



EVK 3505 User Guide



EVALUATION KIT COMPONENTS

The evaluation kit is shown in figure 1. Table 1 details the kit components.

The company's products are covered by one or more of the following:
WO2008250262 (A1), US2008303720 (A1),
US2008305750 (A1), WO2008154173 (A1).
Other patents pending.

GENERAL

This document is designed to serve as a user guide for the VJ 3505 evaluation kit. It is recommended that this document be read after the following documents were viewed:

- VJ 3505 datasheet
- VJ 3505 application notes

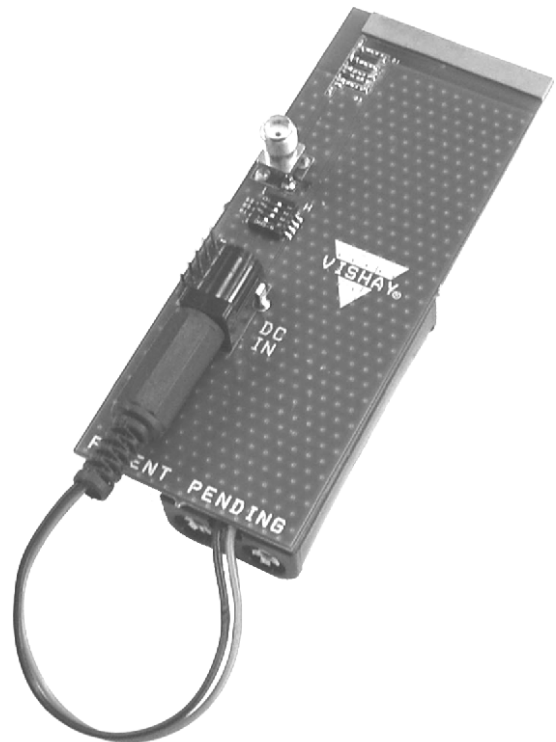


Fig. 1 - Evaluation Kit

TABLE 1 - KIT COMPONENTS	
ITEM	FUNCTIONALITY
Antenna	Ceramic chip antenna. 35 mm by 5 mm by 1.2 mm
SMA connector	Connect a 50 Ω RF cable to this connector, to get signals received on the antenna end
Tuning circuit	A digital tuning circuit used to cover the entire UHF band with 2 control pins
Dip switch array	Used to control the tuning circuit manually. Only pins 2 and 3 (marked D1 and D2) are in use. Pins 1 and 4 are not connected
Digital control pins	Used to control the tuning circuit electrically. Pins D1 and D2 are standard CMOS level digital control pins capable of supplying at least 1 mA
DC connector	Used to feed power to the tuning circuit. This connector is used only in the manual tuning alternative set up

EVK 3505 User Guide

KIT SETUP

There are 2 recommended alternative ways to set up the evaluation kit for testing and use. The difference between these alternatives is in the way the tuning circuit is controlled. Both alternatives are described hereafter.

SET UP ALTERNATIVE 1 - MANUAL CONTROL

In this alternative, the tuning circuit is controlled by the on board mechanical dip switch array. The control line voltage in this setup should be applied to the on board DC connector. A voltage of 2 V to 30 V will ensure good performance. The evaluation kit is supplied with a battery house designed to provide 3 V using two AAA batteries.

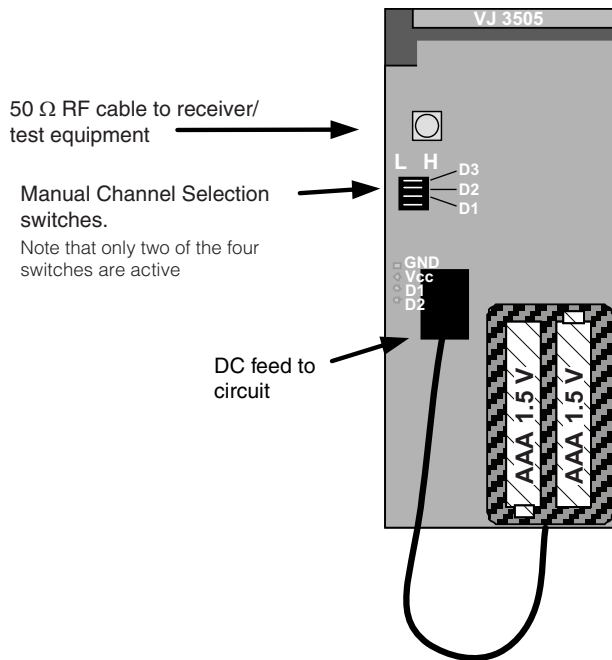


Fig. 2 - Manual Control

SET UP ALTERNATIVE 2 - ELECTRICAL CONTROL

In this alternative, the tuning circuit is controlled by the 5 pin digital connector. In order to function properly in this alternative and avoid short circuit, the following rules need to be followed:

