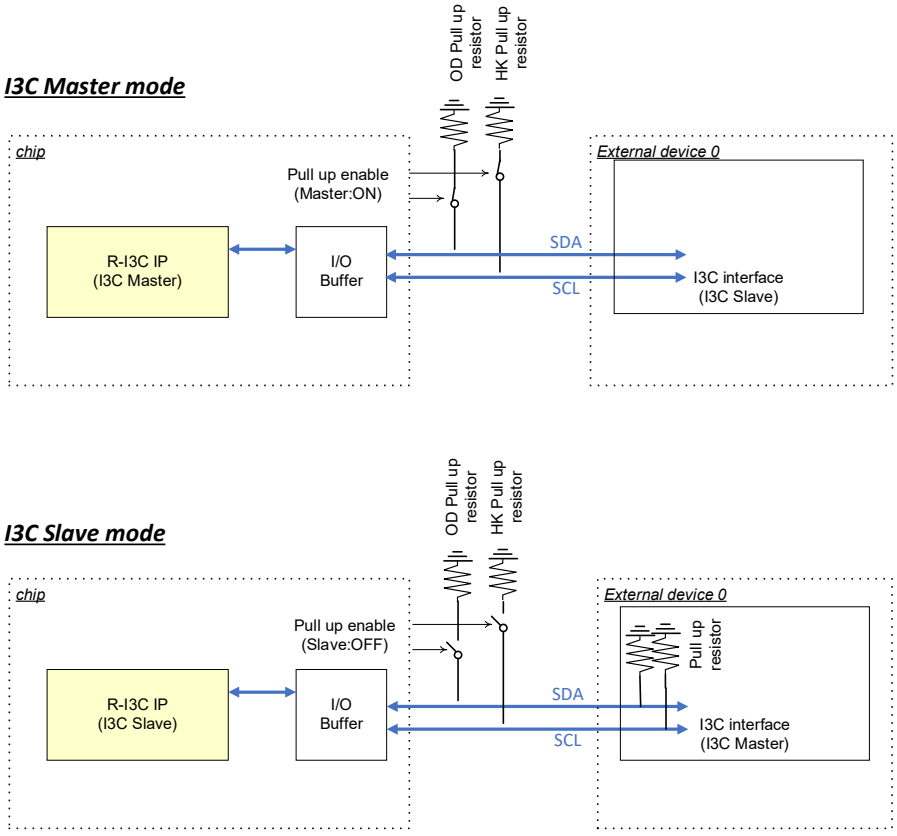


Figure 1. Pull-up resistors controlled by GPIO (case 1)

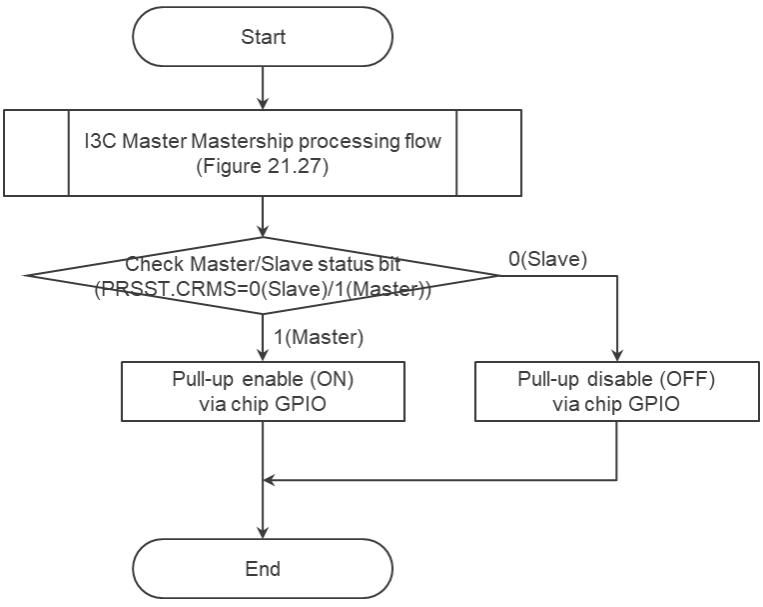


Figure 2. The software processing flow to control Pull-up resistor (case 1)

Recommended Pull-up resistor values:

- SDA (OD Pull-up): 0.9k to 2.8kΩ
- SCL (HK Pull-up): 50kΩ or higher

The Pull-up resistor does not affect to I3C communication speed in the following condition.

ExVCC = 3.3V, CL = 50pF, Drive strength = 2 (High)

In Case 1, the difference between SDA pin state in the I3C Master: Push-pull or No Drive with No Pull-Up (High-Z). In this situation, a Hi-Z state is expected. However, in RI3C, the pin state will be OD Pull-Up instead.

The difference between SCL pin state in the I3C Master: Push-pull or No Drive with No Pull-Up (High-Z). A Hi-Z state is expected in this case, but in RI3C, the pin state will be HK Pull-Up.

