R9A06G037/NJM45001 Circuit Design Guideline

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PCB Circuit Design Guide

Summary

This material is a guideline on PCB circuit for PLC board design by using R9A06G037, the PLC modem LSI by Renesas Electronics and NJM45001 as an AFE-IC. For device and power circuit design, follow guidelines and application notes of the target device.

Note that cautions on this material are based on general board design, and may not be applicable in some cases depending on the board size, parts, and layout.

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1. PLC Board Configuration Example

Figure 1-1 shows a configuration example of a PLC board using R9A06G037, which is a PLC modem LSI manufactured by Renesas Electronics, and NJM45001, an AFE-IC with a built-in Power Amp. This document describes the points to be noted when designing the circuit of the PLC board of this configuration example.

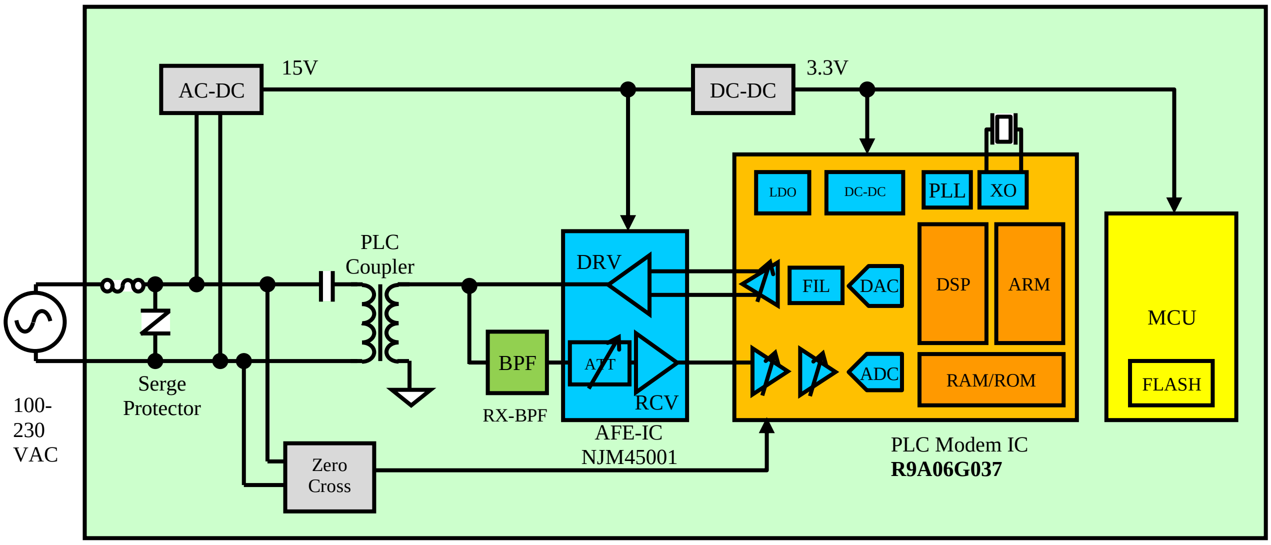


Figure 1-1 PLC Board Configuration Example

2. Cautions regarding peripheral circuits of R9A06G037

2.1 R9A06G037 Peripheral circuit

- Place the decoupling capacitor of R9A06G037 near the terminal. In particular, AVDD33RX1 (12pin) and AVDD33TX1 (62pin) affect the transmission and reception characteristics, so place them near the terminals.

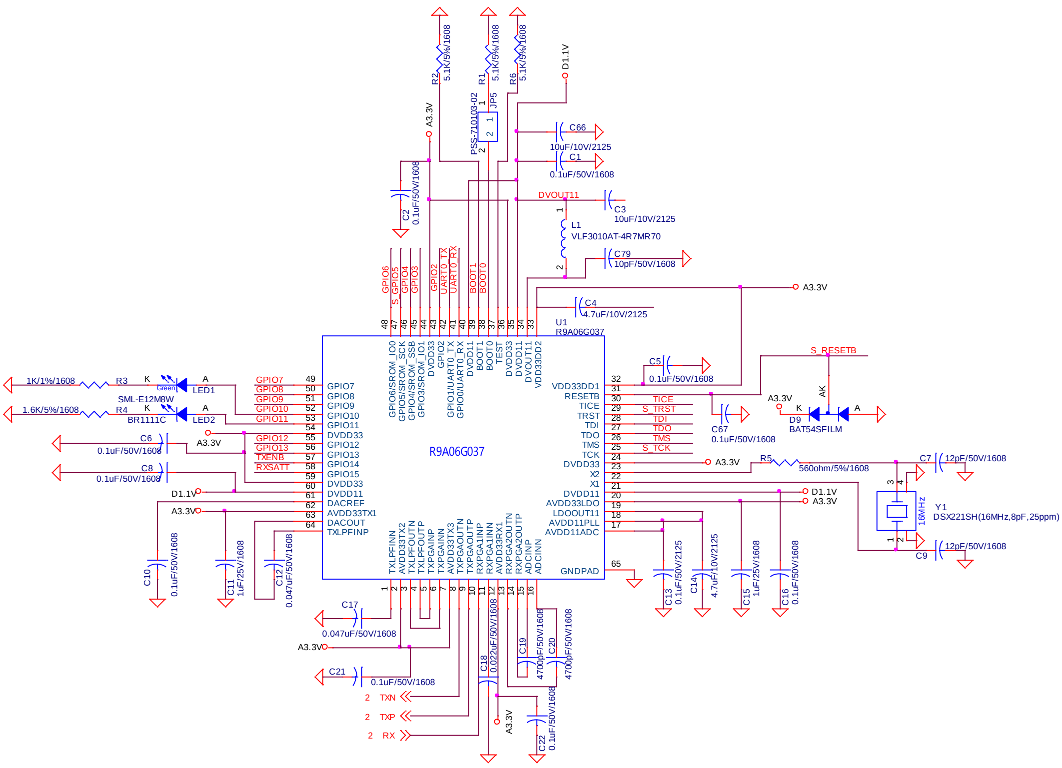


Figure 2-1 R9A06G037 Peripheral circuit

2.2 BOOT terminal setting

2.2.1 BOOT0 terminal

The BOOT0 is a terminal for setting the interface for downloading firmware for boot.

- Set to UART I/F BOOT: Open (High level)
- Set to SROM I F BOOT: Connect to GND via 4.7kΩ or 5.1kΩ (Low level)

Note) The BOOT0 terminal has a built-in pull-up resistor of 50kΩ.

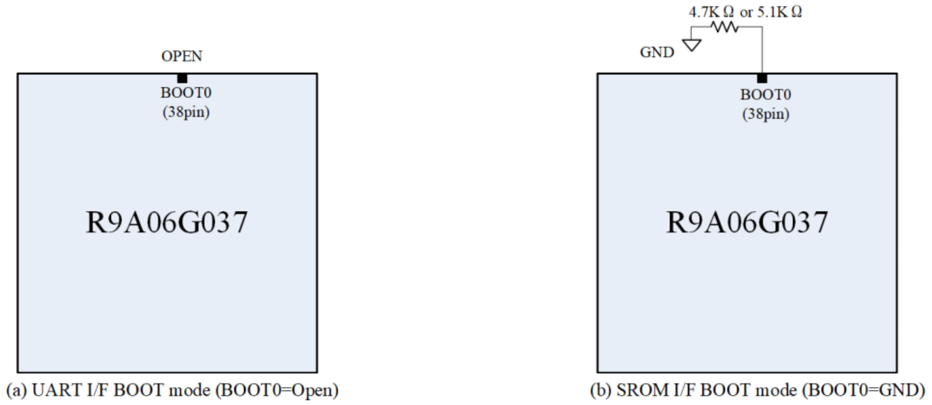


Figure 2-2 BOOT0 terminal connection example

2.2.2 BOOT1 terminal

BOOT1 is a terminal for selecting the clock supply mode.

- Use crystal oscillator: Open (High level) (default setting)
- Use external clock: Connect to GND via 4.7kΩ or 5.1kΩ (Low level)

Note) The BOOT0 terminal has a built-in pull-up resistor of 50kΩ. (a) Crystal oscillator

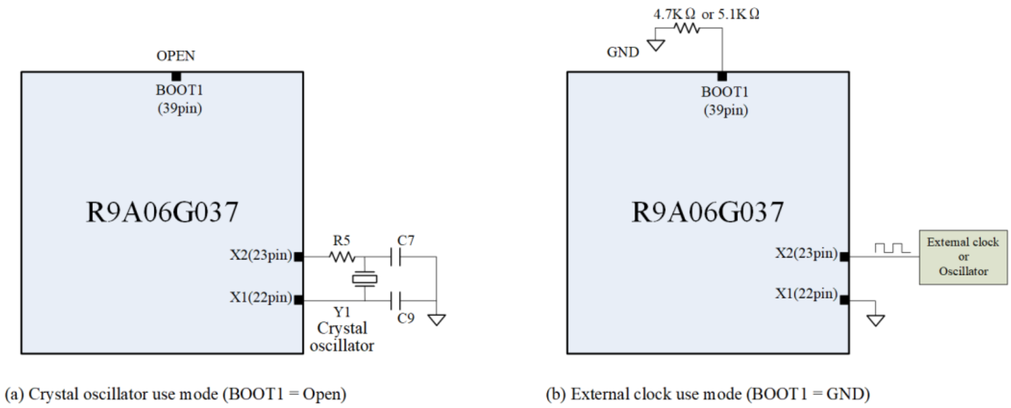


Figure 2-3 BOOT1 terminal connection example

2.3 Reference clock setting

In the reference clock, the G3-PLC standard recommends that the frequency deviation of the system clock be within ± 25 ppm. Therefore, it is recommended to select the reference clock so that the frequency tolerance (deviation) and frequency stability (temperature characteristics) are within ± 25 ppm.

2.3.1 Case using crystal oscillator circuit

- Figure 2-4 shows a connection example of the crystal oscillator circuit.
- Capacitor loads C7 and C9 are required for the X1 (22pin) and X2 (23pin) terminals in order for the 16MHz crystal oscillator to oscillate stably. In addition, R5 is required to adjust the negative resistance.
- Place the crystal oscillator connected to R9A06G037 and its peripheral parts as close to R9A06G037 as possible.

- Table 2-1 shows an example of circuit constants when the crystal oscillator Y1: Kyocera CX2520DB16000D0FLJCC or Daishinku DSX221SH is used. (Crystal oscillator specifications: Frequency: 16MHz, Load capacitor: 8pF, Frequency tolerance: ± 10ppm, Frequency temperature characteristics: ± 15ppm)
- Determine the final circuit constant in consideration of the specifications of the crystal oscillator to be used and the pattern capacitance of the PCB, and consult with the crystal oscillator manufacturer if necessary.

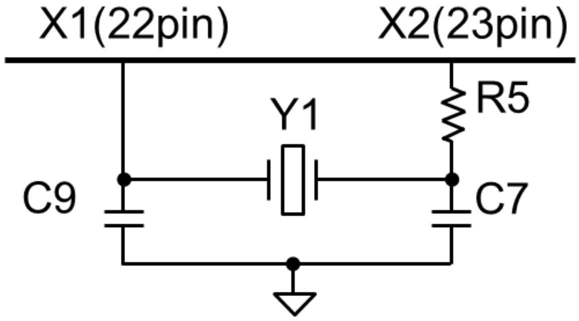


Figure 2-4 Crystal oscillator circuit connection example

Table 2-1 Example of circuit constant of crystal oscillator circuit
(When using crystal oscillator Y1: Kyocera CX2520DB16000D0FLJCC Daishinku DSX221SH)

Component No.	C7	C9	R
Component value	12pF	12pF	560Ω

2.3.2 Case using an external clock

- When using an external clock, connect the X1 terminal to GND and input the external clock signal from the X2 terminal.
- Input 3.3V CMOS level signal to the X2 terminal.
- Place peripheral parts for the external clock connected to R9A06G037 as close to R9A06G037 as possible.

