Power Management IC designed for "NXP® i.MX 8M Quad"

BD71837AMWV Platform Design Guide

1. Introduction

BD71837AMWV is a Power Management Integrated Circuit (PMIC) available in 68-QFN package and dedicated to the application powered by 5V input. PMIC includes eight Buck convertors, seven LDOs, one internal load switch and crystal oscillator driver for RTC clock. These functions are designed to support the specific power requirements from NXP i.MX 8M platform to achieve the required performance for cost-sensitive applications.

The below figure is the outline of the power map between PMIC and i.MX 8M SoC, showing that all voltage rails required by SoC are satisfied.

"BD71837AMWV Platform Design Guide" provides the guideline for designing PCB including recommendation for the PCB layer stack up, the components placement and the PCB routings.

To reduce the risk that comes from PCB layout or parts placement, the guideline is strongly recommended to be applied to the PCB design.

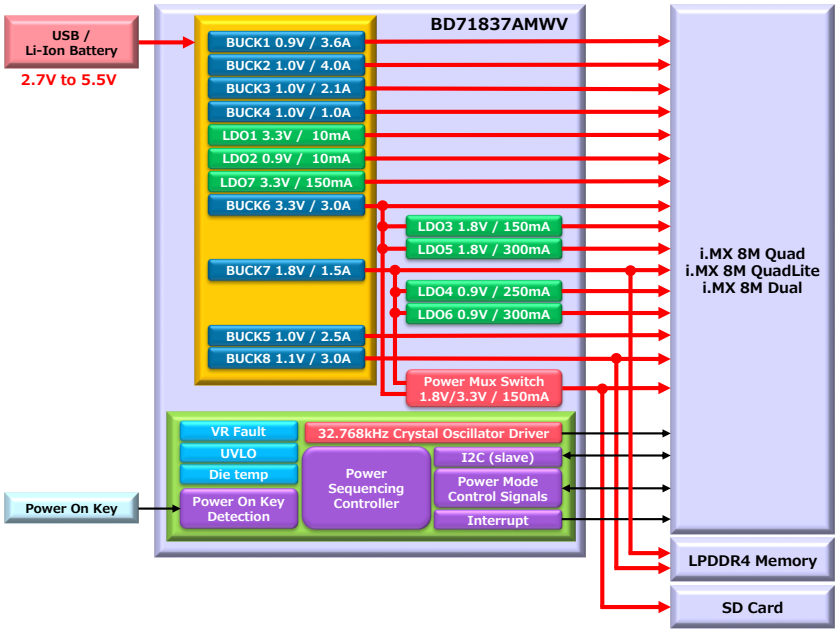

Figure 1.1 The system power map

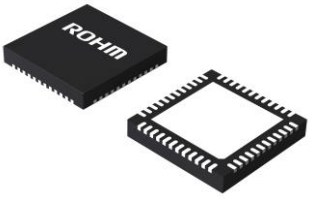

Figure 1.2 The package image

2. Revision History

Table 2.1 Revision History

Revision Number	Description	Revision Date
001	Initial release	Apr. 24th, 2018
002	Fixed the document number Section 5.6: Updated the part number of Crystal Oscillator	Jun. 26th, 2020

3. Features

3.1. Terminologies

Table 3.1 Acronyms, Conventions and Terminologies

Term	Definition
BOM	Bill Of Materials
PMIC	Power Management Integrated Circuit
FET	Field Effect Transistor
I2C	Inter-Integrated Circuit
IRQ	Interrupt ReQuest
LDO	Low Drop-Out Regulator
OCP	Over Current Protection
OVP	Over Voltage Protection
SoC	System-On-a-Chip

3.2. Reference Documents

Table 3.2 Reference Documents

Document
BD71837AMWV Datasheet Rev.001.pdf
BD71837AMWV Reference Schematic Rev.001.pdf
BD71837AMWV Reference BOM Rev001.xlsx
BD71837AMWV Reference Layout Rev.001.brd
BD71837AMWV Schematic Checklist Rev001.xlsx

3.3. PMIC futures

BD71837AMWV supply the power required by SoC and peripheral devices for NXP i.MX 8M platform.

Once PMIC powered up, it can be controlled by I2C interface to determine the internal register settings.

The followings explain the features incorporated in the IC.

Voltage Rails

■ 8ch low power consumption Buck Convertors with Integrated BUCK FETs

- Buck1: 0.7V – 1.3V / 10mV step (DVS), I_{OMAX} = 3.6A
- Buck2: 0.7V – 1.3V / 10mV step (DVS), I_{OMAX} = 4.0A
- Buck3: 0.7V – 1.3V / 10mV step (DVS), I_{OMAX} = 2.1A
- Buck4: 0.7V – 1.3V / 10mV step (DVS), I_{OMAX} = 1.0A
- Buck5: 0.7V – 1.35V / 8 steps, I_{OMAX} = 2.5A
- Buck6: 3.0V – 3.3V / 100mV step, I_{OMAX} = 3.0A
- Buck7: 1.6V – 2.0V / 8 steps, I_{OMAX} = 1.5A
- Buck8: 0.8V – 1.4V / 10mV step, I_{OMAX} = 3.0A

■ 7ch LDO Regulator

- LDO1: 3.0V – 3.3V / 1.6V – 1.9V, I_{OMAX} = 10mA
- LDO2: 0.9V / 0.8V, I_{OMAX} = 10mA
- LDO3: 1.8V – 3.3V, I_{OMAX} = 300mA
- LDO4: 0.9V – 1.8V, I_{OMAX} = 250mA
- LDO5: 1.8V – 3.3V, I_{OMAX} = 300mA
- LDO6: 0.9V – 1.8V, I_{OMAX} = 300mA
- LDO7: 1.8V – 3.3V, I_{OMAX} = 150mA

■ 1ch Internal General Switch

- Mux Switch: 1.8V/3.3V, I_{OMAX} = 150mA

Serial Interface

- I2C interface provides access to configuration registers.

Crystal Oscillator Driver

- 32.768kHz Crystal Oscillator Driver is included.

4. General Design Considerations

This chapter provides general PCB design guidelines such as BD71837AMWV general parts placement.

4.1. Package Dimension of BD71837AMWV

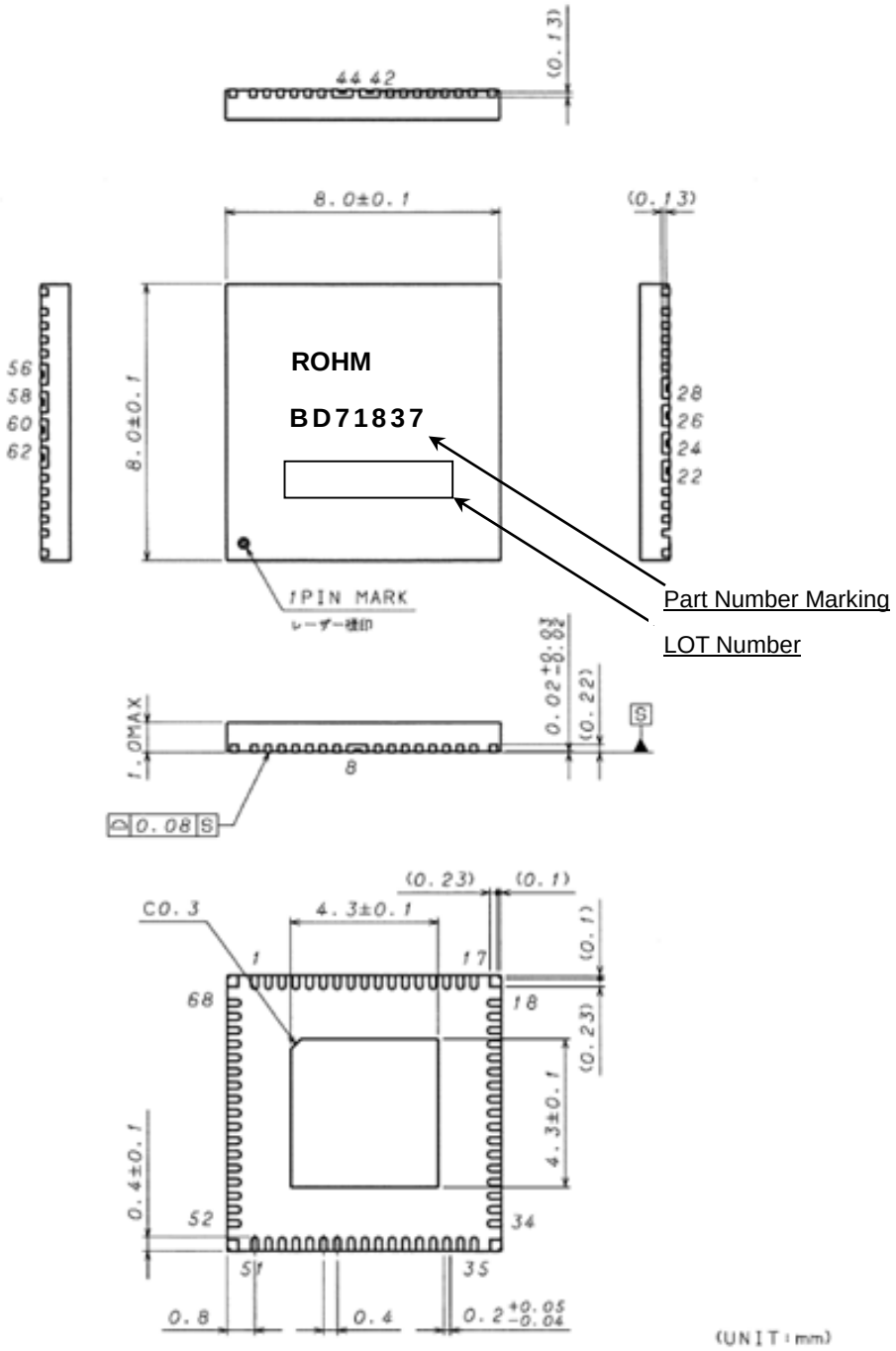

Figure 4.1 The package dimension of BD71837AMWV

4.2. Pin Configuration

The pin configuration of BD71837AMWV is designed and it will result in the effective routings between PMIC and SoC, memory device and other components.

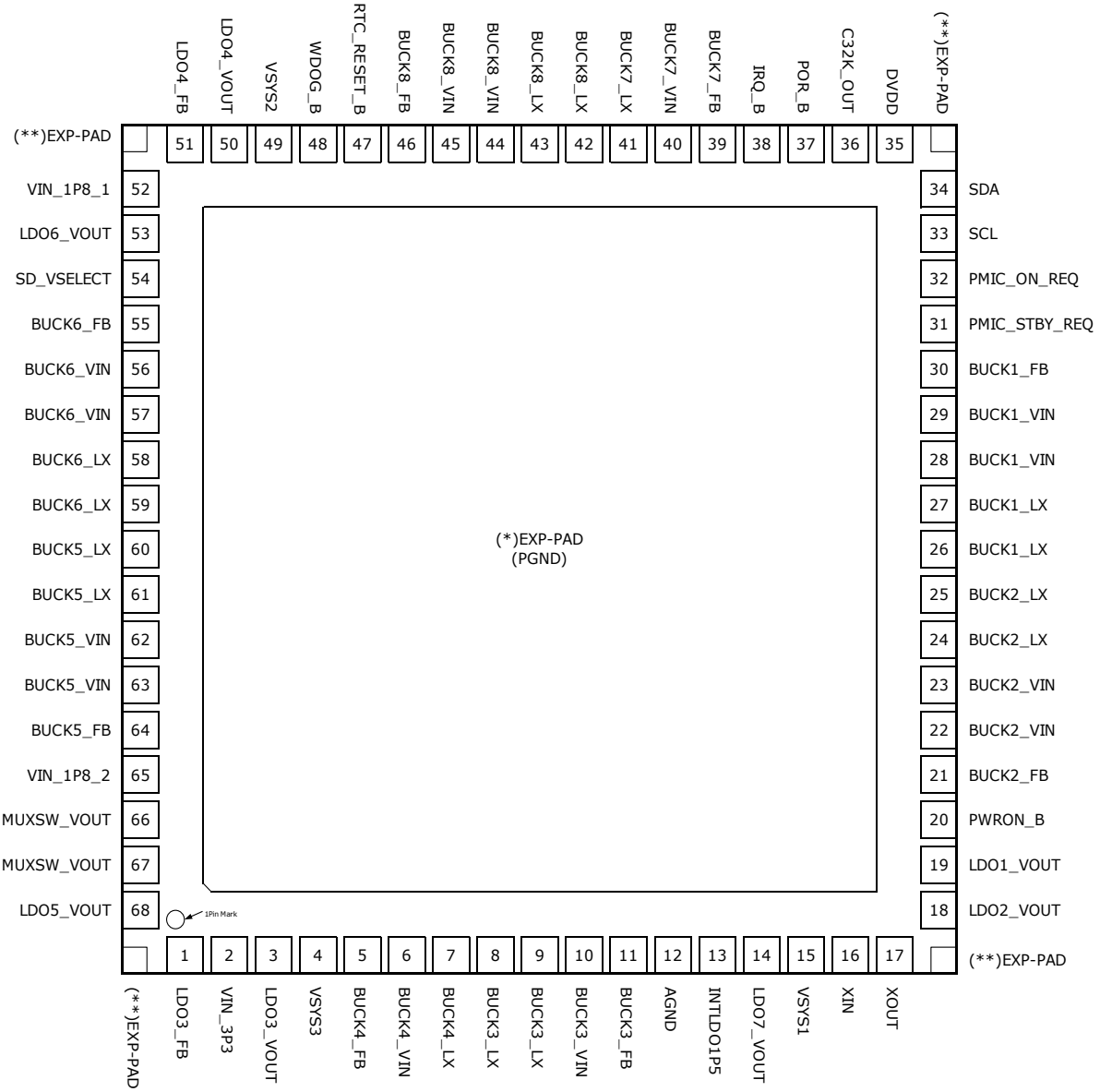

Figure 4.2 BD71837AMWV pin configuration

Note: (*) EXP-PAD is the power GND for PMIC so it should be soldered to GND plane.

(**) EXP-PAD assigned to 4 corners are also the same potentials with (*) EXP-PAD.

4.3. General Stack-up Recommendations

Type-3 and 6 layers PCB technology are used for BD71837AMWV ROHM's EVM.
The following general stack-up is strongly recommended to be applied to all the routings on the PCB.

