DESAIN AND IMPLEMENTATION OF FM RADIO WAVES AS DISTANCE MEASURING AC VOLTAGE AND CURRENT

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ABSTRACT

Increasingly widespread and sophisticated electricity theft committed by businesses and households to make the losses suffered by the State greater. Indicators that can be used as a reference to determine whether the sector in the load point of theft is to observe changes in the value of current flowing in the load point, because in every area of distribution the value of current flowing is determined by PLN. But keep in mind that changes to the current value of a network is not only due solely because of theft but the change in the value of the current can also be caused by external factors, such as lightning disturbances. To solve the theft of electricity is then needed a measuring tool for observing changes in the value of current that can be used in a power grid which then gauge observations are compared with data obtained information from the registrar meter. In the design and manufacture of equipment, data transmission measurements using FM radio communication because communication is more resistant to FM interference (noise). Data measurement results must be recorded and stored on a computer.

KEYWORDS

Distance measurement, current and voltage AC, computer and FM.

1. INTRODUCTION

Increasingly widespread and sophisticated electricity theft committed by businesses and households to make the losses suffered by the State greater. A source revealed each month Country Billions Rupiah harmed due to electricity theft. To prevent theft of electricity or track action is still quite difficult because up to now control measures undertaken is still a method of data analysis of information obtained from the registrar meter monthly.

To solve the theft of electricity is then needed a measuring tool for observing changes in the value of current that can be used in a power grid which then gauge observations are compared with data obtained information from the registrar meter. Because the measurement tool must be installed on the network, it is very dangerous to safety if the need to observe, for the safety of the observations were made under a power grid which gauges installed. So that data can be monitored from the measurement results under the mounting gauge then the data should be sent. In the design and

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manufacture of equipment, data transmission measurements using FM radio communication because communication is more resistant to FM interference (noise).

Research on remote control have done one Agung Edi Wahyono [2008] with the title "ac voltage and current measurement on nets - nets pln-based wireless pc". He uses frequency modulation to transmit data in the form of AC voltage and current. By using frequency modulation, can transmit data over long distances.

Other research dessy novita [2010] with the title "Between designing wireless communication microcontroller automatic control systems". Using wireless communication, he can control DC motors and LED. Communication is a two way she uses, so that he can control and monitoring.

2. RESEARCH METHOD

Designing hardware

Telemetry system design voltage and AC current is composed of two parts, namely the sender and the receiver. Block diagram of the transmitter is shown in Figure 3. The transmitter consists of AC current sensors and AC voltage, signal conditioners, voltage-to-frequency converter, shift lock modulation frequency (FSK) signal generator sine as marker signals and transmitter modulation frequency.

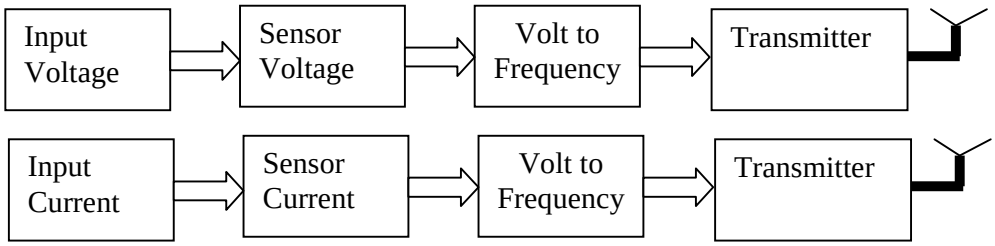

Figure 1 Block diagram of the transmitter circuit

Explanation of each block diagram in Figure 1 as follows:

a. Input signals

On the input signal, the magnitude of which will be measured in the form of electrical quantities such as voltage and AC current.

b. Censorship

Used to measure AC voltage and current. To use current clamp meter. Magnitude of the measured current is converted into voltage form.

c. Voltage To Frequency

As the audio frequency to voltage converter because the voltage is converted into its frequency will be mixed with a high frequency (HF) in the modulator and the result is a wave of radio frequency (RF) signals to be transmitted via the antenna.

