

# Tuning J-board LNA to match the EDGES LNA S11

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## 1. INTRODUCTION

The primary goal of this report is to measure the S-parameters of the J-board and the EDGES Low Noise Amplifier (LNA) and subsequently compare their characteristics. Additionally, the report aims to optimize the S-parameters of the J-board to match those of the EDGES LNA through tuning.

## 2. CIRCUIT DIAGRAM

J-boards LNA is a replication of EDGES LNA circuit from MIT memo 300 as shown in Fig 1. EDGES LNA uses ATF-54143 transistor which is discontinued. Instead of ATF J-board uses SAV541+ transistor as shown in Fig2. Three RF probes are added to J-board LNA for RF debugging and tuning of LNA.

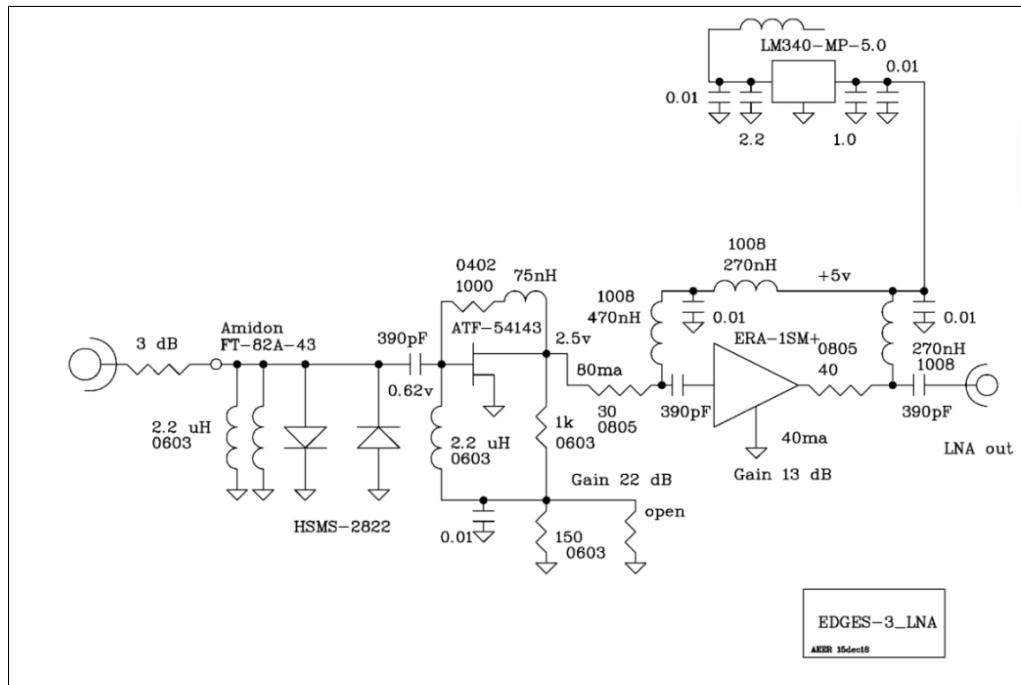


Fig. 1. ECircuit diagram of EDGES LNA (MIT MEMO 300)

## 3. S11 COMPARISION OF EDGES LNA AND J-BOARD

Fig 3 shows the comparison of S11 of EDGES LNA and J-barad LNA for frequency from 40 MHz to 200MHz. The dashed line is J-board LNA in which the resonance is off by around 50MHz when compared with EDGES S11. By tweeking components around the transistor we need to match the resonance to EDGES S11.

