UNIVERSITÄT DUISBURG ESSEN

Offen im Denken

Fachgebiet Hochfrequenztechnik

Feedback Loop Canceller Circuit

Bachelor Thesis

Ahmad Bader Ibrahim Obeidat

Supervised by
Prof. Dr.-Ing. Klaus Solbach

17.11.2014

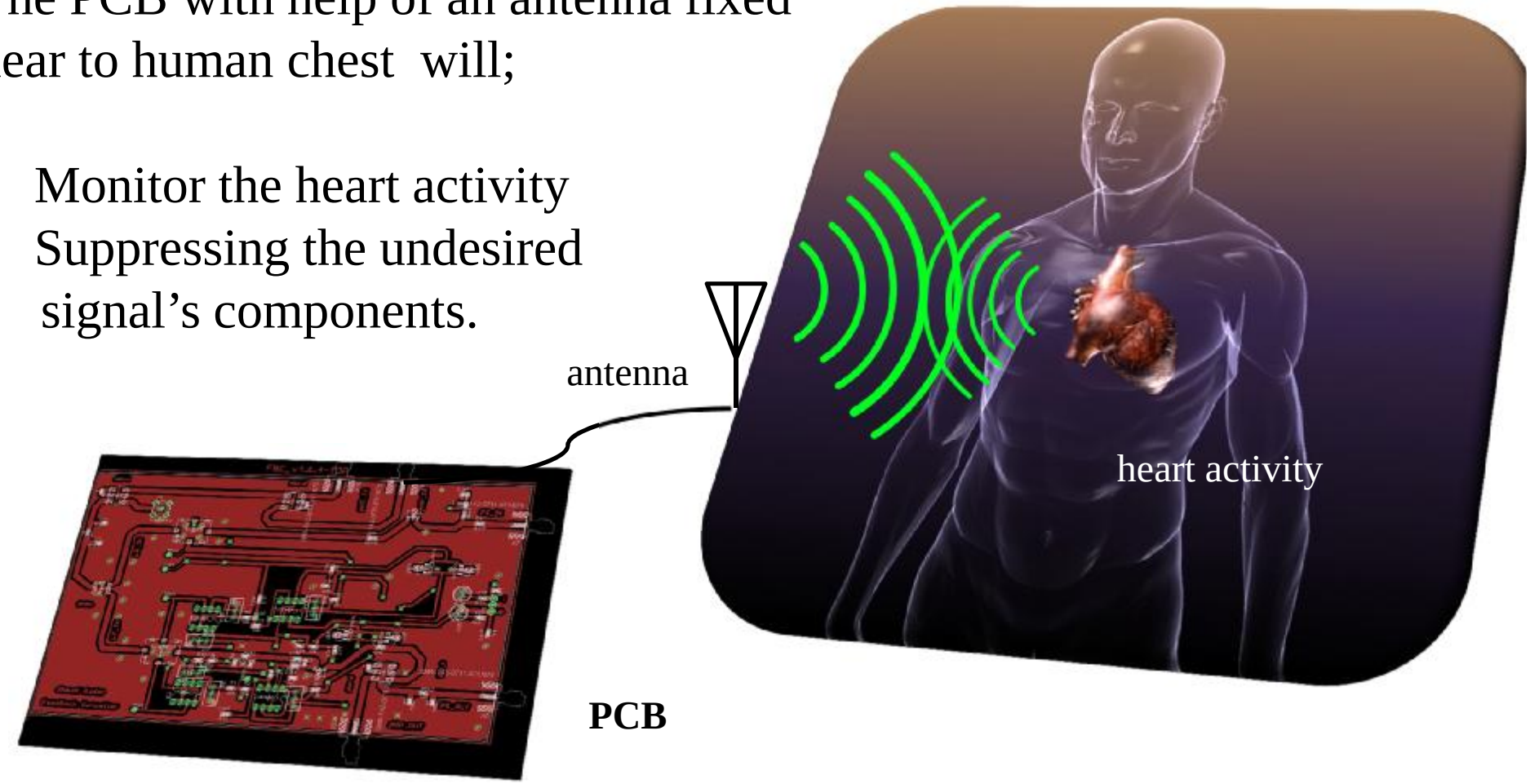
Outline:

1 Motivation
2 Circuit description
3 Tasks and objectives
4 Active and passive Components
5 PCB Design
6 PCB Assembly
7 Testing and Measurements
8 Conclusions

1. Motivation:

Designing a PCB to monitor the heart activity.
The PCB with help of an antenna fixed near to human chest will;

- Monitor the heart activity
- Suppressing the undesired signal's components.



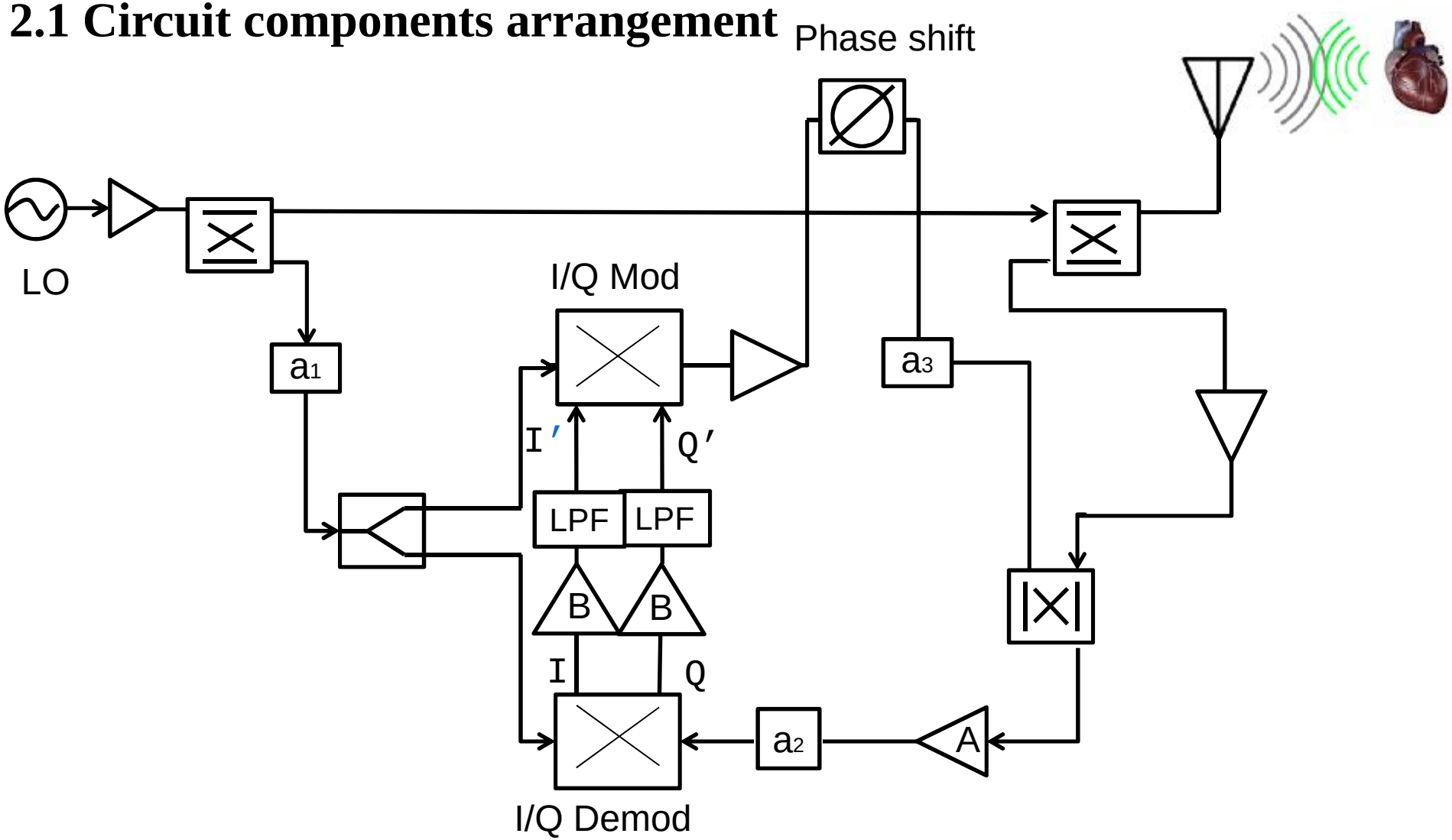
2. Circuit description:

2.1 circuit components :

- Directional couplers
- Power splitter
- IQ Modulator/Demodulator
- TL071CP
- Gali5+ Amplifiers
- SMD components (Resistors, Capacitors and Inductors)

