RL78/G1H, RAA604S00

Board Design Guidelines for Improving Communication Link Budget

Introduction

This document describes the board design guidelines when using an RF front-end module as a communication link budget improvement method for RL78/G1H and RAA604S00.

This document assumes that SE2435L (Skyworks Solutions, Inc.) is used as the RF front-end module.

Note: The contents of this document are provided as an example for reference and do not guarantee the signal quality in systems. When implementing this example into an existing system, thoroughly evaluate the product in the overall system and apply the contents of this document at your own responsibility.

Target Device

RL78/G1H, RAA604S00

Contents

1. Circuit design

This chapter describes the circuit design of the interface between the transceiver IC (RL78/G1H, RAA604S00) and SE2435L. For the design of SE2435L peripheral circuit, refer to the manufacturer's data sheet.

1.1 Pin connection examples

1.1.1 Pin connection examples (other than RF signal line)

Table 1 shows the outline of SE2435L pins and connection examples with the transceiver IC.

Table 1 Outline of SE2435L pins and connection examples

Pin	Pin Name	Description	Connection
1	CSD	Shutdown control	RL78/G1H：Pin60(P130) RAA604S00：MCU pin with standby function
2	PA_IN	Power amplifier input	Refer to chapter 1.1.2.
3	CPS	RX path selection control	RL78/G1H：Pin60(P130) RAA604S00：MCU pin with standby function
4	CTX	TX enable control	RL78/G1H：Pin35(GPIO4) RAA604S00：Pin12(GPIO4) (Pull down this signal line with 100kΩ)
5	TX_FLT	Switch output of TX signal	Refer to chapter 1.1.2.
6	TR	RF signal input / output with transceiver IC	Refer to chapter 1.1.2.
7	ANT_SEL	Antenna selection control	Refer to chapter 1.1.3.
8	GND	Ground	Ground
9	LNA_IN	Low noise amplifier input	SE2435L Pin11 (RX_FLT)
10	N/C	Disconnected	Ground
11	RX_FLT	Antenna switch output of RX signal	SE2435L Pin9(LNA_IN)
12	ANT2	Antenna 2	Antenna 50 Ω termination when not using ANT2
13	N/C	Disconnected	Ground
14	ANT1	Antenna 1	Antenna 50 Ω termination when not using ANT1
15	N/C	Disconnected	Ground
16	TX_IN	Antenna switch input of TX signal	SE2435L Pin20(PA_OUT)
17	N/C	Disconnected	Ground
18	N/C	Disconnected	Ground
19	N/C	Disconnected	Disconnected
20	PA_OUT	Power amplifier output	SE2435L Pin16(TX_IN)
21	VCC2	Power supply	Connect to power supply (3.3V_LDO)
22	N/C	Disconnected	Disconnected
23	VCC0	Power supply	Connect to power supply (3.3V_LDO)
24	VCC1	Power supply	Connect to power supply (3.3V_LDO)
Die Pad	GND	Ground	Ground

1.1.2 Pin connection examples (RF signal line)

The connection method of the RF signal line between the transceiver IC and SE2435L differs depending on the mounting position of a SAW filter. Table 2 and Figures 1 to 4 show how to connect the RF signal line according to the mounting position of the SAW filter. Choose the connection method that best suits customer system.

Table 2 Connection method of the RF signal line depending on a SAW filter mounting position

(1) When a SAW filter is not mounted, or when a SAW filter is mounted on one of TX / RX line

Pin	Name	Description	Connection
2	PA_IN	Power amplifier input	RL78/G1H : Pin43(RFOUT) RAA604S00 : Pin22(RFOUT)
5	TX_FLT	Switch output of TX signal	50Ω termination
6	TR	RF signal input / output with transceiver IC	RL78/G1H : Pin41(RFIP) RAA604S00 : Pin20(RFIP)

(2) When a SAW filter is mounted on both of TX / RX lines

Pin	Name	Description	Connection
2	PA_IN	Power amplifier input	SE2435L Pin5(TX_FLT)
5	TX_FLT	Switch output of TX signal	SE2435L Pin2(PA_IN)
6	TR	RF signal input / output with transceiver IC	RL78/G1H : Pin43(RFOUT) / Pin41(RFIP) RAA604S00 : Pin22(RFOUT) / Pin20(RFIP)

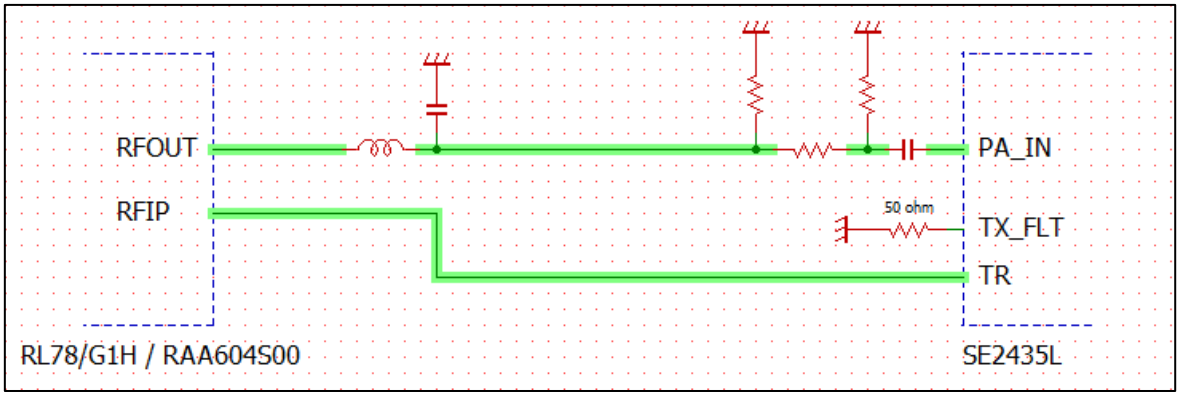

Figure 1 When a SAW filter is not mounted

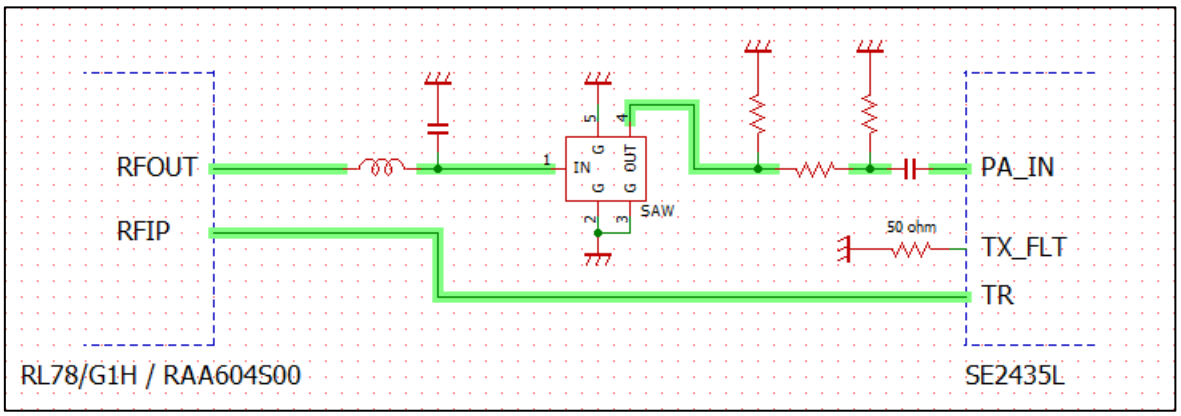

Figure 2 When a SAW filter is mounted on TX line

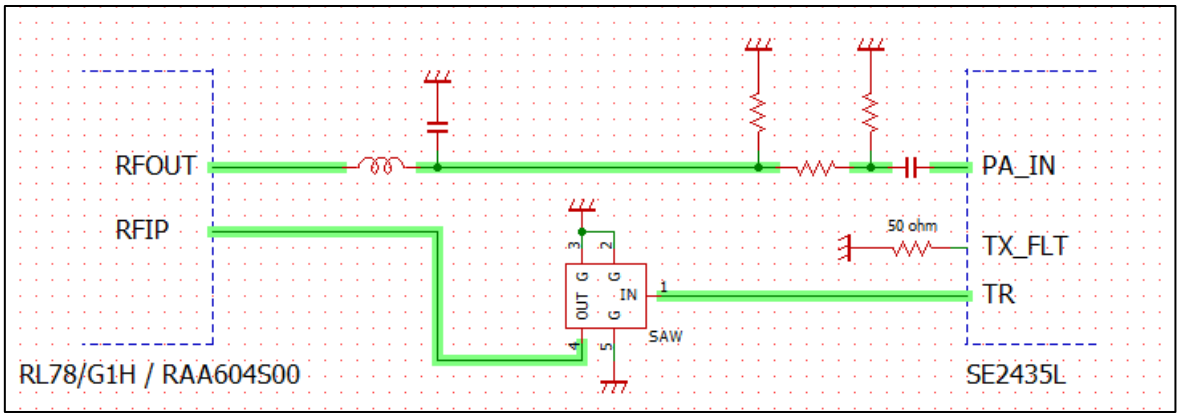

Figure 3 When a SAW filter is mounted on RX line

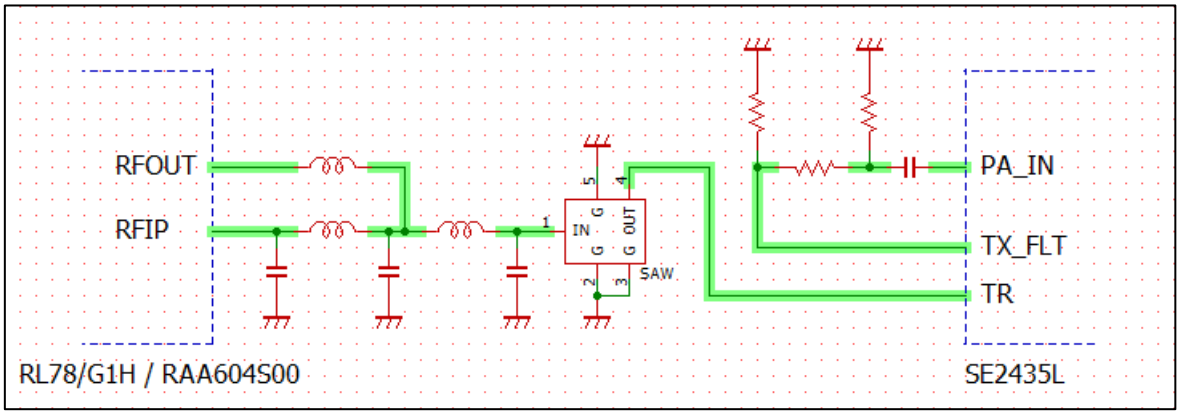

Figure 4 When a SAW filter is mounted on both of TX / RX lines

1.1.3 Pin connection examples (ANT_SEL pin)

The connection method of the antenna selection signal between the transceiver IC and SE2435L differs depending on the antenna mode used. Table 3 shows ANT_SEL pin connection method by the antenna modes.