## 4. EFFECT OF INDUCTOR L28 AND 29 ON J-BOARD S11

Fig4 shows the effect of L28 and 29 on S11 for J-board. The dashed line is with both inductor in the circuit, the dased doted (yellow) is with only L29 in the circuit and the doted line is without

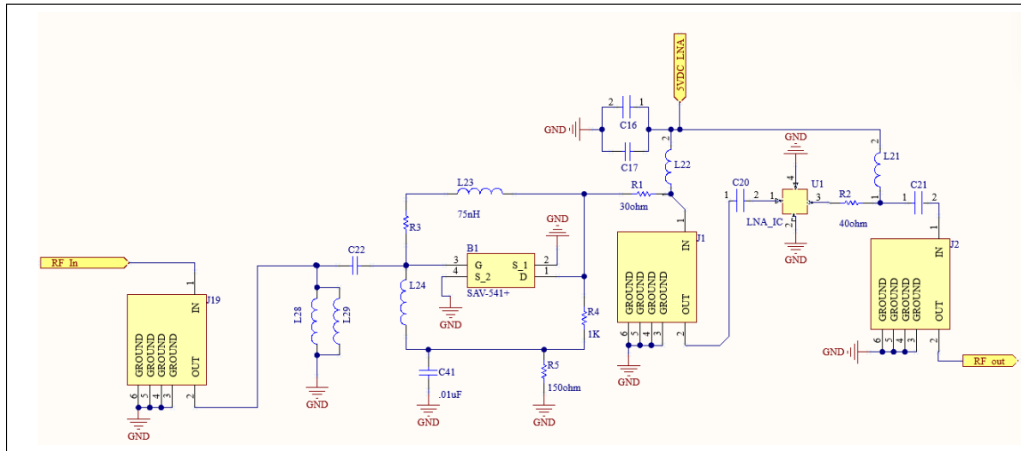


Fig. 2. J-board LNA

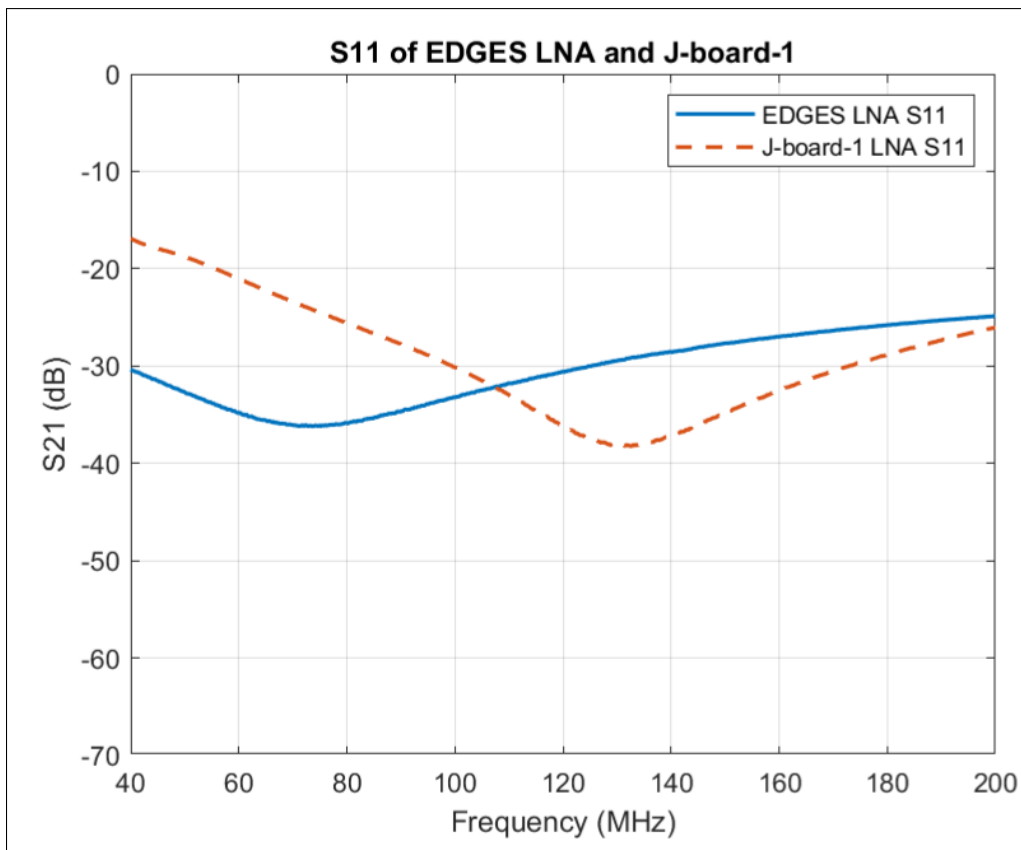
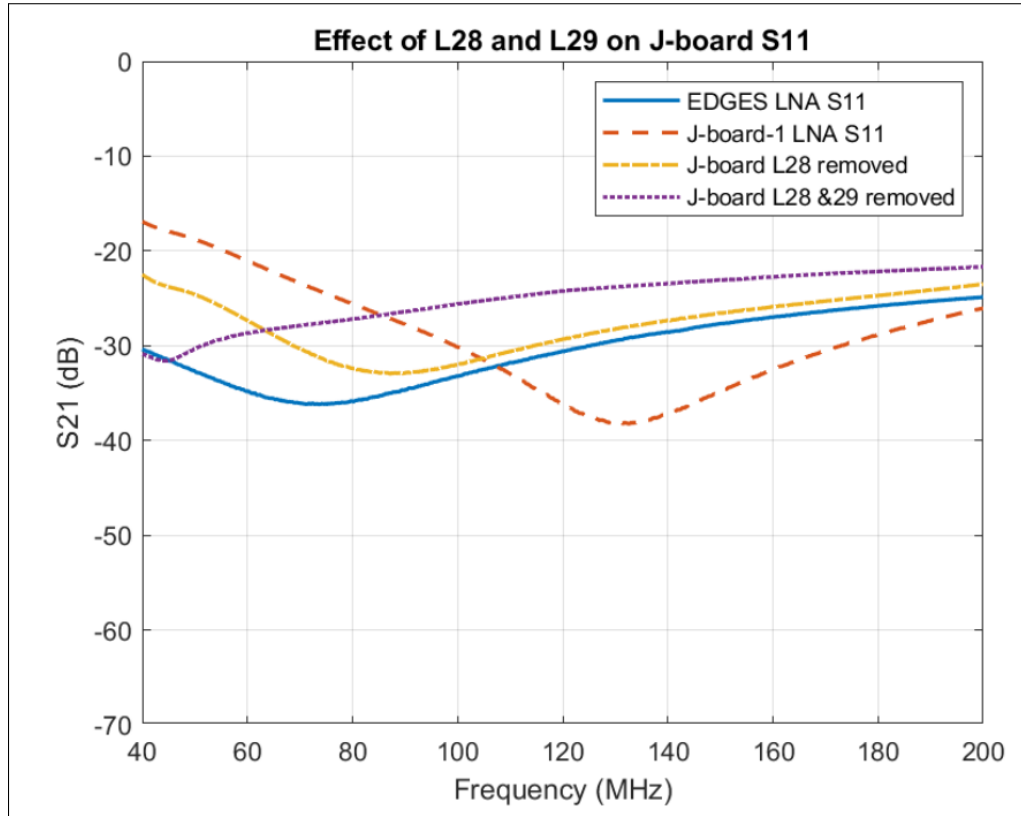


Fig. 3. S11 comparison of EDGES LNA and J-board LNA

L29 and L28. From the plots it is clear that removing one inductor shifts the resonance towards lower frequency. With one inductor S11 is getting close to EDGES S11.



**Fig. 4.** Effect of L28 and 29 on S11

### 5. EFFECT OF CAPACITOR C22

The capacitor value of C22 is varied from 4700pF to 330 pF. Fig 5 shows the effect of capacitor C22. From the S11 plots, it is clear that as the value changes from higher to lower, the resonance frequency also shifts from higher to lower. A capacitor value of 1000pF will give a resonance that is closer to S11 of EDGES LNA.

### 6. EFFECT OF RESISTOR R3

R3 is one of the biasing resistors of the transistor. Four different R3 of 1k are soldered on after the other to see the variability. Fig 6 shows the effect of different R3 1K resistors. There isn't any noticeable difference in the S11.

### 7. EFFECT OF CHANGING SAV 541+ TRANSISTOR

SAV-541+ is an ultra-low noise, high IP3 transistor device manufactured using E-PHEMT. Three different transistors are soldered one after another, measured the S11, and plotted. Fig 7 shows that S11 varies with transistors, and we need to try different transistors and find one with minimum S11.

