VISHAY INTERTECHNOLOGY, INC.

INTERACTIVE

data book

CERAMIC CHIP ANTENNAS

VISHAY VITRAMON

VSE-DB0113-1009

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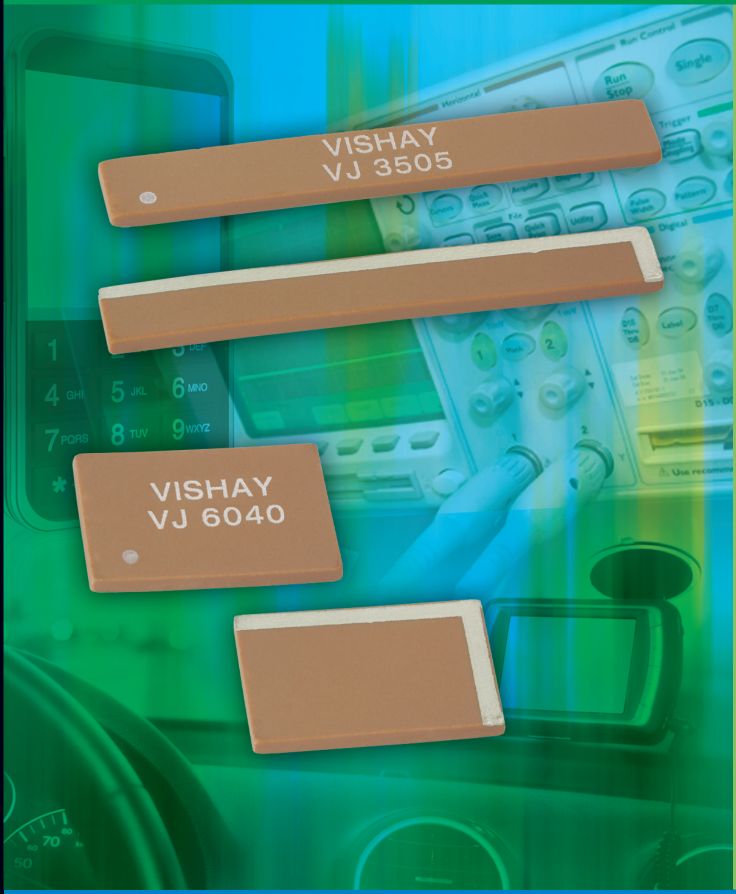

DATA BOOK

CERAMIC CHIP ANTENNAS

VISHAY VITRAMON

www.vishay.com

PRODUCT LISTINGS

SEMICONDUCTORS

RECTIFIERS

- Schottky (single, dual)
- Standard, Fast and Ultra-Fast Recovery (single, dual)
- Bridge
- Superectifier®
- Sinterglass Avalanche Diodes

HIGH-POWER DIODES AND THYRISTORS

- High-Power Fast-Recovery Diodes
- Phase-Control Thyristors
- Fast Thyristors

SMALL-SIGNAL DIODES

- Schottky and Switching (single, dual)
- Tuner/Capacitance (single, dual)
- Bandswitching
- PIN

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- Zener (single, dual)
- TVS (TRANSZORB®, Automotive, ESD, Arrays)

FETs

- Low-Voltage TrenchFET® Power MOSFETs
- High-Voltage TrenchFET® Power MOSFETs
- High-Voltage Planar MOSFETs
- JFETs

OPTOELECTRONICS

- IR Emitters and Detectors, and IR Receiver Modules
- Optocouplers and Solid-State Relays
- Optical Sensors
- LEDs and 7-Segment Displays
- Infrared Data Transceiver Modules
- Custom Products

ICs

- Power ICs
- Analog Switches

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- Power Modules (contain power diodes, thyristors, MOSFETs, IGBTs)

PASSIVE COMPONENTS

RESISTIVE PRODUCTS

- Film Resistors
  - Metal Film Resistors
  - Thin Film Resistors
  - Thick Film Resistors
  - Metal Oxide Film Resistors
  - Carbon Film Resistors
- Wirewound Resistors
- Power Metal Strip® Resistors
- Chip Fuses
- Variable Resistors
  - Cermet Variable Resistors
  - Wirewound Variable Resistors
  - Conductive Plastic Variable Resistors
- Networks/Arrays
- Non-Linear Resistors
  - NTC Thermistors
  - PTC Thermistors
  - Varistors

MAGNETICS

- Inductors
- Transformers

CAPACITORS

- Tantalum Capacitors
  - Molded Chip Tantalum Capacitors
  - Coated Chip Tantalum Capacitors
  - Solid Through-Hole Tantalum Capacitors
  - Wet Tantalum Capacitors
- Ceramic Capacitors
  - Multilayer Chip Capacitors
  - Disc Capacitors
- Film Capacitors
- Power Capacitors
- Heavy-Current Capacitors
- Aluminum Capacitors

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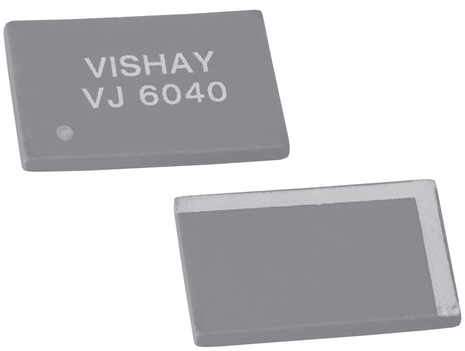
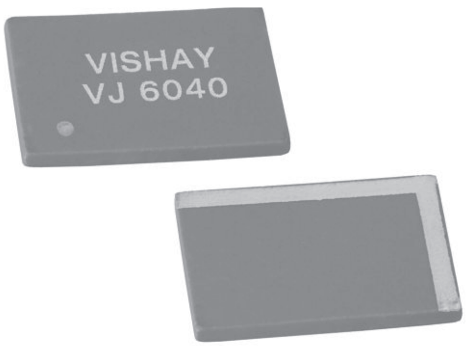
Ceramic Chip Antennas

VJ 6040



Contents

VJ 6040 UHF Chip Antenna for Mobile Devices



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

DESCRIPTION

The VJ 6040 multi-layer ceramic chip antenna is a small form-factor, high-performance, chip-antenna designed for TV reception in mobile devices in the UHF band. It allows mobile TV device manufacturers to design high quality products that do not bear the penalty of a large external antenna. Utilizing Vishay's unique materials and manufacturing technologies, this product complies with the MBRAI standard while maintaining a small outline.
Focusing on consumer applications, the antenna is designed to be assembled onto a PC board in the standard reflow process.

Target customers of the VJ 6040 are mobile phone makers, portable multimedia device makers, notebook OEMs and ODMs, and accessory card OEMs and ODMs.

The VJ 6040 is the first of a family of products developed by Vishay, a world leader in manufacturing of discrete and passive components.

FEATURES

RoHS COMPLIANT

- Small outline (10.5 mm x 15.5 mm x 1.2 mm)
- Omni-directional, linear polarization
- Complies with MBRAI standard
- Complete UHF band coverage (470 MHz to 860 MHz) up to 1.1 GHz
- Requires a tuning circuit and ground plane for optimal performance
- Standard SMT assembly
- 50 Ω unbalanced interface
- Operating temperature range (- 40 °C to + 85 °C)
- Reference design and evaluation boards available upon request
- Compliant to RoHS directive 2002/95/EC

APPLICATIONS

- Mobile UHF TV receivers including DVB-T, DVB-H, ISDB-T, CMMB, ATSC, and MediaFLO devices

ANTENNA PERFORMANCE

Peak gain

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

The antenna parameters presented hereafter were measured according to the configuration suggested by the VJ 6040 evaluation board, utilizing its four channel active digital tuning circuit. The evaluation board ground plane is 40 mm by 80 mm large.

Figure 1 shows peak gain over frequency throughout the UHF band, compared with the MBRAI requirements.

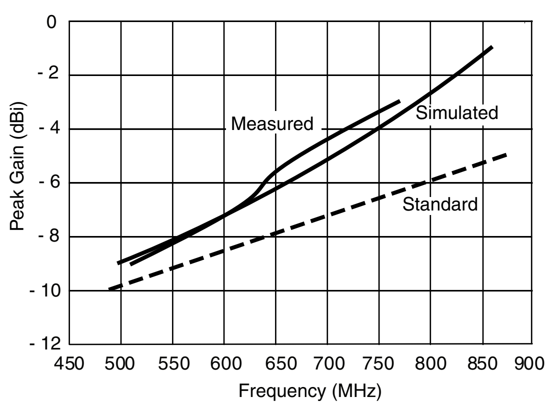


Fig. 1 - Peak Gain vs. Frequency

Figure 2 displays the measured and simulated radiation efficiency of VJ 6040 over frequency.

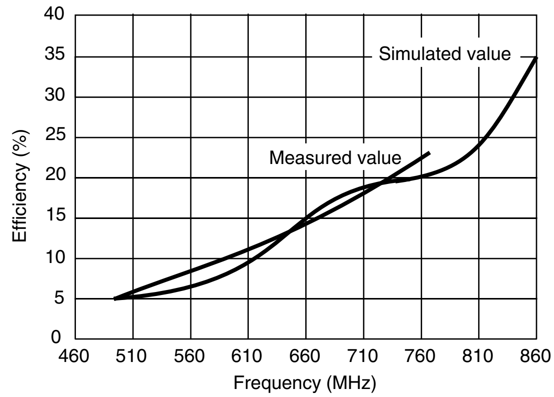


Fig. 2 - Radiation Efficiency vs. Frequency

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

RADIATION PATTERN

The 3D planes of VJ 6040 are defined in figure 3.

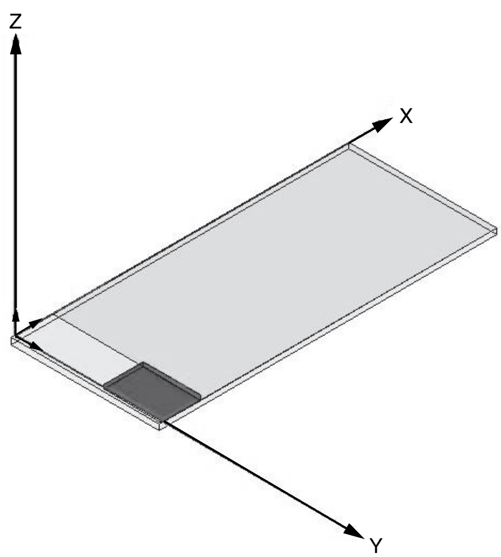


Fig. 3 - VJ 6040 3D Plane Definition

Figure 4. displays the simulated 3D radiation pattern at 650 MHz.

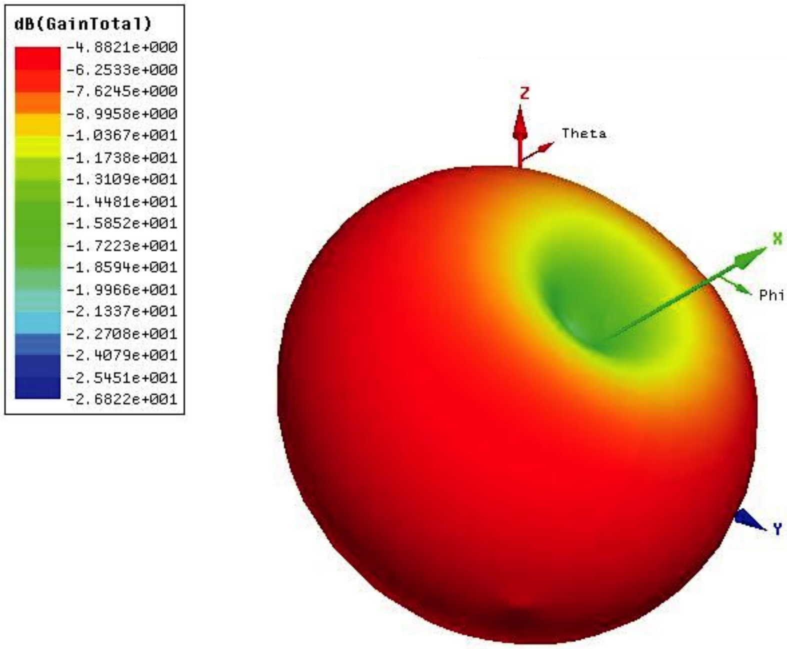


Fig. 4 - Simulated Radiation Pattern

Figure 5. displays the measured radiation patterns of VJ 6040 evaluation board in the YZ plane as defined in figure 3. Zero degrees is defined at the Z axis, stepping counter clockwise.

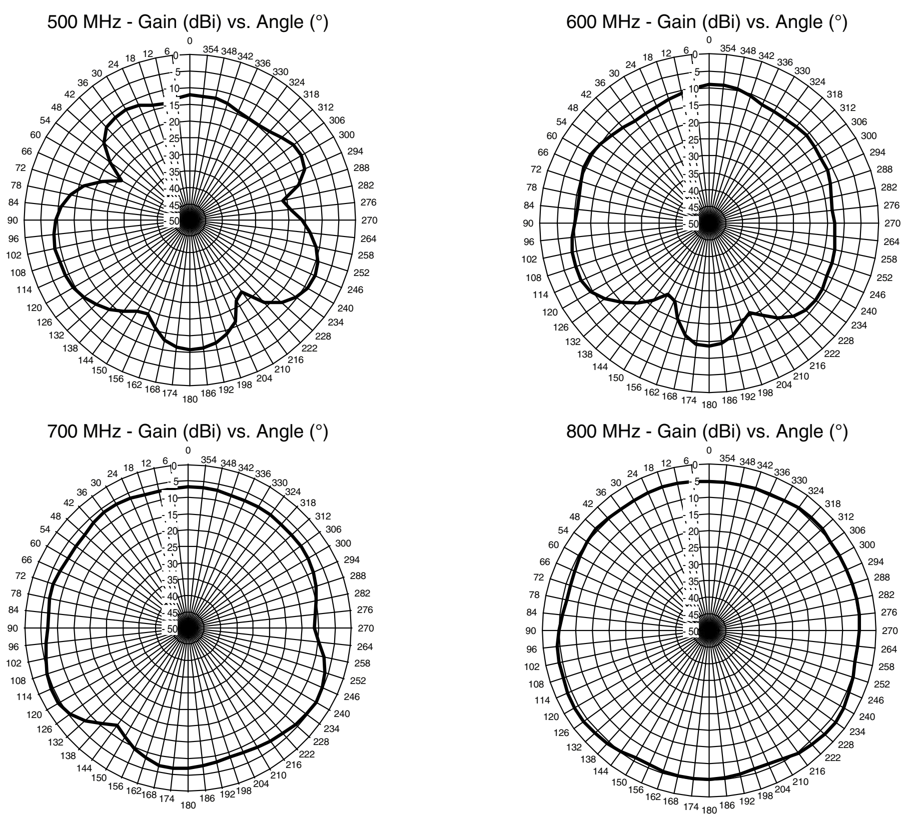


Fig. 5 - Measured Radiation Pattern

FOOTPRINT AND MECHANICAL DIMENSIONS

The antenna footprint and mechanical dimensions are presented in figure 6. For mechanical support, it is recommended to add one or two drops of heat curing epoxy glue. The glue dot should not overlap with any of the soldering pads. It is recommended to apply the glue dot at the center of the antenna, as shown by the diagonal pattern. For more details see "VJ 6040 Assembly Guidelines" section below.