1. Remove the batteries from the battery housing.
2. Leave all dip switches in L position (in this position, the tuning circuit control pins are in High-Z impedance, and can be controlled by the external pins).
3. Connect the GND pin on the EVK to the common ground used by the external digital control circuit.

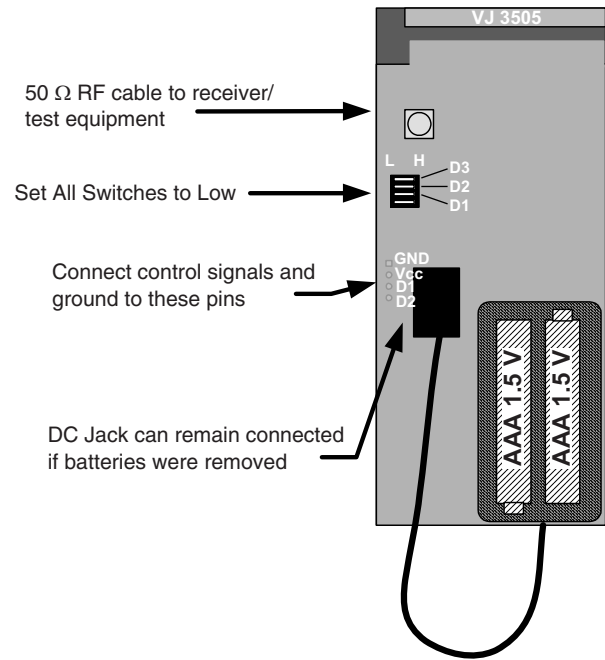


Fig. 3 - Electrical Control

APPLICATION NOTE In set up alternative 1, the tuning circuit is driven and controlled by dip switches D1 and D2. The other two switches in the array are not connected. Maximum current consumed by the tuning circuit is less than 2 mA when operating at 3 V.

A 50 Ω RF cable, connected to the SMA connector, can be used to guide the received signals from the antenna to the desired applicable receiver/test equipment.

Note

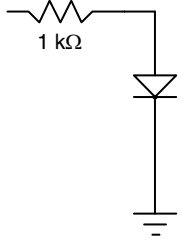
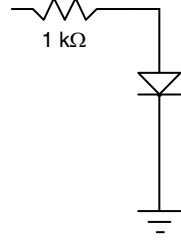
- See table 3 for details regarding channel selection

The 5 pin digital connector is expected to be connected to an external control circuit. The digital control signals D1 and D2 are standard CMOS level signals.

EVK 3505 User Guide

CONTROL SIGNAL INTEGRITY

Table 2 describes the desired control signal properties:

TABLE 2 - SIGNAL INTEGRITY FOR ELECTRICAL CONTROL ALTERNATIVE						
PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	COMMENTS
Logical LOW	V_{il}	- 0.3	0	0.2	V	Equivalent DC Circuit 
Logical HIGH	V_{ih}	2	3	5	V	
Sink current	I_{sink}	0	0.01	0.05	mA	$V_{in} = - 0.3 V$ This is diode reverse leakage current
Source current	I_{source}	4	4.2	5	mA	$V_{in} = 5 V$

