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

ROHM GROUP
LAPIS SEMICONDUCTOR

FEXL7345DG-02

ML7345 Family LSIs
Hardware Design Manual

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ROHM SEMICONDUCTOR

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Introduction

This hardware design manual contains hardware information that should be referenced when designing ML7345 family devices (Hereafter ML7345). And also contains the measurement conditions and example of measurement results of RF characteristics.

Target product：
ML7345
ML7345C
ML7345D

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

- ML7345 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)

Table of Contents

1. Placing decoupling capacitors

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

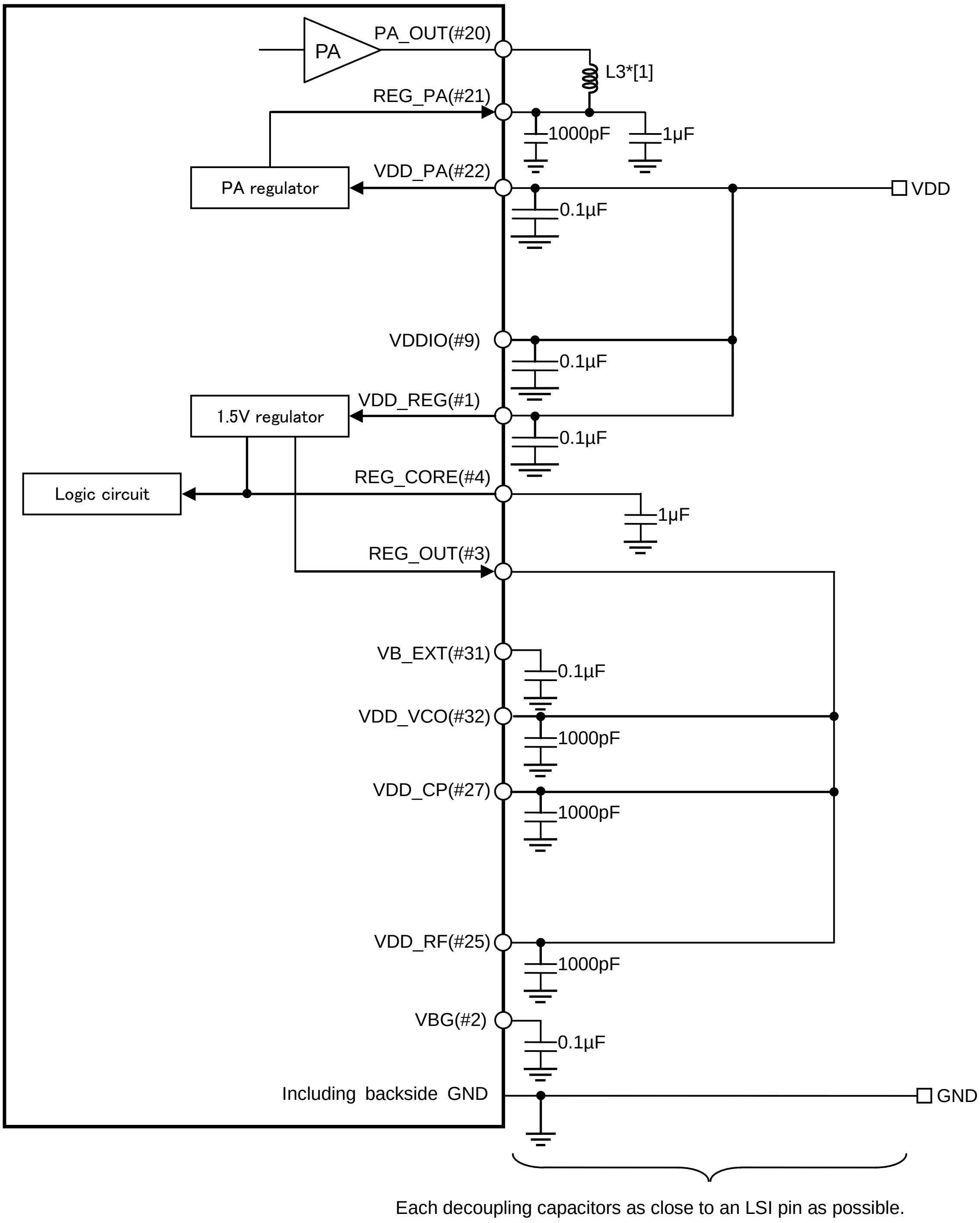


Figure 1.1 Power Supply Block Diagram

*[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 24MHz 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.

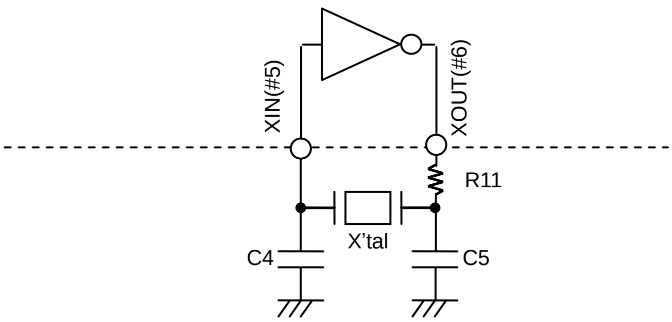


Figure 2.1 Crystal Oscillator circuit configurations

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 (CHP-CZS-6)	24	80Ω	8pF	1pF	1pF	0Ω	1.8 to 3.6	0～+70℃
EPSON	FA-128	24	80Ω	8pF	5pF	5pF	100Ω	1.8 to 3.6	-10～+70℃
YOKETAN	S2016A	24	110Ω	6pF	2.7pF	2.7pF	0Ω	1.8 to 3.6	-10～+70℃

[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.

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. X’tal must connect to ML7345/C/D only. Do not take oscillation signals from the oscillator circuit.

2.2. TCXO circuit (ML7345/ML7345D)

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 ML7345 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 ML7345, #5 pin is N.C. pin, then it should be open.

In order to low current, the TCXO should be disable when sleep mode.

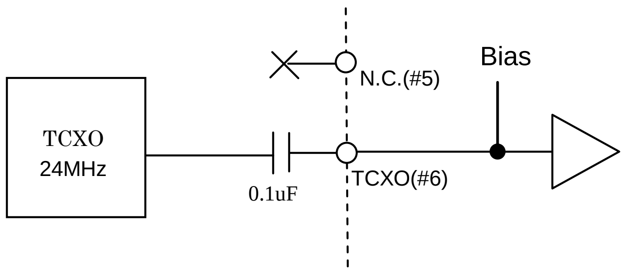


Figure 2.2 External oscillator circuit (TCXO) configurations

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.

