# CHAPTER I

# INTRODUCTION

# CHAPTER II

# REGULATOR INFORMATION

# CHAPTRE III

# HILBERT HUANG TRANSFORM (HHT)

# CHAPTER IV

# RESULTS AND DISCUSSION

## 1.1 OVERVIEW:

Exposed circuit through it's work with various devices to many of the factors that may affect on it's performance or cause the fault in it, as examples to these factors are:

**1. Heat:**

This factor produces through the work of the electronic circuit because of the losses of the electrical energy in it's components, the increasing in the heat of the electronic components (such as diode, transistor and integrated circuit) causes damage in it's internal parts.

2. **Suddenly increasing or decreasing in the electrical current:**

This factor causes suddenly change in the feeding voltage and current which causes damage in some of the electronic components.

**3. Electric and magnetic field:**

Which produces when founding electronic circuit beside other devices which sends electrical and magnetic field.

4. **Erosion the conductors of the printed circuit:**

This factor produces by the atmospheric effects and chemical reactions where eroded those conductors or formed the oxide layer on it's terminals and thus will becomes insulating material caused a short circuit.

## 1.2 PROBLEM STATEMENT:

The electronic circuit consists of components such as resistor and capacitor …etc. After any fault occurs in those components by excess heat, humidity and accumulated dirt…etc which lead to faults in the circuit such as short circuit, open circuit, grounding and mechanical faults. These reasons cause stops to the whole circuit, thus we need several step so that can determine the site of the fault, such as:

1. Must know the function of the electronic circuit in the device.
2. Electronic circuit must be examine ostensibly using the senses.
3. We must measure the continuous feeding effort to make sure it's normal.
4. We must measure the voltage or resistance for each stage in the electronic circuit if it contained more than one stage.

This method may be easy for small and non complex circuits, but it is difficult for the most complex circuits.

### 1.3 OBJECTIVES OF THE RESEARCH:

So that we can detect the faults quickly, easily and without the need to examine each component. The main research objectives of the entire study can be presented as follows:

1 To find a suitable electronic circuit can be tested and influence thermally.

2 To find an effective thermal appropriately to influence on the electronic components without damage to those components.

3 To find a suitable program that can analysis the signal according to the energy levels and events differences between them for each test.

### 1.4 SCOPE OF THE PROJECT:

A caustic welding was used as heat source in this work (as shown in Fig (1.1).,

Figure (1.1) Caustic welding.

An electronic board in the (A.C VOLTAGE REGULATOR ) as axis of study, (as shown in Fig 1.2).


**Figure (1.2) Electronic Board in the (A.C Voltage Regulator).**

Later, (Hilbert Huang Transform) program to analyze the signal, (as shown in Fig 1.3).

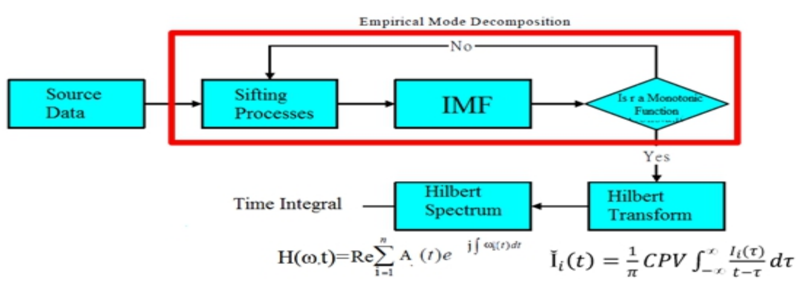


**Figure (1-3) Flow chart of Hilbert Huang Transform.**

Through shed heat by caustic welding on one of the electronic board component of the ac voltage regulator ,we notice that the output signal of this board different from the standard signal which coming out in normal circumstances then we will analyze the output signal of this board by oscilloscope and transmitted it on the computer device by (FREE WAVE3) program and save this signal as excel file To be called up later in (HELBERT HUANG TRANSFORM) program which analyzes the signal according to the energy levels and the calculation of the total energy, which is then used for comparison. Where is the total energy storage of the main signal and a total energy of signals resulting from the shed heat and then compared the signals emerging from the board in the future and give a prompt indicating the site of the fault,(as shown in Fig 1.4).

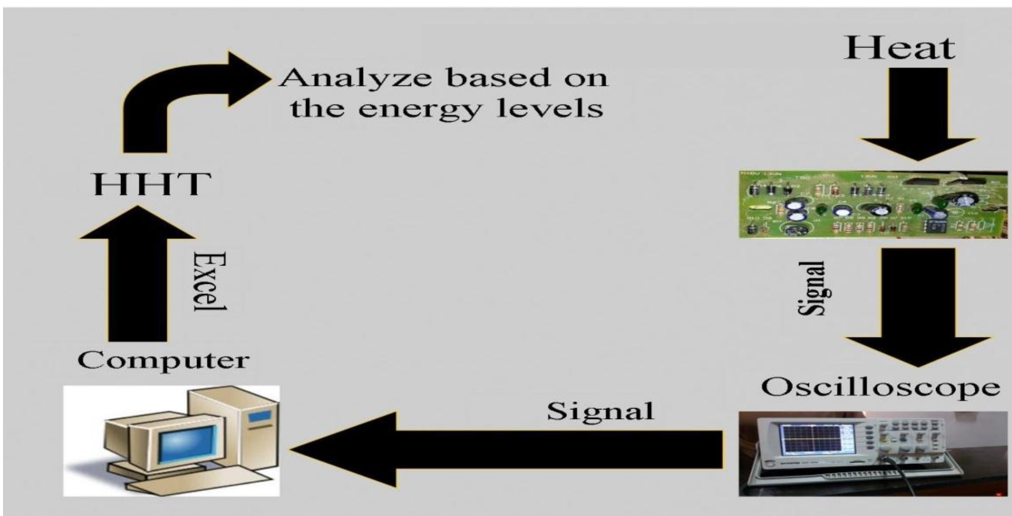


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Figure (1.4)The Procedure of the Project.

## 2.1 Introduction To A.C Voltage Regulators:

An automatic voltage regulator, AVR for short, is a device that is designed to automatically control, adjust or maintain a constant voltage level. - tremendous diversity in the size and type of device that could qualify to be called an AVR. the ultimate reason for using voltage regulation is financial to avoid the costs associated with equipment damage and downtime caused by poor voltage levels.

## 2.2 TYPES OF REGULATORS:

1. Feed-forward design or negative feedback control loops.

2.Mechanical voltage regulator or electronic voltage regulator.

3.used to regulate AC or DC voltages.

4.Active regulators or shunt regulators.

## 2.2 Circuit of Regulators.

The regulator circuit was as shown in figure (2-1).

