AN-1761 Evaluation Board for the LMH2100 Logarithmic Power Detector

1 General Description

This evaluation board, Figure 1, is designed to aid in the characterization of the Texas Instruments LMH2100 Logarithmic Power Detector. This board simplifies the measurement of the DC output voltage that the LMH2100 produces in response to the power level of the RF signal applied to the RF input. Use the evaluation board as a guide for high frequency layout and as a tool to aid in device testing and characterization.

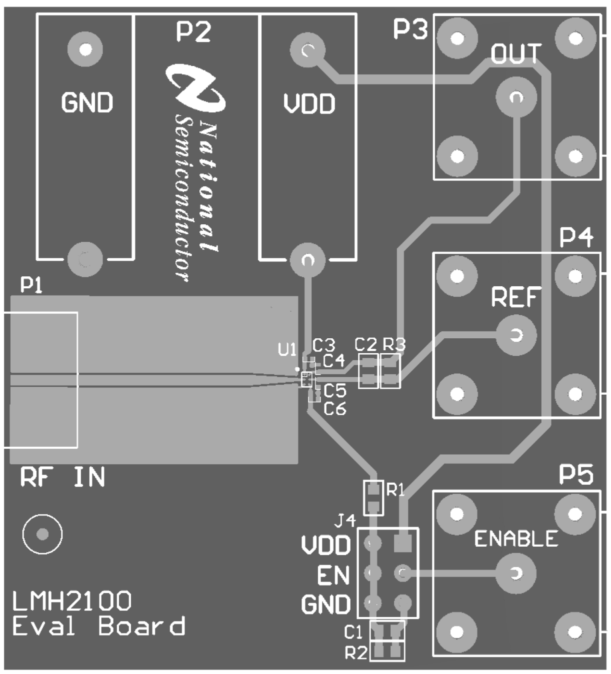

Figure 1. LMH2100 Evaluation Board

2 Basic Operation

The LMH2100 is a 40 dB RF Logarithmic power detector intended for use in CDMA and WCDMA applications. The device has an RF frequency range from 50 MHz to 4 GHz. It provides an accurate temperature and supply compensated output voltage that relates linearly to the RF input power in dBm. The circuit operates with a single supply form 2.7V to 3.3V and has an RF power detection range from −45 dBm to −5 dBm. The board consist of a single LMH2100 along with external components soldered on a printed circuit board. Figure 2 shows the schematic of the LMH2100 evaluation board.

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External supply voltages and input signals can be applied to the onboard connectors. The supply voltage is applied with connectors P2.2 (V_{DD}) and P2.1 (GND). The RF input signal is applied by SMA connector P1. This RF signal is applied through an RF generator and is connected with a 50Ω coax cable. The detector output can be measured via BNC connector P3.

The device can be activated by forcing a “high” voltage to the enable input. This can be done by jumper J4, see Table 1.

The REF input (P4) is directly connected to the inverting input of the transimpedance amplifier in the LMH2100 and can be used to compensate for the temperature drift of the internal reference voltage.

Capacitors C_3, C_4, C_5, and C_6 are decoupling capacitors and will act as RF shorts to prevent RF interference.

Additional low-pass filtering of the output signal can be realized by means of an external resistor (R_3) and capacitor (C_2). For more details about filtering, check the application information in *LMH2100 50 MHz to 4 GHz 40 dB Logarithmic Power Detector for CDMA and WCDMA* (SNWS020).