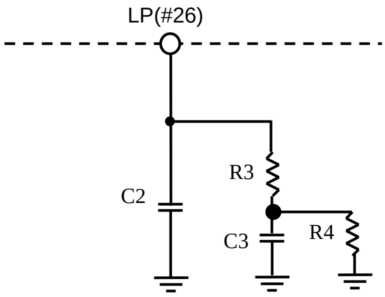


Figure 3.1 PLL loop filter circuit configurations

Table 3.1 Representative component values for the loop filter

	Data rate	
	Less than100kbps	100kbps
C2	10pF	68pF
C3	1000pF	1000pF
R3	6.8kΩ	12kΩ
R4	N.M.	N.M.

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 ML7345. 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 ML7345. Table 4.1 shows the typical value of internal capacitor.

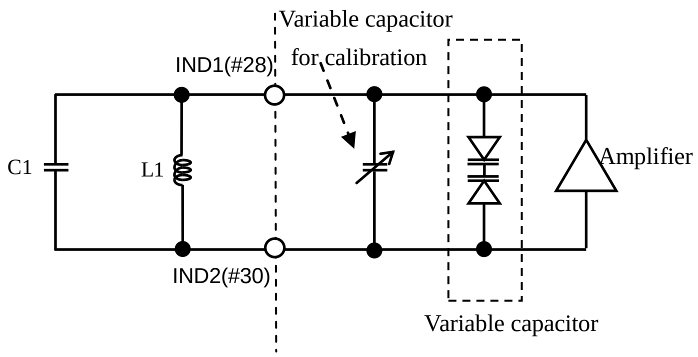


Figure 4.1 VCO tank circuit configurations

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.
VCO calibration is required at customer manufactureing process (normal temperature contorol).In order for the VCO_CAL value to be within the 64(dec)±20code by shipment test, use the deviation of L,C is less than±2%

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

				VCO tank	
	RF frequency	PLL(VCO) Divider setting	VCO Oscillation frequency(F)	L1	C1
ML7345	169MHz	Divide by 6	1014MHz	4.3nH	2.0pF
	426MHz	Divide by 2	852MHz	4.7nH	3.9pF
	868MHz	no divide	868MHz	4.7nH	3.9pF
	920MHz	no divide	920MHz	4.3nH	3.3pF
ML7345C	470~510MHz	no divide	470~510MHz	33nH	N.M.
ML7345D	868MHz	no divide	868MHz	4.7nH	3.9pF
	920MHz	no divide	920MHz	4.3nH	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, recommends within 2 mm. Since the line inductance and capacitance of PCB will effect to the oscillation frequency.
2. ML7345 maximum output power is more than 100mW. 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. 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 ML7345. They should not be placed close to each other. recommends 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.

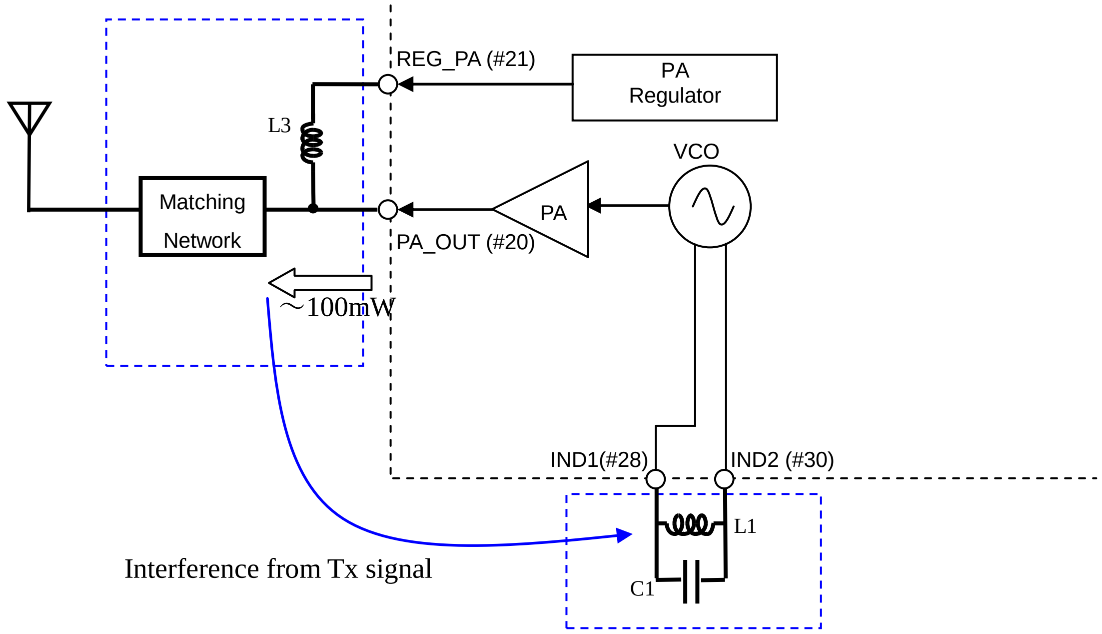


Figure 4.2.1 Notes on the VCO tank circuit

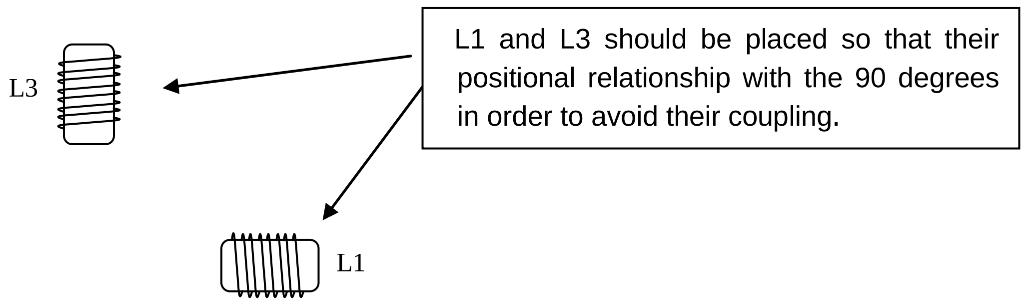


Figure 4.2.2 Recommended placement of L1 and L3

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)]				RX [LNA_P(#24)]
	RF frequency	20dBm	13dBm	10dBm	0dBm	-
ML7345	169MHz	-	3.6 + j16.4	3.6 + j16.4	1.4 + j16.8	627 - j344.7
	426MHz	-	60.5 + j25.3	60.5 + j25.3	8.7 + j87.8	264.8 - j414
	868MHz	-	22.0 - j69.0	22.0 - j69.0	4.9 - j104.7	92.3 - j190.2
	920MHz	-	19.7 - j62.5	19.7 - j62.5	4.6 - j91.2	75.8 - j202
ML7345C	470～510MHz	16.9 + j16.7	-	-	-	2.2 - j90.5
ML7345D	868MHz	-	22.0 - j69.0	22.0 - j69.0	4.9 - j104.7	15.1 - j77
	920MHz	-	19.7 - j62.5	19.7 - j62.5	4.6 - j91.2	13.7- j72.5

[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. RF Line layout from LNA_P(24) and PA_OUT(20) to the Antenna should be the shortest and straight. 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 C47~C50,to suppress harmonics.

