Dear customer

ROHM Co., Ltd. ("ROHM"), on the 1st day of April, 2024,
has absorbed into merger with 100%-owned subsidiary of LAPIS Technology Co., Ltd.

Therefore, all references to "LAPIS Technology Co., Ltd.", "LAPIS Technology" and/or "LAPIS" in this document shall be replaced with "ROHM Co., Ltd."
Furthermore, there are no changes to the documents relating to our products other than the company name, the company trademark, logo, etc.

Thank you for your understanding.

ROHM Co., Ltd.
April 1, 2024

Dear customer

LAPIS Semiconductor Co., Ltd. ("LAPIS Semiconductor"), on the 1st day of October, 2020, implemented the incorporation-type company split (shinsetsu-bunkatsu) in which LAPIS established a new company, LAPIS Technology Co., Ltd. (“LAPIS Technology”) and LAPIS Technology succeeded LAPIS Semiconductor’s LSI business.

Therefore, all references to "LAPIS Semiconductor Co., Ltd.", "LAPIS Semiconductor" and/or "LAPIS" in this document shall be replaced with "LAPIS Technology Co., Ltd."

Furthermore, there are no changes to the documents relating to our products other than the company name, the company trademark, logo, etc.

Thank you for your understanding.

LAPIS Technology Co., Ltd.
October 1, 2020

FEXL7404DG-03

ROHM GROUP
LAPIS SEMICONDUCTOR

ML7404 Family LSIs
Hardware Design Manual

Issue Date: Oct, 5th, 2018

ROHM SEMICONDUCTOR

LAPIS Semiconductor Co.,Ltd.

2-4-8 Shinyokohama, Kouhoku-ku,
Yokohama 222-8575, Japan
http://www.lapis-semi.com/en/

Introduction

This hardware design manual contains hardware information that should be referenced when designing ML7404 family devices (Hereafter ML7404). And also contains the measurement conditions and example of measurement results of RF characteristics.

Target product：

ML7404

The following related manual is available and should be referenced as needed

- ML7404 data sheet

Notation

Classification	Notation	Description
● Numeric value	0x*nn*	Represents a hexadecimal number.
	0b*nnnn*	Represents a binary number.
● Address	0x*nnnn_nnnn*	Represents a hexadecimal number. (indicates 0xnnnnnnnn)
● Unit	word, W	1 word = 32 bits
	byte, B	1 byte = 8 bits
	Mega, M	10^6
	Kilo, K (uppercase)	2^{10}=1024
	Kilo, k (lowercase)	10^3=1000
	Milli, m	10^{-3}
	Micro, μ	10^{-6}
	Nano, n	10^{-9}
	Second, s (lowercase)	Second
● Terminology	"H" level	Signal level on the high voltage side; indicates the voltage level of V_{IH} and V_{OH} as defined in electrical characteristics.
	"L" level	Signal level on the low voltage side; indicates the voltage level of V_{IL} and V_{OL} as defined in electrical characteristics.

● Register description

Read/write attribute: R indicates read-enabled; W indicates write-enabled.

MSB: Most significant bit in an 8-bit register (memory)

LSB: Least significant bit in an 8-bit register (memory)

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1. Placing decoupling capacitors

Place decoupling capacitors between each power pins and GND as shown in Figure 1.1.