d. FM Transmitter

FM transmitter system used is widely used in radio broadcasting, here used for transmitting the measurement of voltage and current AC power. To make a FM transmitter, it must first be made a modulator that can be used to modulate the carrier signal and the signal information. So that will form an FM signal. After the modulated signal, and generates an FM signal so that the signal can be transmitted to go through several stages of strengthening

The receiver section consists of an FM receiver, PLL, low frequency filter pelewat 3 KHz, demodulator FSK, frequency counter, parallel port, and a computer. The diagram for the receiver is shown in Figure 2.

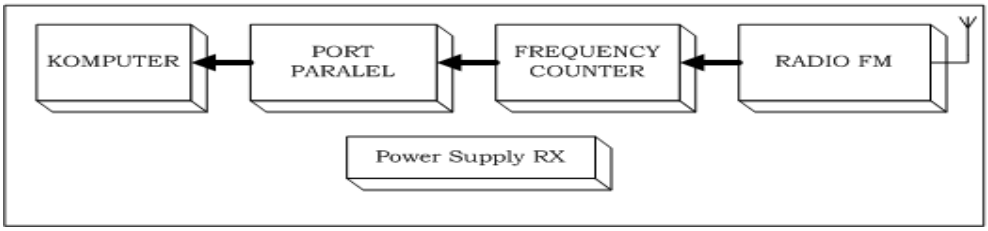

Figure 2 Block diagram of the receiver circuit.

Explanation of each block diagram in Figure 2 as follows:

a. FM Radio

FM receiver used is FM radio-broadcast receivers available on the market. It can be used as FM radio FM receiver. FM receiver used is FM tuner with some supporting components. Some of the supporting components for FM receivers, there LA1260 IC which functions as IF amplifier, quadrature detector, pre-amplifier and the audio frequency output indicators tuning.

b. Frequency counter

Output FM radio is an audio frequency and magnitude equal to the measurement results. By using frequency audio frequency counter converted into digital form which will be displayed on the computer using software delphi.

c. Parallel Port

Digital data of the frequency counter forwarded to the computer using the means of communication used parallel port for communication with the printer. The parallel port is appropriate here because the communication in parallel, making it easy to connect directly to digital strand.

d. Personal Computer (PC)

Personal Computer Dashboard displays the results of measurements made by the oscilloscope and record the measurement result data. Data measurement results can be stored with greater capacity and can be accessed again.

e. Supply

The power supply is used to provide voltage to the receiver circuit. As for the transmitter battery voltage source.

Software design

Software design aims to make the measurement data in the form of AC voltage and current can be shown to the PC. Software built using Delphi 7.0 program aims to retrieve the data output of the circuit FC then process them into information that is needed in the form of AC voltage or current is measured during a specific time interval specified in anyway. Flowchart main program can be seen in Figure 3 below.