*Only ML7345D needs to short C41 by 0ohm.

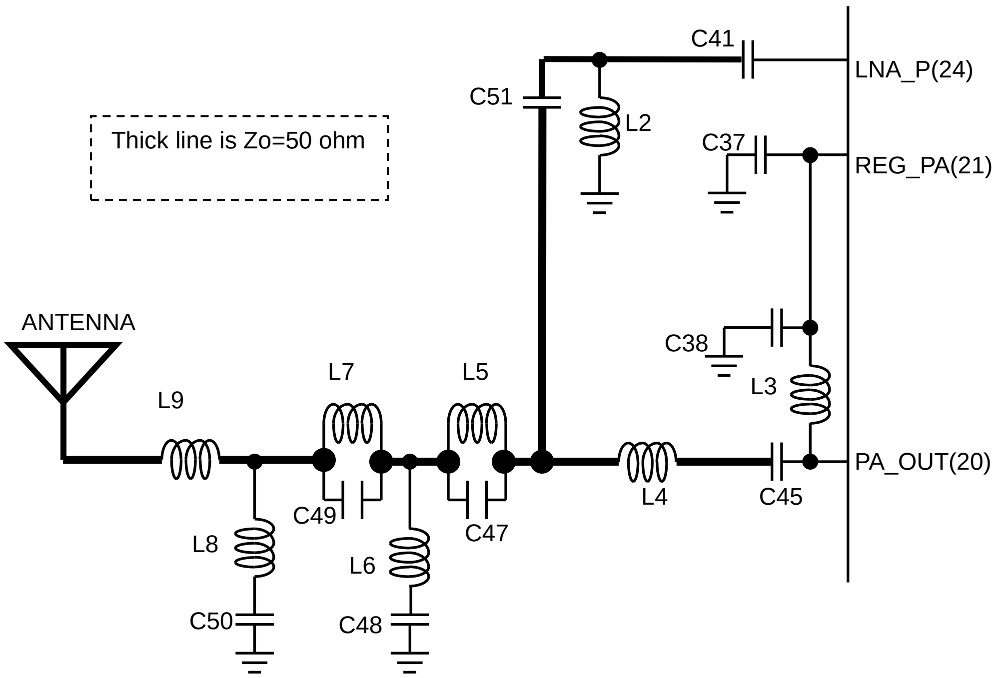


Figure 5.1.1 Transmission matching circuit configurations

6. Notes on selecting external parts (recommendations)

6.1. 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	160~180MHz / 315~450MHz / 470~510MHz / 868MHz / 920MHz band
VSWR	2.0MAX
Nominal Impedance	50Ω

6.2. Inductors

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

6.3. 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 ML7345 has very low current consumption in sleep mode(0.4uA).

6.4. Resistors

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

7. Notes on board artworks (recommendations)

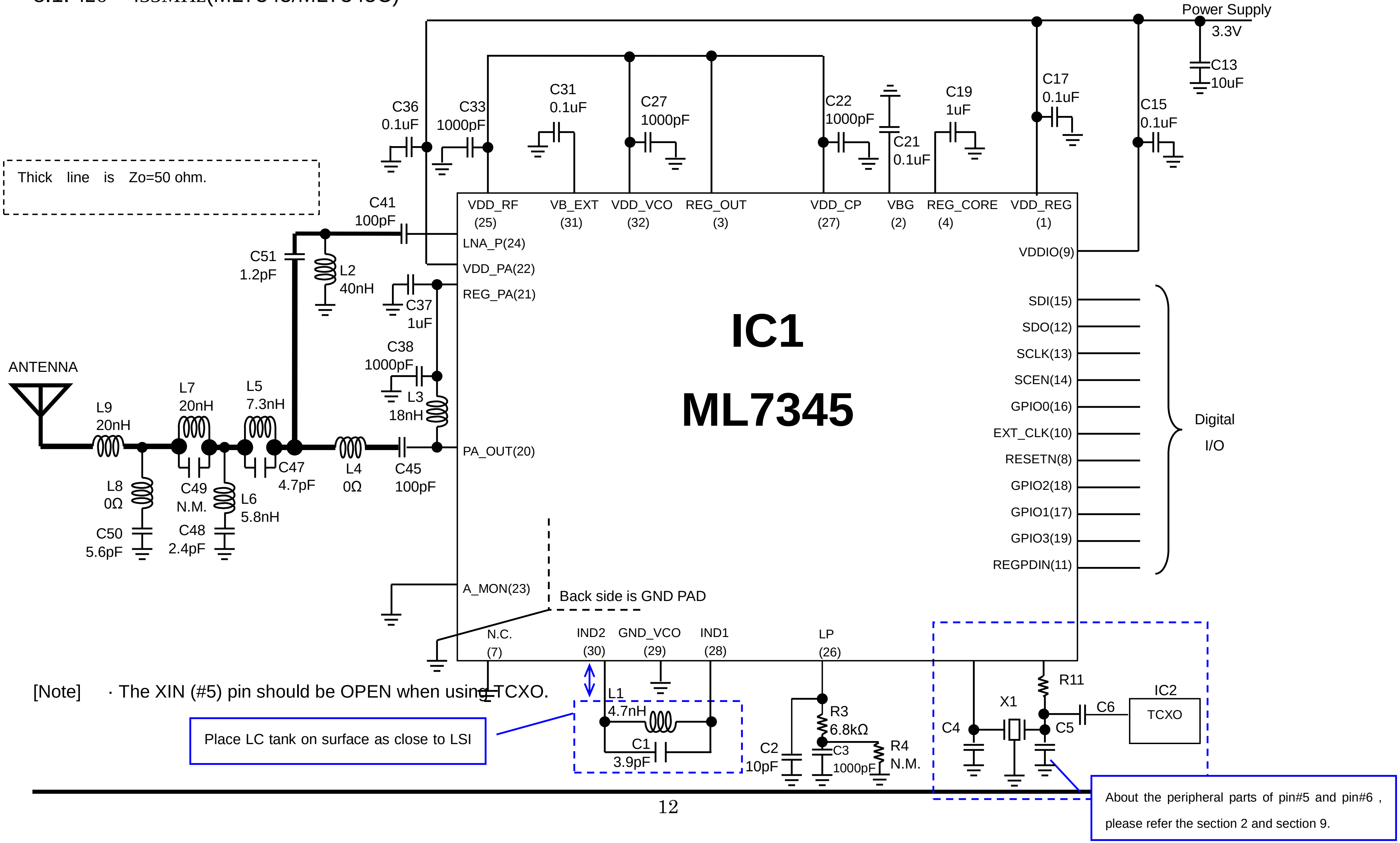
7.1. GND

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.

