WIZnet Ethernet PCB Design

Description

This document is a WIZnet Ethernet Chip design reference. It contains PCB design references using W5100, W5300, W5500, W7500, and W7500P. Includes Medium dependent interface (MDI), power supply, parts placement, Media Independent Interface (MII), etc. You must follow the instructions below. Failure to follow the instructions may result in poor Ethernet performance.

Contens

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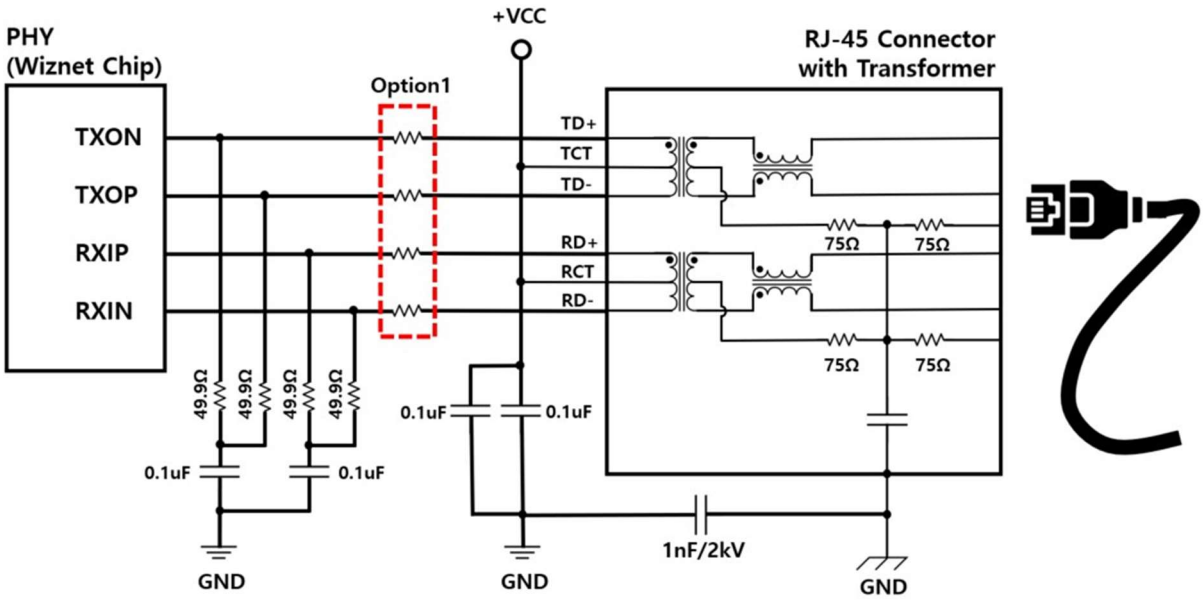
  - ■ W5500
  - ■ W7500, W7500P
  - ■ Using RJ-45 without Transformer
- ✓ PCB Design Guide
  - ■ Ethernet Socket
  - ■ MDI
- ✓ TEST
  - ■ Compliance
  - ■ EMI – RE
- ✓ PoE

✓ SCH Design Guide

- W5100, W5100S, W5300, W6100



- The circuit may change depending on the internal circuit configuration of the Ethernet socket. Make sure to refer to Datasheet and design the circuit in an appropriate way.
- If you use an Ethernet socket that does not include a transformer, you must also design the transformer part of the circuit.
- The TCT of the transformer, the GND connected to the RCT, and the GND connected to the longitudinal resistance of the TX and RX can be designed as AGND instead of the normal GND. This is for the separation of the MDI signal from the system GND noise, in which case the area of the AGND should be large enough. Otherwise, it is more advantageous to integrate AGND and system GND.
- Option1 is a damping resistance against EMC. Resistance to prevent common mode noise and differential mode noise interference; if the resistance value is designed too large, the voltage level of the differential line may decrease, which may cause Ethernet communication problems.

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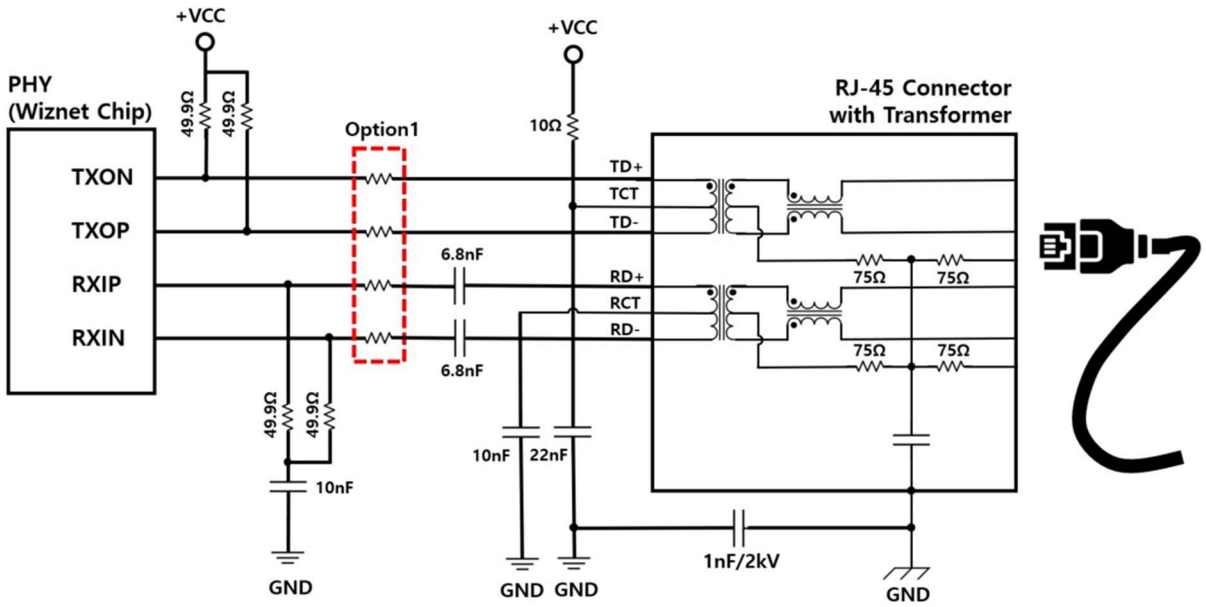
■ W5500