### 8. MEASUREMENT SETUP.

- All measurements are done after 2-port calibration with cables connected to VNA.
- J-board is connected to VNA using two RF probes, which cannot be calibrated(Fig 8. Left)
- EDGES LNA is connected directly to the calibrated cable(Fig 8. Right)

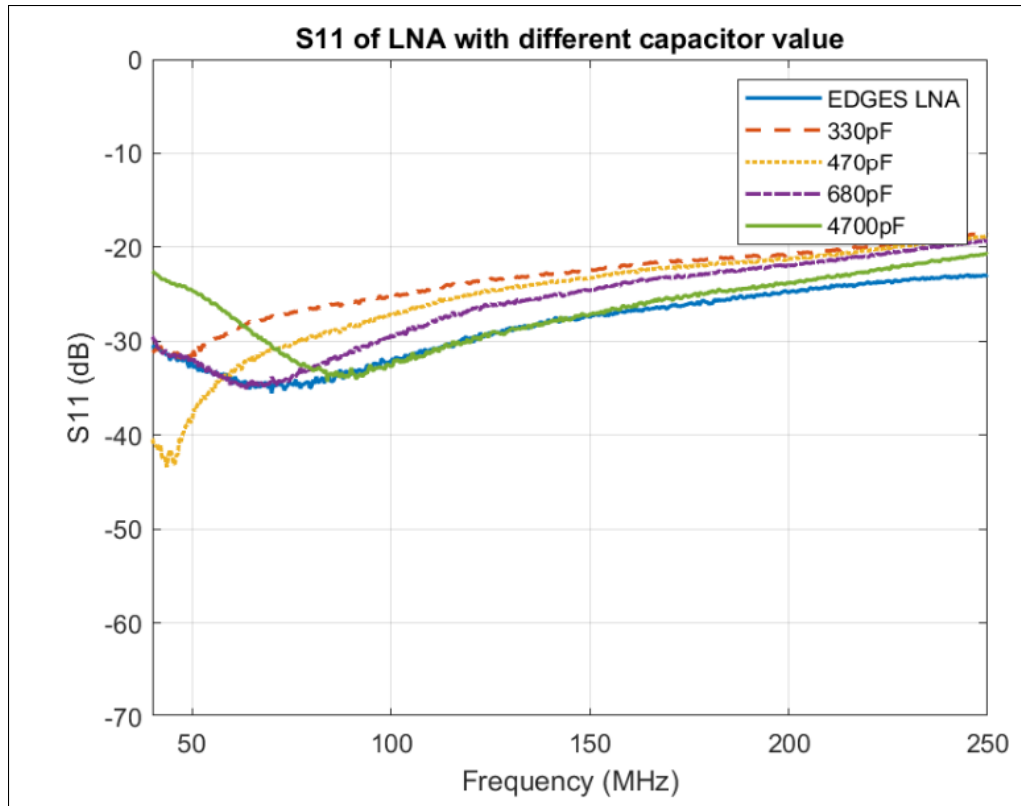


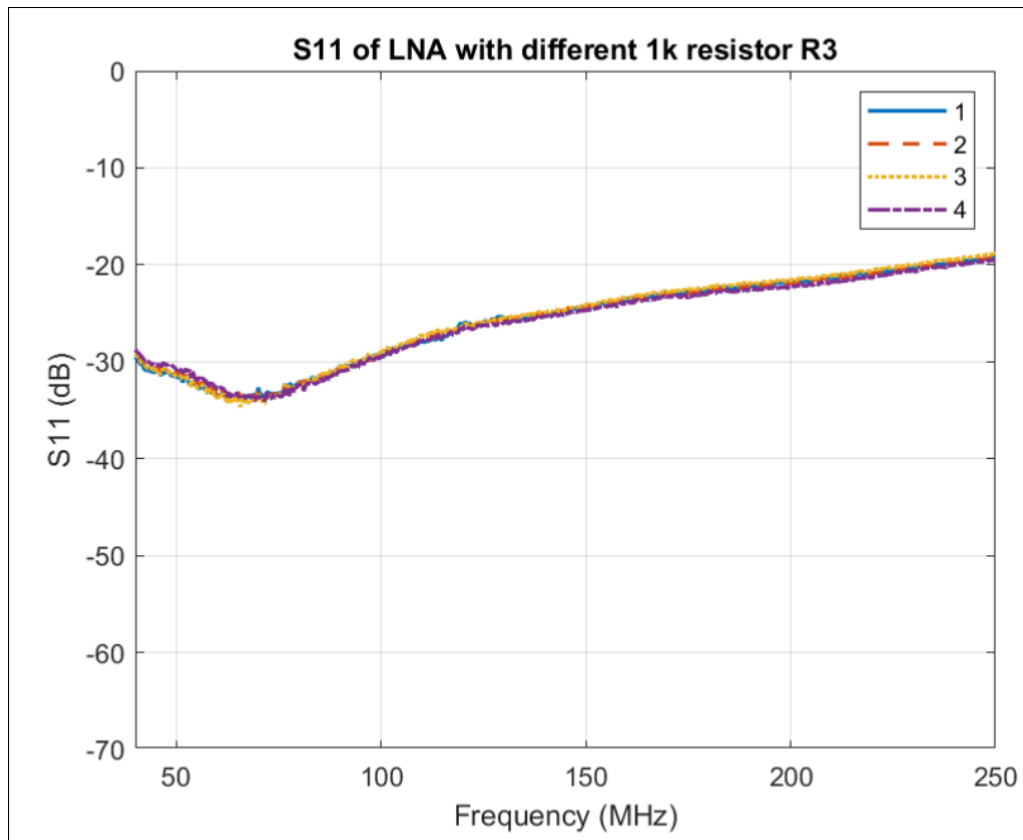
Fig. 5. Effect of capacitor C22 on S11

### 9. S-PARAMETER COMPARISON J-BOARD 1 VS. EDGES LNA

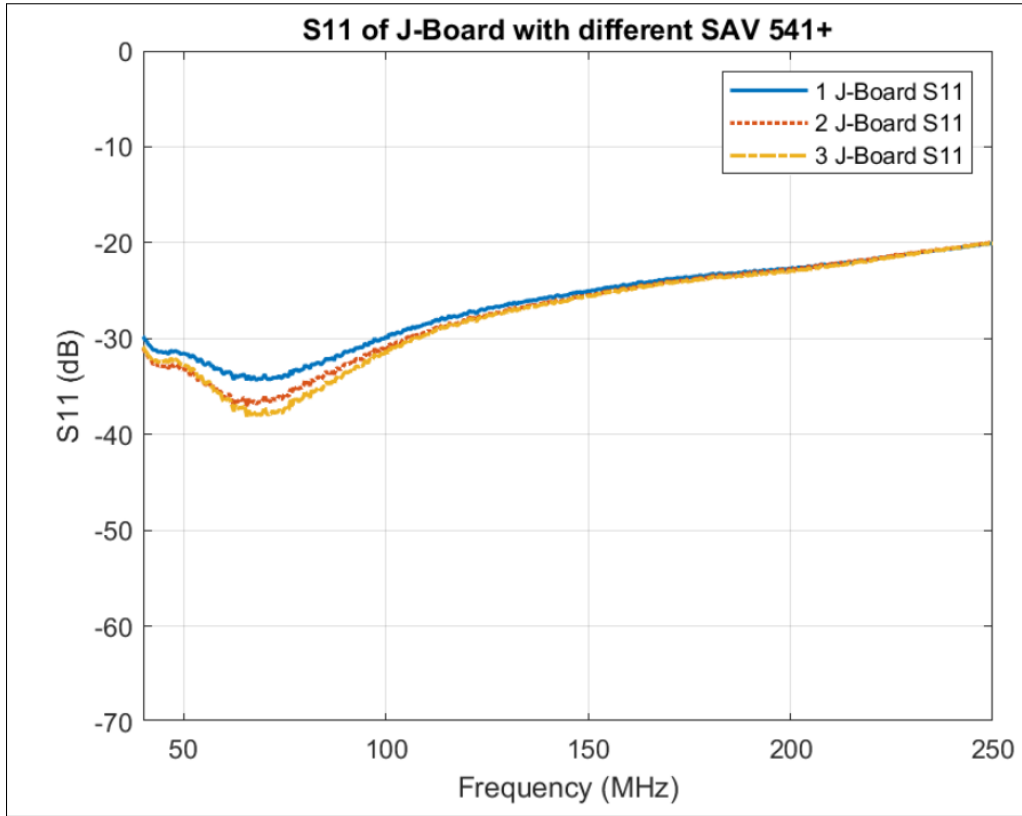
Optimized components

- L28 ,L29 - only one inductor with a value of 2.2uH
