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Analysis of The Electronic System in PAS8E10 Active Speaker at PT Hartono Istana Teknologi

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***Abstract*—This paper contains an analysis and understanding of the operation and performance of the Audio PAS8E10 instrument, an active speaker widely used in various audio applications. The PAS8E10 active speaker is known for its superior sound quality, high durability, and advanced features that support various user needs. This paper will also discuss the technical specifications of the PAS8E10, signal path analysis, and include an analysis of key components such as the power supply and internal amplifier. This active speaker is equipped with modern features like Bluetooth connectivity, multiple input options, all of which play an important role in determining the final performance of this product.**

Keywords: Active Speaker, Analysis, System Architecture

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I. INTRODUCTION

The development of audio technology in Indonesia has advanced rapidly. In the field of technology, especially electronic audio, active speakers have become one of the devices capable of producing high-quality sound, energy-efficient, and providing high safety factors with low levels of pollution. To ensure that audio products offer excellent service, quality, and safety, the electronic devices and components used must meet performance and safety standards. Improving the electronic system is a crucial factor in ensuring the safety and ease of operation of active speakers. Additionally, to enhance the quality of audio products, improvements in the design and electronic technology of active speakers are required by maximizing the performance of the electronic system among the internal components of the speaker.

Active speakers are devices designed to produce high-quality sound and can be connected directly to an audio source without requiring additional amplifiers, which facilitates operation and prevents undesirable occurrences such as sound distortion or component damage. PT Hartono Istana Teknologi is one of the companies that manufactures audio devices, including the PAS8E10 active speaker. In audio technology, every component is interrelated; if one component does not function properly, the sound quality and overall performance of the device will not be optimal. Therefore, proper maintenance and analysis of the electronic system are necessary to ensure that the audio device functions efficiently.

Considering the above phenomena, it is intriguing to delve deeper into the electronic system of the PAS8E10 active speaker produced by PT Hartono Istana Teknologi.

II. METHODOLOGY

A. Resistor SMD

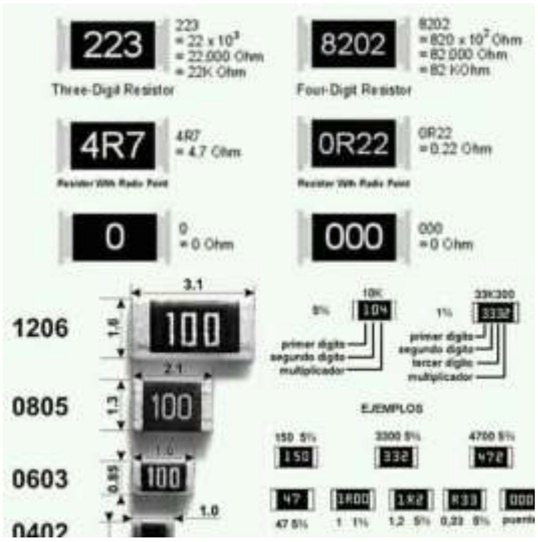

Figure 1. Resistor SMD

SMD (Surface-Mount Device) resistors are a type of resistor designed to be mounted directly on the surface of a printed circuit board (PCB). Unlike through-hole resistors which have long legs to insert into holes in the PCB, SMD resistors have small contacts on both ends that are soldered directly to the surface of the PCB.

Advantages of SMD resistors:
• Smaller size and space saving.
• Better electrical performance.
• Efficient production process.
• Weight loss.

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Comparison of SMD resistors with ordinary resistors:

Table 1. Comparison of SMD resistors with ordinary resistors

Criteria	SMD	Common Resistor
Size	Millimeters	Centimeters
Installation	Surface Mounts	Through holes
Value marking	Using a number code	Use color coding
Application	Portable electronics, solid design PCB	Prototyping, applications that require higher power
Price	Usually cheaper due to production efficiency	Slightly more expensive per unit due to higher material and production costs

B. Switched Mode Power Supply (SMPS)

SMPS (Switched-Mode Power Supply) is a type of power supply that uses switching techniques to convert electrical voltage efficiently. In contrast to linear power supplies, which regulate output voltage through power dissipation, SMPS regulate voltage by rapidly switching between on and off states, resulting in much higher efficiency.