- Surface plane layers are recommended to apply 1.9 Mils thick copper.
- Internal plane layers are recommended to apply 1.2 Mils thick copper.
- It is recommended I2C signals to have the reference versus solid planes over the length of their routing and not to cross plane splits. Ground should be the ideal reference.
- The extra area in each layers should be filled with as much ground or other power rails as possible.
  There should not be any large free areas with no metal for each layer because of the improvement for heat dissipation. Large metal area also reduces stray resistance and inductance.

4.4. 6-layer Board Stack-up

BD71837AMWV ROHM's EVM uses Type 3 PCB technology and Figure 4.3 shows the 6-layer PCB stack-up.

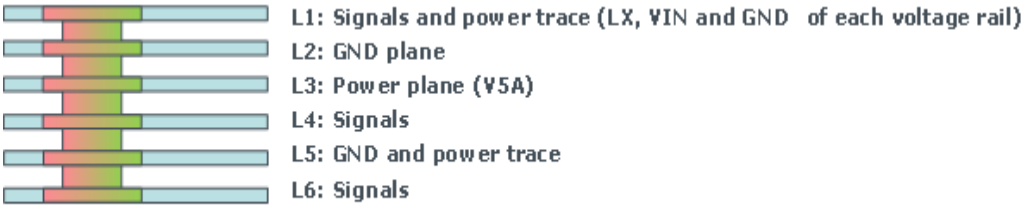

Figure 4.3 6-layers PCB stack-up

4.5. Via Guidelines

This section explains proper via-drill, pad, and anti-pad size.

Note:
Improper drill, pad, and anti-pad size may cause some troubles on the PCB cost, reliability, manufacturability, and electrical characteristics.

Type-3 PCB technology employs plated through-hole (PTH) vias for breakout routing. The dimension of PTH vias may vary as necessary. Table 2.1 shows the recommended via dimension used for the breakout areas of BD71837AMWV. Figure 4.4 shows the image of PTH vias.

Table 4.1 Dimension example for PTH

Via type	Hole size	Pad size	Anti-Pad size
Plated through-hole (PTH)	12 mils	24 mils	32 mils

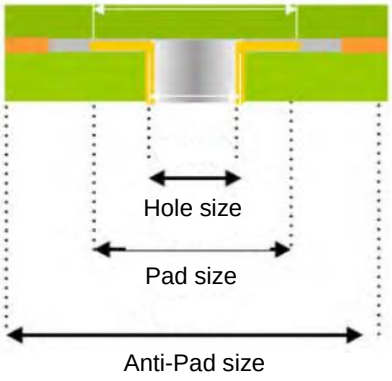

Figure 4.4 The image of PTH vias

4.6. Placement of PTHs underneath the exposed pad

When the distance between the edge of metal mask of the exposed pad and PTH is close, the solder may get on the resist then the PTH and exposed pad of BD71837AMWV will be shorted. To avoid the soldering issue, it is highly recommended to keep the positons of PTHs away from the edge of the exposed pad by 500µm or more, and PTHs should be placed not to disrupt the current flows between each GND of the output capacitors and the exposed pad.

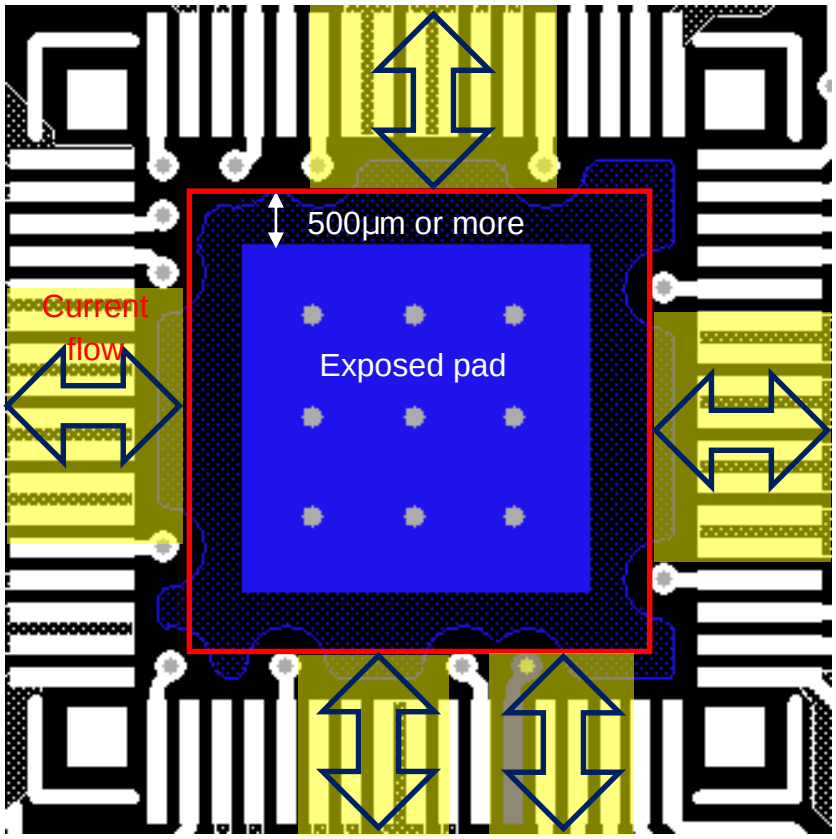

Figure 4.5 The clearance between PTH and the exposed pad

Note

The spaces for the current flows between GNDs of each output capacitor and exposed pad for PMIC PGND should be ensured. So it is recommended that the numbers of PTHs disturbing the current flows should be secured.

4.7. Outline for PCB layout

For understanding the outline of ROHM's reference layout, the layout data for Layer 1(Top Layer) to 6 (Bottom layer) are shown in Figure 4.6 to Figure 4.11.

The layout is designed, supposing the position of the SoC as Figure 4.6.

(1st pin of SoC is positioned at lower right.)

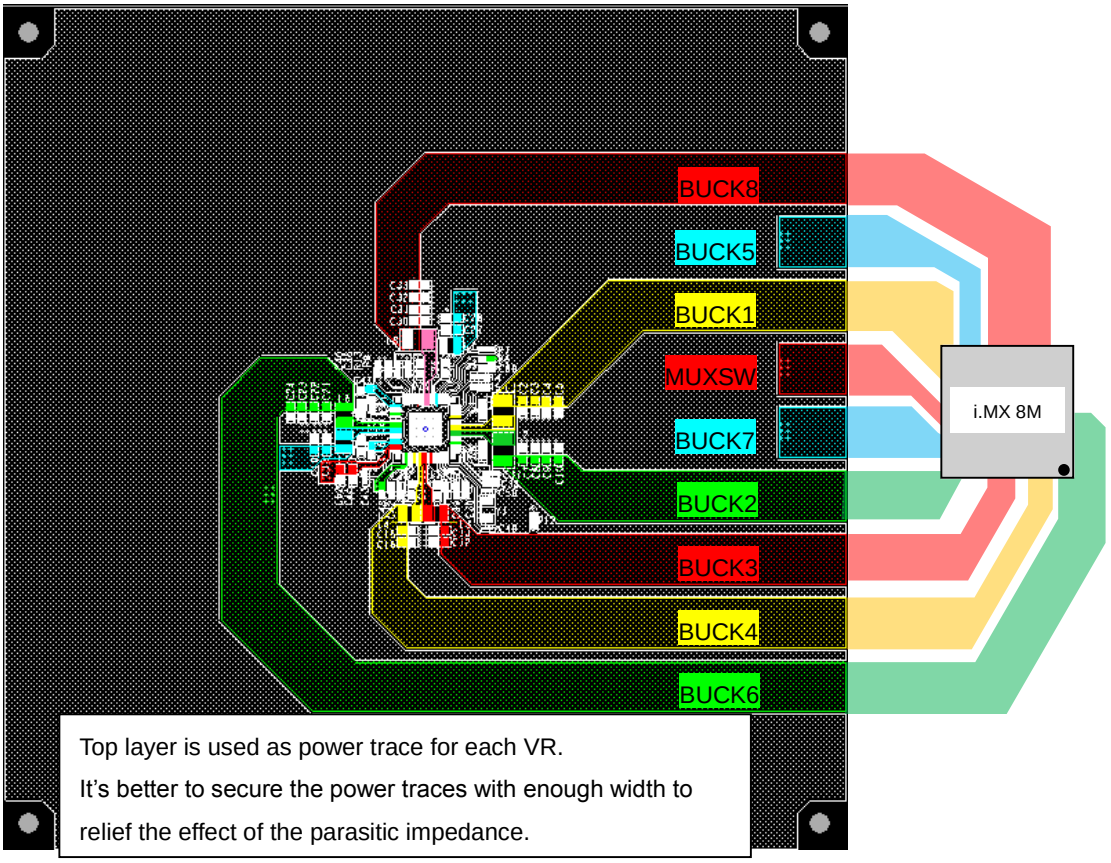

Figure 4.6 BD71837AMWV Reference Board Outline (Top Layer)

Figure 4.7 BD71837AMWV Reference Board Outline (Layer 2)

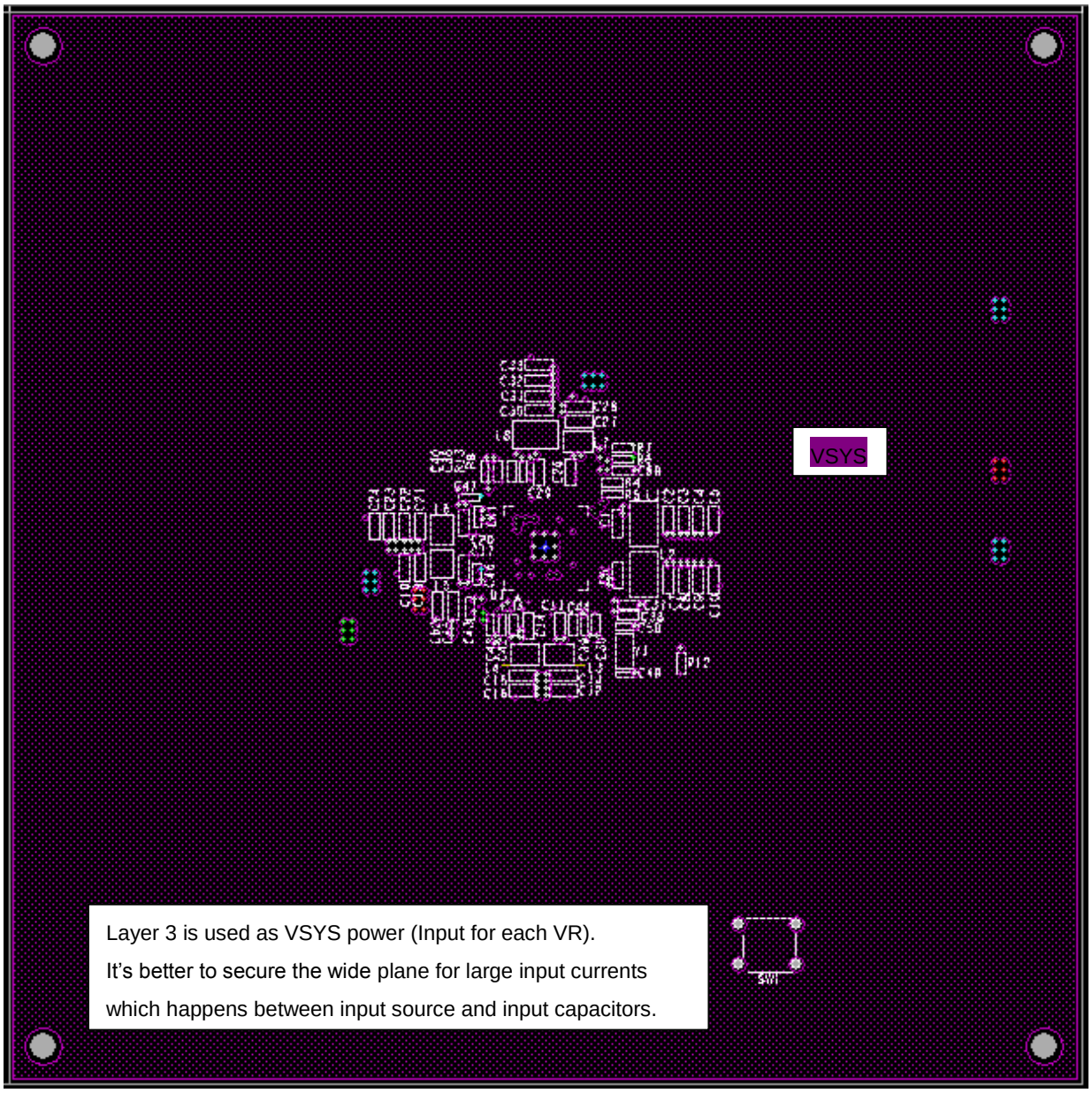

Figure 4.8 BD71837AMWV Reference Board Outline (Layer 3)