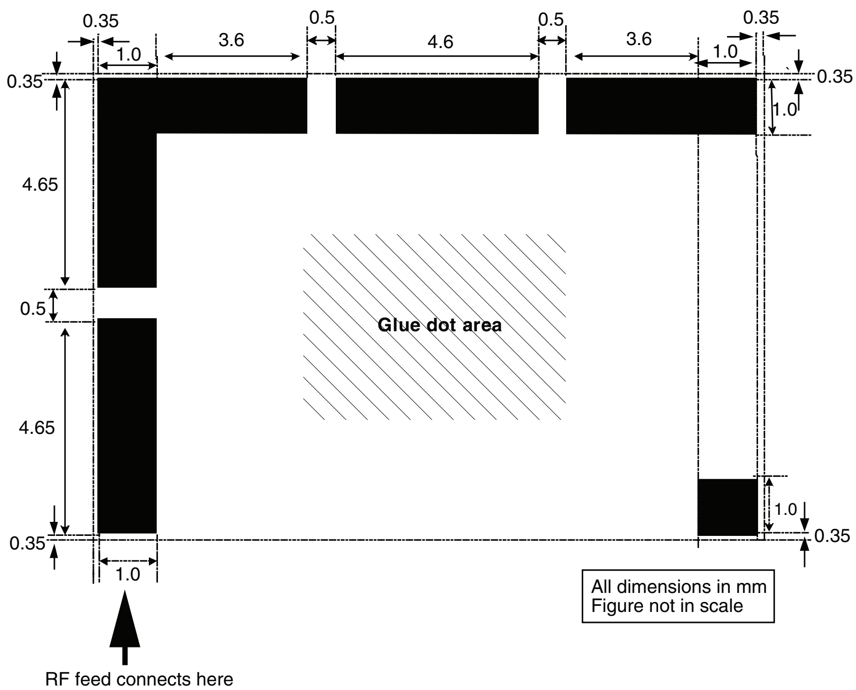


Fig. 6 - VJ 6040 Footprint

VJ 6040 ASSEMBLY GUIDELINES

1. Mounting of antennas on a printed circuit board should be done by reflow soldering. The reflow soldering profiles are shown below.

2. In order to provide the adequate strength between the antenna and the PCB the application of a dot of heat cured epoxy glue in the center of the footprint of the antenna prior to the antenna's soldering to the board should be done. An example for such glue could be Heraeus PD 860002 SA. The weight of the dot should be 5 mg to 10 mg.

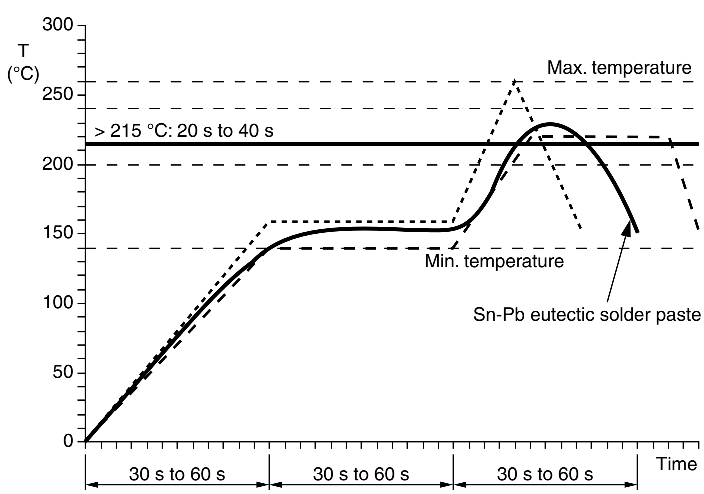


Fig. 7 - Soldering IR Reflow with SnPb Solder

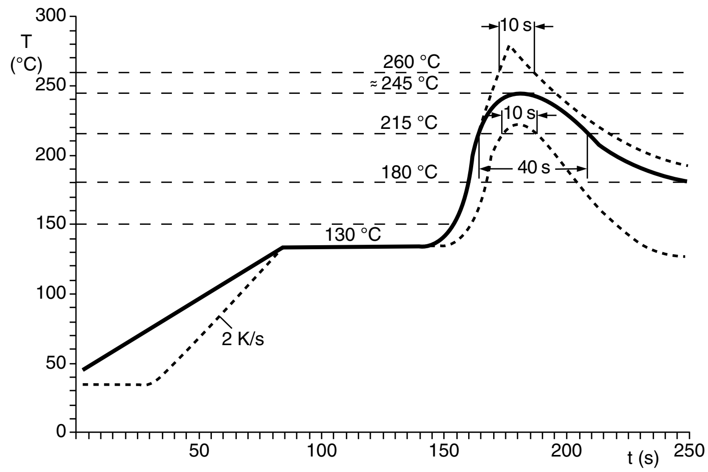


Fig. 8 - Soldering Reflow with Sn Solder

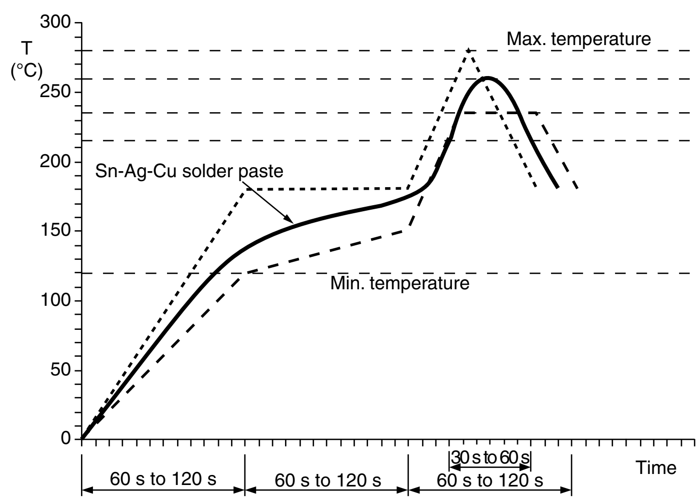


Fig. 9 - Soldering IR Reflow with SnAgCu Solder

ORDERING INFORMATION	VISHAY MATERIAL	PACKAGING QUANTITY
VJ 6040	VJ6040M011SXISRA0	1000 pieces

VJ 6040 Layout Design Principles

LAYOUT DESIGN PRINCIPLES FOR VJ 6040 UHF ANTENNA

VJ 6040 is a multi-layer ceramic chip antenna designed for receiving mobile digital TV transmissions in the UHF band.

The most challenging target application for the VJ 6040 antenna is the cellular phone. For this reason the following document offers design principles that will allow best performance of the VJ 6040 antenna, while maintaining a form factor suitable for most cellular phone designs.

To help in the design-in process, Vishay offers an antenna evaluation kit designed according to the principles described hereafter. The evaluation kit allows designers to test the antenna performance. The evaluation kit measures 40 mm by 90 mm and includes the following:

- VJ 6040 antenna mounted against a 40 mm by 80 mm ground plane
- Active digital tuning circuit controlled by two input lines allowing full coverage of the UHF band 470 to 860 (MHz)
- 50 W SMA termination

Applications that allow larger ground planes can enjoy improved antenna efficiency.

For any technical support please contact: mlcc@vishay.com

ANTENNA ENVIRONMENT

General

VJ 6040, like any other antenna, will be affected by any nearby conducting element.

This effect can be helpful, as in the case of the ground plane. However, it can also be harmful.

When the application is being designed, it is crucial to maximize the benefits offered by correct implementation of the ground plane and minimize the potentially harmful effects of other conduction components.

All cellular applications include at least a single antenna designed for the cellular network itself. Because VJ 6040 is similar to most of these antennas, the same design considerations can be applied to both antennas. For this reason we recommend positioning VJ 6040 close to the cellular antenna. By doing so we can achieve the following goals:

- Both antennas will benefit from the same ground plane
- No additional real estate will be required. Both antennas will use the same ground clearance
- Both antennas will enjoy favorable positioning away from the user’s hand and other potentially harmful elements such as battery, connectors, buttons etc.
- The cellular antenna can be easily customized to perform well in the presence of VJ 6040
- VJ 6040 will not be significantly affected by the presence of the cellular antenna, provided a minimal gap between it and the neighboring antenna will be kept

Ground Plane Configuration

VJ 6040 evaluation kit demonstrates exceptional antenna performance achieved with a 40 mm by 80 mm ground plane. Applications that allow an increase in the overall dimensions of the ground plane will enjoy improved efficiency.

Figure 1 describes two recommended reference ground plane configurations.

VJ 6040 Layout Design Principles

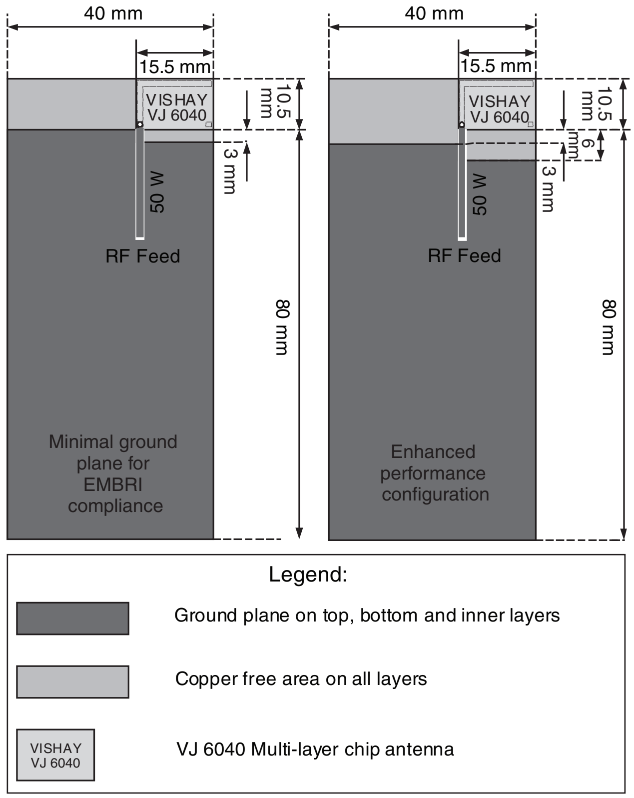


Fig. 1 - Recommended Ground Plane Configurations

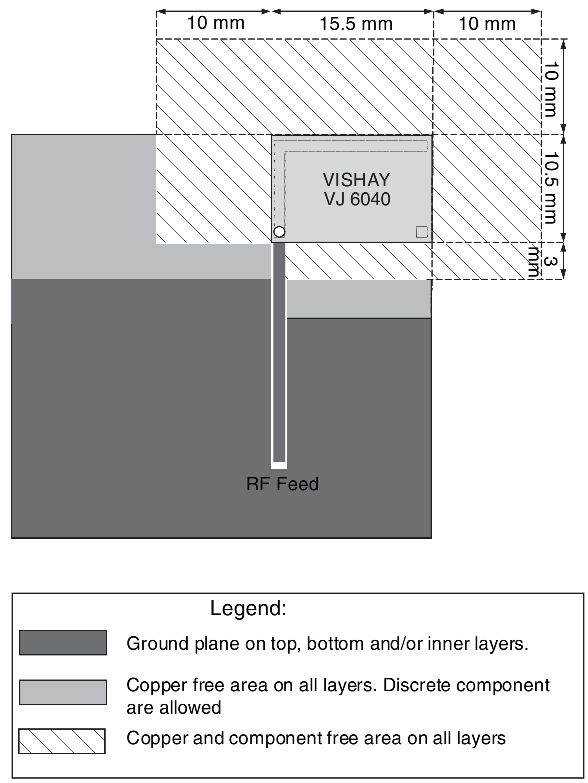


Fig. 2 - Component Free Area Description

The design on the left describes the minimal area required to allow VJ 6040 to comply with the EMBRI standard. This configuration is used by the VJ 6040 evaluation kit. The design on the right describes how to increase the antenna efficiency by approximately 2 dB by enlarging the antenna clearance. Note that antenna tuning will shift up in frequency as antenna clearance increases. This shift should be corrected by modifying the tuning circuit values.

Applications that can support ground planes larger than 80 mm will also benefit from improved antenna parameters. For best antenna performance, it is recommended to keep the copper free area, marked in green, free of any conducting elements such as SMT components, connectors, batteries, wires etc. Applications that cannot comply with this recommendation, due to insufficient space, should follow the guidelines presented in figure 2.

The areas marked in green are less sensitive to the presence of conducting bodies than the areas marked by the diagonal pattern. In cases where the ground clearance must be utilized, it is recommended positioning small discrete components in these areas. The discrete components should be connected using the thinnest wires possible. Large conducting components such as batteries, connectors or buttons should be avoided.

The areas closest to the antenna, marked by the diagonal pattern, are sensitive to the presence of any conducting body. Violating this clearance might result in antenna detuning or loss of radiation efficiency.

In cases where the antenna clearance is shared by both VJ 6040 and an additional antenna, it is recommended to maintain maximum distance between the antennas. Most cellular antennas are mounted on a plastic carrier and are not soldered directly to the main PCB. In these cases, the plastic carrier can be designed to meet the recommended clearance as described above.

Technical support for antenna integration is provided by Vishay Vitramon division.

VJ 6040 Layout Design Principles

Z AXIS DESIGN PRINCIPLES

The following section deals with the recommended clearance required by VJ 6040 in the Z axis. As in the case of the PCB clearance, the area closest to the antenna is sensitive to the presence of any conducting materials. The following figure provides recommendations for the clearance required in elevation:

Plastic housing materials, or any other non-conducting materials, will have negligible effect on the antenna provided that they do not physically touch it. A distance greater than 1 mm should be maintained between the plastic housing and the antenna.