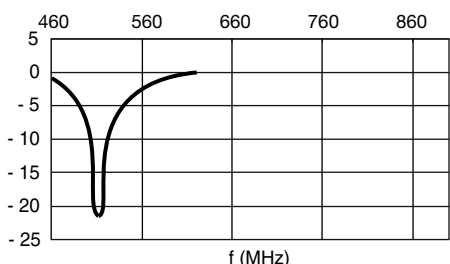
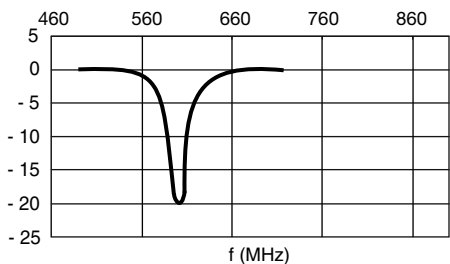
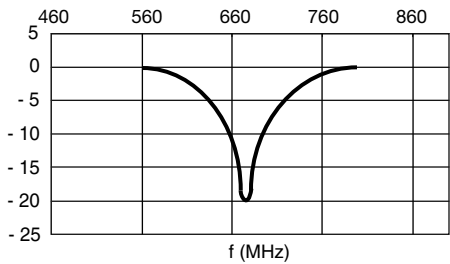
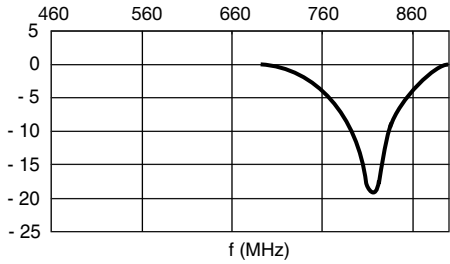
OPERATING THE KIT

To properly operate the kit, the antenna needs to be tuned to the required band. The kit is offering coverage of the entire UHF band, by dividing it into 4 sub-bands. Selecting the correct band is critical for antenna performance.

EVK 3505 User Guide

CHANNEL CHARACTERISTICS

The two digital control lines offer four frequency channels as described in the table 3 below. This table shows the typical peak gain obtained in each of the four channels.

TABLE 3 - TUNING CIRCUIT BANDS				
CHANNEL	D1	D2	BAND (MHz)	S11 (dB)
1	H	L	470 to 540	
2	I	L	540 to 620	
3	H	H	620 to 750	
4	I	h	750 to 860	

Comment: The EVK tuning circuit is optimized to cover the band of 474 MHz to 800 MHz. There is an alternative tuning circuit available, to cover the band of 474 MHz to 860 MHz. For more information see 'VJ 3505 application notes - tuning circuit'.

EVK 3505 User Guide

VJ 3505 EVALUATION KIT ANTENNA PERFORMANCE MEASURED PEAK GAIN AND EFFICIENCY

The Antenna radiation characteristics are influenced by several factors including ground plane dimensions and impedance matching network.

The antenna parameters presented hereafter were measured using to the configuration suggested by the VJ 3505 evaluation board.

Figure 4 shows radiation patterns of the EVK 3505 in various frequencies across the UHF band:

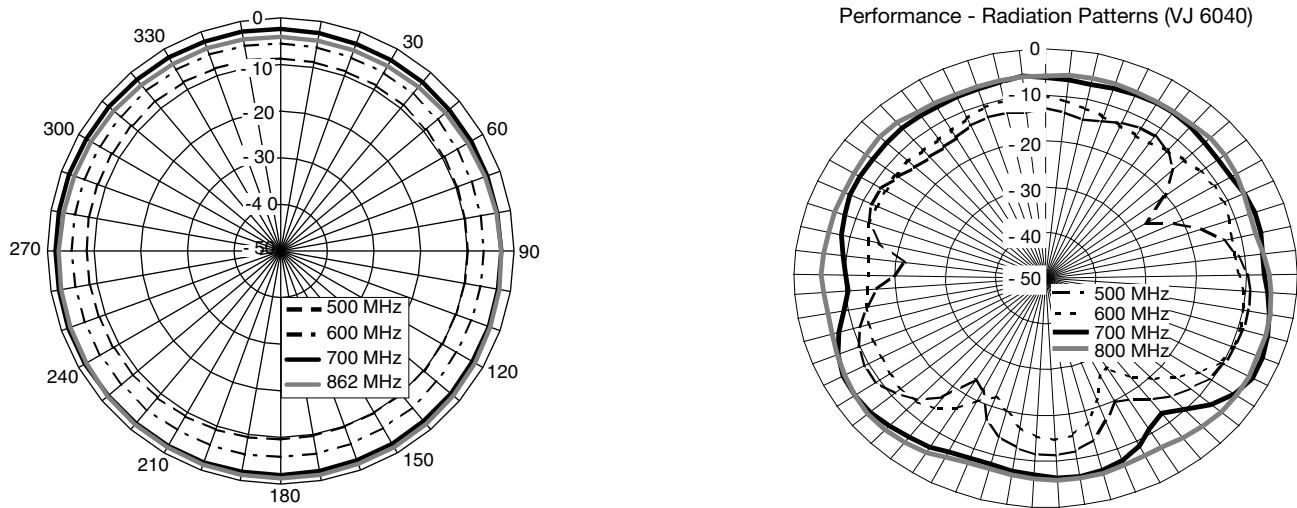


Fig. 4 - Peak Gain vs. Frequency

Applications that do not require full coverage of the UHF band can enjoy additional efficiency by removing the tuning circuit. In this case the antenna can be fixed to any 150 MHz band within the UHF range.