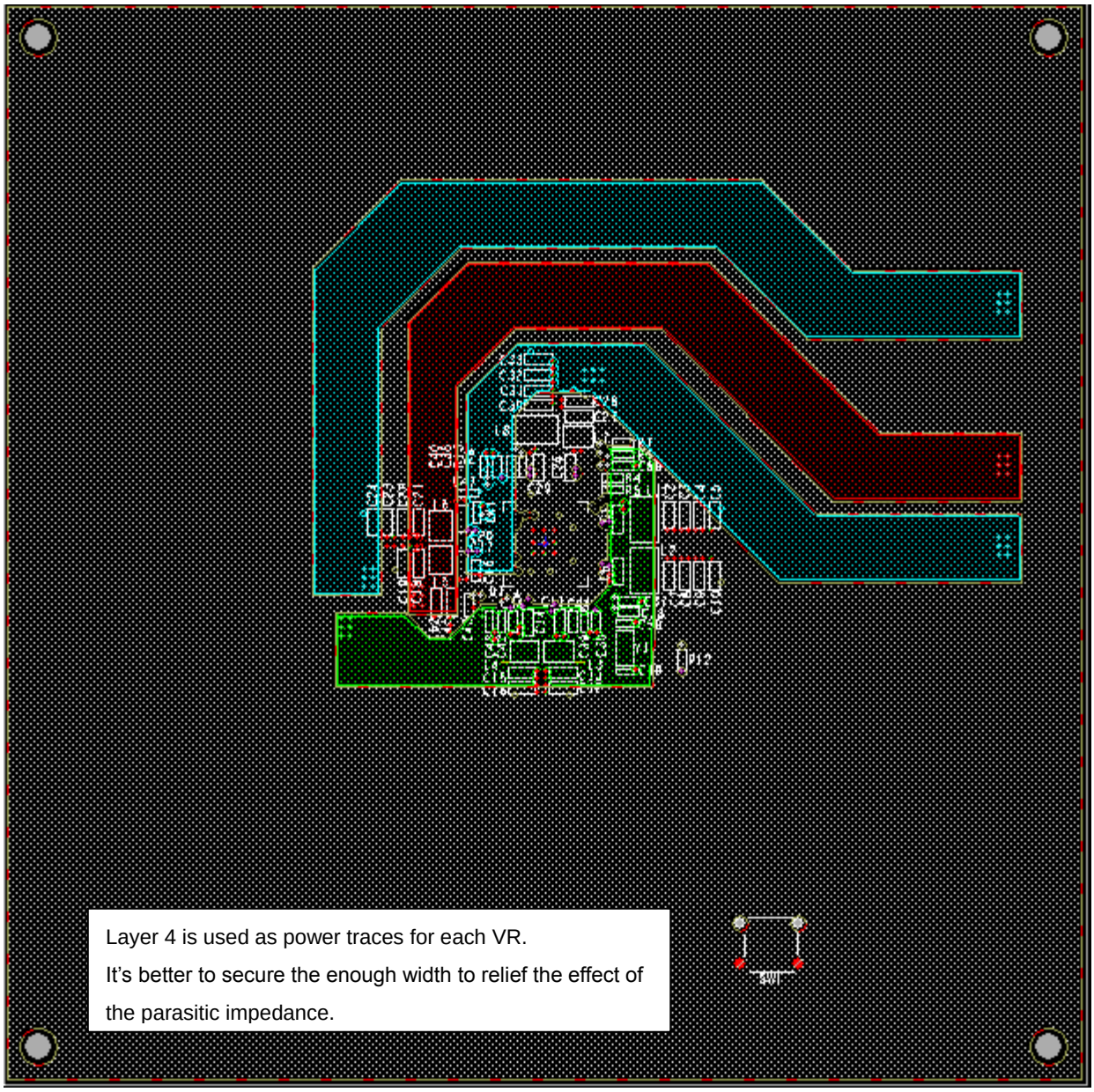

Figure 4.9 BD71837AMWV Reference Board Outline (Layer 4)

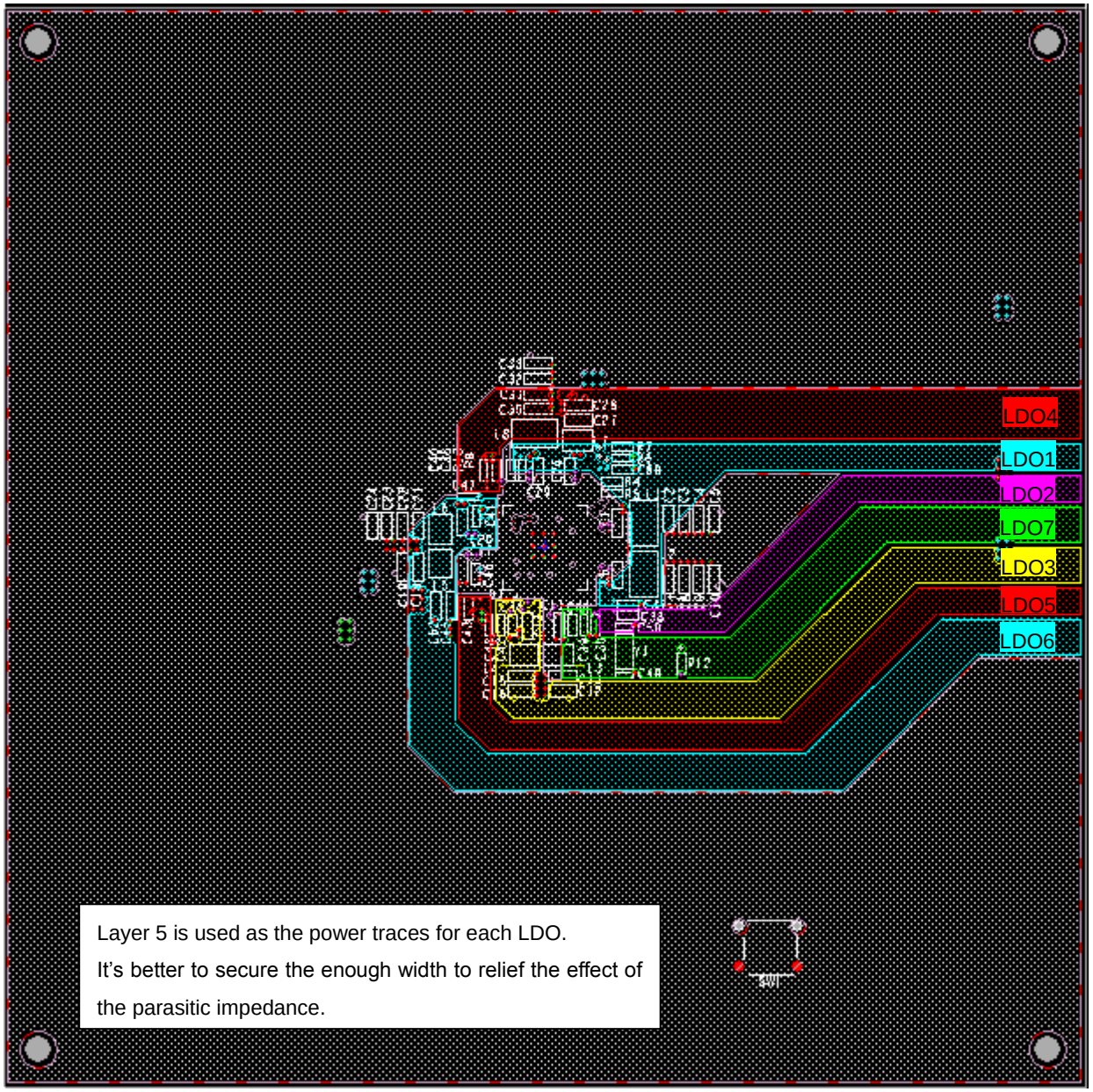

Figure 4.10 BD71837AMWV Reference Board Outline (Layer 5)

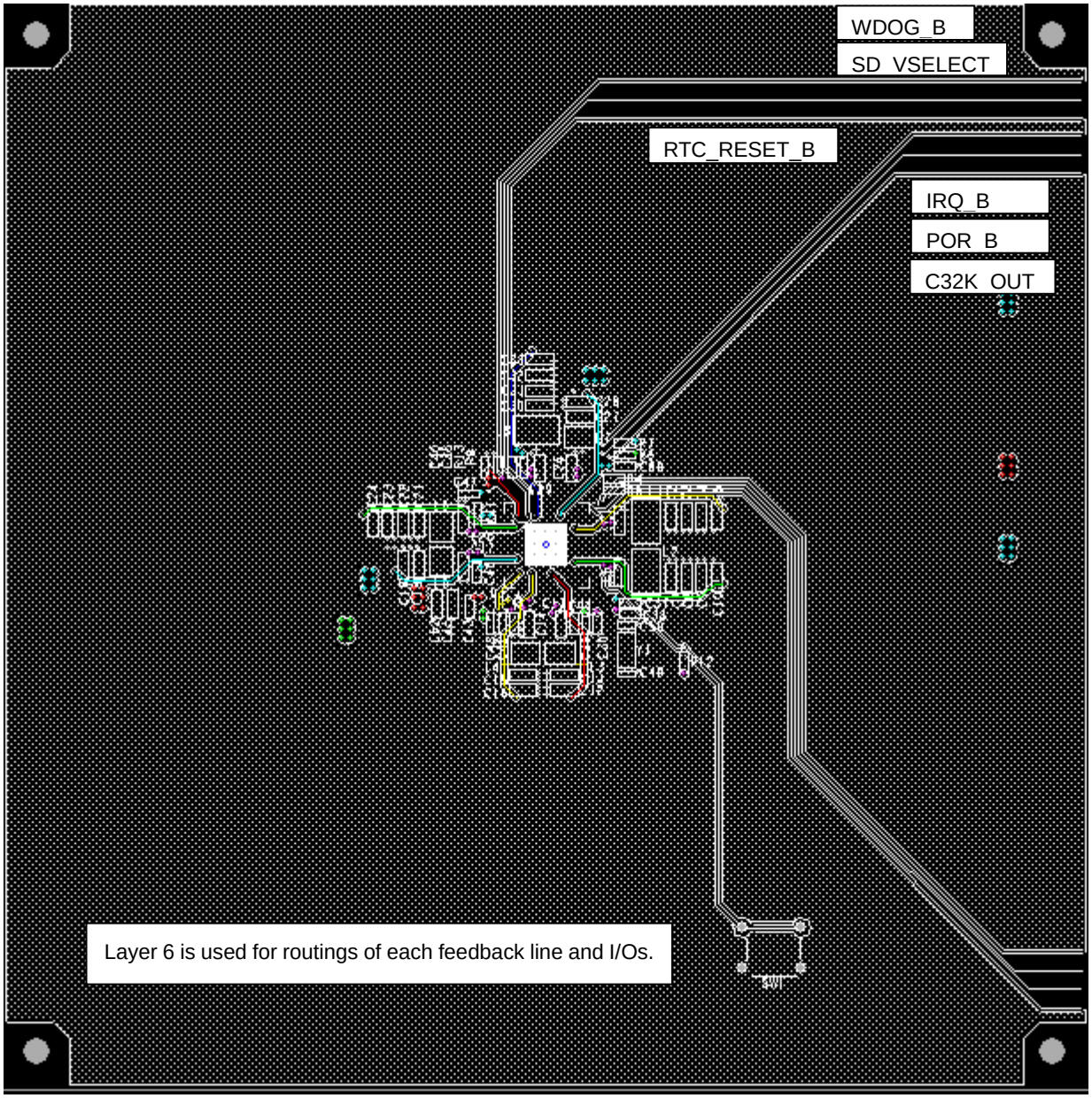

Figure 4.11 BD71837AMWV Reference Board Outline (Layer 6)

5. Platform Power Delivery Guidelines

BD71837AMWV is the PMIC that incorporates single BUCK regulators, LDOs, and the internal load switch.
It is essential to follow the guidelines to ensure the stable power delivery to the SoC and the system.

5.1. Platform Power Delivery

Figure 5.1 shows the voltages BD71837AMWV provides to the SoC and other devices in the system and the information of the maximum currents for each VR are summarized in Table 5.1.

Table 5.1 The Maximum Design Powers for BUCK convertors, LDOs, and the Load Switch

Voltage Rail	Type	Input Voltage	Default Output Voltage [V]	Max Current [mA]	Over Current Protection Min [mA]
BUCK1	Buck	VSYS	0.7 – 1.3	3600	5000
BUCK2	Buck	VSYS	0.7 – 1.3	4000	5500
BUCK3	Buck	VSYS	0.7 – 1.3	2100	3000
BUCK4	Buck	VSYS	0.7 – 1.3	1000	2500
BUCK5	Buck	VSYS	0.7 – 1.35	2500	3500
BUCK6	Buck	VSYS	3.0 – 3.3	3000	4500
BUCK7	Buck	VSYS	1.6 – 2.0	1500	3000
BUCK8	Buck	VSYS	0.8 – 1.4	3000	4500
LDO1	LDO	VSYS	1.6 – 1.9	10	20
LDO2	LDO	VSYS	0.9 / 0.8	10	20
LDO3	LDO	BUCK6 / VSYS	1.8 – 3.3	300	390
LDO4	LDO	BUCK7 / VSYS	0.9 – 1.8	250	325
LDO5	LDO	BUCK6	1.8 – 3.3	300	390
LDO6	LDO	BUCK7	0.9 – 1.8	300	340
LDO7	LDO	VSYS	1.8 – 3.3	150	195
MUXSW	Load Switch	1.8V / 3.3V	1.8 / 3.3	150	-