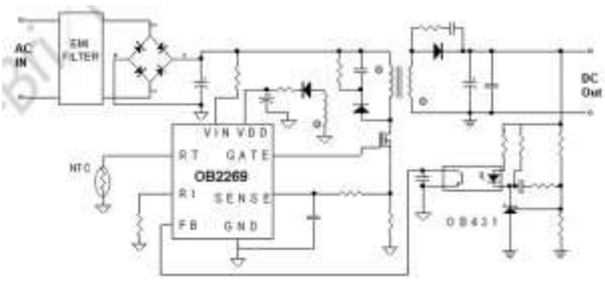

Figure 2. SMPS

Main Components of SMPS:

1. EMI Filters: Eliminates electromagnetic interference from the AC source before it enters the rectifier circuit
2. Rectifier and Filter:
   - Bridge Rectifier: Converts AC voltage to DC voltage.
   - Filter Capacitor: Smoothness pulsating DC voltage to make it more stable.
3. PWM controller:
   - Sets the duty cycle of switching to control the output voltage.
   - Protection: Provides protection features such as OVP, OCP, and OTP.

C. IC OB2269C

IC OB2269C is a PWM (Pulse Width Modulation) controller which is often used in switching power supply (SMPS, Switched-Mode Power Supply) applications. This IC is designed to provide efficient performance with various protection features to increase system reliability.

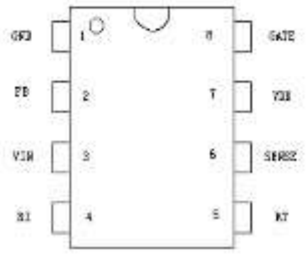

Figure 3. IC OB2269C

Description of each PIN:
1. GND = Ground.
2. FB = Feedback input.
3. VIN = Startup supply, connected to a large resistor.
4. RI = Internal Oscillator Frequency PIN, connected to ground.
5. RT = Temperature sensing.
6. Sense = Current sense.
7. VDD = DC power supply.
8. Gate = Totem pole output for Power Mosfet.

D. IC BP1064L2

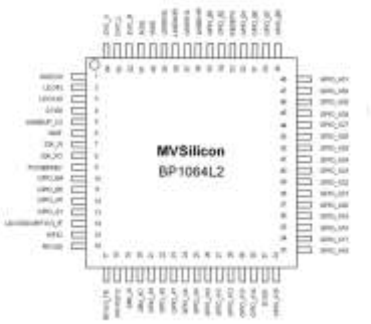

Figure 4. IC BP1064L2

IC BP1064L2 is a Bluetooth chip specifically designed for Bluetooth audio applications, such as headsets, earphones and wireless speakers. The BP1064L2 supports Bluetooth communications, enabling the wireless transfer of audio data between devices such as cell phones, computers and other audio devices. This chip has digital audio signal processing (DSP) capabilities that enable various audio functions such as voice processing, noise reduction, and high-quality audio playback.

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E. Power Amplifier IC TDA2050V

A power amplifier is an electronic device whose job is to increase the amplitude of an audio or electrical signal so that it has enough power to drive speakers or other output devices. In active speakers such as the Audio PAS8E10, a power amplifier is used to amplify the audio signal from the source and drive the speaker driver to produce clear and powerful sound.

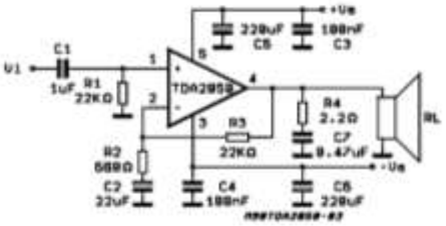

Figure 5. Diagram TDA2050V

The TDA2050 IC is an integrated circuit (IC) which is often used as a power amplifier in various audio applications, including active speakers such as the Audio PAS8E10. This TDA2050V IC is a type of class AB power amplifier that is popular because of its combination of good performance, high power efficiency, and affordable price. This IC has 5 pins:

Pin 1 (Non-Inverting Input - "+IN"): This is the non-inverting input pin of the Amplifier. The audio signal that you want to amplify is entered via this pin.