Table 3 ANT_SEL pin connection method by the antenna modes

(1) When using single antenna (Uses only ANT1 pin)

Pin	Name	Description	Connection
7	ANT_SEL	Antenna selection control	RL78/G1H : Pin31(GPIO0) RAA604S00 : Pin7(GPIO0) (Or connect to GND and fix to Low)

(2) When using single antenna (Uses only ANT2 pin)

Pin	Name	Description	Connection
7	ANT_SEL	Antenna selection control	RL78/G1H : Pin31(GPIO0) RAA604S00 : Pin7(GPIO0) (Or connect to VDD and fix to High)

(3) When using diversity antenna (Uses both ANT1 / 2 pins)

Pin	Name	Description	Connection
7	ANT_SEL	Antenna selection control	RL78/G1H : Pin33(GPIO2) RAA604S00 : Pin10(GPIO2)

1.2 TX signal line

An attenuator of about 6 dB must be mounted on the TX signal line of the transceiver IC and SE2435L. Figure 5 to 7 show the mounting position of the attenuator.

There are two purposes for mounting the attenuator.

(1) It prevents breakdown of SE2435L. The maximum TX power of the transceiver IC is +15 dBm, and the maximum input rating of SE2435L is +10 dBm. By mounting the attenuator, the input power can be reduced below the rating.

(2) It extends the variable range of the TX power. The transceiver IC has the power variable range of -15 to + 15 dBm and about 30 dB. However, since the TX gain of SE2435L is about 26 dB, even if the gain of the transceiver IC is varied, the output of SE2435L remains saturated, and the variable range of the TX power is narrowed. The variable range of the TX power is extended by mounting the attenuator.

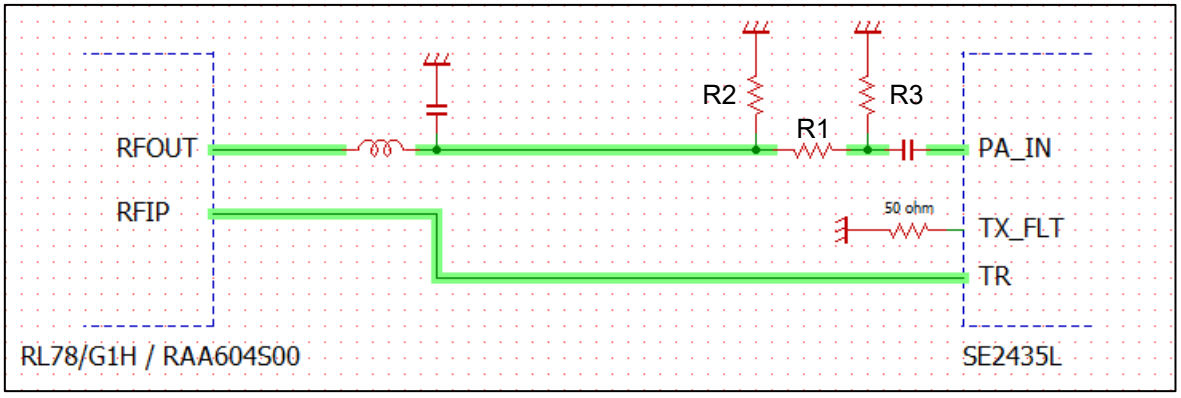

Figure 5 When a SAW filter is not mounted

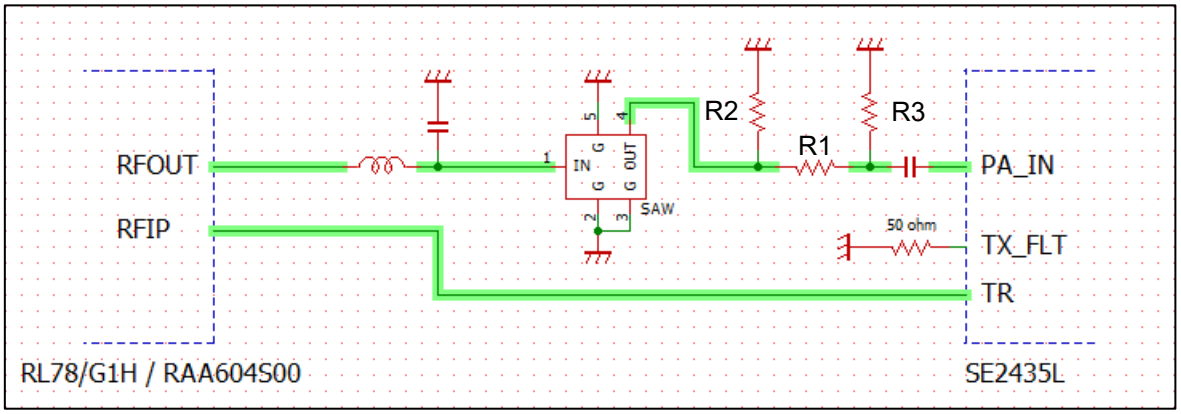

Figure 6 When a SAW filter is mounted on TX line

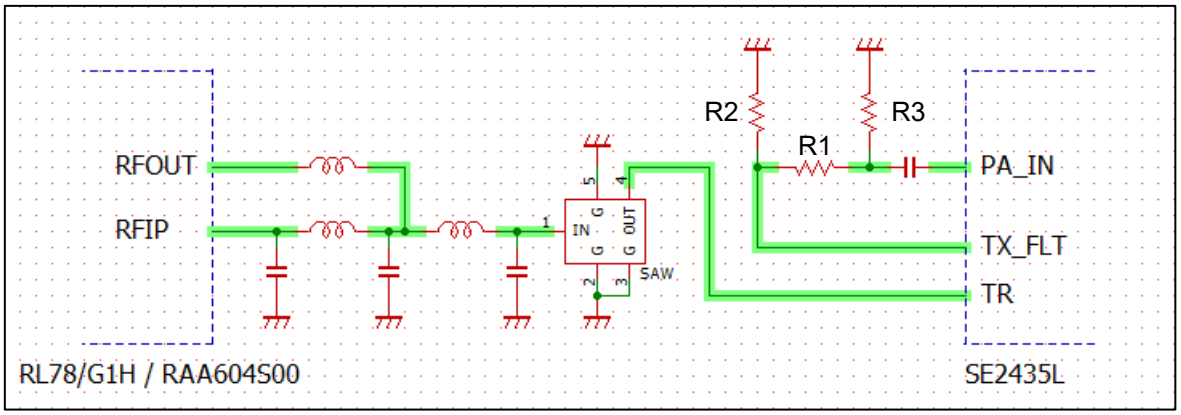

Figure 7 When a SAW filter is mounted on both of TX / RX lines

Table 4 shows examples of the attenuator values and the component values.

When a SAW filter is mounted on the TX line, it is necessary to determine the attenuator value in consideration of the insertion loss of the SAW filter. As an example, the attenuator value when a SAW filter with 2 dB insertion loss is used is shown.

If the variable range is insufficient, the variable range can be extended by increasing the attenuator value.

However, if the attenuator value is increased, the maximum TX power may decrease. Therefore, perform sufficient evaluation by the customer to determine the attenuator value.

Table 4 Examples of the attenuator values and the component values

SAW filter	ATT [dB]	R1 [Ω]	R2 [Ω]	R3 [Ω]
Mounted	6	36	150	150
Not mounted	4	24	220	220

1.3 Antenna signal line

It is recommended to add a notch filter circuit to SE2435L's ANT1 and ANT2 pins in addition to the LC filter recommended for SE2435L. This is to suppress harmonics of the fundamental wave. Figure 8 shows an example of the antenna signal line circuit. Table 5 shows examples of the component values in the initial condition.

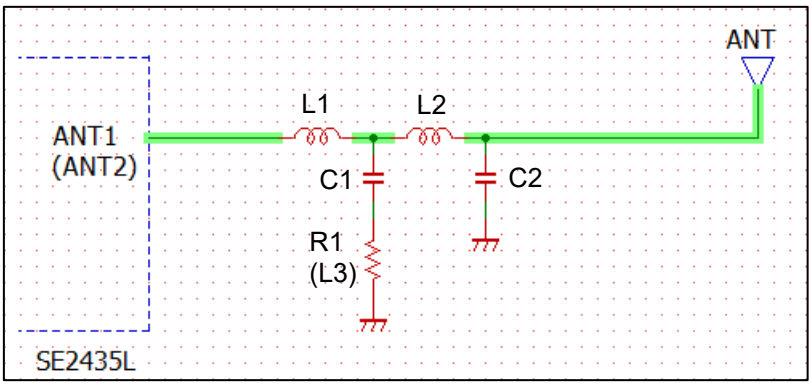

Figure 8 Example of the antenna signal line circuit

Table 5 Examples of the component values (LC filter)

L1 [nH]	L2 [nH]	C1 [pF]	R1 [Ω]	C2 [pF]
6.8	6.8	3.3	0	Not mounted

In the initial condition, C1 and R1 are not used as the notch filter components. Change R1 to inductor (L3) and adjust the component values by the customer, when the harmonic characteristics do not meet the standard in the initial condition.

1.4 Antenna matching

When using a monopole antenna instead of a dipole antenna, it is recommended to mount antenna matching components on the board. Figure 9 shows the circuit example of the antenna matching components. Table 6 shows examples of the component values in the initial condition.

