INA-3XX63 Evaluation Circuit Board Application Note

Preliminary Data

Applies to INA-31063, INA-32063 and INA-34063 Silicon 3V, RFIC amplifiers

Description

The INA-3XX63 printed circuit board is designed to allow you to test and evaluate performance of the INA-31063, INA-32063 and INA-34063 RFIC amplifier for your specific application.

The INA-31063 is a two-stage, high isolation, silicon RFIC amplifier that operates from DC and has a 3dB bandwidth of 3GHz. The INA-31063 uses a unique circuit topology that provides broadband gain and 50 Ω input and 200 Ω output impedance. For detailed design information covering the use of the INA-31063, refer to the Applications section of the data sheet. (Request HP publication XXXX-XXXXE, DC - 2.5 GHz 3V, High Isolation Silicon RFIC Amplifier.)

The INA-32063 is a +3 Volt silicon RFIC amplifier that is designed with a two-stage internal network to provide a broadband gain, 3dB bandwidth of 3.5 GHz and 50 Ω input and output impedance match. For detailed design information covering the use of the INA-32063, refer to the Applications section of the data sheet. (Request HP publication XXXX-XXXXE, 3.0 GHz Wideband Silicon RFIC Amplifier.)

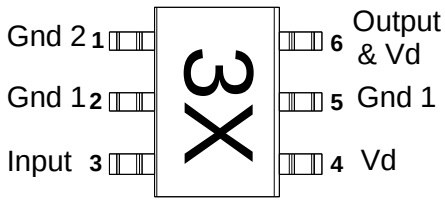

Figure 1. Pin Connections and package making for INA-3XX63 series of RFIC Amplifiers.

The INA-34063 is a +3 Volt silicon RFIC amplifier that is designed with a two stage internal network to provide a broadband gain, 3dB bandwidth of 3.5 GHz and 50 Ω input and output impedance. With a

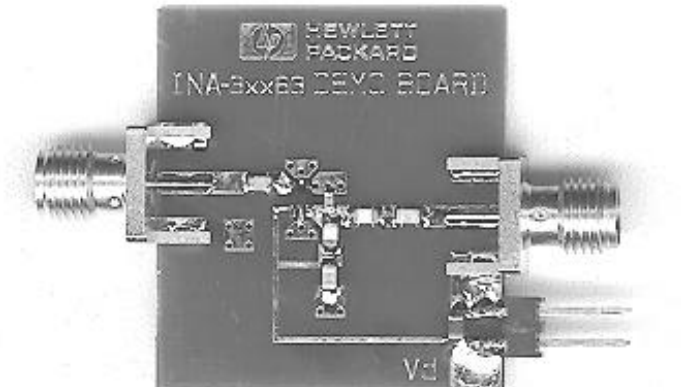

Figure 2. Photograph of INA-3XX63 Evaluation circuit

P-1dB compressed Output Power of 8 dBm and Noise Figure of 4.5 dB at 1900 MHz, the INA-34063 is well suited for buffer amplifier applications in mobile communication. For detailed design information covering the use of the INA-34063, refer to the Applications section of the data sheet. (Request HP publication XXXX-XXXXE, 3.0 GHz Medium Power Silicon RFIC Amplifier.)

The INA-3XX63 circuit board is normally fabricated on 0.031-inch thick FR-4 ($\epsilon_r = 4.65$) dielectric material.

General Assembly Information

The amplifier and related components are assembled onto the printed circuit board as shown in the photograph in Figure 1 and in the assembly drawing in Figure 2. The INA-3XX63 circuit board is designed to use edge-mounting SMA connectors such as Johnson Components, Inc., Model 142-0701-881. These connectors are designed to slip over the edge of 0.031-inch thick circuit boards and obviate the need to mount PCBs on a metal base plate for testing. The center conductors of the connectors are soldered to the input and output microstrip lines. The ground pins are soldered to

the ground plane on the back of the board and to the top ground pads.

A schematic diagram of the circuit is shown in Figure 4. Values for RFC, for various frequencies are listed in Table 1. In addition to Table 1 includes values for Ltune and Ctune for the INA-31063.The ground pad provided near the Vd connection can be used to add C4 for additional bypassing of the bias line if desired. C1 is an optional DC blocking capacitor. If the amplifier is to be connected to a preceding circuit that has a DC voltage present on its output, C1 must be included. The values of the blocking capacitors are determined by the lowest frequency of operation for a particular application. The capacitor's reactance is chosen to be 5% or less of the amplifier's input or output impedance at the lowest operating frequency. For example, an amplifier to be used in an application covering the 902 to 928 MHz band would require an input blocking capacitor of at least 70 pF, which is 2.5 Ω of reactance, or 5% of 50 Ω at 902 MHz. The Vd connection to the amplifier must be RF bypassed by placing a capacitor to ground directly at the bias pin of the package. Like the DC blocking capacitors, the value of the Vd bypass capacitor is determined by the lowest operating frequency for the amplifier. This value is typically the same as that of the DC blocking capacitors. If long bias lines are used to the amplifier to the Vd supply, additional bypass capacitors may be required to prevent resonance.