2.4 TEST terminal

- Connect to GND via 1kΩ to 5.1kΩ to prevent malfunction.

2.5 RESETB terminal

- An example of an external circuit for the RESETB terminal is shown in Figure 2-5, and an example of the circuit constants is shown in Table 2-2.
- Place Cx near the RESETB terminal to prevent malfunction due to noise.
- If surge noise such as ESD is expected and there is a concern about the operating environment such as malfunction or terminal destruction, it is recommended to add Dx near the terminal. (In the circuit constant example in Table 2-2, STMicro's BAT54SFILM is used, but determine the specifications such as current capacitor according to the assumed noise.)
- It is recommended to connect to GND via Rx (pull-down resistor). This is to keep the R9A06G037 in the reset state (RESETB = low) to prevent malfunctions while preparing to download the R9A06G037 firmware after a power-on reset. For the resistance value of Rx, consider the impedance of the reset signal output and set the optimum value. (In the circuit constant example in Table 2-2, it is set assuming that there is a pull-up resistance of 50 kΩ or more.)

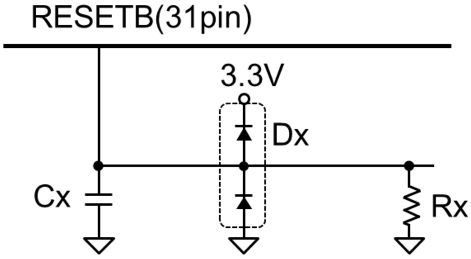


Figure 2-5 Example of an external circuit for the RESETB terminal

Table 2-2 Example of the circuit constants for the RESETB terminal

Component No.	Cx	Dx	Rx
Component value	0.1uF	BAT54SFILM (STMicro)	4.7kΩ or 5.1kΩ

2.6 Power supply circuit

2.6.1 DC-DC converter

- The DC-DC converter uses a switching regulator method to generate a power supply voltage of 3.3V to 1.1V. It is possible to supply the 1.1V power supply of the digital circuit.
- For the frequency stability of the DC-DC converter, set the total to 20uF or more for C3 and C66.
- Figure 2-6 shows an example of an external circuit for a DC-DC converter, and Table 2-3 shows an example of its circuit constants.
- Figure 2-7 shows an example of connecting the decoupling capacitor of the power supply terminal of the DC-DC converter. As shown in (a), place the decoupling capacitor in the immediate vicinity of the power supply terminal.

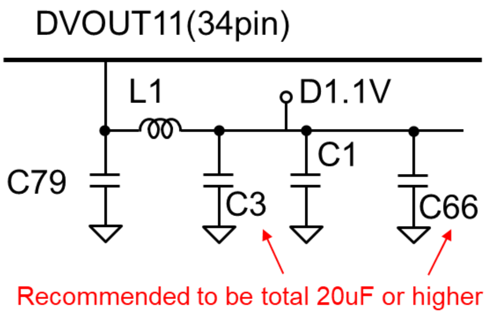


Figure 2-6 Example of an external circuit for a DC-DC converter

Table 2-3 Example of the circuit constants for a DC-DC converter

Component No.	C79	C3	C1	C66	L1
Component value	10pF	10uF	0.1uF	10uF	4.7uH

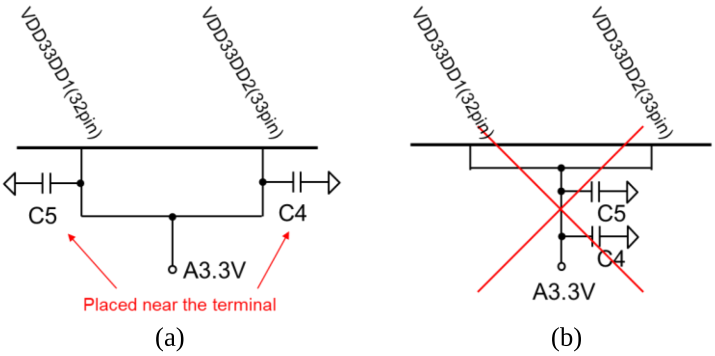


Figure 2-7 Example of connecting the decoupling capacitor of the power supply terminal of the DC-DC converter

2.6.2 LDO

- The LDO uses a series regulator method to generate a power supply voltage of 3.3V to 1.1V. It is possible to supply analog circuits (ADC and PLL) to 1.1V power supply.
- Figure 2-8 shows an example of an external LDO circuit, and Table 2-4 shows an example of its circuit constants.
- As shown in Figure 2-8, place the decoupling capacitors in the immediate vicinity of the power supply terminal.

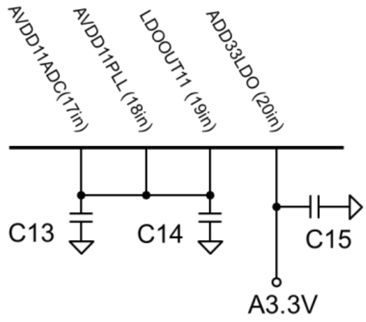


Figure 2-8 Example of an external LDO circuit

Table 2-4 Example of the circuit constants for a LDO circuit

Component No.	C13	C14	C15
Component value	0.1uF	4.7uF	1.0uF

2.7 LED

- Figure 2-9 shows an example of using the LED that shows the transmission / reception status of R9A06G037.
- In this example, it is assumed that LED1 indicates the state when the packet is sent and LED2 indicates the state when the packet is received. (Depends on the firmware port setting for booting.)
- It is recommended to set the current flowing through the LED to about 1mA.
- For LEDs1 and R3, set R3 so that

$\mathrm{I_{LED1}} = \dfrac{(3.3\mathrm{V} - \mathrm{V_{F\_LED1}})}{\mathrm{R3}}$ makes $\mathrm{I_{LED1}}$ about 1mA.

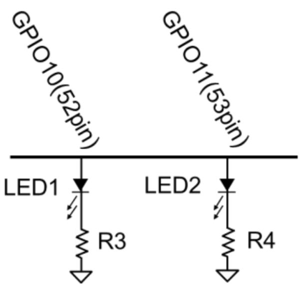


Figure 2-9 Example of using the LED that shows the TX/RX status of R9A06G037

3. Cautions regarding AFE circuit and AC coupling circuit

3.1 AFE-IC(NJM45001) peripheral circuit

- Place the decoupling capacitor of the AFE-IC near the terminals.
- Figure 3-1 shows an example of connecting the AFE-IC peripheral circuit.

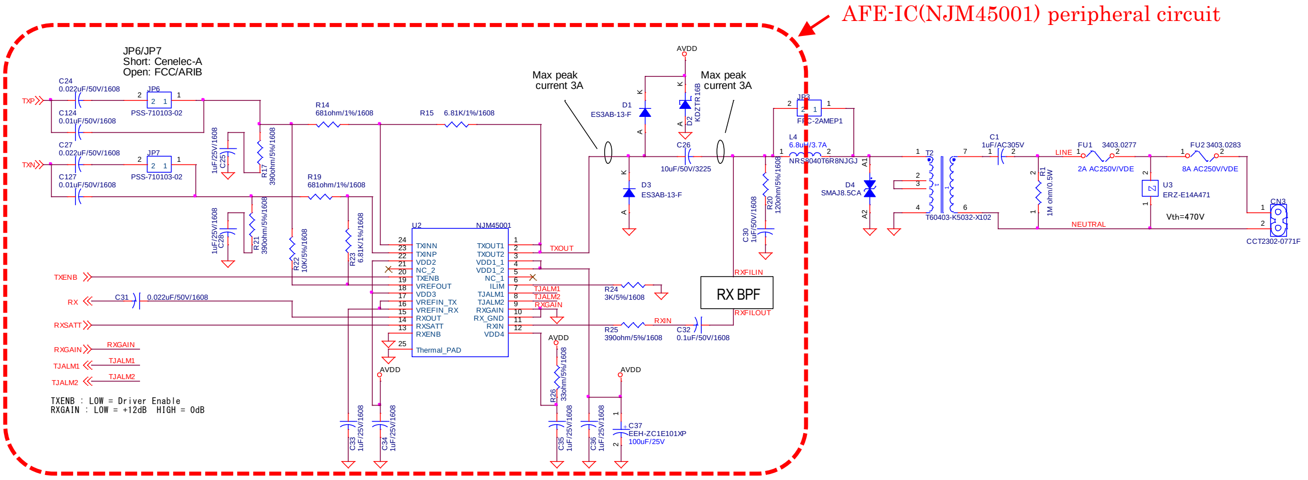


Figure 3-1 Example of connecting the AFE-IC peripheral circuit

3.2 Protection circuit

- Figure 3-2 shows an example of connecting a protection circuit that supports CE marking used for a PLC board.
- Select the protection element in consideration of the expected noise level.
- The FUSE used must be an element that complies with the laws and regulations of that country.

Case using CE marking compatible NJM45001 + 1:1 coupler (T60403-K5032-X102)

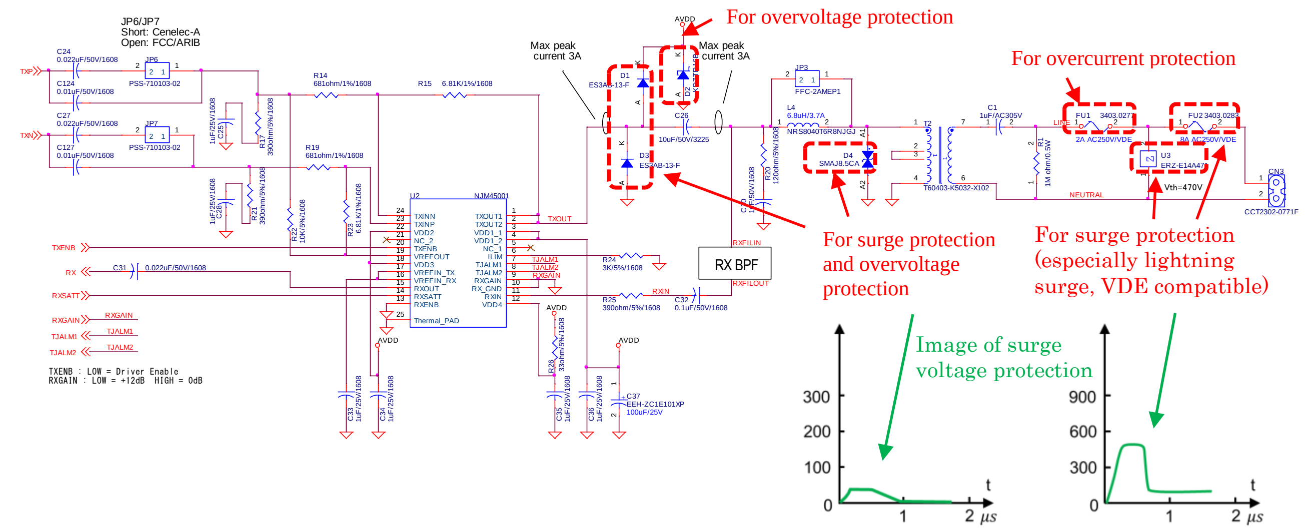


Figure 3-2 Example of connection of protection circuit used for PLC board (CE marking compatible)

3.3 PLC Coupler

This section describes the points to note about the PLC Coupler of the PLC board that uses NJM45001 for Power Amp.

- When using NJM45001, use 1:1 PLC coupler.
- The recommended PLC Coupler is T60403-5032-X102. In the case of ARIB, H93TX1 can also be used. The recommended 1:1 PLC coupler (T60403-5032-X102) connection example (CENELEC-A, FCC / ARIB, Global compatible) is shown in Figure 3-3, and the recommended 1:1 PLC coupler (H93TX1) connection example (ARIB compatible) is shown. Figure 3-4 shows.
- If you use a different component than the above for some reason, select the 1:1 PLC Coupler with the recommended specifications shown in Table 3-1.