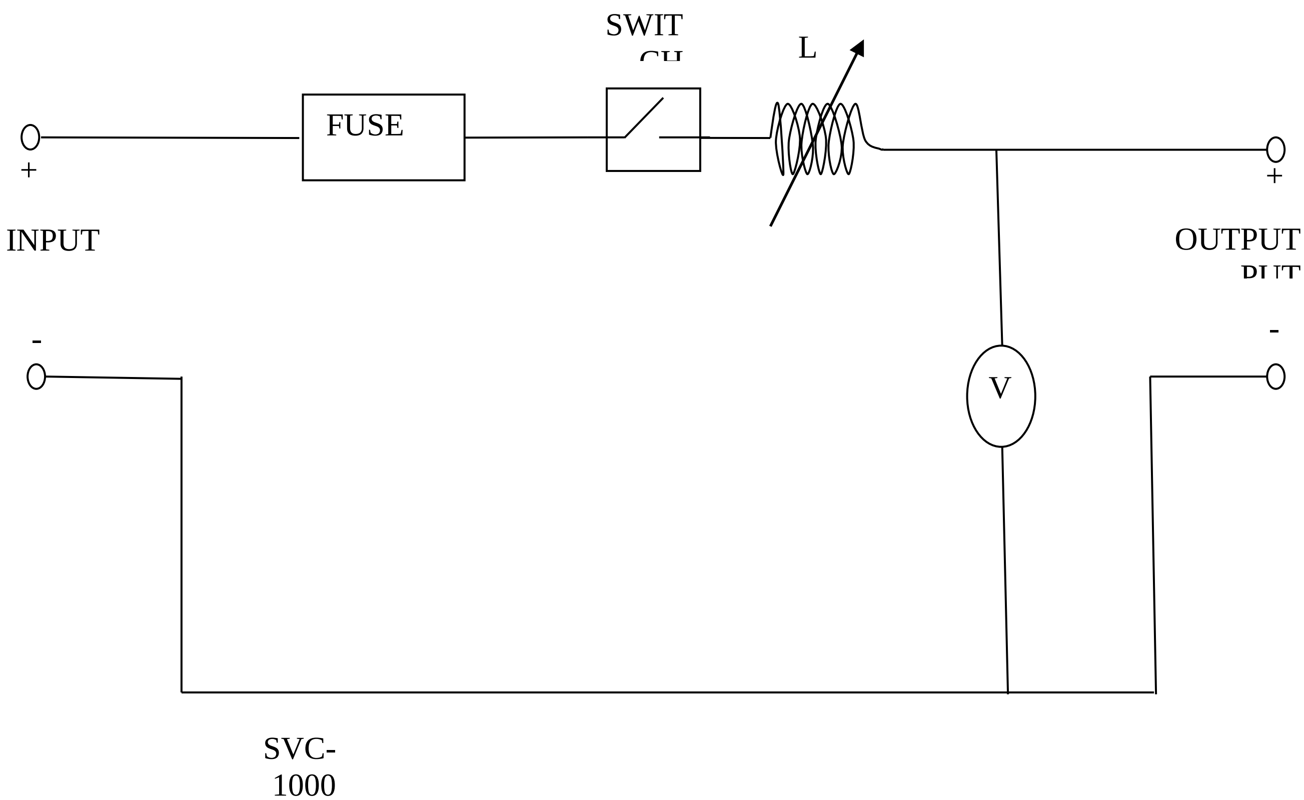
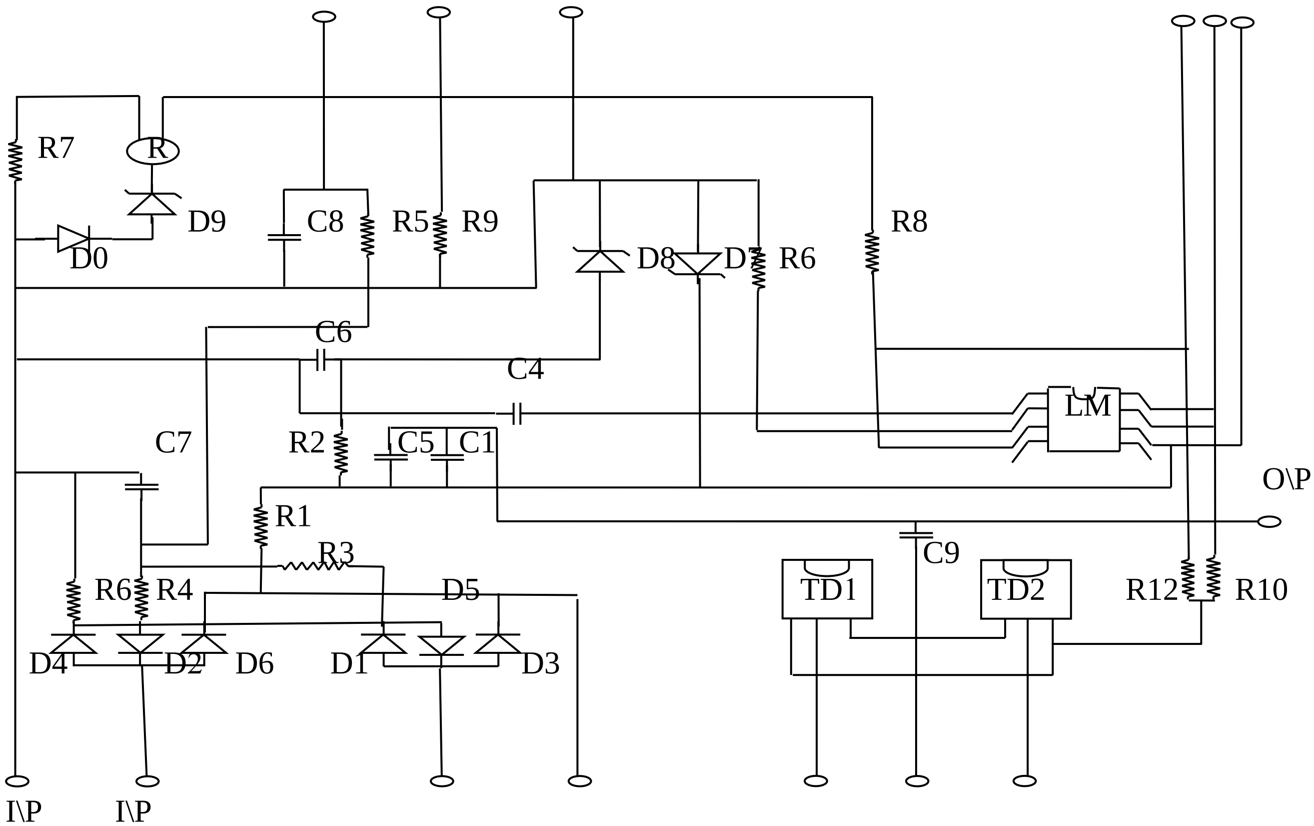



Figure (2-1)The A.C Voltage Regulator Circuit.

The block diagram of the electronic board of the regulator was as shown in figure (2-2).




