Reduction technique for power supply noise of Analog-Digital Mixed Circuit Boards -Adjustment of Attached Resistor Method-

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Abstract

***Abstract* - In analog-digital mixed circuit boards , noises from the digital side to the analog side through GND power supply layer is one of the problems. As one of the methods to reduce noise, slot type GND power supply layer is used. It is to divide GND power supply layer with slot. However, this method has problems. One of the problems is impedance mismatch on the signal line between the analog and digital. And, another problem is increasing the crosstalk between parallel signal line. Therefore, we adjusted to attaching resistor around the circuit board. This Attached Resistor Method is proposal technique as a method reducing radiation noise from power supply layers. As a result evaluation by the simulation, we were able to make sure the effectiveness in reduction noise.**

Ⅰ. INTRODUCTION

In recent years, the information society makes progress, and the device such as LSI become operating high-speed. Therefore, power supply noise is caused by high-speed switching operation device.[1] In analog-digital mixed circuit boards, one of the problems is switching noise from digital circuit to analog circuit through GND power supply layer (Fig 1). Therefore we adjusted to attaching resistor around the circuit board between power supply layers. It is as a method to reduce switching noise from digital circuit to analog circuit through GND power supply layer. This Attached Resister Method is proposal technique as a method of reduction for radiation noise from power supply layers.

Ⅱ. NOISE DECREASING METHOD

Ⅱ. Ⅰ. SLOT TYPE GND LAYER[2][3]

As one of the methods to reduce noise, slit type GND power supply layer is used (Fig 2). It is to divide GND power supply layer with slit. It is able to reduce noise. However, this method has problems. One of the problems is impedance mismatch on the signal line between analog circuit and digital circuit. And, another problem is increasing the crosstalk noise between parallel signal lines.

Ⅱ. Ⅱ ATTACHED RESISTOR METHOD

Therefore we adjusted to attaching resistor around the circuit board between power supply layers (Fig 3). It is as a method to reduce switching noise from digital circuit to analog circuit through GND power supply layer.[4][5][6][7][8] In order to cut DC power of power supply layer, capacitor is connected with resistor in series. This Attached Resister Method is proposal technique as a method of reduction for radiation noise from power supply layers.

Fig 4 shows two method of attaching resistors to the substrate edge. Composite chip component is inserted to the through-hole around the substrate (Fig4 (a)). Sheet resistors are attached to the substrate edge covering (Fig 4 (b)). Sheet resistors are formed resistive film, like the polyimide film. The attaching