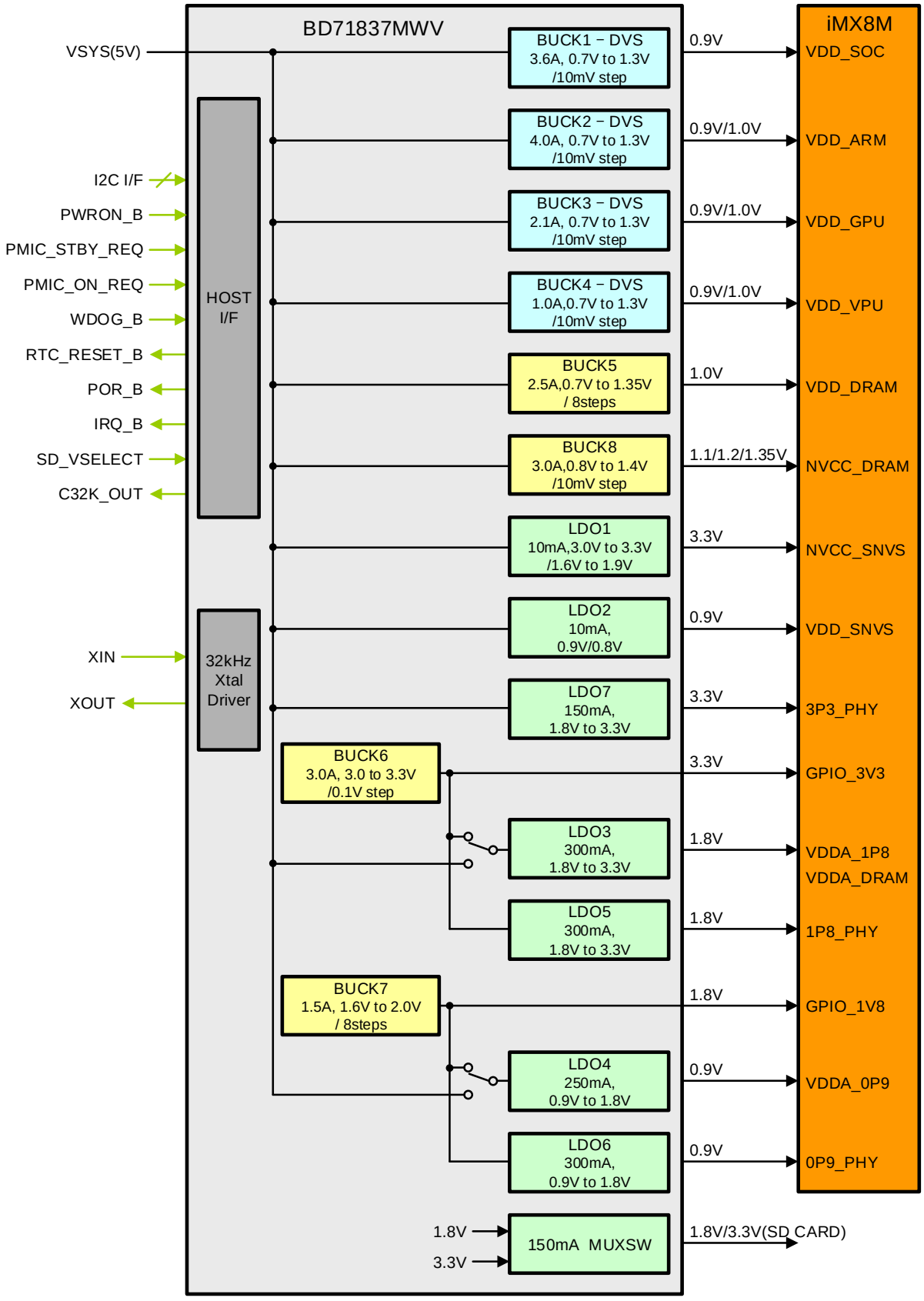

Figure 5.1 BD71837AMWV Power Delivery Map

5.2. General Layout Guideline

This section explains the guideline about the layout for voltage regulators. The voltage rails with higher Iomax current especially for BUCK convertors should be carefully designed not to transmit the unwanted interference caused by switching noises to other signals with high impedance.
And IR drop caused by large switching currents often influence the violation of the stability for the input level for each buck convertor so the design for each input should be also taken care. It is highly recommended to follow the all guidelines in this section.

5.2.1. Overall Component Placement

Figure 5.2 shows the overall parts placement. The figure shows the positions of the components needed to be put closely to PMIC. It is strongly recommended that the components controlling the higher currents like input / output capacitors and inductors are placed in priority to any other components to guarantee the stabilities of each VR.

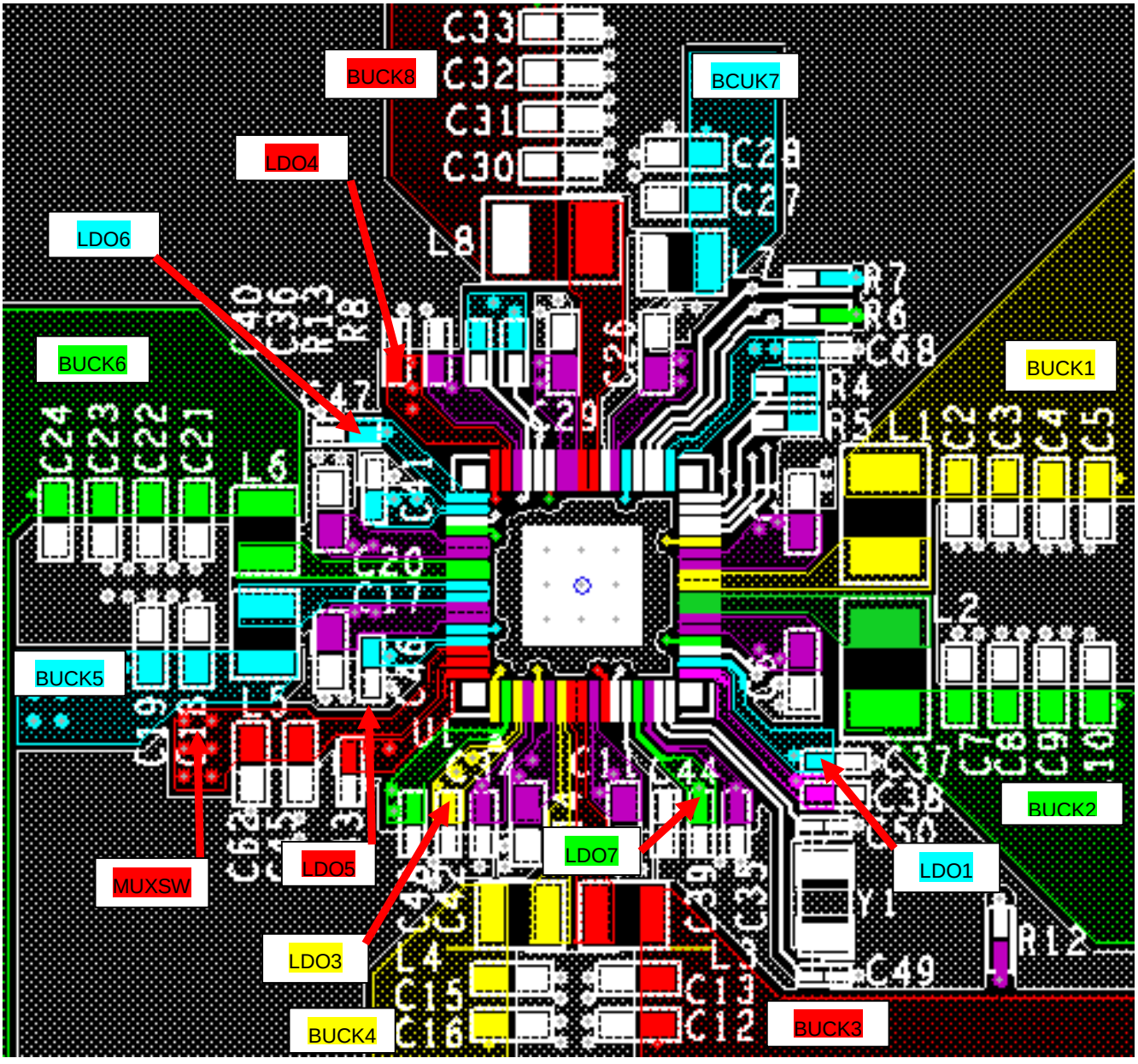

Figure 5.2 Overall component placement example

5.2.2. Large Current Loop

There are 2 high-pulsing current flow loops in the BUCK convertor system.

Loop1

When Tr2 turns ON, the loop starts from the input capacitor, to VIN terminal, to LX terminal, to L (inductor), to output capacitors, and then returns to the input capacitor through GND.

Loop2

When Tr1 turns ON, the loop starts from Tr1, to L (inductor), to output capacitors, and then returns to Tr1 through GND.

To reduce the noise and improve efficiency, please minimize the impedance of the each loop.

Figure 5.3 shows the current loops to be designed carefully.

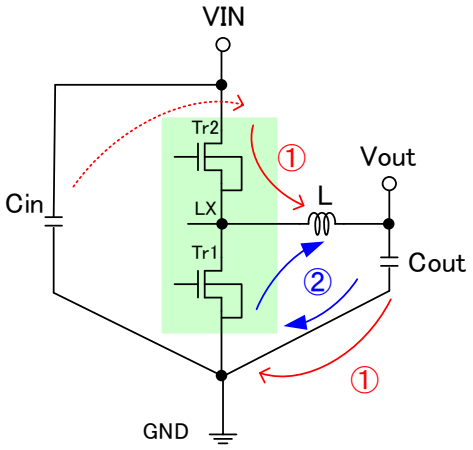

Figure 5.3 BUCK Convertor Large Current Loops

As Figure 5.4 shows, the patterns which handle the heavy currents should be routed as much shortly and widely as possible to suppress the effect of the parasitic impedance coming from PCB layout, especially the node with drastic shift in current or voltage level such as VIN (input voltage) and power ground (GND). Two vias with the diameter of 300µm are used for input and GND for each input capacitor to make the impedance lower.

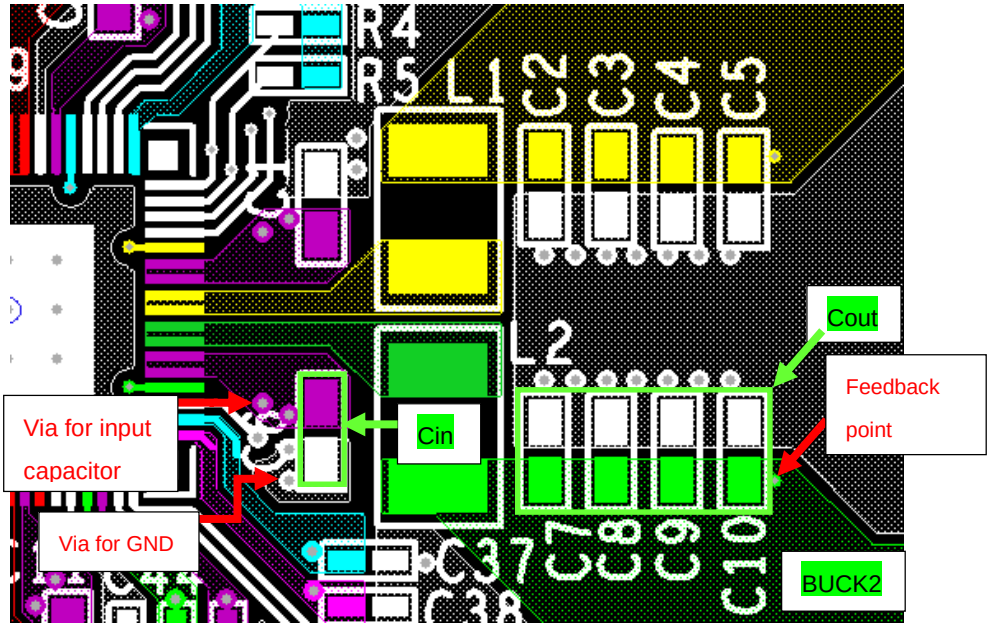

Figure 5.4 Example of parts placement and routings for BUCK2 at the top layer

5.2.3. Power GND

Power ground for BUCK Converters (exposed pad) is the noisy ground because of the current loops indicated in the previous section. Thus, the power ground should take an area as large as possible to keep the impedance low and reduce the swing of ground voltage level.

5.2.4. VSYS (Power supply for BD71837AMWV analog circuit)

BUCK X_VIN (X is 1, 2, 3… and 8) of each VR's input should be connected to VSYS plane directly to minimize the parasitic and common impedance effects.
The enough numbers of vias for input capacitors should be used and the decoupling capacitors should be placed as close to PMIC as possible. The reference layout (BD71837AMWV reference layout) can be referred to for your reference.

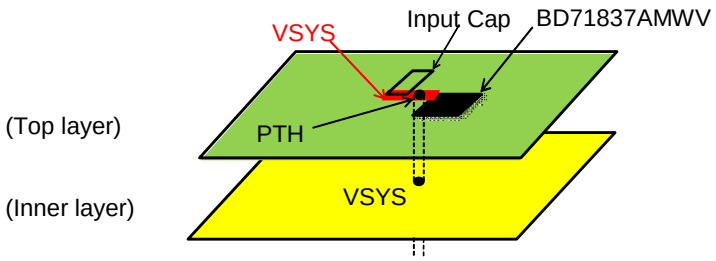

Figure 5.5 Layout for BUCK X_VIN and VSYS

5.2.5. Other Signal Pattern Precautions

Make sure to leave adequate space between noisy lines of voltage rail and serial interface (I2C).

5.2.6. Feedback Sense Lines

Feedback sense lines (e.g., BUCK1_FB, BUCK2_FB etc.) should be routed to monitor the accurate output voltages for each voltage rail. In order to avoid the effects of IR drop and switching noise, please make sure that the feedback sense lines are independently routed from the point near output capacitors.
As the method for voltage sensing, "Local sensing" is recommended in all VRs.
In addition, these lines are interfered by noisy lines since these sense lines are high impedance nodes. Please don't route these sense lines by overlapping with or in parallel with noisy lines such as LX, SCL and SDA.
Drastic voltage shift in feedback lines result in unexpected voltage violations.

5.2.7. AGND layout

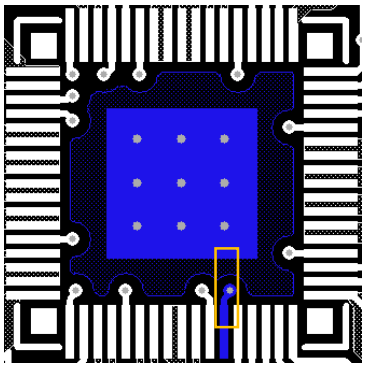

Figure 5.6 Connection between Power GND and Analog GND

AGND is recommended not to be connected to PGND for PMIC (exposed pad) directly to avoid noise effect. It's better to short AGND to a GND at inner GND plane (stable GND) through PTH.
The reference layout as above can be referred to.

5.3. BUCK Convertors

In this section, application circuits for each voltage rail are explained.

For more detail information, the document of “BD71837AMWV schematic check list” can be referred to.

5.3.1. BUCK1 (VDD_SoC)

BUCK1 is a high-efficiency buck converter which converts VSYS (2.7V to 5.5V) voltage to a regulated voltage.

This VR can dynamically change its output voltage setting using the I2C interface. BUCK1 output voltage range is from 0.7V to 1.3V by 10mV step.