**Figure(2-2)The Electronic Board Circuit.**

## 3.1 Hilbert Huang Transform (H)

Based on the concepts that have been clarified in the comparison of HHT, wavelet, and fast Fourier transform presented in chapter II, HHT is the best method to analysis nonlinear and non-stationary signals. The two important parts of HHT are EMD and HSA. Therefore, HHT is investigated by examining EMD and HSA as follows:

## 3.2 Empirical Mode Decomposition (EMD)

The empirical mode decomposition EMD technique decomposes or sifts the original signal into groups of intrinsic mode frequency (IMF) components. The sifting process serves two purposes: to exclude riding waves and to generate symmetric wave profiles [1]. EMD is mainly based on the possibility of coverage of any wave by two envelopes, namely, upper and lower. These two envelopes must cover all of the points of a wave. According to the principles of EMD, only extremes are obtained between two successive zero-crossings. In addition, each mode must be independent from the modes of others [2]. Thus, Huang, et al. [3] report that each IMF should satisfy two conditions:

1- For each set of data, the numbers of extremes and zero-crossings should be equal to each other or differ by one at most.

2- At any time, the mean value of the upper envelope as defined by the local maxima and that of the envelope defined by the local minima is zero.

EMD can analyse any signal given the following steps [1-5]:

Step-1 All local extreme points are identified. In Figure 3.9, $UE_{ij}(t)$ is represented by the upper green curves for the original data series $x(t)$ (blue curve in Figure 3.9-a). These curves are then connected to one another through the cubic spline interpolation method, where $i = 1 \rightarrow n$; $j = 0 \rightarrow k$; $n$ is the number of IMFs in the signal; and $k$ is the number of iterations. [6, 7].

Step-2 Step-1 is repeated for the local minima points [$LE_{ij}(t)$ is denoted by the lower green curves in Figure 3.9].

Step-3 The mean value [$m_1(t)$] of the upper and lower envelopes (red curves in Figure 3.9) is calculated using Equation 3.14.

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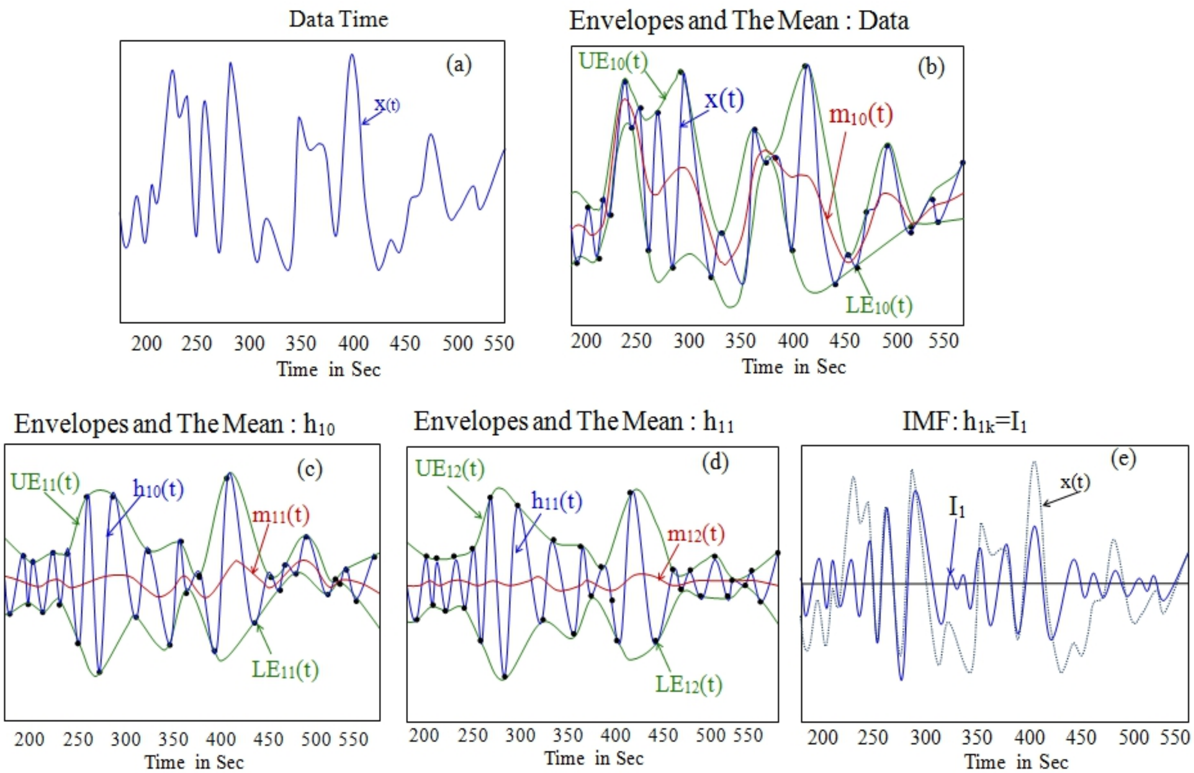


**Figure (3-1) Process of generating the first IMF (*$I_1$*): (a) original or test data in the blue curve [*x(t)*]; (b) original data in the blue curve, upper and lower envelopes (green curves) defined by local maxima and minima and the mean value of these envelopes (red); (c and d) same conceptions in (b) except *$h_{10}$* and *$h_{11}$* parameters represented by the blue curves; (e) comparison of *$I_1$* in the blue curve and the original data in the dots curve.**

$$m_{ij}(t) = \frac{UE_{ij}(t)+LE_{ij}(t)}{2} \tag{3.1}$$

Step-4 The residual $h_{10}$ is determined by Equation 3.2.

$$h_{10} = x(t) - m_{10} \tag{3.2}$$

With $h_{10}$ as the new datum, steps-1 to -3 are reiterated to calculate $m_{11}$ and, in turn, $h_{11}$ as shown in Equation 3.3.

$$h_{11} = h_{10} - m_{11} \tag{3.3}$$

Step-5 Steps-1 to -4 are repeated $k$ times until the residual $h_{ij}$ meets the criteria of IMF ($I_1$) as expressed by Equation 3.4.

$$I_1 = h_{1k} \tag{3.4}$$

Table 3.1 explains this processes step by step.