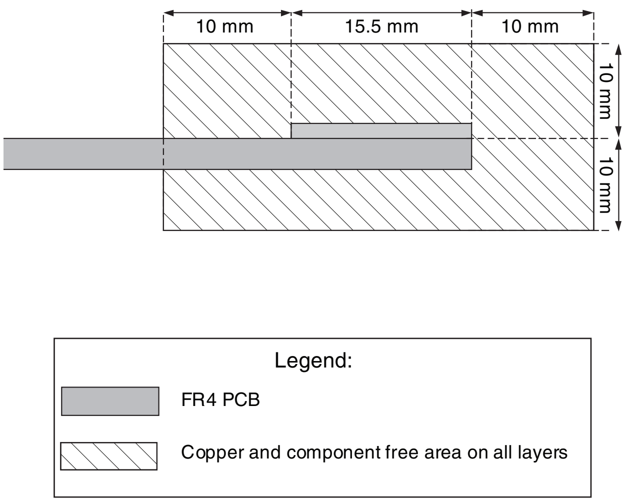


Fig. 3 - Side View of Antenna Assembled on PCB

Features are subject to revisions or changes without notification

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

ORDERING INFORMATION	VISHAY MATERIAL	PACKAGING QUANTITY
VJ 6040	VJ6040M011SXISRA0	1000 pieces

VJ 6040 GSM Interference Immune Tuning Circuit

VJ 6040 GSM INTERFERENCE IMMUNE TUNING CIRCUIT

VJ 6040 is a narrow band antenna that requires an active digital tuning circuit to allow it to cover the UHF band which spans between 470 MHz and 860 MHz. The tuning circuit typology is designed to withstand external interference such as GSM transmission.

Nevertheless, in cases where the GSM transmitter is in close proximity to VJ 6040, the tuning circuit typology should be modified to eliminate the risk of antenna detuning. The following document describes in detail the GSM interference immune tuning circuit.

Vishay offers an evaluation kit fitted with the GSM immune tuning circuit and the VJ 6040 miniature UHF antenna to allow designers to measure the antenna parameters.

For any technical support please contact: mlcc@vishay.com

CHOOSING THE CORRECT TUNING CIRCUIT

Vishay Vitramon division provides two tuning circuit reference designs:

- Standard tuning circuit - described in detail in a separate application note titled “EVK 6040 User Guide”
- GSM immune tuning circuit - described hereafter

The standard typology enables excellent antenna performance while maintaining minimal cost. However, the standard tuning circuit can withstand GSM interference up to 0 dBm, measured at the VJ 6040 antenna feed. The power received by VJ 6040 can be estimated using the test setup described in figure 1.

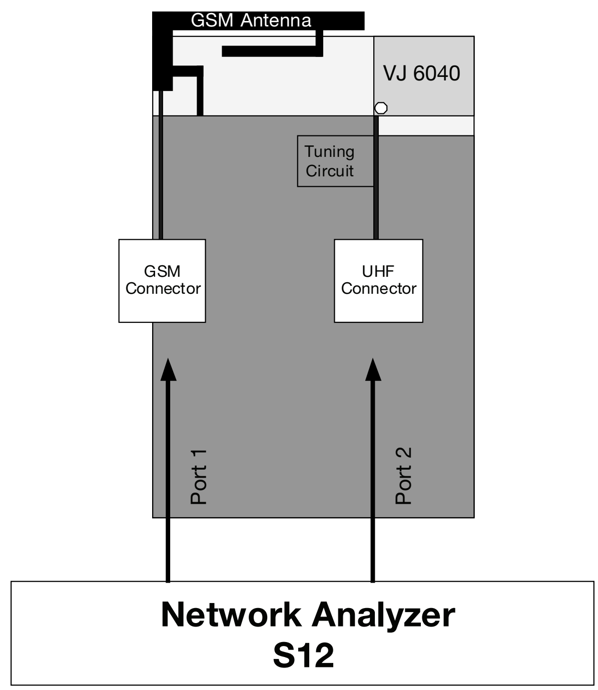


Fig. 1 - Test Setup

A test PCB should be designed to accommodate both VJ 6040 and the GSM antennas. The two antennas should be positioned as far from each other as allowed by the mechanical constraints of the application. Using a network analyzer, the coupling between the antennas can be directly measured for each of the four channels offered by the tuning circuit. The same test setup can later be used to fine tune the tuning element components to negate any detuning caused by the GSM antenna, or other nearby components.

Once the coupling factor is measured, the received power at the VJ 6040 feed can be estimated as follows:

Received Power = Transmitted Power + Coupling Factor

Example:

If the GSM peak power output is + 33 dBm and the coupling factor was found to be - 15 dB then the maximum received power would be + 18 dBm.

The GSM immune tuning circuit should be used in cases where the peak received power is greater than 0 dBm.

VJ 6040 GSM Interference Immune Tuning Circuit

GSM IMMUNE TUNING CIRCUIT TYPOLOGY

Figure 2 presents the schematic drawing of the recommended tuning circuit.

Schematics

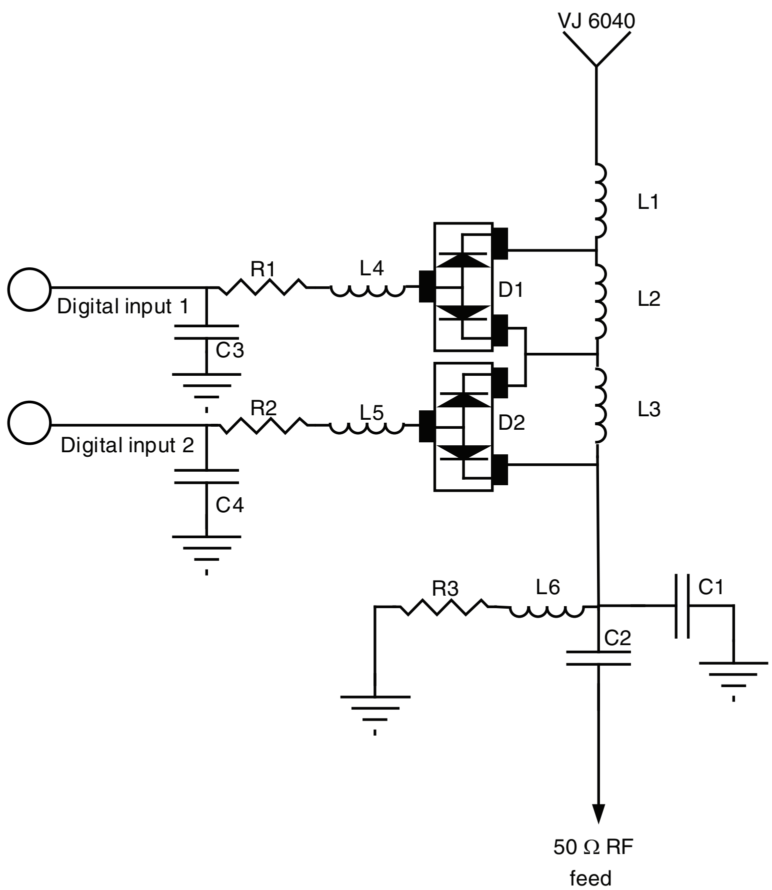


Fig. 2 - Tuning Circuit Schematics

VJ 6040 GSM Interference Immune Tuning Circuit

LAYOUT

Figure 3 shows the recommended layout of the tuning circuit. Layout should be as compact as possible.

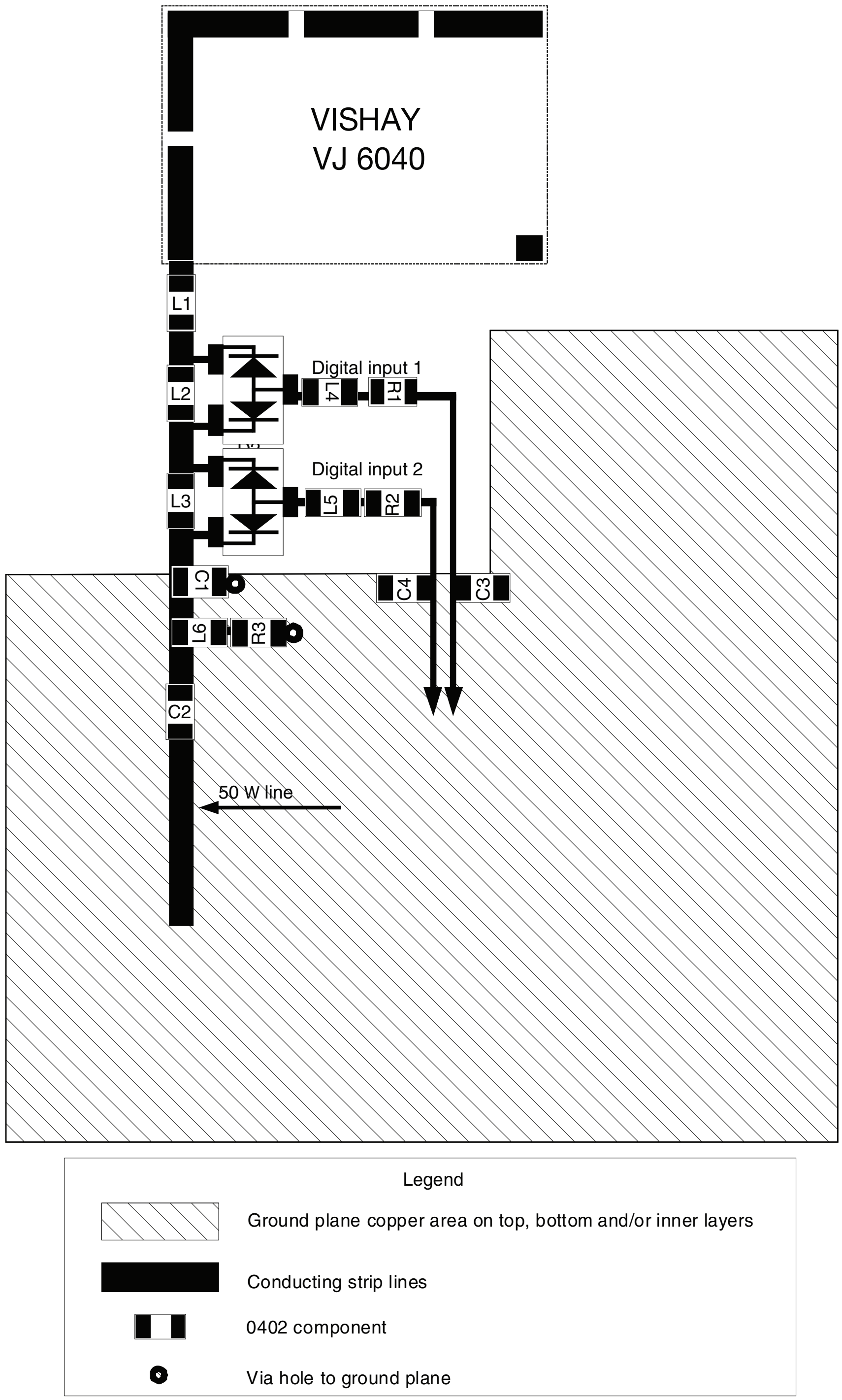


Fig. 3 - Tuning Circuit Layout

VJ 6040 GSM Interference Immune Tuning Circuit

LAYOUT GUIDELINES

1. The distance between the tuning circuit components should be minimized
2. Inductor L1 should be located as close as possible to the antenna
3. Inductors L4 and L5 should be as close as possible to the PIN diodes
4. It is recommended to remove all ground planes from under the tuning circuit. The ground plane should be added to insure a 50 Ω wave guide after capacitor C1

REFERENCE TUNING CIRCUIT BOM

TABLE 1 - TUNING CIRCUIT BILL OF MATERIALS

VALUE	REFERENCE	QUANTITY PER CIRCUIT	PART NUMBER	MANUFACTURER
120 nH	L4, L5, L6	3	HK 1005 R12J-T	Taiyo Yuden
PIN diode	D1, D2	2	BAR63-05W	Infineon
39 nH	L1	1	IMC0402ER39NJ	Vishay
22 nH	L2	1	IMC0402ER22NJ	Vishay
27 nH	L3	1	IMC0402ER27NJ	Vishay
3.9 pF	C1	1	VJ0402A3R9BXACW1BC	Vishay
220 pF	C2, C3, C4	3	VJ0402A221JXACW1BC	Vishay
330 Ω	R1, R2, R3	3	CRCW0402330RFKED	Vishay

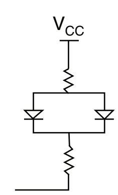
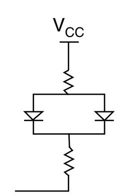
Note

- Any changes made in the reference BOM might result in loss of radiation efficiency.

CONTROL SIGNAL INTEGRITY

The following table describes the desired control signal properties:

TABLE 2 - SIGNAL INTEGRITY FOR ELECTRICAL CONTROL ALTERNATIVE

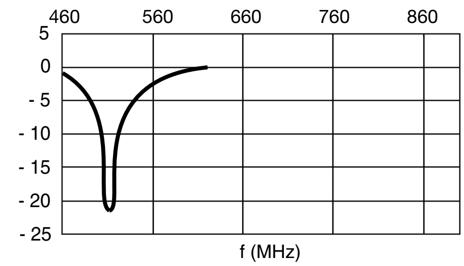
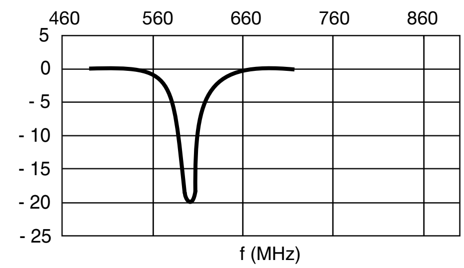
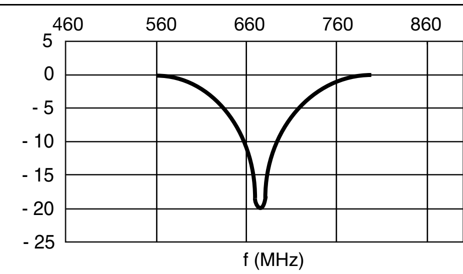
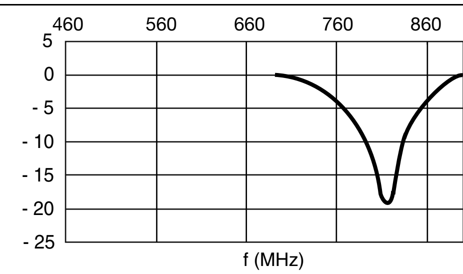
Parameter	SYMBOL	MIN.	TYP.	MAX.	UNITS	COMMENTS
Logical LOW	V_{il}	- 0.3	0	0.2	V	Equivalent DC circuit 
Logical HIGH	V_{ih}	2	3	5	V	Equivalent DC circuit 
Source current	I_{source}	0	0.01	0.05	mA	V_{in} = 5 V Diode reverse leakage current
Sink current	I_{sink}	4	4.2	5	mA	V_{in} = - 0.3 V

VJ 6040 GSM Interference Immune Tuning Circuit

CHANNEL CHARACTERISTICS

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

TABLE 3 - PEAK GAIN OBTAINED IN EACH OF THE FOUR CHANNELS

PARAMETER	D1	D2	BAND (MHz)	S11 (dB)
1	H	H	470 to 540	
2	L	H	540 to 620	
3	H	L	620 to 750	
4	L	L	750 to 860 (1)	

Note

(1) Applications withstanding strong GSM interference will incorporate a band pass filter designed to filter out the interfering signal. Such a filter will add significant attenuation above 750 MHz.