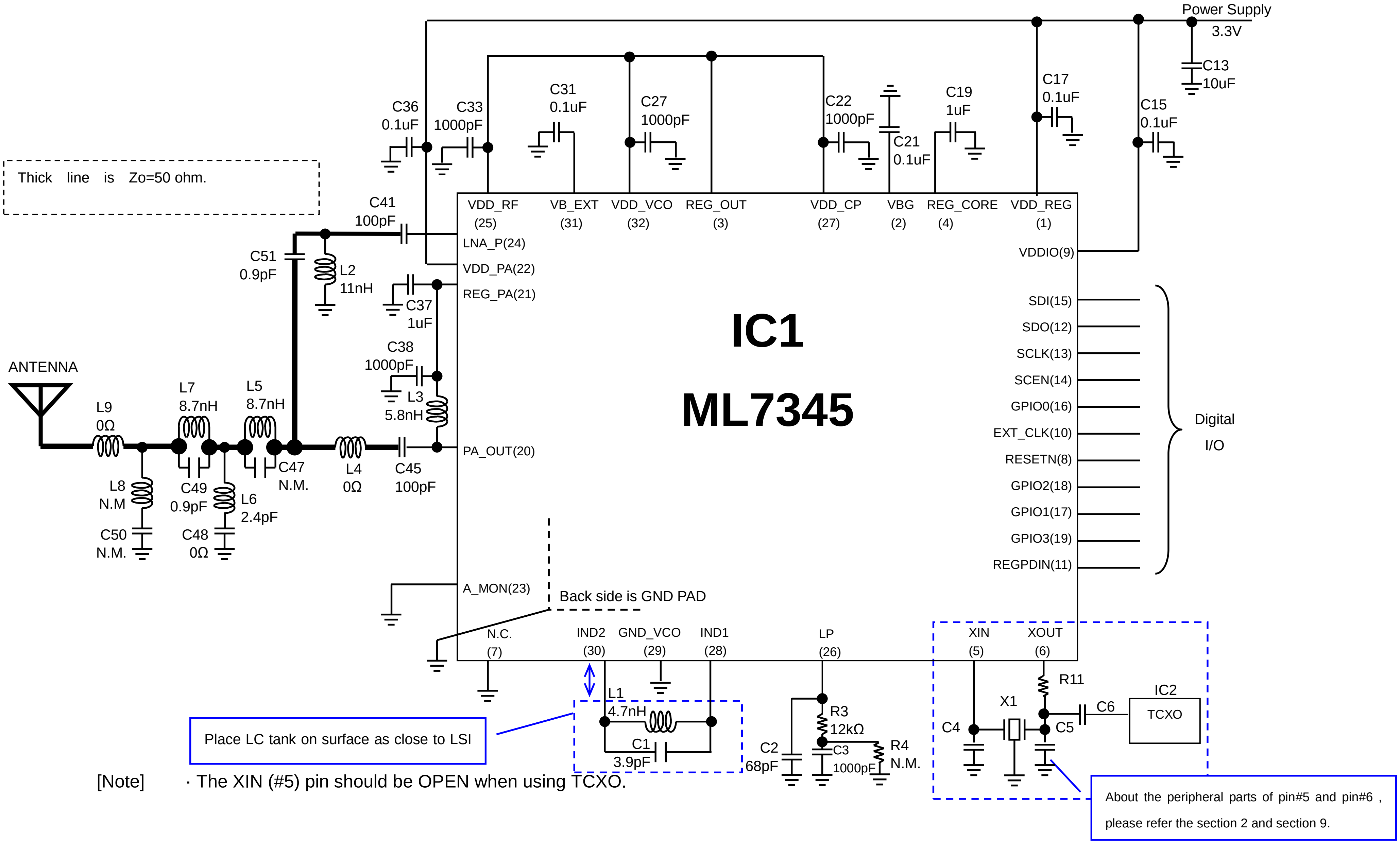
8. Application circuit(ML7345)

8.1. 426～433MHz(ML7345/ML7345C)



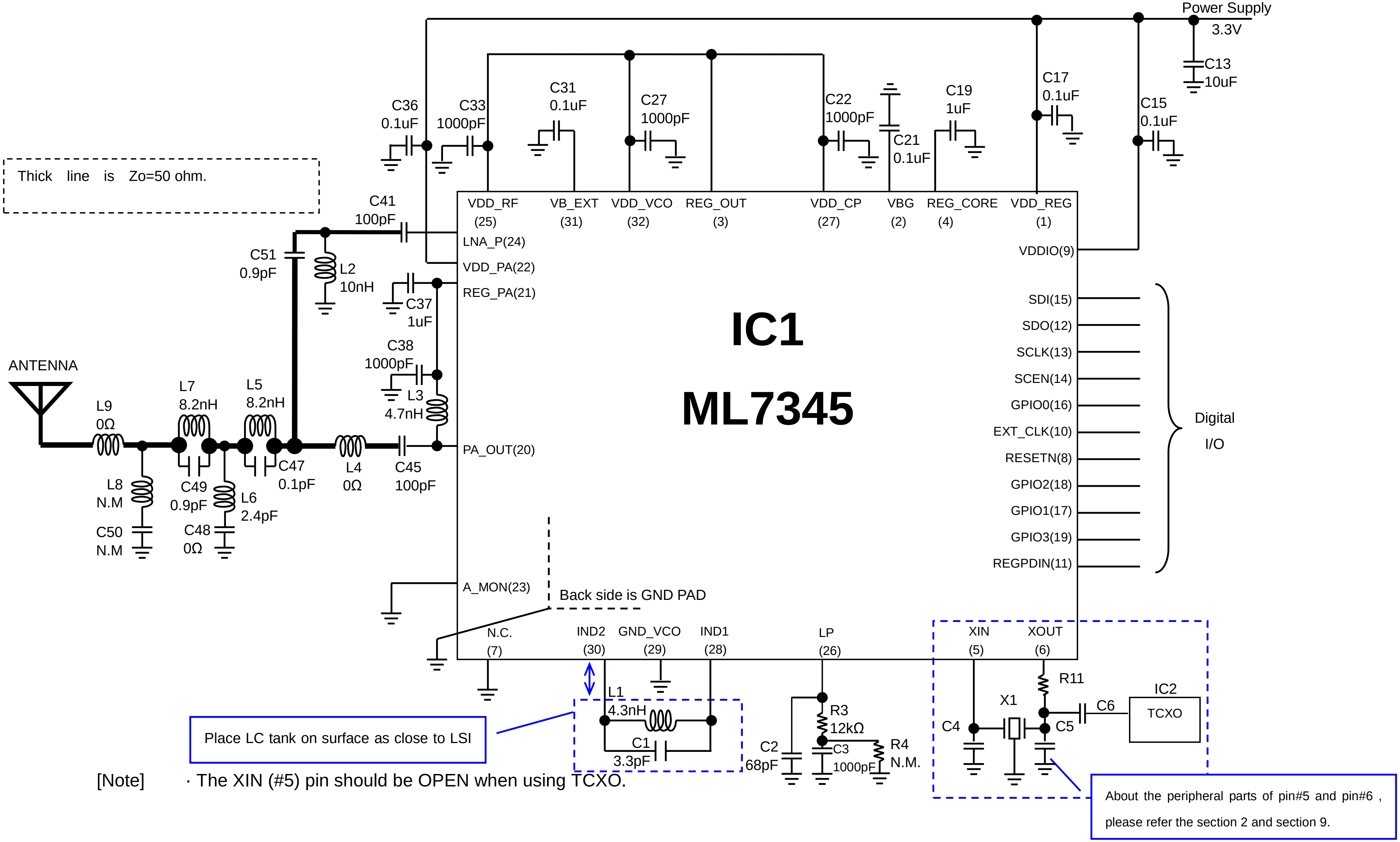
[Note] · The XIN (#5) pin should be OPEN when using TCXO.

