User's Guide

SNOA510B – December 2007 – Revised April 2013

AN-1760 EMIRR Evaluation Boards for LMV851/LMV852/LMV854

1 General Description

To demonstrate the EMI robustness of the LMV851/LMV852/LMV854 and to be able to measure the parameter EMIRR, three evaluation boards have been developed; one for each device. This document describes the evaluation boards and explains how to perform EMIRR measurements. Focus is on one of the input pins as those are most sensitive to EMI. Based on symmetry considerations, it can be expected that both inputs have the same EMIRR. For reasons of simplicity of the required schematic the measurement on the IN+ pin is selected. A detailed description on EMI and EMIRR for the other pins can be found in *AN-1698 A Specification for EMI Hardened Operational Amplifiers* (SNOA497).

To identify EMI robust op amps, a parameter is defined that quantitatively describes the EMI performance. A quantitative measure enables the comparison and the ranking of op amps on their EMI robustness. The definition of the parameter EMIRR is given by:

$$EMIRR_{V_{RF\_PEAK}} = 20 \log \left(\frac{V_{RF\_PEAK}}{\Delta V_{OS}} \right)$$

where

- V_{RF_PEAK} is the amplitude of the applied unmodulated RF signal (V) and ΔV_{OS} is the resulting input-referred offset voltage shift (V). (1)

2 Op Amp Configuration

To have best defined RF levels on the pin under test, no op amp feedback elements should be in the RF signal path. Therefore, the op amp is connected in a unity-gain configuration. This yields the lowest level of RF filtering due to a feedback network. Schematics and layouts are included in this document.

3 Applying the RF Signal

Care needs to be taken in applying the RF signal to the pin under test. Signals up to a few GHz will be used, so the whole RF signal path needs to match the characteristic impedance of the RF generator. This requires proper coaxial cabling from the generator to the test board. On the test board a 50Ω stripline needs to be used to bring the RF signal as close as possible to the pin under test. In this case the stripline can be connected directly from the connector to the IN+ pin. A 50Ω termination at the pin under test is also required. For symmetry reasons this is done with two 100Ω resistors in parallel, one on each side of the strip line. Setting up the test environment with a 50Ω resistor close to the LMV851/LMV852/LMV854 ensures that the RF levels at the pin under test are well defined. This 50Ω resistor is also used to set the bias level of the IN+ pin to ground level. The DC measurements are taken at the output of the op amp. Since the op amp is in the unity gain configuration, the input referred offset voltage shift corresponds one-to-one to the measured output voltage shift.

4 Isolating the Other Pins

When the pin under test is tested, the other pins need to be decoupled for RF signals. This ensures that the obtained offset voltage shift is dominantly a result of coupling the RF signal to the pin under test. For this decoupling standard, SMD components can be used.

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5 Layout Considerations

The layout of the evaluation board requires some attention. For decoupling the supply lines it is suggested that 10 nF capacitors be placed as close as possible to the op amp. For single supply, place a capacitor between V^+ and V^-. For dual supplies, place one capacitor between V^+ and the board ground, and a second capacitor between ground and V^-. On the LMV851 evaluation board, the decoupling of the negative pin V^- is implemented by a capacitor between V^+ and V^-. This is done for easy routing and to keep connections to the pins short. Even with the LMV851/LMV852/LMV854's inherent hardening against EMI, it is still recommended to keep the input traces short and as far as possible from RF sources. Then the RF signals entering the chip are as low as possible, and the remaining EMI can be, almost, completely eliminated in the chip by the EMI reducing features of the LMV851/ LMV852/LMV854.