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WO2008250262 (A1), US2008303720 (A1), US2008305750 (A1), WO2008154173 (A1). Other patents pending.

ORDERING INFORMATION	VISHAY MATERIAL	PACKAGING QUANTITY
VJ 6040	VJ6040M011SXISRA0	1000 pieces

VJ 3505

Contents

VJ 3505 UHF Chip Antenna for Mobile Devices

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

DESCRIPTION

The VJ 3505 multi-layer ceramic chip antenna is a small form-factor, high-performance, chip-antenna designed for TV reception in mobile devices in the UHF band. It allows mobile TV device manufacturers to design high quality products that do not bear the penalty of a large external antenna. Utilizing Vishay's unique materials and manufacturing technologies, this product complies with the MBRAI standard while maintaining a small outline.
Focusing on consumer applications, the antenna is designed to be assembled onto a PC board in the standard reflow process.

Target customers of the VJ 3505 are mobile phone makers, portable multimedia device makers, notebook OEMs and ODMs, and accessory card OEMs and ODMs.

FEATURES

RoHS
COMPLIANT

- Small outline (35 mm x 5 mm x 1.2 mm)
- Omni-directional, linear polarization
- Complies with MBRAI standard
- Complete UHF band coverage (470 MHz to 860 MHz) up to 1.1 GHz
- Requires a tuning circuit and ground plane for optimal performance
- Standard SMT assembly
- 50 Ω unbalanced interface
- Operating temperature range (- 40 °C to + 85 °C)
- Reference design and evaluation boards available upon request
- Compliant to RoHS directive 2002/95/EC

APPLICATIONS

- Mobile UHF TV receivers including DVB-T, DVB-H, ISDB-T, CMMB, ATSC, and MediaFLO devices

ANTENNA PERFORMANCE

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 simulated according to the ground plane configuration suggested by the VJ 3505 evaluation board.

Figure 1. shows simulated peak gain and radiation efficiency over frequency throughout the UHF band, compared with the MBRAI requirements.

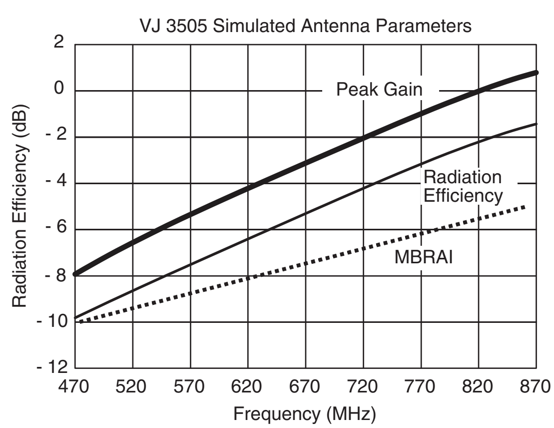


Fig. 1 - Peak Gain and Efficiency vs. Frequency

RADIATION PATTERN

The 3D planes of VJ 3505 are defined in figure 2.

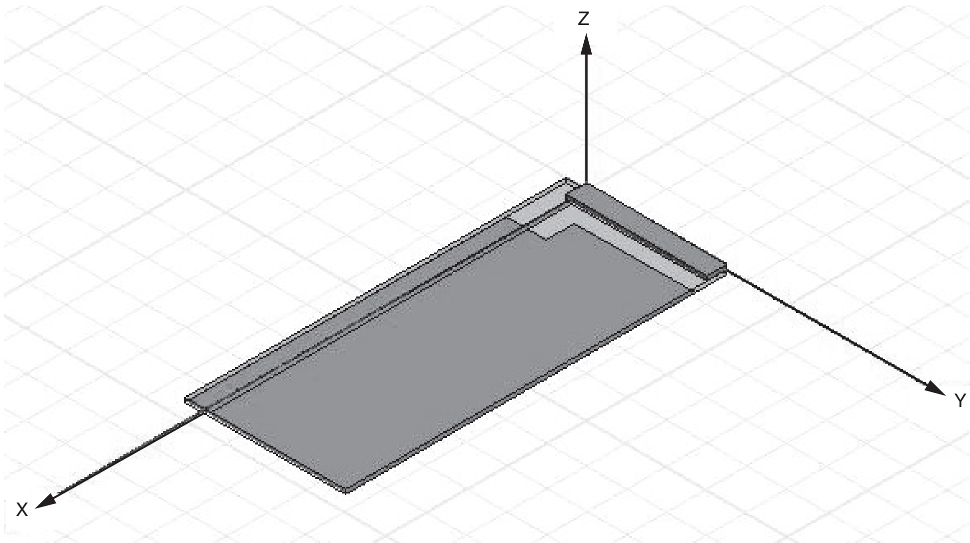


Fig. 2 - VJ 3505 3D Plane Definition

Figure 3. displays the simulated 3D radiation pattern at 550 MHz. The general pattern shape does not change with frequency.

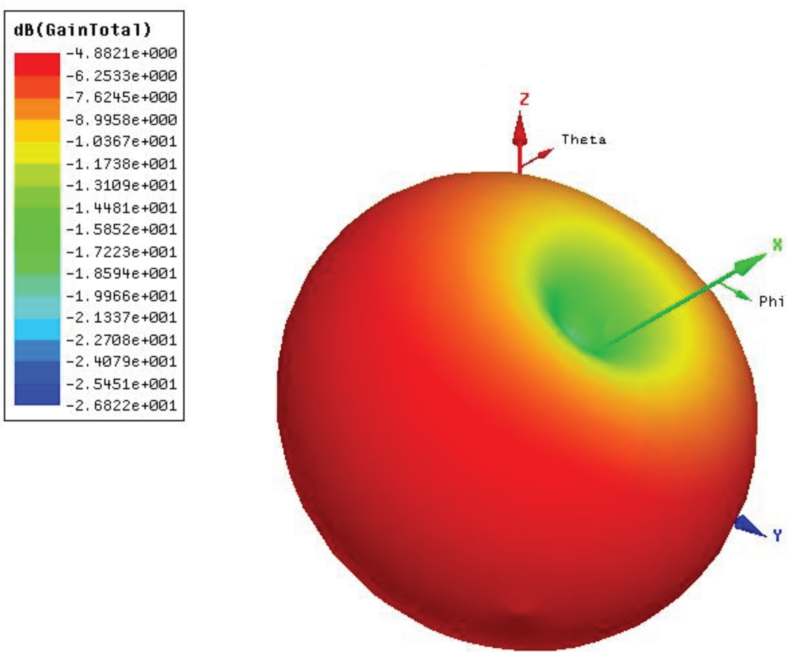


Fig. 3 - Simulated Radiation Pattern at 550 MHz

Fig. 4 displays the measured radiation patterns of VJ 3505 evaluation board in the YZ plane as defined in Fig. 2. Zero degrees is defined at the Z axis, stepping clockwise.

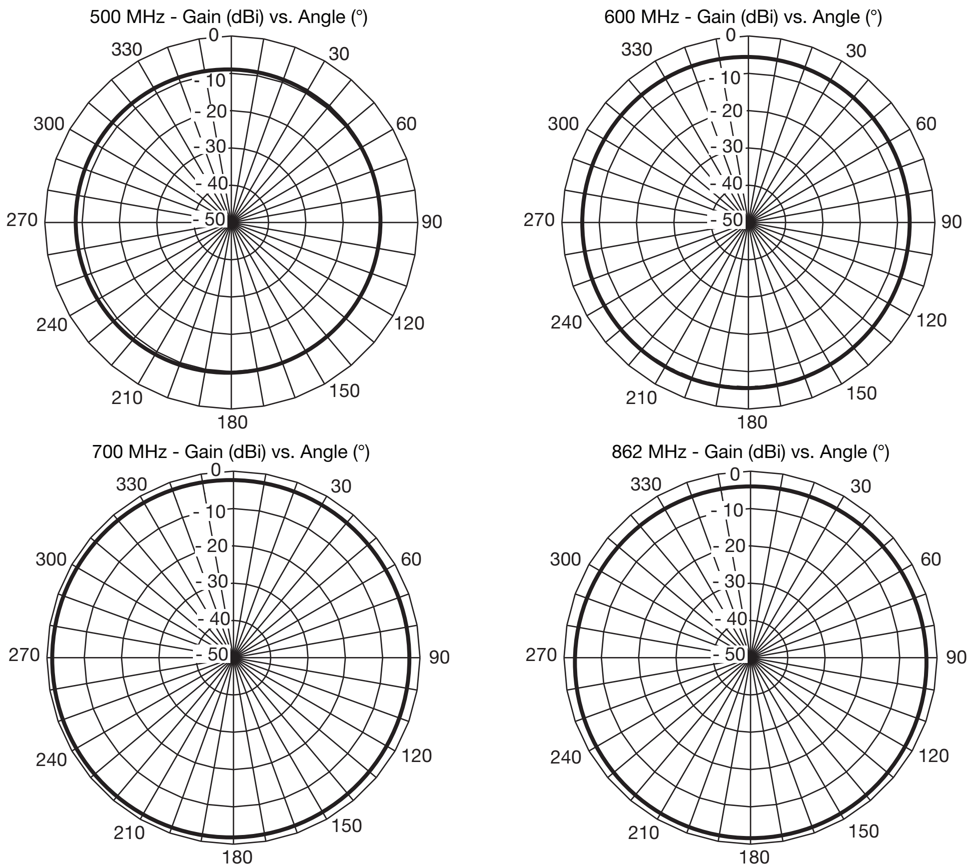


Fig. 4 - Measured Radiation Pattern

FOOTPRINT AND MECHANICAL DIMENSIONS

The antenna footprint and mechanical dimensions are presented in figure 5. For mechanical support, it is recommended to add one or two drops of heat curing epoxy glue. The glue dot should not overlap with any of the soldering pads. It is recommended to apply the glue dot at the center of the antenna, as shown by the diagonal pattern. For more details see "VJ 3505 assembly guidelines" section below.

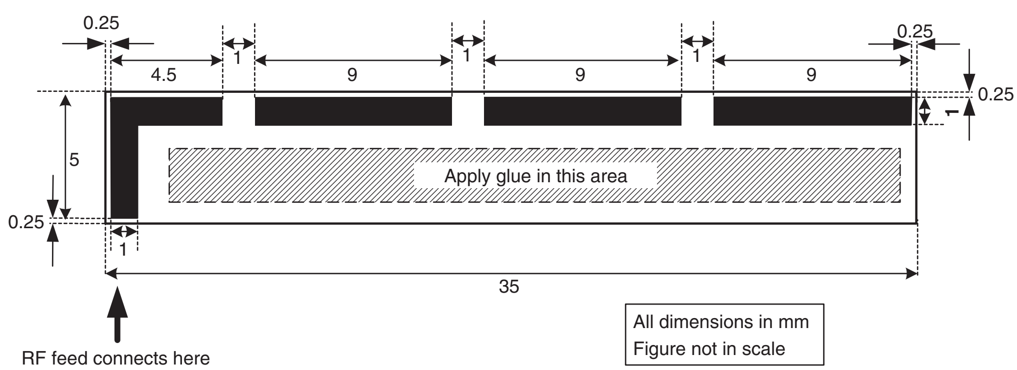


Fig. 5 - VJ 3505 Footprint

DIMENSIONS	(mm)
Length	35 + 0.5/-0
Width	5 + 0.5/-0
Height	1.2 ± 0.1

VJ 3505 ASSEMBLY GUIDELINES

1. Mounting of antennas on a printed circuit board should be done by reflow soldering. The reflow soldering profiles are shown below.

2. In order to provide the adequate strength between the antenna and the PCB the application of a dot of heat cured epoxy glue in the center of the footprint of the antenna prior to the antenna's soldering to the board should be done. An example for such glue could be Heraeus PD 860002 SA. The weight of the dot should be 5 mg to 10 mg.