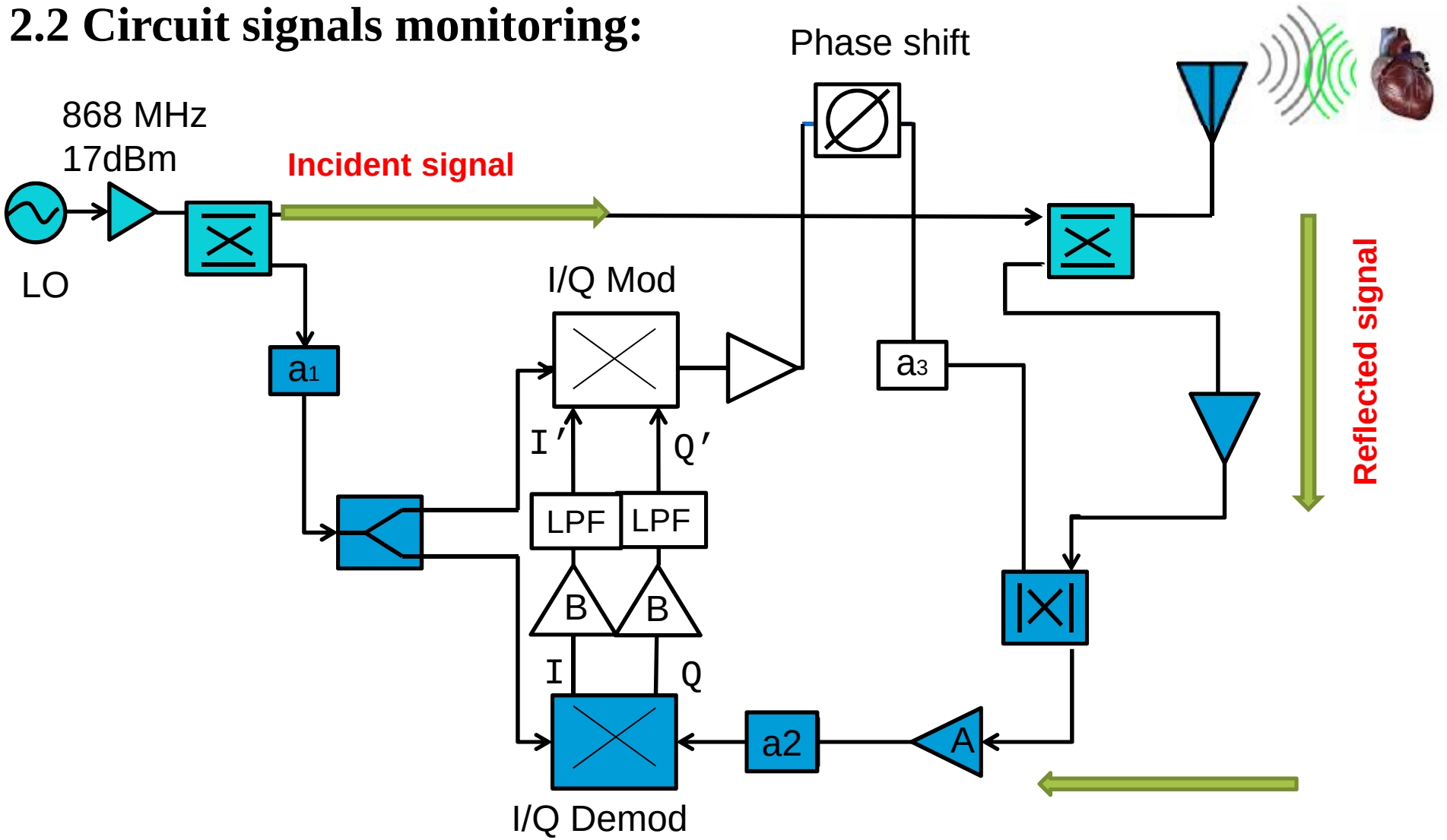
2. Circuit description:

2.1 Circuit components arrangement



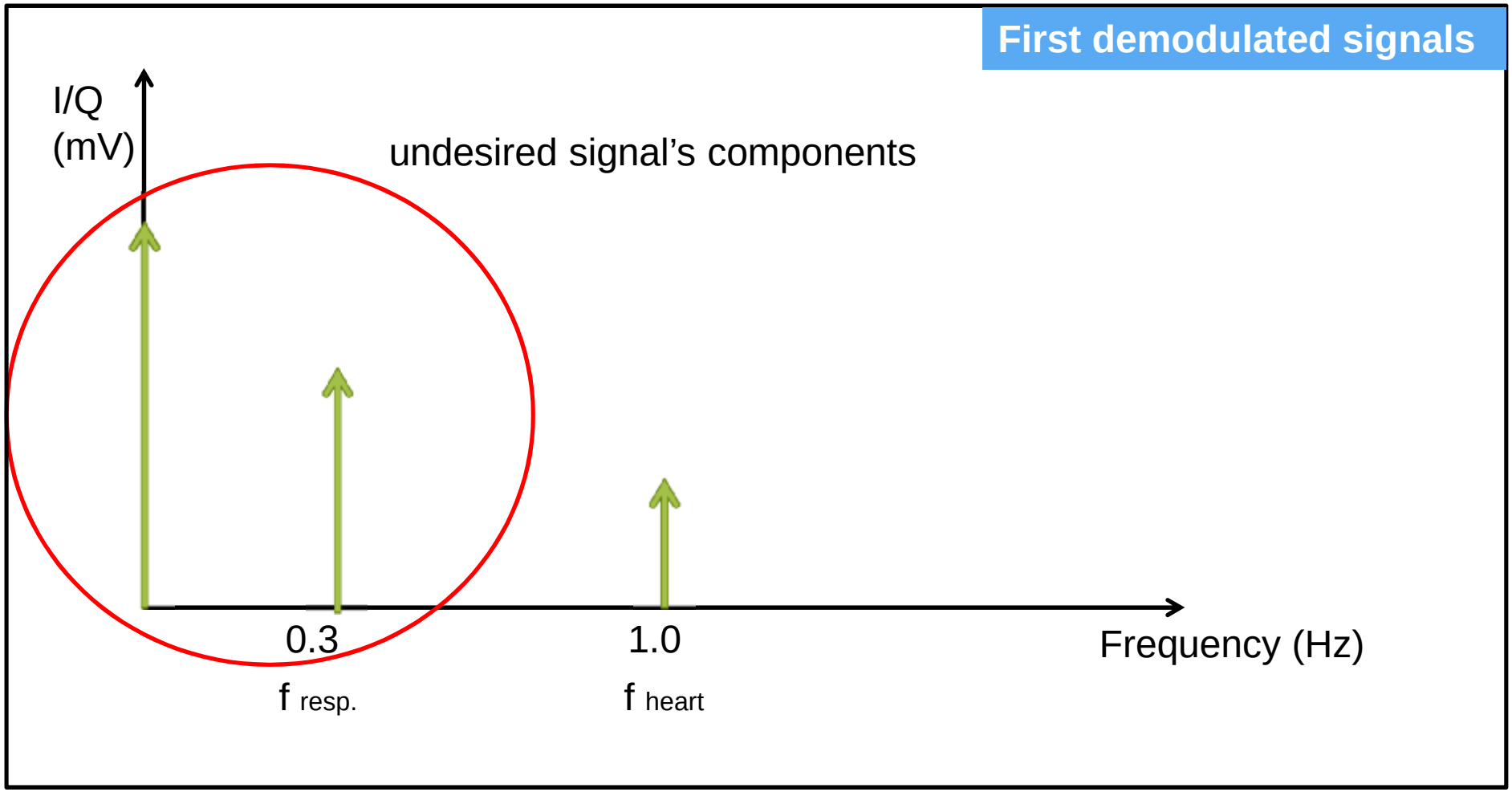
2. Circuit description:

2.2 Circuit signals monitoring:



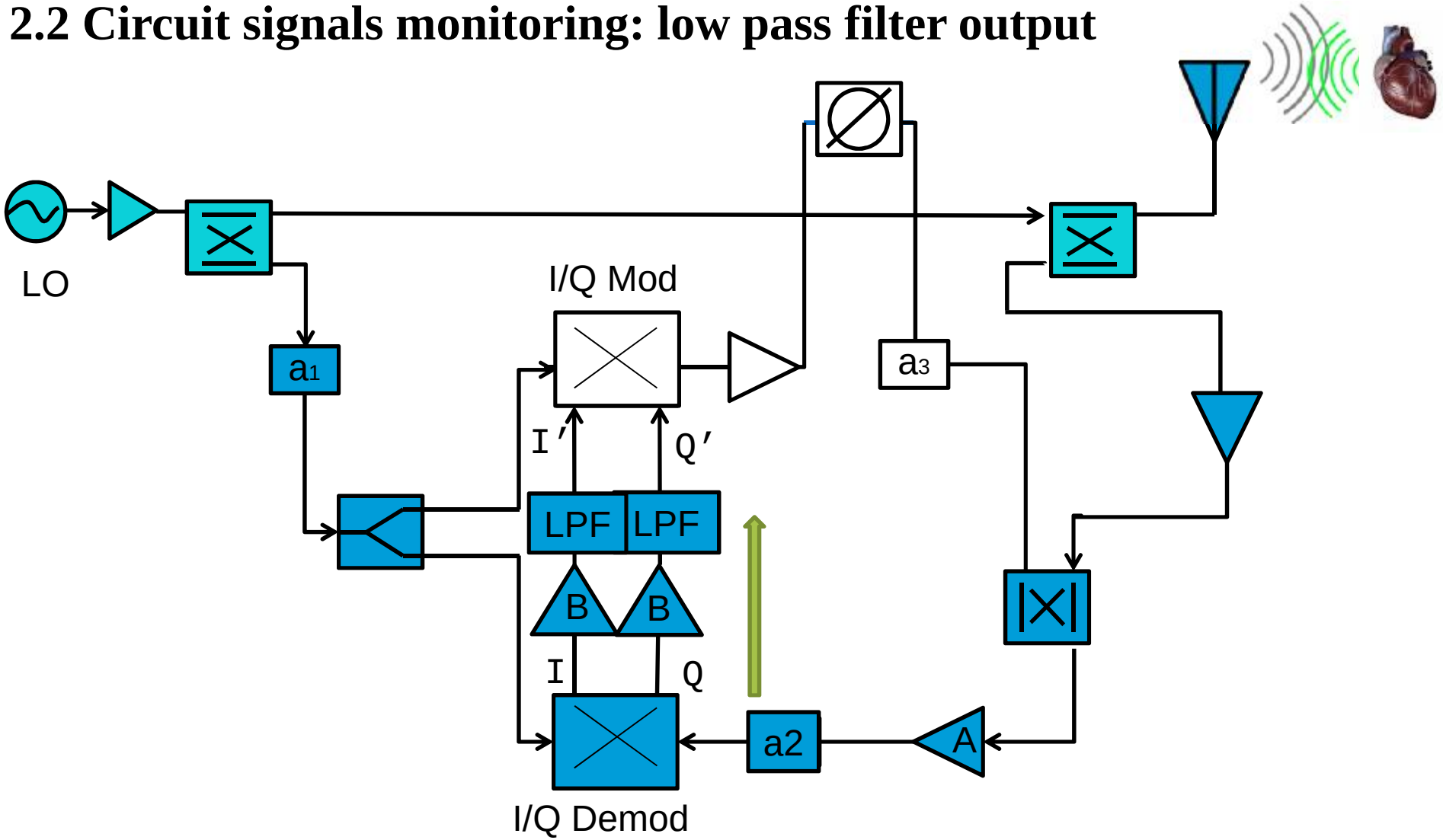
2. Circuit description:

2.2 Circuit signals monitoring: signal's components



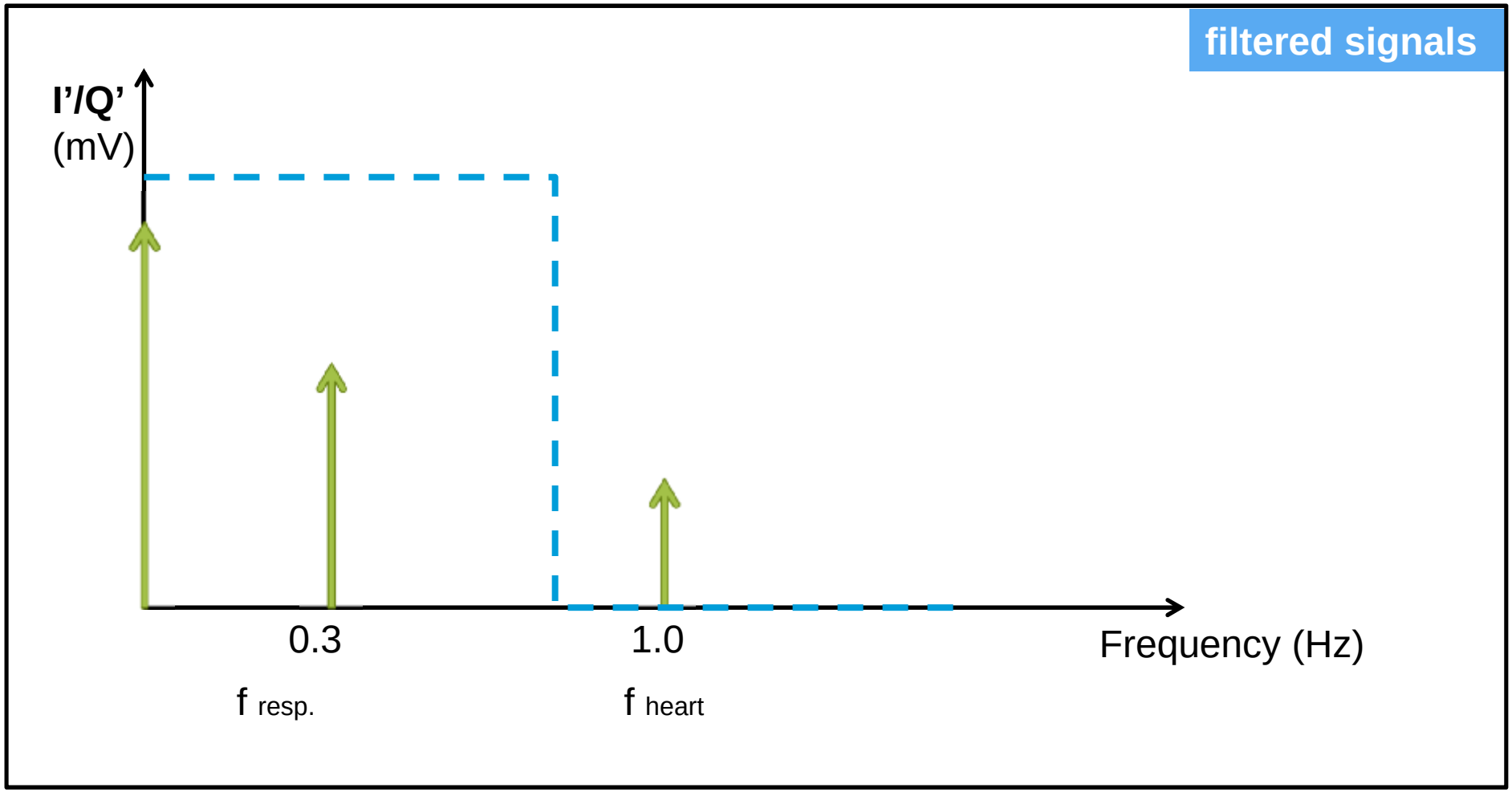
2. Circuit description:

2.2 Circuit signals monitoring: low pass filter output



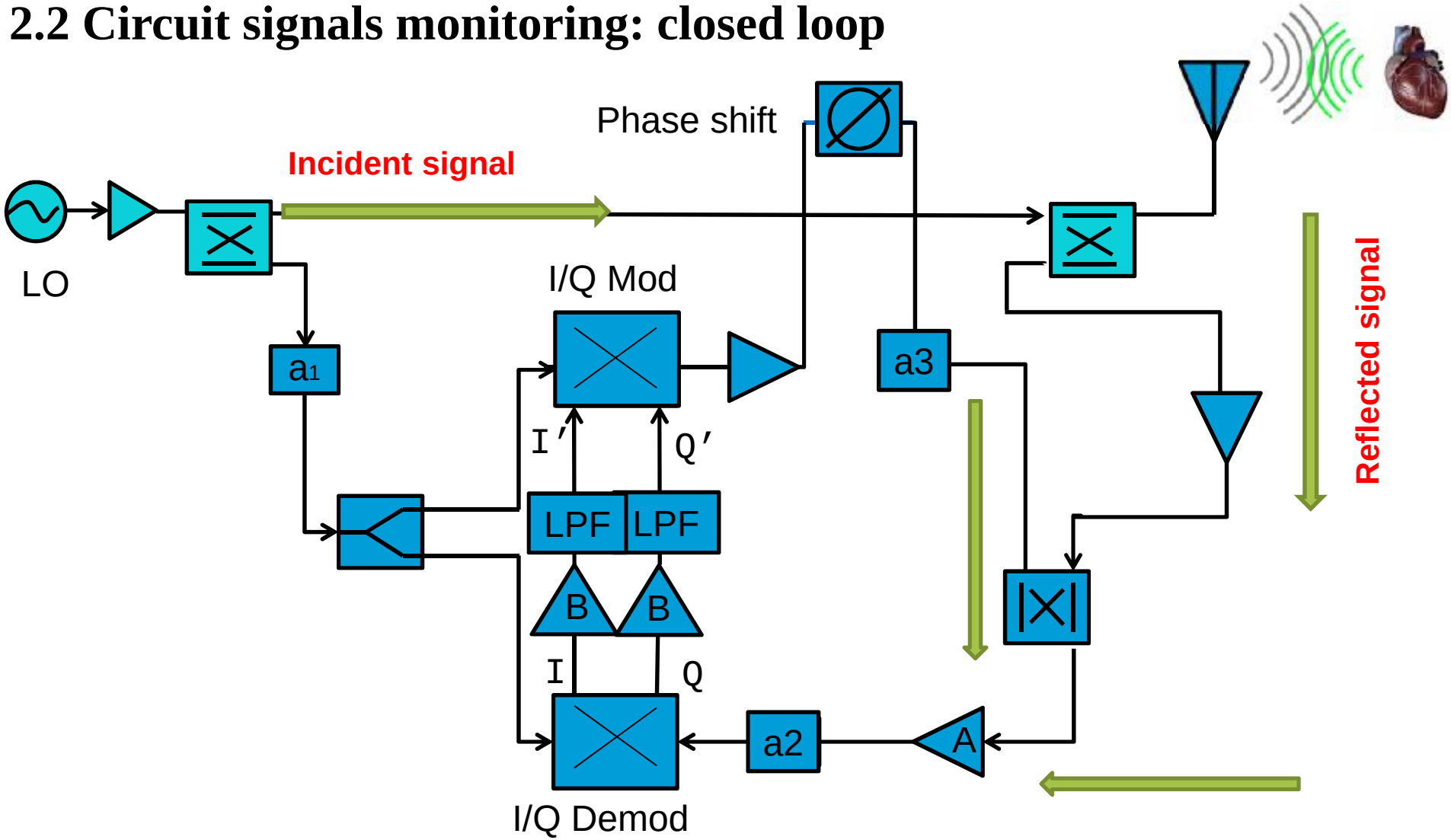
2. Circuit description:

2.2 Circuit signals monitoring: low pass filter output



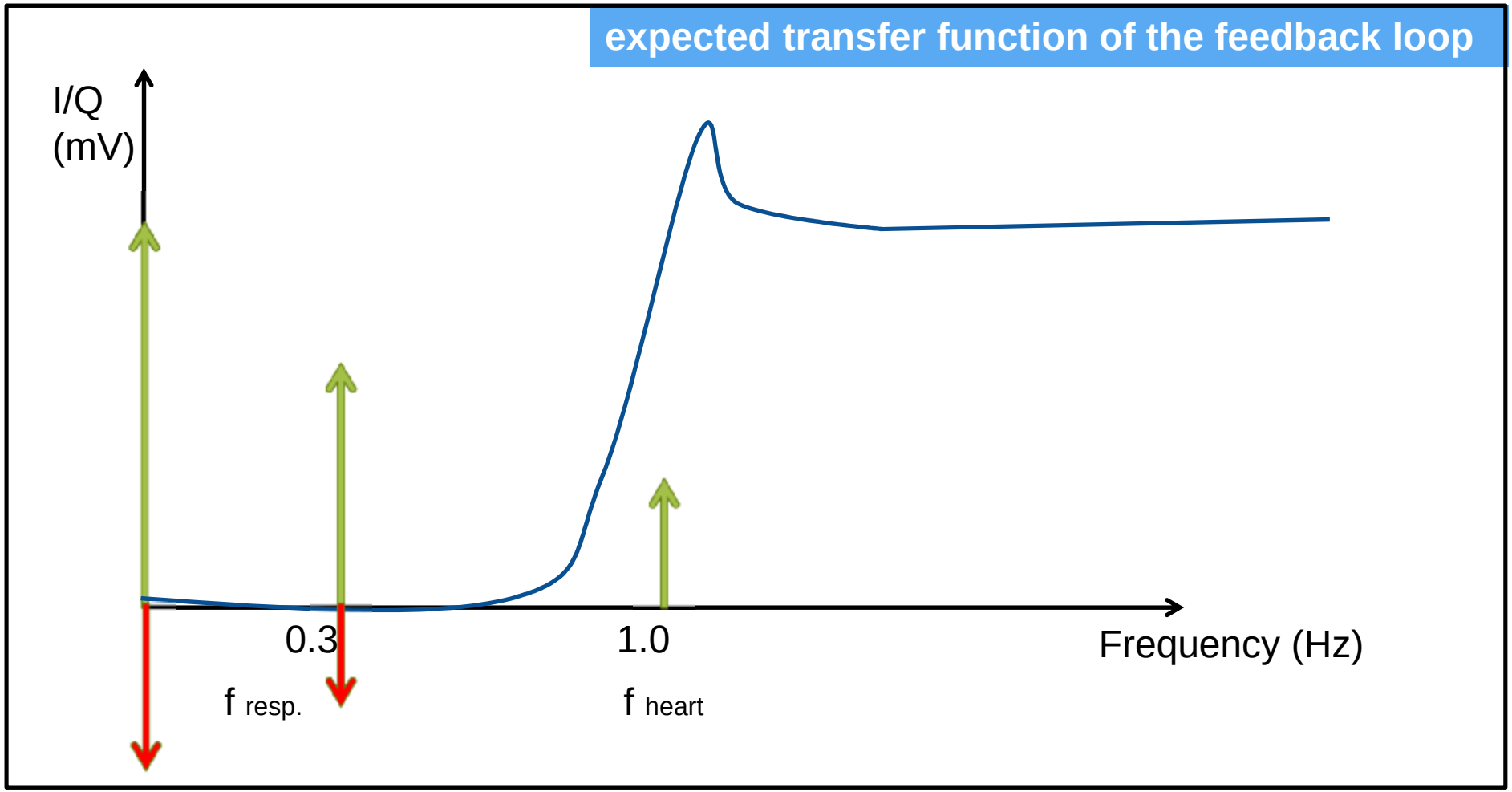
2. Circuit description:

2.2 Circuit signals monitoring: closed loop



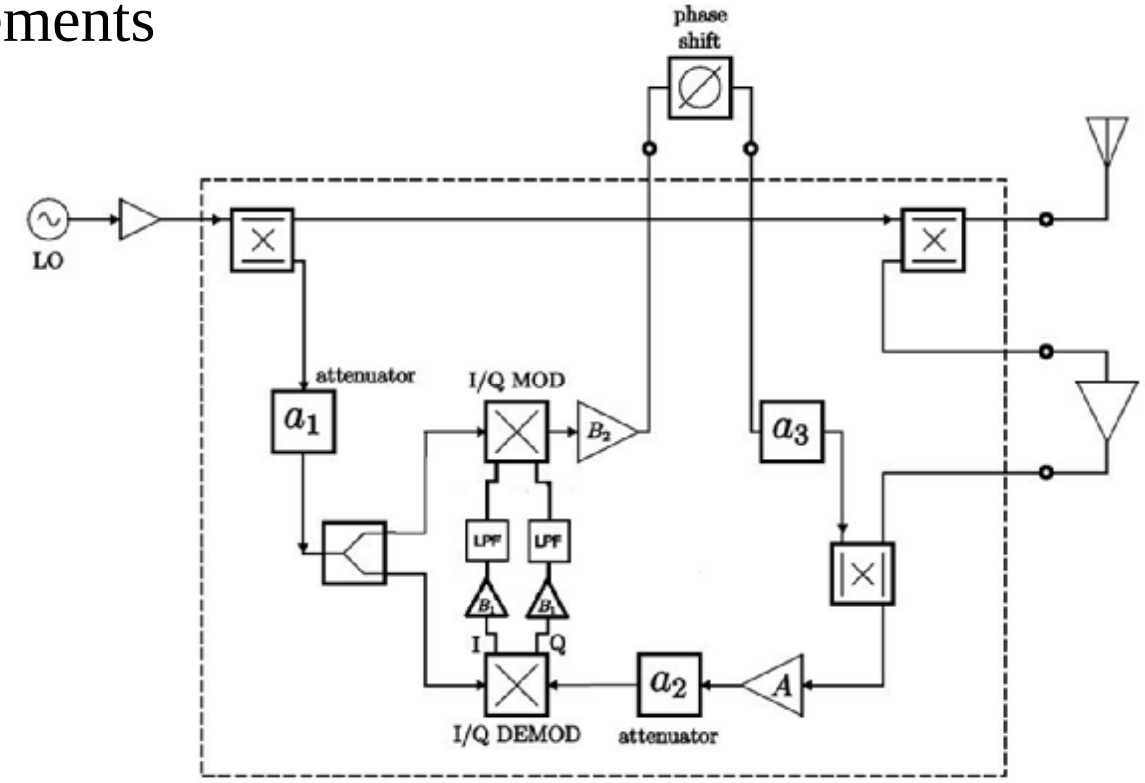
2. Circuit description:

2.2 Circuit signals monitoring: closed loop



3. Tasks

1. Designing : schematic and layout
2. Circuit assembly
3. Testing and measurements



4. Passive and Active Components

4.1 Passive components

1. SMD components:

Advantages

- Smaller components
- Fewer holes to be drilled.
- Flexible soldering
- Good performance at high-frequency

4.1 Passive components

2. MiniCircuit components

Directional Coupler :

FREQ (MHz)	COUPLING (dB)	MAINLINE LOSS (dB)	DIRECTIVITY (dB)
200-1300	6.2±0.5	Max. 2.5	17

IQ-Demodulator :

FREQ (MHz)	CONVERSION LOSS (dB)	AMPLITUDE UNBALANCE (dB)	HARMONIC SUPPRESSION (-dBc)
868 - 895	7.5	0.4	64

IQ-Modulator :

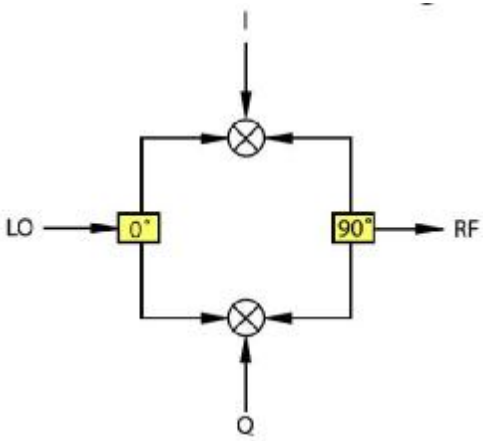
FREQ (MHz)	CONVERSION LOSS (dB)	CARRIER REJECTION (-dBc)	HARMONIC SUPPRESSION (-dBc)
868 - 895	7.5	38	64

4.1 Passive components

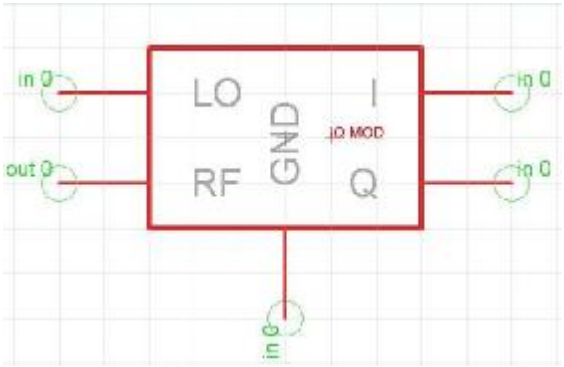
3. IQ-Modulator and IQ-Demodulator:

Advantages

- Low conversion loss, 6.4dB typ.
- Excellent 3rd and 5th order harmonic suppression
- Good amplitude & phase unbalance (demod.)
- Good carrier and sideband rejections (mod.)