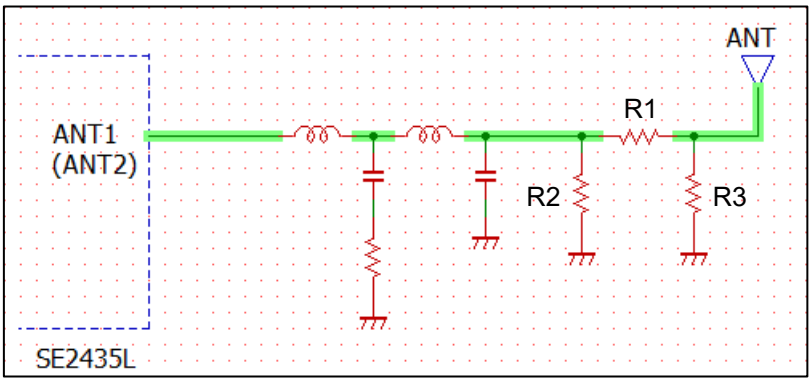

Figure 9 Example of the antenna matching circuit

Table 6 Examples of the component values (Antenna matching)

R1 [Ω]	R2 [Ω]	R3 [Ω]
0	Not mounted	Not mounted

In the initial condition, R1, R2, and R3 are not used as the antenna matching components. Adjust the component values by customer according to the antenna characteristics to be used.

1.5 Power supply

When sharing the power supply of SE2435L with the transceiver IC or MCU power supply, it is recommended to separate the power supply with a noise filter or ferrite beads. Figure 10 shows an example of the power supply circuit using the noise filter. Table 7 shows examples of the component values.

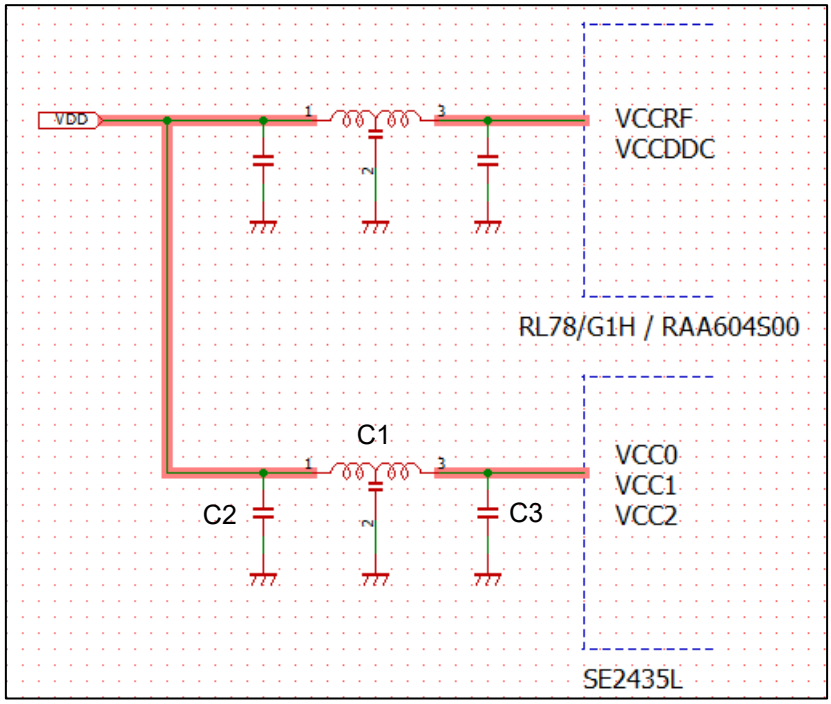

Figure 10 Example of the power supply circuit

Table 7 Examples of the component values (Power supply circuit)

C1	C2 [uF]	C3 [uF]
NFM18CC222R1C3	1	4.7

2. Layout design

This chapter describes the layout design of SE2435L. Basically, it is recommended to use the same layout as the evaluation board provided by the manufacturer.

For the layout design of the transceiver IC (RL78/G1H, RAA604S00), please refer to the board design guidelines on Renesas web site.

2.1 RF signal line

This section describes notes on layout design around the RF signal line. Figure 11 shows the layout example around the RF signal line.

(1) The RF signal line must be the coplanar line and designed to have a characteristic impedance of 50 Ω.

(2) It is recommended to design the line to be 50 Ω with the same width as the chip components to be used.

(3) The ground around the coplanar line must be solid plane ground, and GND vias must be used as much as possible. Do not wire other signal lines around the coplanar line.

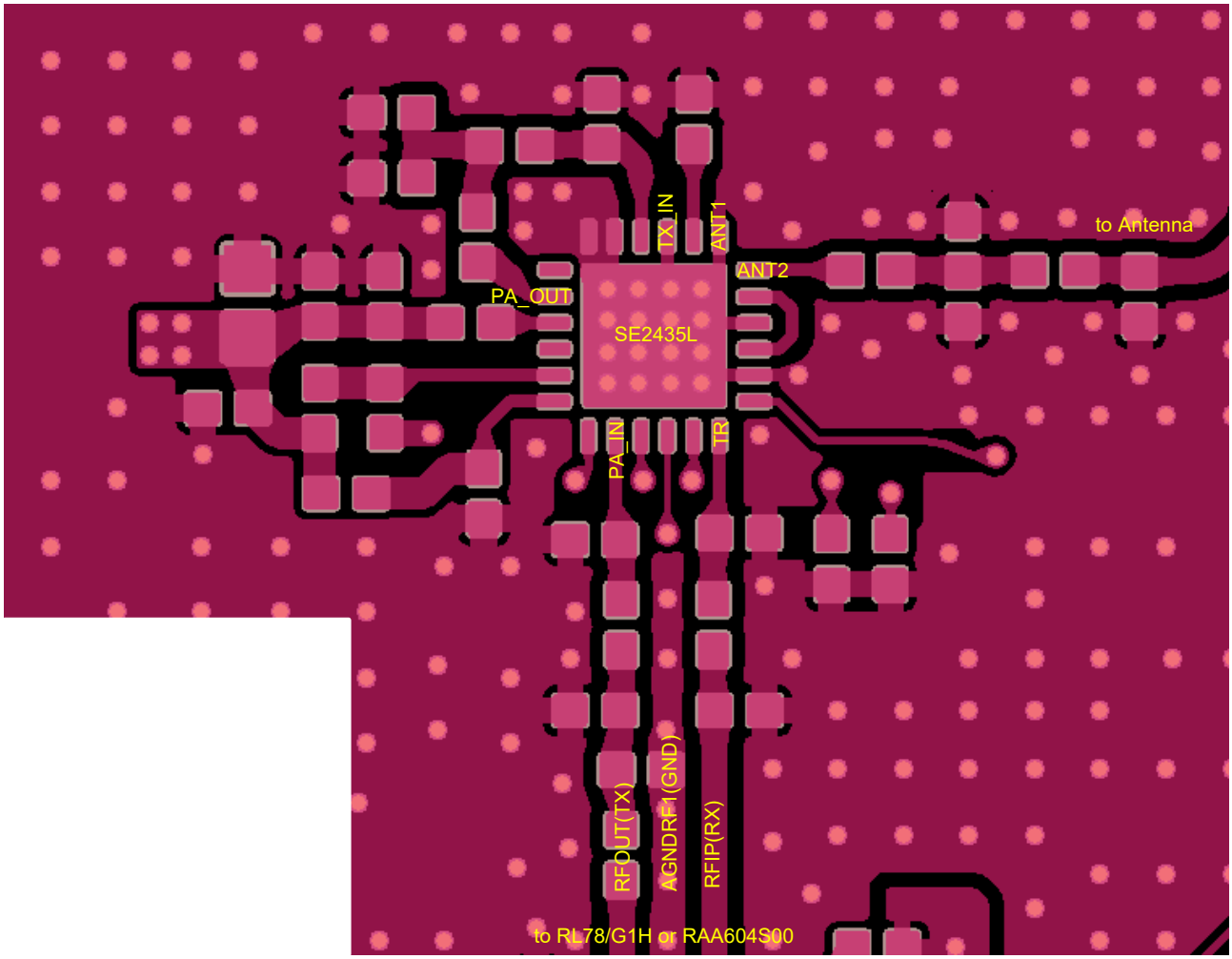

Figure 11 Layout example around the RF signal line

2.2 Power supply

This section describes notes on layout design of the power supply circuit. Figure 12 shows the layout example around the power supply circuit.

(1) The bypass capacitance must be placed on the top layer and close to the terminal.

(2) The power supply line wiring must be thick and low impedance.

(3) The RF ground must not be separated by the power supply line wiring.

(4) One or more GND vias must be placed for one bypass capacitor.

(5) Do not place a power supply via between SE2435L and bypass capacitor.
Supply power in the order of "power supply via -> bypass capacitance -> SE2435L".

(6) When sharing the power supply of SE2435L with the transceiver IC or MCU power supply, separate the power supplies so that they do not have a common impedance.
Separate the power supply wiring of SE2435L, transceiver IC and MCU from LDO output as shown in Figure 13.