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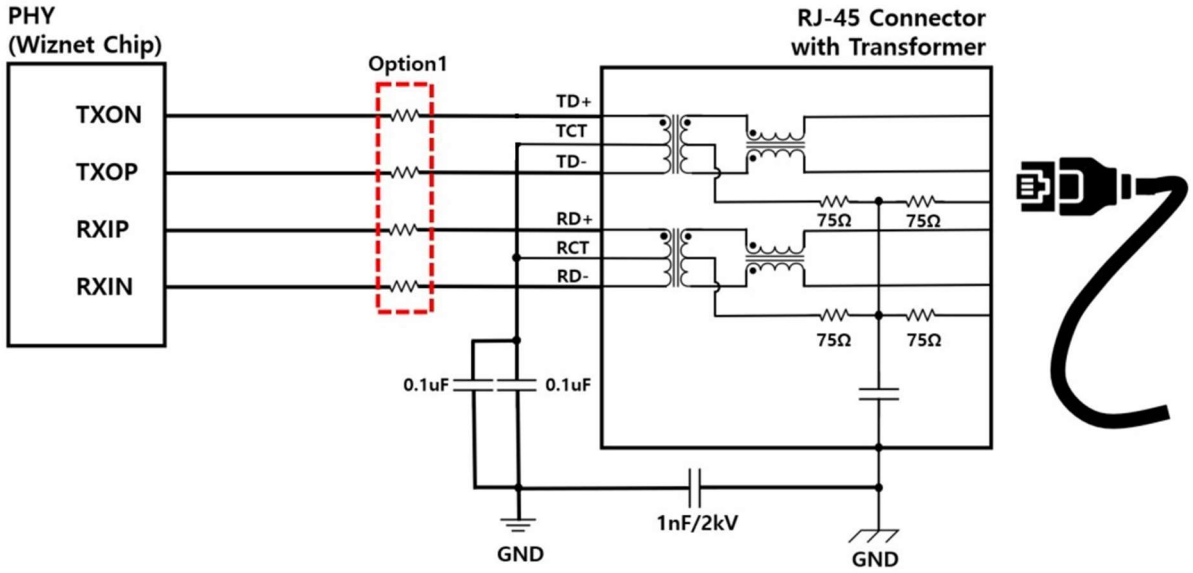
■ W7500, W7500P



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- Option1 is a damping resistance against EMC. Resistance to prevent common mode noise and differential mode noise interference; if the resistance value is designed too large, the voltage level of the differential line may decrease, which may cause Ethernet communication problems.
- The Current Mode PHY has a termination resistor circuit inside, eliminating the need to design an external termination resistor.
- Since the W7500 does not have PHY, additional PHY circuits must be designed.

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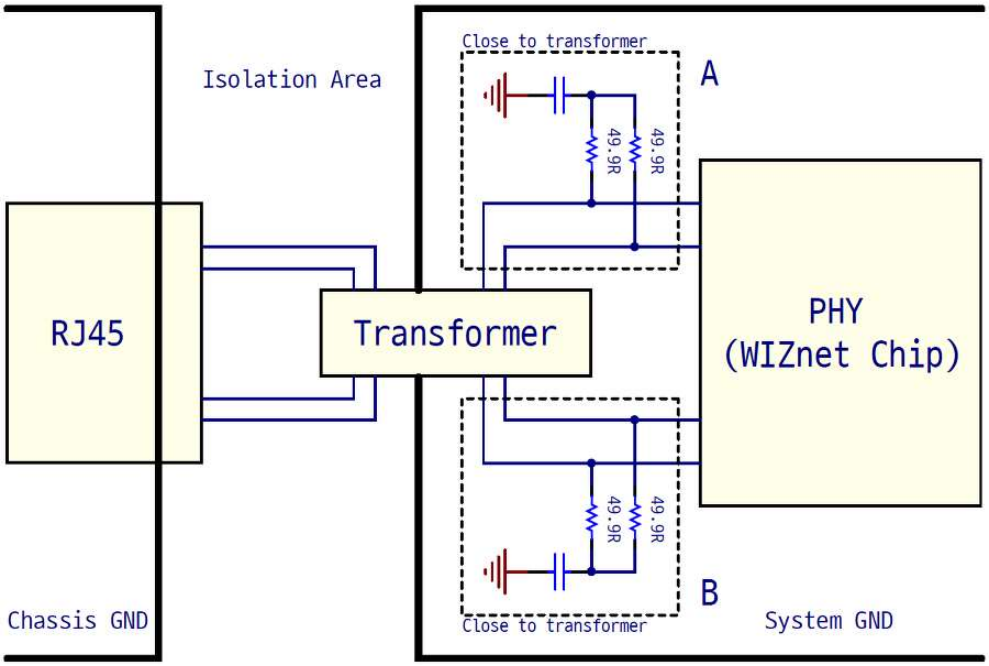
■ Using RJ-45 without Transformer