IQ-Modulator



IQ-Demodulator

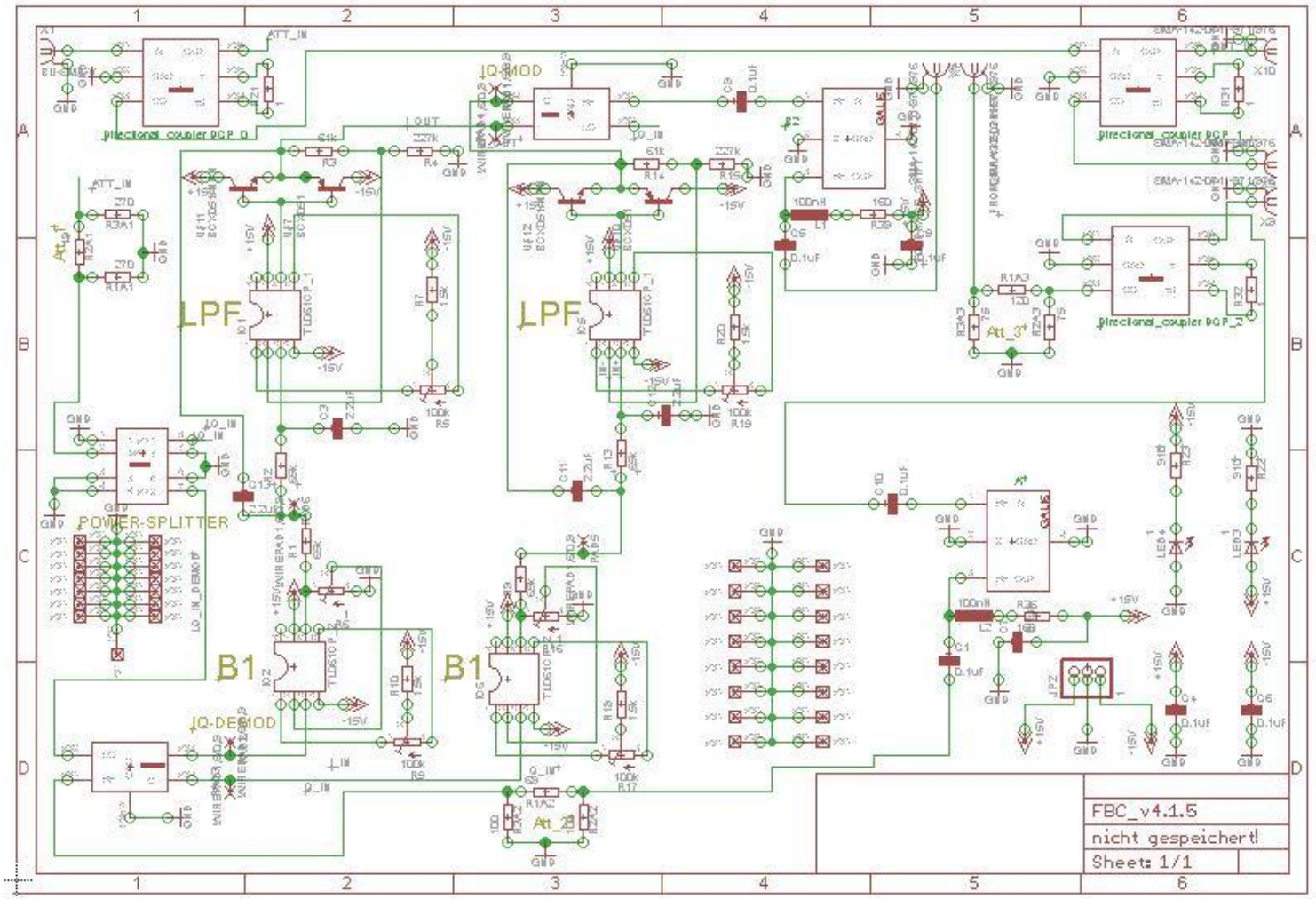
4. Passive and Active Components

4.2 Active components

component	Producer	Power supply	Main purpose
Gali5+	MiniCircuit	+7 V	Signal's Power Amplification
TL071CP	Texas ins.	+/- 7 V	Building the LPF and the I/Q Amplification