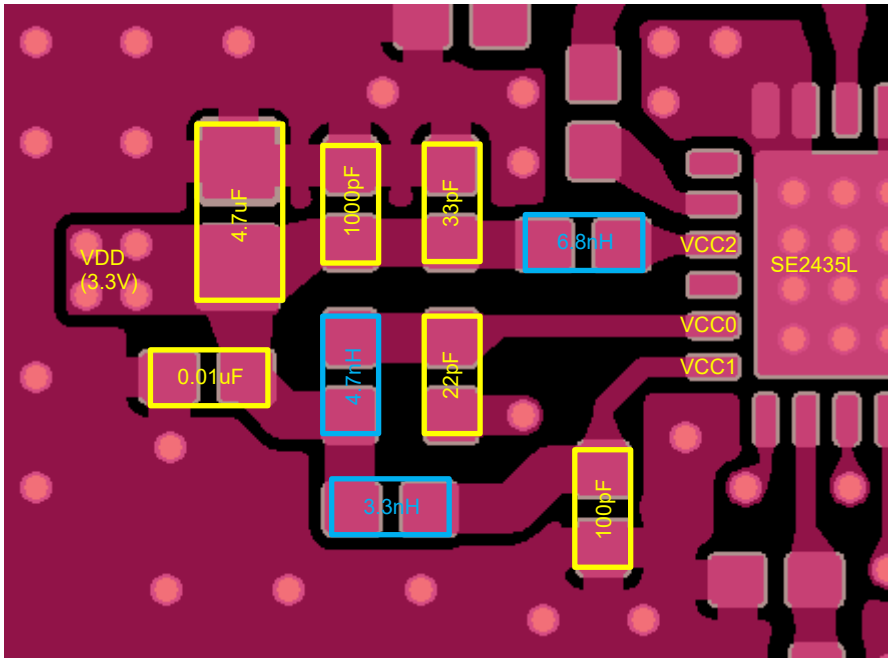

Figure 12 Layout example around the power supply circuit

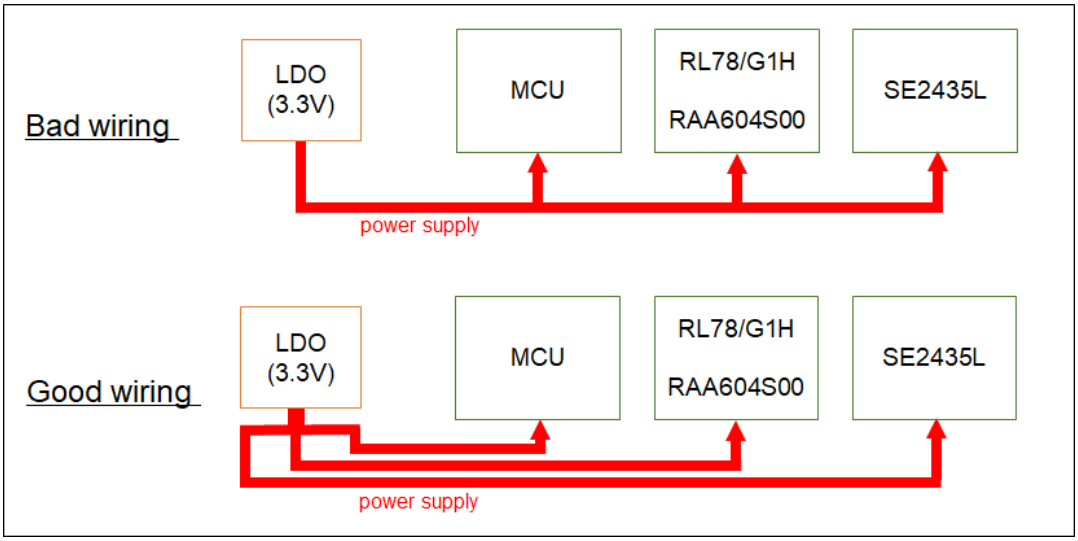

Figure 13 Layout image of power supply separation

2.3 Ground

This section describes notes on layout design of the ground pattern. Figure 14 shows the layout example of the ground pattern.

(1) The solid plane ground and the RF circuit ground must have as many GND vias as possible and short between the top layer and the bottom layer to have low impedance.

(2) SE2435L's Die Pad must have as many GND vias as possible and short between the top layer and the bottom layer to have low impedance.

(3) In the case of a 4-layer board, the second and third layers must be solid plane ground, and control signals to be connected to the transceiver IC must be wired using the bottom layer.

(4) Connect Pin8 (GND), Pin10 (N/C), Pin13 (N/C), Pin15 (N/C), Pin17 (N/C), Pin18 (N/C) to Die Pad. (Pins 10, 13, 15, 17, 18 are listed as "N/C" on the data sheet, but are connected to ground on the manufacturer evaluation board.)

(5) Pin17 (N/C) and Pin18 (N/C) must be the ground. Pull out the ground from the pin and use it as the ground for the coplanar line of the RF signal line of PA_OUT ~ TX_IN.

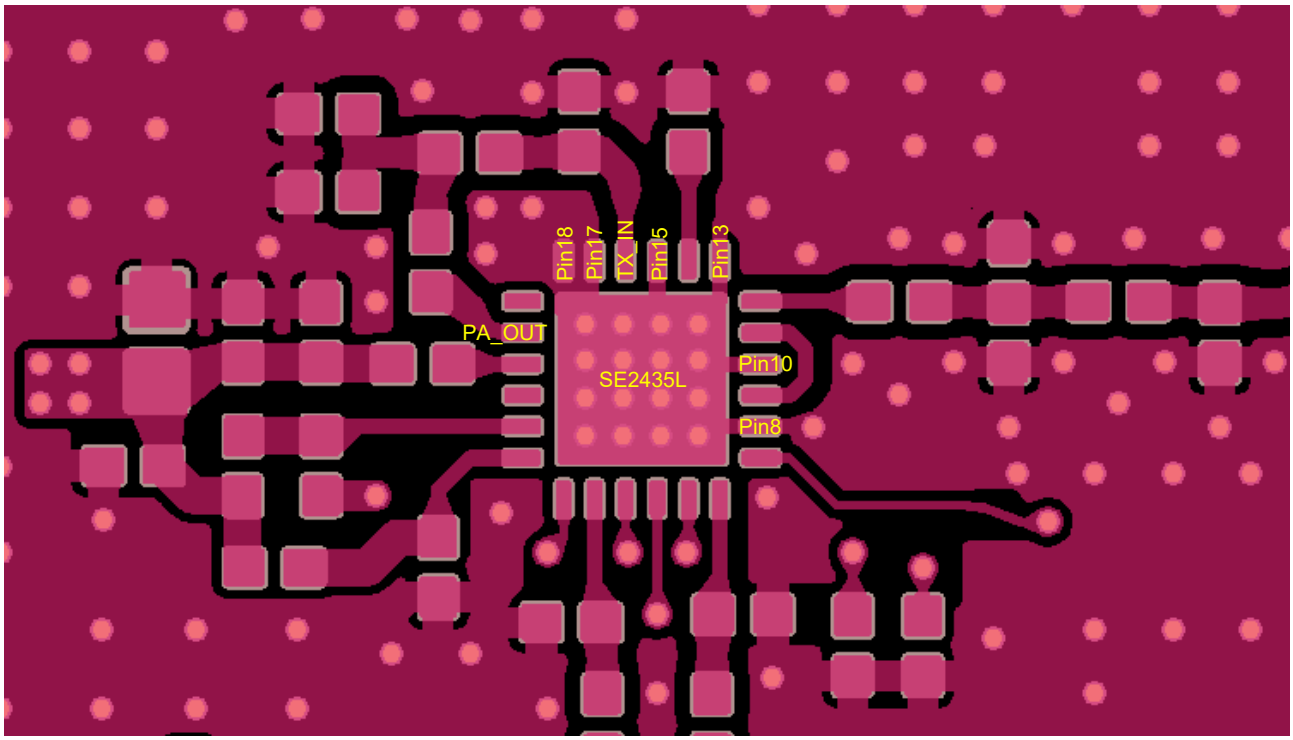

Figure 14 Layout example of the ground pattern

3. Reference circuit using RL78/G1H

3.1 Circuit diagram (When a SAW filter is mounted on TX line)

Figure 15 shows the reference circuit diagram of RL78/G1H and SE2435L when a SAW filter is mounted on TX line.

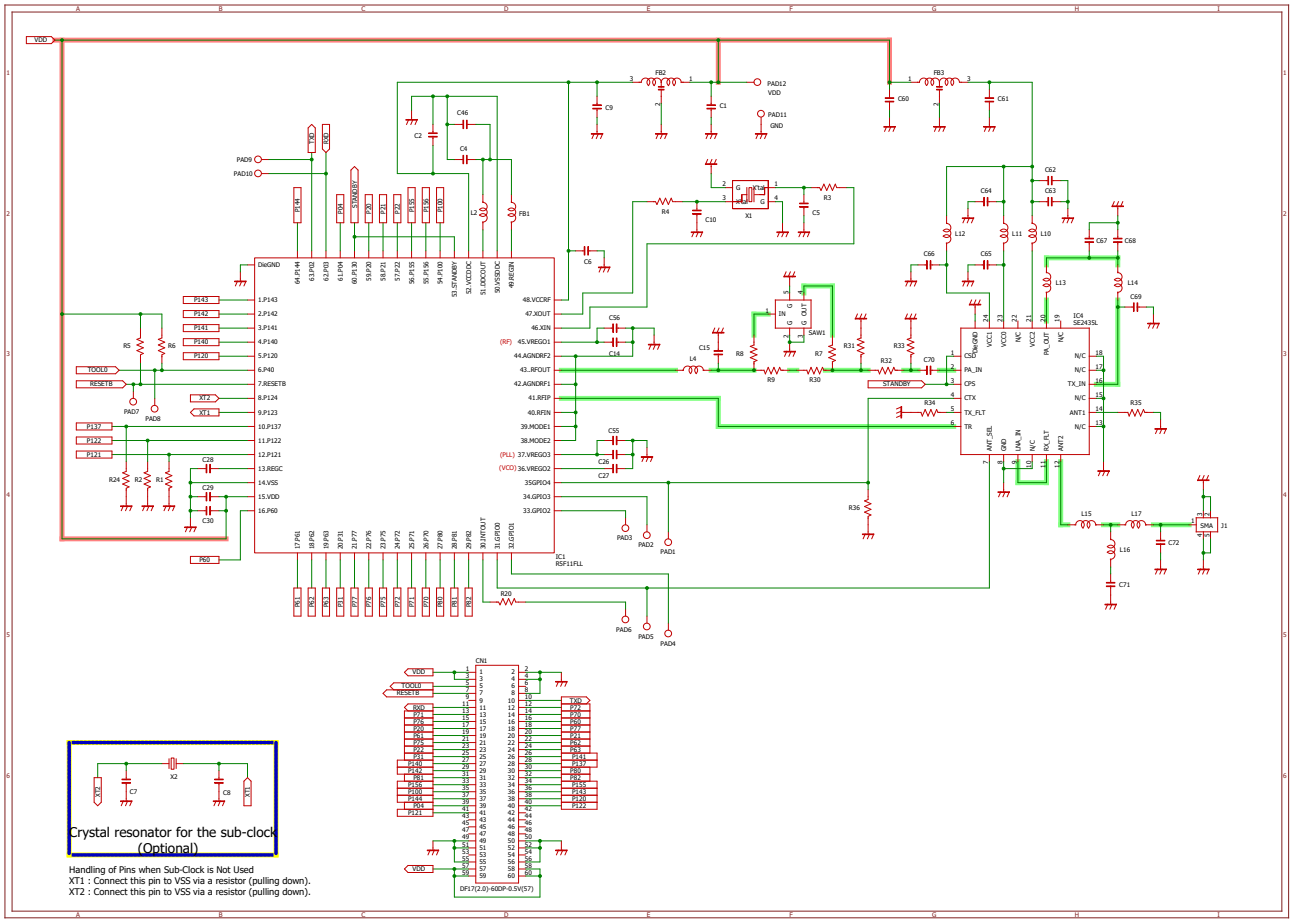

Figure 15 Reference circuit diagram of RL78/G1H and SE2435L (When a SAW is mounted on TX line)

3.2 Parts List (When a SAW filter is mounted on TX line)

Table 8 shows parts list of RL78/G1H and SE2435L when a SAW filter is mounted on TX line.