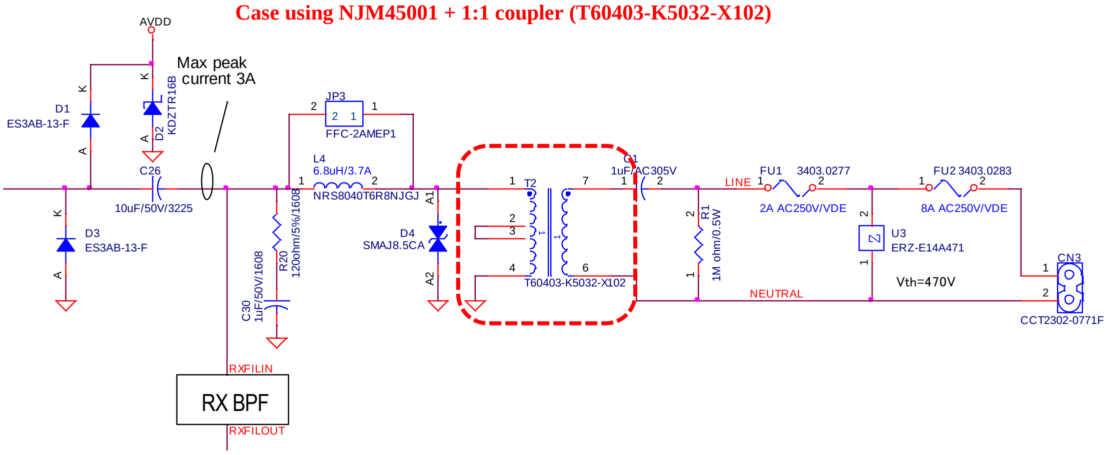


Figure 3-3 The recommended 1:1 PLC coupler (T60403-5032-X102) connection example (CENELEC-A, FCC / ARIB, Global compatible)

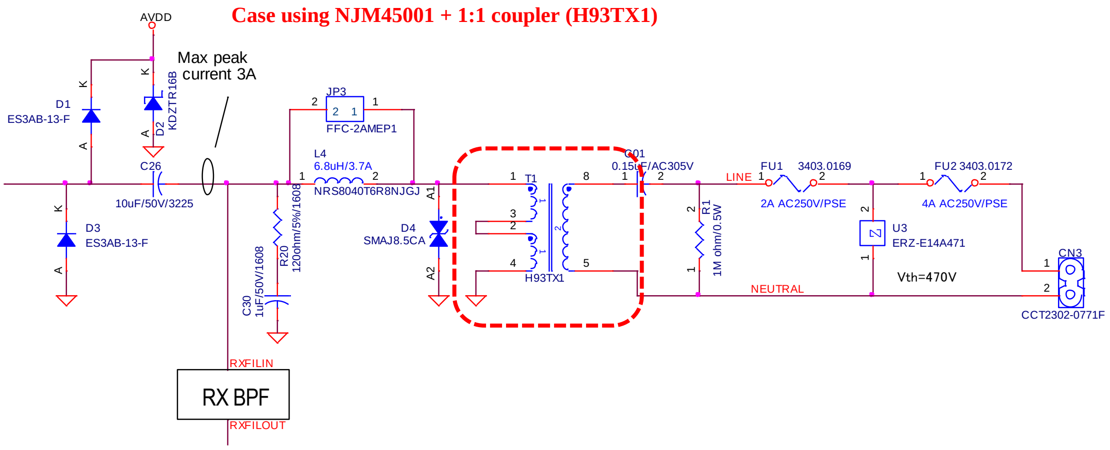


Figure 3-4 The recommended 1:1 PLC coupler (H93TX1) connection example (ARIB compatible)

Table 3-1 The recommended specifications of the 1:1 PLC Coupler

	CENELEC A (35- 90 kHz)	CENELEC B (95-125 kHz)	ARIB (150-500 kHz)	FCC (150-500 kHz)	Global (35-500 kHz)
Inductance (Lp) @primary (secondary open)	> 0.7mH	> 0.7mH	> 0.7mH	> 0.7mH	> 0.7mH
Leakage Inductance (LI) @primary (secondary short)	< 5uH	< 5uH	< 1.2uH	< 1.2uH	< 1.2uH
DC Resistance (Rdc=Rdc(pri)+Rdc(sec))	< 0.80 Ohm	< 0.80 Ohm	< 0.80 Ohm	< 0.80 Ohm	< 0.80 Ohm
DC Bias current (I dc)	> 100 mA	> 100 mA	> 100 mA	> 100 mA	> 100 mA

3.4 Zero cross detection circuit

- When using the phase detection function, input the zero cross detection signal to GPIO2 of R9A06G037.
- Design the zero-cross detection circuit to be the zero-cross detection signal shown in Figure 3-5.
- Figure 3-6 shows an example of a zero-cross detection circuit used in a PLC board.
- As for the resistance value of R3, since the input current is assumed to be about 1-1.2mAAC, set it to 200kΩ for 200-240V_{AC} and 100kΩ for 100-120V_{AC}.
- If necessary, adjust the rise / fall time of the zero cross detection signal with C3.

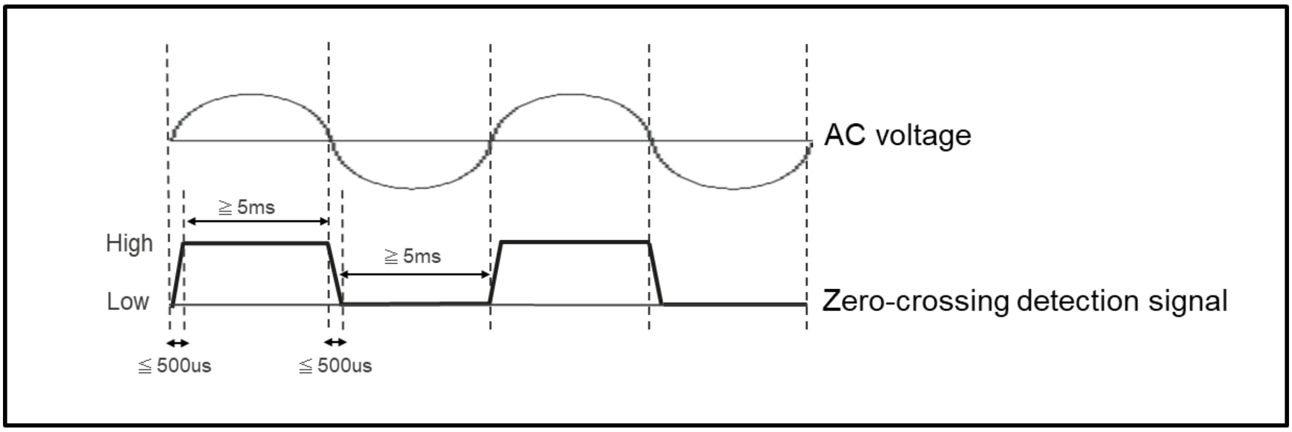


Figure 3-5 The zero-cross detection signal

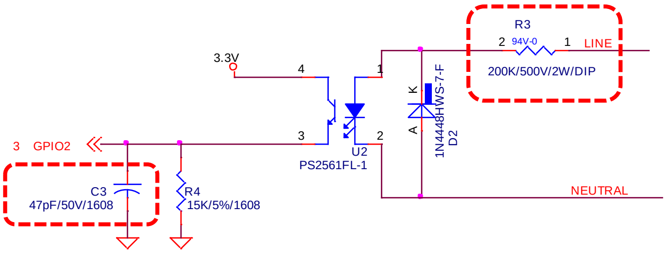
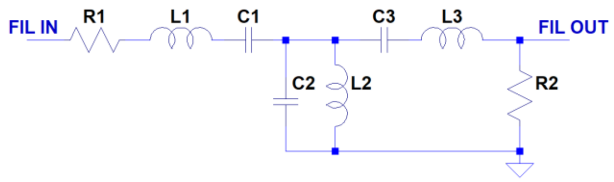


Figure 3-6 Example of a zero-cross detection circuit

3.5 RX-BPF

- RX-BPF is used to suppress a noise of out of the signal frequency band. Select the RX-BPF circuit constants for the frequency band used as shown in Figure 3-7. If you are considering a frequency band other than CENELEC-A and FCC/ARIB, please select Global (35k-500kHz) RX-BPF. (Please contact us if you would like the RX-BPF constants for frequency bands other than CENELEC-A and FCC/ARIB.)
- Figure 3-8 shows frequency characteristics example of RX-BPF. Since the magnitude of noise outside the frequency band differs depending on the installed environment, decide after considering noise outside the frequency band when deleting C3/L3 to reduce component costs.



	CENELEC-A (35k-90kHz)	FCC/ARIB (150k-500kHz)	Global (35k-500kHz)
R1	120ohm	120ohm	120ohm
R2	360ohm	330ohm	330ohm
L1	330uH	47uH	39uH
L2	220uH	82uH	270uH
L3	330uH/ -	47uH/ -	39nH/ -
C1	27nF	10nF	39nF
C2	39nF	5.6nF	5.6nF
C3	27nF/ -	10nF/ -	39uF/ -

Figure 3-7 Configuration of RX-BPF and the circuit constant

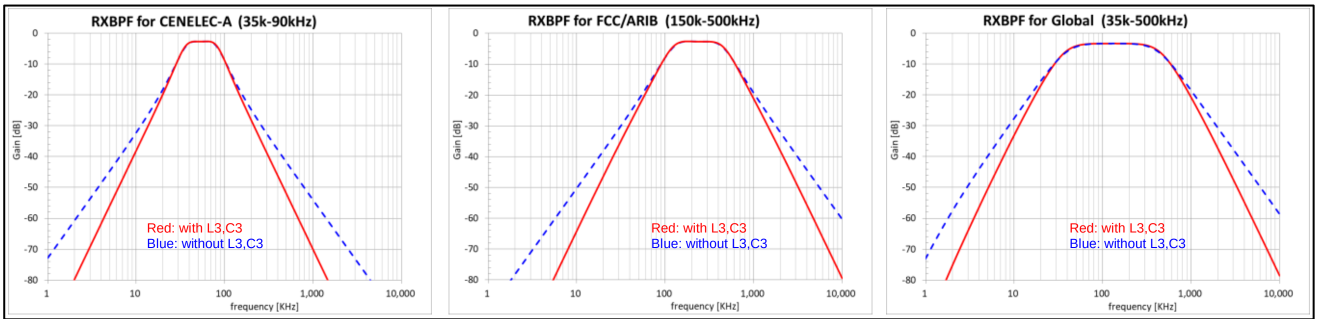


Figure 3-8 Frequency characteristics example of RX-BPF

3.6 Step attenuator circuit

This section describes the Step Attenuator (SATT).

- The function of SATT is to attenuate the received signal so that the receiving circuit can be demodulated without saturation when a signal with a large amplitude exceeding the input level of R9A06G037 or an interfering wave is input. If the received signal is smaller than the predetermined amplitude, the received signal will pass through without attenuation.
- When the receiving circuit is saturated, unnecessary harmonics are generated and it becomes difficult to distinguish it from the received signal. Therefore, insert a SATT circuit into the receiving circuit to prevent saturation of the receiving circuit.

- Figure 3-9 shows how to control SATT.
  (1) Using the received preamble data, the level detection function of the digital baseband section determines whether the signal strength of the ADC output exceeds the signal level saturated in the receiving circuit.
  (2) When the signal level saturated in the receiving circuit is exceeded, the received signal is attenuated by switching the RXSATT signal from 0 to 1 and switching the SATT gain from 0dB to -18dB.
- Figure 3-10 shows an example of the SATT circuit used for the PLC board.
- The AFE-IC NJM45001 has a built-in SATT circuit. For details on how to set the SATT circuit, refer to the NJM45001 data sheet.