**Table (3-1) IMF calculation process**

| | i= 1 to n ; i=1 | i=2 | i=3 | | i= n |
|---|---|---|---|---|---|
| j=0 to k | IMF1 | IMF2 | IMF3 | | IMF n |
| | $X(t)$ | $X(t)-I_{i-1}=r_{i-1}$ | $r_{i-2}-I_{i-1}=r_{i-1}$ | | $r_{n-2}-I_{n-1}=r_{n-1}$ |
| | $X(t)$ | $X(t)-I_1=r_1$ | $r_1-I_1=r_2$ | | $r_{n-2}-I_{n-1}=r_{n-1}$ |
| | $X(t)-m_{ij}=h_{ij}$ | $r_{i-1}-m_{ij}=h_{ij}$ | $r_{i-1}-m_{ij}=h_{ij}$ | | $r_{n-1}-m_{nj}=h_{nj}$ |
| 0 | $X(t)-m_{10}=h_{10}$ | $r_1-m_{20}=h_{20}$ | $r_2-m_{30}=h_{30}$ | | $r_{n-1}-m_{nj}=h_{nj}$ |
| 1 | $h_{10}-m_{11}=h_{11}$ | $h_{20}-m_{21}=h_{21}$ | $h_{30}-m_{31}=h_{31}$ | | $h_{n0}-m_{n1}=h_{n1}$ |
| 2 | $h_{11}-m_{12}=h_{12}$ | $h_{21}-m_{22}=h_{22}$ | $h_{31}-m_{32}=h_{32}$ | | $h_{n1}-m_{n2}=h_{n2}$ |
| 3 | $h_{12}-m_{13}=h_{13}$ | $h_{22}-m_{23}=h_{23}$ | $h_{32}-m_{33}=h_{33}$ | | $h_{n2}-m_{n3}=h_{n3}$ |
| .. | …… | | | | |
| k | $h_{1(k-1)}-m_{1k}=h_{1k}$ | $h_{2(k-1)}-m_{2k}=h_{2k}$ | $h_{3(k-1)}-m_{3k}=h_{3k}$ | | $h_{n(k-1)}-m_{nk}=h_{nk}$ |
| **IMF** | $h_{1k}=I_1$ | $h_{2k}=I_2$ | $h_{3k}=I_3$ | | $h_{nk}=I_n$ |

Step-6 The input for the next iteration is a residue of the original input signal $x_n(t)$ as given in Equations 3.5 and 3.6 and Table 3.1, where *i* equals 2.

$$r_{i-1} = x(t) - I_{i-1} \tag{3.5}$$

$$r_1 = x(t) - I_1 \tag{3.6}$$

$r_1$ is then regarded as original data, and the process is repeated *n* times to determine the other IMFs using Equation 3.7 as depicted in Table 3.1.

$$r_1 - I_2 = r_2 \tag{3.7}$$

$$\vdots$$

$$r_{n-1} - I_n = r_n \tag{3.8}$$

Equation 3.8 presents $r_n$ as the residual value of this process. The sifting process can be stopped given one of the following predetermined criteria [1]: when the value of $I_n$ components or $r_n$ residue is smaller than that of the original data, this small value is either predetermined or indicates that $r_n$ is a monotonic function from which no more IMFs can be extracted. By summing equations 3.6, 3.7, and 3.8, equation 3.9 can be obtained.

$$x(t) = \sum_{i=1}^{n} I_i + r_n \tag{3.9}$$

$I_1$ refers to the components of $x(t)$ with high frequencies and $I_n$ corresponds to those with low frequencies.

## 3.2 ***Hilbert Spectral Analysis*** **(HSA)**

Hilbert transform (HT) is a linear operator that obtains signals, such as $u(t)$, from the time domain to generate the Hilbert spectrum in the same domain. Bedrosian [8] and Nuttall and Bedrosian [9] conclude that the original HT is unstable and can be used only for low-frequency signals. However, HT can be applied to accurately obtain the data series $\check{I}_i(t)$ for each IMF after Huang, et al. [5] proposed the EMD.

$$\check{I}_i(t) = \frac{1}{\pi} CPV \int_{-\infty}^{\infty} \frac{I_i(\tau)}{t-\tau} d\tau \tag{3.10}$$

Where CPV is the Cauchy principal value. By combining $I_i(t)$ and $\check{I}_i(t)$, the analytical signal $AS(t)$ can be expressed as follows:

$$AS(t) = I_i(t) + j\check{I}_i(t) = A_i(t)e^{j\theta_i(t)} \tag{3.11}$$

Where $A_i(t)$ is the amplitude of each IMF and is equal to

$$A_i(t) = \sqrt{{I_i}^2 + {\check{I}_i}^2} \tag{3.12}$$

Whereas $\theta_i$ is the corresponding phase and is equal to

$$\theta_i(t) = \tan^{-1}[\frac{\check{I}_i(t)}{I_i(t)}] \tag{3.13}$$

As a first derivative of Equation 3.26, instantaneous frequency $\omega_i(t)$ can be determined by:

$$\omega_i(t) = \frac{1}{2\pi}\frac{d\theta_i(t)}{dt} \qquad (3.13)$$

The Hilbert spectrum $H(\omega,t)$ expresses amplitude (energy) distribution in the time-frequency plane as:

$$H(\omega, t) = Re\sum_{i=1}^{n} A_i(t)e^{j\int \omega_i(t)dt} \tag{3.14}$$

For each frequency, the marginal spectrum $\hbar(\omega,t)$ is considered the criterion of contribution to total frequency [10]. $\hbar\ (\omega)$ is defined as:

$$\hbar(\omega) = \int_0^B H(\omega, t)dt \qquad (3.15)$$

Total data length is defined by $B$ in equation 3.29. HHT is thus summarized in Figure 3.10.

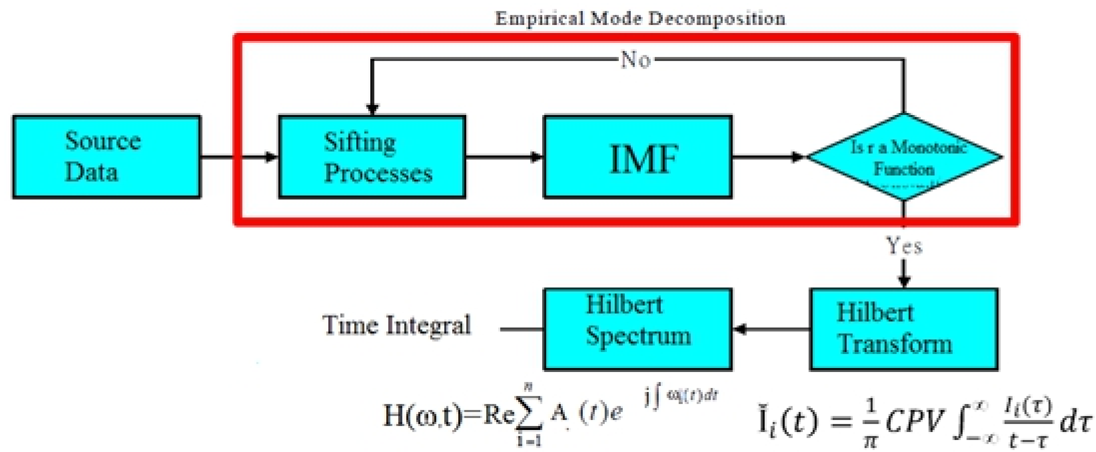


**Figure (3-2) Flow chart of Hilbert Huang Transform.**

## 4.1 Exprremental Work

The important steps of working in this project were:

### 4.1.1 Explanation The Link Of The Whole System:

In this project the electronic board was connected to the oscilloscope by a connecting wire.