- If you use an Ethernet socket without Transformer, you must design an additional Transformer circuit.
- The above circuit is a typical circuit configuration and corresponds to W5100, W5100S, W5300, and W6100 on the WIZnet Ethernet Chip.
- Based on Transformer, PHY to Transformer is the System GND area.
- It is recommended that the termination resistance be placed closest to the end of the signal. (Receiving side)

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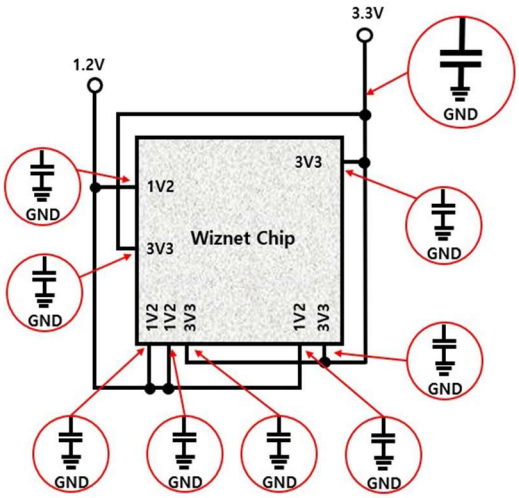
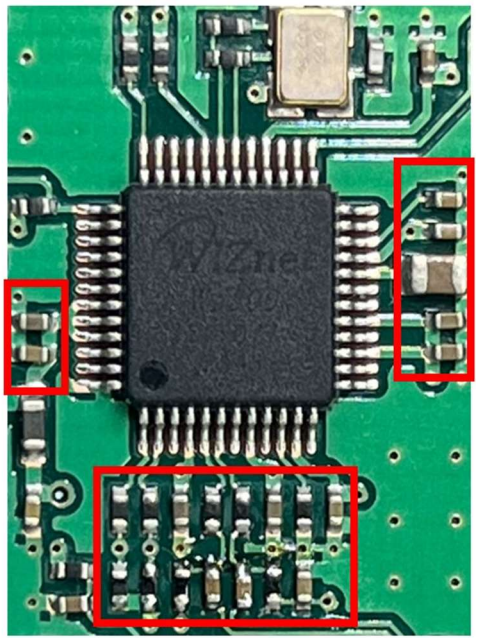
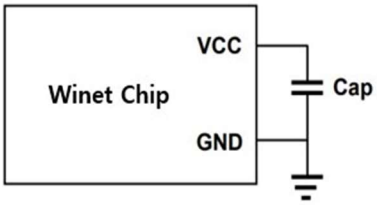
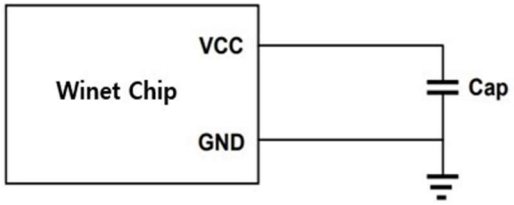
■ Decoupling Capacitor





Good Design	Bad Design
	

- The Decoupling Capacitor is used to remove noise from the power line.
- As filtering is the purpose, it is recommended to place it as close as possible to the chip.
- It is recommended that at least one Capacitor be designed for each power line.