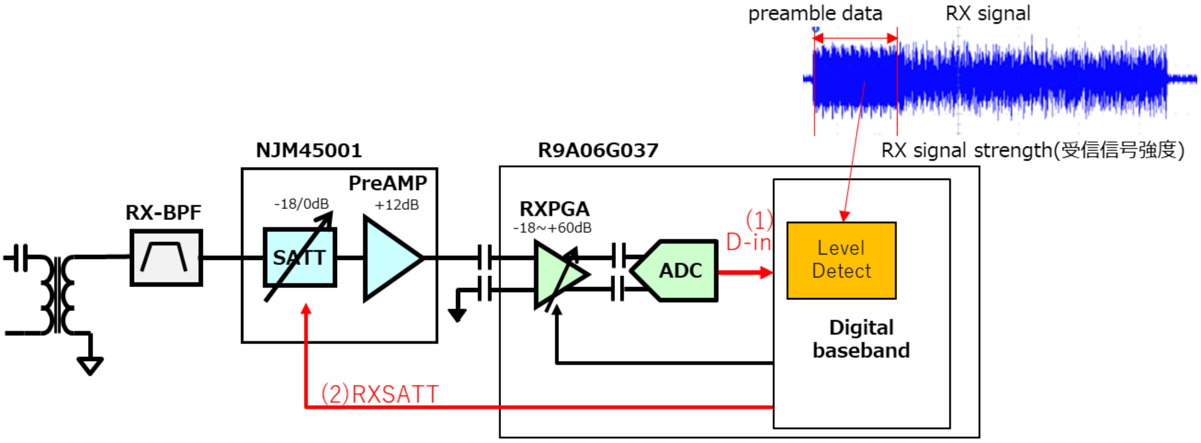


Figure 3-9 Step Attenuator (SATT) control method

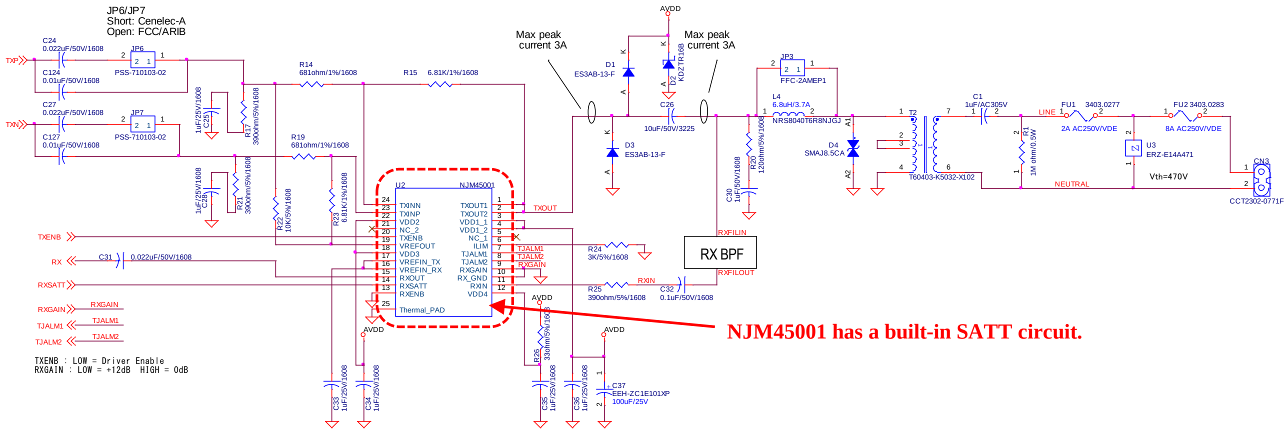


Figure 3-10 Example of Step Attenuator (SATT) circuit

3.7 Measures for low impedance load (CENELEC-A band only)

This section describes measures for low impedance load in the CENELEC-A band of the PLC board.

- For low impedance loads in the CENELEC-A band, the PLC transmission output power can be increased by inserting an L4 inductor in series with the transmission output.
- When inserting the L4, set the resonance frequency of the inductor L4 and the AC coupling capacitor C1 to be within the band of the CENELEC-A band, 35kHz-90kHz.

$$f_Q = \frac{1}{2\pi\sqrt{L4 \cdot C1}}$$

- In the case of NJM45001 + 1:1 PLC coupler configuration, by inserting L4 = 6.8uH for C1 = 1uF, it is possible to increase the transmission output under low impedance load compared to the case without L4.
- For the FCC / ARIB band and Global band, do not insert L4 because the transmission output will decrease if an inductor is inserted.
- Figure 3-11 shows an example of connection for low impedance load measures the CENELEC-A band, and Figure 3-12 shows the example of frequency characteristics.

Case using NJM45001 + 1:1 coupler

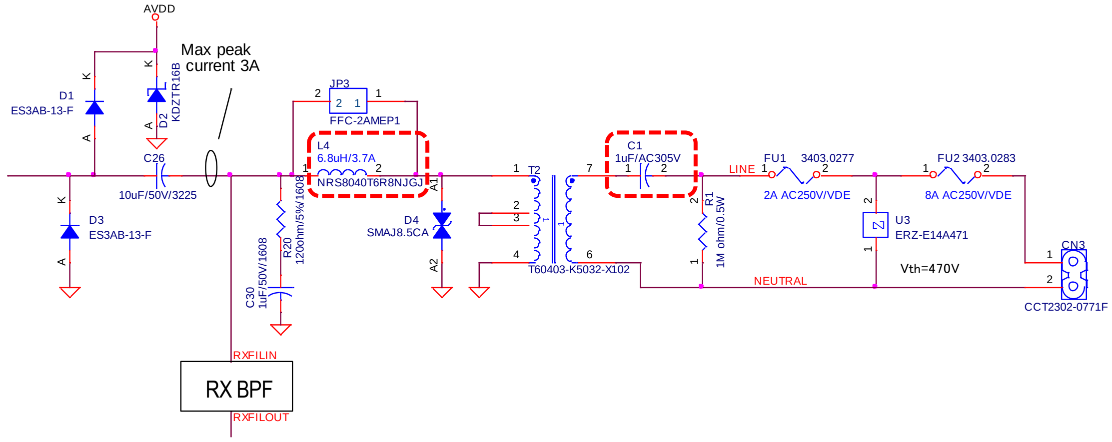


Figure 3-11 Example of connection for low impedance load measures in CENELEC-A band

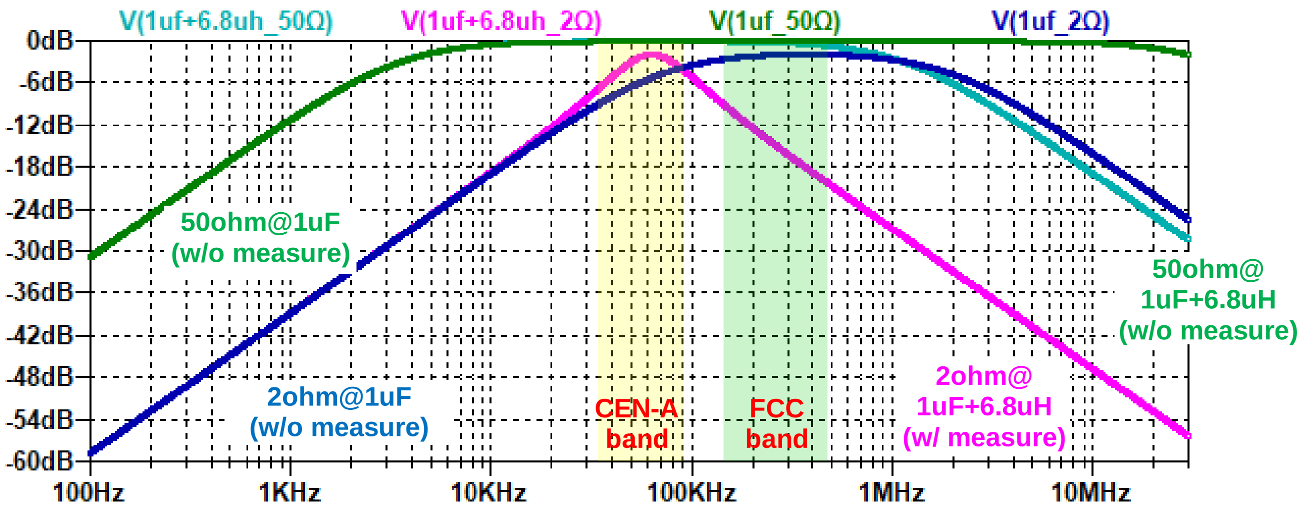


Figure 3-12 Example of frequency characteristics for low impedance load measures in CENELEC-A band

3.8 EN50065-7 compatible impedance measures (CENELEC-A band only)

In this section, the impedance measures for EN50065-7 in the CE marking of the CENELEC-A band of the PLC board are explained assuming the configuration of NJM45001 + 1: 1 PLC coupler (T60403-5032-X102).

- The RX impedance at 3kHz-9kHz may not meet the EN50065-7 compatible impedance standard due to the resonance of C1 and T2 (main inductance). In order to suppress the peak due to the resonance, it is recommended to place R20=120Ω and C30=1uF in the part (a) of Figure 3-13.
- The TX impedance at 95kHz-148.5kHz may not meet the EN50065-7 compatible impedance standard due to the resonance frequency of C1 and (L4 + T2(leakage inductance)) in the part (b) of Figure 3-13. Set so that the resonance frequencies of L4 + T2 (leakage inductance) and C1 are within the band of CENELEC-A band.
- If C1=1uF, it is recommended to insert L4=6.8uH.
- If C1, L4 and T2 are changed, evaluate the impedance characteristics of EN50065-7 and determine the constants if necessary.

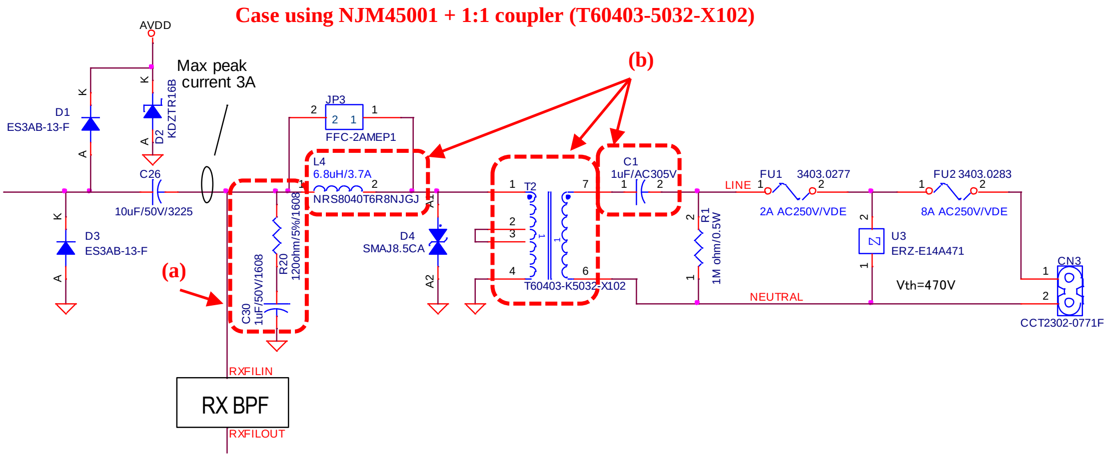


Figure 3-13 Example of impedance measures for EN50065-7 in CENELEC-A band

Table 3-2 EN50065-7:Minimum impedance value |Ze| of an equipment working in the frequency range 9 kHz to 95 kHz

Frequency range	3kHz to 9kHz		9kHz to 95kHz			95kHz to 148.5kHz	
Operating mode	RX	TX	RX		TX	RX	TX
|Ze|	10ohm	Free	Out BW Free	In BW 50ohm	Free	5ohm	3ohm

4. Cautions on the DC-DC Power Supply Circuit

This section describes precautions when designing a DC-DC power supply circuit by mounting a DC-DC power supply IC on the PLC board.