These Pull-up resistors consume current during No Pull-up (High-Z) state.

Table 2. Mismatch Between Expected and RI3C SDA/SCL Pin States in Case 1

Mode	I3C Bus State	IO Buffer State	Expected pin state		RI3C pin state w/ case 1	
			SDA	SCL	SDA	SCL
I3C Master	No Pull-Up (High-Z)	Open-Drain	-	-	-	-
		Push-pull	Hi-Z	Hi-Z	**OD Pull-up**	**HK Pull-up**
		No drive	Hi-Z	Hi-Z	**OD Pull-up**	**HK Pull-up**
	High-Keeper (HK) Pull-Up	Open-Drain	-	-	-	-
		Push-pull	-	-	-	-
		No drive	HK Pull-up	HK Pull-up	OD Pull-up	HK Pull-up
	Open Drain (OD) Pull-Up	Open-Drain	OD Pull-up	-	OD Pull-up	-
		Push-pull	-	-	-	-
		No drive	-	-	-	-
I3C Slave	No Pull-Up (High-Z)	Open-Drain	Hi-Z	-	Hi-Z	-
		Push-pull	Hi-Z	Hi-Z	Hi-Z	Hi-Z
		No drive	Hi-Z	Hi-Z	Hi-Z	Hi-Z

Note: - is unused state.

Case2) When using only Master mode

Please implement Pull-up resistors w/o switch.

If both Master and Slave functions are required and cannot implement w/ switch (case1), please implement w/o switch (case2).

And, in case of not using I3C (DeepSTOP mode, etc.), set the pin state to a value other than low to reduce the current consumption of the Pull-Up resistor. Figure 3 shows an example of a pull-up resistor control circuit.

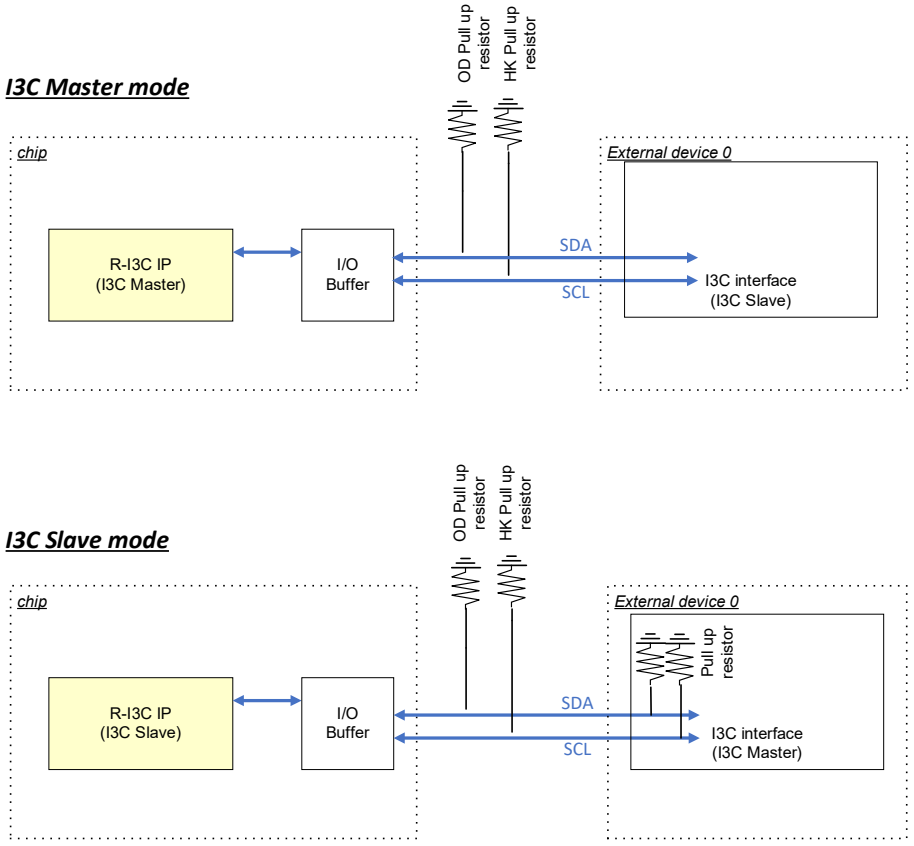


Figure 3. Pull-up resistors w/o switch (case 2)

Recommended Pull-up resistor values:

- SDA (OD Pull-up): 0.9k to 2.8kΩ
- SCL (HK Pull-up): 50kΩ or higher

The Pull-up resistor does not affect to I3C communication speed in the following condition when RI3C is I3C Master in case 2.

ExVCC = 3.3V, CL = 50pF, Drive strength = 2 (High)

Note: When using RI3C as an I3C slave, there is a period when the Pull-up resistor on the I3C Master side is turned on at the same time, which may affect the I3C communication speed.