Pin 2 (Inverting Input - "-IN"): This is the inverting input pin of the Amplifier. Usually connected to ground or to the midpoint of a voltage divider for non-inverting amplifier configurations.

Pin 3 (Negative Supply - "V-"): This is the pin for the negative or ground voltage of the Amplifier power source.

Pin 4 (Output - "OUT"): This is the Amplifier output pin which provides the amplified audio signal.

Pin 5 (Positive Supply - "V+"): This is the pin for positive voltage from the Amplifier power source.

III. RESULTS

A. Block Diagram Signal

Figure 6. Hardware

Based on Figure 6, we get a signal travel block diagram:

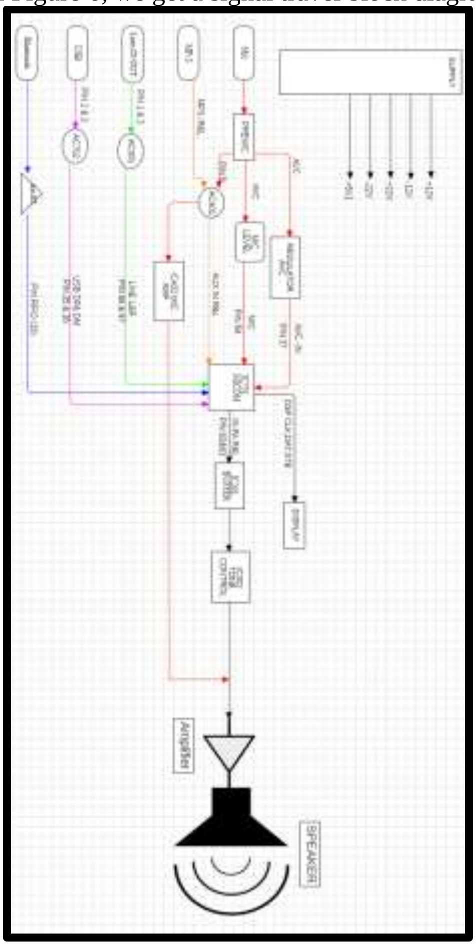

Figure 7. Block Diagram

Resources and Inputs:

- SUPPLY: Provides the various voltages required to operate the entire system (+12V, -12V, +22V, -22V, +5V). It is the primary power source that delivers energy to the various components.
- Mic: The microphone captures audio input from the user's voice or the environment.
- MP-3: Input from an MP3 device that provides audio from music files or digital media.
- Line-IN/OUT: Input and output connectivity for external audio signals, such as from other devices or for interconnection with other audio devices.
- USB: Input from a USB device, allows digital audio to be taken directly from USB (for example, from a computer or USB storage device).
- Bluetooth: The Bluetooth module handles wireless connectivity, enabling audio capture from Bluetooth devices such as phones or tablets.

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Initial Processing

- PREMIC: Pre-amplifier for the microphone, amplifies weak audio signals from the microphone so that it can be processed further.
- AVC REGULATOR: Automatic Volume Control (AVC) regulator, keeps the volume constant.
- MIC LEVEL: Microphone level adjustment, controls the gain level of the microphone signal.
- AC401: Signal controller that processes signals from microphone and other audio inputs (MP3, AUX).

Signal Processing and Control

- IC701 MICOM: The main microcontroller (Microcontroller) that manages digital signal processing, controls various system functions, and handles communication with other devices.
- DSP CLK, DAT, STB: Digital Signal Processing (DSP) signals for clock, data, and strobe, enabling complex digital signal processing.
- IC301 BUFFER: A buffer that maintains signal integrity when transferring signals between different blocks, usually to prevent distortion or loss of signal.
- IC302 TONE CONTROL: A tone control module that regulates the balance between bass and treble in an audio signal, allowing the user to adjust the sound characteristics according to preference.