- It is necessary to generate 3.3V to use R9A06G037 and 15V or 12V to use NJM45001 on the PLC board.
- When using a DC-DC power supply circuit, operating switching noise may affect the PLC signal and circuit.
- To avoid affecting the signal band (35kHz-500kHz) of the NB-PLC, use a DC-DC power supply IC that can select a switching frequency of 1MHz or higher.
- For the switching operation of the DC-DC power supply circuit, use a DC-DC power supply IC that has a PWM (Pulse Width Modulation) fixed operation function. The operation method of PFM (Pulse Frequency Modulation) and PSM (Pulse Skipping Modulation) may operate within the signal band of NB-PLC (35kHz-500kHz), which may affect the characteristics of PLC.
- To remove noise components contained in the input power supply supplied to the DC-DC power supply circuit, and to reduce the influence of switching noise generated in the DC-DC power supply circuit on other power supply circuits, it is recommended to insert a filter consisting of an LC circuit into the input section of the DC-DC power supply circuit. Table 4-1 shows an example of an input filter for a DC-DC power supply circuit, and Table 4-1 shows an example of its circuit constants.
- Figure 4-2 shows an example of a DC-DC power supply circuit that generates 3.3V from 15V using ISL85415.

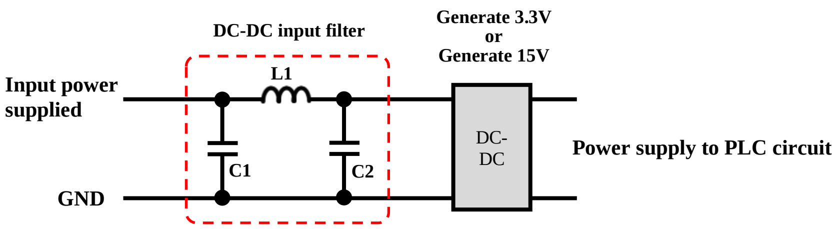


Figure 4-1 Example of input filter for DC-DC power supply circuit

Table 4-1 Example of circuit constants of input filter for DC-DC power supply circuit

	Circuit constant
L1	10uH
C1	10uF-22uF
C2 1)	10uF-22uF

Note.1) C2 can be omitted if the input capacitor of the DC-DC power supply circuit is 10uF or more.

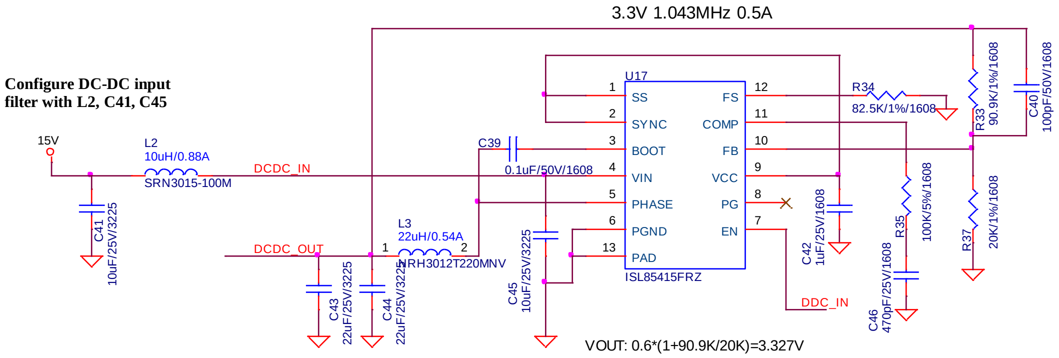


Figure 4-2 Example of DC-DC power supply circuit using ISL85415

5. Cautions on the AC-DC Power Supply Circuit

This section describes precautions when mounting the AC-DC power supply circuit on the PLC board. When installing an AC-DC power supply circuit, the switching noise of the AC-DC power supply circuit may affect the EMC standard and the transmission / reception characteristics of the PLC, so pay attention to the following items when designing.

- Separate the GND of the AC-DC circuit from the GND of other circuits.
- Insert L1 and L2 as an impedance upper between the AC-DC power supply circuit and the PLC signal. This is to prevent the input impedance of the AC-DC power supply circuit from affecting the load of the PLC output.
- Insert C1 between the AC-DC power circuit and the PLC signal as a measure against differential noise. (Recommendation) By combining L1, L2 and C1, it functions as a differential mode noise filter. If the input capacitor of AD-DC is 0.22uF or more, C1 can be omitted.
- Insert CM1 (common mode choke coil) as a countermeasure against common mode noise between the AC-DC power supply circuit and the PLC signal. (Recommendation)
- Figure 5-1 shows an example of an input filter for an AC-DC power supply circuit, and Table 5-1 shows an example of its circuit constants.

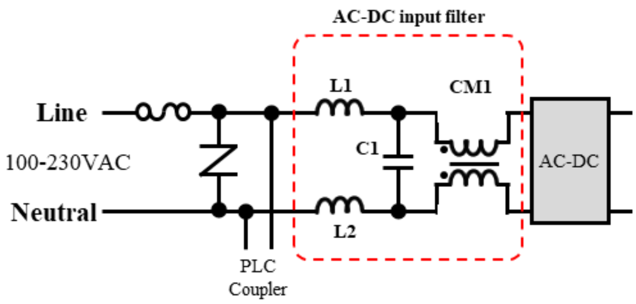


Figure 5-1 Example of input filter for AC-DC power supply circuit

Table 5-2 Example of circuit constant of input filter for AC-DC power supply circuit

	CENELEC-A	Global	FCC/ARIB
L1/L2	1mH or more		0.22mH or more
C1 2)	0.22uF or more		
CM1	15mH or more		

Note.2) If the input capacitor of the AD-DC power supply circuit is 0.22uF or more, C1 can be omitted.

6. Circuit design example

- Regarding the contents explained in Chapters 2 to 4, this chapter shows the PLC board RTK0EE0003D01002BJ (for CENECLEC-A, FCC, Global) of Renesas Electronics as a reference as a circuit design example. Regarding the AC coupling circuit section, the AC coupling circuit section of RTK0EE0003D02002BJ (ARIB) is also shown as a circuit design example for reference.
- Since Renesas Electronics does not prepare a PLC board equipped with an AC-DC power supply circuit, the AC-DC circuit in Chapter 5 is not included in the circuit design example in this chapter.
- If the contents of Chapters 2 to 4 differ from the circuit design examples in this chapter, give priority to the contents of Chapters 2 to 4.
- Section 6.1 shows an example of circuit design (Figure 6-1-Figure 6-8), and Section 6.2 shows an example of Bill of materials (Table 6-1-Table 6-6).

6.1 Example of circuit design

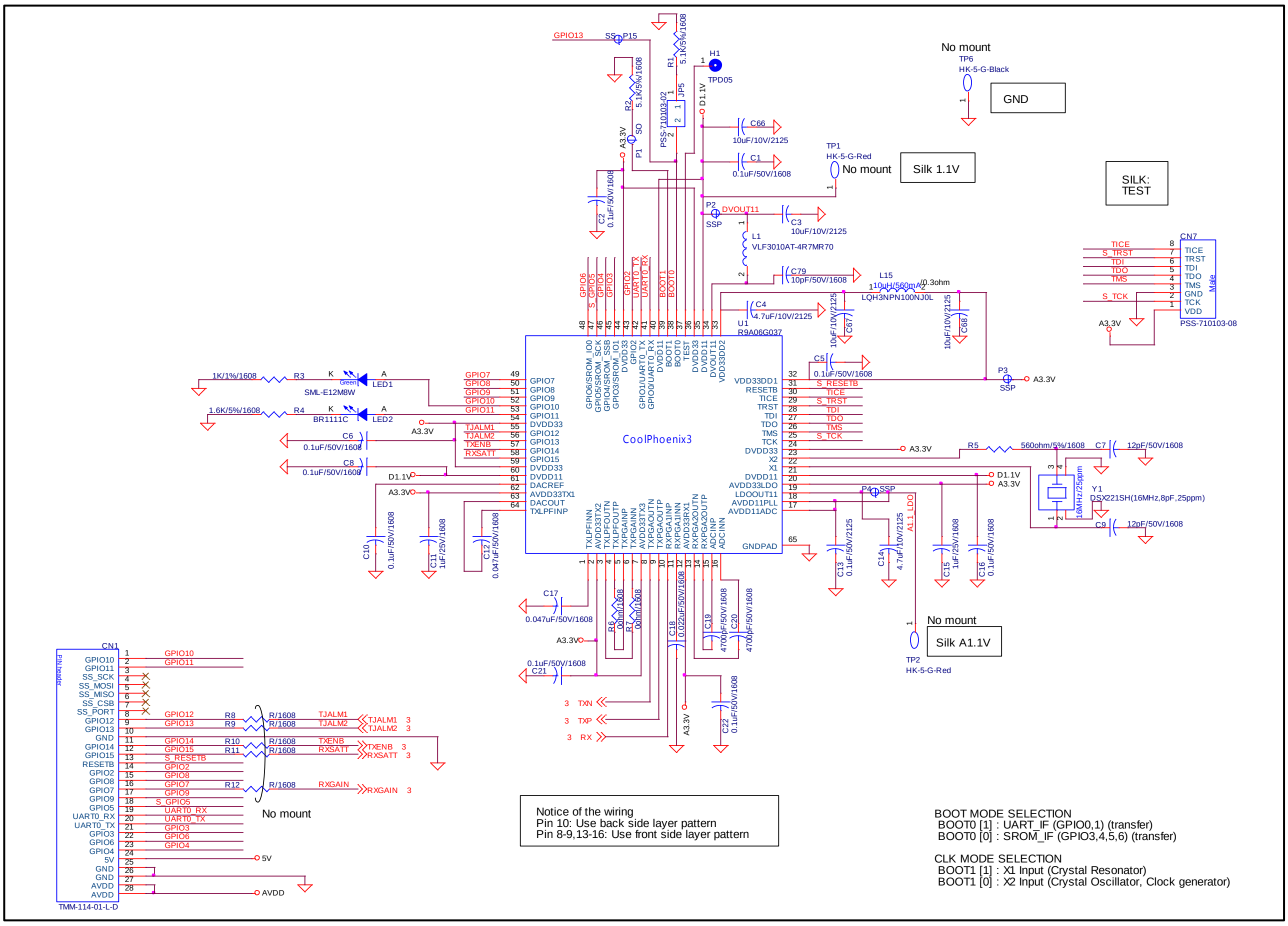


Figure 6-1 PLC board (R9A06G037 peripheral circuit)

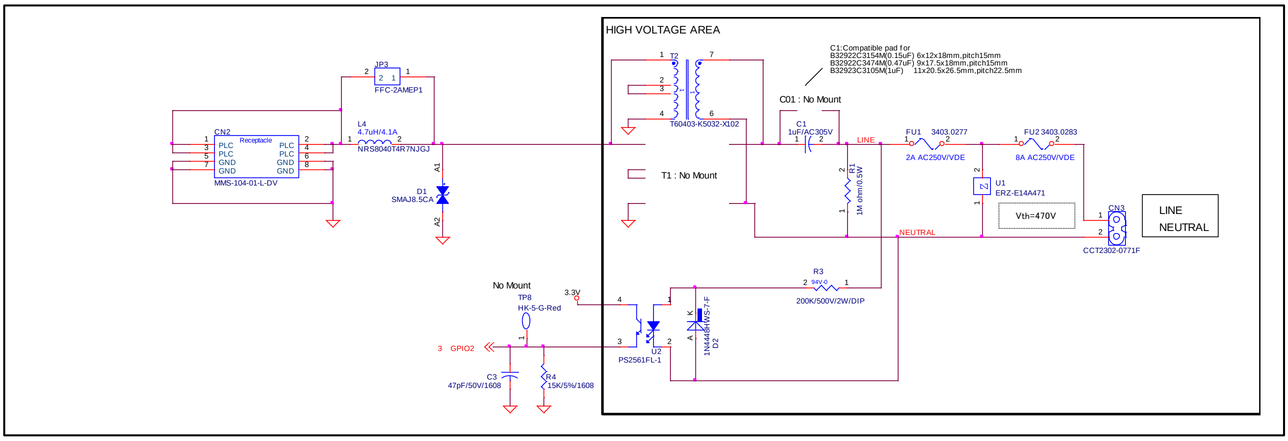


Figure 6-2 BASE board (AC coupling circuit for CENELEC-A, FCC, Global)