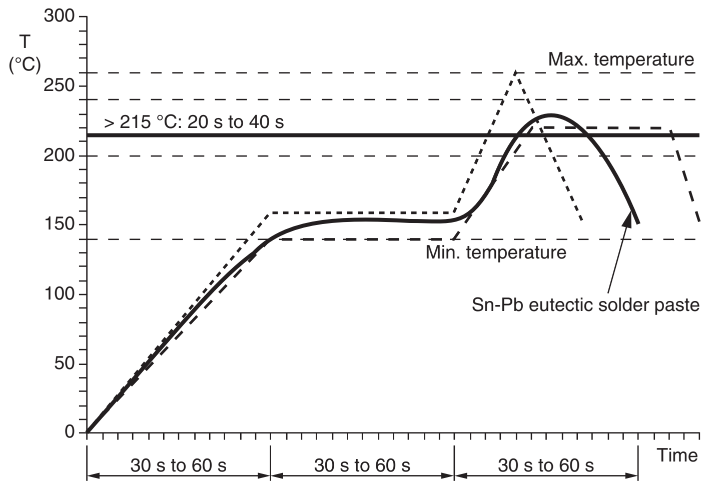


Fig. 6 - Soldering IR Reflow with SnPb Solder

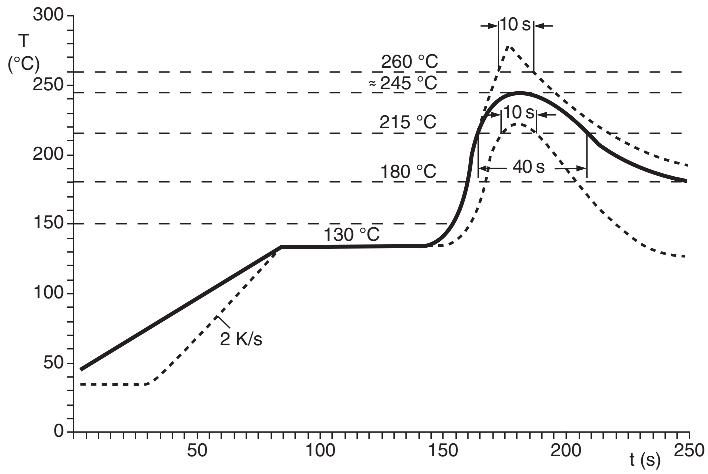


Fig. 7 - Soldering Reflow with Sn Solder

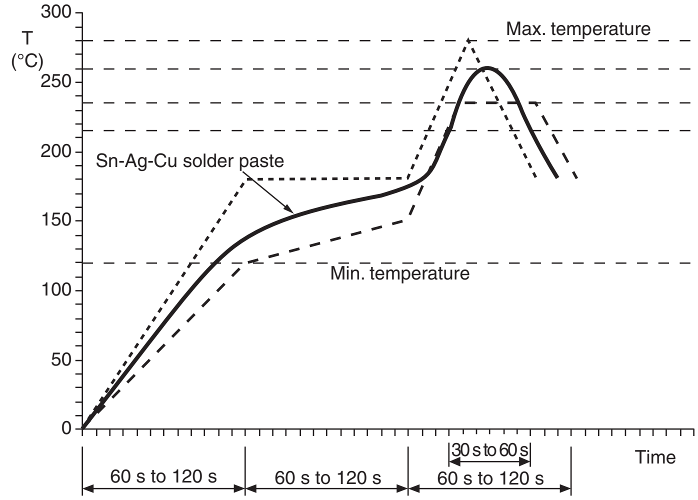


Fig. 8 - Soldering IR Reflow with SnAgCu Solder

ORDERING INFORMATION	VISHAY MATERIAL	PACKAGING QUANTITY
VJ 3505	VJ3505M011SXMSRA0	1000 pieces

VJ 3505 Layout Design Principles

LAYOUT DESIGN PRINCIPLES FOR VJ 3505 UHF ANTENNA

VJ 3505 is a multilayer ceramic chip antenna designed for receiving mobile digital TV transmissions in the UHF band.

The most challenging target application for the VJ 3505 antenna is the cellular phone. For this reason the following document offers design principles that will allow best performance of the VJ 3505 antenna, while maintaining a form factor suitable for most cellular phone designs.

To help in the design-in process, Vishay offers an antenna evaluation kit designed according to the principles described hereafter. The evaluation kit allows designers to test the antenna performance. The evaluation kit measures 40 mm by 100 mm and includes the following:

- VJ 3505 antenna mounted against a 40 mm by 85 mm ground plane
- Active digital tuning circuit controlled by two input lines allowing full coverage of the UHF band 470 MHz to 860 MHz
- 50 W SMA termination

Applications that allow larger ground planes can enjoy improved antenna efficiency.

We encourage our consumers to take advantage of the technical support offered by Vishay Vitramon division.
For any technical support please contact: mlcc@vishay.com

ANTENNA ENVIRONMENT

General

VJ 3505, like any other antenna, will be affected by any nearby conducting element.

This effect can be helpful, as in the case of the ground plane. However, it can also be harmful.

When the application is being designed, it is crucial to maximize the benefits offered by correct implementation of the ground plane and minimize the potentially harmful effects of other conduction components.

All cellular applications include at least a single antenna designed for the cellular network itself. Because VJ 3505 is similar to most of these antennas, the same design considerations can be applied to both antennas. For this reason we recommend positioning VJ 3505 close to the cellular antenna. By doing so we can achieve the following goals:

- Both antennas will benefit from the same ground plane
- No additional real estate will be required. Both antennas will use the same ground clearance
- Both antennas will enjoy favorable positioning away from the user's hand and other potentially harmful elements such as battery, connectors, buttons etc.
- The cellular antenna can be easily customized to perform well in the presence of VJ 3505
- VJ 3505 will not be significantly affected by the presence of the cellular antenna, provided a minimal gap between it and the neighboring antenna will be kept

VJ 3505 Layout Design Principles

GROUND PLANE CONFIGURATION

VJ 3505 evaluation kit demonstrates exceptional antenna performance achieved with a 40 mm by 80 mm ground plane. Applications that allow an increase in the overall dimensions of the ground plane will enjoy improved efficiency.

Figure 1 describes two recommended reference ground plane configurations.

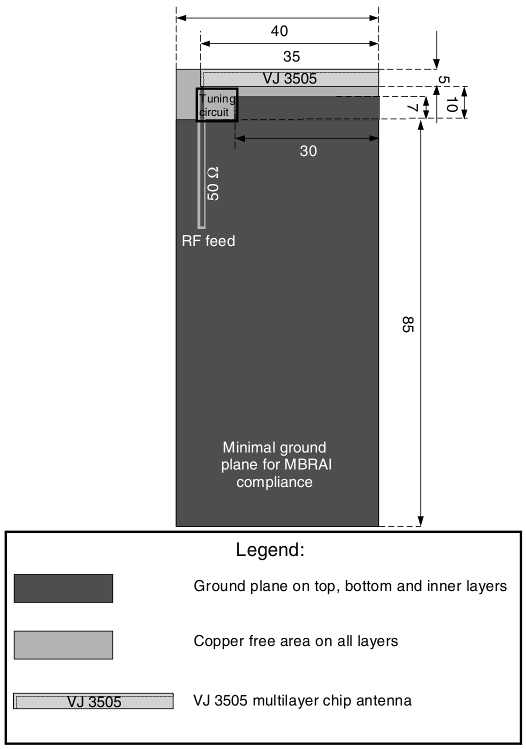


Fig. 1 - Recommended Ground Plane Configurations all Dimensions in mm

The recommended design describes the minimal area required to allow VJ 3505 to comply with the MBRAI standard. This configuration is used by the VJ 3505 evaluation kit.

Applications that can support ground planes larger than 80 mm will also benefit from improved antenna parameters.

Improved antenna performance can be obtained by increasing the ground clearance. A clearance of 10 mm from the antenna will result in optimal performance.

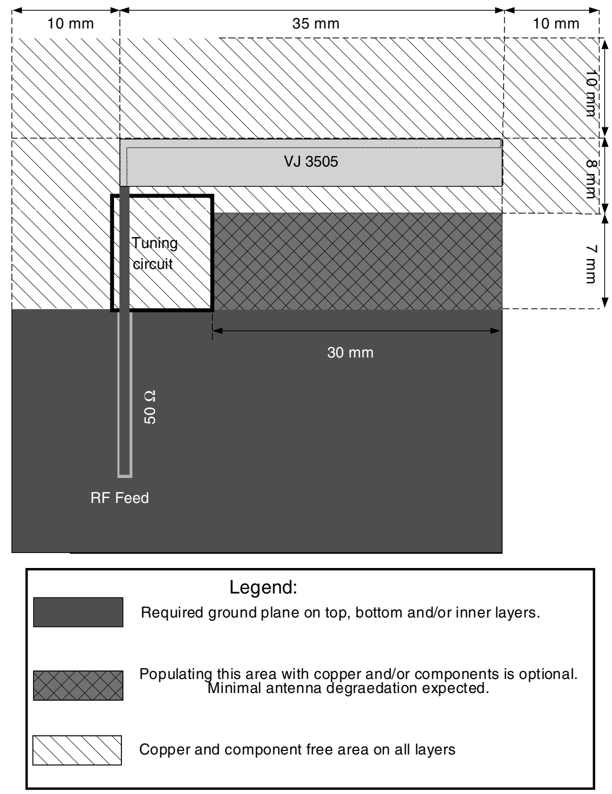


Fig. 2 - Component Free Area Description

The area marked by the crisscross pattern is less sensitive to the presence of conducting bodies than the areas marked by the diagonal pattern. In cases where the ground clearance must be utilized, it is recommended to populate this area with small discrete components. The discrete components should be connected using the thinnest wires possible. Large conducting components such as batteries, connectors or buttons should be avoided.

The areas closest to the antenna, marked by the diagonal pattern, are sensitive to the presence of any conducting body. Violating this clearance might result in antenna detuning or loss of radiation efficiency.

In cases where the antenna clearance is shared by both VJ 3505 and an additional antenna, it is recommended to maintain maximum distance between the antennas. Most cellular antennas are mounted on a plastic carrier and are not soldered directly to the main PCB. In these cases, the plastic carrier can be designed to meet the recommended clearance as described above.

Technical support for antenna integration is provided by Vishay Vitramon division.

VJ 3505 Layout Design Principles

Z AXIS DESIGN PRINCIPLES

The following section deals with the recommended clearance required by VJ 3505 in the Z axis. As in the case of the PCB clearance, the area closest to the antenna is sensitive to the presence of any conducting materials. The following figure provides recommendations for the clearance required in elevation:

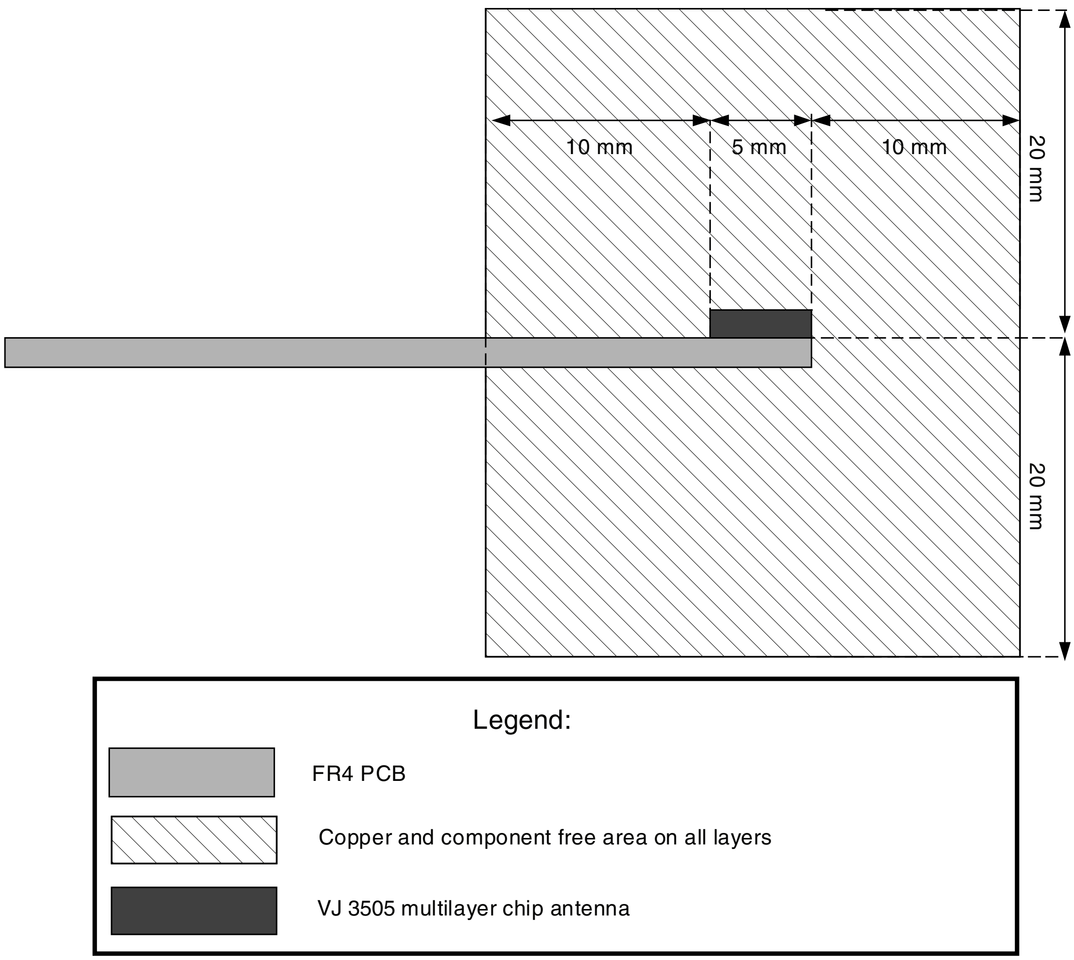


Fig. 3 - Side View of Antenna Assembled on PCB

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

ORDERING INFORMATION	VISHAY MATERIAL	PACKAGING QUANTITY
VJ 3505	VJ3505M011SXMSRA0	1000 pieces

VJ 3505 GSM Interference Immune Tuning Circuit

VJ 3505 GSM INTERFERENCE IMMUNE TUNING CIRCUIT

VJ 3505 is a narrow band antenna that requires an active digital tuning circuit to allow it to cover the UHF band which spans between 470 MHz and 860 MHz. The tuning circuit typology is designed to withstand external interference such as GSM transmission. Nevertheless, in cases where the GSM transmitter is in close proximity to VJ 3505, the tuning circuit typology should be modified to eliminate the risk of antenna detuning. The following document describes in detail the GSM interference immune tuning circuit.

Vishay offers an evaluation kit fitted with the GSM immune tuning circuit and the VJ 3505 miniature UHF antenna to allow designers to measure the antenna parameters.
For any technical support please contact: mlcc@vishay.com

CHOOSING THE CORRECT TUNING CIRCUIT

Vishay Vitramon division provides two tuning circuit reference designs:

- Standard tuning circuit - described in detail in a separate application note titled "EVK 3505 User Guide"
- Active digital tuning circuit controlled by two input lines allowing full coverage of the UHF band 470 to 860 (MHz)
- GSM immune tuning circuit - described hereafter

The standard typology enables excellent antenna performance while maintaining minimal cost. However, the standard tuning circuit can withstand GSM interference up to 0 dBm, measured at the VJ 3505 antenna feed. The power received by VJ 3505 can be measured using the test setup described in figure 1.

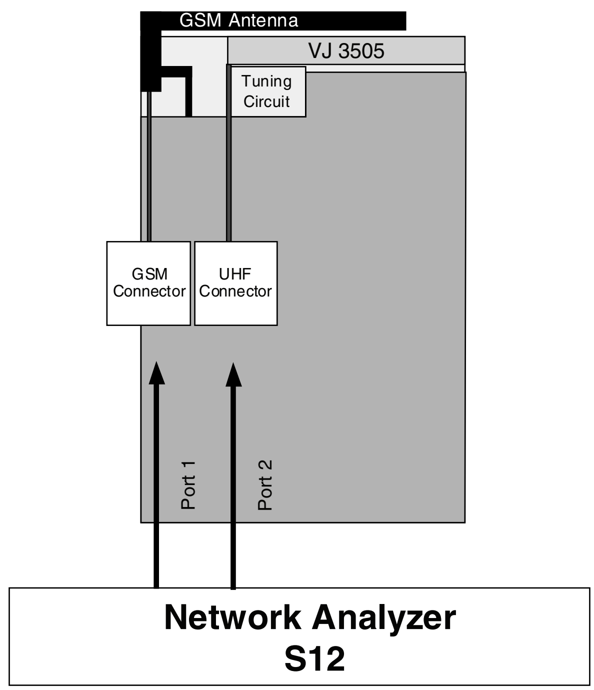


Fig. 1 - Test Setup

A test PCB should be designed to accommodate both VJ 3505 and the GSM antennas. The two antennas should be positioned as far from each other as allowed by the mechanical constraints of the application. Using a network analyzer, the coupling between the antennas can be directly measured for each of the four channels offered by the tuning circuit. The same test setup can later be used to fine tune the tuning element components to negate any detuning caused by the GSM antenna, or other nearby components.