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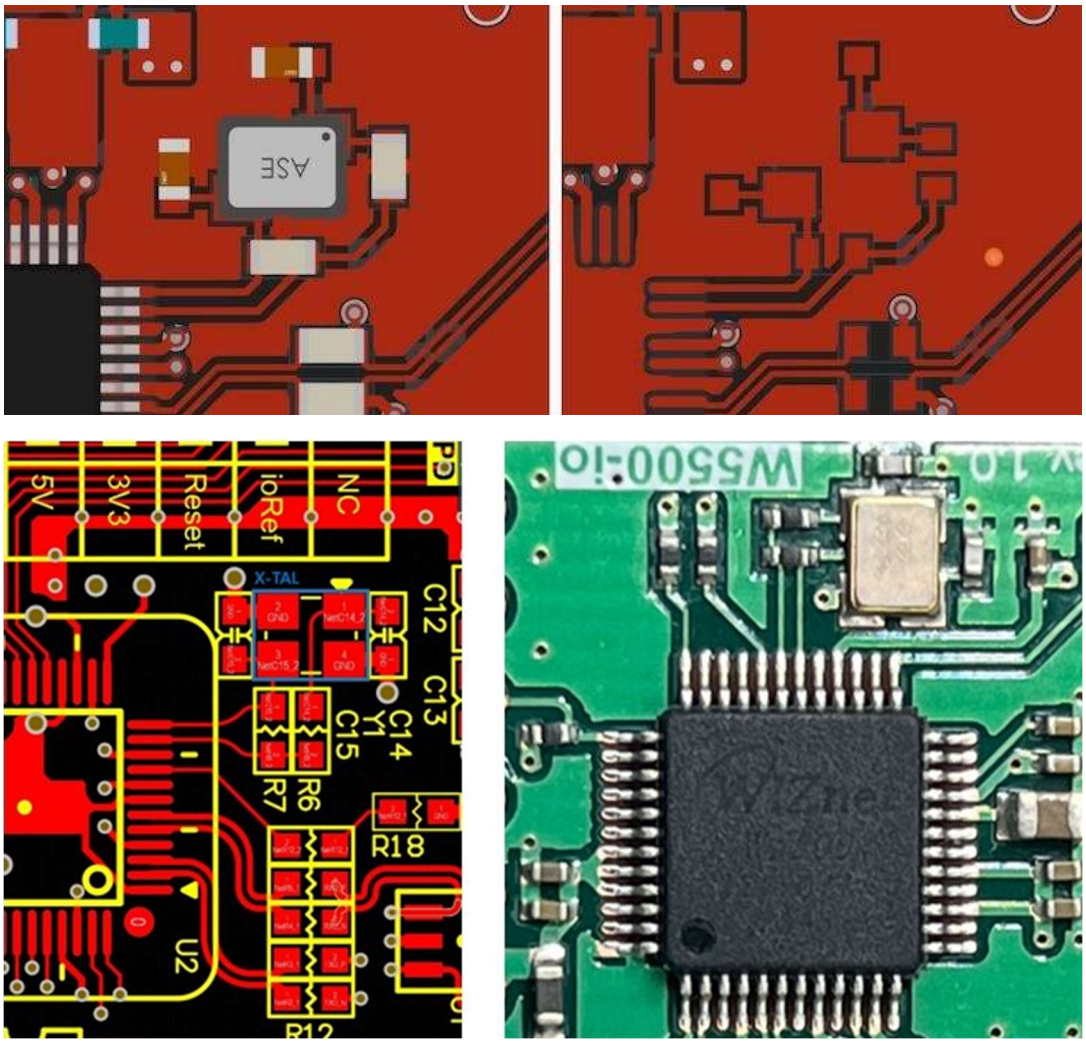
■ Oscillator



- Because it is a high-frequency signal, it is recommended to design without Via in layers such as Chip during Artwork.
- It is recommended that only one chip be connected to one oscillating element. (current problem, interference

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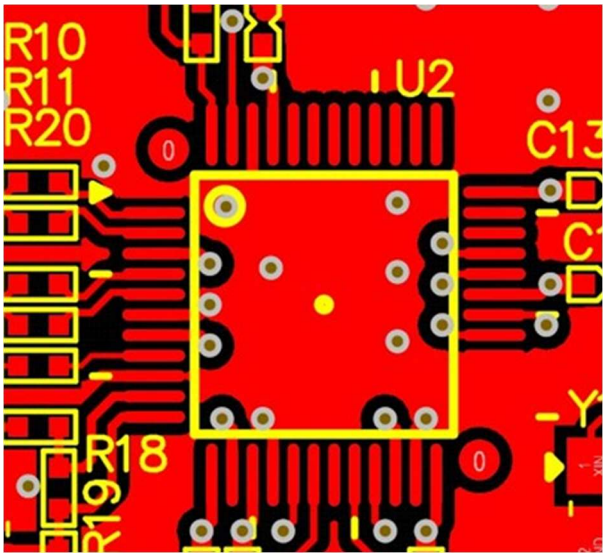
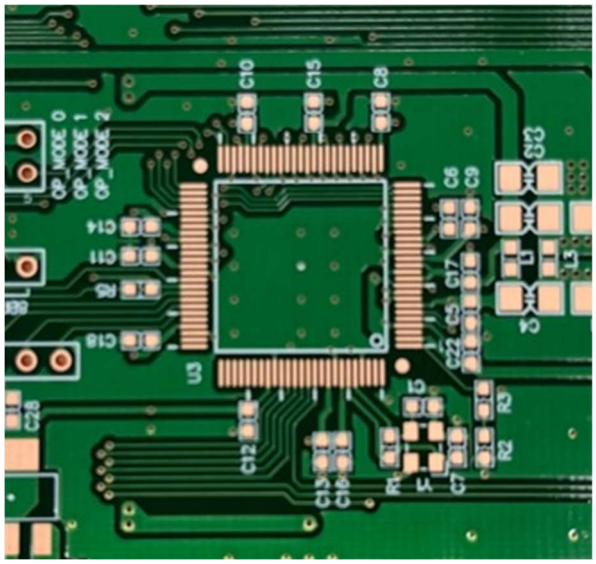
■ GND Plane





- It is also recommended to put GND Copper powder on the inside of the chip.
- It is recommended that no other digital lines pass across the chip.
- It is recommended that you place multiple Via's to maintain good GND connectivity.
- It is recommended to distinguish between AGND and DGND.
- If you separate AGND and DGND, it is not functionally good if it is located on the same coordinate even if it is a different layer.