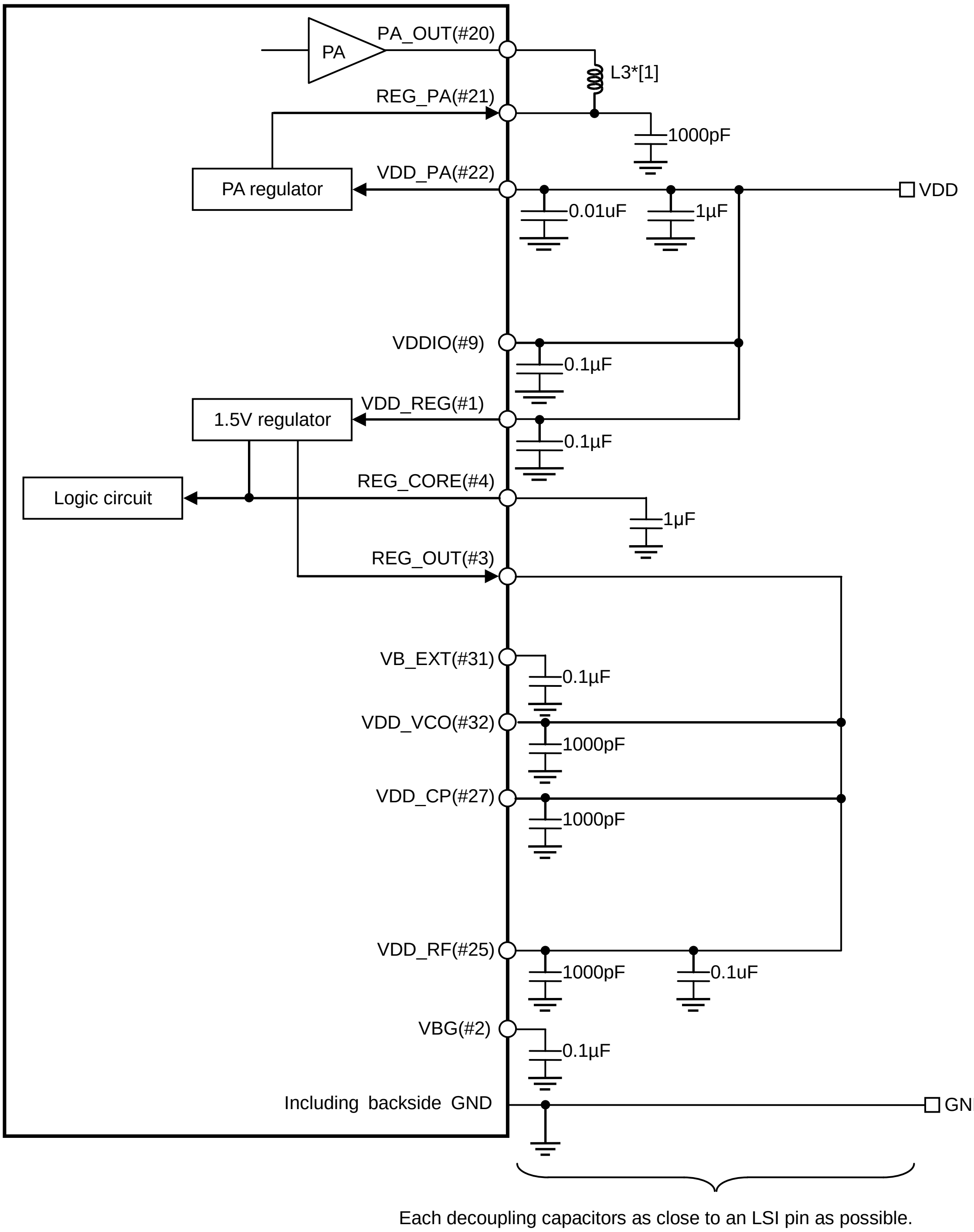


Figure 1.1 Power Supply Block Diagram

*[1] The supply voltage for the PA_OUT pin (#20) should be provided the DC bias through the inductor (L3)

Notes the following when placing decoupling capacitors:

1. The VDD and GND traces should be wider than other signal line traces to reduce the resister element.

2. Decoupling capacitor should be placed as close to an LSI pin as possible.

3. The smaller capacitor should be closer to an LSI pin than other capacitors.

4. VDDIO (#9), VDD_PA (#22), VDD_REG (#1) pins connected to the VDD share the trace.

5. A 1 μF decoupling capacitor should be placed to the REG_CORE (#4) pin to stabilize 1.5V regulator.

6. The VBG (#2) pin is a reference voltage output pin of band-gap reference circuit. Placing a 0.1μF multilayer ceramic capacitor to the VBG (#2) pin to reduce the noise from the band-gap reference circuit.

2. Clock Input

2.1. Crystal Oscillator circuit

Figure 2.1 shows a configuration example of the crystal oscillator circuit. Capacitors should be connected to XIN (#5) and XOUT (#6) pins to stabilize 36MHz crystal oscillator circuit. To determine the component values, the oscillator circuit evaluation on your designing board is required, since the stray capacitor of the board will be influenced.

Amplitude level, oscillation margin, frequency accuracy and oscillator circuit start-up time should be considered and evaluated.

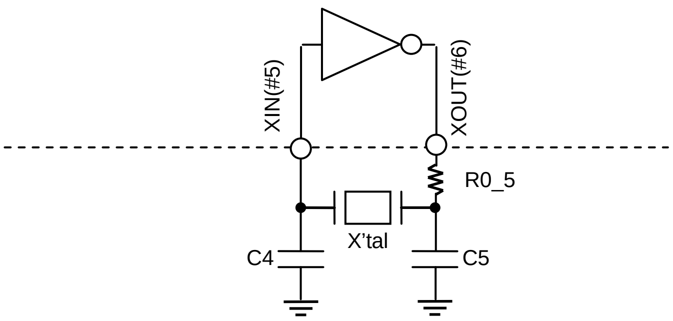


Figure 2.1.1 Crystal Oscillator circuit configurations

2.1.1. Circuit component values for crystal oscillator circuit

It is recommended to ask your oscillator manufacturer to evaluate the matching component values on the assembled board. The following tables show the matching component values with LAPIS Semiconductor RF board as reference.

Table 2.1.1 Representative matching component values

Manufacturer	Oscillator Type	Frequency (MHz)	Equivalent series resister Max(Ω)	Load capacitor (pF)	Component Values			Operating Condition (+/-10ppm)	
					C4 (pF)	C5 (pF)	R11 (Ω)	Power supply voltage range VDDIO(V)	Temperature range (℃)
NDK	NX2016SA (EXS00A-CS07050)	36	T.B.D.	6	T.B.D.	T.B.D.	T.B.D.	1.8 to 3.6	T.B.D.
EPSON	T.B.D.	36	T.B.D.	T.B.D.	T.B.D.	T.B.D.	T.B.D.	1.8 to 3.6	T.B.D.
YOKETAN	T.B.D.	36	T.B.D.	T.B.D.	T.B.D.	T.B.D.	T.B.D.	1.8 to 3.6	T.B.D.

[Note] These component values appropriate for use on the LAPIS Semiconductor's RF board. It is not guaranteed to obtain same result on your specific board.

[Note] The frequency tolerance of reference clock must be within +/-2.5ppm in order to correspond to IEEE802.15.4k. TCXO should be used.

2.1.2. Notes on the crystal oscillator circuit configuration

Note the following when designing the crystal oscillator circuit.

1. The capacitors value of C4 and C5 depends on the crystal oscillator specification.

2. C1 and C2 should be placed as close as possible to the XIN (#5) and the XOUT (#6) pins to suppress parasitic LCR and stabilize the oscillator.

3. Do not place the crystal oscillator circuit across other signal lines.

4. Do not trace signal lines where large current flow around the crystal oscillator circuit.

5. For the oscillator circuit capacitors, make sure the potential of the ground points is always equal to that of the GND. Do not connect the capacitors to GNDs where large current flow.

6. Do not take oscillation signals from the oscillator circuit.

2.2. TCXO circuit (ML7404)

Please use a TCXO that satisfy the following specification.

- Output load: 10kΩ//10pF
- Output level: 0.8Vpp to 1.5Vpp
- Frequency accuracy: below ±10ppm

The ML7404 has integrated bias circuit and the DC bias is applied to the TCXO (#6) pin. A 0.1uF capacitor should be placed on the TCXO line as following.
In ML7404, #5 pin is N.C. pin, then it should be open.