Once the coupling factor is measured, the received power at the VJ 3505 feed can be estimated as follows:

Received Power = Transmitted Power + Coupling Factor

Example:
If the GSM peak power output is + 33 dBm and the coupling factor was found to be - 15 dB then the maximum received power would be + 18 dBm.

The GSM immune tuning circuit should be used in cases where the peak received power is greater than 0 dBm.

VJ 3505 GSM Interference Immune Tuning Circuit

GSM IMMUNE TUNING CIRCUIT TOPOLOGY

SCHEMATICS

Figure 2 presents the schematic drawing of the recommended tuning circuit.

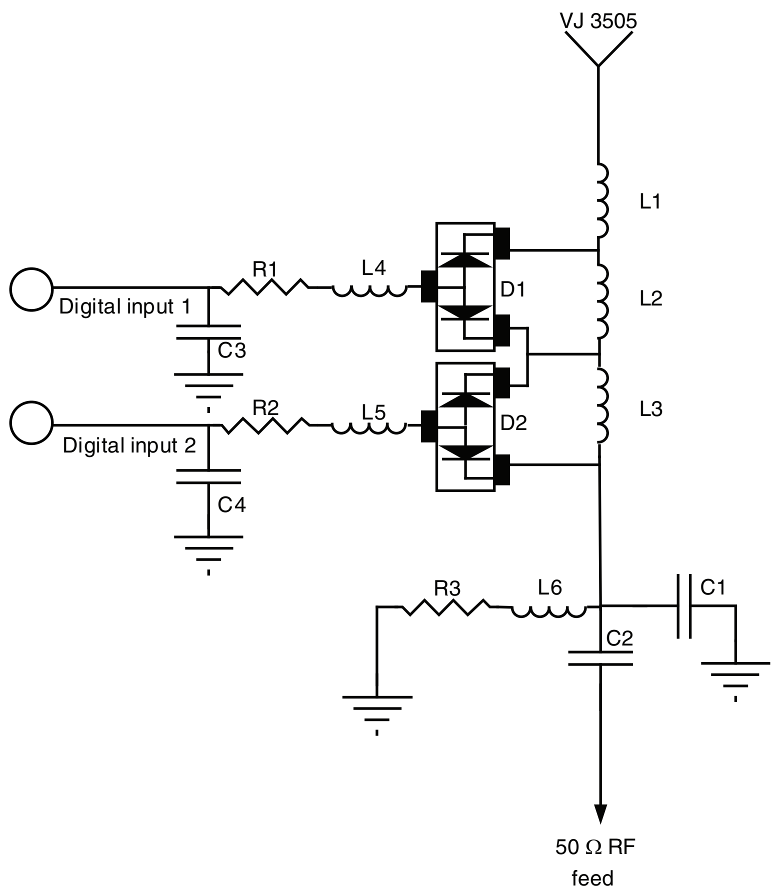


Fig. 2 - Tuning Circuit Schematics

VJ 3505 GSM Interference Immune Tuning Circuit

LAYOUT

Figure 3 shows the recommended layout of the tuning circuit. Layout should be as compact as possible.

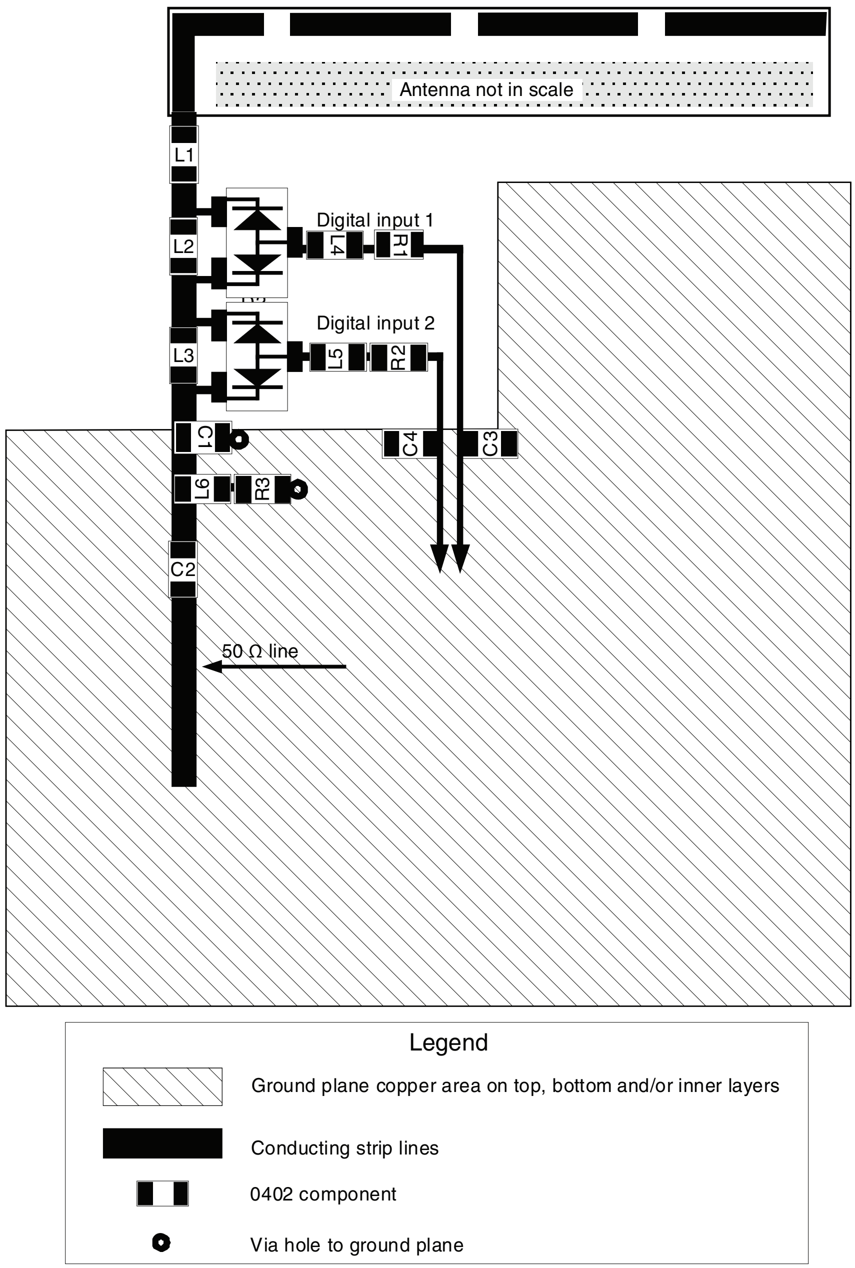


Fig. 3 - Tuning Circuit Layout

VJ 3505 GSM Interference Immune Tuning Circuit

LAYOUT GUIDELINES

1. The distance between the tuning circuit components should be minimized
2. Inductor L1 should be located as close as possible to the antenna
3. Inductors L4 and L5 should be as close as possible to the PIN diodes
4. It is recommended to remove all ground planes from under the tuning circuit. The ground plane should be added to insure a 50 Ω wave guide after capacitor C1

REFERENCE TUNING CIRCUIT BOM

TABLE 1 - TUNING CIRCUIT BILL OF MATERIALS

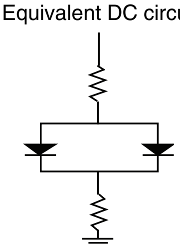
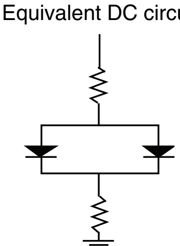
VALUE	REFERENCE	QUANTITY PER CIRCUIT	PART NUMBER	MANUFACTURER
120 nH	L4, L5, L6	3	HK 1005 R12J-T	Taiyo Yuden
PIN diode	D1, D2	2	BAR63-06W	Infineon
15 nH	L1	1	IMC0402ER15NJ	Vishay
12 nH	L2	1	IMC0402ER12NJ	Vishay
27 nH	L3	1	IMC0402ER27NJ	Vishay
3.9 pF	C1	1	VJ0402A3R9BXACW1BC	Vishay
220 pF	C2, C3, C4	3	VJ0402A221JXACW1BC	Vishay
330 Ω	R1, R2, R3	3	CRCW0402330RFKED	Vishay

Note
- Any changes made in the reference BOM might result in loss of radiation efficiency.

CONTROL SIGNAL INTEGRITY

The following table describes the desired control signal properties:

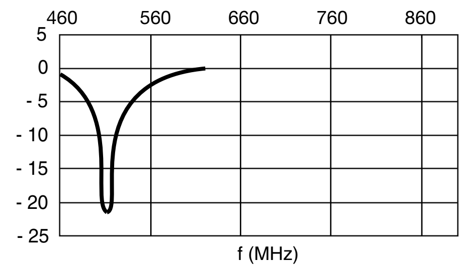
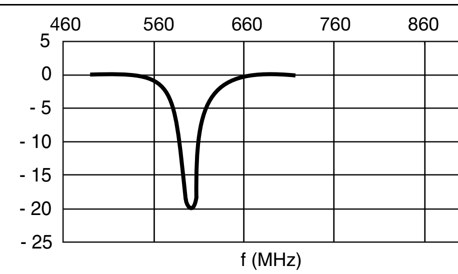
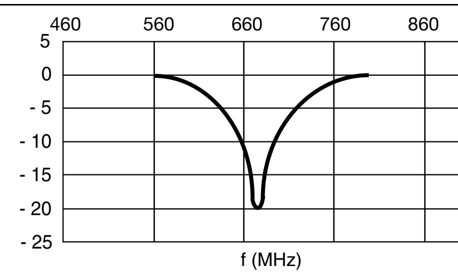
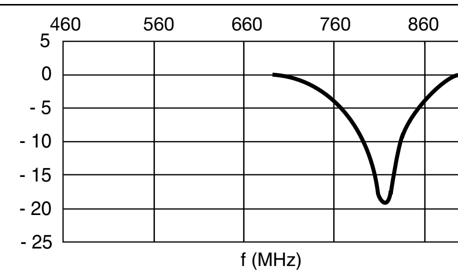
TABLE 2 - SIGNAL INTEGRITY FOR ELECTRICAL CONTROL ALTERNATIVE

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS	COMMENTS
Logical LOW	V_{il}	- 0.3	0	0.2	V	Equivalent DC circuit 
Logical HIGH	V_{ih}	3	3.3	5	V	Equivalent DC circuit 
Source current	I_{source}	4	4.2	5	mA	V_{in} = 5 V Diode reverse leakage current
Sink current	I_{sink}	0	0.01	0.05	mA	V_{in} = - 0.3 V

VJ 3505 GSM Interference Immune Tuning Circuit

CHANNEL CHARACTERISTICS

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

TABLE 3 - PEAK GAIN OBTAINED IN EACH OF THE FOUR CHANNELS				
PARAMETER	D1	D2	BAND (MHz)	S11 (dB)
1	L	L	470 to 540	
2	H	L	540 to 620	
3	L	H	620 to 750	
4	H	H	750 to 860 [1]	

Note

[1] Applications withstanding strong GSM interference will incorporate a band pass filter designed to filter out the interfering signal. Such a filter will add significant attenuation above 750 MHz.

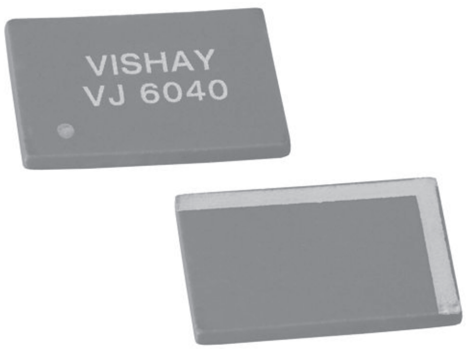
The company's products are covered by one or more of the following:
WO2008250262 (A1), US2008303720 (A1), US2008305750 (A1), WO2008154173 (A1). Other patents pending.

ORDERING INFORMATION	VISHAY MATERIAL	PACKAGING QUANTITY
VJ 3505	VJ3505M011SXMSRA0	1000 pieces

Evaluation Board

Contents

EVK 6040 User Guide



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 6040 evaluation kit. It is recommended that this document be read after the following documents were viewed:

- VJ 6040 datasheet
- VJ 6040 application notes

EVALUATION KIT COMPONENTS

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

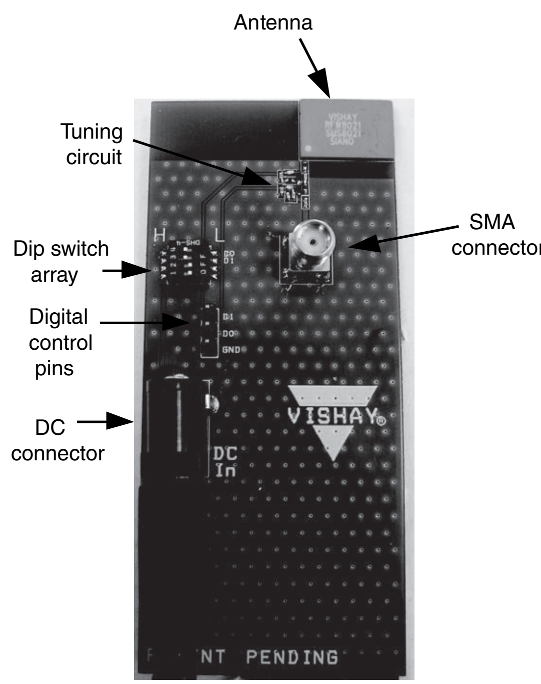


Fig. 1 - Evaluation Kit

TABLE 1 - KIT COMPONENTS	
ITEM	FUNCTIONALITY
Antenna	Actual ceramic chip antenna
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 3 and 4 (marked D0 and D1) are in use. Pins 1 and 2 are not connected
Digital control pins	Used to control the tuning circuit electrically. Pins D0 and D1 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 6040 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.