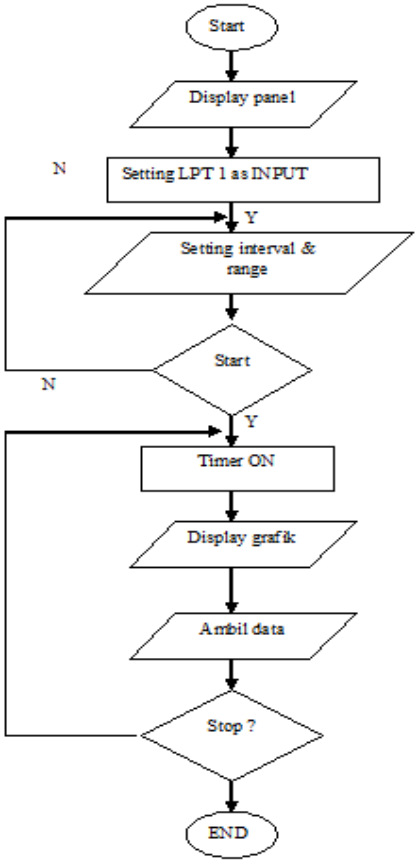

Figure 3 Flowchart main program

3. RESULT AND DISCUSSION

The whole series is divided into several blocks. Input for this application using the sensor (op-amp as the signal input signal condition). The information submitted is current and voltage information. Before the data is transmitted voltage and current gets FM transmitter, the data is forwarded to the circuit volts to frequency to be changed into the form of frequency. Thus, the frequency is used as an information signal to be transmitted in the form of radio waves by using the FM transmitter. These radio waves captured by the receiver side using the FM receiver circuit. Information received voltage and current in FM receiver in the form of frequency information,

which is a reflection of the frequency of the information value of the measured voltage and current. Frequency which is a reflection of the voltage and current values are then passed on to the next miss frequency counter display to a computer with a parallel port interface. FC section is sampling the signal made to get the value of the voltage and current required and the value of the amount shown on the PC. The process of sampling signals that do not relate to the rate niquis, because the desired information is only a frequency value that is a reflection of the magnitude of the voltage and current values are measured. Data sampling time frequency can be determined by choosing a setting found on the PC display. So, in other words the sampling here is taking a number of data within a certain time. Physical form tool can be seen in Figure 3.