Figure 5 shows simulated peak gain and radiation efficiency of the VJ 3505 antenna over frequency throughout the UHF band, compared with the MBRAI requirements:

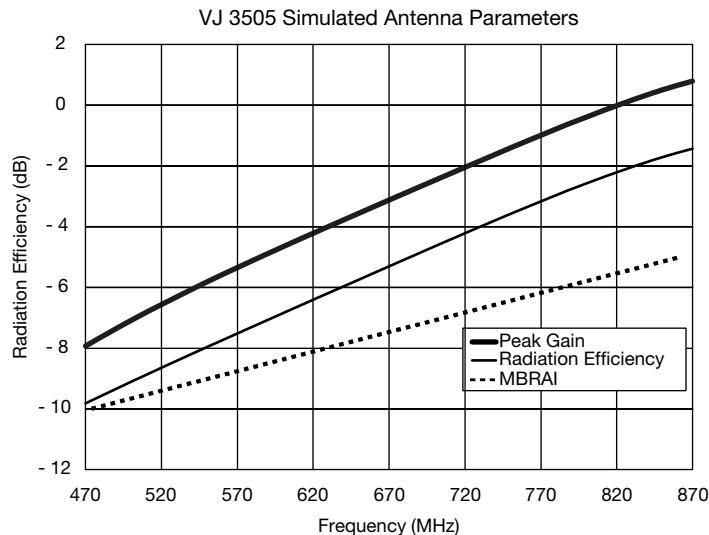


Fig. 5 - Simulated Radiation Efficiency and Peak gain vs. Frequency

EVK 3505 User Guide

SCHEMATIC DRAWING

Figure 6 below shows the schematic drawing of the evaluation kit. See tuning circuit application note for details regarding recommended BOM.