6 Measurement Procedure

The measurement procedure is the same for all test circuits. To measure the input referred offset voltage shift needed for calculating the EMIRR, the following procedure can be used:

1. Measure V_{OUT} when the RF signal is off.
2. Measure V_{OUT} when the RF signal is on.
3. Translate measured V_{OUT} voltages to input referred voltages. Translation is one-to-one in this case since the gain is one in the IN+ test setup.
4. Subtract the two measured input referred voltages.
5. Verify if the offset shift is above the noise level of the op amp setup and the op amp is not saturated. If this is not the case choose another RF level and start the procedure again.
6. Calculate the EMIRR.
7. If needed, transform the results to an EMIRR based on a 100 mV_P RF signal.

7 LMV851 Evaluation Board

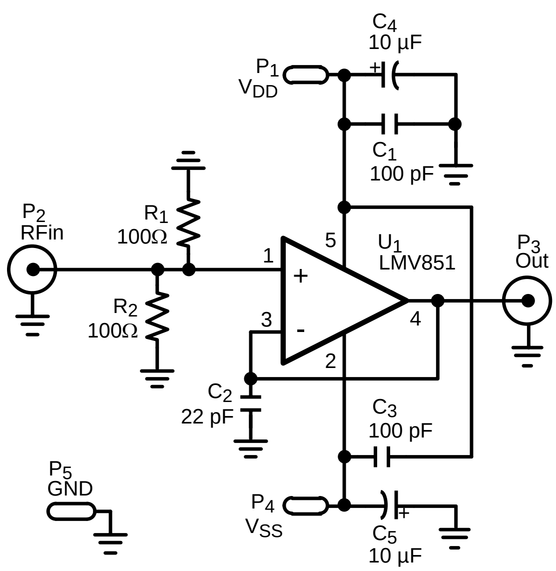

Figure 1. Schematic for LMV851, Coupling RF Signal to the IN+ Pin

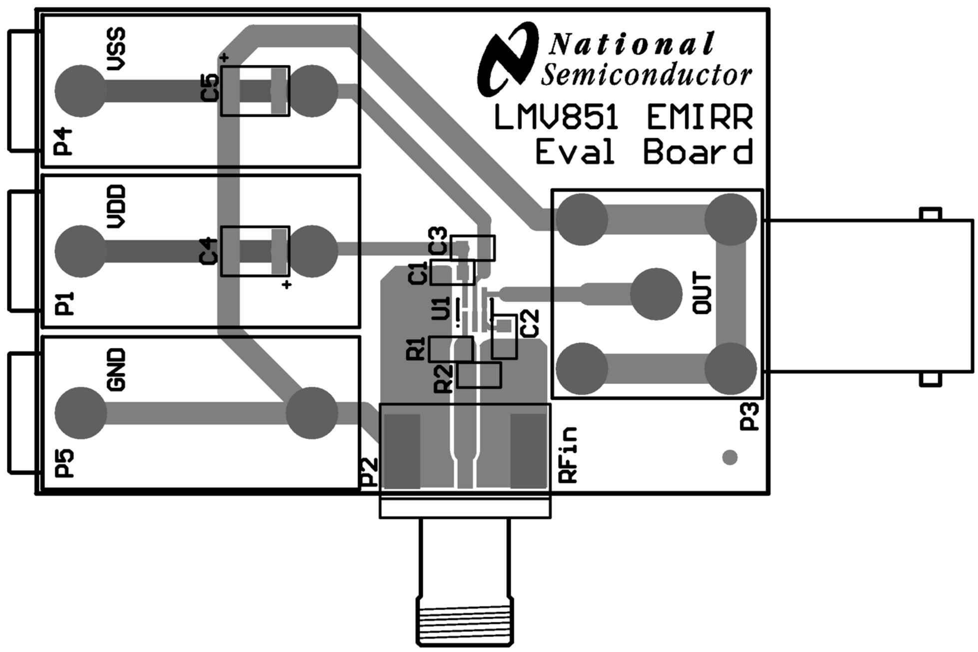

Figure 2. Layout for LMV851, All Layers

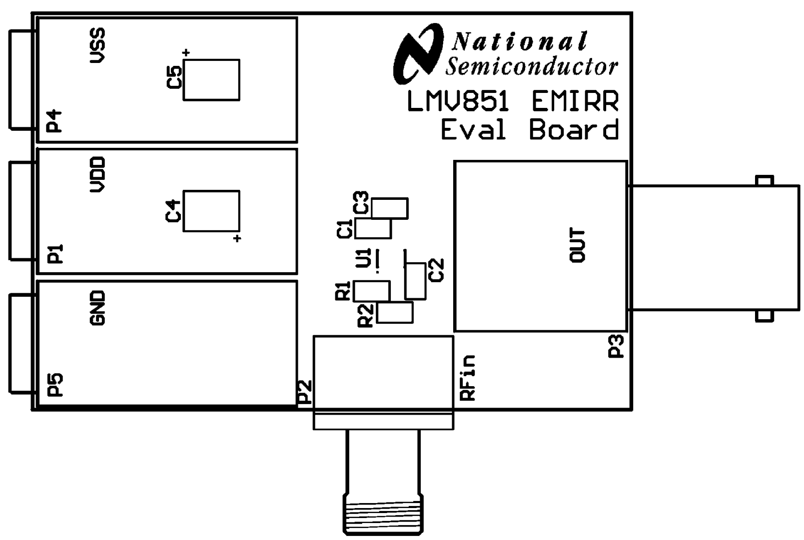

Figure 3. Layout for LMV851, Silk Screen

8 LMV852 Evaluation Board

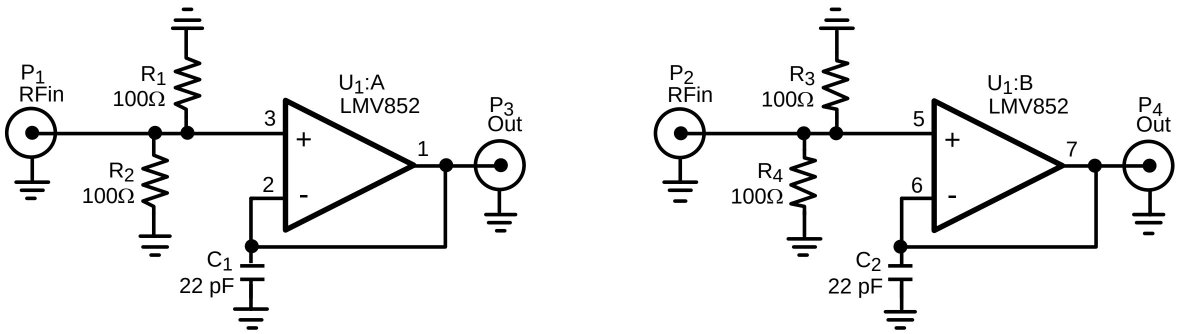

Figure 4. Schematic for LMV852, Coupling RF Signal to the IN+ Pin

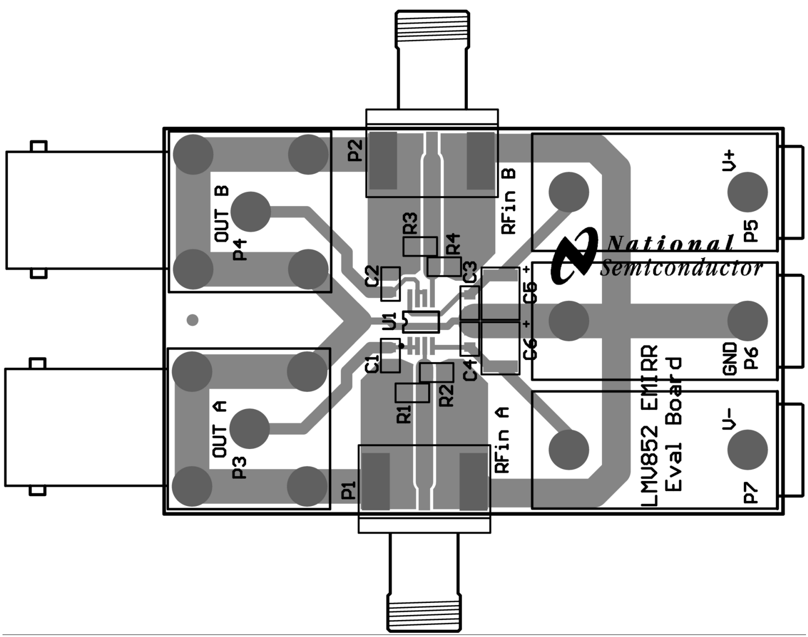

Figure 5. Layout for LMV852, All Layers

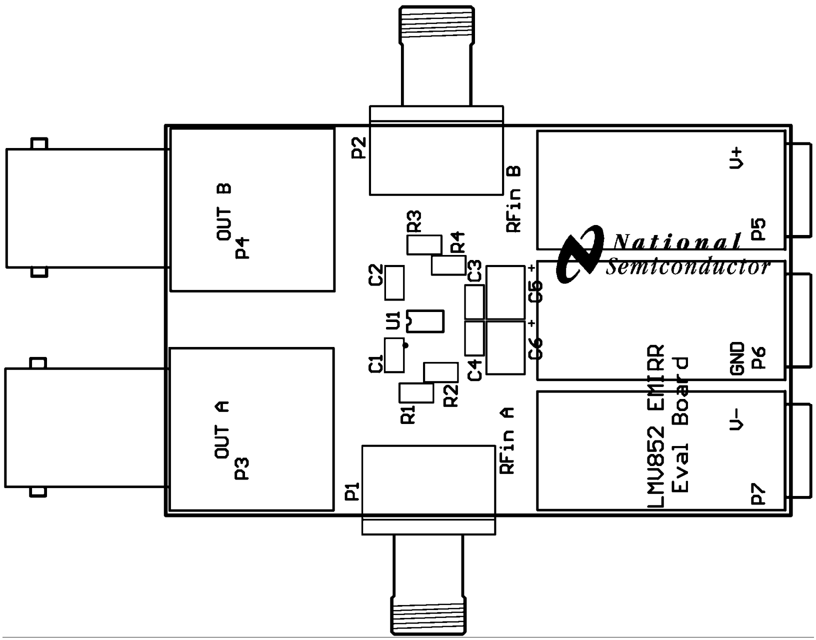

Figure 6. Layout for LMV852, Silk Screen

9 LMV854 Evaluation Board