5.3.1.1. Schematic Example

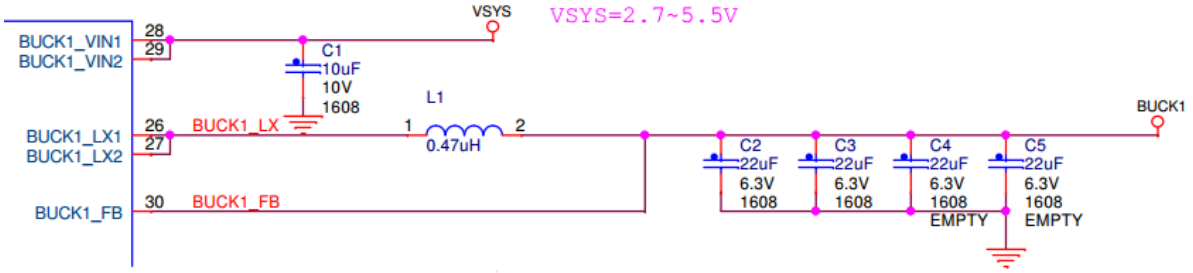

Figure 5.7 BUCK1 Schematic Example

5.3.1.2. Schematic checklist

Table 5.2 BUCK1 schematic checklist

Pin Names	Dir.	Notes (Unit of parts size : mm)	Check
Buck1 (VDD_SoC)			
BUCK1_VIN[1:0]	I	Connect to the 5V power supply in the system.	
		As a decoupling capacitor, use **one 10µF**. Select the input capacitor with the capacitance≧**3.5µF** including the DC bias effect at VSYS=5.0V. <The recommended part of capacitor is shown below.> A.LMK107BBJ106MALT, size:1608, capacitance: 10µF, tolerance:10V	
BUCK1_LX[1:0]	O	Connect to BUCK1 via the inductor.	
		Connect **one 0.47µH** ±20% inductors to BUCK1_LX0 and 1. Select the inductor to be used according to board area and cost restrictions. <The recommended part of inductor is shown below.> A.HMLE32251E-R47MSR, size: 3225 , Rated DC Current : 7.2A	
		As output capacitors, use **two 22µF** capacitors. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of 22µF capacitor is shown below.> A.GRM188R60J226MEA0D, size:1608, capacitance: 22µF, tolerance:6.3V	
BUCK1_FB	I	Connect to the sense pin of BUCK1_FB to near output capacitors.	

Note: Some dummy pads for output capacitors should be prepared like the reference schematic for the fine tuning in the actual board.

5.3.1.3. Parts placement for each decoupling capacitor

About the parts placement for each capacitor around BUCK1, the below reference layout can be referred to.

BUCK1_FB should be connected to near output capacitors.

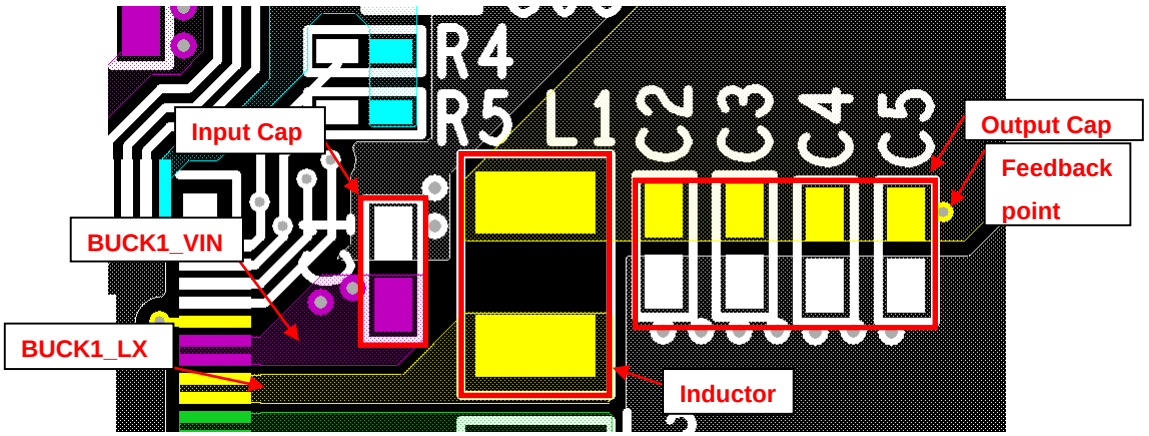

Figure 5.8 BUCK1 Layout Example (Top Layer)

5.3.2. BUCK2 (VDD_ARM)

BUCK2 is a high-efficiency buck converter which converts VSYS (2.7V to 5.5V) voltage to a regulated voltage. This VR can dynamically change its output voltage setting using the I2C interface. BUCK2 output voltage range is from 0.7V to 1.3V by 10mV step.

5.3.2.1. Schematic Example

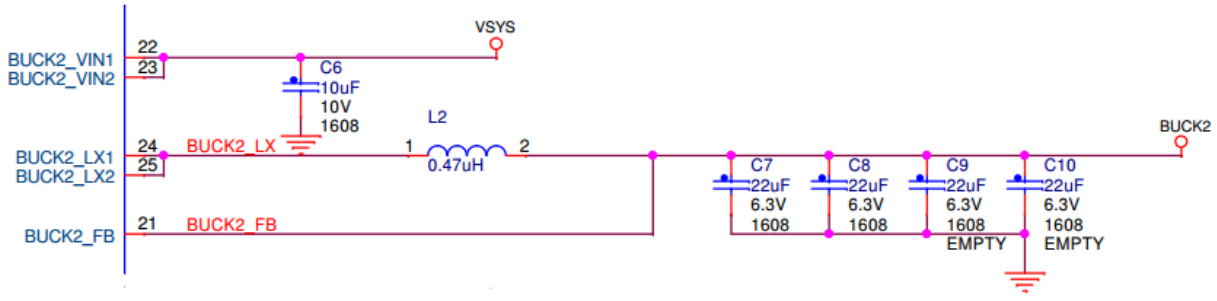

Figure 5.9 BUCK2 Schematic Example

5.3.2.2. Schematic checklist

Table 5.3 BUCK2 schematic checklist

Pin Names	Dir.	Notes (Unit of parts size : mm)	Check
BUCK2 (VDD_ARM)			
BUCK2_VIN[1:0]	I	Connect to the 5V power supply in the system.	
		As a decoupling capacitor, use **one 10μF**. Select the input capacitor with the capacitance≧**3.5μF** including the DC bias effect at VSYS=5.0V. <The recommended part of capacitor is shown below.> A.LMK107BBJ106MALT, size:1608, capacitance: 10μF, tolerance:10V	
BUCK2_LX[1:0]	O	Connect to BUCK2 via the inductor.	
		Connect **one 0.47μH** ±20% inductors to BUCK2_LX0 and 1. Select the inductor to be used according to board area and cost restrictions. <The recommended part of inductor is shown below.> A.HMLE32251E-R47MSR, size: 3225 , Rated DC Current : 7.2A	
		As output capacitors, use **two 22μF** capacitors. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of 22μF capacitor is shown below.> A.GRM188R60J226MEA0D, size:1608, capacitance: 22μF, tolerance:6.3V	
BUCK2_FB	I	Connect to the sense pin of BUCK2_FB to near output capacitors.	

Note: Some dummy pads for output capacitors should be prepared like the reference schematic for the fine tuning in the actual board.

5.3.2.3. Layout Example

About the parts placement for each capacitor around BUCK2, the below reference layout can be referred to.

BUCK2_FB should be connected to near output capacitors.

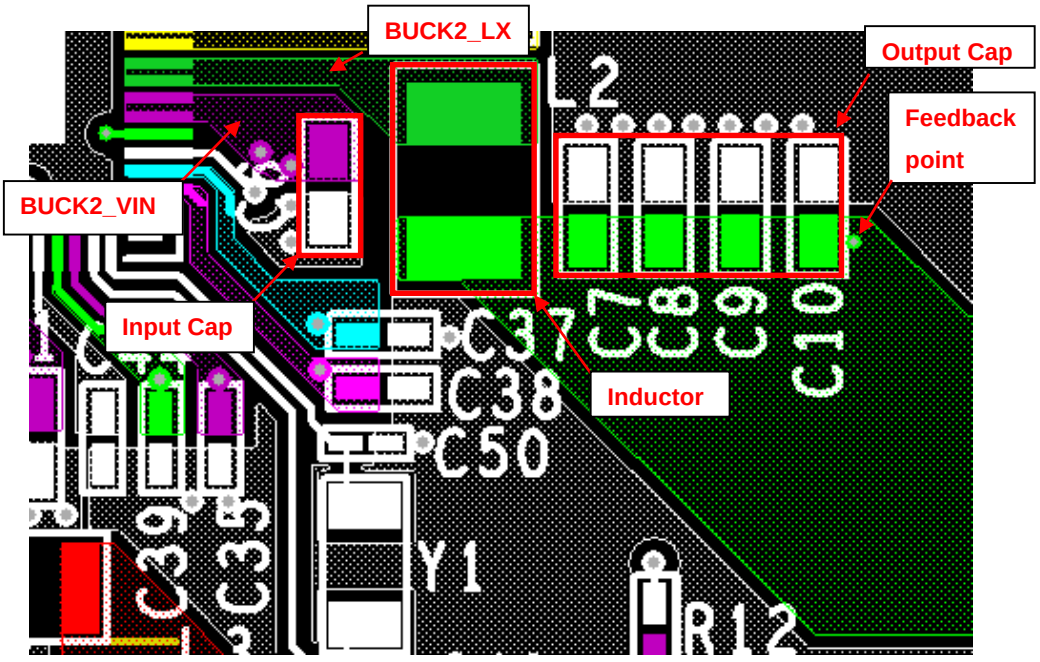

Figure 5.10 BUCK2 Layout Example (Top Layer)

5.3.3. BUCK3 (VDD_GPU)

BUCK3 is a high-efficiency buck converter which converts VSYS (2.7V to 5.5V) voltage to a regulated voltage. This VR can dynamically change its output voltage setting using the I2C interface. BUCK3 output voltage range is from 0.7V to 1.3V by 10mV step.

5.3.3.1. Schematic Example

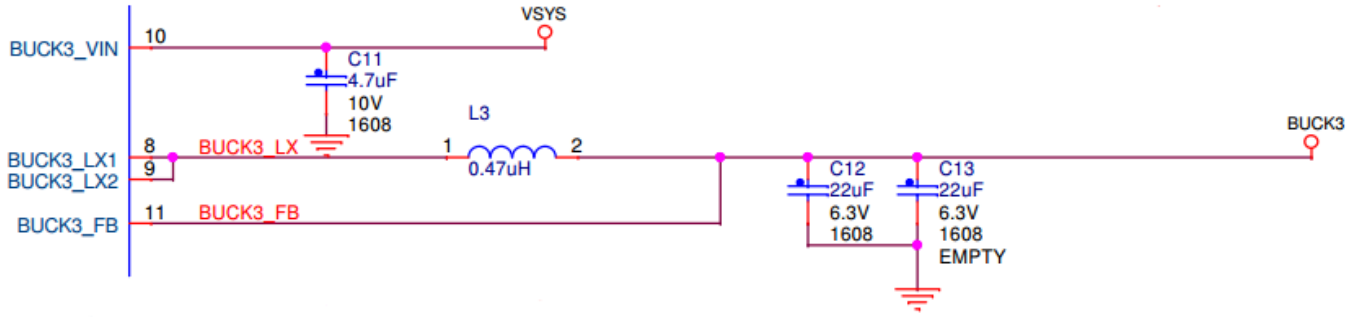

Figure 5.11 BUCK3 Schematic Example

5.3.3.2. Schematic Checklist

Table 5.4 BUCK3 schematic checklist

Pin Names	Dir.	Notes (Unit of parts size : mm)	Check
BUCK3 (VDD_GPU)			
BUCK3_VIN	I	Connect to the 5V power supply in the system.	
		As a decoupling capacitor, use **one 4.7µF**. Select the input capacitor with the capacitance≧**1.88µF** including the DC bias effect at VSYS=5.0V. <The recommended part of capacitor is shown below.> A.LMK107BJ475MA, size:1608, capacitance: 4.7µF, tolerance:10V	
BUCK3_LX[1:0]	O	Connect to BUCK3 via the inductor.	
		Connect **one 0.47µH** ±20% inductors to BUCK3_LX0 and 1. Select the inductor to be used according to board area and cost restrictions. <The recommended part of inductor is shown below.> A.MAMK2520HR47M, size: 2520 , Rated DC Current : 5.8A	
		As output capacitors, use **one 22µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of 22µF capacitor is shown below.> A.GRM188R60J226MEA0D, size:1608, capacitance: 22µF, tolerance:6.3V	
BUCK3_FB	I	Connect to the sense pin of BUCK3_FB to near output capacitors.	

Note: Some dummy pads for output capacitors should be prepared like the reference schematic for the fine tuning in the actual board.

5.3.3.3. Layout Example

About the parts placement for each capacitor around BUCK3, the below reference layout can be referred to.

BUCK3_FB should be connected to near output capacitors.

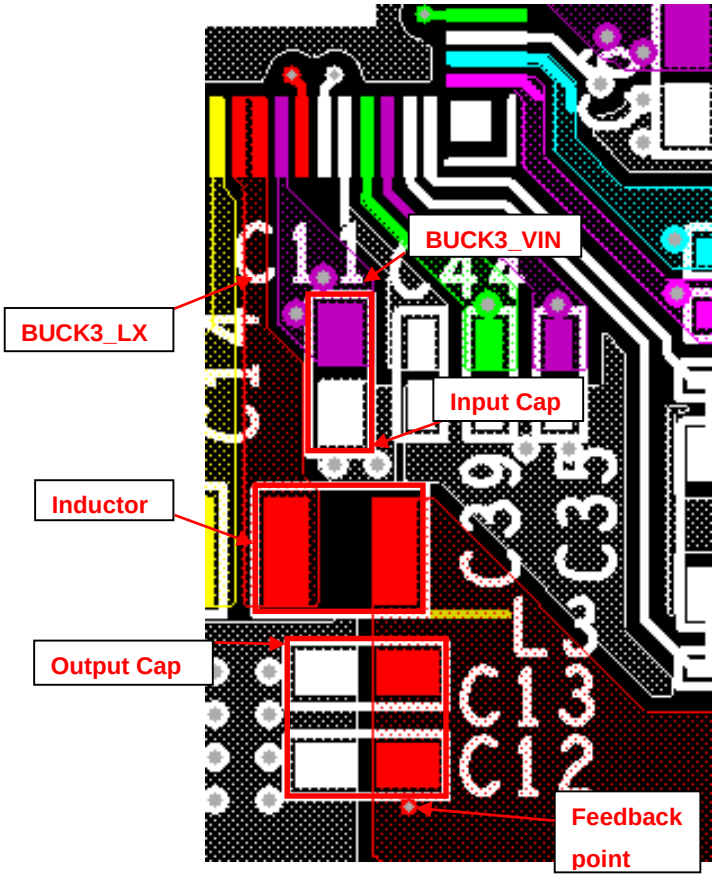

Figure 5.12 BUCK3 Layout Example (Top Layer)

5.3.4. BUCK4 (VDD_VPU)

BUCK4 is a high-efficiency buck converter which converts VSYS (2.7V to 5.5V) voltage to a regulated voltage. This VR can dynamically change its output voltage setting using the I2C interface. BUCK4 output voltage range is from 0.7V to 1.3V by 10mV step.