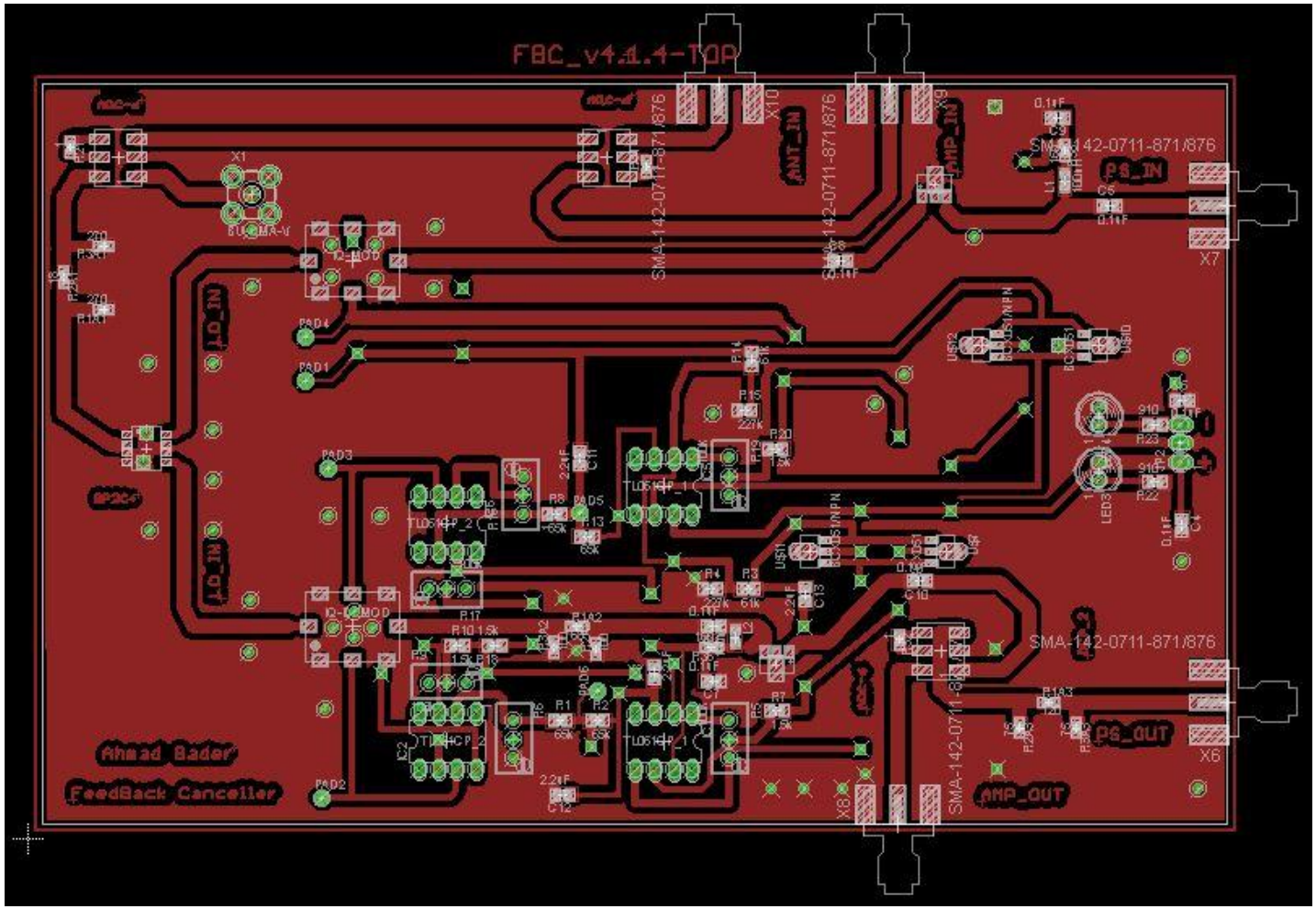
5. PCB Design

Board schematic



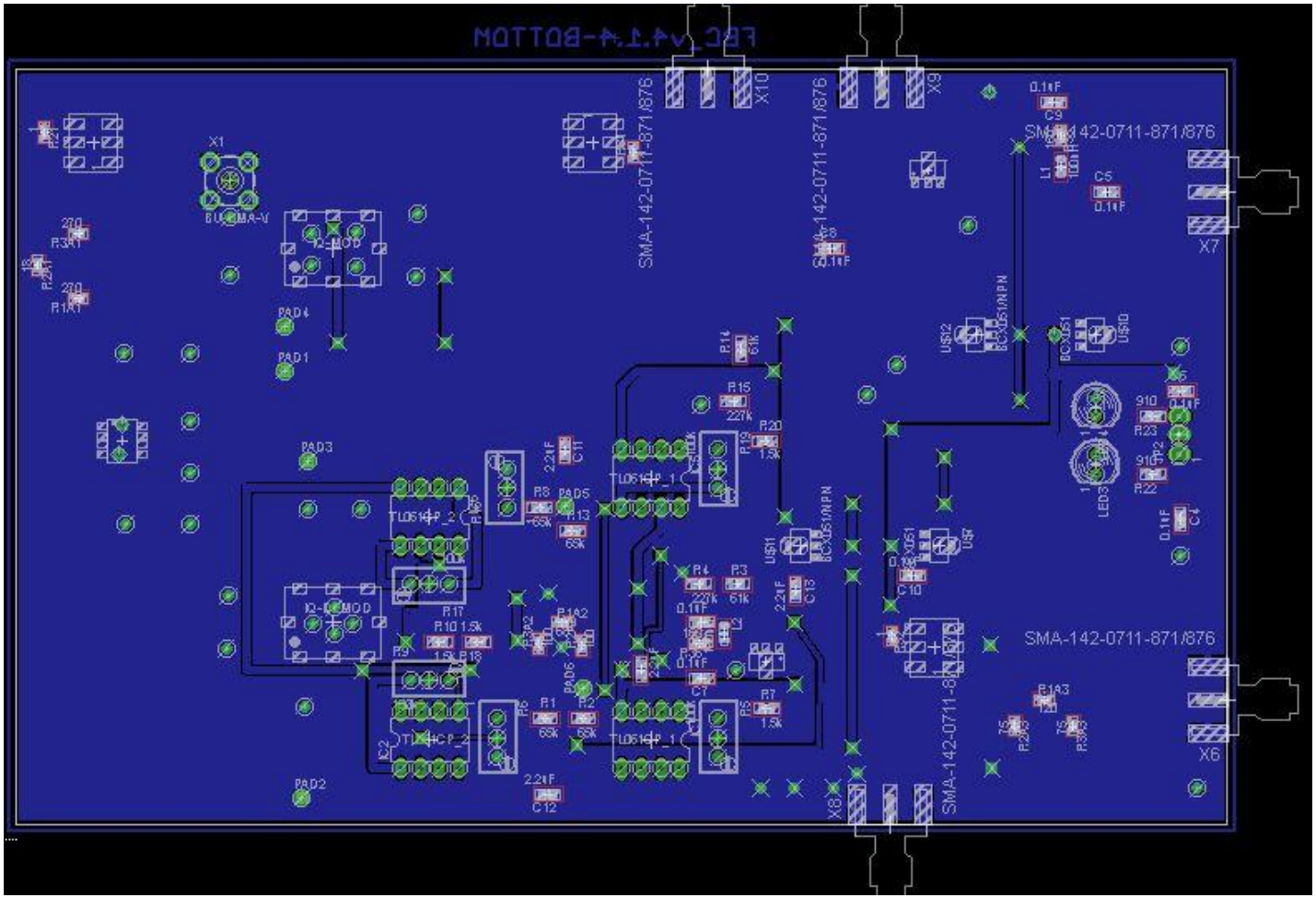
6. PCB Assembly

6.1 Top view



6. PCB Assembly

6.2 Bottom view

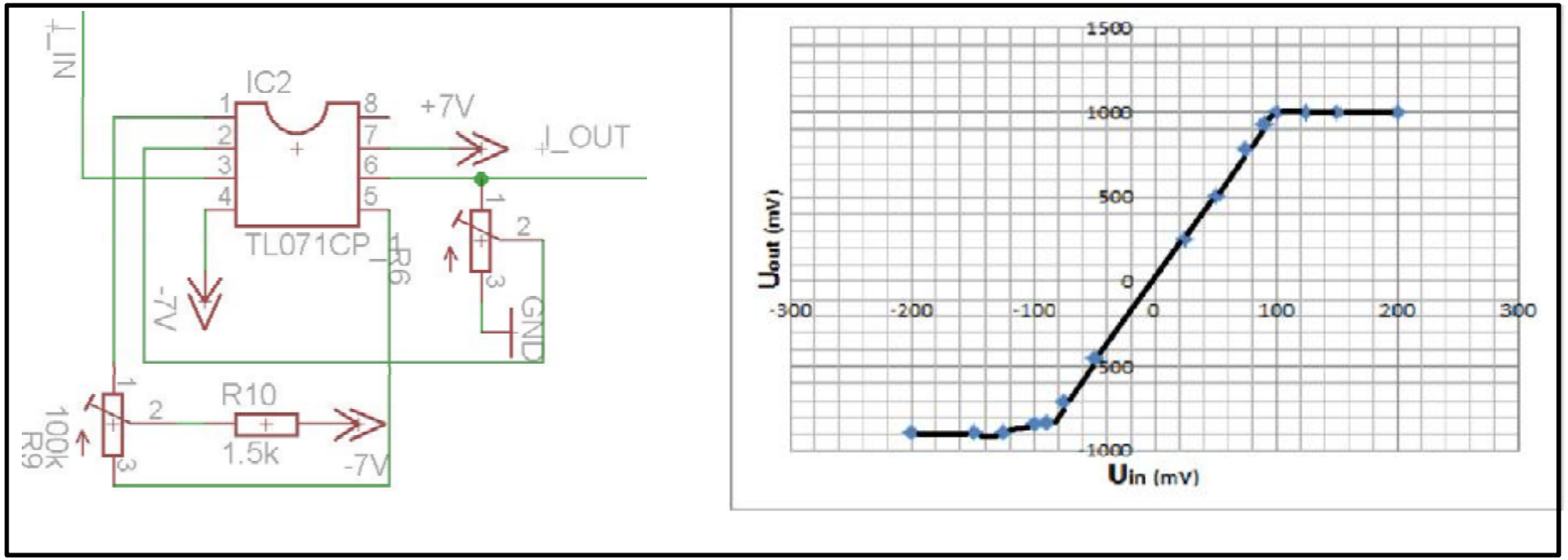


7. Testing and Measurements

7.1 Operational Amplifier (saturation)

$$G = 1 + \frac{R_1}{R_2} = 11.3$$ (potentiometer used to adjust amp. and offset values)

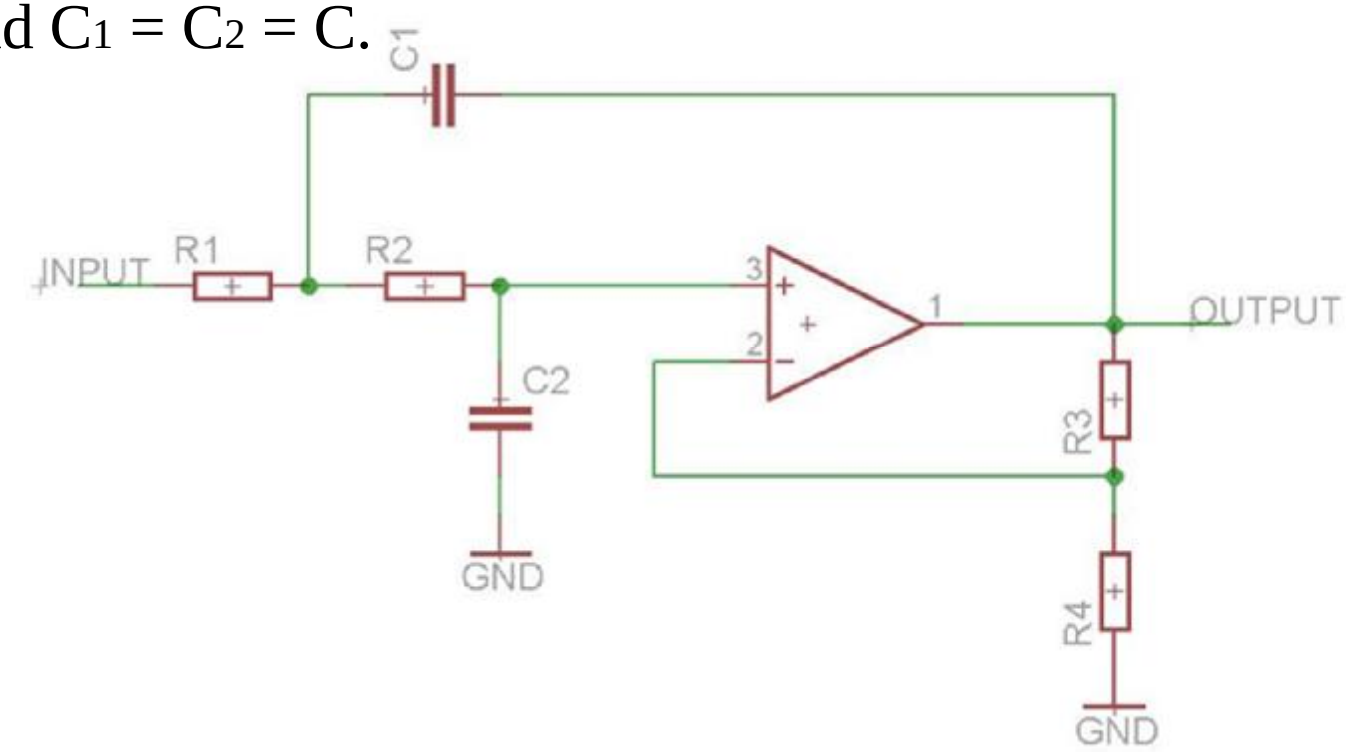
Measurement	Power supply	Procedure	Result
OP-Amp Saturation	+/-7 Volt	Varying input voltage and measure the output voltage	Saturation at +100mV and -125mV



7. Testing and Measurements

7.2 Second-Order Low-Pass Filter

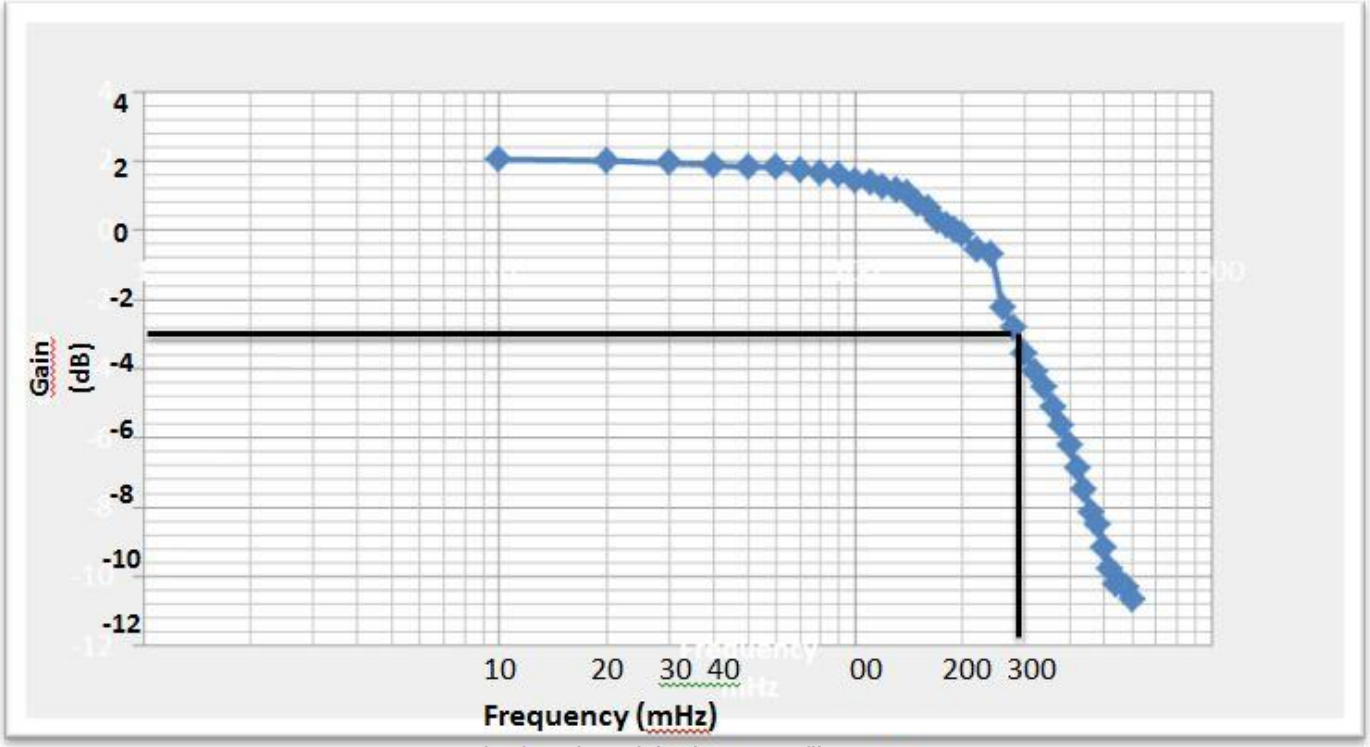
- Sallen-Key Topology
- $f_c = \frac{1}{2\pi RC}$ =0.3 Hz
- $R_1 = R_2 = R$ and $C_1 = C_2 = C$.