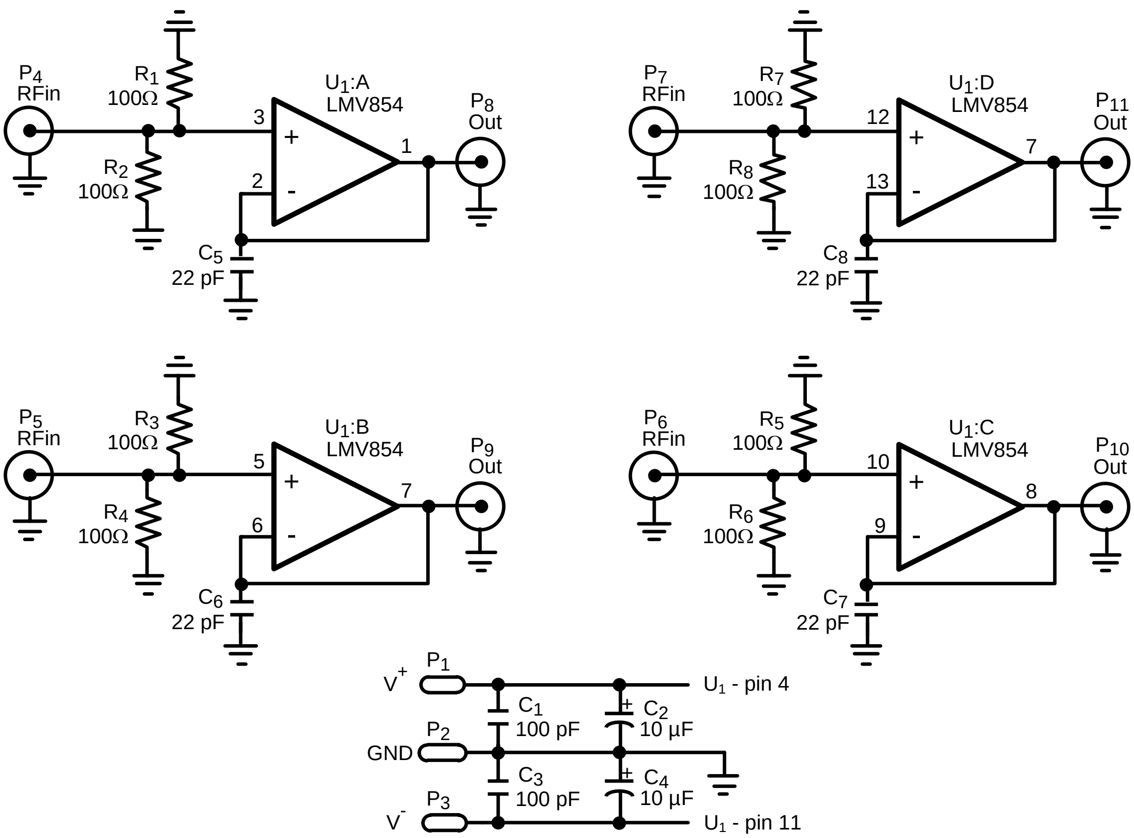

Figure 7. Schematic for LMV854, Coupling RF Signal to the IN+ Pin

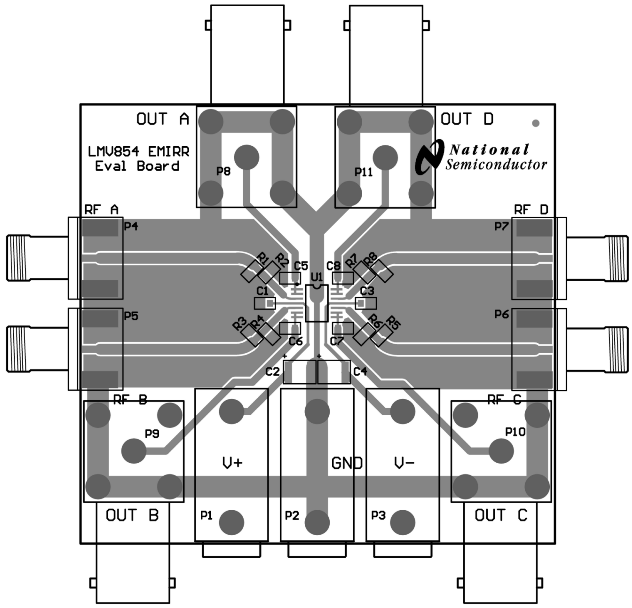

Figure 8. Layout for LMV854, All Layers

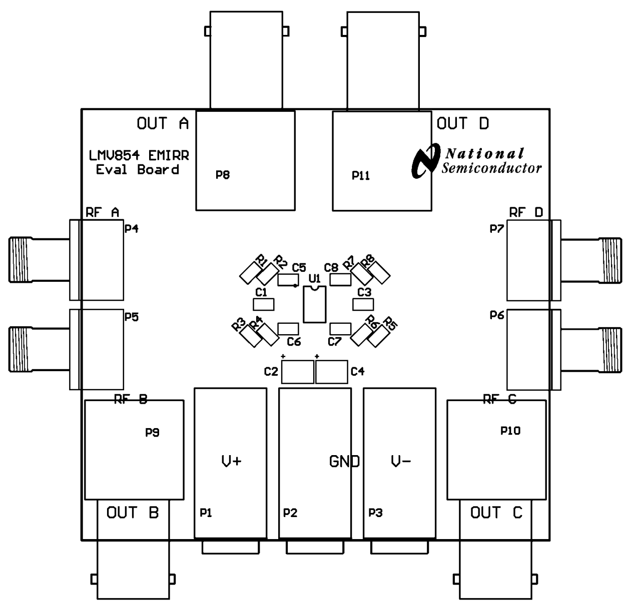

Figure 9. Layout for LMV854, Silk Screen

10 Measurement Results

To show the sensitivity of the IN+ pin two types of measurement results are presented using the LMV851 evaluation board:

- The EMIRR as a function of the *frequency* of the applied signal. The level of the signal is set to the standard level of 100 mV_P (−20 dBV_P).
- The EMIRR as a function of the *level* of the applied signal. The frequency is set to four typical values: 400 MHz, 900 MHz, 1.8 GHz, and 2.4 GHz.

10.1 EMIRR vs Frequency