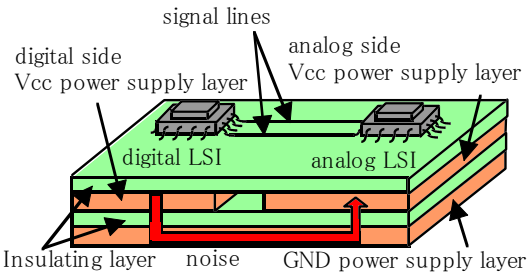


Fig 1. analog-digital mixed circuit board

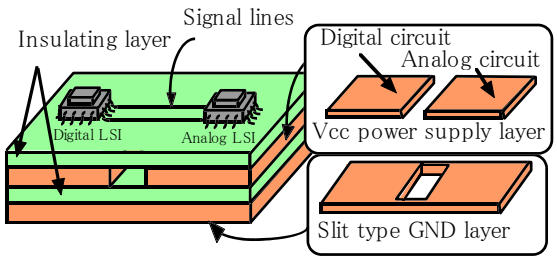


Fig 2. Slot type GND power supply layer

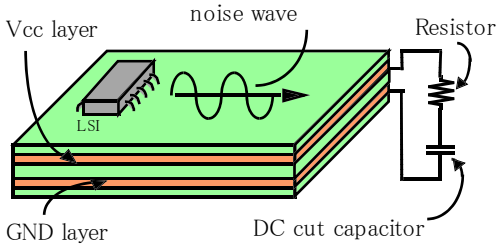
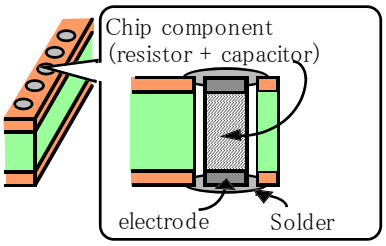
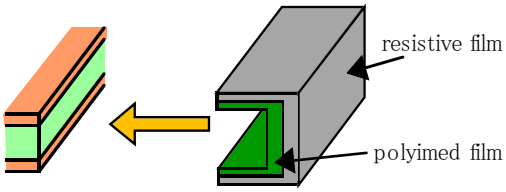


Fig 3. Attached Resistor Method



(b)Chip composite component



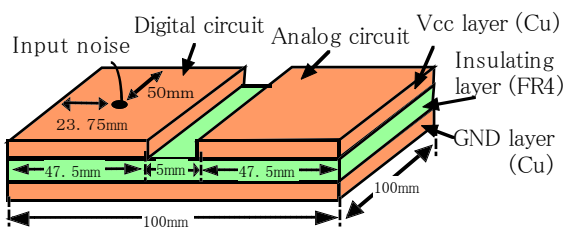
(b) sheet resistor

Fig 4. attached resistor method type

resistance value is set the characteristic impedance of power supply layers.

Ⅲ. ANALYSIS MODEL

Fig 5 shows 3D simulation model. The substrate has Vcc layer, isolation layer, GND layer. The substrate size is 100×100[mm]. The power supply layers thickness is 35[μm], the isolation layer thickness is 1.6[mm], Vcc layer is divided in the center 5[mm] width. Fig 5 shows simulation model structure. In simulation, We input noise to center of digital circuit between power supply layers, and measure potential charge of analog circuit . The input noise signal is 2.36[GHz] . This simulation is FDTD.

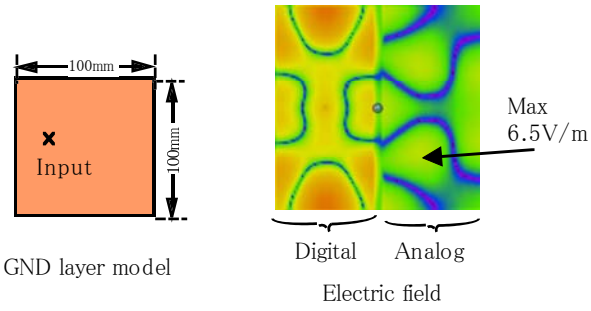


Ⅳ. RESULTS OF SIMULATION

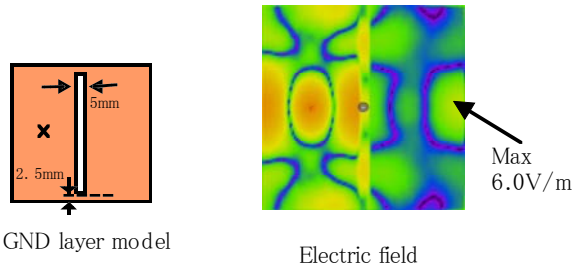
Ⅳ. Ⅰ . THE EFFECT OF DECREASING OF THE ATTACHING RESISTORS

Fig 6 shows the simulation result of (a)using no resistor, (b)using slot type GND layer and (c)attaching resistors to the substrate edge. Resistors value is 53.8[ohm]. The resistors are attached on 2.5[mm] pitch. The slot is 5[mm] width in center.