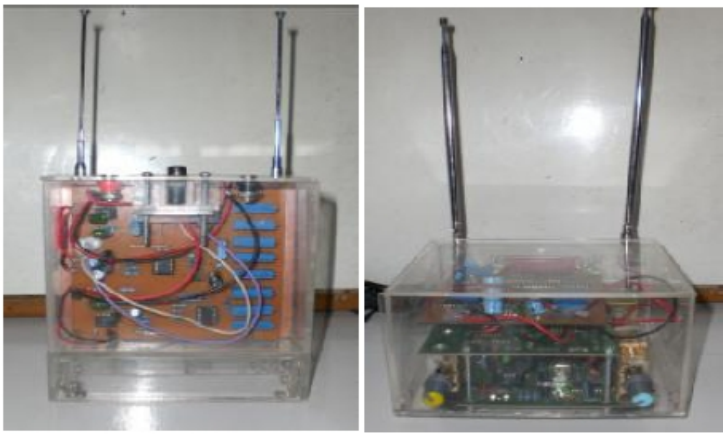

Figure 3 Transmitter and receiver

1. Measuring current and voltage circuits

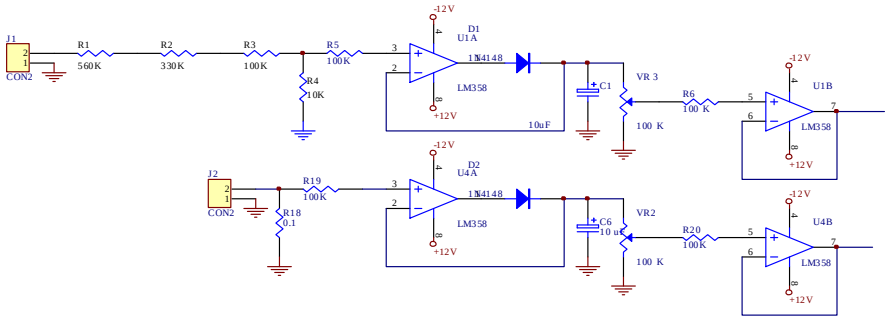

Figure 4 The series of current and voltage

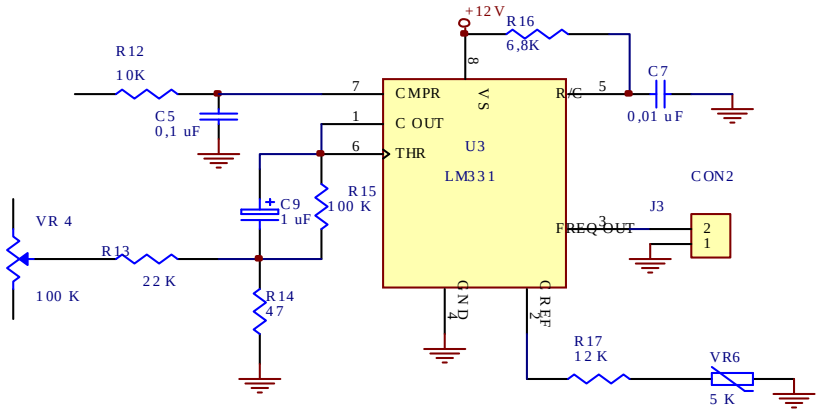

Figure 5 The circuit Volt to Frequency

The circuit in Figure 4 serves as a tool for measuring AC voltages and currents. The workings of this circuit is the input magnitude to be measured (voltage and current AC) through a voltage divider. The function of the voltage divider is a determinant of the range (range). Series of things in Figure 5 is the circuit volts to frequency, changing the voltage of the circuit in the form of frequency because the data in the form of frequency will be transmitted using FM modulation. Because these data information transmitted by FM modulation, the information signal is a frequency that is a reflection of the amount of the value of the voltage signal superimposed on the carrier or carriers.

2. FM transmitter circuit

The transmitter is a device used in the transmitter using a transistor level two, which is the first level as well as a means of generating the frequency and frequency modulation resulting audio frequency. The second level is the RF amplifier her. Transmitter circuit is shown in Figure 6.

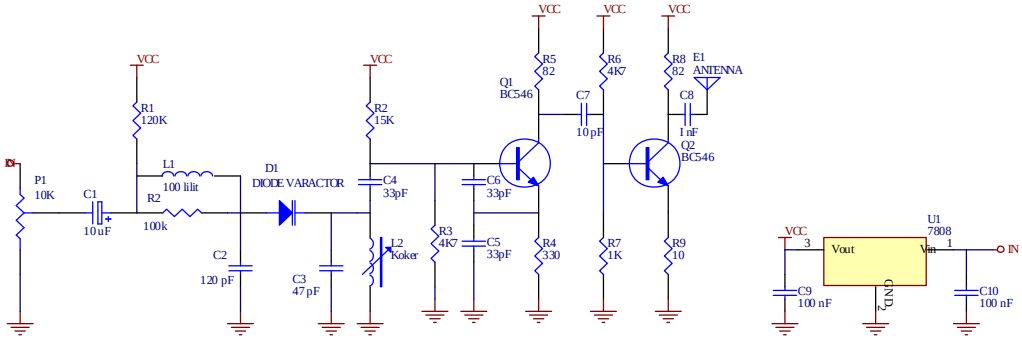

Figure 6 Series transmitter

Oscillator circuit formed by the first transistor Hartley oscillator circuit. As the frequency generator to the circuit is a circuit L and C, which are in the scheme are mounted parallel L C 47 pF. Changes in the value of the capacity of the L will change the value of the frequencies produced. The output of the oscillator circuit is then fed to a second transistor which serves as a reinforcement. Very important function of the second transistor amplifier circuit is isolated

antenna oscillator circuit, so this will make a higher frequency stability. Before the RF signal generated is fed into the first antenna is coupled with the use kondenstor (the scheme using kondenstor 1nF). Kondenstor is used to prevent damage to the transistor when a short circuit occurs on the antenna ground point. The audio signal is given to the input voltage changes will provide varaktor diode. The nature varaktor diode capacitance is a change if given the change in voltage. This resulted in a change in capacitance changes the resonant frequency according to the formula: $f = \frac{1}{2\pi\sqrt{LC}}$

Changes from varaktor diode means providing a system of frequency modulation (FM), where the output frequency can be received by a standard FM receiver. Before being used to transmit information, and can be received at the receiver oscillator testing prior to the FM transmitter circuit by turning on the FM radio waves are empty and setting up the radio volume audible hissing sound. Rotate the core Koker (L1) to right up to the maximum (resulting oscillator frequency lower). Turn on the FM transmitter, core Koker left until the hissing sound played on FM radio is lost or tuning until the indicator light turns on. If the acquired signal strong and stable, the oscillator of FM transmitter works well.