Table 8 Parts list of RL78/G1H and SE2435L (When a SAW is mounted on TX line)

Patrs ID	Description	Type	Patrs number	Manufacture	Size	Tolerance
C1	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C2	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C4	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C5	9pF	Capacitor	GRM1555C1H9R0BA01D	Murata	1.0x0.5x0.5mm	±0.1pF
C6	2.2uF	Capacitor	GRM155R60G225ME15D	Murata	1.0x0.5x0.5mm	±20%
C7	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C8	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C9	10uF	Capacitor	GRM188D71A106MA73	Murata	1.6x0.8x0.8mm	±20%
C10	9pF	Capacitor	GRM1555C1H9R0BA01D	Murata	1.0x0.5x0.5mm	±0.1pF
C14	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C15	5.6pF	Capacitor	GRM1552C1H5R6CA01D	Murata	1.0x0.5x0.5mm	±0.25pF
C26	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C27	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C28	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C29	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C30	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C46	47pF	Capacitor	GRM1552C1H470JA01D	Murata	1.0x0.5x0.5mm	±5%
C55	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C56	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C60	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C61	4.7uF	Capacitor	GRM188B30J475KE18	Murata	1.0x0.5x0.5mm	±10%
C62	1000pF	Capacitor	GRM1552C1H102JA01	Murata	1.0x0.5x0.5mm	±5%
C63	33pF	Capacitor	GRM1552C1H330JZ01	Murata	1.0x0.5x0.5mm	±5%
C64	0.01uF	Capacitor	GRM155B31H103KA88	Murata	1.0x0.5x0.5mm	±10%
C65	22pF	Capacitor	GRM1552C1H220JZ01	Murata	1.0x0.5x0.5mm	±5%
C66	100pF	Capacitor	GRM1552C1H101JA01	Murata	1.0x0.5x0.5mm	±5%
C67	8.2pF	Capacitor	GJM1555C1H8R2CB01	Murata	1.0x0.5x0.5mm	±0.25pF
C68	1.8pF	Capacitor	GJM1555C1H1R8BB01	Murata	1.0x0.5x0.5mm	±0.1pF
C69	2.4pF	Capacitor	GJM1555C1H2R4BB01	Murata	1.0x0.5x0.5mm	±0.1pF
C70	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
C71	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
C72	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
FB1	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
FB2	2200pF	EMI Filter	NFM18CC222R1C3	Murata	1.6x0.8x0.6mm	±20%
FB3	2200pF	EMI Filter	NFM18CC222R1C3	Murata	1.6x0.8x0.6mm	±20%
J1	-	SMA	73251-1150	Molex	-	-
CN1	-	Connector	DF17(2.0)-60DP-0.5V(57)	Hirose	-	-
L2	10uH	Inductor	MLZ1608M100WT	TDK	1.6x0.8x0.8mm	±20%
L4	4.7nH	Inductor	LQW15AN4N7C00	Murata	1.0x0.5x0.5mm	±0.2nH
L10	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
L11	4.7nH	Inductor	MLG1005S4N7S	TDK	1.0x0.5x0.5mm	±0.3nH
L12	3.3nH	Inductor	MLG1005S3N3S	TDK	1.0x0.5x0.5mm	±0.3nH
L13	1.3nH	Inductor	MLG1005S1N3S	TDK	1.0x0.5x0.5mm	±0.3nH
L14	5.6nH	Inductor	MLG1005S5N6S	TDK	1.0x0.5x0.5mm	±0.3nH
L15	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
L16	3.3pF	Capacitor	GJM1555C1H3R3BB01	Murata	1.0x0.5x0.5mm	±0.1pF
L17	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
R1	100kΩ	Resistor	RK73H1ETTP1003F	KOA	1.0x0.5x0.5mm	±1%
R2	100kΩ	Resistor	RK73H1ETTP1003F	KOA	1.0x0.5x0.5mm	±1%
R3	22nH	Inductor	LQG15HS22NJ02D	Murata	1.0x0.5x0.5mm	±5%
R4	22nH	Inductor	LQG15HS22NJ02D	Murata	1.0x0.5x0.5mm	±5%
R5	10kΩ	Resistor	RK73H1ETTP1002F	KOA	1.0x0.5x0.5mm	±1%
R6	10kΩ	Resistor	RK73H1ETTP1002F	KOA	1.0x0.5x0.5mm	±1%
R7	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R8	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R9	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
R20	Not mounted	Short	-	-	1.0x0.5x0.5mm	-
R24	100kΩ	Resistor	RK73H1ETTP1003F	KOA	1.0x0.5x0.5mm	±1%
R30	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
R31	150Ω	Resistor	RK73H1ETTP1500F	KOA	1.0x0.5x0.5mm	±1%
R32	36Ω	Resistor	RK73H1ETTP36R0F	KOA	1.0x0.5x0.5mm	±1%
R33	150Ω	Resistor	RK73H1ETTP1500F	KOA	1.0x0.5x0.5mm	±1%
R34	51Ω	Resistor	RK73H1ETTP51R0F	KOA	1.0x0.5x0.5mm	±1%
R35	51Ω	Resistor	RK73H1ETTP51R0F	KOA	1.0x0.5x0.5mm	±1%
R36	100kΩ	Resistor	RK73H1ETTP1003F	KOA	1.0x0.5x0.5mm	±1%
X1	48MHz	Crystal resonator	XRCMD48M000FXQ60R0	Murata	1.6x1.2x0.33mm	-
X2	Optional(Not mounted	Crystal resonator	ST3215SB32768H5HRXAA	Kyocera	3.2x1.5x0.8mm	-
IC1	-	LSI	R5F11FLL	Renesas	9.0x9.0x1.0mm	-

3.3 Circuit diagram (When a SAW filter is mounted on TX/RX lines)

Figure 16 shows the reference circuit diagram of RL78/G1H and SE2435L when a SAW filter is mounted on TX/RX lines.

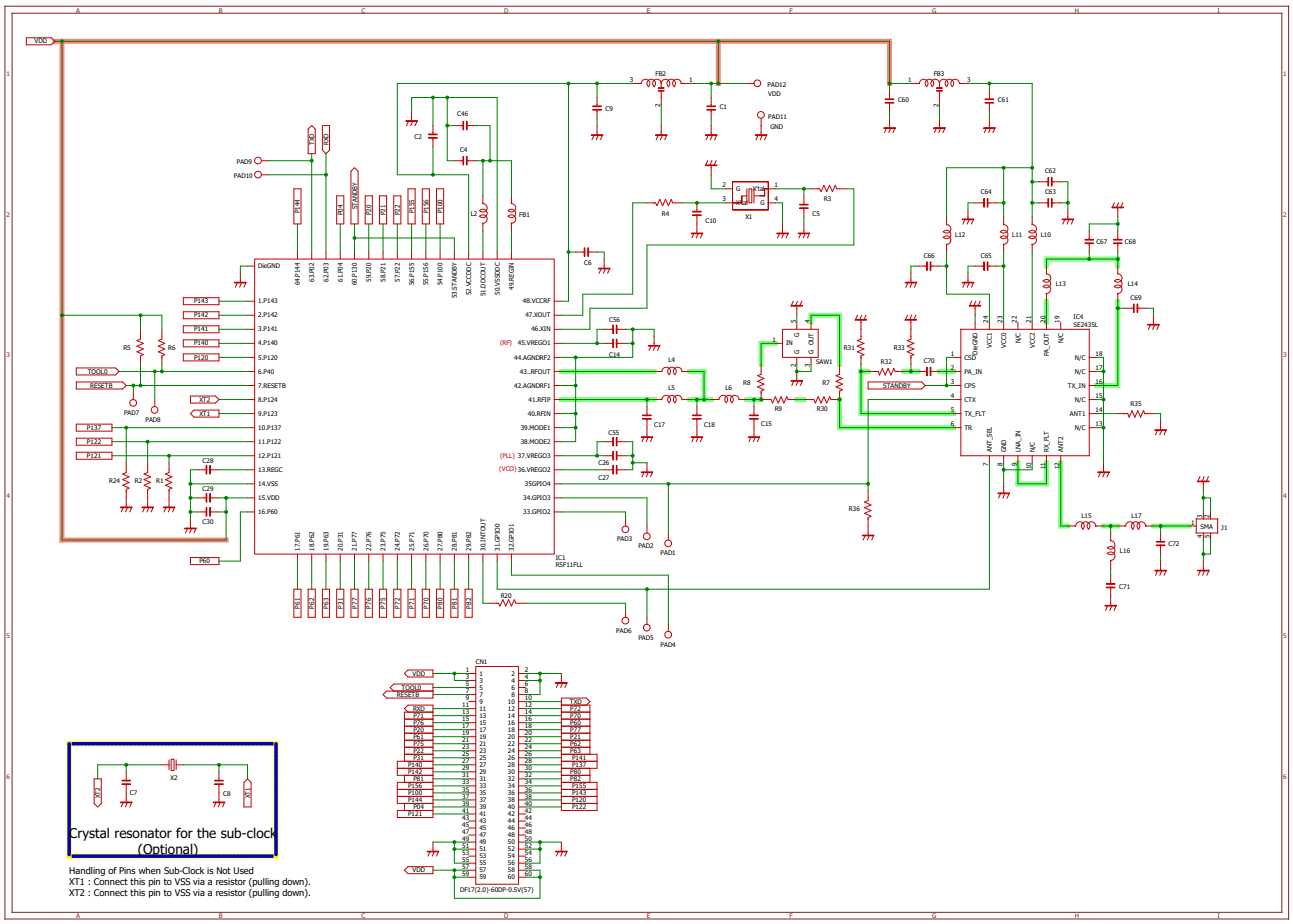

Figure 16 Reference circuit diagram of RL78/G1H and SE2435L (When a SAW is mounted on TX/RX lines)

3.4 Parts List (When a SAW filter is mounted on TX/RX lines)

Table 9 shows parts list of RL78/G1H and SE2435L when a SAW filter is mounted on TX/RX lines.