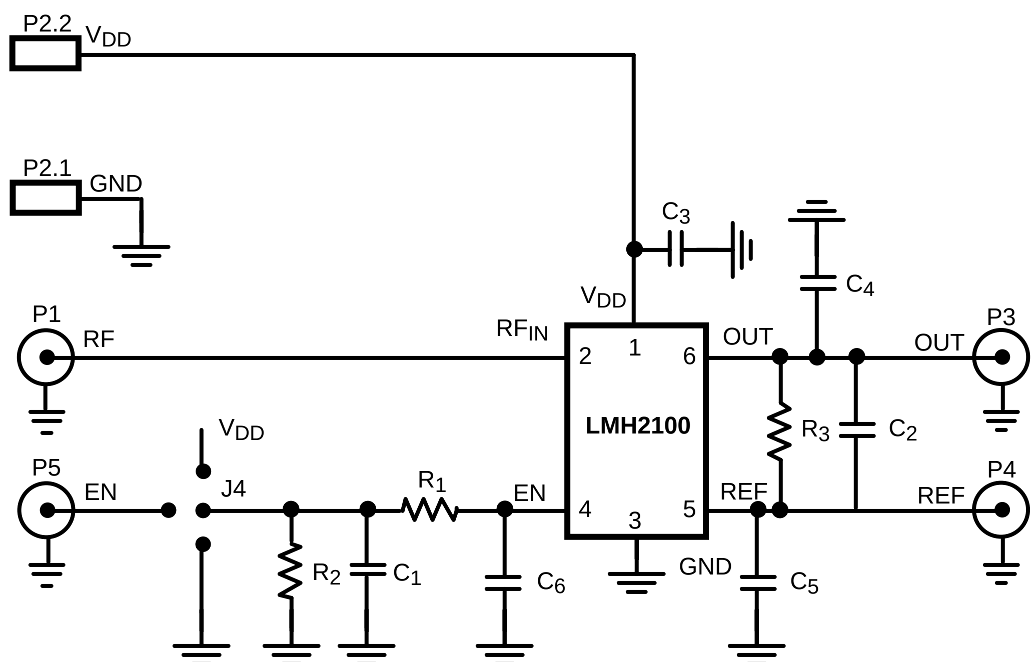

Figure 2. LMH2100 Evaluation Board Schematic

Table 1. Jumper J4 Connections

Jumper J4	Device	
V_{DD}		Active
EN	V_{EN} = high	Active
	V_{EN} = low	Shutdown
GND		Shutdown

3 Layout Considerations

As with any other RF device, careful attention must be paid to the board layout. If the board layout is not properly designed, unwanted signals will be detected or interference will be picked up. Electrical signals (voltage/currents) need a finite time to travel through a trace or transmission line. RF voltage levels at the generator side and at the detector side can therefore be different. This is not true for the RF strip line, but is true for all traces on the PCB. Signals at different locations or traces on the PCB will be in different phase of the RF frequency cycle. Phase differences in, for example the voltage across neighboring lines, may result in crosstalk between lines, due to parasitic capacitance or inductive coupling. The crosstalk is further enhanced by the fact that all traces on the PCB are susceptible to resonance. The resonance frequency depends on the trace geometry. Traces are particularly sensitive to interference when the length of the trace corresponds to a quarter of the wavelength of the interfering signal or a multiple.

3.1 Supply Lines

Since the PSRR of the LMH2100 is finite, variations of the supply can result in some variation at the output. This can be caused by RF injection from other parts of the circuitry or on/off switching of the PA or other various issues.

3.2 Positive Supply (V_{DD})

In order to minimize injection of the RF interference into the LMH2100 through the supply lines, the PCB traces connecting to V_{DD} and GND should be shorted for RF. This can be done by placing a small decoupling capacitor between the V_{DD} and GND. It should be placed as close as possible to the V_{DD} and GND pins of the LMH2100 as indicated in Figure 3. The resonance frequency of the capacitor itself should be above the highest RF frequency used in the application, since the capacitance acts as an inductor used above its resonance frequency.

Low frequency supply voltage variations due to PA switching might result in a ripple at the output voltage. The LMH2100 has a Power Supply Rejection Ratio of 60 dB for low frequencies.