3. FM receiver circuit

FM receiver functions to receive electromagnetic waves emitted by the FM transmitter. The main component is the receiver circuit FM Tuner IC LA production Ronica and IC 1260 which is the AM / FM system. FM Tuner function as an FM frequency receiver from the transmitter. Contained in FM tuner oscillator frequency generator that serves as a local. Oscillator frequency area of work is in the area of FM receiver between 87 MHz to 108 MHz. By turning the oscillator on the FM tuner, then the resulting frequency will change. If there is a transmitter whose frequency corresponds to the frequency of the oscillator, the frequency of the transmitter will be strengthened (resonance) and passed to the output pin of the IF tuner IC LA1260 heading input. Figure 7 is a series of FM radio receivers.

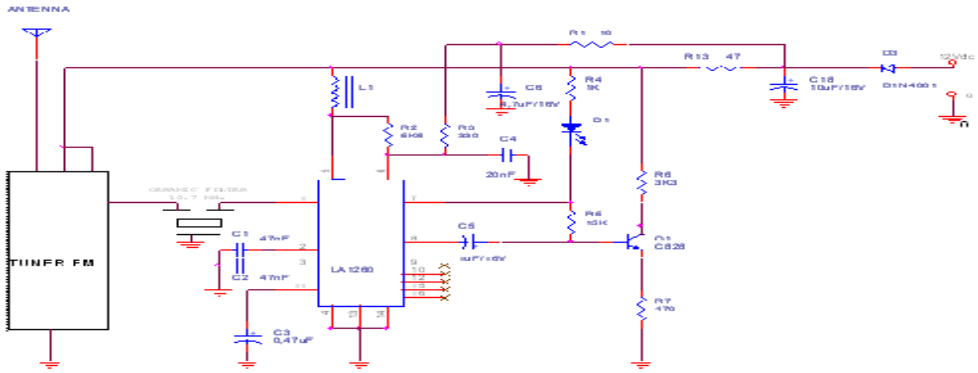

Figure 7 FM Radio Receiver Series

IF Output generated by the FM tuner is connected to pin 1 of the LA1260. By using components LA1260, the FM signal is separated between the carrier signal and the signal information, so from pin 8 LA1260 output signal obtained. Another LA1260 function is as an indicator of the output tuning. Pin 7 is connected to the LED, if the received audio signal is strong, it can output current pin 7 to turn on the LED.

4. Frequency Counter (FC)

Counter frequency circuits used to process the data to be displayed to the PC via the parallel port interface. Since the output of the FM receiver is still a sine signal, then the required strand modifiers waveforms from sine wave to square wave. In this case the used strands Schmitt trigger with Op-amp LM 358 and 74HC14.