Operation

The INA-3 series of RFIC amplifiers are voltage-biased device. To operate, it is only necessary to apply +3 volts to the Vd connection. Typical current drain for each device is given in the data sheet.

INA-31063 Typical Configuration

The 200 Ω output impedance of the INA-31063 may be used to an advantage when connecting directly with devices having higher than 50 Ω input impedances, such as DSP, additional RFICs and some filters. The INA-31063 may also be used in a simple cascade without impedance matching. The advantages of such a configuration is that with no interstage matching, less board space is use and the component count may be reduced.

INA-31063 Operation in a 50 W system.

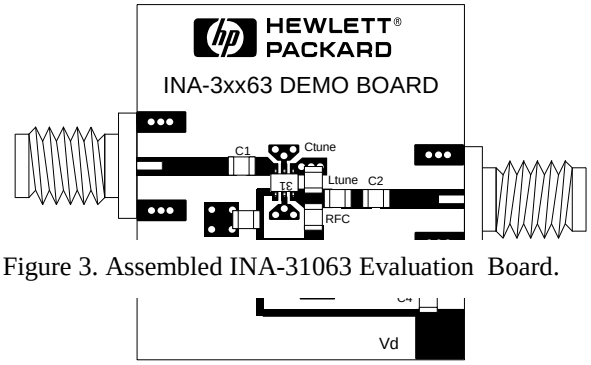

Figure 3. Assembled INA-31063 Evaluation Board.

The values in Table 1 for inductor Ltune and Ctune provide the best two element output match to 50 Ω for frequencies in the 400-900 MHz range.

Frequency	RFC	Ltune	Ctune
400 MHz	120nH	27nH	2.7pF
900 MHz	56nH	12nH	1.0pF
1900 MHz	33nH	4.7nH	None
2400 MHz	27nH	1.8nH	None

Table 1. Suggested matching elements for common frequency bands

At higher frequencies a single element output match is sufficient to provide the best return loss match. The use of a simple impedance matching network will typically increase both gain and output power by 2.0 dB and 2.0 dBm, respectively. The only adjustment that may be required is to fine-tune the output inductor Ltune to achieve the best return loss on the output of the INA-31063. The values for Ltune that are shown in Table 1 may vary slightly depending on the particular components used in the assembly.

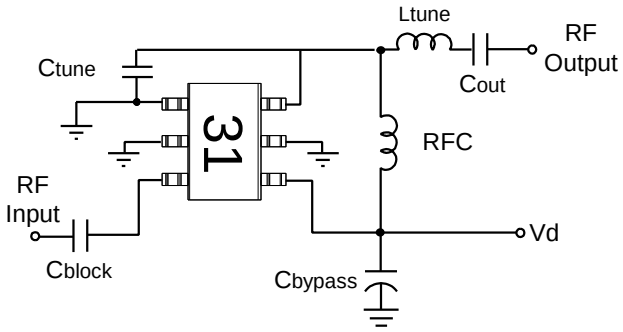

Figure 4. Schematic Diagram of INA-31063 Impedance Matched Amplifier Circuit

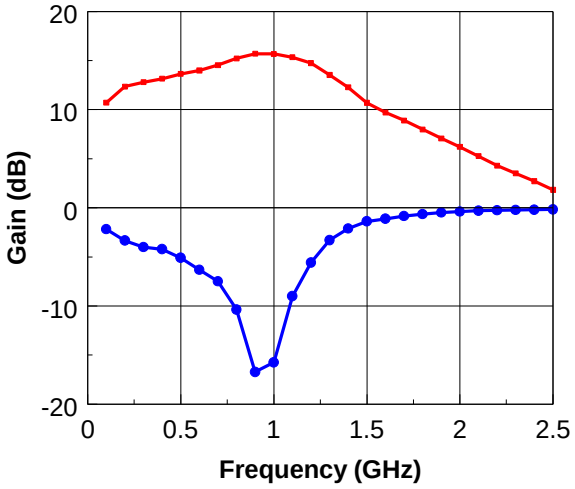

Figure 5. INA-31063 Gain and Output Return Loss of impedance matched amplifier at 900MHz.