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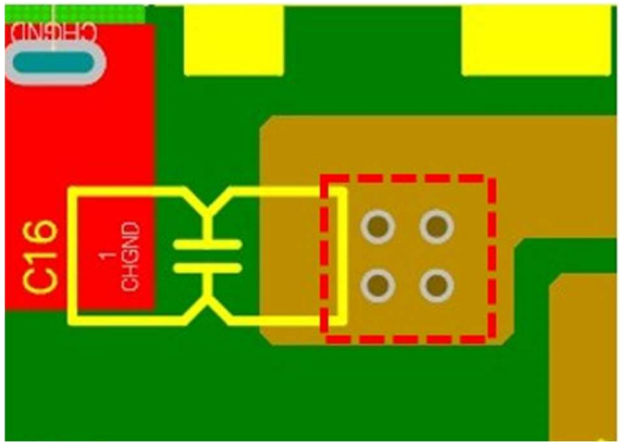
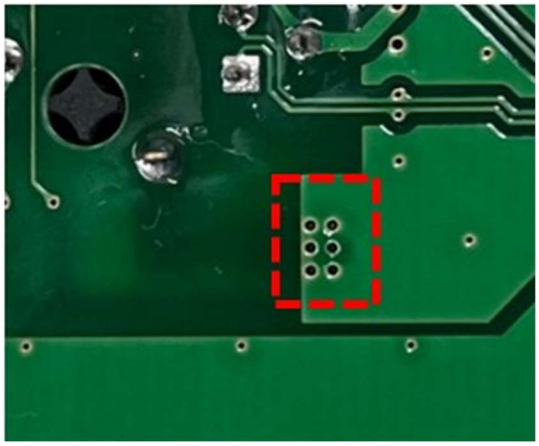
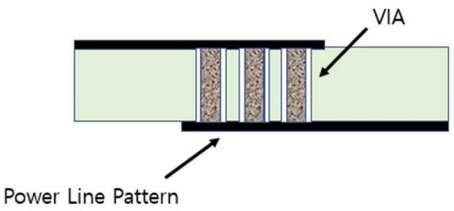
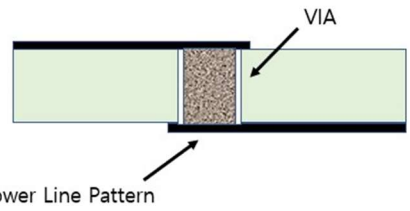
■ Power Pattern





Good Design	Bad Design
	

- The Power Plane should also consider Pattern and Via. The current capacity of the pattern depends on the width, thickness, OZ, and temperature.
- If possible, it is better to design with several smaller Via rather than one larger Via. (Current capacity is greater)

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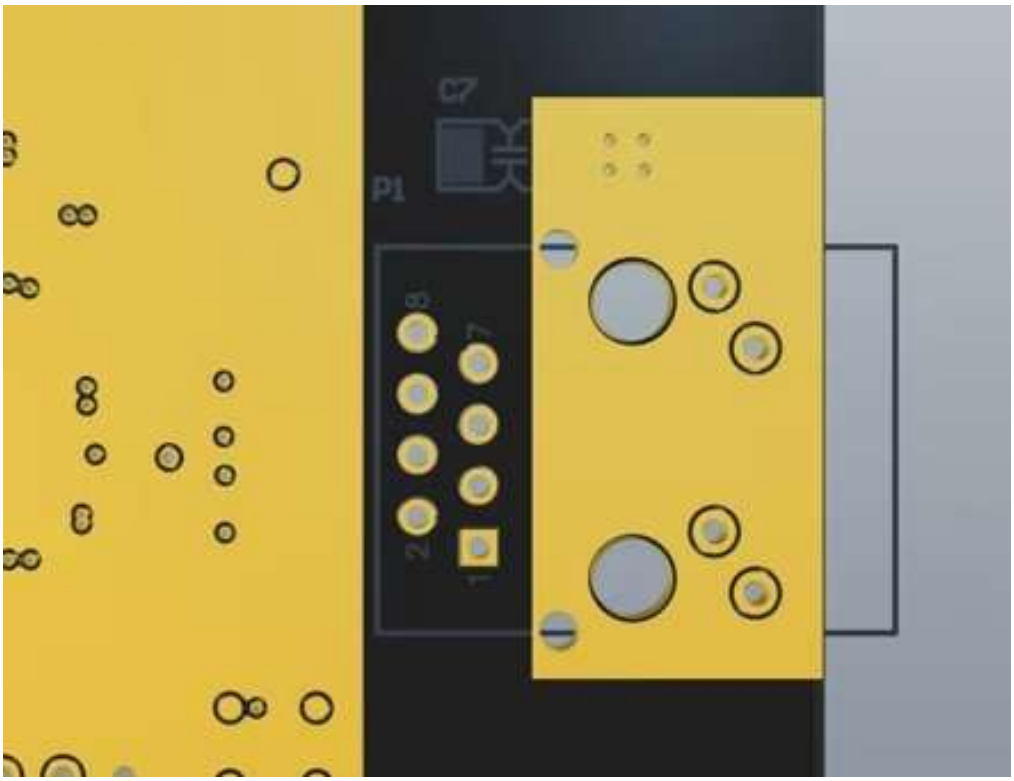
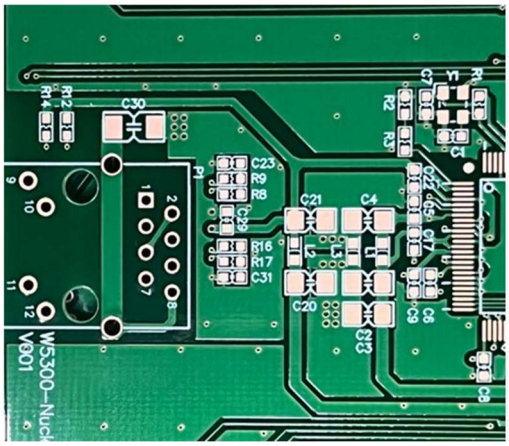
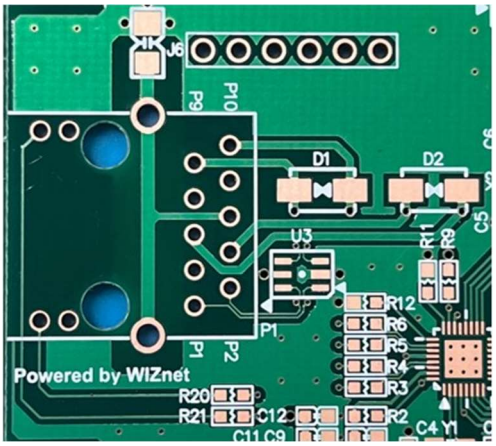
■ Ethernet Socket