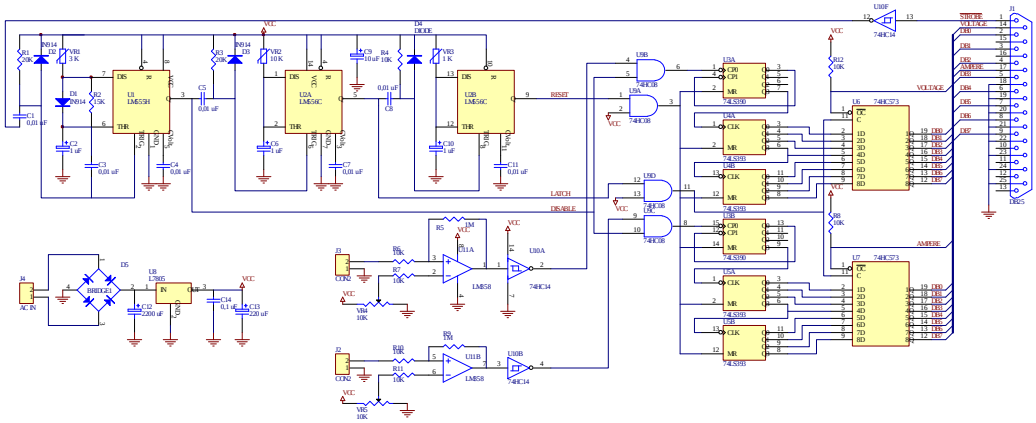

Figure 8 Series Frequency Counter

The workings of FC is to calculate the number of cycles within a certain time frame. As time base generator using a 555 timer IC and a 556 timer IC so that there are three blocks of the system timer. 555 Timer as a disable signal generator that serves as a determinant of the length of the gate is opened. IC 555 works when there is a trigger signal from the PC rather strobe signal on the parallel port. Timer 556 block 1 receives input from the timer 555 and generate a signal pulse that serves as a latch, meaning the results of counts (the process of converting analog signals into digital bits) on the IC 74LS393 counter which is forwarded to the IC 74HC573 registers are saved. Timer 556 receives input from block 2 blocks 1 and generate a reset signal pulse, the goal emptied 74LS393 counter. IC counter will count the incoming pulses into a binary combination, they form binary numbers which is the information of the signal. enumeration results of this data is stored in register. then sent to the PC via the parallel port. Required sampling rate adjusted to the time interval that can be selected in software tempilan. When the sampling interval is not selected then the measurement process can not be done, because stobe signal from the parallel port can not trigger the timer circuit, timer circuit if it does not work then the whole series on this FC will not bekarja.

4. IMPLEMENTATION AND SYSTEM TESTING

1) Calibration

Voltage and current measuring instruments calibrated by AC design process of comparison between the magnitudes measured on digital clamp meters and multimeters known standards with a measurable amount of voltage and current measuring instrument design. Quantity that can be measured from this design tool is the voltage and AC current. After being measured will get the difference between the amount of the voltage and current measuring instrument design with a digital scale on the multimeter and clamp meter reference. From this difference will get an error that will be known accuracy, resolution, and all the physical scale associated with the performance of the tool. Furthermore, this error can be seen from the performance of electronic circuits are also used. And can further be used as a reference for the development and improvement of these tools.

2) Data Collection

Measuring devices and digital multimeter clamp meter as the reference (standard) on the process of collecting data. Then the measurement tool design compared to the standard gauge. At each sampling results will be searched values mistake by using the following equation.

$$\%error = \frac{N - M}{N} x100\%$$

Description:

M = The measurement results using a multimeter setandar
N = Result of measurement logger designed by using a multimeter.
The magnitude of the mean percentage of errors by a tool designed pegukuran obtained by the following equation.

$$\%\text{The mean error} = \frac{\sum \%error}{\sum \text{measurement}}$$

The mean error affects the level of accuracy, the higher the accuracy of the smaller faults, and vice versa. The percentage level of accuracy can be calculated by the following equation.
% Accuracy = 100% -% mean error

The process of data collection at each scale are as follows:

a. The results of the data collection on the current AC

Table 1 Mean error AC current measurements

No	No reference current (A)	Measurement readings (A)	% error
1	2.5	2.58	3.52
2	3	3.08	2.73
3	3.5	3.56	1.82
4	4	4.01	0.92
5	4.5	4.54	0.97
6	5	5.04	0.8
7	5.5	5.43	1.27
8	6	5.98	0.7
9	6.5	6.48	0.24
10	7	7.05	1.4
11	7.5	7.4	1.72
12	8	7.97	0.45
13	8.5	8.51	0.44
14	9	9	0.53
15	9.5	9.52	0.33
16	10	10	0.42

$$\%\text{The mean error} = \frac{\sum \%error}{\sum \text{measurement}} = \frac{18.26}{16} = 1.14\ \%$$

% accuracy = 100% − %The mean error

= 100% − 1.14 %
= 98.86 %

Result% AC current measurement error in Table 4.8 can be made chart shown in Figure 9 as follows.