5.3.4.1. Schematic Example

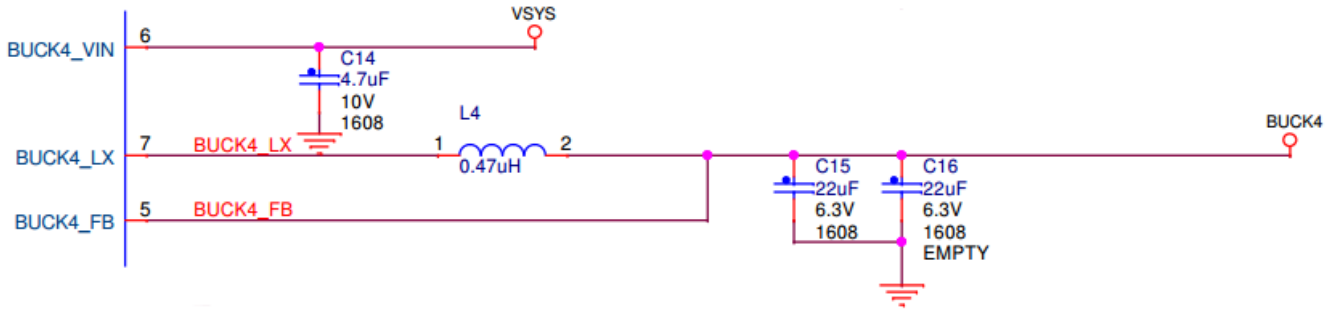

Figure 5.13 BUCK4 Schematic Example

5.3.4.2. Schematic Checklist

Table 5.5 BUCK4 schematic checklist

Pin Names	Dir.	Notes (Unit of parts size : mm)	Check
BUCK4 (VDD_VPU)			
BUCK4_VIN	I	Connect to the 5V power supply in the system.	
		As a decoupling capacitor, use **one 4.7µF**. Select the input capacitor with the capacitance≧**1.88µF** including the DC bias effect at VSYS=5.0V. <The recommended part of capacitor is shown below.> A.LMK107BJ475MA, size:1608, capacitance: 4.7µF, tolerance:10V	
BUCK4_LX	O	Connect to BUCK3 via the inductor.	
		Connect **one 0.47µH** ±20% inductors to BUCK3_LX. Select the inductor to be used according to board area and cost restrictions. <The recommended part of inductor is shown below.> A.MAMK2520HR47M, size: 2520 , Rated DC Current : 5.8A	
		As output capacitors, use **one 22µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of 22µF capacitor is shown below.> A.GRM188R60J226MEA0D, size:1608, capacitance: 22µF, tolerance:6.3V	
BUCK4_FB	I	Connect to the sense pin of BUCK4_FB to near output capacitors.	

Note: Some dummy pads for output capacitors should be prepared like the reference schematic for the fine tuning in the actual board.

5.3.4.3. Layout Example

About the parts placement for each capacitor around BUCK4, the below reference layout can be referred to.

BUCK4_FB should be connected to near output capacitors.

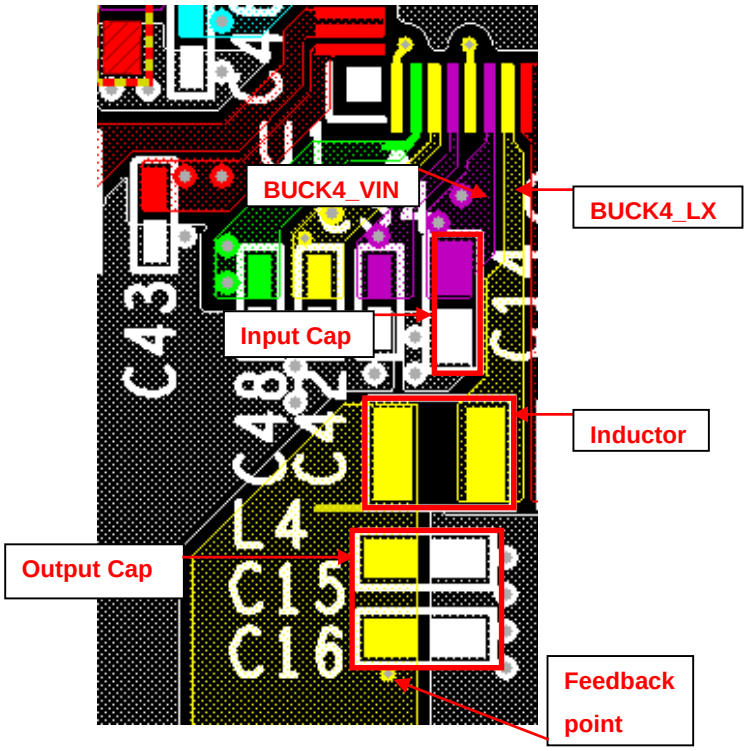

Figure 5.14 BUCK4 Layout Example (Top Layer)

5.3.5. BUCK5 (VDD_DRAM)

BUCK5 is a high-efficiency buck converter which converts VSYS (2.7V to 5.5V) voltage to a regulated voltage. BUCK5 output voltage is programmable by the register and its range is from 0.7V to 1.35V.

5.3.5.1. Schematic Example

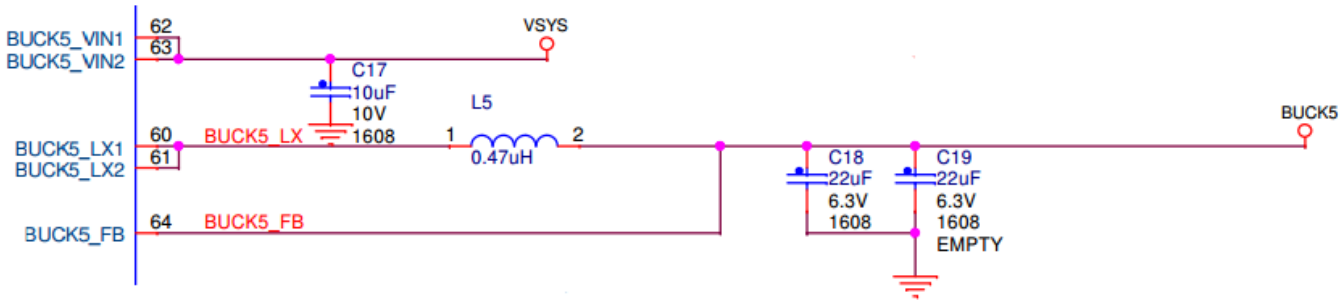

Figure 5.15 BUCK5 Schematic Example

5.3.5.2. Schematic Checklist

Table 5.6 BUCK5 schematic checklist

Pin Names	Dir.	Notes (Unit of parts size : inch)	Check
BUCK5 (VDD_DRAM)			
BUCK5_VIN[1:0]	I	Connect to the 5V power supply in the system.	
		As a decoupling capacitor, use **one 10μF**. Select the input capacitor with the capacitance≧**3.5μF** including the DC bias effect at VSYS=5.0V. <The recommended part of capacitor is shown below.> A.LMK107BBJ106MALT, size:1608, capacitance: 10μF, tolerance:10V	
BUCK5_LX[1:0]	O	Connect to BUCK5 via the inductor.	
		Connect **one 0.47μH** ±20% inductors to BUCK5_LX[1:0]. Select the inductor to be used according to board area and cost restrictions. <The recommended part of inductor is shown below.> A.MAMK2520HR47M, size: 2520 , Rated DC Current : 5.8A	
BUCK5_FB	I	As output capacitors, use **one 22μF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of 22μF capacitor is shown below.> A.GRM188R60J226MEA0D, size:1608, capacitance: 22μF, tolerance:6.3V	

Note: Some dummy pads for output capacitors should be prepared like the reference schematic for the fine tuning in the actual board.

5.3.5.3. Layout Example

About the parts placement for each capacitor around BUCK5, the below reference layout can be referred to.

BUCK5_FB should be connected to near output capacitors.

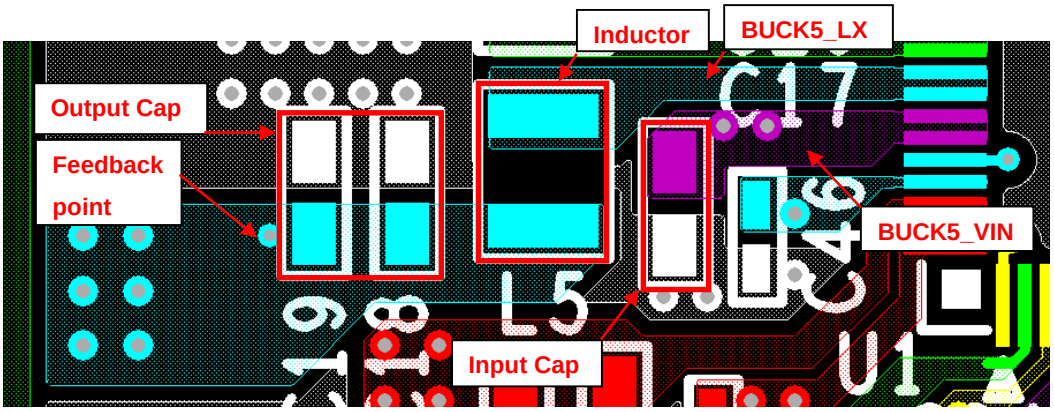

Figure 5.16 BUCK5 Layout Example (Top Layer)

5.3.6. BUCK6 (NVCC_3P3)

BUCK6 is a high-efficiency buck converter which converts VSYS (2.7V to 5.5V) voltage to a regulated voltage. BUCK6 output voltage is programmable by the register and its range is from 3.0V to 3.3V by 100mV step.

5.3.6.1. Schematic Example

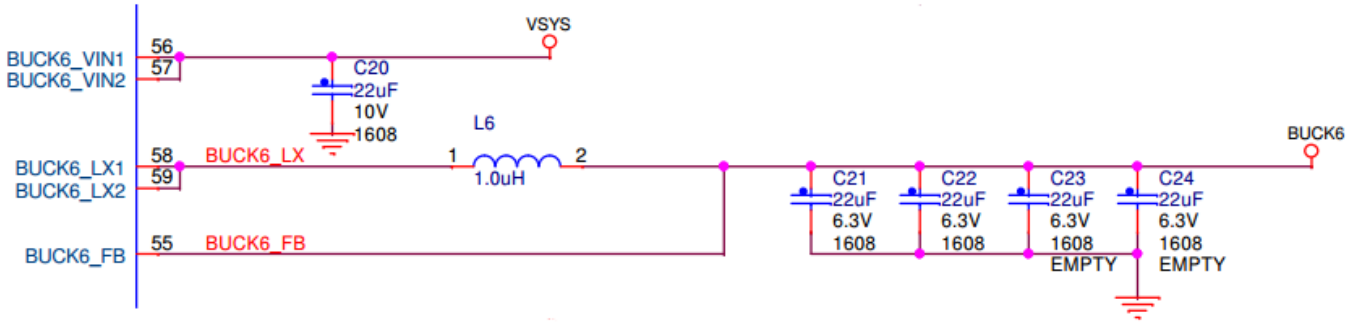

Figure 5.17 BUCK6 Schematic Example

5.3.6.2. Schematic Checklist

Table 5.7 BUCK6 schematic checklist

Pin Names	Dir.	Notes (Unit of parts size : inch)	Check
BUCK6 (NVCC_3P3)			
BUCK6_VIN[1:0]	I	Connect to the 5V power supply in the system.	
		As a decoupling capacitor, use **one 22μF**. Select the input capacitor with the capacitance≧**7.7μF** including the DC bias effect at VSYS=5.0V. <The recommended part of capacitor is shown below.> A.LMK107BBJ226MA-T, size:1608, capacitance: 22μF, tolerance:10V	
BUCK6_LX[1:0]	O	Connect to BUCK6 via the inductor.	
		Connect **one 1.0μH** ±20% inductors to BUCK6_LX[1:0]. Select the inductor to be used according to board area and cost restrictions. <The recommended part of inductor is shown below.> A.MAMK2520H1R0M, size: 2520 , Rated DC Current : 3.1A	
BUCK6_FB	I	As output capacitors, use **two 22μF** capacitors. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of 22μF capacitor is shown below.> A.GRM188R60J226MEA0D, size:1608, capacitance: 22μF, tolerance:6.3V	

Note: Some dummy pads for output capacitors should be prepared like the reference schematic for the fine tuning in the actual board.

5.3.6.3. Layout Example

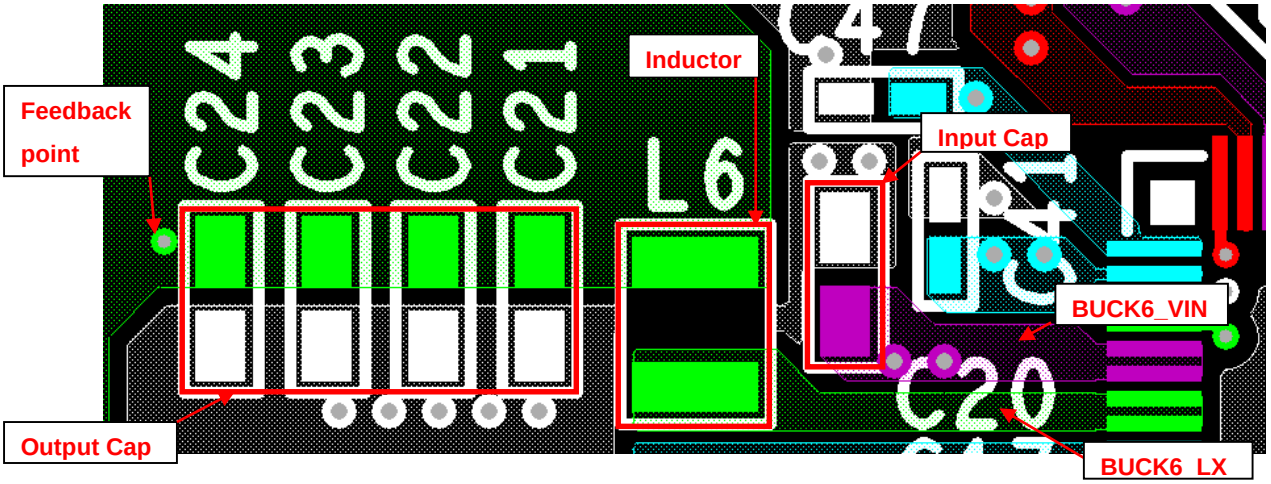

Figure 5.18 BUCK6 Layout Example (Top Layer)

5.3.7. BUCK7 (NVCC_1V8)

VBUCK7 is a high-efficiency buck converter which converts VSYS (2.7V to 5.5V) voltage to a regulated voltage. BUCK7 output voltage is programmable by the register and its range is from 1.6V to 2.0V by eight steps.