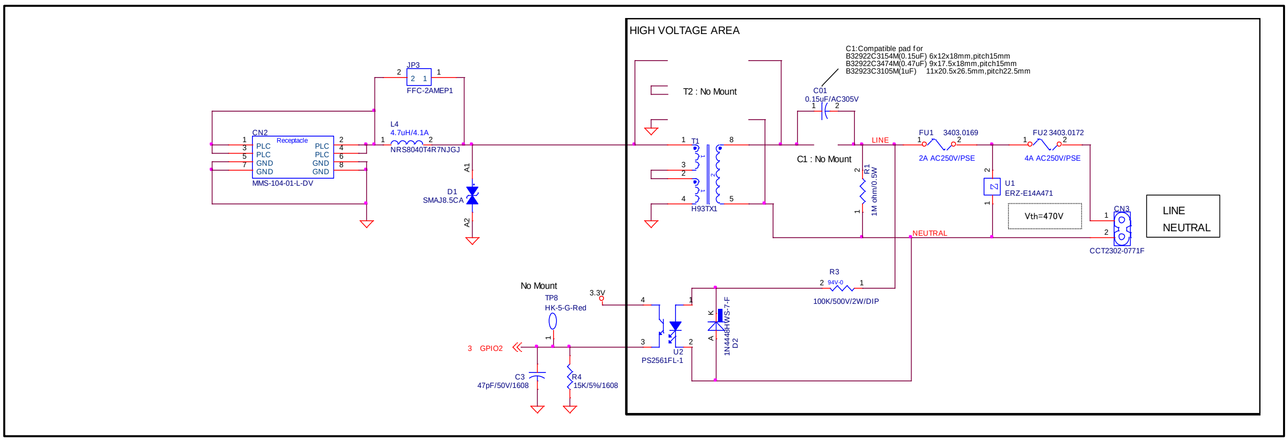


Figure 6-3 BASE board (AC coupling circuit for ARIB)

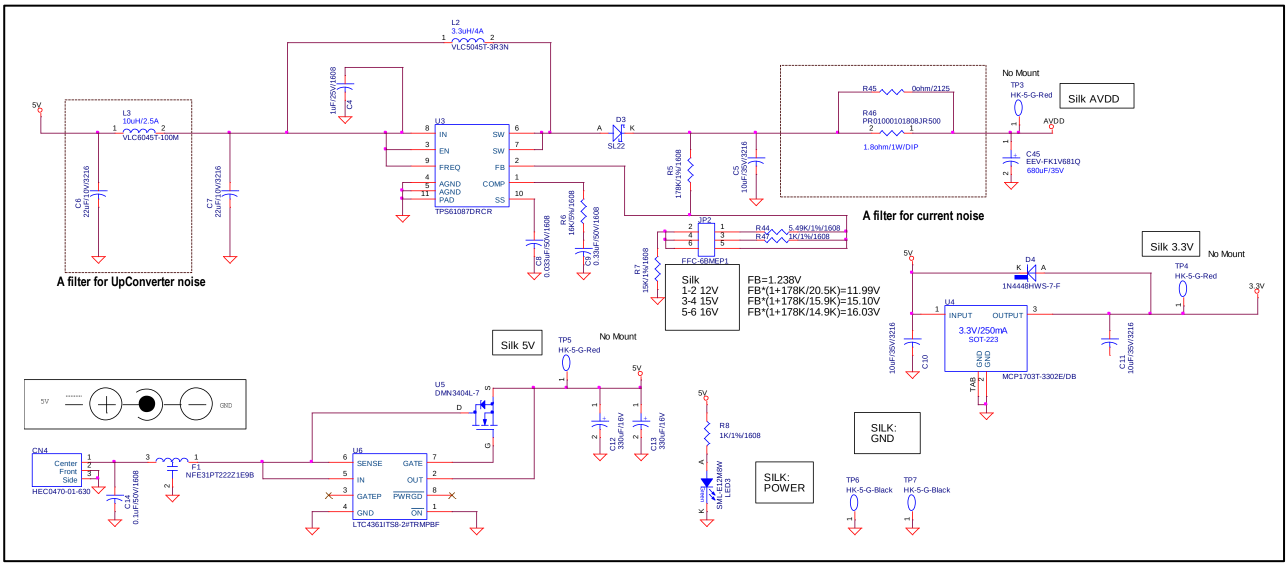


Figure 6-4 BASE board (DC-DC power supply circuit)

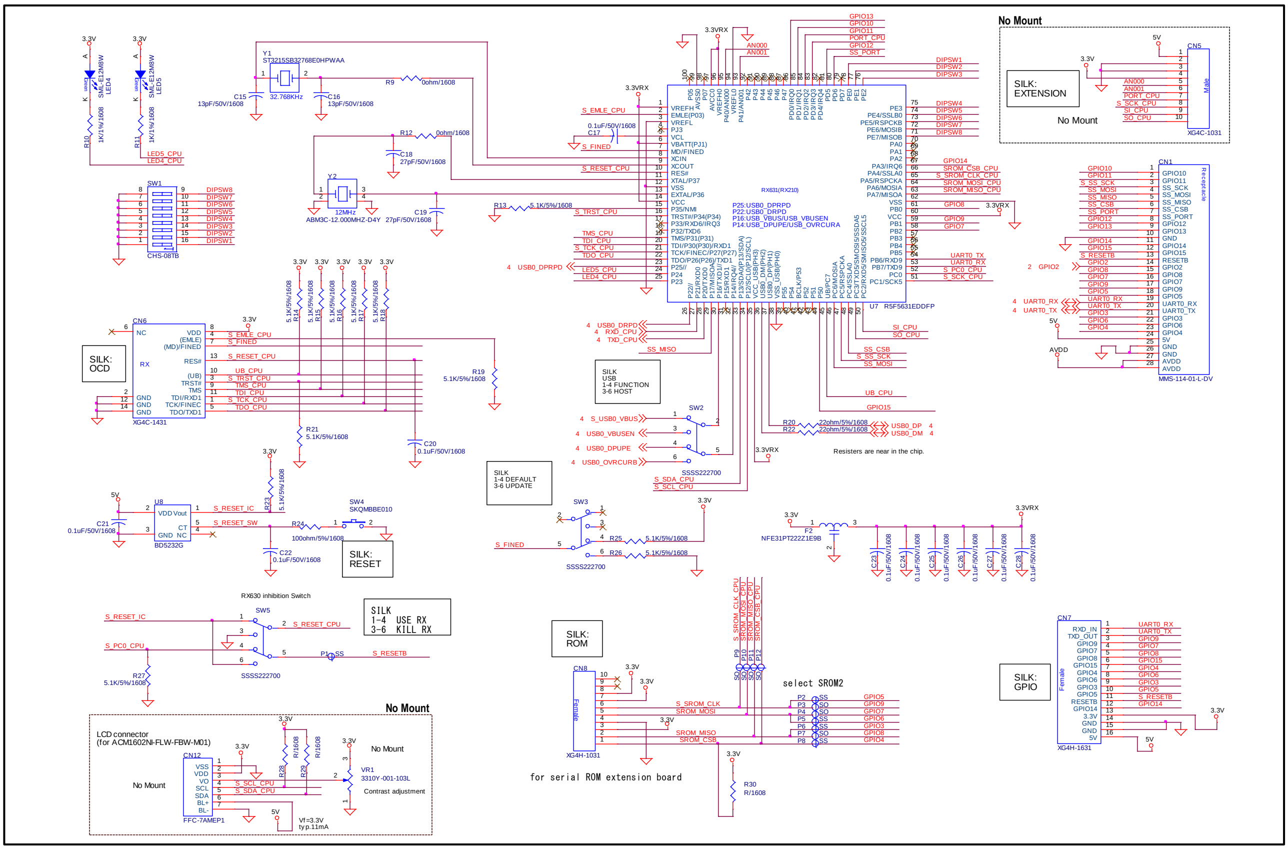


Figure 6-5 BASE board (MCU peripheral circuit)

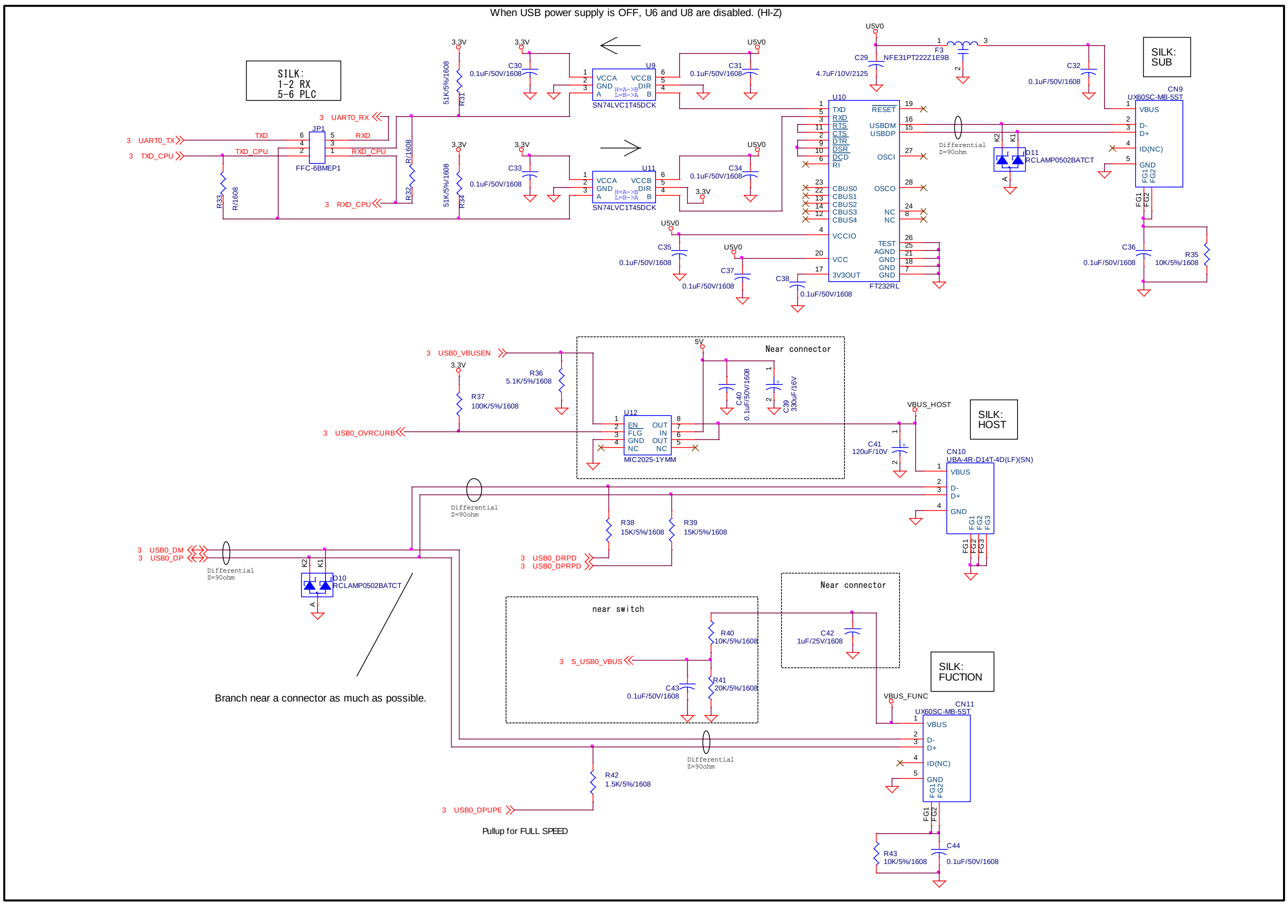


Figure 6-6 BASE board (USB-serial circuit and USB circuit)