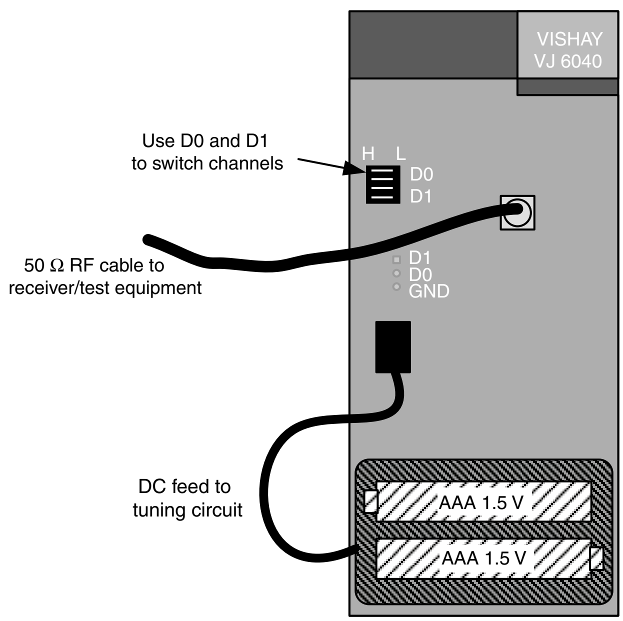


Fig. 2 - Manual Control

In set up alternative 1, the tuning circuit is driven and controlled by dip switches D0 and D1. 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.

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.
   Disconnect the DC jack from the DC connector
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

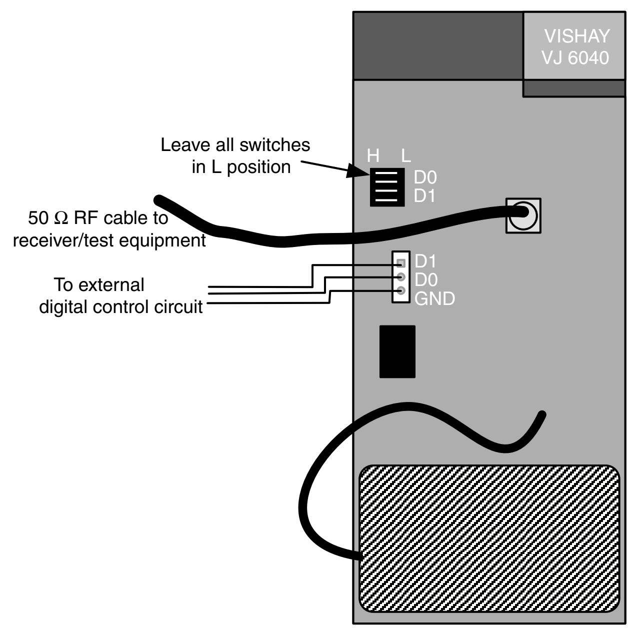


Fig. 3 - Electrical Control

The 3 pin digital connector is expected to be connected to an external control circuit. The digital control signals D0 and D1 are standard CMOS level signals.

Note

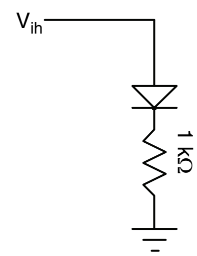
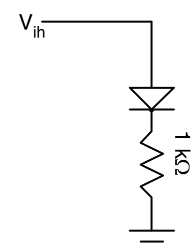
- Signal integrity is detailed in table 2.

EVK 6040 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	Equivalent DC circuit 
Source current	I_{source}	0	0.01	0.05	mA	V_{in} = 5 V This is diode reverse leakage current
Sink current	I_{sink}	4	4.2	5	mA	V_{in} = - 0.5 V

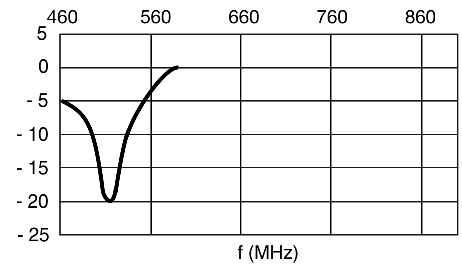
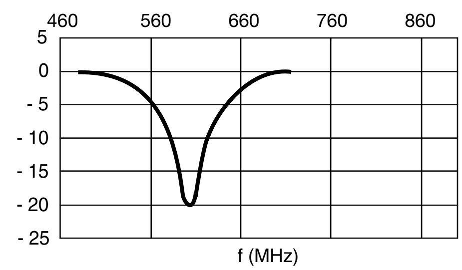
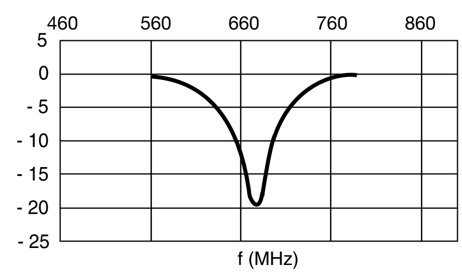
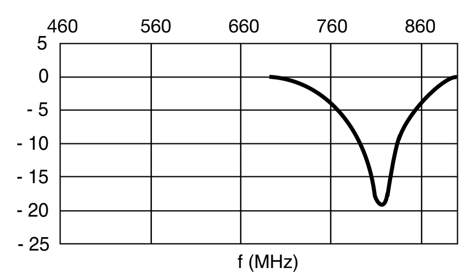
OPERATING THE KIT

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 6040 User Guide

Table 3 describes channel selection for both manual and electrical set up alternatives.

TABLE 3 - TUNING CIRCUIT BANDS, FOR CHANNEL SELECTION ONLY

CHANNEL	D1	D2	BAND (MHz)	S11 (dB)
1	H	L	470 to 540	
2	L	L	540 to 620	
3	H	H	620 to 750	
4	L	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 6040 application notes - tuning circuit”.

EVK 6040 User Guide

VJ 6040 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 6040 evaluation board.

Figure 4 shows radiation patterns of the EVK 6040 in various frequencies across the UHF band:

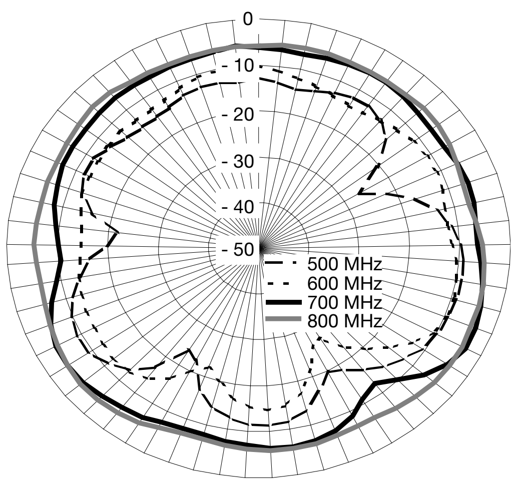


Fig. 4 - Peak Gain vs. Frequency

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 6040 antenna over frequency throughout the UHF band, compared with the MBRAI requirements:

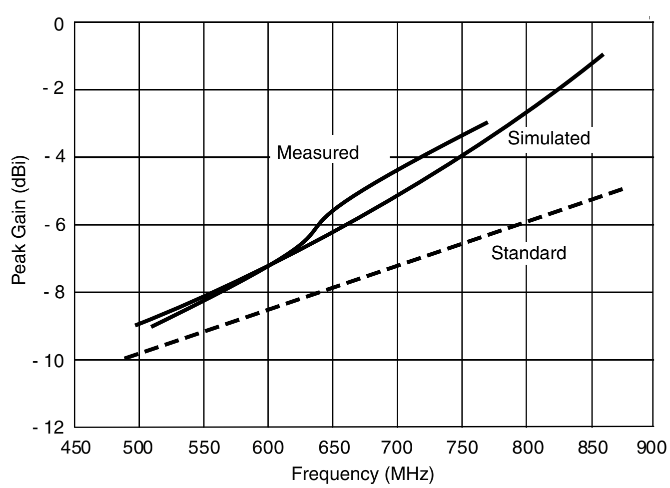


Fig. 5 - Peak Gain vs. Frequency

EVK 6040 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.

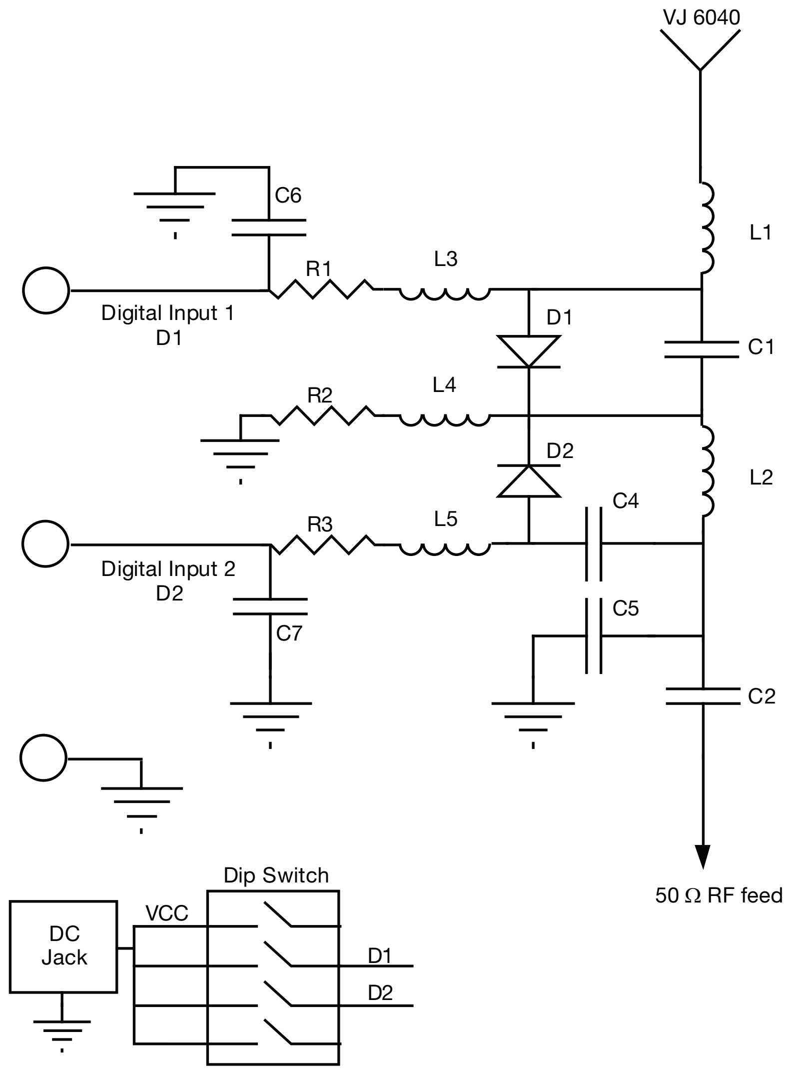


Fig. 6 - EVK 6040 Schematic

TABLE 4 - EVK6040 BOM LIST

VALUE	REFERENCE	QUANTITY PER CIRCUIT	PART NUMBER	MANUFACTURER
Antenna	VJ 6040	1	VJ6040M011SXISRA0	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.

EVK 6040 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):

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

$$\omega = 2\pi f$$

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 conductance 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 (W)
0	0	High Z	High Z	$j * \left(\omega L_1 - \frac{1}{\omega C_1} + \omega L_2\right)$
0	1	High Z	2 Ω	$j * \left(\omega L_1 - \frac{1}{\omega C_1}\right) + 2$
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:

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

When:

R = resistive value (in Ω) for R1

$V_{control}$ = control voltage (in V) 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:

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

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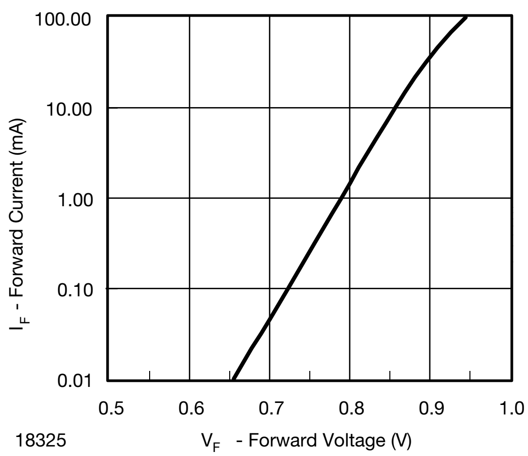

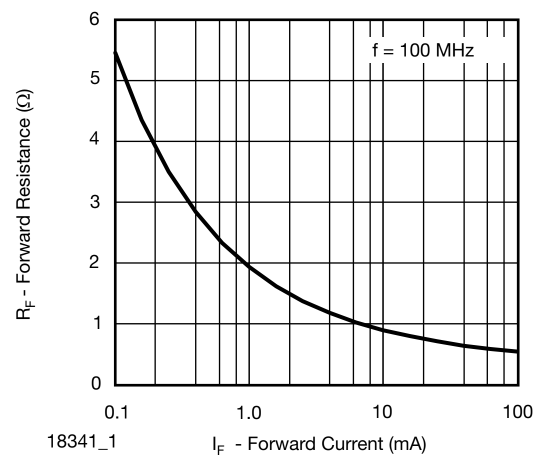

Fig. 7 - Pin Diode Characteristics

GROUND PLANE CONFIGURATION

General

The VJ 6040 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 6040. The recommended ground plane configuration presented below includes recommendations regarding how to set the cellular antenna relative to the VJ 6040 to minimize losses to both antennas.

VJ 6040 evaluation board demonstrates exceptional antenna performance achieved with a 40 mm by 80 mm ground plane.

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 6040. The presence of an additional antenna might cause loss of efficiency to both antennas.