- If you use an RJ-45 socket without Transformer, you must design the Transformer circuit additionally.
- The above circuit is a typical circuit configuration and corresponds to W5100S, W6100, and W5300 on the WIZnet Ethernet Chip.
- Based on Transformer, PHY to Transformer is the System GND area.

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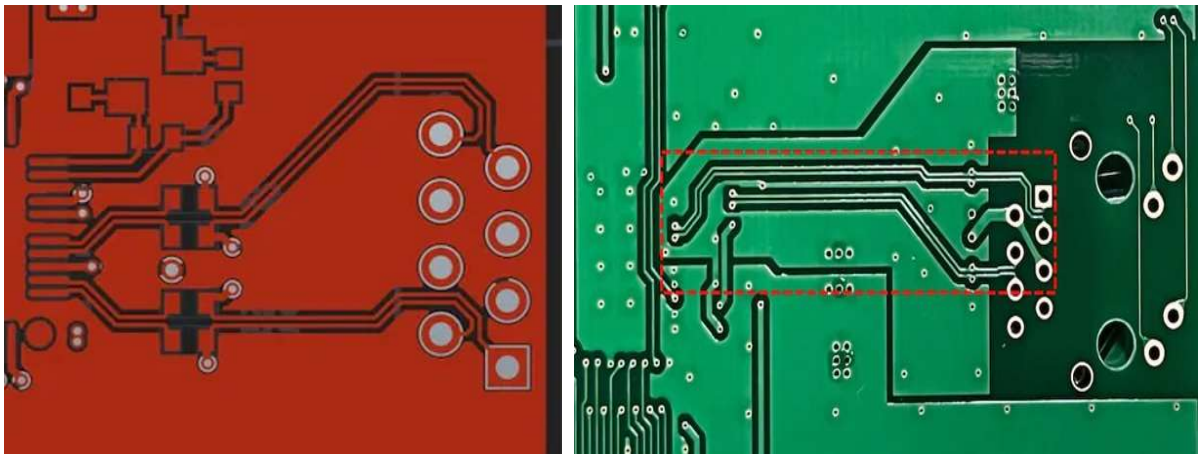
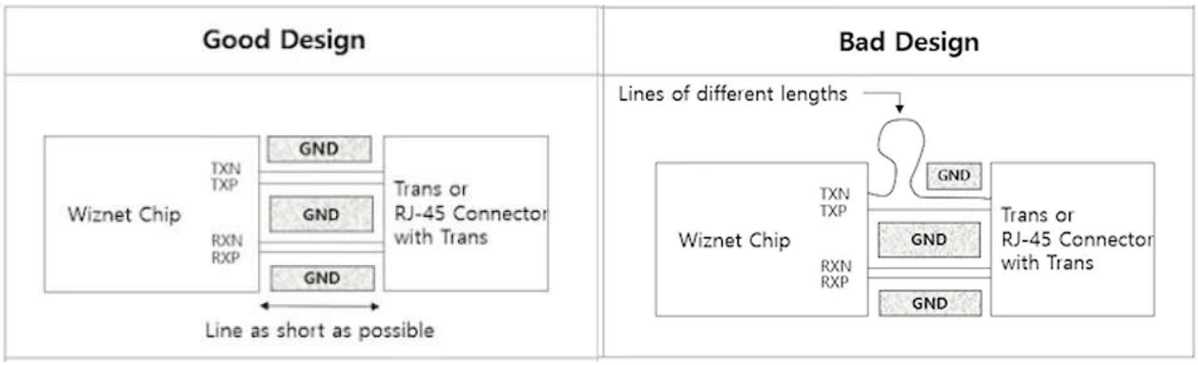
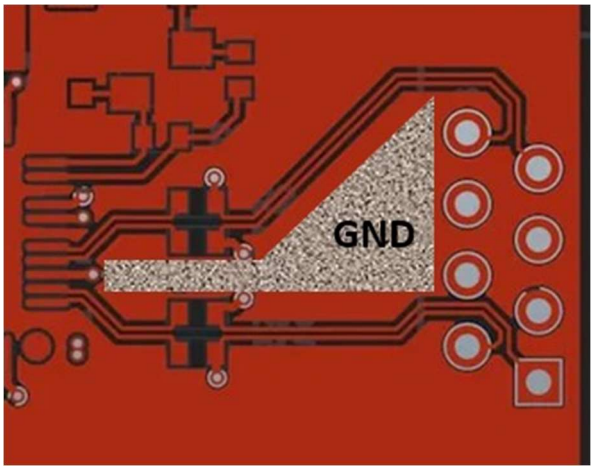
■ MDI