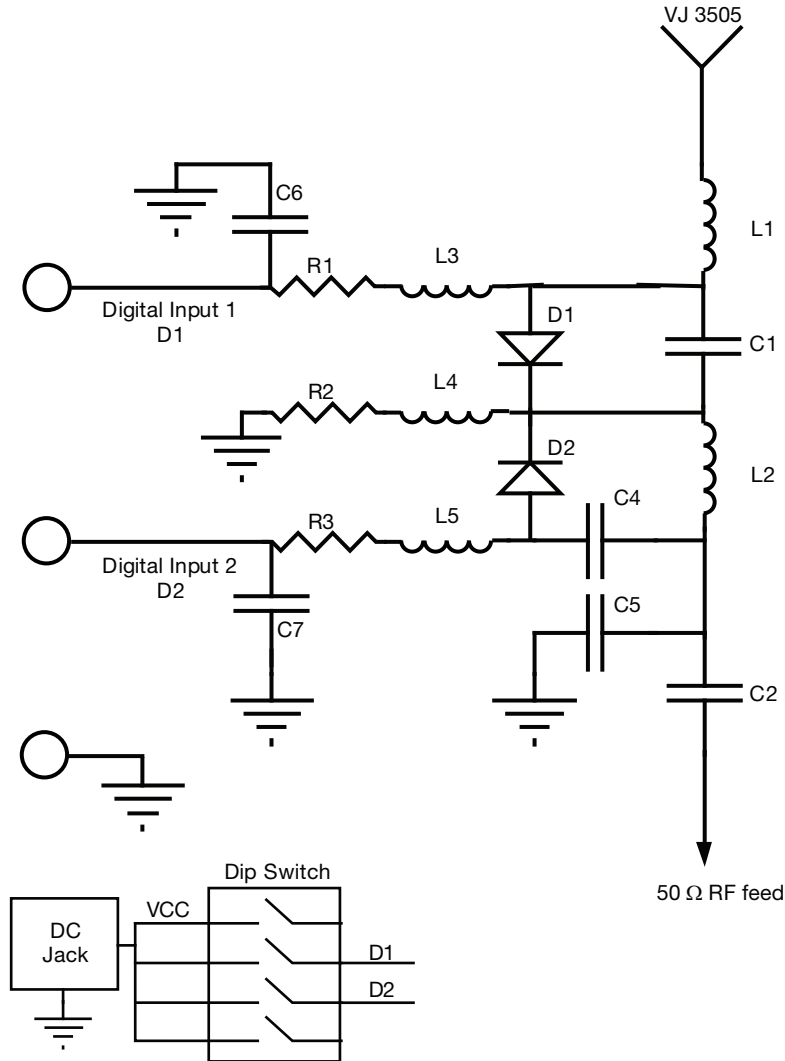


Fig. 6 - EVK 3505 Schematic

TABLE 4 - EVK3505 BOM LIST

VALUE	REFERENCE	QUANTITY PER CIRCUIT	PART NUMBER	MANUFACTURER
Antenna	VJ 3505	1	VJ3505M011SXMSRA0	Vishay
120 nH	I3, I4, I5	3	HK1005R12J-T	Taiyo Yuden
PIN diode	D1, D2	2	BAR63-02V	Infineon
27 nH	L1	1	IMC0402ER27NJ	Vishay
39 nH	L2	1	IMC0402ER39NJ	Vishay
3.3 pF	C1	1	VJ0402A3R3BXACW1BC	Vishay
2.2 pF	C5	1	VJ0402A2R2BXACW1BC	Vishay
220 pF	C2, C4, C6, C7	4	VJ0402A221JXACW1BC	Vishay
1 kΩ	R1, R3	2	CRCW1KJNED	Vishay
0 Ω	R2	1	CRCW0R0Z0ED	Vishay

Features are subject to revisions or changes without notification

APPLICATION NOTE

EVK 3505 User Guide

ELECTRICAL CHARACTERISTICS AND FUNCTIONAL DESCRIPTION

The tuning circuit herein is effectively an inductor, connected in series with a capacitor. The total impedance generated by this circuit can be described in the following equation (excluding the capacitors C2, C3 and C4):

$$Z = Z_{L_1} + Z_{C_1} + Z_{L_2} = j * (\omega L_1 - \frac{1}{\omega C_1} + \omega L_2)$$

$$\omega = 2\pi f$$

By connecting PIN diodes in parallel to C1 and L2, the tuning circuit can electrically short-circuit one of the two reactants or both. Table 2 is detailing all logical states of the tuning circuit, and the electrical effect as presented in the impedance Z. For the sake of small signal analysis, when the PIN diode is in forward conduction mode, it is represented as a 2 Ω resistor.

TABLE 5 - TUNING CIRCUITS' IMPEDANCES				
DIGITAL INPUT 1	DIGITAL INPUT 2	PIN 0	PIN 1	Z (Ω)
0	0	High Z	High Z	$j * (\omega L_1 - \frac{1}{\omega C_1} + \omega L_2)$
0	1	High Z	2 Ω	$j * (\omega L_1 - \frac{1}{\omega C_1}) + 2$
1	0	2 Ω	High Z	$j * (\omega L_1 + \omega L_2) + 2$
1	1	2 Ω	2 Ω	$j * \omega L_1 + 4$

As evident from table 2, each one of the 4 possible logic states represents a different tuning circuit between the antenna and the receiver port.

By applying the values shown in table 1 to L1, C1 and L2 the 4 states cover the entire UHF band.

SELECTING THE RESISTIVE VALUES OF R

R1 resistor is used to DC bias the PIN diodes. Selecting the value for R1 can be derived for the following equation:

$$R = \frac{V_{\text{control}} - V_d}{I_d}$$

When:

R = resistive value (in Ω) for R1

V_{control} = control voltage (in volts) as generated by the controller

V_d = forward voltage (in V) generated on the PIN diode when biased

I_d = forward current (in A) through the PIN diode when biased

Example:

The PIN diode should be forward biased at 0.8 V to allow just over 1 mA to pass through it (see the graphs below). At 1 mA, the diode small signal impedance drops to its required value of 2 Ω.