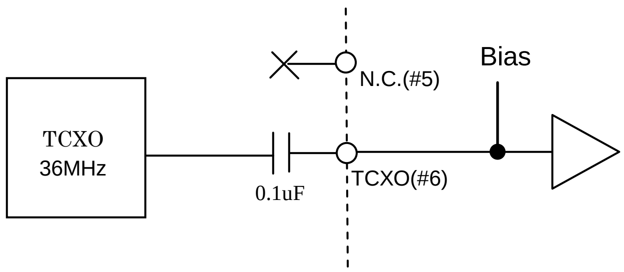


Figure 2.2.1 External oscillator circuit (TCXO) configurations

2.3. Frequency tolerance of Input Clock

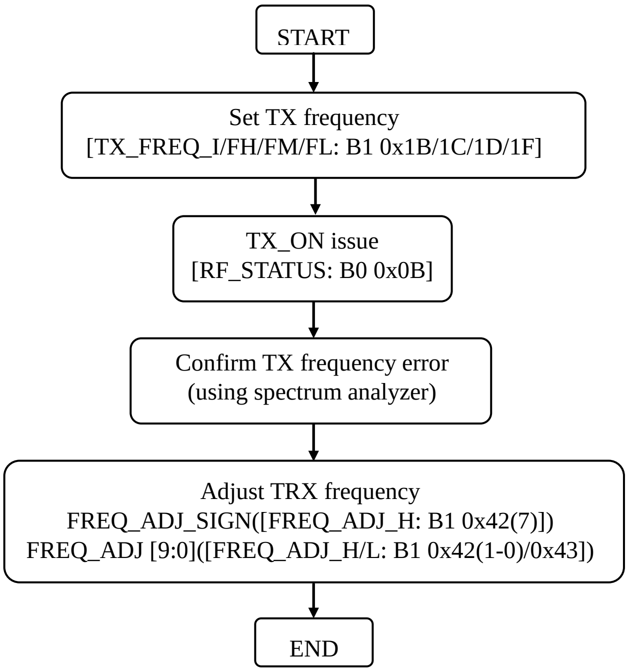
Table 2.1.1Relationship between Use case and frequency tolerance of reference clock

	Use case							Unit
	1	2	3	4	5	6	7	
Sigfox	Yes	Yes	Yes	No	Yes	No	No	
IEEE802.15.4k	Yes	Yes	No	Yes	No	Yes	No	
IEEE802.15.4g (ARIB STD T-108)	Yes	No	Yes	Yes	No	No	Yes	
Recommended clock source	TCXO	TCXO	TCXO/XO	TCXO	TCXO/XO	TCXO	TCXO/XO	
Frequency tolerance[1] (36MHz)	±3	±3	±20	±3	±20	±3	±20	ppm

[1] Frequency tolerance is indicated by the sum of the following 3 items.
A. Initial frequency tolerance
B. Frequency/Temperature characteristics
C. Long-term Frequency stability
It is possible to compensate the item A(Initial frequency tolerance) by adjusting the frequency of transmission / reception in ML7404. When adjusting the initial frequency tolerance for each set, the frequency tolerance required for reference clock source is only the sum of B and C.

●Example of an adjustment flow for initial frequency tolerance

The example of an adjustment flow in the case of measuring the frequency of a transmitted signal and compensating initial frequency tolerance is shown below. In addition, for details, refer to the “LSI Adjustment items and Adjustment method” - “TRX Frequency Adjustment” of data sheet (FEDL7404-0X).



3. PLL loop filter

Figure 3.1 shows a configuration example of the PLL loop filter circuit . C3 and R3 values depend on the data rate to satisfy phase noise feature. The recommend values are listed in Table 3.1.

It is recommended to select the components with flat temperature characteristics and temperature coefficient is managed. Capacitors, do not select high dielectric type and semiconductor type, so there is low accuracy and non-linear temperature characteristics.

In order to prevent noise, the loop filter components (C3, R3 and C2) should be placed as close to the LP (#26) pin as possible, recommends within 5 mm. Do not trace signal lines that become a noise source like a reference clock line, around the loop filter.

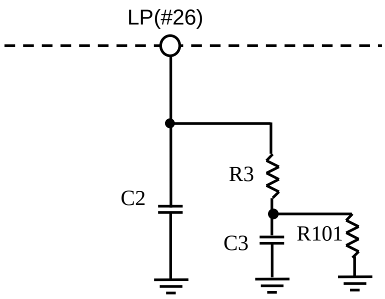


Figure 3.1 PLL loop filter circuit configurations

Table 3.1 Representative component values for the loop filter

	315~960MHz
C2	68pF
C3	1000pF
R3	6.2kΩ
R101	N.M.

[Note] These component values appropriate for use on the LAPIS Semiconductor’s RF board. It is not guaranteed to obtain same result on your specific board.

4. VCO

Figure 4.1 shows a configuration example of the VCO tank circuit. VCO oscillator frequency calculated as follows:

$$F = \frac{1}{2\pi\sqrt{LC}}$$

The L in the above equation will be the sum of the inductor L1, the line inductance of the PCB and the internal inductance of the ML7404. And the C will be the sum of the capacitor C1, the line capacitor of the PCB and the internal capacitor (including calibration capacitor) of the ML7404. Table 4.1 shows the typical value of internal capacitor.

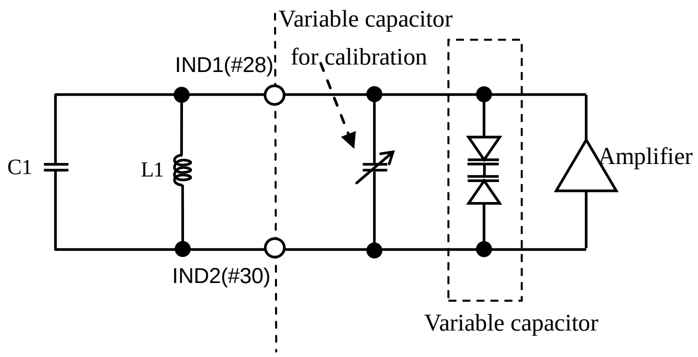


Figure 4.1 VCO tank circuit configurations

Table 4.1: Internal capacitor value

VCO_CAL[6:0](B0, 0x6E)	Internal capacitor value[pF]
0x00	2.94pF
0x40	2.46pF
0x7F	1.97pF

conditions：LP(#26) pin voltage（VCO tuning voltage）=0.75V

4.1. Adjusting component values for VCO tank

Adjustment procedure of the VCO tank components is as below:

1. Execute the VCO calibration with the following condition.
   - Set the frequency to the center of usingfrequency range.
   - In the idle state with the room temperature.