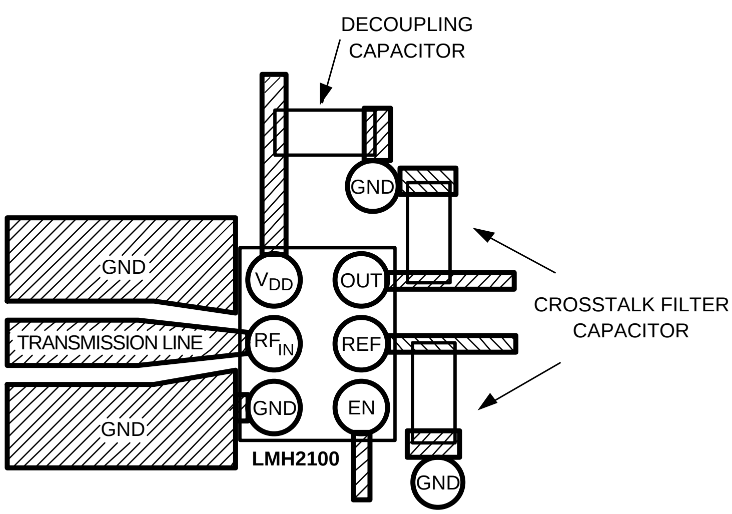

Figure 3. Recommended Board Layout

3.3 Ground (GND)

The LMH2100 needs a ground plane free of noise and other disturbing signals. It is important to separate the RF ground return path from the other grounds. This is due to the fact that the RF input handles large voltage swings. A power level of 0 dBm will cause a voltage swing larger than 0.6 V_{PP}, over the internal 50Ω input resistor. This will result in a significant RF return current towards the source. It is therefore recommended that the RF ground return path is not used for other circuits in the design. The RF path should be routed directly back to the source without loops.

3.4 RF Input Interface (RF_{IN})

The LMH2100 is designed to be used in RF applications that have a characteristic impedance of 50Ω. To achieve this impedance, the input of the LMH2100 needs to be connected via a 50Ω transmission line. Transmission lines can be easily created on PCBs using microstrip or (grounded) coplanar waveguide configurations. Both configurations are discussed in more detail in the application information of the LMH2100 datasheet or in microwave designer handbooks.

3.5 Reference (REF)

The reference pin can be used to compensate for temperature drift of the internal reference voltage of the LMH2100. The REF pin is directly connected to the inverting input of the transimpedance amplifier. Thus, RF signals and other spurious signals couple directly through to the output. Introduction of RF signals into the REF pin can be prevented by connecting a small capacitor (C_5) between the REF pin and ground. The capacitor should be placed as close to the REF pin as possible.

3.6 Output (OUT)

The OUT pin is sensitive to crosstalk from the RF input, especially at high power levels. The ESD diode between the output and V_{DD} may rectify the RF signal, but may not add an unwanted inaccurate DC component to the output voltage. The board layout should minimize crosstalk between the detectors input RF_{IN} and the detector"s output. Using an additional capacitor (C_4) connected between the output and the positive supply voltage V_{DD} pin or GND can prevent this. For optimal performance this capacitor should be placed as close as possible to the OUT pin of the LMH2100.

3.7 Board Layout

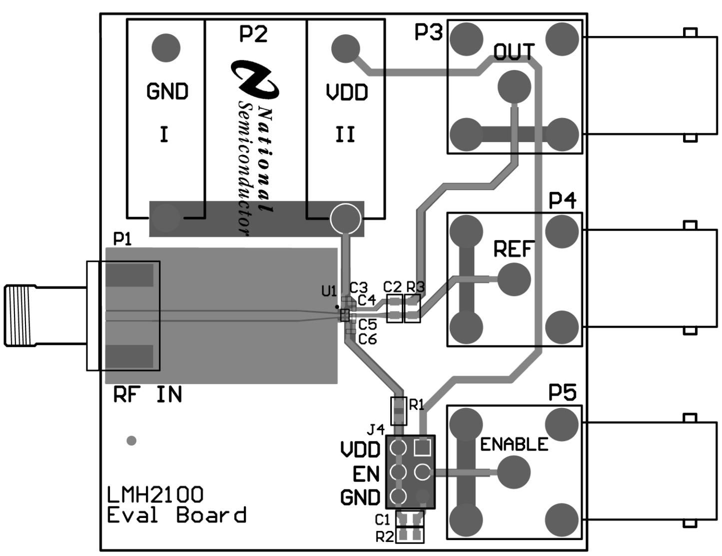

Figure 4. LMH2100 Evaluation Board Layout

3.8 Bill of Materials

The Bill of Material (BOM) of the evaluation board is listed in Table 2.

Table 2. LMH2100 Evaluation Board Bill of Materials

Designator	Description	Comment
R1	0603 Resistor	100 kΩ
R2	0603 Resistor	100 kΩ
R3	0603 Resistor	NU
C1	0603 Capacitor	10n
C2	0603 Capacitor	NU
C3	0201 Capacitor	10p
C4	0201 Capacitor	10p
C5	0201 Capacitor	1p
C6	0603 Capacitor	10p
J4	Jumper	Header 2 × 3
P1	Connector	SMA
P2.1	Connector	banana socket
P2.2	Connector	banana socket
P3	Connector	BNC-RA
P4	Connector	BNC-RA
P5	Connector	BNC-RA
U1	6-Bump DSBGA	LMH2100

4 Measurement Procedure

The performance of the LMH2100 can be measured with the setup given in Figure 5.