8.2. 868MHz(ML7345)



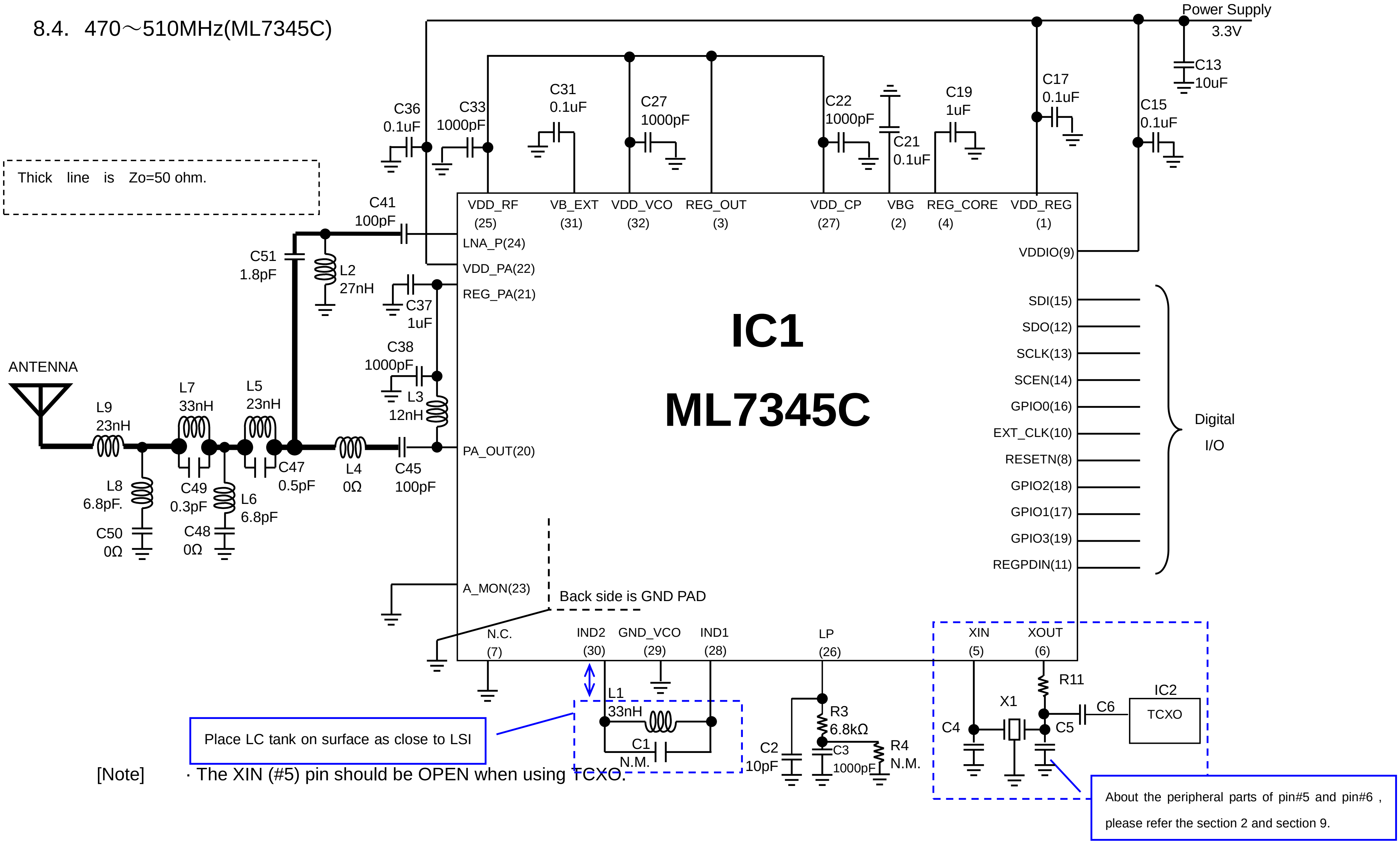
[Note] · The XIN (#5) pin should be OPEN when using TCXO.

8.3. 922MHz(ML7345)



[Note] · The XIN (#5) pin should be OPEN when using TCXO.

8.4. 470～510MHz(ML7345C)



[Note] · The XIN (#5) pin should be OPEN when using TCXO.

9. Bill of Materials(ML7345/ML7345C)

9.1 426～433MHz/868MHz/922MHz band (ML7345) 470MHz～490MHz band (ML7345C)

The following table shows the bill of materials for 10/20mW transmission circuit for ML7345 at 426～433MHz band or for 100mW transmission circuit for ML7345C at 470～510MHz band

Common components

Component	Value (ML7345)			Value (ML7345C)	Vender	Remarks
	433MHz	868MHz	922MHz	490MHz		
L1	4.7nH	4.7nH	4.3nH	33nH	Murata Manufacturing Co., Ltd	LQW15AN Series *2
L2	40nH	11nH	10nH	27nH	Murata Manufacturing Co., Ltd	LQW15AN Series *4
L3	18nH	5.8nH	4.7nH	12nH	Murata Manufacturing Co., Ltd	LQW15AN Series *4
L4	0Ω	0Ω	0Ω	0Ω	KOA Corporation	RK73Z1ETTP *4
L5	7.3nH	8.7nH	8.2nH	23nH	Murata Manufacturing Co., Ltd	LQW15AN Series *4
L6	5.8nH	2.4pF	2.4pF	6.8pF	Murata Manufacturing Co., Ltd	LQW15/GJM15 Series *4
L7	20nH	8.7nH	8.2nH	33nH	Murata Manufacturing Co., Ltd	LQW15AN Series *4
L8	0Ω	N.M.	N.M.	6.8pF	KOA Corporation/ Murata Manufacturing Co., Ltd	RK73Z1ETTP /GJM15Series *4
L9	20nH	0Ω	0Ω	23nH	KOA Corporation/ Murata Manufacturing Co., Ltd	RK73Z1ETTP /LQW15AN Series *4
C1	3.9pF	3.9pF	3.3pF	N.M.	Murata Manufacturing Co., Ltd	GJM15 Series *2
C2	10pF	68pF	68pF	10pF	Murata Manufacturing Co., Ltd	GJM15 Series *1
C3	1000pF	1000pF	1000pF	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K *1
C13	10uF				NEC	TEESVA1C106M8R
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
C23	N.M.				-	-
C24	N.M.				-	-
C25	N.M.				-	-
C26	N.M.				-	-
C27	1000pF				Murata Manufacturing Co., Ltd	GRM155B11H102K
C28	N.M.				-	-
C29	N.M.				-	-
C30	N.M.				-	-
C31	0.1uF				Murata Manufacturing Co., Ltd	GRM155B31C104K
C32	N.M.					
C33	1000pF				Murata Manufacturing Co., Ltd	GRM155B11H102K
C34	N.M.				-	-
C35	N.M.				-	-
C36	0.1uF				Murata Manufacturing Co., Ltd	GRM155B31C104K
C37	1uF				Murata Manufacturing Co., Ltd	GRM155B31A105K
C38	1000pF				Murata Manufacturing Co., Ltd	GRM155B11H102K