2. Adjust the L1 and C1 values so that the calibration value obtained by [VCO_CAL] register (B0 0x6E) becomes close to “64”(Decimal).
   - Reducing one or both L1 and C1 values if decreasing the VCO_CAL value.
   - Increasing one or both L1 and C1 values if increasing the VCO_CAL value.

[Note] In order to lock the PLL, the VCO_CAL value is required to be in the range from 1 to 126 (decimal) under all conditions.

The frequency range that PLL can lock, VCO phase noise and the temperature feature depend on the L1, C1 values. It is recommended to evaluate these characteristics when L1 and C1 values is fixed.

Table 4.1.1 Representative component values for operating frequency

Target	RF frequency	PLL（VCO）divider setting	VCO oscillation frequency	VCO tank value	
				L1	C1
ML7404	426MHz	divide by 2	852MHz	4.7nH	3.9pF
	494.998MHz	divide by 2	980MHz	3.6nH	3.3pF
	868MHz	no divide	868MHz	4.7nH	3.9pF
	920MHz	no divide	920MHz	3.9nH	3.3pF

[Note] These component values appropriate for use on the LAPIS Semiconductor’s RF board. It is not guaranteed to obtain same result on your specific board.

4.2. Note on the VCO tank circuit

Note the following when designing the VCO tank cercuit.

1. In order to stable VCO oscillation, the VCO tank components (L1 and C1) should be placed as close to the IND1 (#28) and IND2 (#30) pins as possible(within 2 mm). Since the line inductance and capacitance of PCB will effect to the oscillation frequency. Inductor L1 Should be placed closer to IND1(#28) pin or IND2(#30) pin of ML7404 than capacitor C1. Trace length to the L1 from IND1 (#28) pin and IND2(#30) pin of ML7404 should be same length.
2. ML7404 maximum output power is more than50mW. As shown in the Figure 4.2.1, high output will flow on the transmission path from PA_OUT (#20) pin. If this output affects on VCO tank circuit, it may cause the PLL unlock. So be careful the followings:

2.1. As shown in the Figure 4.2.2, VCO tank inductor L1 and PA choke inductor L3 should be placed so that their positional relationship becomes the 90 degrees to avoid their coupling.
2.2. L1 and L3 should be placed close to their connect pins of ML7404. They should not be placed close to each other within 2 mm. Spacing between each inductors is recommended more than 8mm.
2.3. RF maching circuit should not be close to the L1. recommends more than 6mm.
2.4. PCB traces to the L1, C1 from VCO pins(IND1/IND2) should be symmetrical.
2.5. L1 should be placed nearer to the VCO pins(IND1/IND2) than C1.
2.6. Avoid signal line or Vdd line underneath layers of L1,C1.

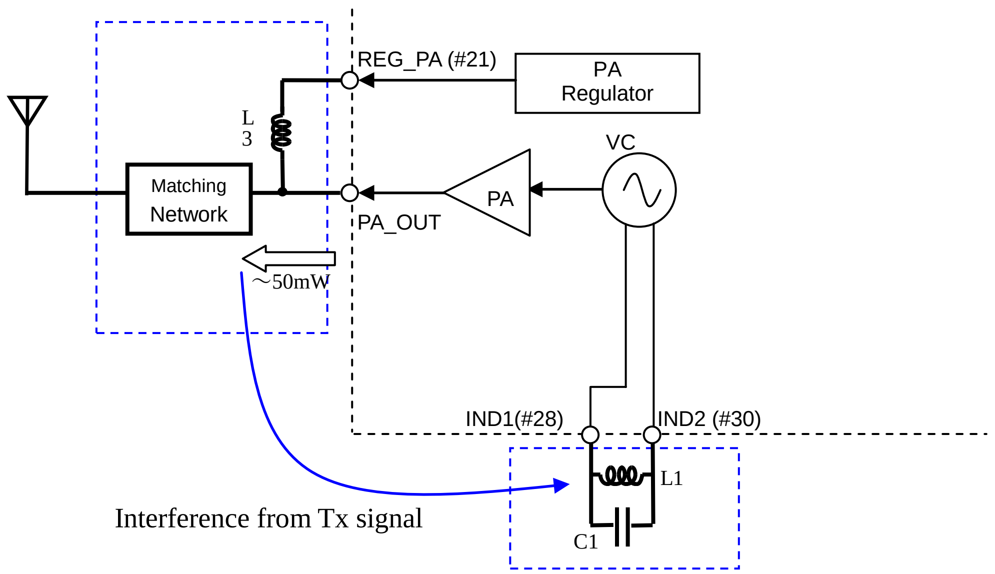


Figure 4.2.1 Notes on the VCO tank circuit

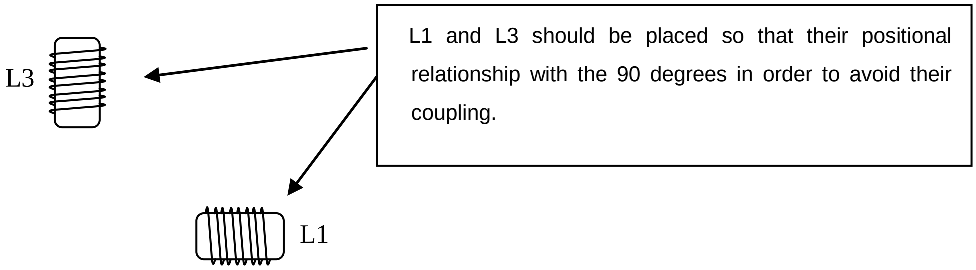


Figure 4.2.2 Placement of L1 and L3

5. RF matching component values

Table 5.1 shows the measured impedance of the PA_OUT (#20) pin and the LNA_P (#24) pin at operationg frequency.These impedances are presented as a reference.

Table 5.1 Measured RF impedance

		R + jX [Ω]			
		Tx（PA_OUT(#20) pin）			Rx（LNA_P(#24) pin）
Target	Measurement frequency	13dBm	10dBm	0dBm	
ML7404	426MHz	6.5 + j9.8	4.9 + j10.1	2.0 + j11.0	11.5 - j204.3
	868MHz	43.6 - j7.6	63.2 - j3.4	204.3 + j92.1	10.2 - j132.2
	920MHz	48.2 - j8.8	73.0 – j14.1	259.3 – j130.3	10.6 - j130.3

[Note] These component values appropriate for use on the LAPIS Semiconductor's RF board. It is not guaranteed to obtain same result on your specific board.