7. Testing and Measurements

7.2 Second-Order Low-Pass Filter (transfer function)

Measurement	Power supply	Procedure	Result
transfer function	+/-7 Volt	Using function generator to deliever $V_{pp} = 500mV$ varying the frequency	cutoff frequency is optimal

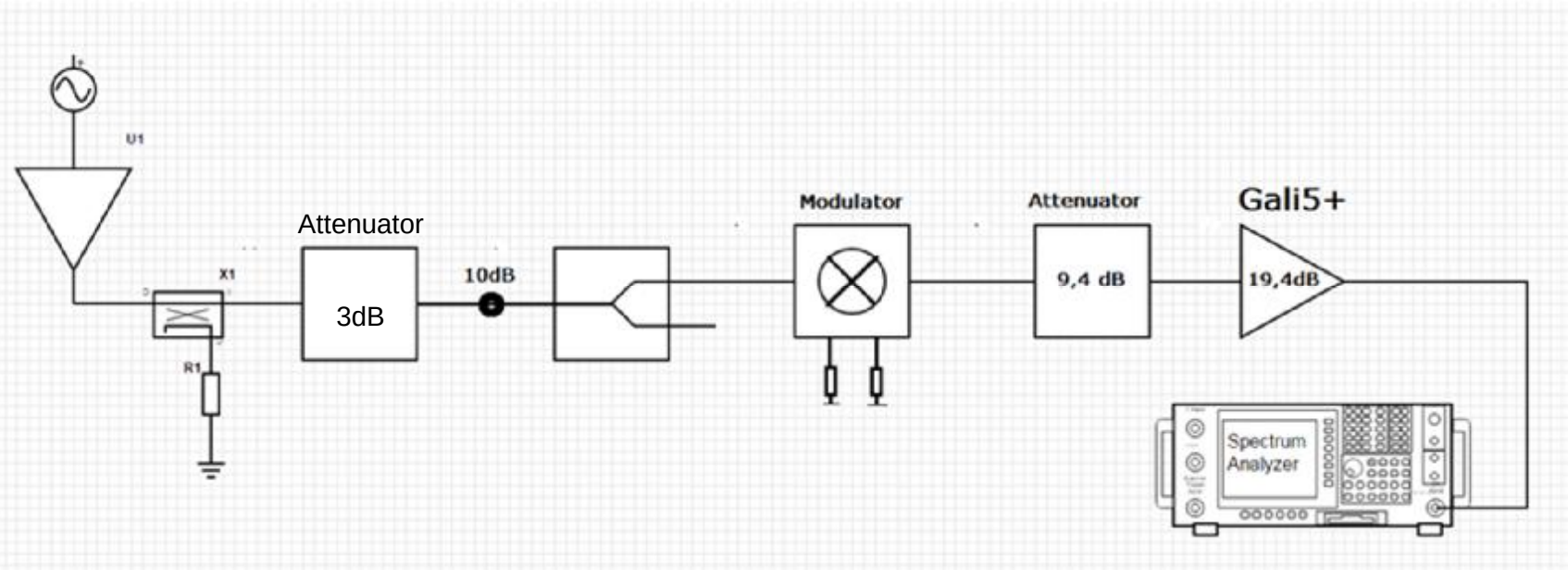


transfer function of the low pass filter

7. Testing and Measurements

7.3 IQ Modulator function test

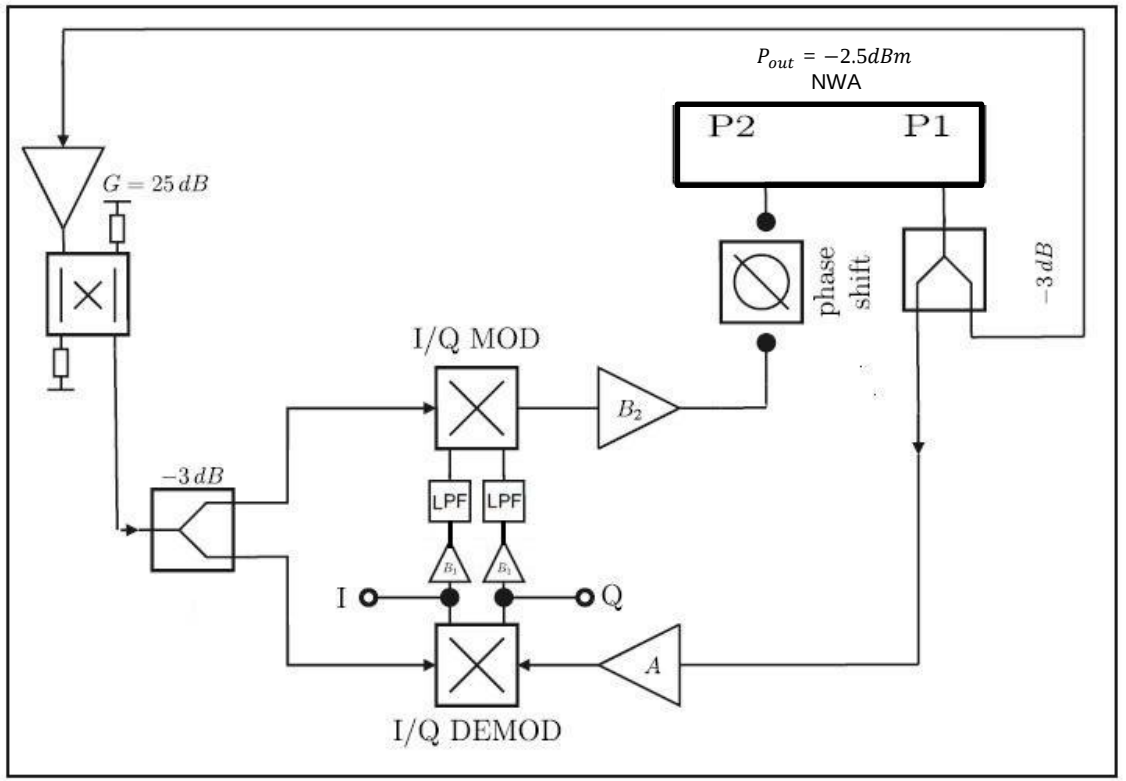
- Equipment used : RF Signal Generator, directional coupler, Power Divider and Spectrum Analyzer.
- Results: Signal's power is low
- Solution :
  - attenuator removed
  - LC filters added
  - Copper tape used



7. Testing and Measurements

7.3 S-Parameter

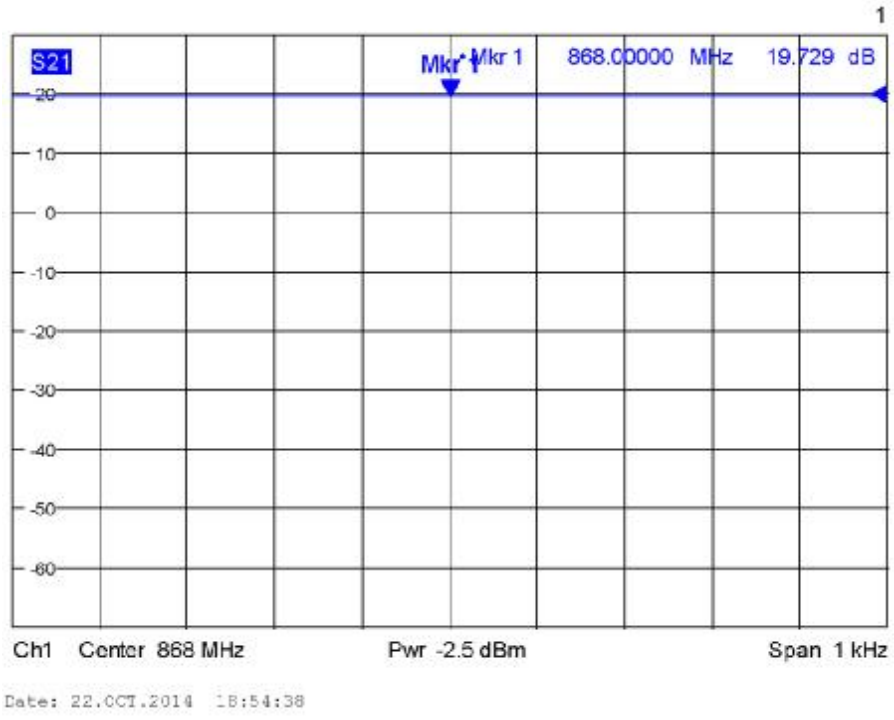
- Device used R&S ZVL network analyzer
- Calibration Kit 85052D
- Frequency = 868 MHz
- Power = -2,5 dBm