Component	Value (ML7345)			Value (ML7345C)	Vender	Remarks
	433MHz	868MHz	922MHz	490MHz		
C41	100pF				Murata Manufacturing Co., Ltd	GRM1552C1H101J *4
C44	N.M.				-	-
C45	100pF				Murata Manufacturing Co., Ltd	GRM1552C1H101J
C47	4.7pF	N.M.	0.1pF	0.5pF	Murata Manufacturing Co., Ltd	GJM15 Series *4
C48	2.4pF	0Ω	0Ω	0Ω	Murata Manufacturing Co., Ltd	GJM1552C1H2R4B *4
C49	N.M.	0.9pF	0.9pF	0.3pF	Murata Manufacturing Co., Ltd	GJM15 Series *4
C50	5.6pF	N.M.	N.M.	0Ω	Murata Manufacturing Co., Ltd	RK73Z1ETTP/ GJM15 Series *4
C51	1.2pF	0.9pF	0.9pF	1.8pF	Murata Manufacturing Co., Ltd	GJM15 Series *4
C60	N.M.				-	-
R3	6.8kΩ	12kΩ	12kΩ	6.8kΩ	KOA Corporation	RK73B1ETTP Series *1
R4	N.M.				-	-
R5	0Ω				KOA Corporation	RK73Z1ETTP
R10	0Ω				KOA Corporation	RK73Z1ETTP
Q1	N.M.				-	-
IC1	ML7345			ML7345C	LAPIS Semiconductor Co., Ltd.	RF LSI

Crystal input [ML7345]

Component	Value	Vender	Remarks
X1	24MHz	River Eletec Corporation	FA-128
		Nihon Denpa Kogyo Co.,Ltd	NX2016SA
IC2	N.M.	-	-
C4	1pF	Murata Manufacturing Co., Ltd	GRM155 or equivalent. (1005) The value depends on the using crystal. *3
C5	1pF	Murata Manufacturing Co., Ltd	GRM155 or equivalent. (1005) The value depends on the using crystal. *3
C6	N.M.	-	-
R11	0Ω	KOA Corporation	The value depends on the using crystal. *3

TCXO input [ML7345]

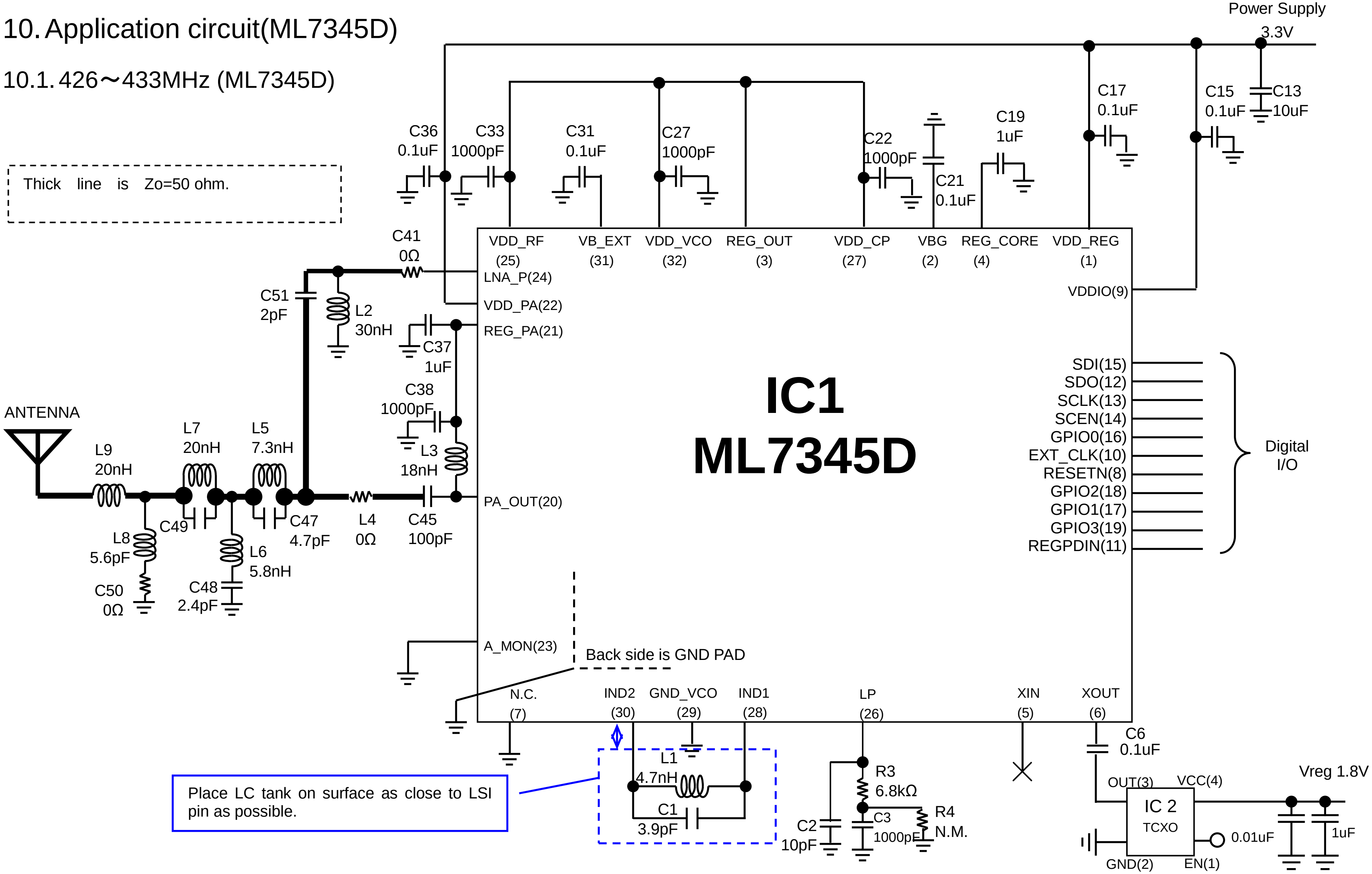
Component	Value	Vender	Remarks
X1	N.M.	-	-
IC2	24MHz	EPSON	TG-5035CG
		Nihon Denpa Kogyo Co.,Ltd	NT2016SB
C4	N.M.	-	-
C5	N.M.	-	-
C6	0.1uF	Murata Manufacturing Co., Ltd	GRM155B31C104K

*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.
*3: Please refer the Table 2.1.1 in the section 2.1
*4: Please refer the section 5.1.