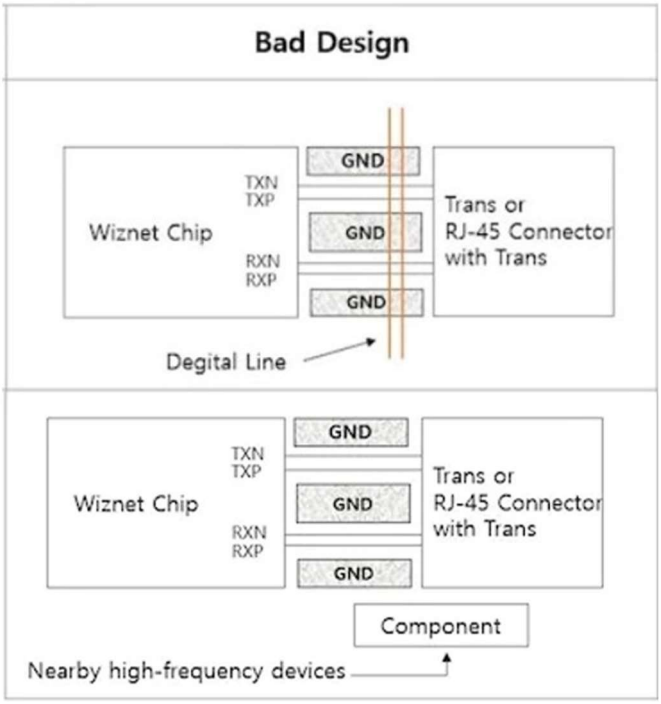




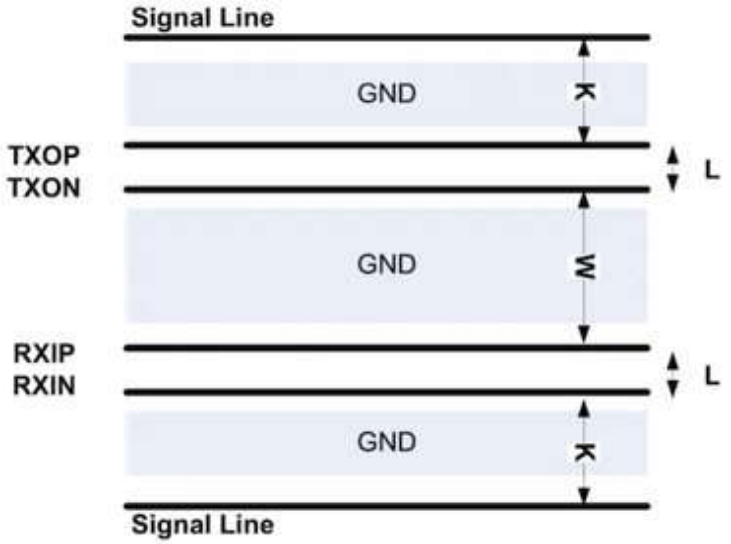
- The distance between RJ-45 and Chip should be as close as possible.
- Because the Tx, Rx signals are differential signals, each line must be of the same length. If the lines are formed differently, the differential mode signal can switch to common mode noise, affecting EMI, and causing Ethernet communication to become a problem.



- It is recommended that a GND pattern be placed between TX and RX so that there is no influence between the two lines.
- If the distance between the two lines is wide enough not to affect each other, there is no need for GND Copper.
- The Impedance of the Line depends on the GND processing. When designing this part, Impedance Matching is possible with line thickness and Clearance.



- It is not good for other Digital Lines to pass through the TX and RX lines.
- It is not good to have a high frequency device around (OCS, etc.)



	Min	Typ	MAX	Descriptions
D	6mil	-	12mil	TX+/- and RX+/- Trace thickness, **ex) 8mil**
L	-	-	10mil	Distance between +/- Differential signal, **ex) 4mil**
W	20mil	-	-	Distance between TX+/- and RX+/- signals, **ex) 30mil**
K	20mil	-	-	Distance between TX+/- and RX+/- signals and others & power, **ex) 30mil**, separate by GND.

- Minimum condition for Ethernet Impedance Line design.
- The impedance of Ethernet is 100 ohms.
- In order to design an accurate Impedance 100 ohm, you should ask the PCB manufacturer to design it.

  (Impedance changes depending on Solder Mask, Oz, and process method.)

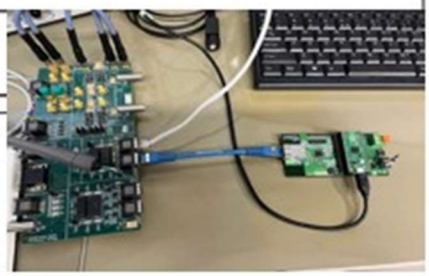
✓ **TEST**

■ **Compliance**

Test Report

Pass

Test Configuration Details	
Application	
Name	D9010ETHC Ethernet
Version	2.72.0.0
Device Description	
Tests10BT	No
Tests100BT	Yes
Tests1000BT	No
Tests10BT_EEE	No
Tests100BT_EEE	No
Tests1000BT_EEE	No
DisturbingSignal	Yes
TxTclk	Yes
DisturberSource	Use Keysight 33250A
ReturnLossTest	Use Vector Network Analyzer
Test Session Details	
Infiniium SW Version	06.40.00714
Infiniium Model Number	MSOS104A
Infiniium Serial Number	MY55160128
Debug Mode Used	No
Compliance Limits	IEEE Std. 802.3 Specification (official)
Probe (Channel 2)	Model: N2750A Serial: US53331201 Atten: Calibrated (18 NOV 2022 15:23:49), Using Cal Atten (9.9742E+00) Skew: Not Calibrated, Using Default Skew
Probe (Channel 3)	Model: User Defined Probe Serial: No Serial Num Atten: Not Calibrated, Using Default Atten (1.0000E+00) Skew: Not Calibrated, Using Default Skew
Probe (Channel 4)	Model: User Defined Probe Serial: No Serial Num Atten: Not Calibrated, Using Default Atten (1.0000E+00) Skew: Not Calibrated, Using Default Skew
Last Test Date	2022-11-18 15:37:29 UTC +08:00