Audio Output and Reproductions

- Speaker: The final component in the chain, where the audio signal is emitted as sound. The diagram shows that the output of the audio system is directed to the speakers via the final gain path.

Signal Path

- Red Path: Representation of the main signal path for input from various sources (mic, MP3, AUX, etc.) leading to pre-processing.
- Orange Line: Connects the line from preprocessing to the main signal controller (IC701).
- Purple Line: Connects signal processing from the USB and Bluetooth modules to the microcontroller (IC701).
- Blue Line: Connects the signal path from the radio frequency (RFIO) to the microcontroller.
- Green Line: Connects the input from Line-IN/OUT to the microcontroller (IC701).
- Pink Line: Connects USB DP and DM (differential pair for USB data) to the microcontroller.

Component Specific Functions

- MIC AMP (IC402): Microphone amplifier, amplifies the audio signal coming from the microphone before further processing.
- DISPLAY: Shows system status and control information to the user, often interfaced with a microcontroller for real-time display updates.

B. Measurement Quantities

This measurement was carried out using qualitative methods. The data was obtained by taking measurements on the speaker board at frequencies of 60, 80, 100, 300, 500, 800, 1000, 3000, 5000, 8000, and 10000 Hz, and conditions of ½ & ¼ volume, bazoke on & off, and position tone control bass & treble low, bass & treble middle, bass & treble high. Each of these conditions is given input from an audio generator of 200mV, 500mV, and 1V. With these conditions, measurements are carried out at certain points, such as:

- J333 & J334 are the points where the right and left signals from the Audio Generator enter.
- J603 & J318 are the right and left points after the signal passes through the tone control and are input to the power amplifier.
- J518 & J610 are the right and left signal output points to the woofer after passing through the power amplifier.
- C519 is +Vs voltage output.
- J626 is a -Vs voltage output.
- J709 is +5V1 voltage output.

At each point, measurements are made by looking at the amplitude on the oscilloscope. Dummy Load is used as a replacement for Woofer to reduce noise due to high frequencies.

Table 2. Parameter

Condition	Size
Volume ¼	3.6 Ω
Volume ½	7.2 Ω
Dummy Load	7.3 Ω
Bass & Treble min	0 rounds
Bass & Treble min	½ turn
Bass & Treble max	1 round
Bazoke On	0 rounds
Bazooke Off	1 round

C. Experimental Data Volume ½, Signal Input 1 V

1) J333 & J334

Table 3. J333 & J334

Tone control			1V Tegangan output modul Line In/Out di titik ukur J333 & J334 (V) Frekuensi										
Bass	Treble	Superbass	60	80	100	300	500	800	1000	3000	5000	8000	10000
Min	Min	OFF	0,14	0,15	0,169	0,25	0,311	0,311	0,311	0,366	0,366	0,311	0,28
Mid	Mid	OFF	0,14	0,15	0,169	0,25	0,311	0,311	0,311	0,366	0,366	0,311	0,28
Max	Max	OFF	0,14	0,15	0,169	0,25	0,311	0,311	0,311	0,366	0,366	0,311	0,28
Min	Min	ON	0,15	0,169	0,169	0,288	0,311	0,311	0,311	0,37	0,37	0,311	0,28
Mid	Mid	ON	0,15	0,169	0,169	0,288	0,311	0,311	0,311	0,37	0,37	0,311	0,28
Max	Max	ON	0,15	0,169	0,169	0,288	0,311	0,311	0,311	0,37	0,37	0,311	0,28