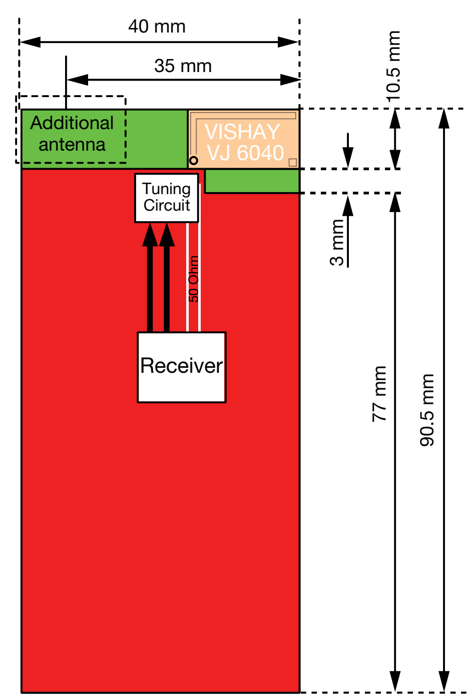

Fig. 8 - Recommended Ground Plane

APPLICATION NOTE

EVK 3505 User Guide

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

EVALUATION KIT COMPONENTS

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

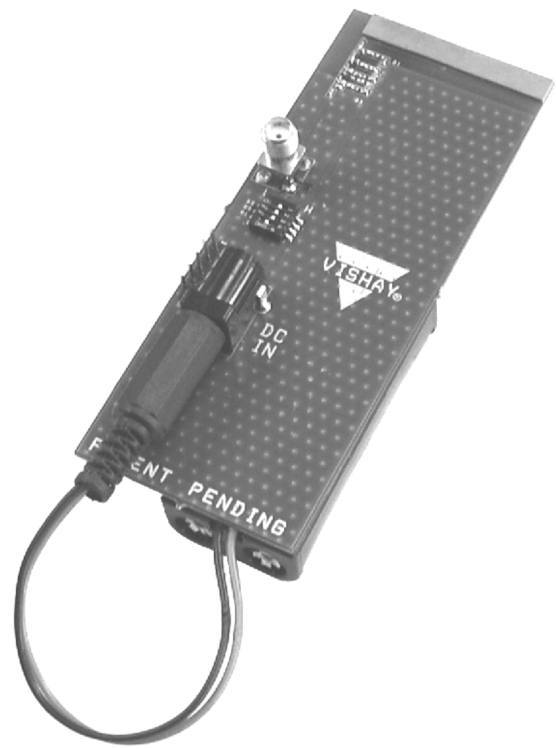

Fig. 1 - Evaluation Kit

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

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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.

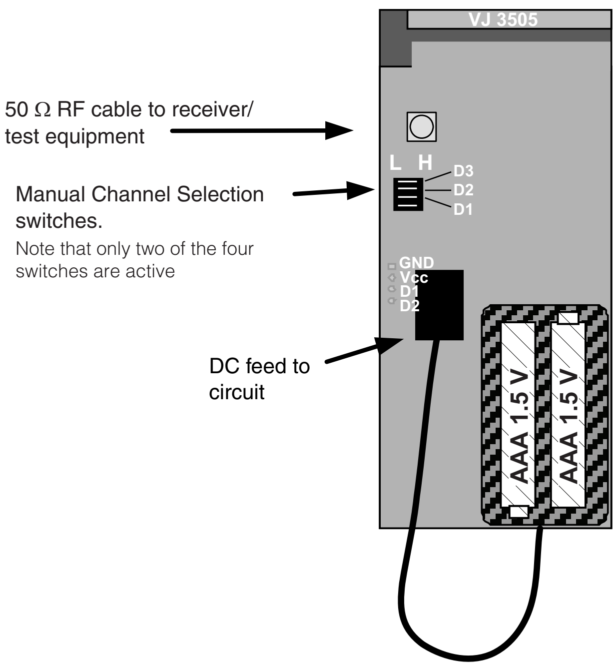

Fig. 2 - Manual Control

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.

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

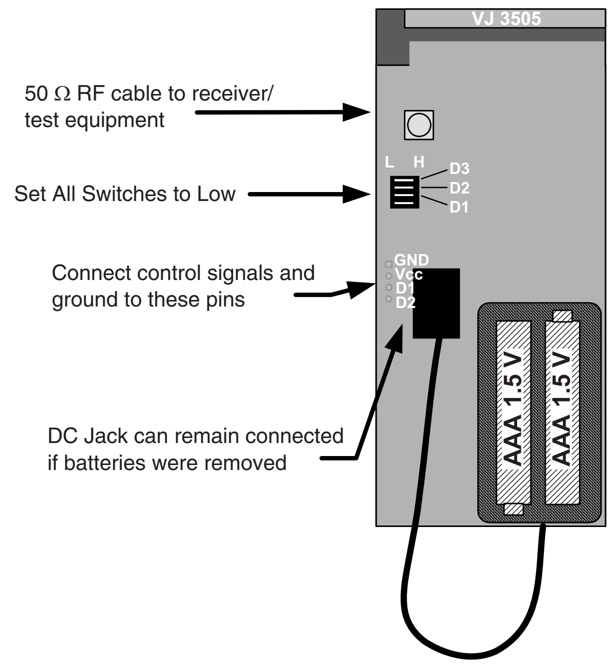

Fig. 3 - Electrical Control

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.

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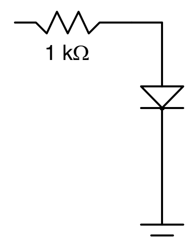
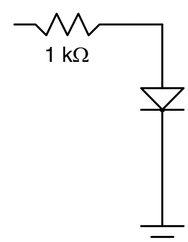
CONTROL SIGNAL INTEGRITY

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	Equivalent DC circuit 
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.

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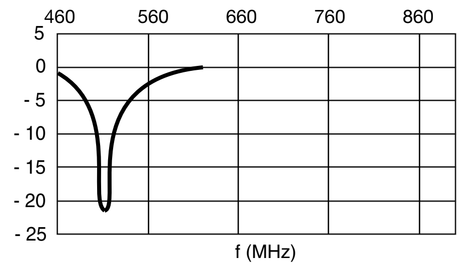
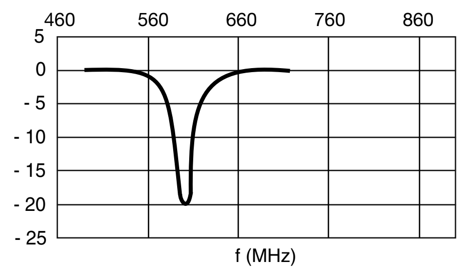
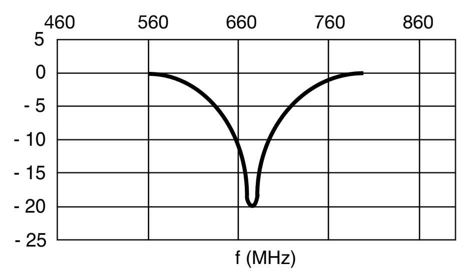
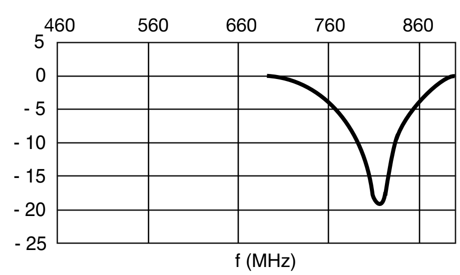
CHANNEL CHARACTERISTICS

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'.

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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:

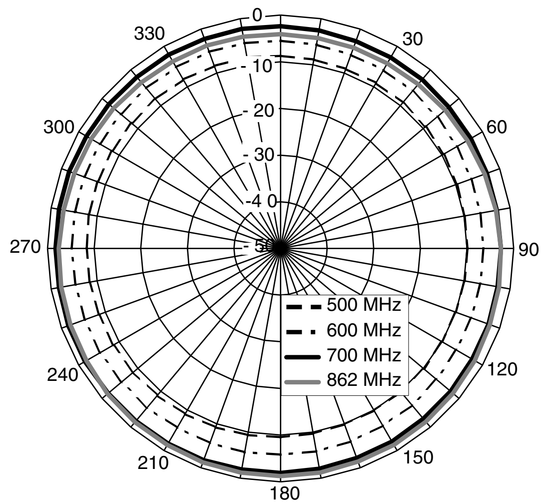

Fig. 4 - Peak Gain vs. Frequency

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:

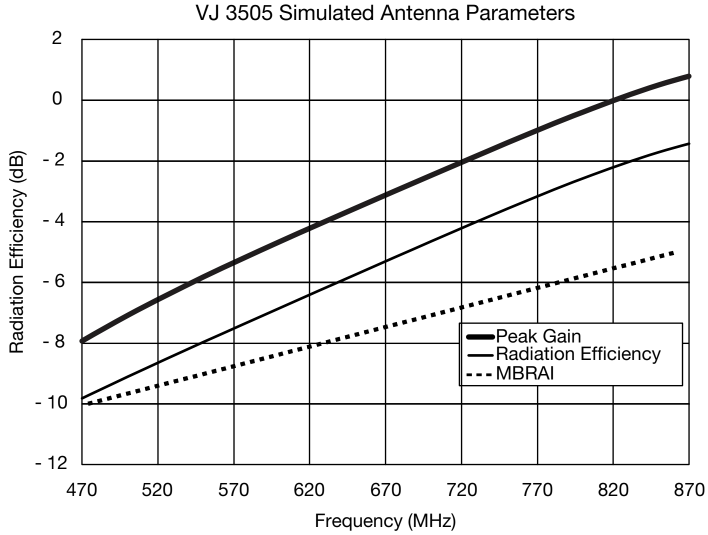

Fig. 5 - Simulated Radiation Efficiency and Peak Gain vs. Frequency

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SCHEMATIC DRAWING

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

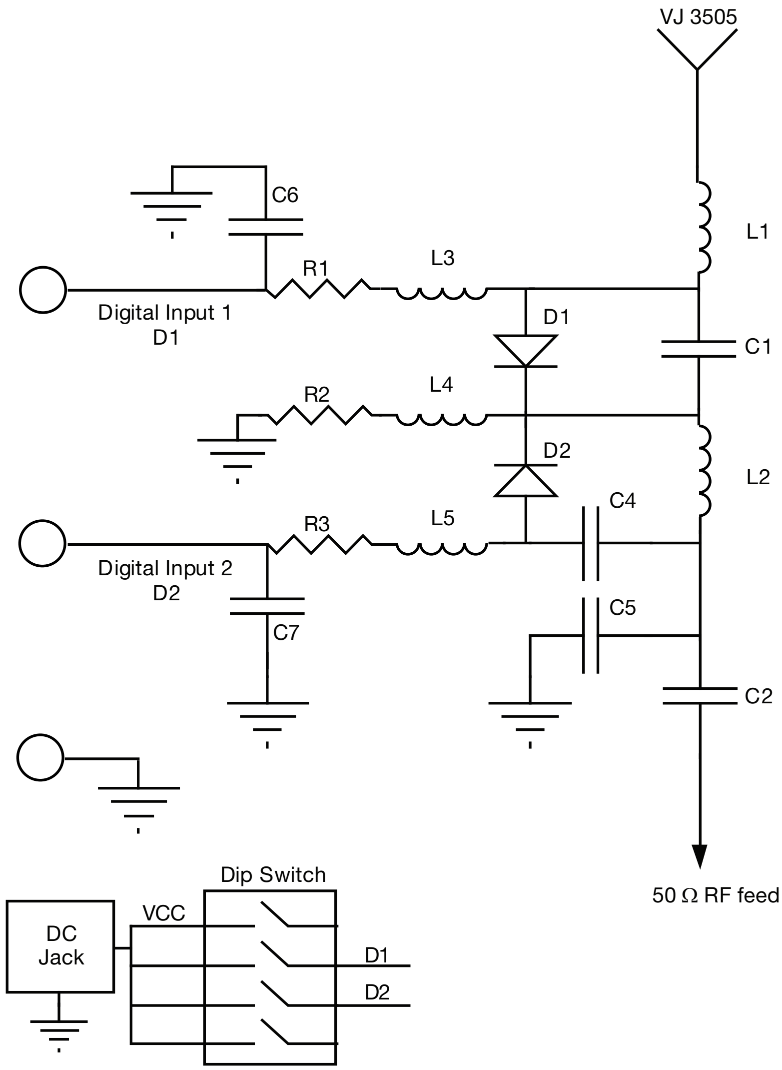

Fig. 6 - EVK 3505 Schematic

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.

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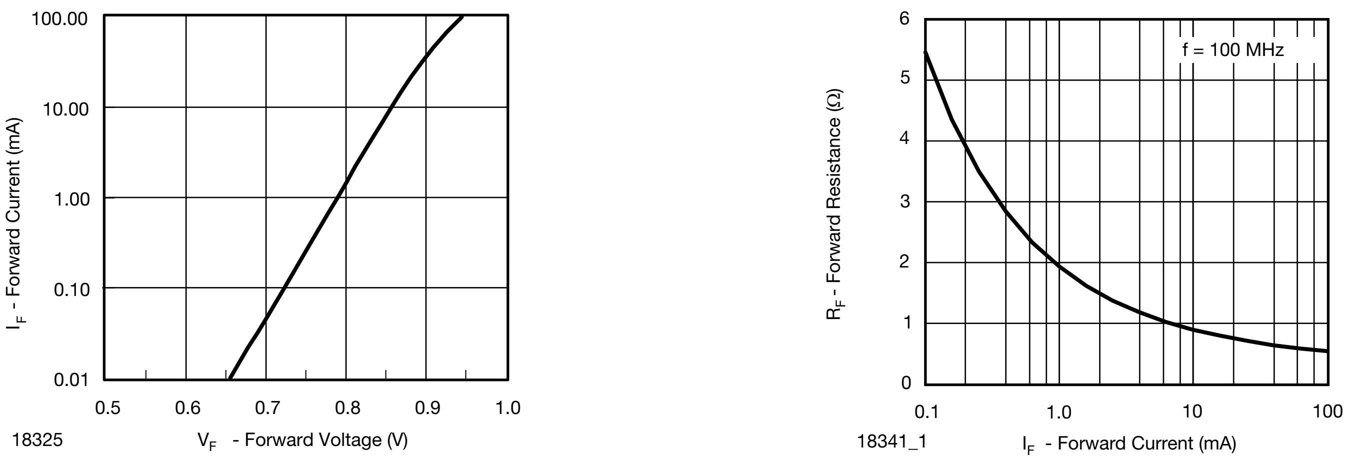

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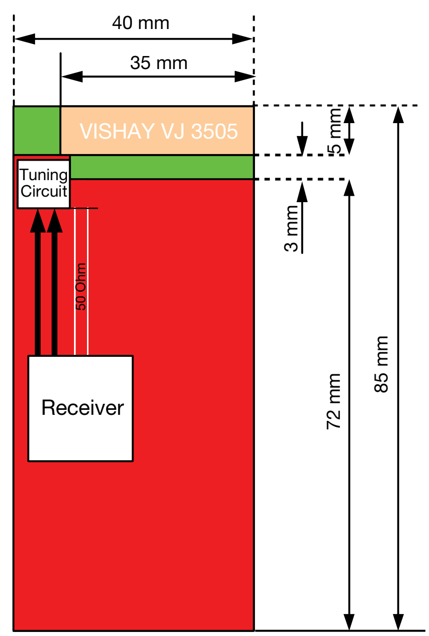

Fig. 8 - Recommended Ground Plane

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