5.1. ANTENNA Tx and Rx direct tie matching circuit

Figure 5.1.1 shows the Antenna maching circuit configuraltions. The REG_PA (#21) pin provides the DC bias to the PA_OUT(#20) pin. This DC bias should be provided through the inductor (L3). Chebyshev lowpass filter is consist of components L5~L8 and LPF1, C47~C50,to suppress harmonics.

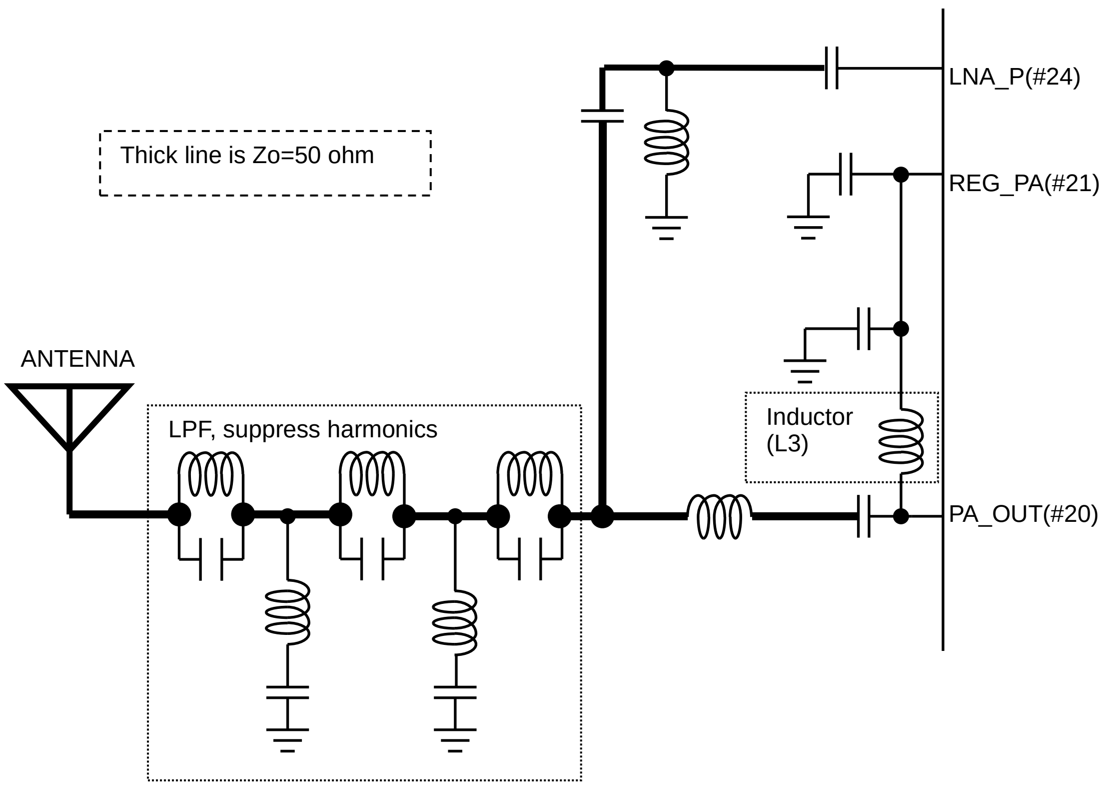


Figure 5.1.1 Transmission matching circuit configurations

6. Notes on selecting external parts (recommendations)

- Anntenna

It is recommended to use an antenna with the specifications shown in Table 6.1.

Select an antenna with the best directive characteristics for your specific operating, environmental and installation condition. Since antennas are affected by installation conditions such as GND, external factors should always be taken into account.

It is recommended to ask the manufacturer of the selected antenna for installation details in relation to various factors, including the shape and stray capacitance of the board to be used.

Table 6.1 Antenna

Frequency band	315~450MHz / 470~510MHz / 868MHz / 920MHz band
VSWR	2.0MAX
Nominal Impedance	50Ω

- Inductors

Use inductors with high Q. It is recommended to use LQW15AN series (manufactured by Murata Manufacturing Co. Ltd) or equivalent.

- Capacitors

Use capacitors with a CH (temperature compensating) or a B (high dielectric constant type) of temperature characteristics. It is recommended to use capacitors of 0 ± 60 ppm/°C or less for areas that affect high frequency characteristics. To realize lower power system it recommended to use low leak components because ML7404 has very low current consumption in sleep mode.

- Resistors

Use resistors for which the resistance variation are small when the temperature changes.

7. Notes on board artworks (recommendations)

7.1. GND

About IC’s back side GND pad, the number of through-hole to board GND plane should be placed more than 12. And drawing GND line width should be more wide as much as possible. Almost of L2 layer should be GND plane for double-layered board.

8. Standard

8.1. ARIB STD-T108

In IEEE802.15.4k, in order to correspond to ARIB STD-T108, ML7404 should be used on condition of the following.

- TX power: 10dBm
- Unit channel: 5 bundled unit channel *[2]
- Frequency range: 921MHz~924.6MHz *[3]

However, it is possible to deal with ARIB STD-T108 by changing a data rate to reduce the unit channel to be used. ML7404 passed the electric wave attestation examination (TELEC-T245) corresponding to ARIB STD-T108 under the following conditions.

Unit channel	Modulation	Data(chip) Rate	Standard	TX Power(Peak Power)
1	2GFSK	50kbps	IEEE802.15.4g	13dBm
2 bundled	2GFSK	100kbps	IEEE802.15.4g	13dBm
1	BPSK	100bps	Sigfox	10dBm
2 bundled	BPSK	40kcps	Original	10dBm
2 bundled	BPSK	50kcps	Original	10dBm
5 bundled	BPSK	200kcps	IEEE802.15.4k	10dBm

*[2] a unit channel is 200kHz.