The connection between the computer and tle oscilloscope was by using soft ware (free wave 3.21) which followed the gwinstek gds-1062 company.

This soft ware can deliverthe signal from the oscilloscope to the computer so that it can save as image and excel file which will uses to analyze later.

The connection of the system in this project must be shown in figure (4-1).

**Figure (4-1)The connections of the devices which are used.**

### 4.1.2 Shed of Heat:

the components of this project were (R2,R9,D4,R4,R12 and D9) as shown in figure (4-2).

The effect on the electronic board thermally was by using caustic welding as shown in figure (4-3).

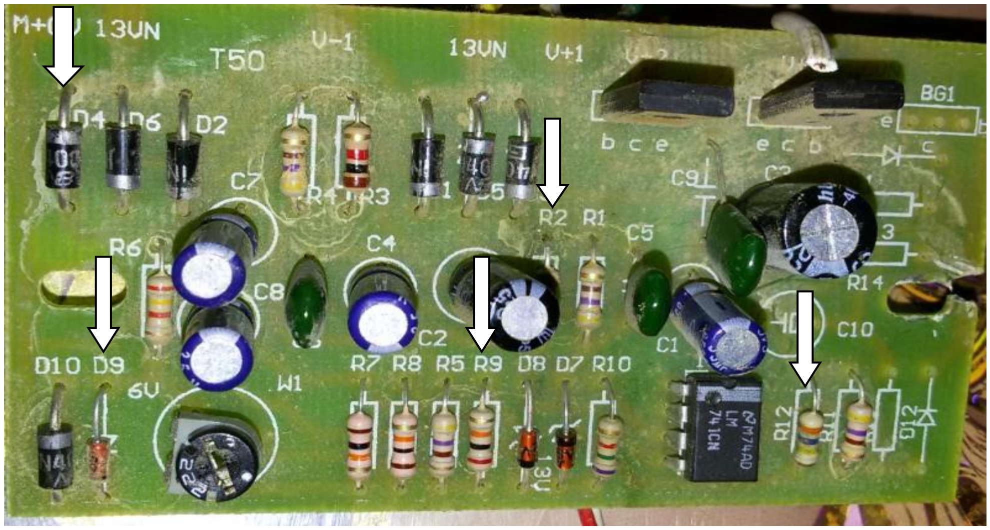


**Figure (4-2)The components which are used.**


**Figure (4-3)Shed heat on the resistance (R2).**

The time was chosen as aperiod effect on the components without damage was (30sec) as amaximum period to can to bring this components back to it's  natural state after remove the heating source from these components.

### 4.1.3 Oscilloscope Results:

As results obtained from oscilloscope was an image and excel file,the image as shown in figure (4-4)

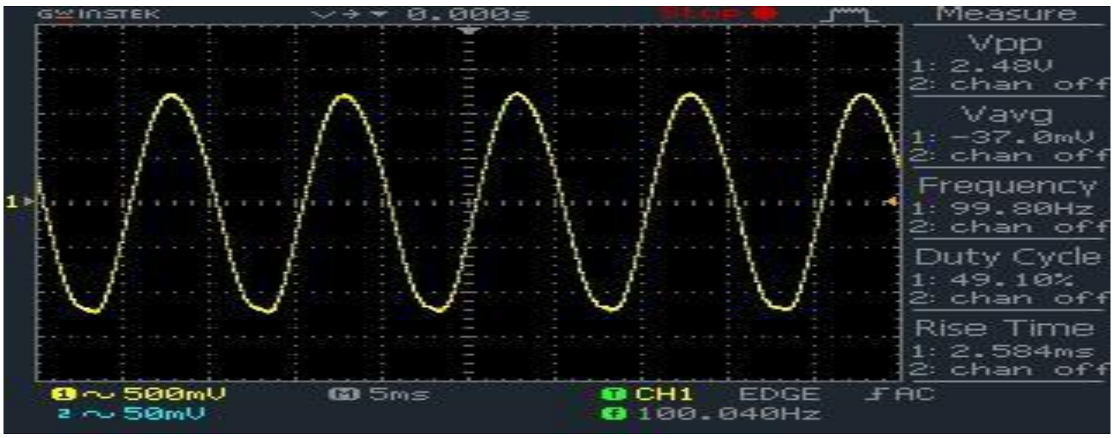


**Figure (4-4)The image results from the oscilloscope.**

## 4.2 Hilbert Huang Analysis:

As shown in chapteriii the data was analysis by using Hilbert Huang Transform (HHT) which analyze signal based on the energy levels.

This methode can be gives the total energy which was the summation of the energy levels (I) ,which uses to compare with another fault to detection the fault location.thus ,each the fault total energy difference from other fault total energy,as shown in figure (4-5).

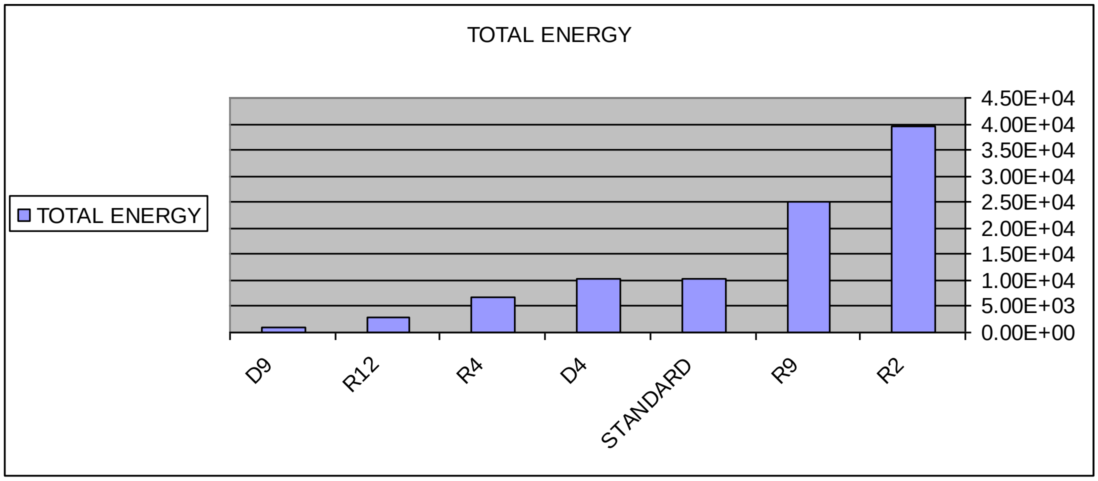


**Figure (4-5)The comparesion between the difference faults total energy.**

This methode make the recognization between faults very easy.

## 4.3 Results:

As example to show HHT components,it was chosen the signal of the fault in R9,it's wave form is as shown in figure (4-6).


**Figure (4-6)The wave form of the fault in resistance (R9)**

And the analysis of the signal at different frequency shown in figure (4-7).