Table 9 Parts list of RL78/G1H and SE2435L (When a SAW is mounted on TX/RX lines)

Patrs ID	Description	Type	Patrs number	Manufacture	Size	Tolerance
C1	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C2	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C4	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C5	9pF	Capacitor	GRM1555C1H9R0BA01D	Murata	1.0x0.5x0.5mm	±0.1pF
C6	2.2uF	Capacitor	GRM155R60G225ME15D	Murata	1.0x0.5x0.5mm	±20%
C7	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C8	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C9	10uF	Capacitor	GRM188D71A106MA73	Murata	1.6x0.8x0.8mm	±20%
C10	9pF	Capacitor	GRM1555C1H9R0BA01D	Murata	1.0x0.5x0.5mm	±0.1pF
C14	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C15	3.3pF	Capacitor	GRM1553C1H3R3CZ01D	Murata	1.0x0.5x0.5mm	±0.25pF
C17	4.7pF	Capacitor	GRM1552C1H4R7CZ01D	Murata	1.0x0.5x0.5mm	±0.25pF
C18	5.6pF	Capacitor	GRM1552C1H5R6CA01D	Murata	1.0x0.5x0.5mm	±0.25pF
C26	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C27	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C28	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C29	1uF	Capacitor	GRM155B31C105KA12D	Murata	1.0x0.5x0.5mm	±10%
C30	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C46	47pF	Capacitor	GRM1552C1H470JA01D	Murata	1.0x0.5x0.5mm	±5%
C55	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C56	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C60	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C61	4.7uF	Capacitor	GRM188B30J475KE18	Murata	1.0x0.5x0.5mm	±10%
C62	1000pF	Capacitor	GRM1552C1H102JA01	Murata	1.0x0.5x0.5mm	±5%
C63	33pF	Capacitor	GRM1552C1H330JZ01	Murata	1.0x0.5x0.5mm	±5%
C64	0.01uF	Capacitor	GRM155B31H103KA88	Murata	1.0x0.5x0.5mm	±10%
C65	22pF	Capacitor	GRM1552C1H220JZ01	Murata	1.0x0.5x0.5mm	±5%
C66	100pF	Capacitor	GRM1552C1H101JA01	Murata	1.0x0.5x0.5mm	±5%
C67	8.2pF	Capacitor	GJM1555C1H8R2CB01	Murata	1.0x0.5x0.5mm	±0.25pF
C68	1.8pF	Capacitor	GJM1555C1H1R8BB01	Murata	1.0x0.5x0.5mm	±0.1pF
C69	2.4pF	Capacitor	GJM1555C1H2R4BB01	Murata	1.0x0.5x0.5mm	±0.1pF
C70	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
C71	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
C72	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
FB1	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
FB2	2200pF	EMI Filter	NFM18CC222R1C3	Murata	1.6x0.8x0.6mm	±20%
FB3	2200pF	EMI Filter	NFM18CC222R1C3	Murata	1.6x0.8x0.6mm	±20%
J1	-	SMA	73251-1150	Molex	-	-
CN1	-	Connector	DF17(2.0)-60DP-0.5V(57)	Hirose	-	-
L2	10uH	Inductor	MLZ1608M100WT	TDK	1.6x0.8x0.8mm	±20%
L4	2.2nH	Inductor	LQW15AN2N2C10	Murata	1.0x0.5x0.5mm	±0.2nH
L5	5.6nH	Inductor	LQW15AN5N6C10	Murata	1.0x0.5x0.5mm	±0.2nH
L6	5.6nH	Inductor	LQW15AN5N6C10	Murata	1.0x0.5x0.5mm	±0.2nH
L10	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
L11	4.7nH	Inductor	MLG1005S4N7S	TDK	1.0x0.5x0.5mm	±0.3nH
L12	3.3nH	Inductor	MLG1005S3N3S	TDK	1.0x0.5x0.5mm	±0.3nH
L13	1.3nH	Inductor	MLG1005S1N3S	TDK	1.0x0.5x0.5mm	±0.3nH
L14	5.6nH	Inductor	MLG1005S5N6S	TDK	1.0x0.5x0.5mm	±0.3nH
L15	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
L16	3.3pF	Capacitor	GJM1555C1H3R3BB01	Murata	1.0x0.5x0.5mm	±0.1pF
L17	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
R1	100kΩ	Resistor	RK73H1ETTP1003F	KOA	1.0x0.5x0.5mm	±1%
R2	100kΩ	Resistor	RK73H1ETTP1003F	KOA	1.0x0.5x0.5mm	±1%
R3	22nH	Inductor	LQG15HS22NJ02D	Murata	1.0x0.5x0.5mm	±5%
R4	22nH	Inductor	LQG15HS22NJ02D	Murata	1.0x0.5x0.5mm	±5%
R5	10kΩ	Resistor	RK73H1ETTP1002F	KOA	1.0x0.5x0.5mm	±1%
R6	10kΩ	Resistor	RK73H1ETTP1002F	KOA	1.0x0.5x0.5mm	±1%
R7	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R8	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R9	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
R20	Not mounted	Short	-	-	1.0x0.5x0.5mm	-
R24	100kΩ	Resistor	RK73H1ETTP1003F	KOA	1.0x0.5x0.5mm	±1%
R30	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
R31	150Ω	Resistor	RK73H1ETTP1500F	KOA	1.0x0.5x0.5mm	±1%
R32	36Ω	Resistor	RK73H1ETTP36R0F	KOA	1.0x0.5x0.5mm	±1%
R33	150Ω	Resistor	RK73H1ETTP1500F	KOA	1.0x0.5x0.5mm	±1%
R35	51Ω	Resistor	RK73H1ETTP51R0F	KOA	1.0x0.5x0.5mm	±1%
R36	100kΩ	Resistor	RK73H1ETTP1003F	KOA	1.0x0.5x0.5mm	±1%
SAW1	Not mounted	SAW Filter	B2672	RF360	1.4x1.1x0.45mm	-
X1	48MHz	Crystal resonator	XRCMD48M000FXQ60R0	Murata	1.6x1.2x0.33mm	-
X2	Optional(Not mounted	Crystal resonator	ST3215SB32768H5HRXAA	Kyocera	3.2x1.5x0.8mm	-
IC1	-	LSI	R5F11FLL	Renesas	9.0x9.0x1.0mm	-

4. Reference circuit using RA604S00

4.1 Circuit diagram (When a SAW filter is mounted on TX line)

Figure 17 shows the reference circuit diagram of RA604S00 and SE2435L when a SAW filter is mounted on TX line. This is an example using RX651 (R5F5651EDDFM).

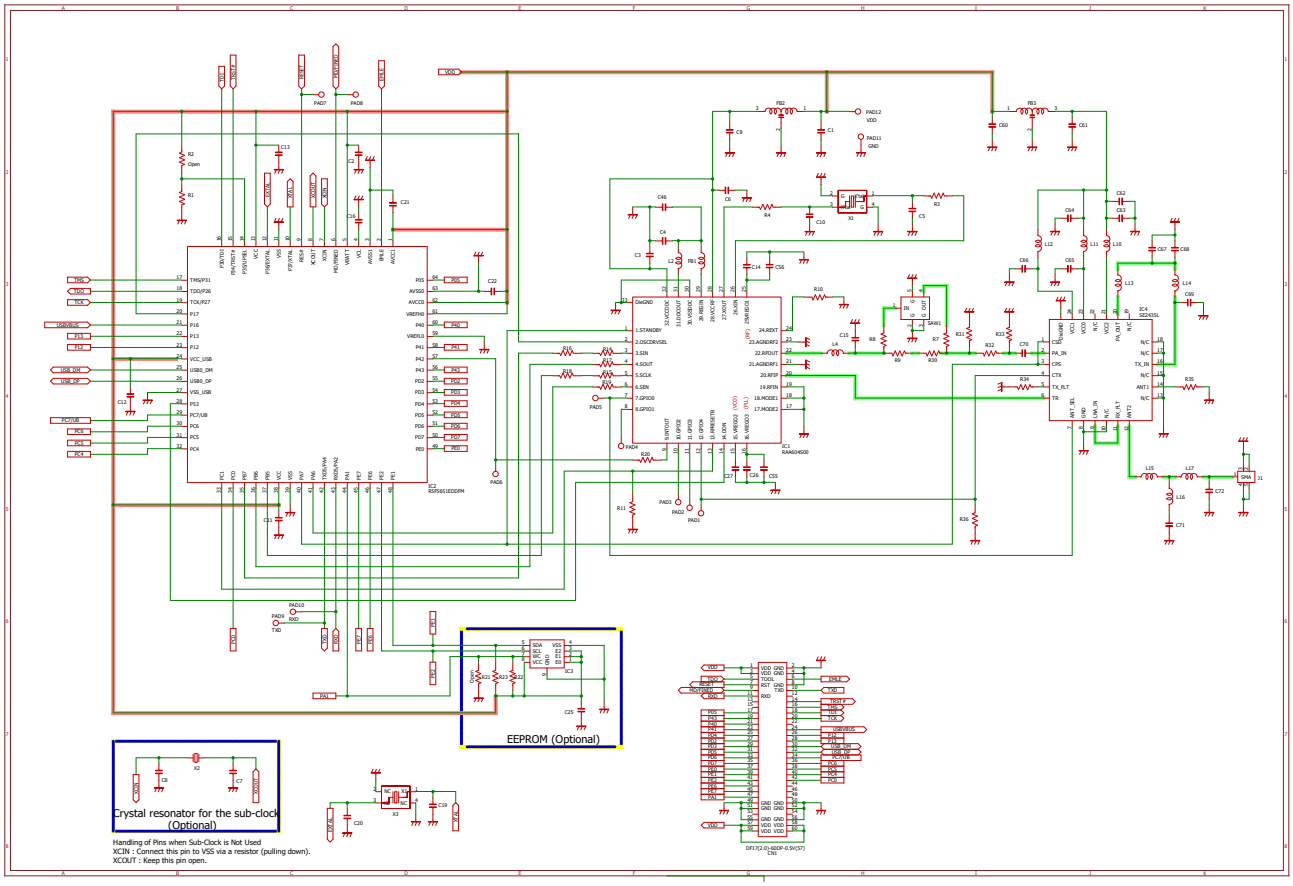

Figure 17 Reference circuit diagram of RA604S00 and SE2435L (When a SAW is mounted on TX line)

4.2 Parts List (When a SAW filter is mounted on TX line)

Table 10 shows parts list of RAA604S00 and SE2435L when a SAW filter is mounted on TX line.