*[3] In case of using IEEE802.15.4k, in order to satisfy the spurious emission, ML7404 should be used 5 bundled unit channel (Figure. 8.1). Therefore, it is necessary to perform CCA(Clear Channel Assessment) by 5 bundled unit channel. But, actual transmitting occupied bandwidth (OBW) is 2 bundled unit channel (400kHz) or less. As a result, channel separation can be made into 2 bundled unit channel (400kHz) (Figure 8.2).

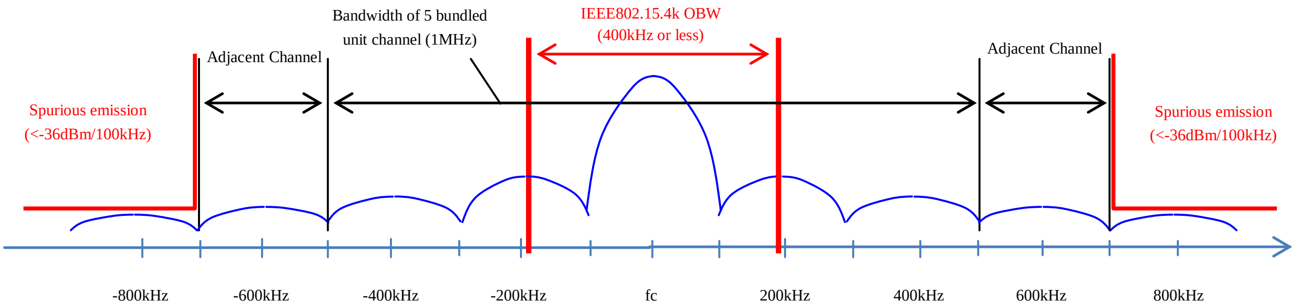


Figure 8.1 Relationship between spurious emission and unit channel

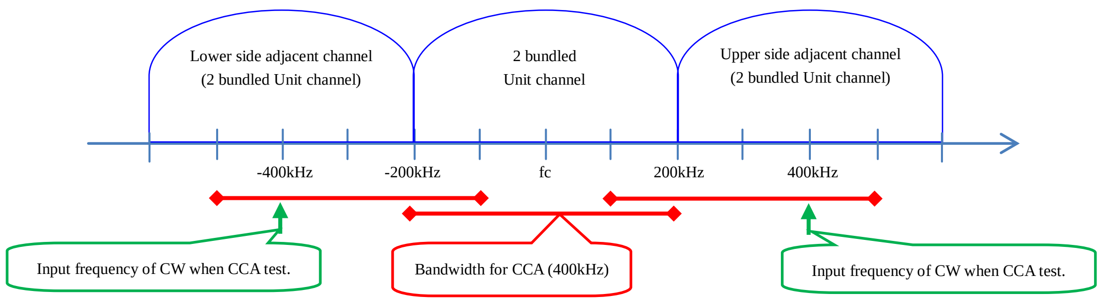
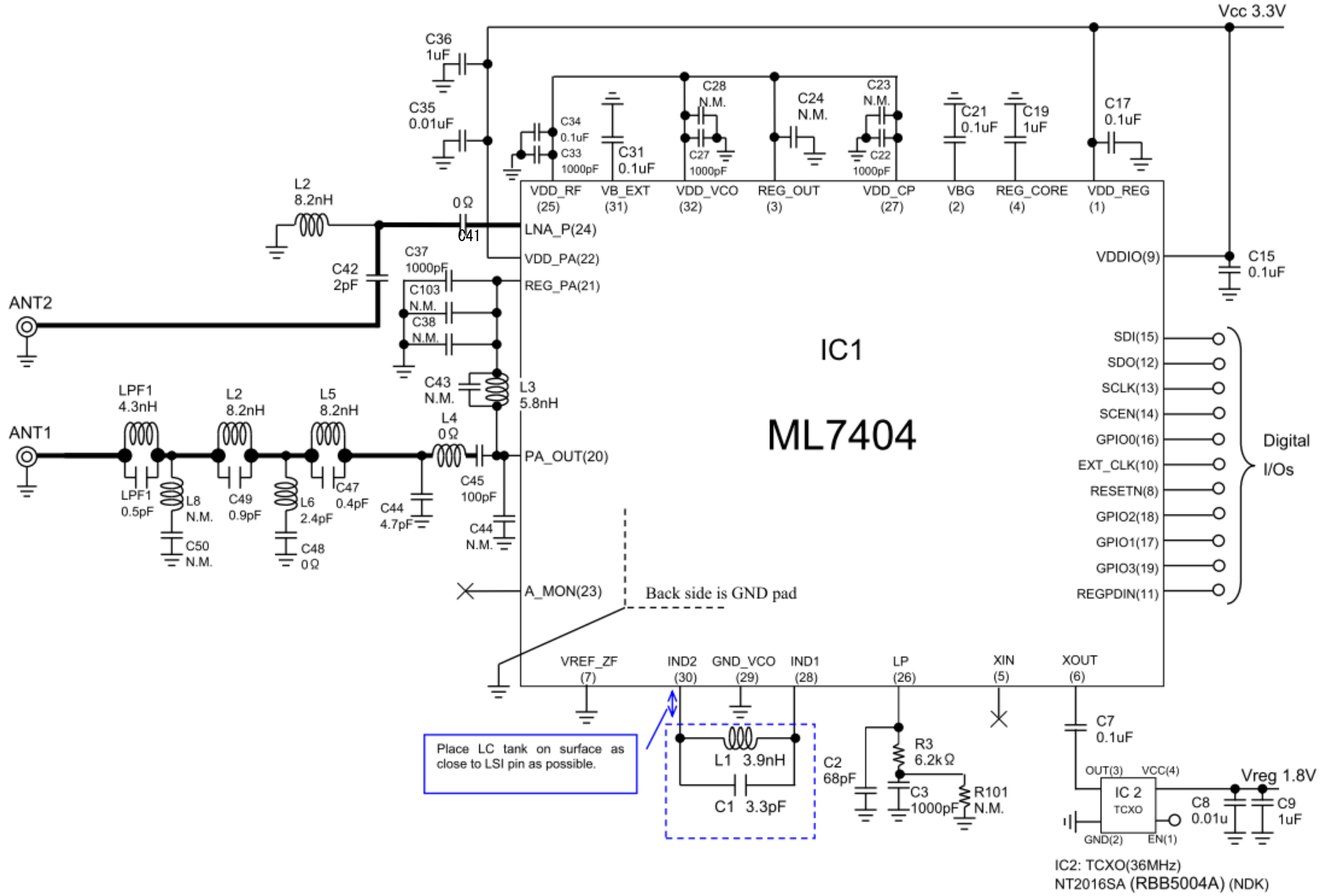


Figure 8.2 Example of channel arrangement and CCA execution(3 times time sharing)

9. Circuit for RF characteristic measurement (920MHz)



Note
Use inductors with high Q type exclude specified LQG type. It is recommended to use LQW15AN series (manufactured by Murata Manufacturing Co. Ltd) or equivalent.