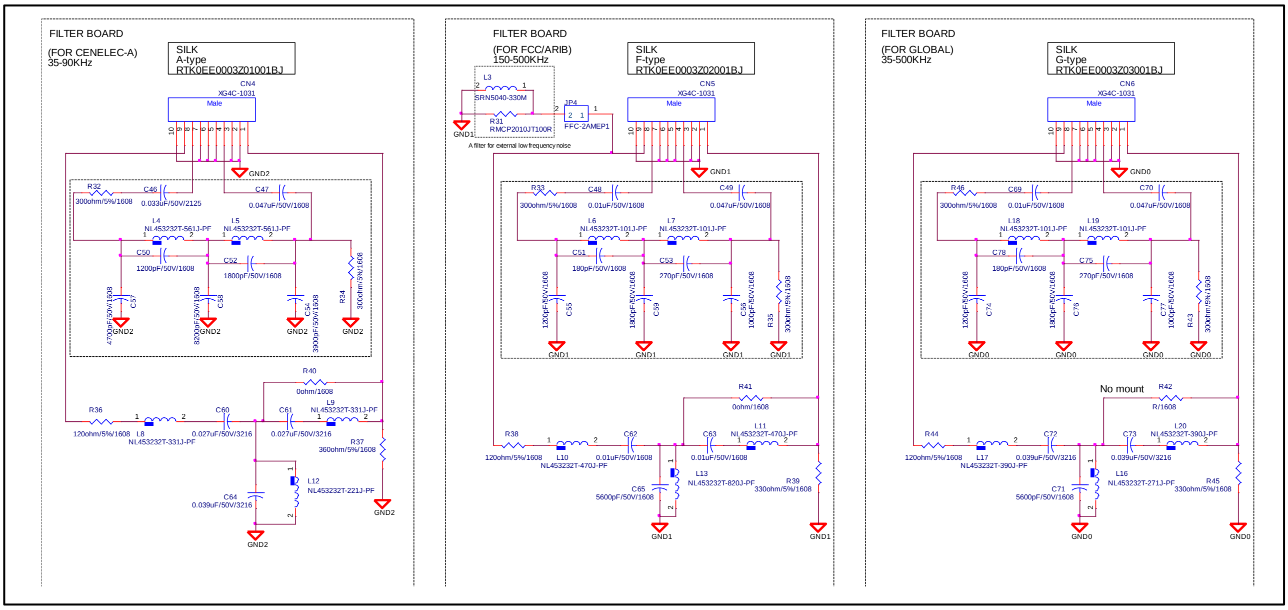


Figure 6-7 Filter board (RX-BPF)

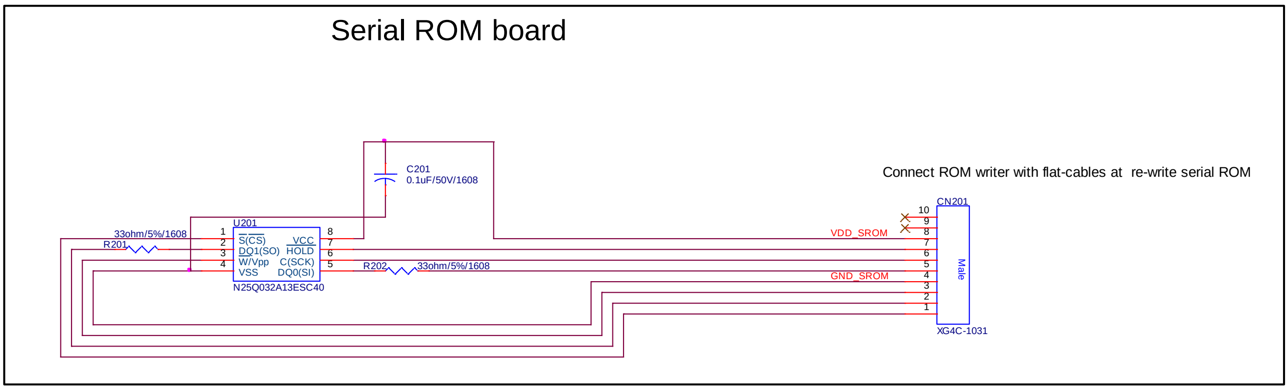


Figure 6-8 S-ROM board

6.2 Example of Bill of materials

Table 6-1 PLC board

Quantity	Reference	KIND	Parts Name	Manufacturer	Memo
1	CN1	CONNECTOR	TMM-114-01-L-D	SAMTEC	
1	CN2	CONNECTOR	TMM-104-01-L-D	SAMTEC	
1	CN3	CONNECTOR	XG4H-1031	OMRON	
1	CN7	CONNECTOR	PSS-710103-08	HIROSUGI	
13	C1,C2,C5,C6,C8,C10,C16,C21,C22,C32,C44,C45,C13	CERAMIC CAPACITOR	CC0603KRX7R9BB104	Yageo	0.1uF/50V/1608/X7R 10%
7	C3,C38,C42,C43,C66,C67,C68	CERAMIC CAPACITOR	LMK212B7106KG-TD	Taiyo Yuden	10uF/10V/2125/X7R 10%
2	C19,C20	CERAMIC CAPACITOR	CGA3E2C0G1H472J	TDK	4700pF/50V/1608/C0G 5%
2	C7,C9	CERAMIC CAPACITOR	C1608C0G1H120J	TDK	12pF/50V/1608/C0G 5%
9	C11,C15,C25,C28,C33,C34,C35,C36,C40	CERAMIC CAPACITOR	TMK107B7105KA-T	Taiyo Yuden	1uF/25V/1608/X7R 10%
2	C12,C17	CERAMIC CAPACITOR	CC0603KRX7R9BB473	Yageo	0.047uF/50V/1608/X7R 10%
2	C14,C4	CERAMIC CAPACITOR	C2012X7R1A475K	TDK	4.7uF/10V/2125/X7R 10%
4	C18,C24,C27,C31	CERAMIC CAPACITOR	C1608X7R1H223K	TDK	0.022uF/50V/1608/X7R 10%
1	C26	CERAMIC CAPACITOR	GRM32ER71H106KA12L	TDK	10uF/50V/3225/X7R 10%
1	C30	CERAMIC CAPACITOR	C1608C0G1H122J	TDK	1200pF/50V/1608/C0G 5%
1	C37	ALUM CAP	EEH-ZC1E101XP	Panasonic	EEH-ZC1E101XP
1	C39	CERAMIC CAPACITOR	C1608C0G1H101J080AA	TDK	100pF/50V/1608 C0G 5%
1	C41	CERAMIC CAPACITOR	LMK316AB7226ML-TR	Taiyo Yuden	22uF/10V/3216/X7R 20%
1	C79	CERAMIC CAPACITOR	GRM1885C1H100JA01D	MURATA	10pF/50V/1608/C0G 5%
2	C124,C127	CERAMIC CAPACITOR	C1608C0G1E103J080AA	TDK	0.01uF/50V/1608/C0G 5%
2	D3,D1	DIODE	ES3AB-13-F	Diodes Inc	
1	D2	DIODE	KDZTR16B KDZVTR16B	Rohm Rohm	
3	JP5,JP6,JP7	CONNECTOR	PSS-710103-02	HIROSUGI	
1	LED1	LED	SML-E12M8W	Rohm	
1	LED2	LED	BR1111C	STANLEY	
1	L1	INDUCTOR	VLF3010AT-4R7MR70	TDK	alternative : VLS3015ET-4R7M, VLS3012HBX-4R7MTTDK), NR3010T4R7M, NR3012T4R7M, NRH3012T4R7MN, NRH3012T4R7MNV(Taiyo Yuden), LQH3NPN4R7MJRL, LQH3NPN4R7MGRL(Murata), SRN3010-4R7M, SRN3010TA-4R7M, SRN3012TA-4R7M(Bourns)
1	L2	INDUCTOR	NR3010T4R7M	Taiyo Yuden	alternative : NR3012T4R7M, NRH3012T4R7MN, NRH3012T4R7MNV(Taiyo Yuden), VLS3015ET-4R7M, VLS3012HBX-4R7M(TDK), LQH3NPN4R7MJRL,LQH3NPN4R7MGRL, SRN3010-4R7M, SRN3010TA-4R7M, SRN3012TA-4R7M(Murata)
1	L15	INDUCTOR	LQH3NPN100NJ0L	Murata	alternative : LQH3NPN100MJRL(Murata), VLS3012CX-100M-1(TDK), LQH3NPN100MMEL, LQH3NPN100MGRL(Murata)
2	R2,R1	RESISTOR	5.1K/5%/1608		
1	R3	RESISTOR	1K/1%/1608		
1	R4	RESISTOR	1.6K/5%/1608		
1	R5	RESISTOR	560ohm/5%/1608		
2	R6,R7	RESISTOR	0ohm/1608		
2	R19,R14	RESISTOR	681ohm/1%/1608		
2	R15,R23	RESISTOR	6.81K/1%/1608		
1	R16	RESISTOR	3522ZR	TE AMP	
3	R17,R21,R25	RESISTOR	390ohm/5%/1608		
1	R20	RESISTOR	51ohm/5%/1608		
1	R24	RESISTOR	3K/5%/1608		
1	R26	RESISTOR	33ohm/5%/1608		
1	R27	RESISTOR	150K/1%/1608		
1	R28	RESISTOR	56.2K/1%/1608		
1	R29	RESISTOR	100K/1%/1608		
1	R30	RESISTOR	31.6K/1%/1608		
1	R28	RESISTOR	56.2K/1%/1608		
1	R29	RESISTOR	100K/1%/1608		
1	R30	RESISTOR	31.6K/1%/1608		
1	R22	RESISTOR	10K/5%/1608		
1	U1	IC	R9A06G037GNP#AA0	Renesas	
1	U2	IC	NJM45001	NJRC	
1	U3	IC	RAA230215GSB#HA0	Renesas	
1	Y1	CRYSTAL	DSX221SH CX2520DB16000D0FLJCC	KDS(Daishinku) KCD(Kyosera)	16MHz,CL:8pF, Frequecy tolerance:±10ppm , Frequecy cahacteristics over temperature:±15ppm