Table 10 Parts list of RAA604S00 and SE2435L (When a SAW is mounted on TX line)

Patrs ID	Description	Type	Patrs number	Manufacture	Size	Tolerance
C1	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C2	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C3	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C4	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C5	9pF	Capacitor	GRM1555C1H9R0BA01D	Murata	1.0x0.5x0.5mm	±0.1pF
C6	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C7	24pF	Capacitor	GRM1555C1H240JA01D	Murata	1.0x0.5x0.5mm	±5%
C8	24pF	Capacitor	GRM1555C1H240JA01D	Murata	1.0x0.5x0.5mm	±5%
C9	10uF	Capacitor	GRM188R61C106MAALD	Murata	1.6x0.8x0.8mm	±20%
C10	9pF	Capacitor	GRM1555C1H9R0BA01D	Murata	1.0x0.5x0.5mm	±0.1pF
C11	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C12	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C13	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C14	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C15	5.6pF	Capacitor	GRM1552C1H5R6CA01D	Murata	1.0x0.5x0.5mm	±0.25pF
C16	0.22uF	Capacitor	GRM155R61A224KE19D	Murata	1.0x0.5x0.5mm	±10%
C19	6pF	Capacitor	GRM1552C1H6R0CA01D	Murata	1.0x0.5x0.5mm	±0.25pF
C20	6pF	Capacitor	GRM1552C1H6R0CA01D	Murata	1.0x0.5x0.5mm	±0.25pF
C21	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C22	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C25	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C26	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C27	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C46	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C55	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C56	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C60	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C61	4.7uF	Capacitor	GRM188B30J475KE18	Murata	1.0x0.5x0.5mm	±10%
C62	1000pF	Capacitor	GRM1552C1H102JA01	Murata	1.0x0.5x0.5mm	±5%
C63	33pF	Capacitor	GRM1552C1H330JZ01	Murata	1.0x0.5x0.5mm	±5%
C64	0.01uF	Capacitor	GRM155B31H103KA88	Murata	1.0x0.5x0.5mm	±10%
C65	22pF	Capacitor	GRM1552C1H220JZ01	Murata	1.0x0.5x0.5mm	±5%
C66	100pF	Capacitor	GRM1552C1H101JA01	Murata	1.0x0.5x0.5mm	±5%
C67	8.2pF	Capacitor	GJM1555C1H8R2CB01	Murata	1.0x0.5x0.5mm	±0.25pF
C68	1.8pF	Capacitor	GJM1555C1H1R8BB01	Murata	1.0x0.5x0.5mm	±0.1pF
C69	2.4pF	Capacitor	GJM1555C1H2R4BB01	Murata	1.0x0.5x0.5mm	±0.1pF
C70	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
C71	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
C72	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
FB1	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
FB2	2200pF	EMI Filter	NFM18CC222R1C3	Murata	1.6x0.8x0.6mm	±20%
FB3	2200pF	EMI Filter	NFM18CC222R1C3	Murata	1.6x0.8x0.6mm	±20%
J1	-	SMA	73251-1150	Molex	-	-
CN1	-	Connector	DF17(2.0)-60DP-0.5V(57)	Hirose	-	-
L2	10uH	Inductor	MLZ1608M100WT	TDK	1.6x0.8x0.8mm	±20%
L4	4.7nH	Inductor	LQW15AN4N7C00	Murata	1.0x0.5x0.5mm	±0.2nH
L10	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
L11	4.7nH	Inductor	MLG1005S4N7S	TDK	1.0x0.5x0.5mm	±0.3nH
L12	3.3nH	Inductor	MLG1005S3N3S	TDK	1.0x0.5x0.5mm	±0.3nH
L13	1.3nH	Inductor	MLG1005S1N3S	TDK	1.0x0.5x0.5mm	±0.3nH
L14	5.6nH	Inductor	MLG1005S5N6S	TDK	1.0x0.5x0.5mm	±0.3nH
L15	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
L16	3.3pF	Capacitor	GJM1555C1H3R3BB01	Murata	1.0x0.5x0.5mm	±0.1pF
L17	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
R1	4.7kΩ	Resistor	RK73H1ETTP4701F	KOA	1.0x0.5x0.5mm	±1%
R2	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R3	22nH	Inductor	LQG15HS22NJ02D	Murata	1.0x0.5x0.5mm	±5%
R4	22nH	Inductor	LQG15HS22NJ02D	Murata	1.0x0.5x0.5mm	±5%
R7	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R8	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R9	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
R10	56kΩ	Resistor	RK73H1ETTP5602F	KOA	1.0x0.5x0.5mm	±1%
R11	4.7kΩ	Resistor	RK73H1ETTP4701F	KOA	1.0x0.5x0.5mm	±1%
R14	300Ω	Resistor	RK73H1ETTP3000F	KOA	1.0x0.5x0.5mm	±1%
R15	300Ω	Resistor	RK73H1ETTP3000F	KOA	1.0x0.5x0.5mm	±1%
R16	82nH	Inductor	LQG15HS82NJ02D	Murata	1.0x0.5x0.5mm	±5%
R17	300Ω	Resistor	RK73H1ETTP3000F	KOA	1.0x0.5x0.5mm	±1%
R18	82nH	Inductor	LQG15HS82NJ02D	Murata	1.0x0.5x0.5mm	±5%
R19	300Ω	Resistor	RK73H1ETTP3000F	KOA	1.0x0.5x0.5mm	±1%
R20	300Ω	Resistor	RK73H1ETTP3000F	KOA	1.0x0.5x0.5mm	±1%
R21	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R22	4.7kΩ	Resistor	RK73H1ETTP4701F	KOA	1.0x0.5x0.5mm	±1%

R23	2.2kΩ	Resistor	RK73H1ETTP2201F	KOA	1.0x0.5x0.5mm	±1%
R30	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
R31	150Ω	Resistor	RK73H1ETTP1500F	KOA	1.0x0.5x0.5mm	±1%
R32	36Ω	Resistor	RK73H1ETTP36R0F	KOA	1.0x0.5x0.5mm	±1%
R33	150Ω	Resistor	RK73H1ETTP1500F	KOA	1.0x0.5x0.5mm	±1%
R34	51Ω	Resistor	RK73H1ETTP51R0F	KOA	1.0x0.5x0.5mm	±1%
R35	51Ω	Resistor	RK73H1ETTP51R0F	KOA	1.0x0.5x0.5mm	±1%
R36	100kΩ	Resistor	RK73H1ETTP1003F	KOA	1.0x0.5x0.5mm	±1%
SAW1	Not mounted	SAW Filter	B2672	RF360	1.4x1.1x0.45mm	-
X1	48MHz	Crystal resonator	XRCMD48M000FXQ60R0	Murata	1.6x1.2x0.33mm	-
X2	Optional	Crystal resonator	ST3215SB32768H5HRXAA	Kyocera	3.2x1.5x0.8mm	-
X3	16MHz	Crystal resonator	CX3225CA16000D0PRTC3	Kyocera	3.2x2.5x0.8mm	-
IC1	-	LSI	RAA604S00	Renesas	5.0x5.0x1.0mm	-
IC2*1	-	LSI	R5F5651EDDFM	Renesas	10x10x1.4mm	-
IC3	Optional	EEPROM	M24C64-DFMC6TG	STMicro	3.0x2.0x0.55mm	-
IC4	PA/LNA/SW	Front-end Module	SE2435L	SKYWORKS	4.0x4.0x0.9mm	-
*1 It is recommended to mount EEPROM separately for products without data flash memory.						

4.3 Circuit diagram (When a SAW filter is mounted on TX/RX lines)

Figure 18 shows the reference circuit diagram of RAA604S00 and SE2435L when a SAW filter is mounted on TX/RX lines. This is an example using RX651 (R5F5651EDDFM).