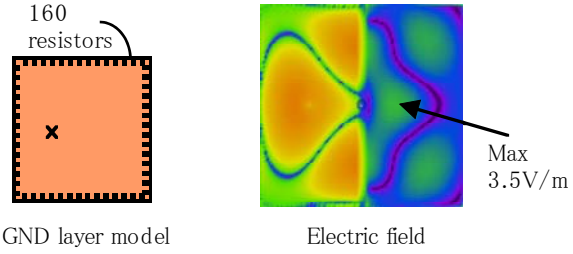
In the result, max noise on substrate without resistor is 6.5[V/m]. Max noise on substrate with slot type GND layer is 6.0[V/m]. Max noise on substrate with resistor is 3.5[V/m]. The smallest noise is substrate attached resistor. It was confirmed that Attached Resistor Method reduces 46.2% noise than no slit type power supply layer.



(a) No Slit type GND power supply layer



(b) Slit type GND power supply layer



(c) No Slit type power supply layer Attached Resistor

Fig 6. Simulation result

IV. II. ATTACHING POSITION

For reducing resistors, we change the position of attaching resistor. Fig 7 shows four attaching positions, (Fig 7(a))digital side edge,(Fig 7(b))around digital side, (Fig 7(c))analog side edge, (Fig 7(d))around analog side.

(Fig 7(a)) shows simulation result of substrate attached resistor on digital side edge. In this case, max noise is 4.8[V/m]. This noise value is smaller than Fig 6(a) no resistor result.

Fig 7(b) shows simulation result of substrate attached resistor around digital side. In this case, max noise is 1.7[V/m]. This noise value is a quarter of no resistor result.

Fig 7(c) shows simulation result of substrate attached resistor on analog side edge. In this case, max noise is 2.7[V/m]. This noise value is smaller than Fig 6(b) slot type GND layer result.

Fig 7(d) shows simulation result of substrate attached resistor around digital side. In this case, max noise is 0.9[V/m]. This noise value is the smallest in every attaching positions.

In resistor position, case of attaching on analog is better for noise reduction than case of attaching on digital. It is because case of attaching on analog doesn't cause noise reflection on analog side edge.

IV. III. ATTACHING RESISTOR PITCH

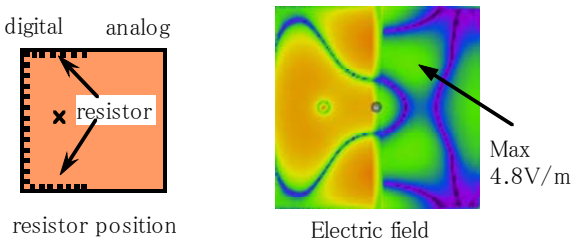
For reducing resistors, we change the pitch of attaching resistor. Simulation attaching position cases are five. They are digital side edge, around digital side, analog side edge, around digital side, devided section, substrate edge. Simulation pitches of resistor are 2.5[mm], 5.0[mm], 10.0[mm], 20[mm], 50[mm].

Fig 8 shows simulation result changing pitch of attaching resistor. All of the position cases, max noise increase when attaching pitch is wide.

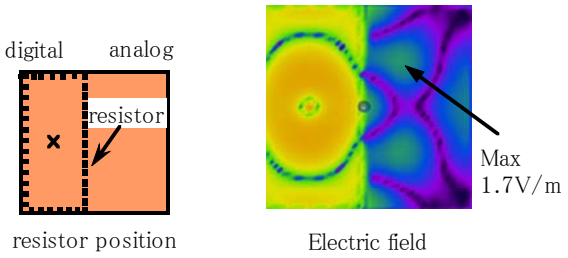
when pitch is 2.5[mm], 5.0[mm], noise of substrate attached digital side edge is the biggest.

when pitch is 2.5[mm], 5.0[mm], noise of substrate attached around analog side is the smallest. when pitch is 50[mm], noise of substrate attached all edge is the smallest.

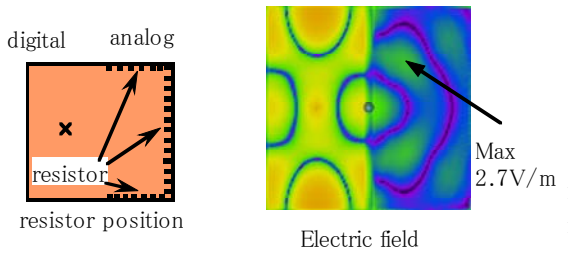
when pitch is over 10[mm], max noise of every attaching position is biger than 5[V/m].