5.3.7.1. Schematic Example

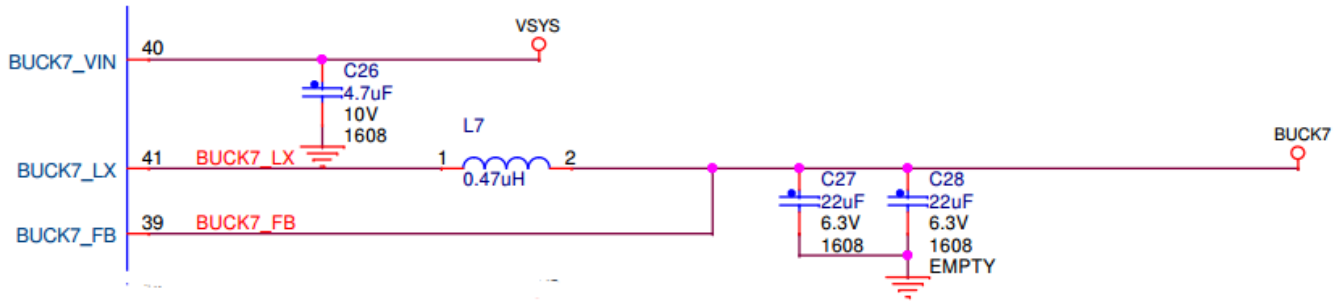

Figure 5.19 BUCK7 Schematic Example

5.3.7.2. Schematic Checklist

Table 5.8 BUCK7 schematic checklist

Pin Names	Dir.	Notes (Unit of parts size : inch)	Check
BUCK7 (NVCC_1V8)			
BUCK7_VIN	I	Connect to the 5V power supply in the system.	
		As a decoupling capacitor, use **one 4.7µF**. Select the input capacitor with the capacitance≧**1.88µF** including the DC bias effect at VSYS=5.0V. <The recommended part of capacitor is shown below.> A.LMK107BJ475MA, size:1608, capacitance: 4.7µF, tolerance:10V	
BUCK7_LX	O	Connect to BUCK7 via the inductor.	
		Connect **one 0.47µH** ±20% inductors to BUCK7_LX. Select the inductor to be used according to board area and cost restrictions. <The recommended part of inductor is shown below.> A.MAMK2520HR47M, size: 2520 , Rated DC Current : 5.8A	
BUCK7_FB	I	As output capacitors, use **one 22µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of 22µF capacitor is shown below.> A.GRM188R60J226MEA0D, size:1608, capacitance: 22µF, tolerance:6.3V	

Note: Some dummy pads for output capacitors should be prepared like the reference schematic for the fine tuning in the actual board.

5.3.7.3. Layout Example

About the parts placement for each capacitor around BUCK7, the below reference layout can be referred to.

BUCK7_FB should be connected to near output capacitors.

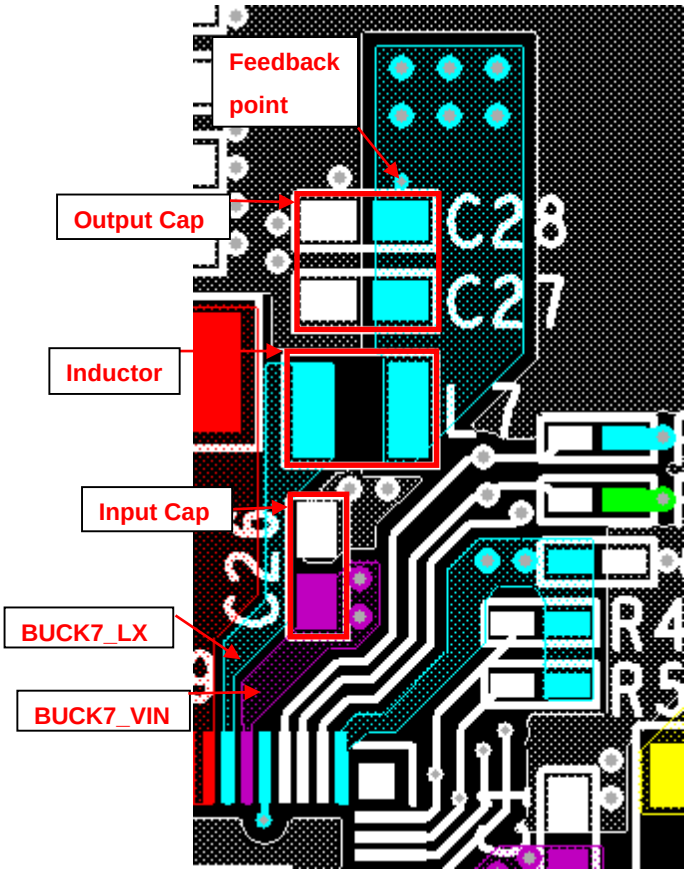

Figure 5.20 BUCK7 Layout Example (Top Layer)

5.3.8. BUCK8 (NVCC_DRAM)

BUCK8 is a high-efficiency buck converter which converts VSYS (2.7V to 5.5V) voltage to a regulated voltage. BUCK8 output voltage is programmable by the register and its range is from 0.8V to 1.4V by 10mV step.

5.3.8.1. Schematic Example

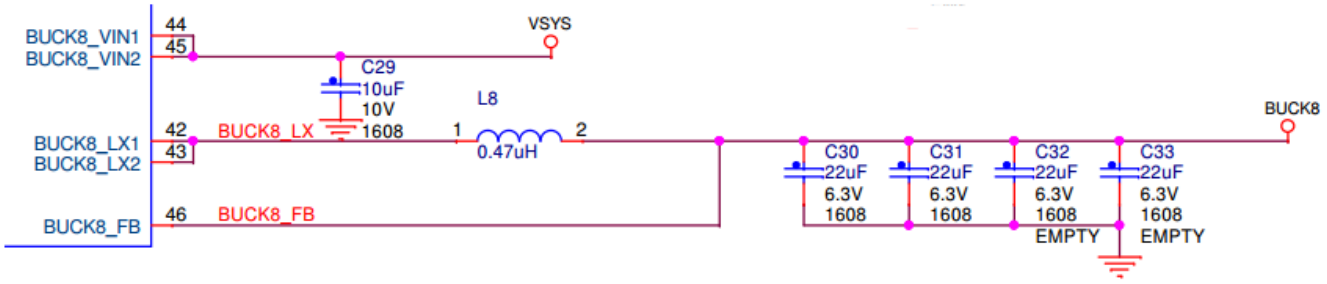

Figure 5.21 BUCK8 Schematic Example

5.3.8.2. Schematic Checklist

Table 5.9 BUCK8 schematic checklist

Pin Names	Dir.	Notes (Unit of parts size : inch)	Check
BUCK8 (NVCC_DRAM)			
BUCK8_VIN[1:0]	I	Connect to the 5V power supply in the system.	
		As a decoupling capacitor, use **one 10µF**. Select the input capacitor with the capacitance≧**3.5µF** including the DC bias effect at VSYS=5.0V. <The recommended part of capacitor is shown below.> A.LMK107BBJ106MALT, size:1608, capacitance: 10µF, tolerance:10V	
BUCK8_LX[1:0]	O	Connect to BUCK8 via the inductor.	
		Connect **one 0.47µH** ±20% inductors to BUCK8_LX0 and 1. Select the inductor to be used according to board area and cost restrictions. <The recommended part of inductor is shown below.> A.HMLE32251E-R47MSR, size: 3225 , Rated DC Current : 7.2A	
BUCK8_FB	I	As output capacitors, use **two 22µF** capacitors. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of 22µF capacitor is shown below.> A.GRM188R60J226MEA0D, size:1608, capacitance: 22µF, tolerance:6.3V	

Note: Some dummy pads for output capacitors should be prepared like the reference schematic for the fine tuning in the actual board.

5.3.8.3. Layout Example

About the parts placement for each capacitor around BUCK8, the below reference layout can be referred to.

BUCK8_FB should be connected to near output capacitors.

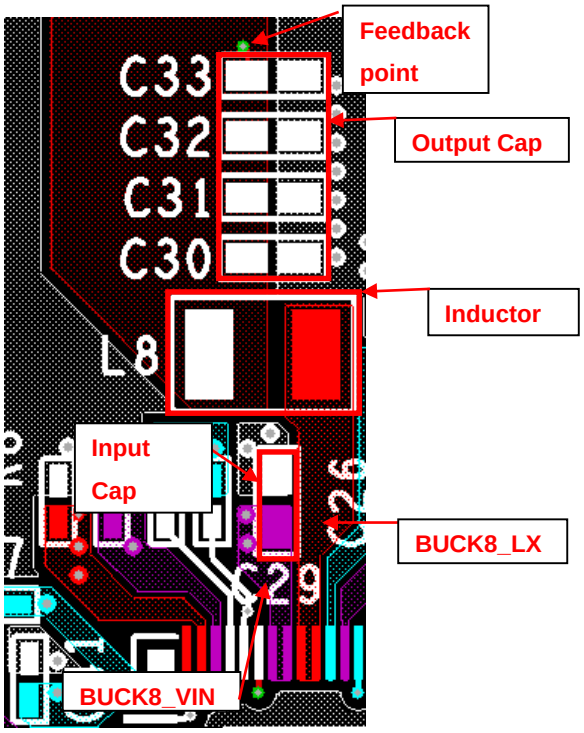

Figure 5.22 BUCK8 Layout Example (Top Layer)

5.4. LDOs

5.4.1. LDO1 (NVCC_SNVS)

VLDO1 converts VSYS (2.7V to 5.5V) voltage to a regulated voltage.

LDO1 output voltage is programmable by the register and its range is from 3.0V to 3.3V or 1.6V to 1.9V by 100mV step.

LDO1 should be used as the input for DVDD and pull up voltages for IRQ_B, RTC_RESET_B, WDOG_B and I2C interface.

5.4.2. LDO2 (VDD_SNVS)

VLDO2 converts VSYS (2.7V to 5.5V) voltage to a regulated voltage.

LDO2 output voltage is programmable and can be selected between 0.8V and 0.9V by the register.

5.4.3. LDO3 (VDDA_1P8/VDDA_DRAM)

VLDO3 converts VSYS (2.7V to 5.5V) voltage to a regulated voltage when BUCK6 is OFF.

After BUCK6 is ON, the input source will be changed from VSYS to BUCK6 automatically.

LDO3 output voltage is programmable and its voltage range is from 1.8V to 3.3V by 100mV step.

5.4.4. LDO4 (VDDA_0P9)

VLDO4 converts VSYS (2.7V to 5.5V) voltage to a regulated voltage when BUCK7 is OFF.

After BUCK7 is ON, the input source will be changed from VSYS to BUCK7 automatically.

LDO4 output voltage is programmable and its voltage range is from 0.9V to 1.8V by 100mV step.

5.4.5. LDO5 (1P8_PHY)

VLDO5 converts BUCK6 voltage to the regulated voltage.

LDO5 output voltage is programmable and its voltage range is from 1.8V to 3.3V by 100mV step.

5.4.6. LDO6 (0P9_PHY)

VLDO6 converts BUCK7 voltage to the regulated voltage.

LDO6 output voltage is programmable and its voltage range is from 0.9V to 1.8V by 100mV step.

5.4.7. LDO7 (3P3_PHY)

VLDO7 converts VSYS (2.7V to 5.5V) voltage to the regulated voltage.

LDO7 output voltage is programmable and its voltage range is from 0.9V to 1.8V by 100mV step.