[Note] In case of using TCXO, XIN(#5) pin should be “open”.

10. Bill of Materials

10.1. 494.998MHz

The following table shows the bill of materials for 20mW transmission circuit for ML7404 at 490MHz band.

Common components

Component	Value	Vender	Remarks
L1	3.6nH	Murata Manufacturing Co., Ltd	LQW15AN3N6G00 *2
L2	22nH	Murata Manufacturing Co., Ltd	LQW15AN22NG00
L3	100nH	Murata Manufacturing Co., Ltd	LQW15ANR10J00
L4	0Ω	KOA Corporation	RK73Z1ETTP
L5	23nH	Murata Manufacturing Co., Ltd	LQW15AN23NG00
L6	0Ω	KOA Corporation	RK73Z1ETTP
L7	33nH	Murata Manufacturing Co., Ltd	LQW15AN33NG00
L8	0Ω	KOA Corporation	RK73Z1ETTP
LPF1	23nH	Murata Manufacturing Co., Ltd	LQW15AN23NG00
C1	3.3pF	Murata Manufacturing Co., Ltd	GJM1553C1H3R3B *2
C2	68pF	Murata Manufacturing Co., Ltd	GRM1552C1H680J *1
C3	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K *1
C8	0.01uF	Murata Manufacturing Co., Ltd	GRM155B11E103K
C9	1uF	Murata Manufacturing Co., Ltd	GRM155B31A105K
C14	N.M.	-	-
C15	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K
C16	N.M.	-	-
C17	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K
C18	N.M.	-	-
C19	1uF	Murata Manufacturing Co., Ltd	GRM155B31A105K
C21	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K
C22	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K *1
C23	N.M.	-	-
C24	N.M.	-	-
C25	N.M.	-	-
C27	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K
C28	N.M.	-	-
C31	N.M.	-	-
C32	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K
C33	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K
C34	N.M.	-	-
C35	0.01uF	Murata Manufacturing Co., Ltd	GRM155B11E103K
C36	1uF	Murata Manufacturing Co., Ltd	GRM155B31A105K
C37	100pF	Murata Manufacturing Co., Ltd	GRM155B11H101J
C38	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K
C41	0Ω	KOA Corporation	RK73Z1ETTP
C42	2pF	Murata Manufacturing Co., Ltd	GJM1554C1H2R0BB
C43	N.M.	-	-

Component	Value	Vender	Remarks
C44	N.M.	-	-
C45	100pF	Murata Manufacturing Co., Ltd	GRM155B11H101J
C46	N.M.	-	-
C47	0.5pF	Murata Manufacturing Co., Ltd	GJM1555C1HR50WB
C48	6.8pF	Murata Manufacturing Co., Ltd	GJM1554C1H6R8CB
C49	0.3pF	Murata Manufacturing Co., Ltd	GJM1555C1HR30WB
C50	6.8pF	Murata Manufacturing Co., Ltd -	GJM1554C1H6R8CB
C103	N.M.	-	-
R3	12kΩ	KOA Corporation	RK73B1ETTP123J
R101	N.M.	-	-
IC1	-	LAPIS Semiconductor Co., Ltd.	ML7404

TCXO input [ML7404]

Component	Value	Vender	Remarks
IC2	36MHz	Nihon Denpa Kogyo Co.,Ltd	NT2016SA (RBB5004A)
C7	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K

*1: Please refer the Table 3.1 in the section 3.1.

*2: Please refer the Table 4.1.1 in the section 4.1.

[Note]

These component values are the reference value. LAPIS Semiconductor does not guarantee the evaluation result.

10.2. 920MHz

The following table shows the bill of materials for 20mW transmission circuit for ML7404 at 920MHz band.

Common components

Component	Value	Vender	Remarks
L1	3.9nH	Murata Manufacturing Co., Ltd	LQW15AN4N3G00 *2
L2	8.2nH	Murata Manufacturing Co., Ltd	LQW15AN7N3G00
L3	5.8nH	Murata Manufacturing Co., Ltd	LQW15AN5N8G00
L4	0Ω	KOA Corporation	RK73Z1ETTP
L5	8.2nH	Murata Manufacturing Co., Ltd	LQW15AN8N2G00
L6	2.4pF	Murata Manufacturing Co., Ltd	GJM1555C1H2R4B
L7	8.2nH	Murata Manufacturing Co., Ltd	LQW15AN8N2G00
L8	N.M.	-	-
LPF1	4.3nH	Murata Manufacturing Co., Ltd	LQW15AN4N3G00
LPF1	0.5pF	KOA Corporation	GJM1555C1HR50WB
C1	3.3pF	Murata Manufacturing Co., Ltd	GJM1553C1H3R3B *2
C2	68pF	Murata Manufacturing Co., Ltd	GRM1552C1H680J *1
C3	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K *1
C8	0.01uF	Murata Manufacturing Co., Ltd	GRM155B11E103K
C9	1uF	Murata Manufacturing Co., Ltd	GRM155B31A105K
C14	N.M.	-	-
C15	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K
C16	N.M.	-	-
C17	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K
C18	N.M.	-	-
C19	1uF	Murata Manufacturing Co., Ltd	GRM155B31A105K
C21	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K
C22	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K *1
C23	N.M.	-	-
C24	N.M.	-	-
C25	N.M.	-	-
C27	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K
C28	N.M.	-	-
C31	N.M.	-	-
C32	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K
C33	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K
C34	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K
C35	0.01uF	Murata Manufacturing Co., Ltd	GRM155B11E103K
C36	1uF	Murata Manufacturing Co., Ltd	GRM155B31A105K
C37	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H101J
C38	N.M.	-	-
C41	0Ω	KOA Corporation	RK73Z1ETTP
C42	2.0pF	Murata Manufacturing Co., Ltd	GJM1554C1H2R0BB
C43	N.M.	-	-
C44	N.M.	-	-