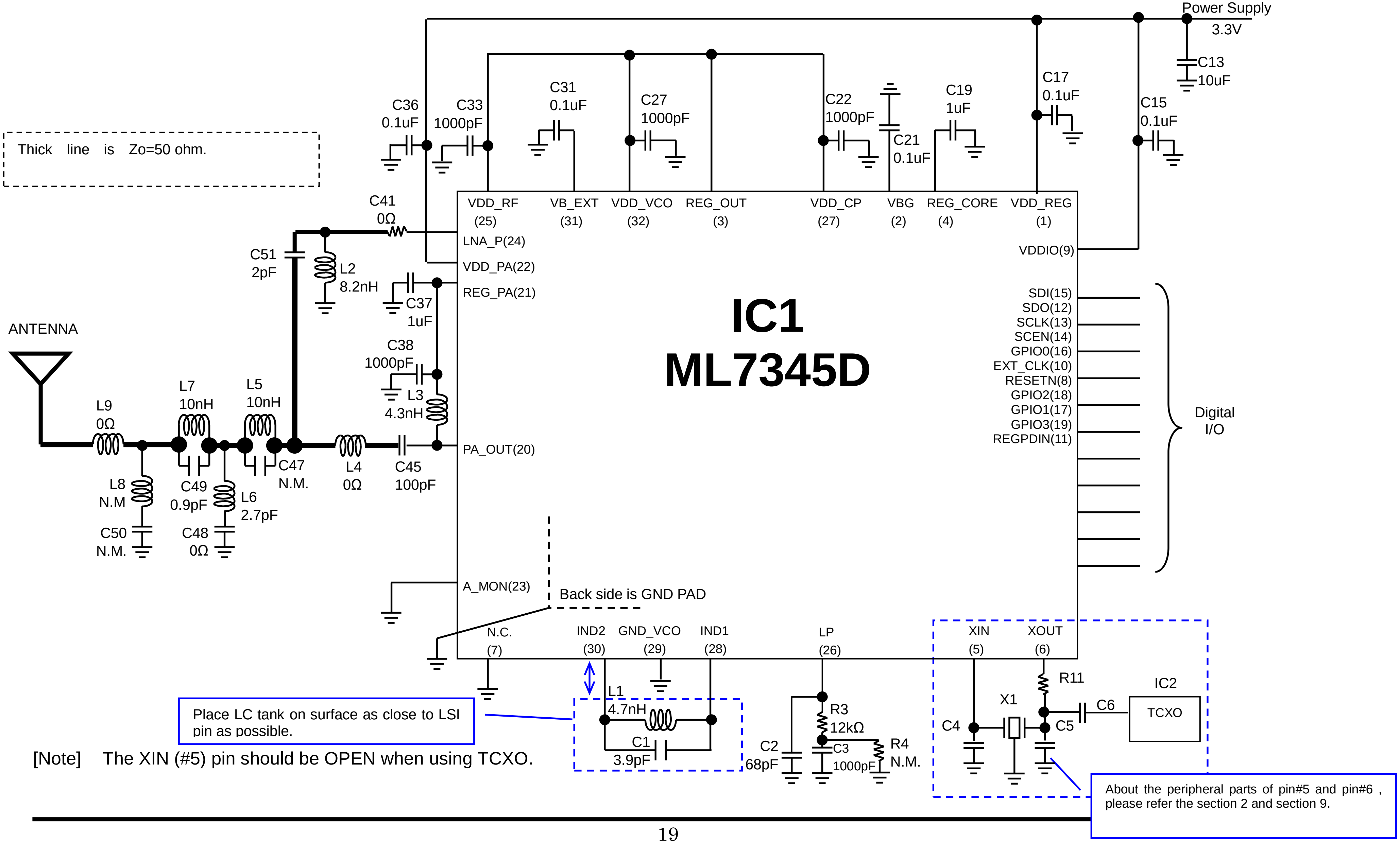
[Note]
These component values are the reference value. LAPIS Semiconductor does not guarantee RF performance..

10. Application circuit(ML7345D)

10.1. 426～433MHz (ML7345D)