Table 6-2 BASE board

Quantity	Reference	KIND	Parts Name	Manufacturer	Memo
1	CN1	CONNECTOR	MMS-114-01-L-DV	SAMTEC	
1	CN2	CONNECTOR	MMS-104-01-L-DV	SAMTEC	
1	CN3	CONNECTOR	CCT2302-0771F	CMK	alternative: AC-M11PB73C(Echo Electric)
1	CN4	CONNECTOR	HEC0470-01-630	HOSHIDEN	
1	CN6	CONNECTOR	XG4C-1431	OMRON	
1	CN7	CONNECTOR	XG4H-1631	OMRON	
1	CN8	CONNECTOR	XG4H-1031	OMRON	
2	CN11,CN9	CONNECTOR	UX60SC-MB-5ST	HIROSE	
1	CN10	CONNECTOR	UBA-4R-D14T-4D(LF)(SN)	JST	alternative: UE27AC54100(Amphenol)
1**	C1	FILM CAPACITOR	B32923C3105M	EPCOS	**For CENELEC-A, FCC, Global
1***	C01	FILM CAPACITOR	B32923C3105M	EPCOS	***For ARIB
1	C3	CERAMIC CAPACITOR	C1608C0G1H470J	TDK	47pF/50V/1608/C0G 5%
2	C42,C4	CERAMIC CAPACITOR	TMK107B7105KA-T	Taiyo Yuden	1uF/25V/1608/X7R 10%
3	C5,C10,C11	CERAMIC CAPACITOR	GMK316AB7106KL-TR	Taiyo Yuden	10uF/35V/3216/X7R 10%
2	C6,C7	CERAMIC CAPACITOR	LMK316AB7226ML-TR	Taiyo Yuden	22uF/10V/3216/X7R 10%
1	C8	CERAMIC CAPACITOR	CC0603KRX7R9BB333	Yageo	0.033uF/50V/1608/X7R 10%
1	C9	CERAMIC CAPACITOR	C1608X7R1H334K080AC	TDK	0.33uF/50V/1608/X7R 10%
3	C12,C13,C39	ELECTROLYTIC CAP	EEU-FM1C331	Panasonic	
23	C14,C17,C20,C21,C22,C23,C24,C25,C26,C27,C28,C30,C31,C32,C33,C34,C35,C36,C37,C38,C40,C43,C44	CERAMIC CAPACITOR	CC0603KRX7R9BB104	Yageo	0.1uF/50V/1608/X7R 10%
2	C16,C15	CERAMIC CAPACITOR	GRM1885C1H130JA01D	MURATA	13pF/50V/1608 5%
2	C19,C18	CERAMIC CAPACITOR	C1608C0G1H270J	TDK	27pF/50V/1608 5%
1	C29	CERAMIC CAPACITOR	C2012X7R1A475K	TDK	4.7uF/10V/2125/X7R 10%
1	C41	ELECTROLYTIC CAP	UPJ1A121MED	Nichicon	
1	C45	ELECTROLYTIC CAP	EEV-FK1V681Q	Panasonic	
1	D1	DIODE	SMAJ8.5CA	Bourns Inc.	
2	D2,D4	DIODE	1N4448HWS-7-F	Diodes Inc	
1	D3	DIODE	SL22	Vishay	
2	D11,D10	DIODE	RCLAMP0502BATCT	Semtech	
1	FU1	FUSE	3403.0277	Schurter Inc	
1	FU2	FUSE	3403.0283	Schurter Inc	
3	F1,F2,F3	FILTER	NFE31PT222Z1E9B	Murata	
2	JP1,JP2	CONNECTOR	FFC-6BMEP1	HONDA	
1	JP3	CONNECTOR	FFC-2AMEP1	HONDA	
3	LED3,LED4,LED5	LED	SML-E12M8W	Rohm	
1	L2	INDUCTOR	VLC5045T-3R3N	TDK	alternative : VLS5045EX-3R3N(TDK), 74404054033(WE), NR5040T3R3N(Taiyo Yuden), SRN5040TA-3R3M(Bourns)
1	L3	INDUCTOR	VLC6045T-100M	TDK	alternative : VLS6045EX-100M(TDK), CDRH60D43RNP-100MC(Sumida), NR6045T100M(Taiyo Yuden), SRN6045-100M(Bourns)
1	L4	INDUCTOR	NRS8040T4R7NJGJ	Taiyo Yuden	alternative : LSXNH8080YBL4R7NJG(Taiyo Yuden), SRN8040-4R7Y(Bourns)
1	R1	RESISTOR	SPRM12B105J	Akabane Dengu	alternative : RCR50+CT52A105J, RCR50ENCT52A105J, RCR60CT52A105J(KOA), VR37000001004JR500(Vishay)
1	R3	RESISTOR	FMP200JR-52-200K	Yageo	
3	R4,R38,R39	RESISTOR	15K/5%/1608		
1	R5	RESISTOR	178K/1%/1608		
1	R6	RESISTOR	16K/5%/1608		
1	R7	RESISTOR	15K/1%/1608		
4	R8,R10,R11,R47	RESISTOR	1K/1%/1608		
2	R9,R12	RESISTOR	0ohm/1608		
13	R13,R14,R15,R16,R17,R18,R19,R21,R23,R25,R26,R27,R36	RESISTOR	5.1K/5%/1608		
2	R20,R22	RESISTOR	22ohm/5%/1608		
1	R24	RESISTOR	100ohm/5%/1608		
2	R34,R31	RESISTOR	51K/5%/1608		
3	R35,R40,R43	RESISTOR	10K/5%/1608		
1	R37	RESISTOR	100K/5%/1608		
1	R41	RESISTOR	20K/5%/1608		
1	R42	RESISTOR	1.5K/5%/1608		
1	R44	RESISTOR	5.49K/1%/1608		
1	R45	RESISTOR	0ohm/2125		
1	R46	RESISTOR	PR01000101808JR500	Vishay	
1	SW1	Switch	CHS-08TB	COPAL	
3	SW2,SW3,SW5	SWITCH	SSSS222700	ALPS	
1	SW4	SWITCH	SKQMBBE010	ALPS	
2	TP6,TP7	TEST PIN	HK-5-G-Black	MAC8	
1**	T2	TRANS	T60403-K5032-X102	VAC Magnetic	**For CENELEC-A, FCC, Global
1***	T1	TRANS	H93TX1	Hitachi Ferrite	***For ARIB
1	U1	Surge Absorber	ERZ-E14A471 ERZ-E14A511	Panasonic Panasonic	
1	U2	PHOTOCOUPLER	PS2561FL-1	CEL	
1	U3	IC	TPS61087DRCR		
1	U4	REGULATOR	MCP1703T-3302E/DB	Microchip	
1	U5	Transistor	DMN3404L-7	Diodes Incorporated	
1	U6	IC	LTC4361ITS8-2#TRMPBF	Linear Technology	
1	U7	IC	R5F5631EDDFP#V0	Renesas	
1	U8	IC	BD5232G BD52E32G	Rohm Rohm	
2	U11,U9	IC	SN74LVC1T45DCK	TI	
1	U10	IC	FT232RL	FTDI	
1	U12	IC	MIC2025-1YMM	Micrel	
1	Y1	CRYSTAL	ST3215SB32768E0HPWAA	Kyocera	
1	Y2	CRYSTAL	ABM3C-12.000MHZ-D4Y	Abracon	

Table 6-3 Filter board (A-type)

Quantity	Reference	KIND	Parts Name	Manufacturer	Memo
1	CN4	CONNECTOR	XG4C-1031	OMRON	
2	L4,L5	INDUCTOR	NL453232T-561J-PF PM1812-561J-RC	TDK Bourns	
2	L8,L9	INDUCTOR	NL453232T-331J-PF PM1812-331J-R	TDK Bourns	
1	L12	INDUCTOR	NL453232T-221J-PF PM1812-221J-RC	TDK Bourns	
1	C46	CERAMIC CAPACITOR	CGA4J2C0G1H333J125AA	TDK	0.033uF/50V/2125/C0G 5%
1	C47	CERAMIC CAPACITOR	CC0603KRX7R9BB473	Yageo	0.047uF/50V/1608/X7R 10%
1	C50	CERAMIC CAPACITOR	C1608C0G1H122J	TDK	1200pF/50V/1608/C0G 5%
1	C52	CERAMIC CAPACITOR	CGA3E2C0G1H182J	TDK	1800pF/50V/1608/C0G 5%
1	C54	CERAMIC CAPACITOR	CGA3E2C0G1H392J	TDK	3900pF/50V/1608/C0G 5%
1	C57	CERAMIC CAPACITOR	CGA3E2C0G1H472J	TDK	4700pF/50V/1608/C0G 5%
1	C58	CERAMIC CAPACITOR	CGA3E2C0G1H822J	TDK	8200pF/50V/1608/C0G 5%
2	C60,C61	CERAMIC CAPACITOR	GRM3195C1H273JA01D	MURATA	0.027uF/50V/3216/C0G 5%
1	C64	CERAMIC CAPACITOR	GRM3195C1H393JA01D	MURATA	0.039uF/50V/3216/C0G 5%
2	R32,R34	RESISTOR	300ohm/5%/1608		
1	R36	RESISTOR	120ohm/5%/1608		
1	R37	RESISTOR	360ohm/5%/1608		
1	R40	RESISTOR	0ohm/1608		

Table 6-4 Filter board (F-type)

Quantity	Reference	KIND	Parts Name	Manufacturer	Memo
1	CN5	CONNECTOR	XG4C-1031	OMRON	
1	JP4	CONNECTOR	FFC-2AMEP1	HONDA	
1	L3	INDUCTOR	SRN5040-330M NR5040T330M	Bourns Inc. Taiyo Yuden	
2	L6,L7	INDUCTOR	NL453232T-101J-PF PM1812-101J-RC	TDK Bourns	
2	L10,L11	INDUCTOR	NL453232T-470J-PF PM1812-470J-RC	TDK Bourns	
1	L13	INDUCTOR	NL453232T-820J-PF PM1812-820J-RC	TDK Bourns	
3	C48,C62,C63	CERAMIC CAPACITOR	C1608C0G1E103J080AA	TDK	0.01uF/50V/1608/C0G 5%
1	C49	CERAMIC CAPACITOR	CC0603KRX7R9BB473	Yageo	0.047uF/50V/1608/X7R 10%
1	C51	CERAMIC CAPACITOR	C1608C0G1H181J	TDK	180pF/50V/1608/C0G 5%
1	C53	CERAMIC CAPACITOR	C1608C0G1H271J	TDK	270pF/50V/1608/C0G 5%
1	C55	CERAMIC CAPACITOR	C1608C0G1H122J	TDK	1200pF/50V/1608/C0G 5%
1	C56	CERAMIC CAPACITOR	C1608C0G1H102J	TDK	1000pF/50V/1608/C0G 5%
1	C59	CERAMIC CAPACITOR	CGA3E2C0G1H182J	TDK	1800pF/50V/1608/C0G 5%
1	C65	CERAMIC CAPACITOR	CGA3E2C0G1H562J080AA	TDK	5600pF/50V/1608/C0G 5%
1	R31	RESISTOR	RMCP2010JT100R	Stackpole	
2	R33,R35	RESISTOR	300ohm/5%/1608		
1	R38	RESISTOR	120ohm/5%/1608		
1	R39	RESISTOR	330ohm/5%/1608		
1	R41	RESISTOR	0ohm/1608		

Table 6-5 Filter board (G-type)

Quantity	Reference	KIND	Parts Name	Manufacturer	Memo
1	CN6	CONNECTOR	XG4C-1031	OMRON	
2	L18,L19	INDUCTOR	NL453232T-101J-PF PM1812-101J-RC	TDK Bourns	
1	L16	INDUCTOR	NL453232T-271J-PF PM1812-271J-RC	TDK Bourns	
2	L17,L20	INDUCTOR	NL453232T-390J-PF PM1812-390J-RC	TDK Bourns	
1	C69	CERAMIC CAPACITOR	C1608C0G1E103J080AA	TDK	0.01uF/50V/1608/C0G 5%
1	C70	CERAMIC CAPACITOR	CC0603KRX7R9BB473	Yageo	0.047uF/50V/1608/X7R 10%
1	C71	CERAMIC CAPACITOR	CGA3E2C0G1H562J080AA	TDK	5600pF/50V/1608/C0G 5%
2	C72,C73	CERAMIC CAPACITOR	GRM3195C1H393JA01D	MURATA	0.039uF/50V/3216/C0G 5%
1	C74	CERAMIC CAPACITOR	C1608C0G1H122J	TDK	1200pF/50V/1608/C0G 5%
1	C75	CERAMIC CAPACITOR	C1608C0G1H271J	TDK	270pF/50V/1608/C0G 5%
1	C76	CERAMIC CAPACITOR	CGA3E2C0G1H182J	TDK	1800pF/50V/1608/C0G 5%
1	C77	CERAMIC CAPACITOR	C1608C0G1H102J	TDK	1000pF/50V/1608/C0G 5%
1	C78	CERAMIC CAPACITOR	C1608C0G1H181J	TDK	180pF/50V/1608/C0G 5%
2	R43,R46	RESISTOR	300ohm/5%/1608		
1	R44	RESISTOR	120ohm/5%/1608		
1	R45	RESISTOR	330ohm/5%/1608		

Table 6-6 S-ROM board

Quantity	Reference	KIND	Parts Name	Manufacturer	Memo
1	CN201	CONNECTOR	XG4C-1031	OMRON	
1	C201	CERAMIC CAPACITOR	CC0603KRX7R9BB104	Yageo	0.1uF/50V/1608/X7R 10%
2	R202,R201	RESISTOR	33ohm/5%/1608		
1	U201	IC	N25Q032A13ESC40	Micron	alternative : AT25SF321-SSHD-T, AT25SF321B-SSHB Adesto(Dialog), W25Q32JVSNIM(Winbond), MX25L3233FM1I-08G(Macronix)

Website and Support

Renesas Electronics Website
https://www.renesas.com/jp/en

Inquiries
https://www.renesas.com/jp/en/contact-us

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	2022.07.01		First Edition issued

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