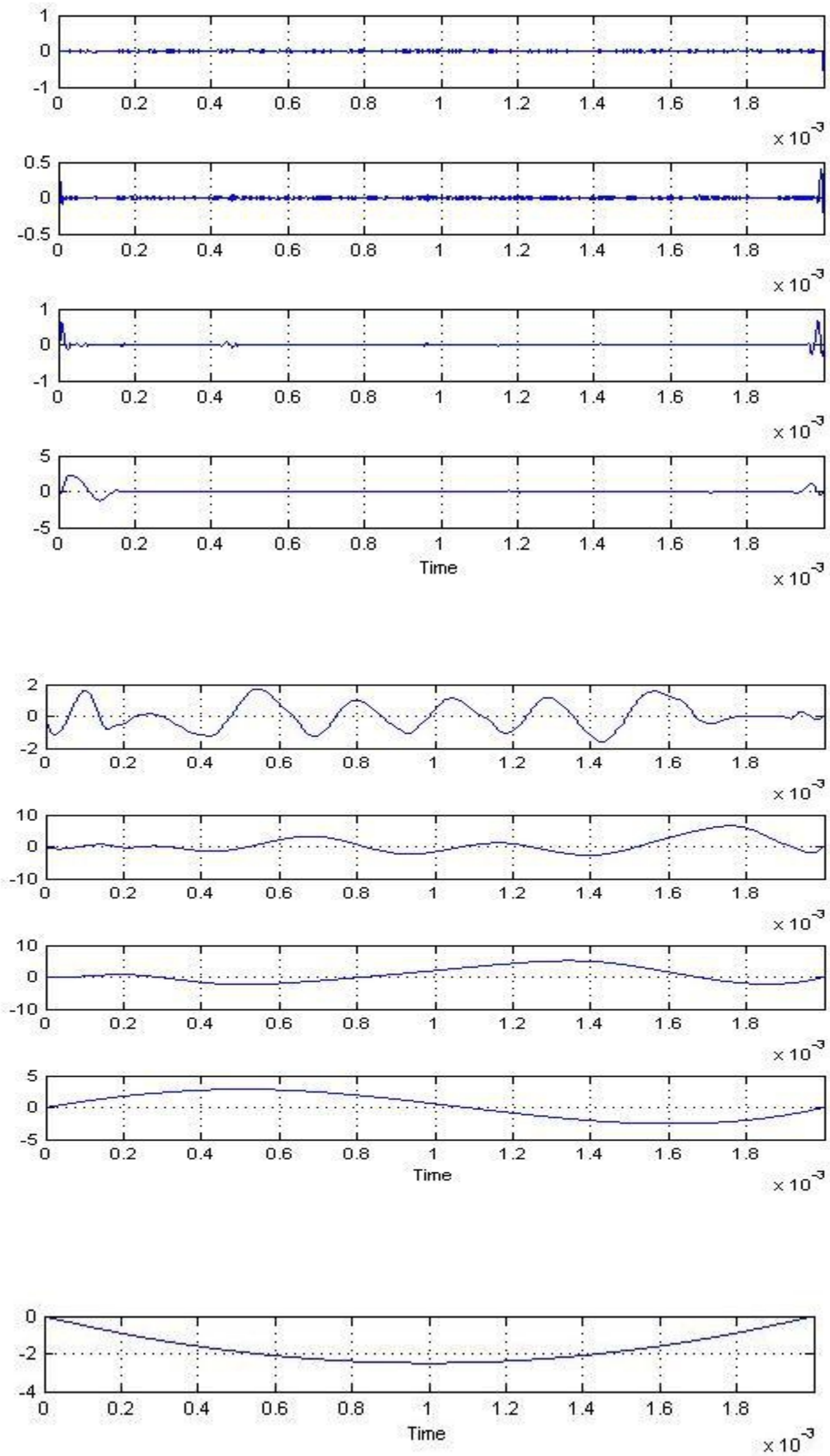


**Figure (4-7)The analysis of the signl in the different frequency.**

And it's three dimension figure  as shown in figure (4-10).

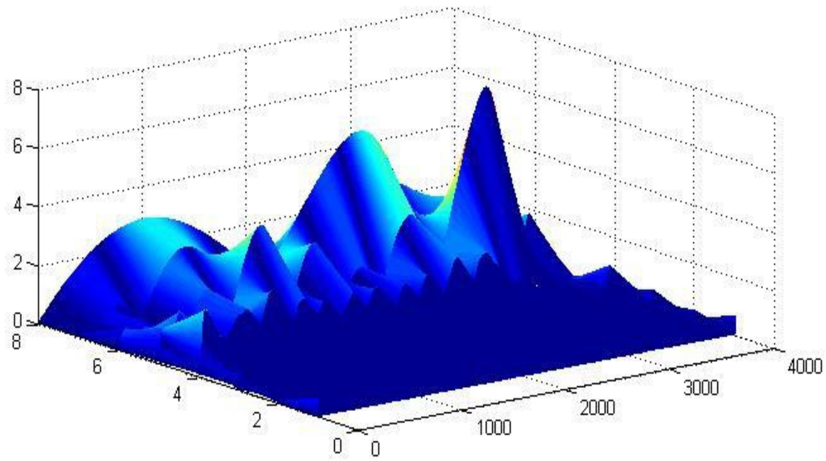


**Figure (4-10)Three dimenssion to the fault in R9.**

## 4.4 Discussion:

Shed the heat on the diode (D9) causes large difference to the signal from the standard,the peak to peak voltage and frequency  become very small approximately zero,as shown in figure (4-11).

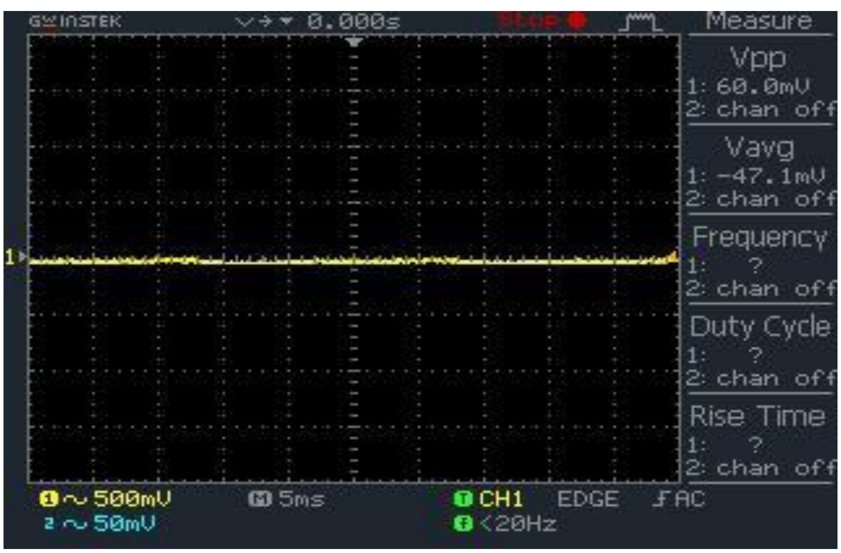


**Figure (4-11) The wave form of the fault in the diode (D9).**

So,shed heat on the resistance (R9) will effect on the form of signal which causes deformation in the positive half of the signal and the negative half of the signal appears in cycle and disappears in another which causes difference in the frequency to the result signal from the standard signal,thus the result signal frequency becomes half the frequency of the standard,and the amplitude must be increases to the two times large than the standard signal amplitude,as shown in figure (4-12).