For SDA in Slave Mode:

The presence of a 0.9 kΩ pull-up resistor on the Master side does not affect the I3C communication speed on the RI3C side. On the Master side, if the fall time is 12 ns or less, the I3C communication speed remains unaffected.

For SCL in Slave Mode:

The presence of a 50 kΩ pull-up resistor on the Master side does not affect the I3C communication speed on the RI3C side. On the Master side, if the fall time is 12 ns or less, the I3C communication speed remains unaffected.

In Case 2, in addition to the differences in case 1, there are differences in the case of I3C slave.

The difference between SDA pin state in the I3C Slave: Open-Drain, Push-pull, or No Drive with No Pull-Up (High-Z). In this situation, a Hi-Z state is expected. However, in RI3C, the pin state will be OD Pull-Up instead.

The difference between SCL pin state in the I3C Slave: Push-pull or No Drive with No Pull-Up (High-Z). A Hi-Z state is expected in this case, but in RI3C, the pin state will be HK Pull-Up.

These Pull-up resistors consume current during No Pull-up (High-Z) state.

Table 3. Mismatch Between Expected and RI3C SDA/SCL Pin States in Case 2

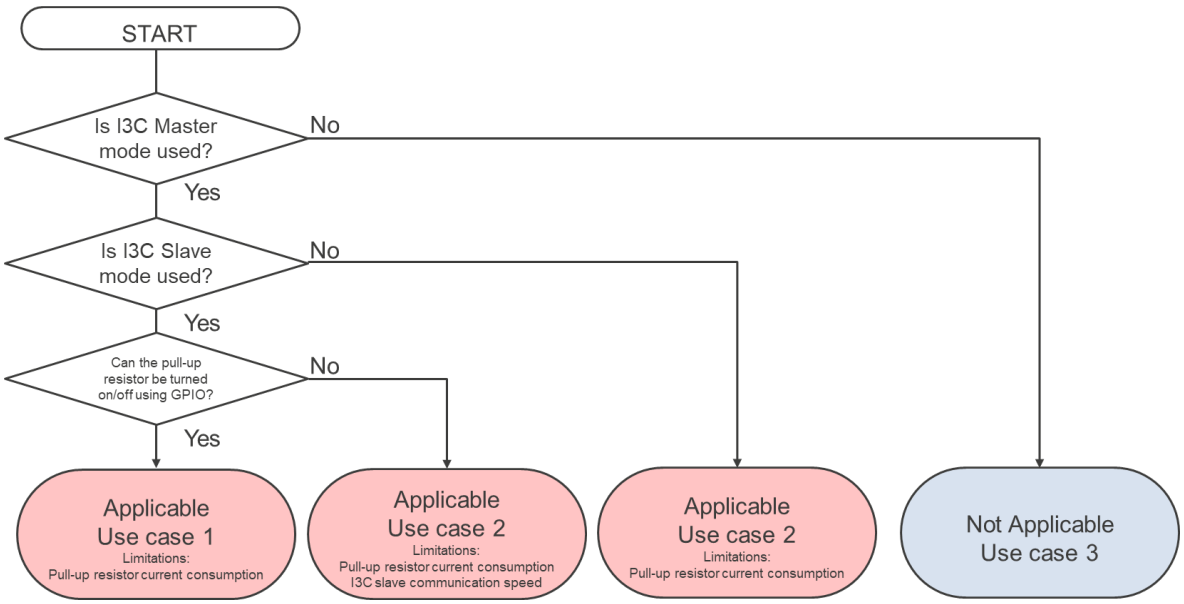
Mode	I3C Bus State	IO Buffer State	Expected pin state		RI3C pin state w/ case 2	
			SDA	SCL	SDA	SCL
I3C Master	No Pull-Up (High-Z)	Open-Drain	-	-	-	-
		Push-pull	Hi-Z	Hi-Z	**OD Pull-up**	**HK Pull-up**
		No drive	Hi-Z	Hi-Z	**OD Pull-up**	**HK Pull-up**
	High-Keeper (HK) Pull-Up	Open-Drain	-	-	-	-
		Push-pull	-	-	-	-
		No drive	HK Pull-up	HK Pull-up	OD Pull-up	HK Pull-up
	Open Drain (OD) Pull-Up	Open-Drain	OD Pull-up	-	OD Pull-up	-
		Push-pull	-	-	-	-
		No drive	-	-	-	-
I3C Slave	No Pull-Up (High-Z)	Open-Drain	Hi-Z	-	**OD Pull-up**	-
		Push-pull	Hi-Z	Hi-Z	**OD Pull-up**	**HK Pull-up**
		No drive	Hi-Z	Hi-Z	**OD Pull-up**	**HK Pull-up**

Note: - is unused state.

Case3) When using only Slave mode

No countermeasure is required because I3C Master of the external device controls the Pull-up resistors.

[Judgement Flow]



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