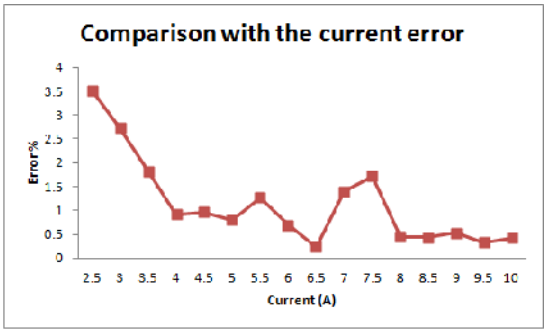

Figure 9 Graph% AC current measurement error

Based on the graph% AC current measurement error shown in Figure 9 to see the average error in the measurement of AC current without wires by 1.14%. The percentage of the biggest mistakes in the measurements 2.5A biggest and the smallest percentage of error in the measurements 9.5A According to IEC Standards no. 13B-23 specifies that the accuracy of the measuring instrument pointing a maximum of 5%.

b. The results of data retrieval in AC Voltage

Table 2 Mean AC Voltage measurement error

No	No reference current (A)	Measurement readings (A)	% error
1	50	51.7	2.714
2	60	60.7	1.544
3	70	70.6	0.748
4	80	81.6	0.997
5	90	91.5	0.697
6	100	101	0.956
7	110	110.4	0.073
8	120	120.5	0.19
9	130	130.3	0.093
10	140	139.5	0.151
11	150	149.4	0.177
12	160	159.9	0.09
13	170	169.2	0.224
14	180	179.6	0.105
15	190	189	0.223
16	200	198	0.933
17	210	208.6	0.614
18	220	218.8	0.196
19	230	228.7	0.206
20	240	238.7	0.796

$$\%\text{The mean error} = \frac{\sum \%error}{\sum \text{measurement}} = \frac{11.72}{20} = 0.58\ \%$$

$$\%\ \text{accuracy} = 100\% - \%\text{The mean error}$$

$$= 100\% - 0.58\ \%$$

$$= 99.42\ \%$$

Result% AC current measurement error in Table 2 can be made chart shown in Figure 4.13 as follows.

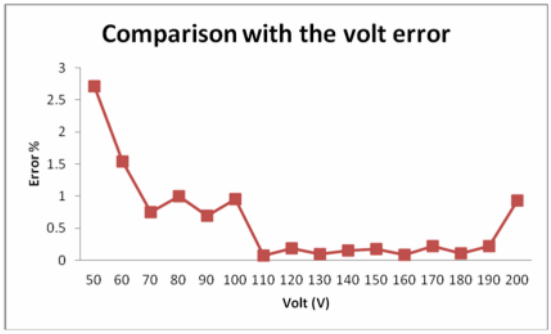

Figure 10 Graph% AC voltage measurement error

Based on the graph% error AC voltage and current measurements are shown in Figure 10 can be seen the average error in the measurement of AC voltage without wires by 0.58%. The percentage of the biggest mistakes in the measurements 50V biggest and the smallest percentage of error in the measurements 110V. According to IEC Standards no. 13B-23 specifies that the accuracy of the measuring instrument pointing a maximum of 5%. The percentage of error is used to determine the quality of the work of a smaller gauge the percentage of fault gauge better the quality, careful measurement is the measurement of the percentage of error is small. So that this measure could be used as a good measure for the percentage error of less than 5%.

5. CONCLUSIONS

The results of the design and testing of the tool, it can be concluded that

- Equipment in accordance with the results of the design that is capable of measuring voltages specification 50-240 volts AC with a mean error 0.58% and 2.5-10 Ampere AC current with a mean error 1.14%.
- result of this design tool can measure AC voltages and currents in the PLN grid, recording and retrieval of measurement results using a PC.

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