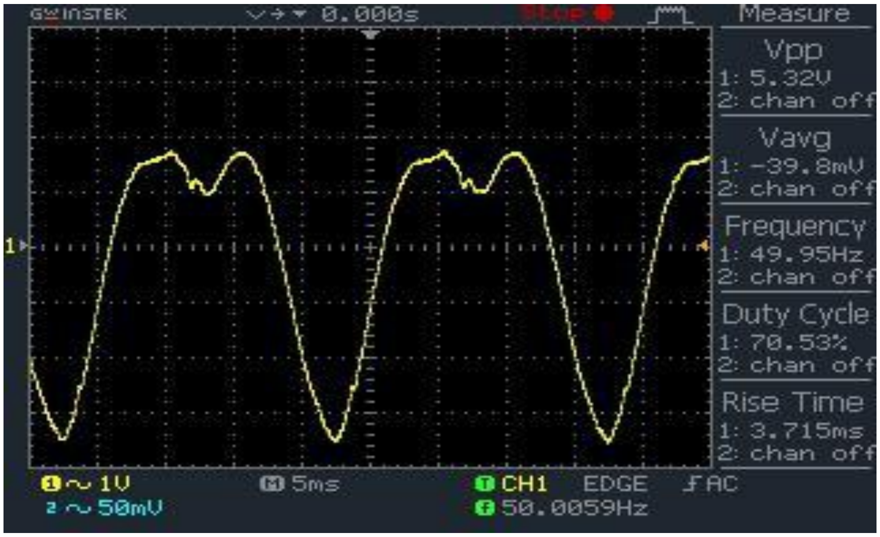


**Figure (4-12) The wave form of the fault in the resistance (R9)**

Heat affected on the resistance (R12),the frequency arrives to the half amount of the standard frequency and so the peak to peak voltage arrives to the half amount of the standard peak to peak voltage which causes very large deformation to the signal,as shown in figure (4-13).


**Figure (4-13) The wave form of the fault in the resistance (R12).**

When shed heat on the diode (D4) ,the frequency,the peak to peak voltage and the wave form changed by a very small amount hardly noticed,as shown in figure (4-13).

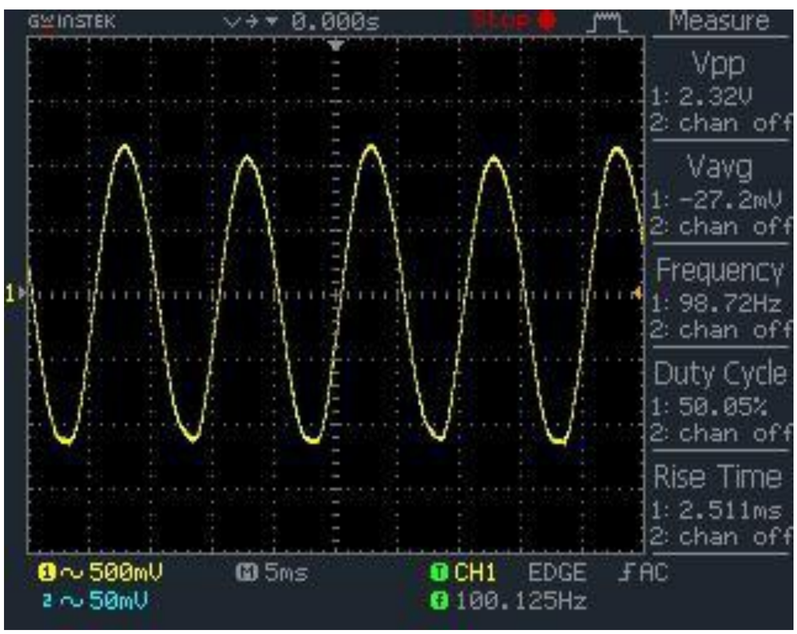


**Figure (4-13) The wave form of the fault in the diode (D4).**

So when shed heat on the resistance (R2) the changes was very small in the frequency,the peak to peak voltage and the wave form,as shown in figure (4-14).

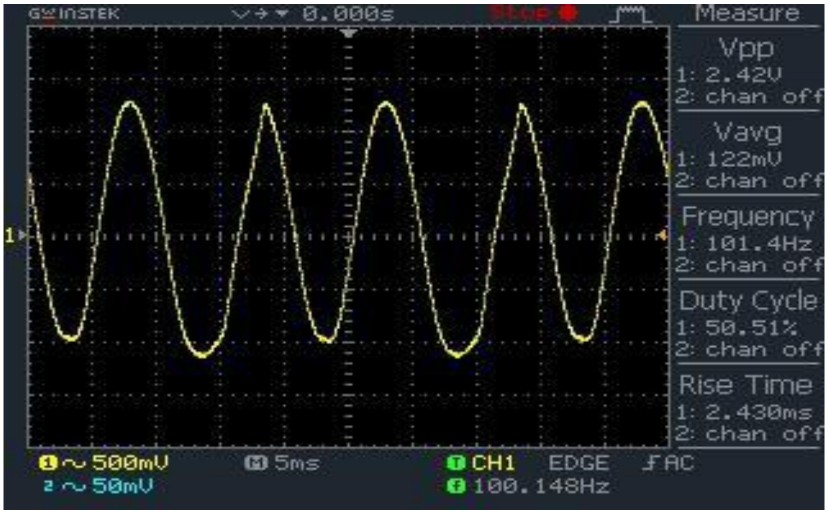


**Figure (4-14) The wave form of the fault in the resistance (R2).**

## 4.5 Conclusion:

The Hilbert Huange Transform succeed in recognition the location of the faults by analyzing the signal and finding the total energy to this signal,thus notice that the total energy difference from one component to another (as shown in figure (4-15), and can be determine the fault location by comparing the total energy to the faults in the different component.