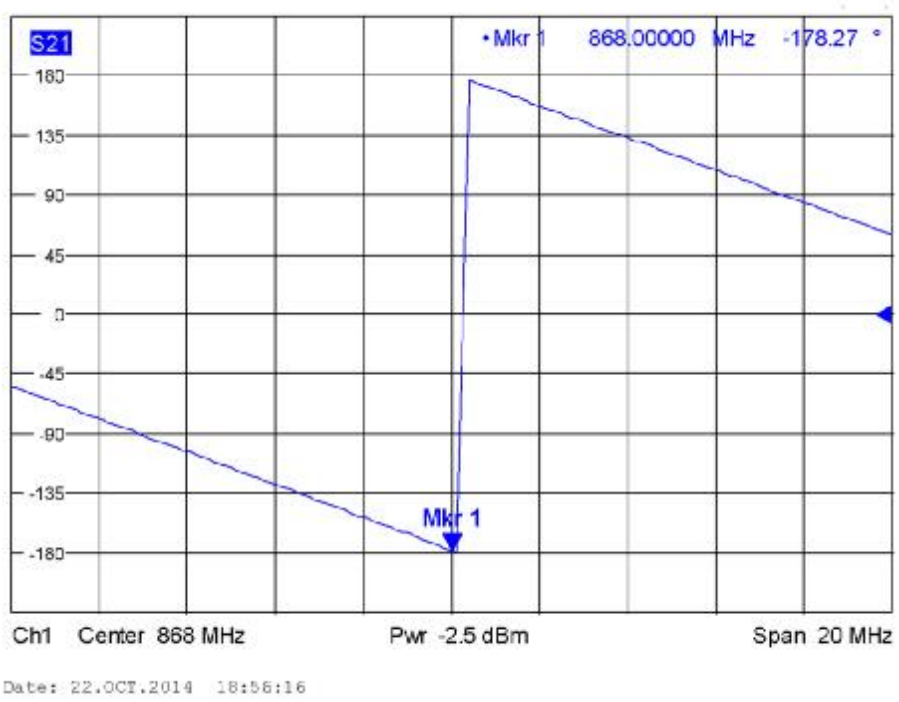


7. Testing and Measurements

7.4 S-Parameter

Amplification $S_{21} = 19.3dB$
Phase set up $= -180^o$

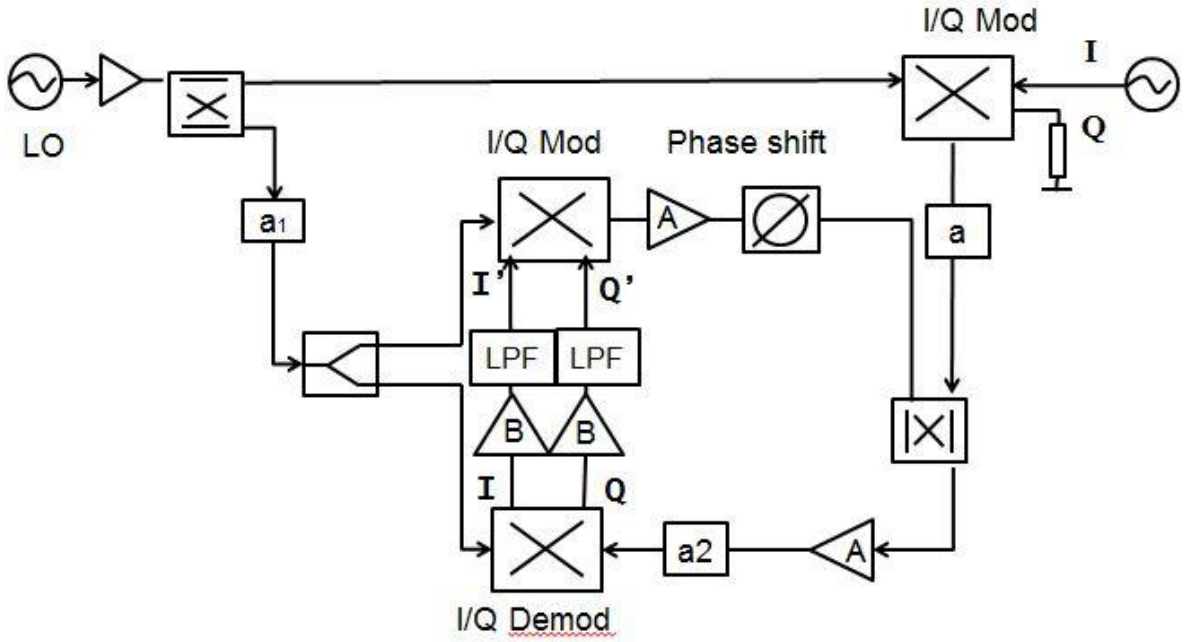




7. Testing and Measurements

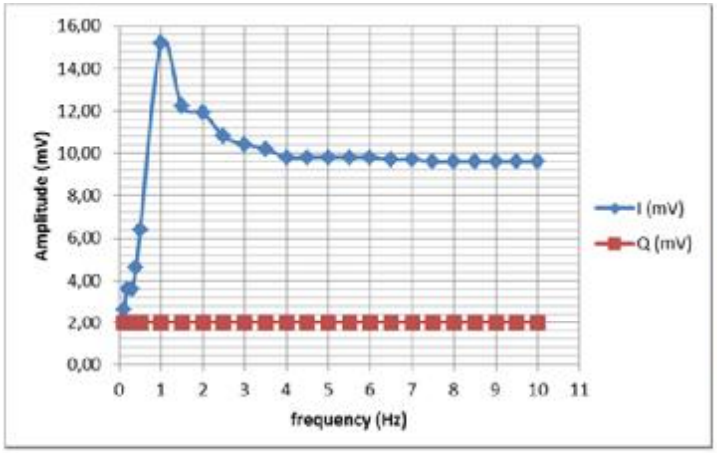
7.5 Transfer function measurement of the feedback loop

- Function generator : 200mV_{pp} , Frequency : 100mHz-10 Hz
- Frequency generator : 868 MHz LO-Signal with -11dBm
- Digital oscilloscope
- External IQ-Modulator

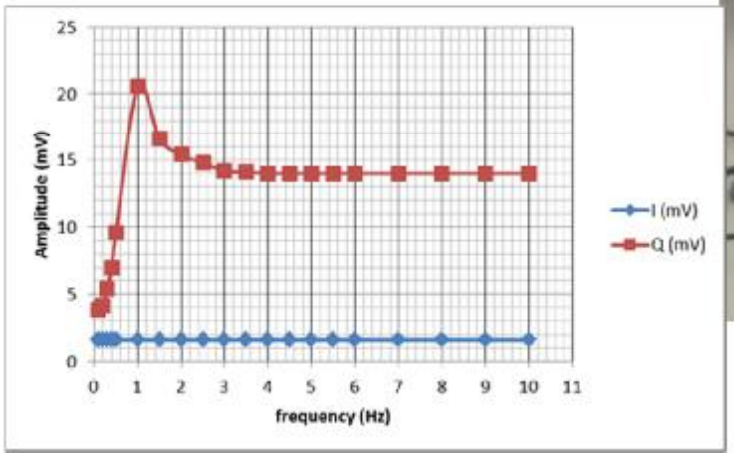


7. Testing and Measurements

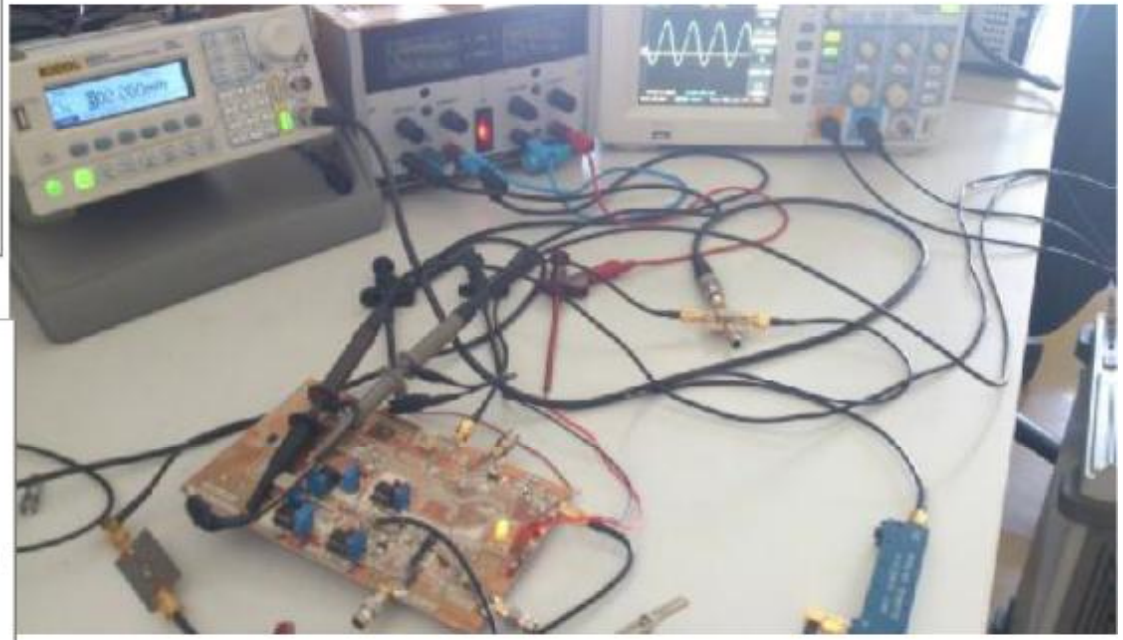
7.5 Transfer function of the feedback loop



I-Signal measurement



Q-Signal measurement



8. Conclusions

- PCB of the feedback canceller was designed, tested and can be improved.
- Every sub-circuit was tested and optimized.

Thank You