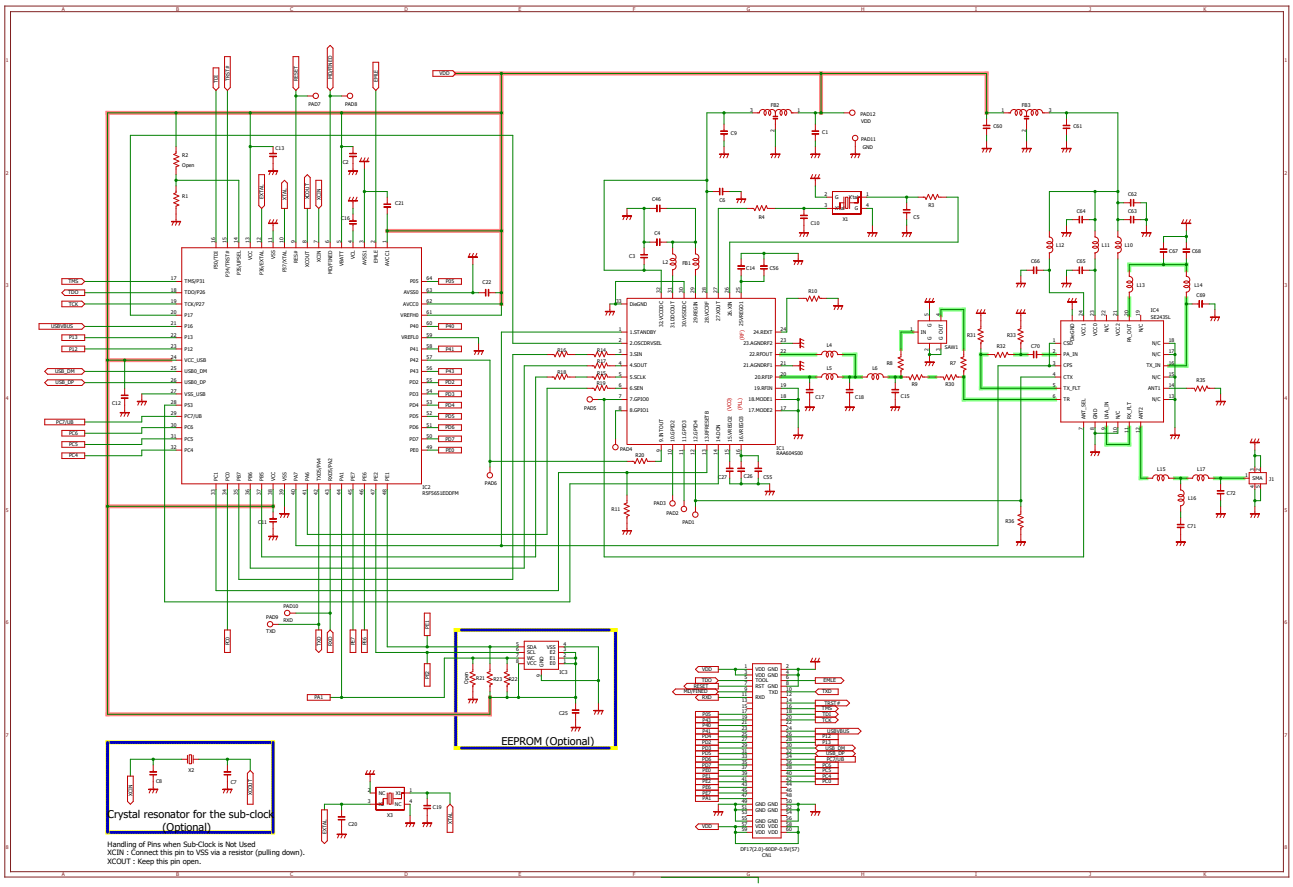

Figure 18 Reference circuit diagram of RAA604S00 and SE2435L (When a SAW is mounted on TX/RX lines)

4.4 Parts List (When a SAW filter is mounted on TX/RX lines)

Table 11 shows parts list of RAA604S00 and SE2435L when a SAW filter is mounted on TX/RX lines.

Table 11 Parts list of RAA604S00 and SE2435L (When a SAW is mounted on TX/RX lines)

Patrs ID	Description	Type	Patrs number	Manufacture	Size	Tolerance
C1	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C2	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C3	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C4	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C5	9pF	Capacitor	GRM1555C1H9R0BA01D	Murata	1.0x0.5x0.5mm	±0.1pF
C6	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C7	24pF	Capacitor	GRM1555C1H240JA01D	Murata	1.0x0.5x0.5mm	±5%
C8	24pF	Capacitor	GRM1555C1H240JA01D	Murata	1.0x0.5x0.5mm	±5%
C9	10uF	Capacitor	GRM188R61C106MAALD	Murata	1.6x0.8x0.8mm	±20%
C10	9pF	Capacitor	GRM1555C1H9R0BA01D	Murata	1.0x0.5x0.5mm	±0.1pF
C11	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C12	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C13	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C14	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C15	3.3pF	Capacitor	GRM1553C1H3R3CZ01D	Murata	1.0x0.5x0.5mm	±0.25pF
C16	0.22uF	Capacitor	GRM155R61A224KE19D	Murata	1.0x0.5x0.5mm	±10%
C17	4.7pF	Capacitor	GRM1552C1H4R7CZ01D	Murata	1.0x0.5x0.5mm	±0.25pF
C18	5.6pF	Capacitor	GRM1552C1H5R6CA01D	Murata	1.0x0.5x0.5mm	±0.25pF
C19	6pF	Capacitor	GRM1552C1H6R0CA01D	Murata	1.0x0.5x0.5mm	±0.25pF
C20	6pF	Capacitor	GRM1552C1H6R0CA01D	Murata	1.0x0.5x0.5mm	±0.25pF
C21	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C22	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C25	0.1uF	Capacitor	GRM155R61E104KA87D	Murata	1.0x0.5x0.5mm	±10%
C26	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C27	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C46	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C55	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C56	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
C60	1uF	Capacitor	GRM155C81C105KE11D	Murata	1.0x0.5x0.5mm	±10%
C61	4.7uF	Capacitor	GRM188B30J475KE18	Murata	1.0x0.5x0.5mm	±10%
C62	1000pF	Capacitor	GRM1552C1H102JA01	Murata	1.0x0.5x0.5mm	±5%
C63	33pF	Capacitor	GRM1552C1H330JZ01	Murata	1.0x0.5x0.5mm	±5%
C64	0.01uF	Capacitor	GRM155B31H103KA88	Murata	1.0x0.5x0.5mm	±10%
C65	22pF	Capacitor	GRM1552C1H220JZ01	Murata	1.0x0.5x0.5mm	±5%
C66	100pF	Capacitor	GRM1552C1H101JA01	Murata	1.0x0.5x0.5mm	±5%
C67	8.2pF	Capacitor	GJM1555C1H8R2CB01	Murata	1.0x0.5x0.5mm	±0.25pF
C68	1.8pF	Capacitor	GJM1555C1H1R8BB01	Murata	1.0x0.5x0.5mm	±0.1pF
C69	2.4pF	Capacitor	GJM1555C1H2R4BB01	Murata	1.0x0.5x0.5mm	±0.1pF
C70	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
C71	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
C72	Not mounted	Capacitor	-	-	1.0x0.5x0.5mm	-
FB1	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
FB2	2200pF	EMI Filter	NFM18CC222R1C3	Murata	1.6x0.8x0.6mm	±20%
FB3	2200pF	EMI Filter	NFM18CC222R1C3	Murata	1.6x0.8x0.6mm	±20%
J1	-	SMA	73251-1150	Molex	-	-
CN1	-	Connector	DF17(2.0)-60DP-0.5V(57)	Hirose	-	-
L2	10uH	Inductor	MLZ1608M100WT	TDK	1.6x0.8x0.8mm	±20%
L4	2.2nH	Inductor	LQW15AN2N2C10	Murata	1.0x0.5x0.5mm	±0.2nH
L5	5.6nH	Inductor	LQW15AN5N6C10	Murata	1.0x0.5x0.5mm	±0.2nH
L6	5.6nH	Inductor	LQW15AN5N6C10	Murata	1.0x0.5x0.5mm	±0.2nH
L10	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
L11	4.7nH	Inductor	MLG1005S4N7S	TDK	1.0x0.5x0.5mm	±0.3nH
L12	3.3nH	Inductor	MLG1005S3N3S	TDK	1.0x0.5x0.5mm	±0.3nH
L13	1.3nH	Inductor	MLG1005S1N3S	TDK	1.0x0.5x0.5mm	±0.3nH
L14	5.6nH	Inductor	MLG1005S5N6S	TDK	1.0x0.5x0.5mm	±0.3nH
L15	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
L16	3.3pF	Capacitor	GJM1555C1H3R3BB01	Murata	1.0x0.5x0.5mm	±0.1pF
L17	6.8nH	Inductor	MLG1005S6N8J	TDK	1.0x0.5x0.5mm	±5%
R1	4.7kΩ	Resistor	RK73H1ETTP4701F	KOA	1.0x0.5x0.5mm	±1%
R2	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R3	22nH	Inductor	LQG15HS22NJ02D	Murata	1.0x0.5x0.5mm	±5%
R4	22nH	Inductor	LQG15HS22NJ02D	Murata	1.0x0.5x0.5mm	±5%
R7	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R8	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R9	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
R10	56kΩ	Resistor	RK73H1ETTP5602F	KOA	1.0x0.5x0.5mm	±1%
R11	4.7kΩ	Resistor	RK73H1ETTP4701F	KOA	1.0x0.5x0.5mm	±1%
R14	300Ω	Resistor	RK73H1ETTP3000F	KOA	1.0x0.5x0.5mm	±1%
R15	300Ω	Resistor	RK73H1ETTP3000F	KOA	1.0x0.5x0.5mm	±1%
R16	82nH	Inductor	LQG15HS82NJ02D	Murata	1.0x0.5x0.5mm	±5%
R17	300Ω	Resistor	RK73H1ETTP3000F	KOA	1.0x0.5x0.5mm	±1%
R18	82nH	Inductor	LQG15HS82NJ02D	Murata	1.0x0.5x0.5mm	±5%

R19	300Ω	Resistor	RK73H1ETTP3000F	KOA	1.0x0.5x0.5mm	±1%
R20	300Ω	Resistor	RK73H1ETTP3000F	KOA	1.0x0.5x0.5mm	±1%
R21	Not mounted	Resistor	-	-	1.0x0.5x0.5mm	-
R22	4.7kΩ	Resistor	RK73H1ETTP4701F	KOA	1.0x0.5x0.5mm	±1%
R23	2.2kΩ	Resistor	RK73H1ETTP2201F	KOA	1.0x0.5x0.5mm	±1%
R30	0Ω	Resistor	MCR01MZPJ000	Rohm	1.0x0.5x0.5mm	±5%
R31	150Ω	Resistor	RK73H1ETTP1500F	KOA	1.0x0.5x0.5mm	±1%
R32	36Ω	Resistor	RK73H1ETTP36R0F	KOA	1.0x0.5x0.5mm	±1%
R33	150Ω	Resistor	RK73H1ETTP1500F	KOA	1.0x0.5x0.5mm	±1%
R35	51Ω	Resistor	RK73H1ETTP51R0F	KOA	1.0x0.5x0.5mm	±1%
R36	100kΩ	Resistor	RK73H1ETTP1003F	KOA	1.0x0.5x0.5mm	±1%
SAW1	Not mounted	SAW Filter	B2672	RF360	1.4x1.1x0.45mm	-
X1	48MHz	Crystal resonator	XRCMD48M000FXQ60R0	Murata	1.6x1.2x0.33mm	-
X2	Optional	Crystal resonator	ST3215SB32768H5HRXAA	Kyocera	3.2x1.5x0.8mm	-
X3	16MHz	Crystal resonator	CX3225CA16000D0PRTC3	Kyocera	3.2x2.5x0.8mm	-
IC1	-	LSI	RAA604S00	Renesas	5.0x5.0x1.0mm	-
IC2*1	-	LSI	R5F5651EDDFM	Renesas	10x10x1.4mm	-
IC3	Optional	EEPROM	M24C64-DFMC6TG	STMicro	3.0x2.0x0.55mm	-
IC4	PA/LNA/SW	Front-end Module	SE2435L	SKYWORKS	4.0x4.0x0.9mm	-
*1 It is recommended to mount EEPROM separately for products without data flash memory.						

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Mar.6.2020	-	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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