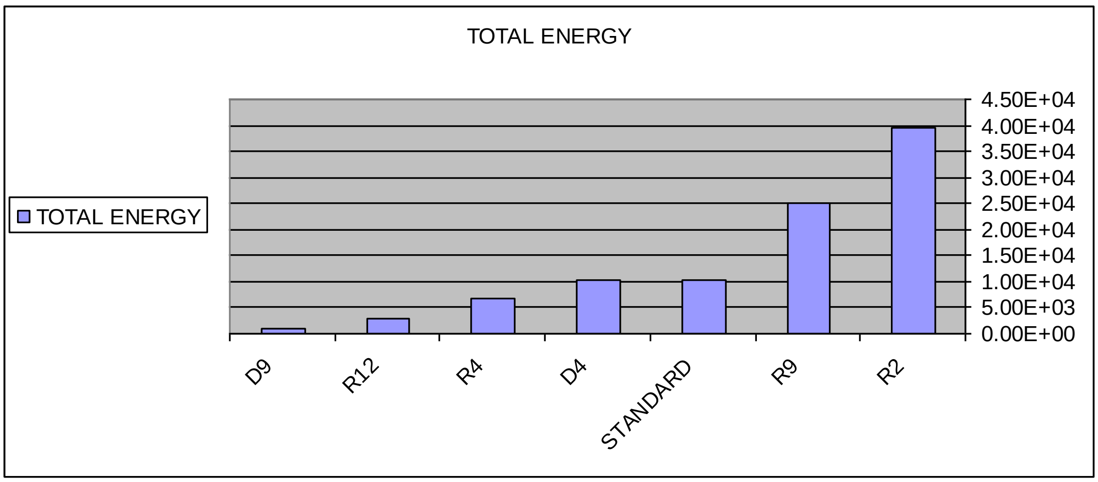


**Figure (4-15)The total energy of the different faults.**

By analyzing the signal at different frequencies in (HHT),finding that the high frequency (as shown in figure(4-16) can be more sensitivity than the low frequency to the changes in the components( figure (4-17) shown the sensitivity of low frequency) .

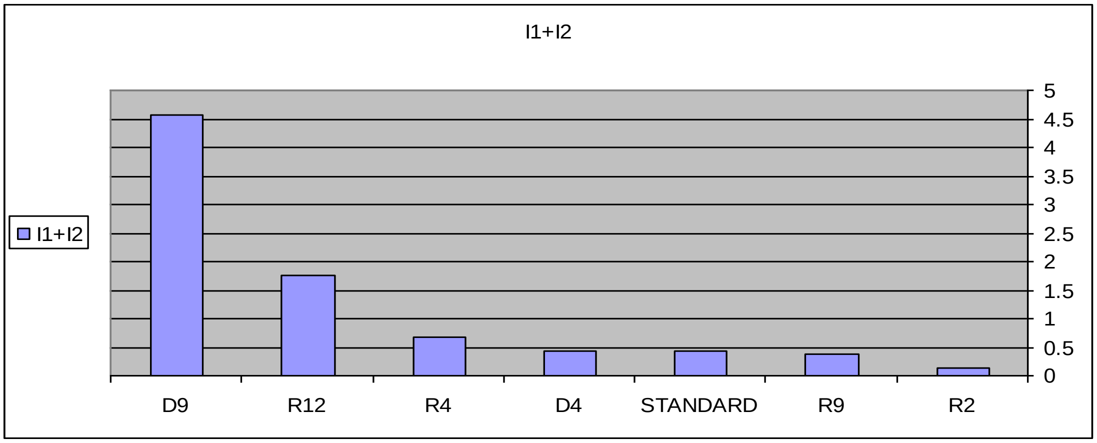


**Figure (4-16)The analysis signal of different faults at high frequency.**

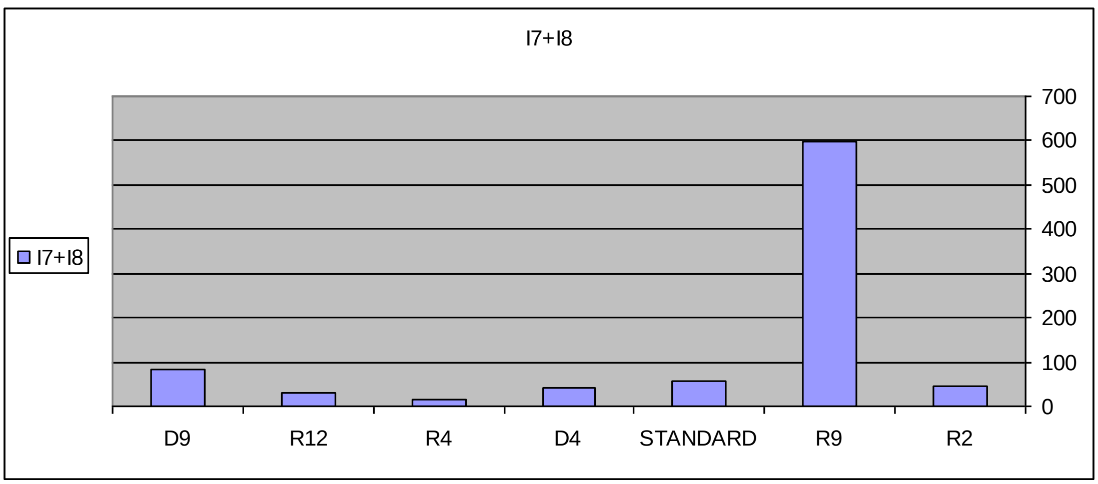


**Figure (4-17) The analysis signal of different faults at low frequency.**

## 4.6 Recommendations:

Hope that in the future will can design circuit works on the HHT methode to determine the locations of the faults to facilliate the repair of the devices electronic boards without having to examine all components of the electronic board.

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Ministry of Higher Education And Scientific Research.

University Of Diyala.

College Of Engineering.

Electronic Department.

# Prediction of Faults of The System Through output Signals

A project Submitted to the Department of Electronic Engineering University Of Diyala in Partial Fulfillment of the requirements for the Degree of Bachelor in Electronic Engineering.

By:

**Haider Abd Al-Kareem.**

**Manal Waleed.**

Supervised by:

**Dr.Arshed Abdulhamed.**

**2016**

بسم الله الرحمن الرحيم
((وَقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ))
صدق الله العظيم

# أَلإِهداء

إلى سبب وجودي في الحياة وسرُ نجاحي والدتي الغالية إليكِ يا شمسُ صباحي إليكِ يا قمراً أضاء لي درب النجاح يا مَن تعجزُ الكلماتُ عن وصفكِ أُهديكِ مِنَ القلبِ حُبا يعجزُ لساني عن وصفه.

إلى والدي العزيز يا من منحني الثقة بالنفس إلى من علمني مواجهةُ الصعاب اهديكَ عبقاً من نسيم المحبة.

إلى كل من أضاء بعلمه دروب الأجيال إلى من هم فخرُ الزمان حاضره وماضيه إليكم يا أساتذتي الكرام أُهدي أسمى آيات الشكر والتقدير يا من أنرتم بعلمكم طريقنا دمتم لنا فخراً وقدوةً نقتدي بِها.
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إليكم نهدي هذا العمل المتواضع سائلين الله عز وجل أَن ينال رضاكم.

# شكر وتقدير

نتقدم بالشكر والتقدير الى رئاسة قسم الالكترونيك و اساتذته الافاضل والى الدكتور أرشد عبد الحميد لتعاونه الكبير معنا.

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