Component	Value	Vender	Remarks
C45	100pF	Murata Manufacturing Co., Ltd	GRM155B11H101J
C46	N.M.	-	-
C47	0.4pF	Murata Manufacturing Co., Ltd	GJM1555C1HR40WB
C48	0Ω	KOA Corporation	RK73Z1JTTD
C49	0.9pF	Murata Manufacturing Co., Ltd	GJM1555C1HR90WB
C50	N.M.	-	-
C103	N.M.	-	-
R3	6.2kΩ	KOA Corporation	RK73B1ETTP622J
R101	N.M.	-	-
IC1	-	LAPIS Semiconductor Co., Ltd.	ML7404

TCXO input [ML7404]

Component	Value	Vender	Remarks
IC2	36MHz	Nihon Denpa Kogyo Co.,Ltd	NT2016SA (RBB5004A)
C7	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K

*1: Please refer the Table 3.1 in the section 3.1.

*2: Please refer the Table 4.1.1 in the section 4.1.

The internal VCO oscillates at 920MHz. There is a possibility that the oscillation signal output from the antenna is coupled with the external inductor of the VCO. Especially, the LQW type may degrade the transmission spurious characteristics due to the large amount of coupling. Therefore, LQG type is recommended for 920MHz band.

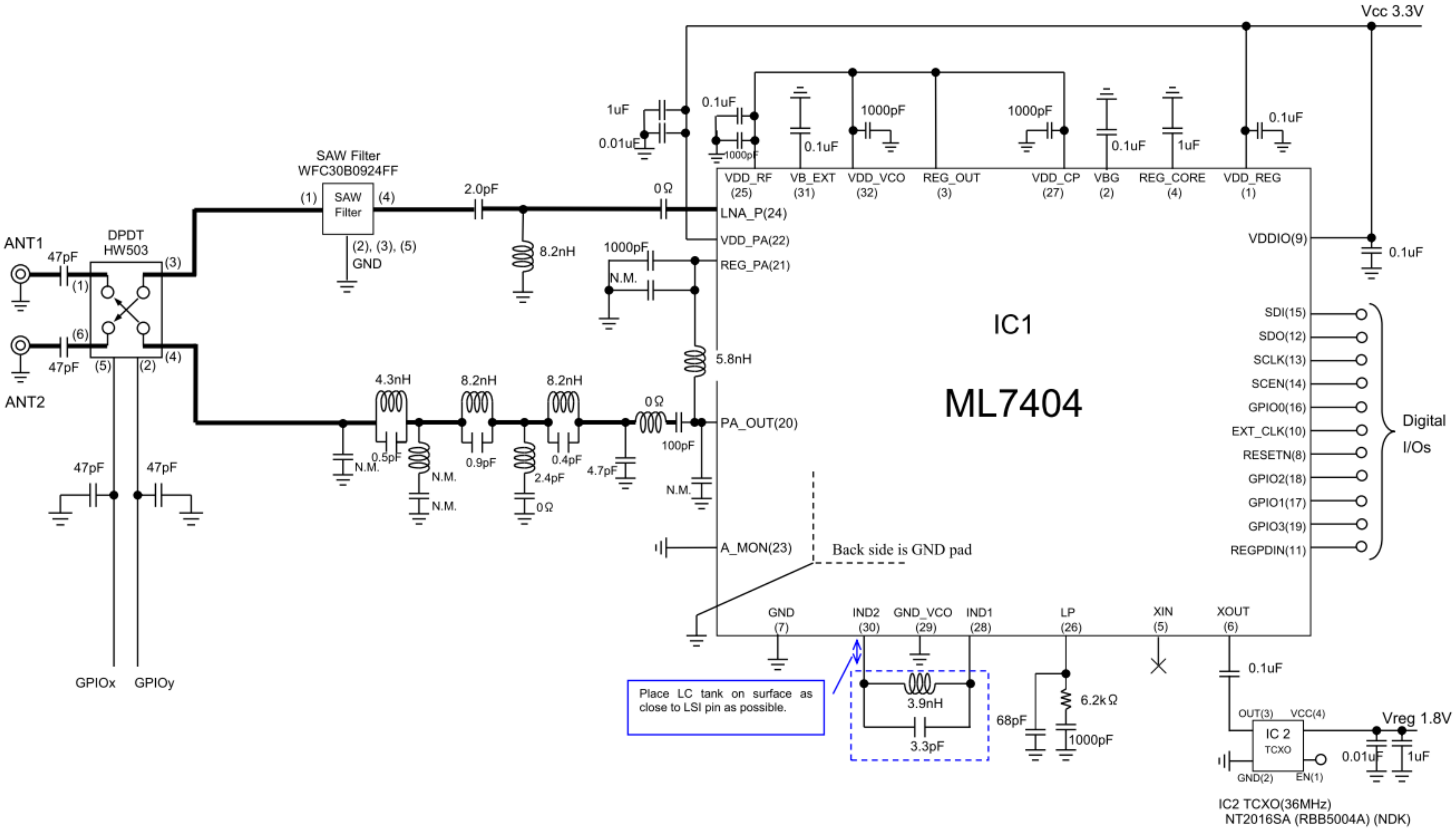
*3: Please refer the Table 2.1.1 in the section 2.1

*4: Please refer the section 5.1.

[Note]

These component values are the reference value. LAPIS Semiconductor does not guarantee the evaluation result.

10.3. Application Circuit



Note
Use inductors with high Q type exclude specified LQG type. It is recommended to use LQW15AN series (manufactured by Murata Manufacturing Co., Ltd) or equivalent.

Revision history

Document No.	Release Date	Page		Content
		Before revision	After revision	
FEXL7404DG-02	May 28th, 2018	–	–	1st revision
FEXL7404DG-03	Oct 5th, 2018	18	18	Bill of Materials(920MHz) added description to (*2)