Let's assume that the digital control line is 1.8 V when high. To allow a current of 1 mA, R1 should be set as follows:

$$R_1 = \frac{1.8 - 0.8}{0.001} = 1 \text{ k}\Omega$$

EVK 3505 User Guide

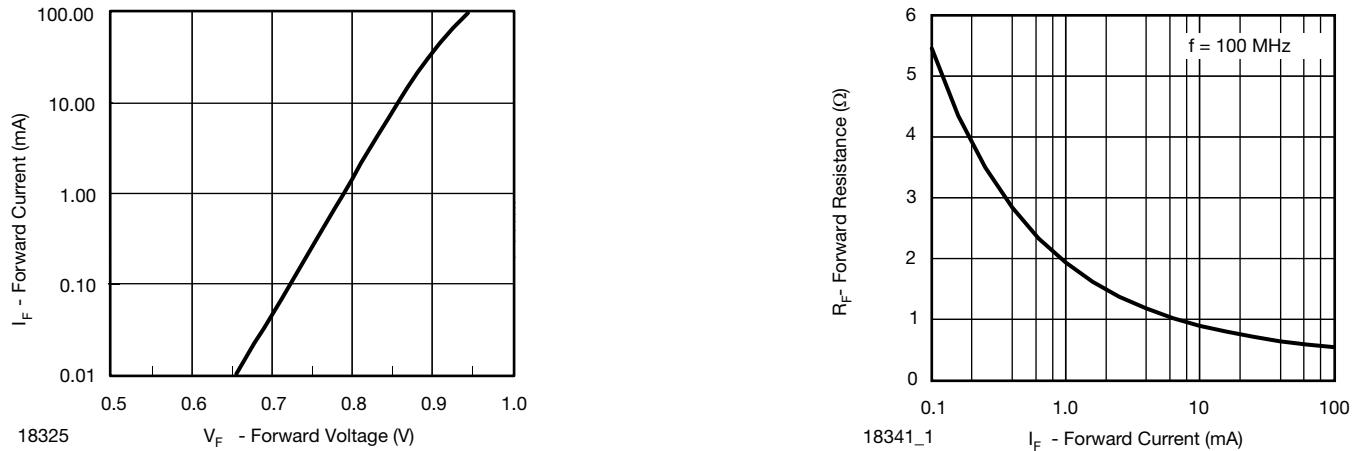


Fig. 7 - PIN Diode Characteristics

GROUND PLANE CONFIGURATION

General

The VJ 3505 antenna is unbalanced, therefore requiring a ground plane for its operation. The ground plane dimensions significantly influence the antenna performance. The rule of thumb in unbalanced antenna ground plane design is that antenna efficiency increases with ground plane size. The evaluation board demonstrates how the antenna complies with the EMBRAI standard when set against a ground plane small enough to fit into most cellular phone designs. Applications that allow larger ground planes can enjoy higher efficiency.

An important consideration in the design of this product into cell phone applications is the coexistence of the cell phone antenna with VJ 3505. The recommended ground plane configuration presented below includes recommendations regarding how to set the cellular antenna relative to the VJ 3505 to minimize losses to both antennas.

VJ 3505 evaluation board demonstrates exceptional antenna performance achieved with a 40 mm by 80 mm ground plane.

APPLICATION NOTE Figure 4 describes a recommended reference ground plane configuration.

The areas marked in green in the close proximity to the antenna should remain empty from large conducting surfaces including ground planes (outer or inner layers), batteries, connectors, buttons, or other large components.

Applications that require additional antennas, such as cell phones, should position the cellular antenna at the top left hand side while maintaining maximum distance from VJ 3505. The presence of an additional antenna might cause loss of efficiency to both antennas.

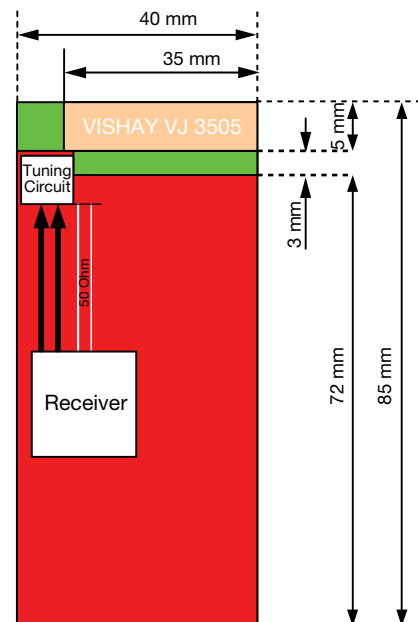


Fig. 8 - Recommended Ground Plane