- C22 - 1000pF
- SAV541+ - transistor with minimum S11

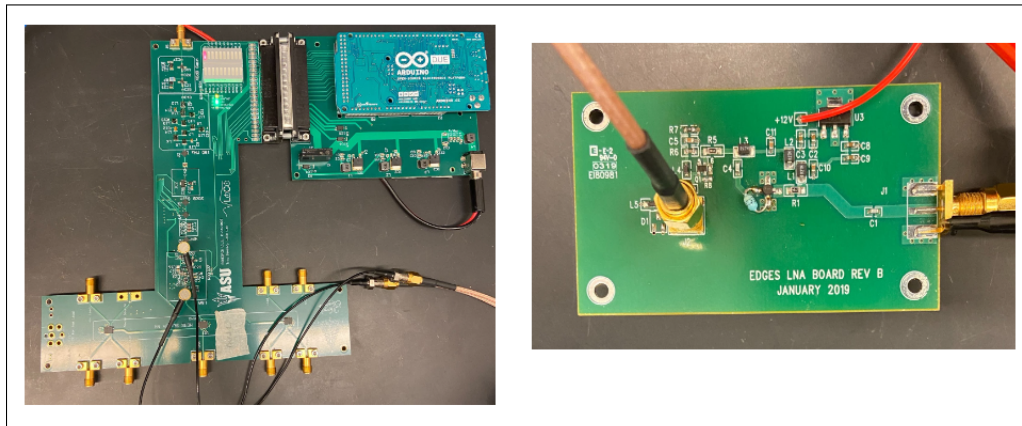
### 10. S-PARAMETER COMPARISON J-BOARD 2 VS. EDGES LNA



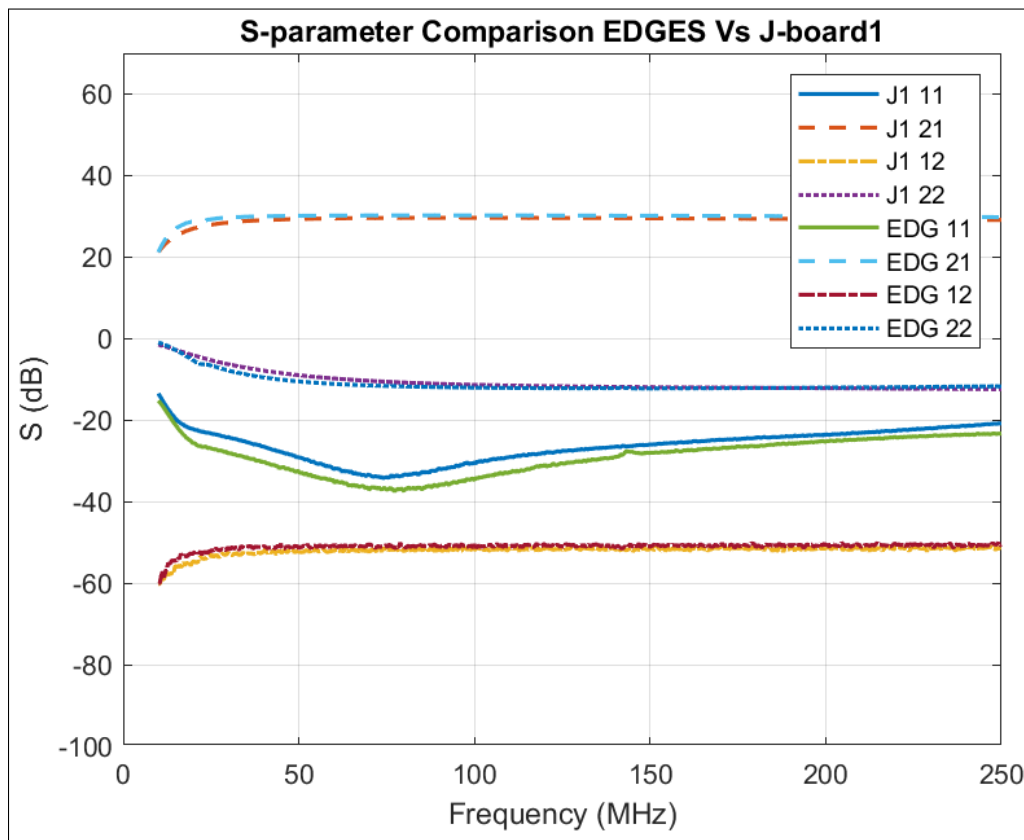
**Fig. 6.** Effect of changing the R3 1k resistor



