# LABORATORY #6

# BUILDING AND TESTING AM RECEIVER

## OBJECTIVES

1. To solder and connect together all stages of the complete AM receiver.
2. To test and troubleshoot different stages of the AM receiver individually.
3. To test and measure parameters of the AM receiver.
4. To connect receiver to the antenna and audio amplifier and attempt reception of the 10.00MHz signal.

## EQUIPMENT

1. Digital multimeter BK PRECISION 2831B
2. Digital oscilloscope Tektronix TDS 3012
3. Function Generator STANFORD DS345.
4. Construction breadboard
5. DC Power Supply

## PRE-LABORATORY PREPARATION

*The lab preparation must be completed before coming to the lab. Show it to your TA for checking and grading at the beginning of the lab and get his/her signature.*

### 1. Soldering

1.1. By the time you reach Lab #6, all stages of your receiver should be already soldered on the PCB.
1.2. Print (or draw) a circuit diagram of the entire AM receiver with **your** component values.

## PROCEDURE

### 1. Testing individual stages of the receiver

1.1. It is recommended to test the individual stages of the AM receiver after you solder them on the PCB. Make sure each stage works before connecting the next. Sometimes a working circuit on the breadboard will not be functional once it is transferred to the PCB. The most common reasons are:
- Components are misplaced during transfer onto the PCB.
- Bad soldering techniques provide missing or "cold" contact between components or to the power bars.

1.2. It is very important to check DC biasing of each stage before testing it with AC signal. If the DC conditions are different from recommended and tested in the Lab, your circuit will not work properly. Find the reason for this – see section 1.1.

1.3. Once the DC biasing conditions are met, apply an appropriate input signal to the tested stage and check the output. If the transfer to the PCB is done properly, you should get at least the same or even better results compared to your regular lab with this stage.

1.4. Once you have tested all stages of the receiver and made sure they work according to the expectations, you can test the entire AM receiver with a signal generator.

1.5. Use the 20dB attenuator and apply minimum input signal of 1mV. If you don't see any output signal, try adjusting the sensitivity of the AM receiver by increasing the gain of the IF amplifier.

1.6. Apply 10.00MHz AM modulated signal from the signal generator to the antenna input of your circuit and check the output of the demodulator. You should see the audio signal, which corresponds to the modulation signal as a waveform and frequency.

1.7. Test the gain frequency response of the entire AM receiver by applying a modulated signal at the antenna input and checking the audio output signal after the demodulator. Record your results in Table 6.1.

1.8. After making all tests with your circuit, bring it to the testing station, where parameters of your AM receiver will be measured by your TA and recorded in Table 6.2 of the Lab Measurements Sheet:

| PARAMETER | TARGET VALUE |
|---|---|
| 1. Sensitivity (minimum Vin, where Vout is noticeable ) | Vin <10µV |
| 2. Overall Gain $\quad A_V = 20\log\dfrac{V_o}{V_{in}}$ | $A_V$>60 dB |
| 3. Effective Bandwidth at -3dB $\qquad \Delta f = f_2 - f_1$ | $\Delta f$<50kHz |
| 4. Image frequency Rejection $\quad A_i = 20\log\dfrac{V_{image}}{V_o}$ | $A_i$<-5 dB |

1.9. Test your device with external antenna to receive a time signal and record your result in section 2 of LMS.

1.10. Submit your receiver to your TA.

# LAB MEASUREMENTS SHEET – LAB #6

# BUILDING AND TESTING AM RECEIVER

**Name** _____

**Student No_____**

**Workbench No_____**

*NOTE: Questions are related to observations, and must be answered as a part of the procedure of this experiment. Sections marked \* are pre-lab preparation and must be completed BEFORE coming to the lab.*

1. Frequency response of the AM receiver.

**Table 6.1**

| F [MHz] | Lab measurements | | |
|---------|---------|----------|--------|
|         | Vin [V] | Vout [V] | Av[dB] |
| 9.000   |         |          |        |
| 9.300   |         |          |        |
| 9.500   |         |          |        |
| 9.600   |         |          |        |
| 9.700   |         |          |        |
| 9.800   |         |          |        |
| 9.900   |         |          |        |
| 9.950   |         |          |        |
| 10.000  |         |          |        |
| 10.050  |         |          |        |
| 10.100  |         |          |        |
| 10.200  |         |          |        |
| 10.300  |         |          |        |
| 10.400  |         |          |        |
| 10.500  |         |          |        |
| 10.700  |         |          |        |
| 11.000  |         |          |        |
| 11.500  |         |          |        |

2. Compare and comment possible difference in simulated and measured gain-frequency response of AM receiver.

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3. Final AM receiver test results:

**Table 6.2**

| PARAMETER | $V_{in}$ [Vrms] | $V_{out}$ [Vrms] | $A_v$ [dB] |
|---|---|---|---|
| **1. Sensitivity** | | | |
| **2. Overall Gain at 7.335MHz** | | | |
| **3. Bandwidth**<br><br>**$\Delta f = f_2 - f_1$** | $f_o$=10.00MHz<br><br>$V_o =$ | $0.7V_o =$<br>@ $f_1=$        MHz<br>$0.7V_o =$<br>@  $f_2=$        MHz | $\Delta f =$         [kHz] |
| **4. Image frequency Rejection 20 log [Vo/Vi]** | $f_o$=10.00MHz<br><br>$V_o =$ | fi = 9.09 MHz<br><br>$V_{im} =$ | 20 log [Vi/Vo] =<br><br>=          [dB] |
| **5. Antenna Test** | | | |

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**MARKING SHEET**                              **TA name:**_____

**To be completed by TA during the lab session.**

| Check Boxes | | | Max Marks | Granted Marks | TA Signature | Student Task |
|---|---|---|---|---|---|---|
| | | | 40 | | | Pre-lab preparation |
| | | | 30 | | | AC frequency response completed and data collected |
| | | | 20 | | | Final AM receiver test completed and data collected |
| | | | 10 | | | Data collected and observations made |
| | | | **100** | | | **TOTAL** |