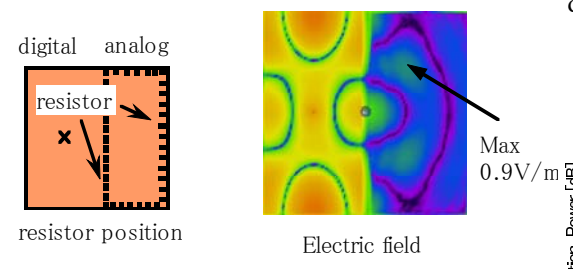
(a) digital side edge



(b) around digital side



(c) analog side edge



(d) around analog side

Fig 7. Simulation result

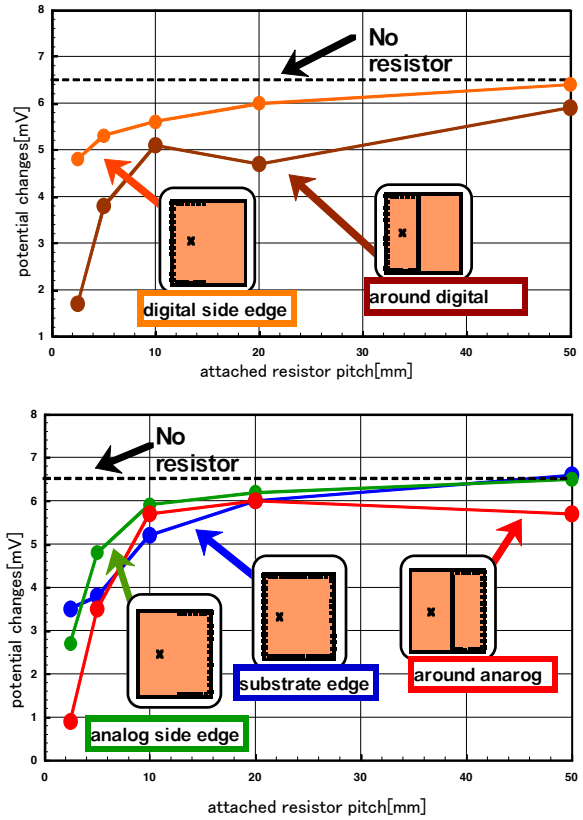


Fig 8. effect of resistor pitch

IV.III. RADIATION NOISE

Fig 6 shows the simulation result of radiation noise from substrate. This shows four attaching positions, no resistor, digital side edge,digital side edge and divided section and substrate edge.

In this figure, attaching resistor position of the smollest radiation noise is digital side edge and divided section.

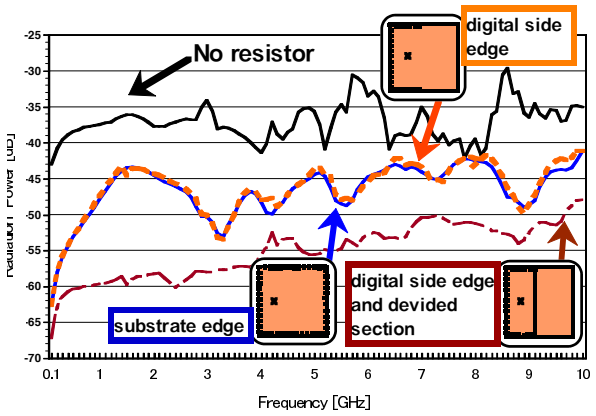


Fig 9. radiation noise

V. CONCLUTION

In this paper, I introduce the effect of.attached resistor method for analog-digital mixed circuit board. It is possible to decrease the noise on substract by attached resistor method. And it is possible to decrease the noise when resistor position and pitch.

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