Figure 10 depicts the EMIRR versus frequency for the various temperatures. The measurement is performed with a fixed RF level of −20 dBV_P and a varying RF signal frequency. The frequency range is 10 MHz to 4 GHz.

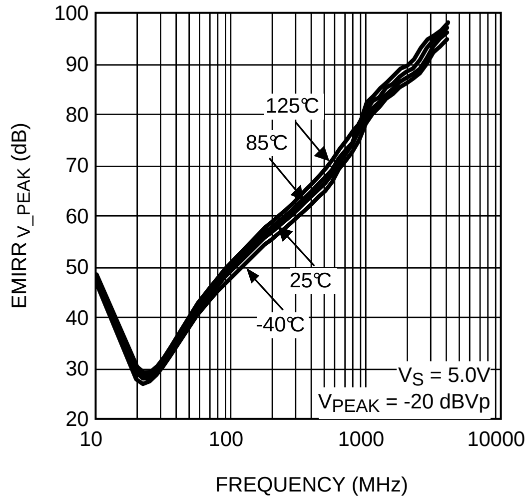

Figure 10. EMIRR vs. Frequency

10.2 EMIRR vs Power

Figure 11 depicts the EMIRR as a function of power at four typical frequencies.

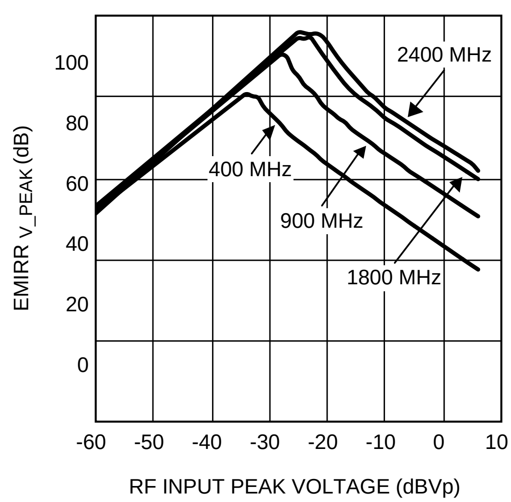

Figure 11. EMIRR vs. Power

In this figure two areas can be distinguished. At the left side of the figure, the EMIRR increases as a function of input level; whereas at the right side the EMIRR decreases as a function of the input level.

The left side of the figure is actually an artifact resulting from the limited accuracy of the measurement setup. For the relatively low input levels, the resulting offset voltage shift is well below the noise level. Thus, when calculating the EMIRR for that region, the ratio of the input level to the noise level is depicted. As the noise level is constant for the setup, an increasing EMIRR is obtained for increasing input signal level.

For the right side, the obtained offset-shift is well above the noise level. As the relation between offset voltage shift and RF input level is quadratic, the ratio as used in the EMIRR is inversely proportional to the RF input level, which is in line with the displayed slope of "−1".

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