INA-32063 and INA-34063 Typical Configuration

The INA-32063 and INA-34063 have both been designed with a two stage internal network to provide a broadband gain and 50 Ω input and output impedance. For operation in a 50 Ω system no additional matching elements are required on the input or output. The schematic diagram shown in Figure 6. Shows the typical implementation of the INA-32063 and INA-34063. For the evaluation of the INA-32063 and INA-34063 on the INA-3XX63 demo board it will be necessary to bridge the output track with copper foil, as Ltune is not required.

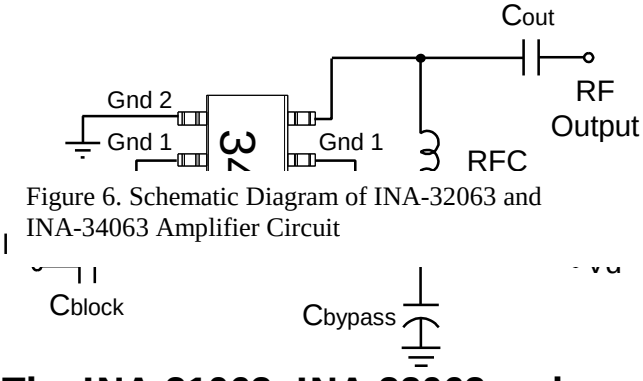

Figure 6. Schematic Diagram of INA-32063 and INA-34063 Amplifier Circuit

The INA-31063, INA-32063 and INA-34063 at higher voltage levels

The INA-3XX63 series has been designed to operate in 3-volt battery powered applications. It can be seen from the characterization data included in the data sheets, that the INA-3XX63 series RF performance is very stable over the range 2.7 to 3.3 volts. This is to reflect the supply voltage depending on the freshness or state of charge in the case of rechargeable batteries. At higher voltage levels the RF performance of the INA-34063 is not improved substantially. Small improvements in P-1dB performance can be achieved to a maximum of 4.8 volts. At higher input voltage levels the P-1dB does not increase. The additional DC input power has to be dissipated inside the die and package. It is not recommended that the INA-31063, INA-32063 and INA-34063 be used at higher voltage levels.

Notes on RF grounding

The performance of the INA-3XX63 series is sensitive to ground path inductance. The two-stage design creates the possibility of a feedback loop being formed through the ground returns of the stages, Gnd 1 and Gnd 2.

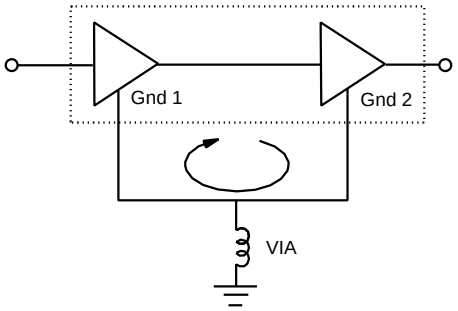

Figure 7. INA-3XX63 Potential Ground Loop.

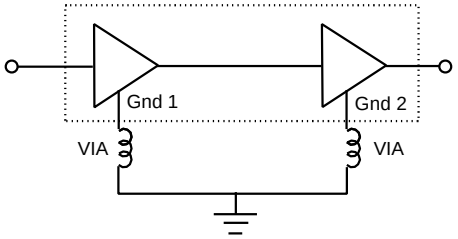

Figure 8. INA-3XX63 Suggested layout

At least one ground via should be placed adjacent to each ground pin to assure good RF grounding. Multiple vias are used to reduce the inductance of the path to ground and should be placed as close to the package terminals as practical.

The effects of the potential ground loop shown in Figure 11 may be observed as a “peaking” in the

gain versus frequency response, an increase in input VSWR, or even as return gain at the input of the INA-3XX63 amplifier series.

A Final Note on Performance

Actual performance of the INA-31063, INA-32063 and INA-34063 series of RFIC mounted on the INA-3XX63 demonstration board may not exactly match data sheet specifications. The board material, passive components, and connectors all introduce losses and parasitics that may degrade device performance, especially at higher frequencies. Some variation in measured results is also to be expected as a result of the normal manufacturing distribution of products.

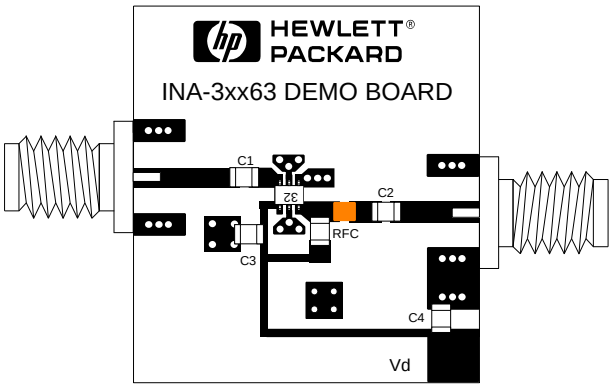

Figure 9. Assembled INA-31063 Evaluation Board.

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