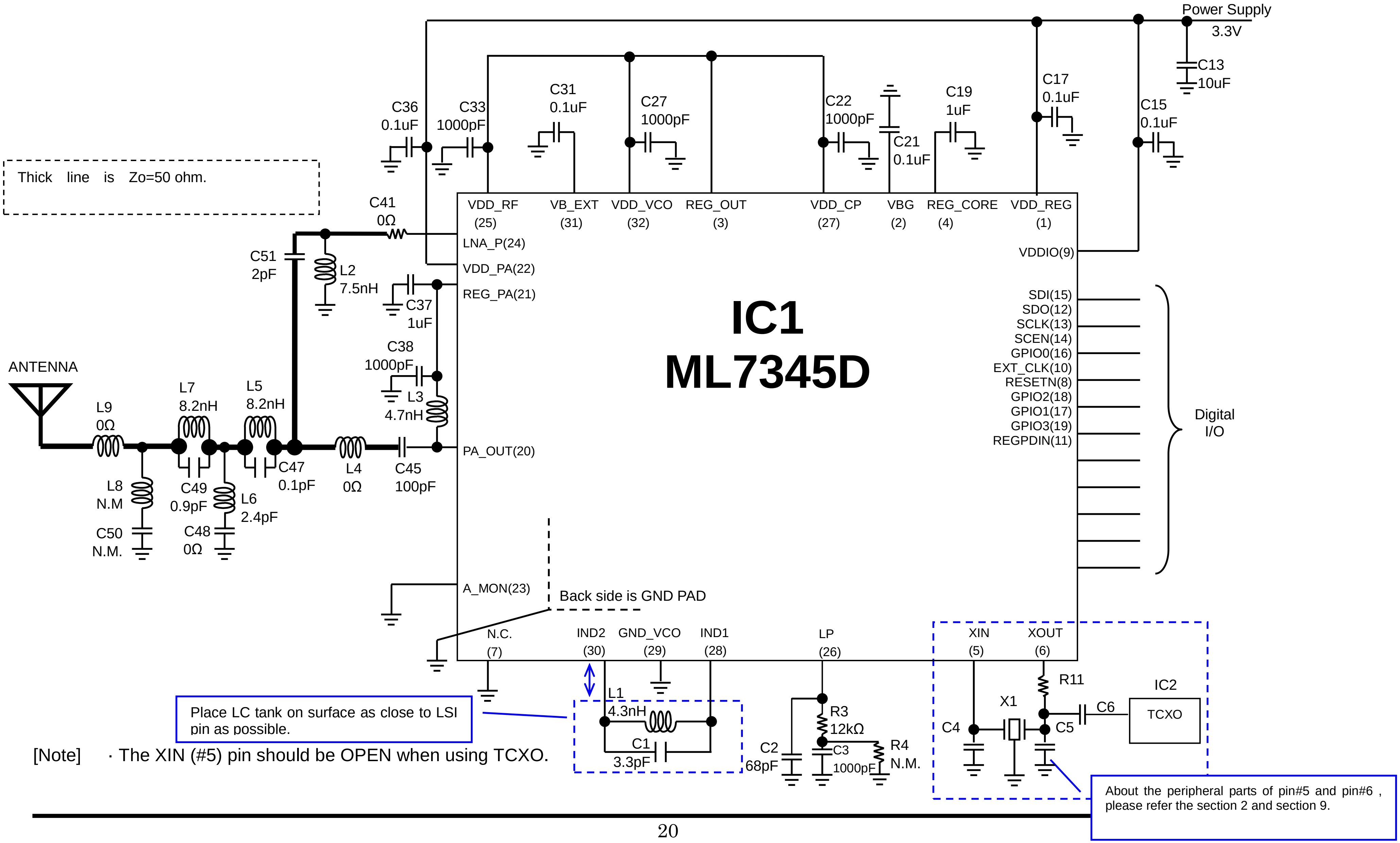


10.2. 868MHz(ML7345D)



[Note] The XIN (#5) pin should be OPEN when using TCXO.

10.3. 922MHz(ML7345D)



[Note] · The XIN (#5) pin should be OPEN when using TCXO.

11. Bill of Materials(ML7345D)

11.1 426～433MHz/868MHz/922MHz band (ML7345D)

The following table shows the bill of materials for 10/20mW transmission circuit for ML7345D at 426～433MHz/868MHz/922MHz band.

Common components

Component	Value			Vender	Remarks
	433MHz	868MHz	922MHz		
L1	4.7nH	4.7nH	4.3nH	Murata Manufacturing Co., Ltd	LQW15AN Series *2
L2	30nH	8.2nH	7.5nH	Murata Manufacturing Co., Ltd	LQW15AN Series *4
L3	18nH	4.3nH	4.7nH	Murata Manufacturing Co., Ltd	LQW15AN Series *4
L4	0Ω	0Ω	0Ω	KOA Corporation	RK73Z1ETTP *4
L5	7.3nH	10nH	8.2nH	Murata Manufacturing Co., Ltd	LQW15AN Series *4
L6	5.8nH	2.7pF	2.4pF	Murata Manufacturing Co., Ltd	LQW15/GJM15 Series *4
L7	20nH	10nH	8.2nH	Murata Manufacturing Co., Ltd	LQW15AN Series *4
L8	5.6pF	N.M.	N.M.	Murata Manufacturing Co., Ltd	GJM1552C1H5R6C *4
L9	20nH	0Ω	0Ω	Murata Manufacturing Co., Ltd	LQW15AN Series *4
C1	3.9pF	3.9pF	3.3pF	Murata Manufacturing Co., Ltd	GJM15 Series *2
C2	10pF	68pF	68pF	Murata Manufacturing Co., Ltd	GJM15 Series *1
C3	1000pF	1000pF	1000pF	Murata Manufacturing Co., Ltd	GRM155B11H102K *1
C13	10uF			NEC	TEESVA1C106M8R
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
C23	N.M.			-	-
C24	N.M.			-	-
C25	N.M.			-	-
C26	N.M.			-	-
C27	1000pF			Murata Manufacturing Co., Ltd	GRM155B11H102K
C28	N.M.			-	-
C29	N.M.			-	-
C30	N.M.			-	-
C31	0.1uF			Murata Manufacturing Co., Ltd	GRM155B31C104K
C32	N.M.				
C33	1000pF			Murata Manufacturing Co., Ltd	GRM155B11H102K
C34	N.M.			-	-
C35	N.M.			-	-
C36	0.1uF			Murata Manufacturing Co., Ltd	GRM155B31C104K
C37	1uF			Murata Manufacturing Co., Ltd	GRM155B31A105K
C38	1000pF			Murata Manufacturing Co., Ltd	GRM155B11H102K

Component	Value			Vender	Remarks
	433MHz	868MHz	922MHz		
C41	0Ω			KOA Corporation	RK73Z1ETTP *4
C44	N.M.			-	-
C45	100pF			Murata Manufacturing Co., Ltd	GRM1552C1H101J
C47	4.7pF	N.M.	0.1pF	Murata Manufacturing Co., Ltd	GJM15 Series *4
C48	2.4pF	0Ω	0Ω	Murata Manufacturing Co., Ltd	GJM1552C1H2R4B *4
C49	N.M.	0.9pF	0.9pF	Murata Manufacturing Co., Ltd	GJM15 Series *4
C50	0Ω	N.M.	N.M.	KOA Corporation/ Murata Manufacturing Co., Ltd	RK73Z1ETTP/ GJM15 Series *4
C51	2pF			Murata Manufacturing Co., Ltd	GJM1554C1H2R0B *4
C60	N.M.			-	-
R3	6.8kΩ	12kΩ	12kΩ	KOA Corporation	RK73B1ETTP Series *1
R4	N.M.			-	-
R5	0Ω			KOA Corporation	RK73Z1ETTP
R10	0Ω			KOA Corporation	RK73Z1ETTP
Q1	N.M.			-	-
IC1	ML7345D			LAPIS Semiconductor Co., Ltd.	RF LSI

Crystal input [ML7345D]

Component	Value	Vender	Remarks
X1	24MHz	River Eletec Corporation	FA-128
		Nihon Denpa Kogyo Co.,Ltd	NX2016SA
IC2	N.M.	-	-
C4	1pF	Murata Manufacturing Co., Ltd	GRM155 or equivalent. (1005) The value depends on the using crystal. *3
C5	1pF	Murata Manufacturing Co., Ltd	GRM155 or equivalent. (1005) The value depends on the using crystal. *3
C6	N.M.	-	-
R11	0Ω	KOA Corporation	The value depends on the using crystal. *3

TCXO input [ML7345D]

Component	Value	Vender	Remarks
X1	N.M.	-	-
IC2	24MHz	EPSON	TG-5035CG
		Nihon Denpa Kogyo Co.,Ltd	NT2016SB
C4	N.M.	-	-
C5	N.M.	-	-
C6	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.
*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 RF performance..

Revision history

Document No.	Release Date	Page		Content
		Before revision	After revision	
FEXL7345DG-01	2018.5.8	–	–	1st revision
FEXL7345DG-02	2019.9.5	5	5	2.2.TCXO circuit (ML7345/ML7345D)
		8	8	4.1.Adjusting component values for VCO tank
		10	10	5. RF matching component values table5.1 error correction.
		12	12	Separate the Application circuits and BOM by RF band