**Fig. 7.** Effect of SAV541+ transistor on S11



**Fig. 8.** Measurement setup a) J-board with connected RF probes b) EDGES LNA



**Fig. 9.** S-parameter EDGES LNA compared with J-board1

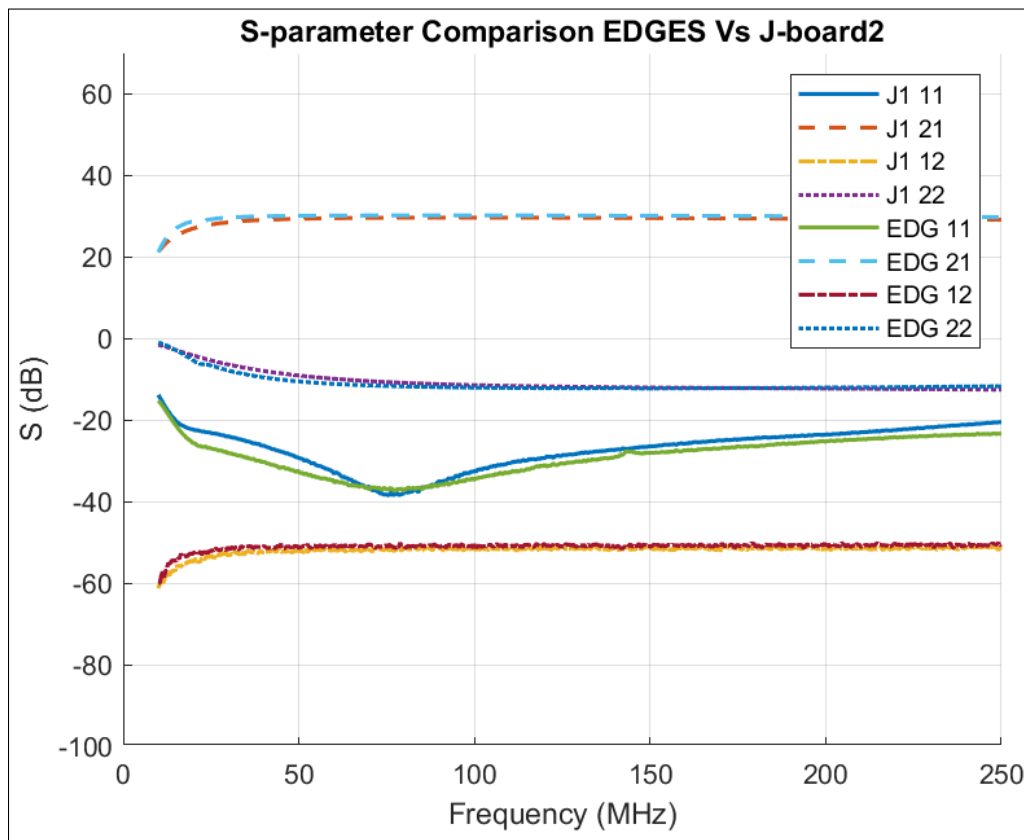


Fig. 10. S-parameter EDGES LNA compared with J-board2