5.4.8. Schematic Examples

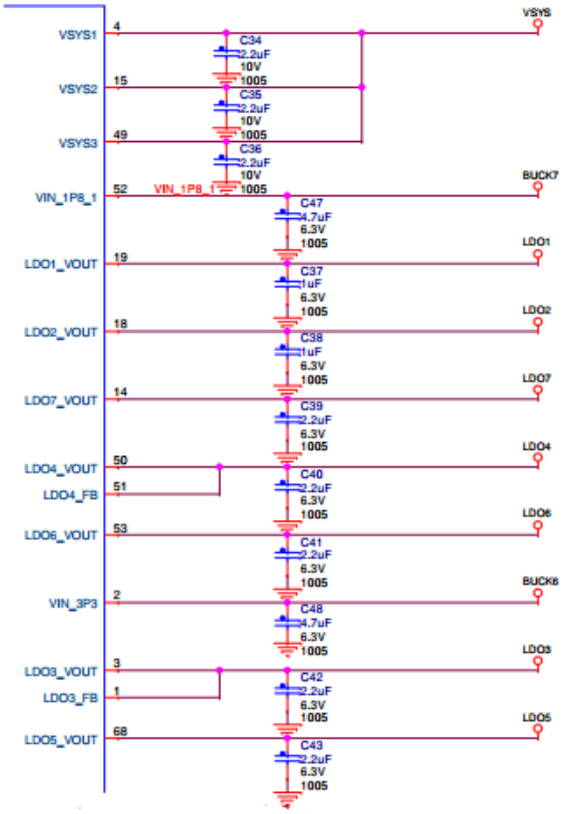

Figure 5.23 LDO1 to 7 Schematic Example

5.4.8.1. Schematic Checklist

Table 5.10 LDO1-7 schematic checklist

Pin Names	Dir.	Notes (Unit of parts size : mm)	Check
LDO1 (NVCC_SNVS) : Vout = 3.0V-3.3V / 1.6V-1.9V , Iomax=10mA			
LDO1	O	As the output capacitor, use **one 1µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of capacitor is shown below.> A.JMK105BJ105MV-F, size:1005, capacitance: 1.0µF, tolerance:6.3V	
LDO2 (VDD_SNVS) : Vout = 0.9V / 0.8V , Iomax=10mA			
LDO2	O	As the output capacitor, use one **1µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of capacitor is shown below.> A.JMK105BJ105MV-F, size:1005, capacitance: 1.0µF, tolerance:6.3V	
LDO3 (VDDA_DRAM) : Vout = 1.8V - 3.3V, Iomax=300mA			
LDO3	O	As the output capacitor, use **one 2.2µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of capacitor is shown below.> A.JMK105BJ225MV-F, size:1005, capacitance: 2.2µF, tolerance:6.3V	

Pin Names	Dir.	Notes (Unit of parts size : mm)	Check
LDO4 (VDDA_0P9) : Vout = 0.9V - 1.8V, Iomax=250mA			
LDO4	O	As the output capacitor, use **one 2.2µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of capacitor is shown below.> A.JMK105BJ225MV-F, size:1005, capacitance: 2.2µF, tolerance:6.3V	
LDO5 (1.8V PHY) : Vout = 1.8 - 3.3V, Iomax=300mA			
LDO5	O	As the output capacitor, use **one 2.2µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of capacitor is shown below.> A.JMK105BJ225MV-F, size:1005, capacitance: 2.2µF, tolerance:6.3V	
LDO6 (0.9V PHY) : Vout = 0.9V - 1.8V, Iomax=300mA			
LDO6	O	As the output capacitor, use **one 2.2µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of capacitor is shown below.> A.JMK105BJ225MV-F, size:1005, capacitance: 2.2µF, tolerance:6.3V	
LDO7 (3.3V PHY) : Vout = 1.8V - 3.3V, Iomax=150mA			
LDO7	O	As the output capacitor, use **one 2.2µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of capacitor is shown below.> A.JMK105BJ225MV-F, size:1005, capacitance: 2.2µF, tolerance:6.3V	
Inputs for LDOs			
VSYS1	I	As the input capacitor, use **one 2.2µF** capacitor. <The recommended part of capacitor is shown below.> A.GRM155R61A225KE95, size:1005, capacitance: 2.2µF, tolerance:10V	
VSYS2	I	As the input capacitor, use **one 2.2µF** capacitor. <The recommended part of capacitor is shown below.> A.GRM155R61A225KE95, size:1005, capacitance: 2.2µF, tolerance:10V	
VSYS3	I	As the input capacitor, use **one 2.2µF** capacitor. <The recommended part of capacitor is shown below.> A.GRM155R61A225KE95, size:1005, capacitance: 2.2µF, tolerance:10V	
VIN_1P8_1	I	The input for LDO4, 6 and connect to BUCK7. As the input capacitor, use **one 4.7µF** capacitor. <The recommended part of capacitor is shown below.> A.JMK105BBJ475MV-F, size:1005, capacitance: 4.7µF, tolerance:6.3V	
VIN_3P3	I	The input for LDO3, 5, MUXSW and connect to BUCK6. As the input capacitor, use **one 4.7µF** capacitor. <The recommended part of capacitor is shown below.> A.JMK105BBJ475MV-F, size:1005, capacitance: 4.7µF, tolerance:6.3V	

5.5. Load SW

5.5.1. MUXSW (NVCC_SD2)

VMUXSW is the internal load switch for SD card power.

MUXSW output voltage supports 1.8V and 3.3V which are determined by the setting of SD_VSELECT.

5.5.1.1. Schematic Examples

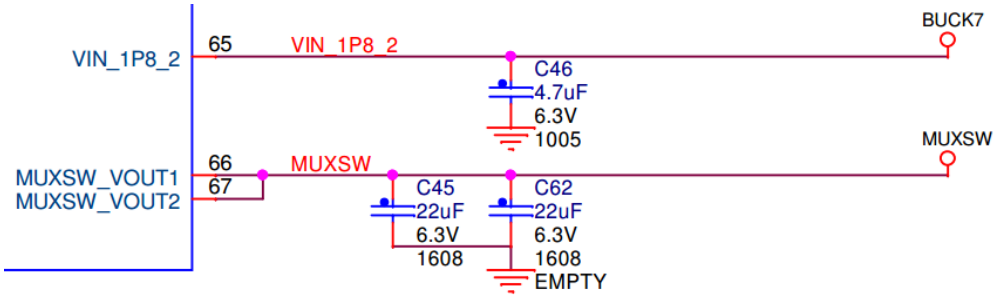

Figure 5.24 MUXSW Schematic Example

5.5.1.2. Schematic Checklist

Table 5.11 MUXSW schematic checklist

Pin Names	Dir.	Notes (Unit of parts size : mm)	Check
MUXSW : Vout = 1.8V / 3.3V, Iomax=150mA			
VIN_1P8_2	I	The input for MUXSW and connect to BUCK7. As the input capacitor, use **one 4.7µF** capacitor. <The recommended part of capacitor is shown below.> A.JMK105BBJ475MV-F, size:1005, capacitance: 4.7µF, tolerance:6.3V	
MUXSW_VOUT[1:0]	O	As the output capacitor, use **one 22µF** capacitor. Select the output capacitors within the capacitance range defined in the datasheet of BD71837AMWV. <The recommended part of 22µF capacitor is shown below.> A.GRM188R60J226MEA0D, size:1608, capacitance: 22µF, tolerance:6.3V	

Note: According to the setting of SD_VSELECT by SoC, the output of MUXSW is determined.

When SD_VSELECT = 0V, "3.3V mode" is selected and VIN_3P3 is used as the input.

When SD_VSELECT = DVDD, "1.8V mode" is selected and VIN_1P8_2 is used as the input.

5.6. Crystal Oscillator Driver

5.6.1. XIN / XOUT / C32K_OUT

BD71837AMWV has the crystal oscillator driver for 32.768 kHz for RTC in SoC internally.

The external load capacitors of C49 and C50 shown in the Figure 5.25 are set to 18pF and this value was determined after fine tuning the specific parameters for the crystal of FC-135 (Load capacitance is 12.5pF) together with ROHM's evaluation board.

So it is ideal to confirm the valid capacitance value supported by the crystal supplier finely since the peripheral environment around the crystal including the crystal part number itself should be different from the condition in ROHM's evaluation.

5.6.1.1. Schematic Examples

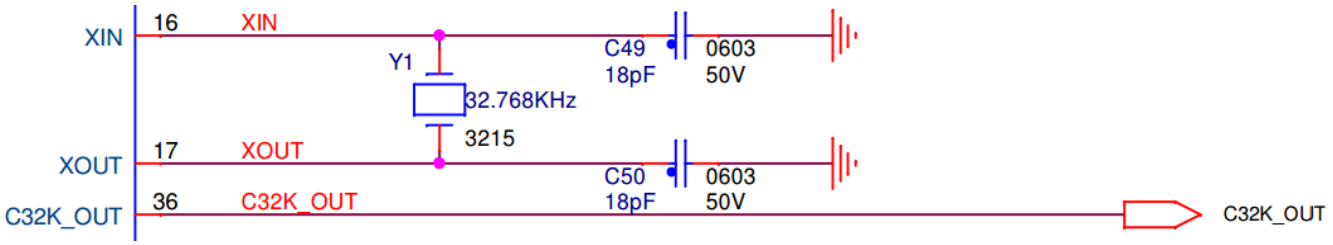

Figure 5.25 Crystal Oscillator Driver Schematic Example

5.6.1.2. Schematic Checklist

Table 5.12 Schematic checklist of crystal oscillator driver

Pin Names	Dir.	Notes (Unit of parts size : mm)	Check
Crystal Oscillator Driver			
XIN	I	As the load capacitor, use **one 18pF** capacitor. (Refer to comment for other part.) <The recommended part of capacitor is shown below.> A.UMK063CH180JT-F, size:0603, capacitance: 18pF, tolerance:50V	
XOUT	O	As the load capacitor, use **one 18pF** capacitor. (Refer to comment for other part.) <The recommended part of capacitor is shown below.> A.UMK063CH180JT-F, size:0603, capacitance: 18pF, tolerance:50V	
C32K_OUT		Connect to SoC	

Note: As the crystal oscillator for RTC clock circuit, 32.768 kHz and 12.5pF (SEIKO EPSON) is used together with BD71837AMWV evaluation board. 18pF is the value based on the test result for FC-135 in our evaluation board.

It is recommended to tune the load capacitance finely in the actual set to guarantee the stable oscillation.

<The recommended part of capacitor is shown below.>

A. SEIKO EPSON / FC-135, size: 3215, Load capacitance: 12.5pF

B. SEIKO EPSON / FC-12M, size: 2.05 x 1.25, Load capacitance: 12.5pF

C. MURATA / WMRAG32K76CS1C00R0, size: 0906, Load capacitance: 8pF

For C part, load capacitance for XIN and XOUT is **3pF** after matching test in our evaluation board.

5.6.1.3. Layout Example

Crystal oscillator driver circuit is extremely sensitive to external environment like parasitic capacitance due to the long wirings for XIN and XOUT. So it is recommended to position the Crystal oscillator part near PMIC to shorten the length of the wirings.

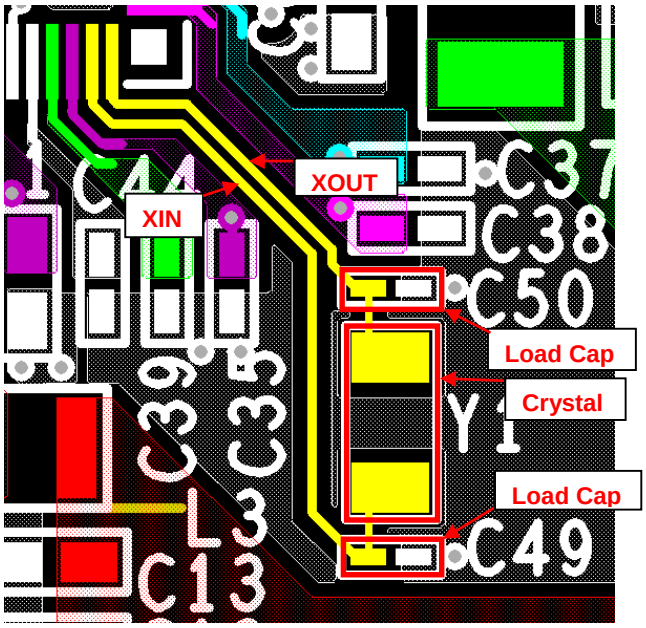

Figure 5.26 XIN / XOUT Layout Example (Top Layer)

5.7. Interfaces

I2C interface is selected for the communication between PMIC and SoC.

5.7.1. I2C

Table 5.13 Schematic checklist of I2C

Pin Names	Dir.	Signal Voltage Level	System Pull-up/Pull-down (RTT)	Termination if it is not used	Notes	Check
I2C						
DVDD	I	-	-	-	The input power source for C32K_OUT and I2C interface. Capacitor for decoupling, use **one 1.0μF** ± 20% (size : 1005, capacitance : 1.0μF, tolerance : 6.3V)	
SCL	I	DVDD	Pulled up to DVDD with 1kohm	-	Connect to SoC (Note) If pull up resistor is prepared within SoC, the additional pull up resistor is not needed.	
SDA	I/O	DVDD	Pulled up to DVDD with 1kohm	-	Connect to SoC (Note) If pull up resistor is prepared within SoC, the additional pull up resistor is not needed.	

Note: Recommended to use LDO1 (NVCC_SNVS) as power source for DVDD.

If DVDD is not used as the pull up voltage for SCL and SDA, it's recommended to use NVCC_I2C in SoC as the pull up voltage.

5.7.2. System Control – Reset, Power, and Control Signals

Table 5.14 Schematic checklist of System Control – Reset, Power, and Control Signals

Pin Names	Dir.	Expected Signal Voltage Level	Expected System Pull-up/Pull-down (RTT)	Termination if it is not used	Notes	Check
System Control - Reset, Power, and Control Signals						
PWRON_B	I	VSYS	Pulled up to VSYS with 100kohm	Pulled up to VSYS with 100kohm	Connect to Power Button	
POR_B	O	BUCK6 Refer to Notes	Pulled up to BUCK6 with 10kohm	NC	Connect to SoC (Note1) If pull up resistor is prepared within SoC, the additional pull up resistor is not needed.	
IRQ_B	O	DVDD Refer to Notes	Pulled up to DVDD with 10kohm	NC	Connect to SoC (Note2) If pull up resistor is prepared within SoC, the additional pull up resistor is not needed.	
RTC_RESET_B	O	DVDD Refer to Notes	Pulled up to DVDD with 10kohm	NC	Connect to SoC (Note3) If pull up resistor is prepared within SoC, the additional pull up resistor is not needed.	
PMIC_STBY_REQ	I	DVDD Refer to Notes	-	-	Connect to SoC (Note4)	
PMIC_ON_REQ	I	DVDD Refer to Notes	-	-	Connect to SoC (Note4)	
WDOG_B	I	DVDD Refer to Notes	Pulled up to DVDD with 10kohm	Pulled up to DVDD with 10kohm	Connect to SoC (Note2) If pull up resistor is prepared within SoC, the additional pull up resistor is not needed.	
SD_VSELECT	I	DVDD Refer to Notes	-	GND	Connect to SoC (Note5)	

Note1: The source for pull up should be BUCK6 to avoid a leakage current. POR_B keeps L level until PMIC_ON_REQ is issued by SoC and POR_B is de- asserted during the power sequence.

Note2: If the power source for NVCC_GPIO1 in SoC is different from the voltage of DVDD in PMIC, the pull up voltage is set to NVCC_GPIO1.

Note3: If DVDD is different from the voltage of NVCC_SNVS in SoC, the pull up voltage is set to NVCC_SNVS.

Note4: This signal comes from SoC so the signal voltage level depends on the power source for NVCC_SNVS.

Note5: The voltage level depends on the power source for NVCC_GPIO1 which is the power source for GPIO in SoC.

5.7.3. MISC

Table 5.15 Schematic checklist of MISC

Pin Names	Dir.	Signal Voltage Level	Notes	Check
MISC				
AGND	-	GND	Connect to PGND at inner GND plane	
EXP-PADs (PGND0~4)	-	GND	Connect to the inner GND plane with lower impedance	

Note: The package has one pad at bottom and four corner pads to fix the position of the part.
These pads are shorted internally and it is recommended to solder these pads to the board.

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