Summary of Results

Test Statistics	
Failed	0
Passed	15
Total	15

Margin Thresholds	
Warning	< 2 %
Critical	< 0 %

Pass	# Failed	# Trials	Test Name (click to jump)	Actual Value	Margin	Pass Limits
✓	0	1	100 Base-TX, UTP +Vout Differential Output Voltage	955.4 mV	5.4 %	950.0 mV < VALUE < 1.0500 V
✓	0	1	100 Base-TX, UTP -Vout Differential Output Voltage	-950.7 mV	0.7 %	950.0 mV < |VALUE| < 1.0500 V
✓	0	1	100 Base-TX, UTP Signal Amplitude Symmetry	-1.005	37.5 %	980 m < |VALUE| < 1.020
✓	0	1	100 Base-TX, +Vout Overshoot	-1.2 %	124.0 %	VALUE < 5.0 %
✓	0	1	100 Base-TX, -Vout Overshoot	-1.1 %	122.0 %	VALUE < 5.0 %
✓	0	1	100 Base-TX, UTP AOI Template	0.000	100.0 %	No Mask Failures
✓	0	1	100 Base-TX, AOI +Vout Rise Time	3.809 ns	40.5 %	3.000 ns < VALUE < 5.000 ns
✓	0	1	100 Base-TX, AOI +Vout Fall Time	3.836 ns	41.8 %	3.000 ns < VALUE < 5.000 ns
✓	0	1	100 Base-TX, AOI +Vout Rise/Fall Symmetry	80.89 ps	83.8 %	VALUE < 500.00 ps
✓	0	1	100 Base-TX, AOI -Vout Rise Time	3.700 ns	35.0 %	3.000 ns < VALUE < 5.000 ns
✓	0	1	100 Base-TX, AOI -Vout Fall Time	3.692 ns	34.6 %	3.000 ns < VALUE < 5.000 ns
✓	0	1	100 Base-TX, AOI -Vout Rise/Fall Symmetry	135.00 ps	73.0 %	VALUE < 500.00 ps
✓	0	1	100 Base-TX, AOI Overall Rise/Fall Symmetry	198.10 ps	60.4 %	VALUE < 500.00 ps
✓	0	1	100 Base-TX, Transmit Jitter	374 ps	73.3 %	VALUE < 1.400 ns
✓	0	1	100 Base-TX, Duty Cycle Distortion	54.890 ps	89.0 %	VALUE <= 500.000 ps

- Test conducted at 10/100M
- Power - USB Micro B Type

✓ TEST

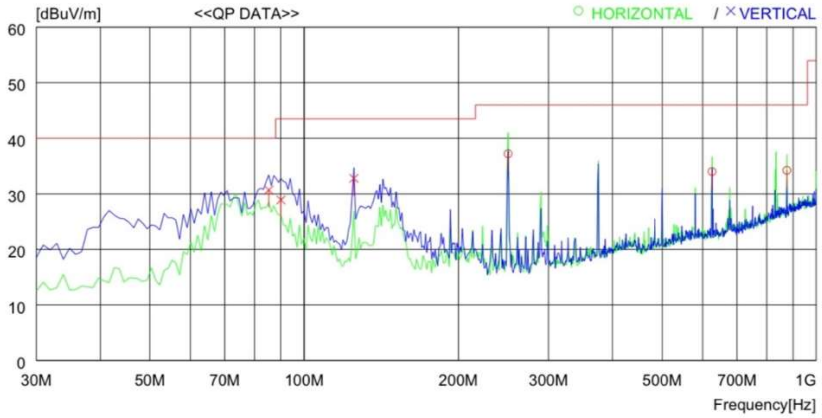
■ EMI - RE

RADIATED EMISSION

2022. 11. 23

Trade Name	:		AGR No.	:	
Model Name	:	W5100S_MAG_C	Power Supply	:	220 V~, 60 Hz
Serial No.	:		Temp / Humi	:	23.8 'C, 45.8 % R.H.
Mode	:		Operator	:	OH SUN EAK
	:				

LIMIT : FCC Part15 Subpart.B Class B (3m)



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal ------										
1	250.190	46.0	12.7	6.2	27.7	37.2	46.0	8.8	200	297
2	625.577	33.4	19.2	10.5	29.1	34.0	46.0	12.0	200	359
3	875.830	28.5	21.7	12.2	28.2	34.2	46.0	11.8	200	174
----- Vertical ------										
4	85.290	46.3	9.1	3.5	28.2	30.7	40.0	9.3	100	0
5	90.140	43.0	10.5	3.6	28.2	28.9	43.5	14.6	100	0
6	125.060	47.1	9.6	4.3	28.2	32.8	43.5	10.7	100	0

- Source Power – 5 Volt Adapter Power
- Test running with maximum Dummy Data transmission and reception