An external power supply provides a voltage of 2.7V to 3.3V to the evaluation board. An accurate and stable RF Signal Generator is used to produce a test signal. Be sure to use low loss coax cables to ensure reliable measurement data. The detected output voltage can be measured with a Digital Voltage Meter (DVM). To make continuous measurements, place a jumper from V_{DD} to enable (EN).

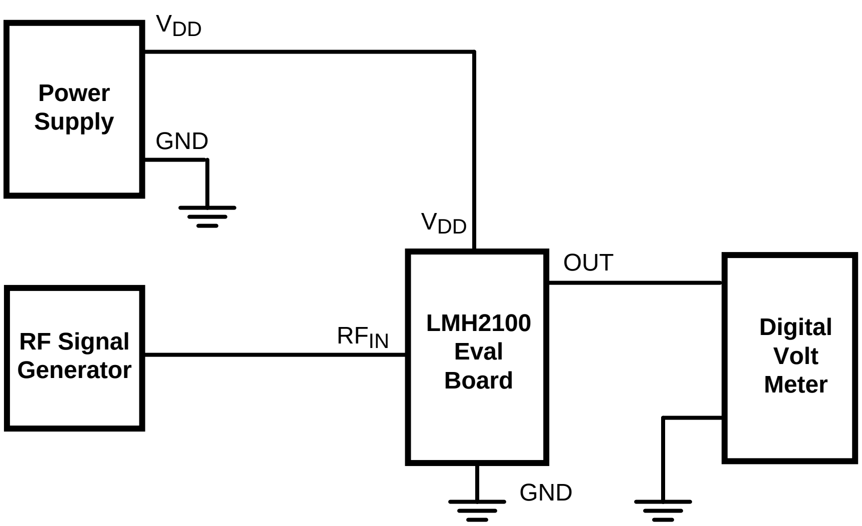

Figure 5. Measurement Setup

5 Measurement Results

Figure 6 shows the frequency response of the LMH2100 at various RF input power levels.

Figure 7 shows the detector response for an RF input power sweep at various frequencies.

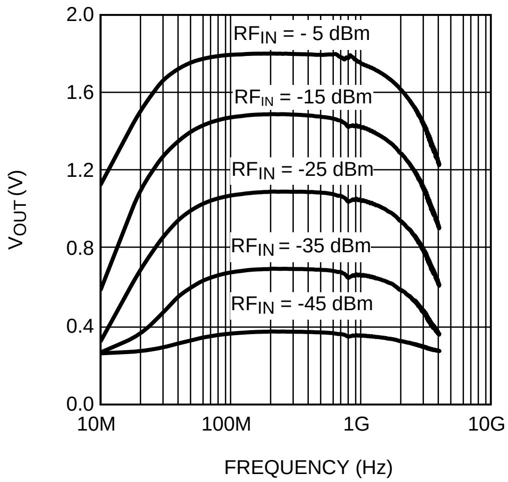

Figure 6. V_{OUT} vs. RF Input Frequency

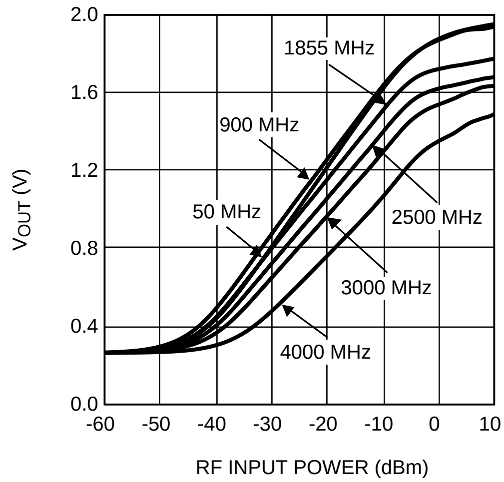

Figure 7. V_{OUT} vs. RF Input Power Level