2) J318 & J603

Table 4. J318 & J603

Tone control			1V Tegangan output blok Tone control di titik ukur J318 & J603(V) Frekuensi										
Bass	Treble	Superbass	60	80	100	300	500	800	1000	3000	5000	8000	10000
Min	Min	OFF	0,0083	0,0098	0,01	0,025	0,028	0,025	0,022	0,012	0,0084	0,0042	0,0028
Mid	Mid	OFF	0,015	0,0169	0,0188	0,031	0,038	0,0311	0,028	0,018	0,021	0,013	0,014
Max	Max	OFF	0,07	0,063	0,063	0,048	0,042	0,032	0,0311	0,07	0,081	0,089	0,085
Min	Min	ON	0,49	0,28	0,21	0,02	0,028	0,028	0,024	0,014	0,0084	0,0053	0,0029
Mid	Mid	ON	0,49	0,38	0,24	0,035	0,038	0,034	0,028	0,026	0,021	0,015	0,014
Max	Max	ON	0,49	0,38	0,28	0,056	0,042	0,035	0,035	0,07	0,088	0,088	0,088

3) J518 & J610

Table 5. J318 & J603

Tone control			1V Tegangan output blok Power amplifier di titik ukur J518 & J610(V) Frekuensi										
Bass	Treble	Superbass	60	80	100	300	500	800	1000	3000	5000	8000	10000
Min	Min	OFF	0,25	0,51	0,35	0,87	0,98	0,84	0,83	0,42	0,28	0,14	0,1
Mid	Mid	OFF	0,49	0,55	0,8	1,2	1,15	1	0,87	0,7	0,57	0,45	0,48
Max	Max	OFF	2,1	2	1,97	1,69	1,27	1,13	1,11	3,6	3,08	3,11	2,95
Min	Min	ON	12,7	10,6	7	0,74	0,98	0,84	0,82	0,28	0,298	0,14	0,095
Mid	Mid	ON	12,7	10,9	7,7	1,06	1,1	0,98	0,98	0,7	0,59	0,49	0,47
Max	Max	ON	12,7	11,3	8,4	1,69	1,2	1,06	1,08	2,2	0,098	0,098	0,098

4) C519

Table 6. C519

Tone control			1V Tegangan output blok Power supply di titik ukur C519(V) Frekuensi										
Bass	Treble	Superbass	60	80	100	300	500	800	1000	3000	5000	8000	10000
Min	Min	OFF	13	13	13	13	13	13	13	13	13	13	13
Mid	Mid	OFF	13	13	13	13	13	13	13	13	13	13	13
Max	Max	OFF	13	13	13	13	13	13	13	13	13	13	13
Min	Min	ON	13	13	13	13	13	13	13	13	13	13	13
Mid	Mid	ON	13	13	13	13	13	13	13	13	13	13	13
Max	Max	ON	13	13	13	13	13	13	13	13	13	13	13

5) J626

Table 7. J626

Tone control			1V Tegangan output blok Power supply di titik ukur J626 (V) Frekuensi										
Bass	Treble	Superbass	60	80	100	300	500	800	1000	3000	5000	8000	10000
Min	Min	OFF	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5
Mid	Mid	OFF	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5
Max	Max	OFF	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5
Min	Min	ON	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5
Mid	Mid	ON	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5
Max	Max	ON	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5	-11,5

6) J709

Table 8. J709

Tone control			1V Tegangan output blok Power supply di titik ukur J709 (V) Frekuensi										
Bass	Treble	Superbass	60	80	100	300	500	800	1000	3000	5000	8000	10000
Min	Min	OFF	5	5	5	5	5	5	5	5	5	5	5
Mid	Mid	OFF	5	5	5	5	5	5	5	5	5	5	5
Max	Max	OFF	5	5	5	5	5	5	5	5	5	5	5
Min	Min	ON	5	5	5	5	5	5	5	5	5	5	5
Mid	Mid	ON	5	5	5	5	5	5	5	5	5	5	5
Max	Max	ON	5	5	5	5	5	5	5	5	5	5	5

D. Volume Analysis ½, Signal Input 1 V

1) Bass Min, Treble Min, Superbass OFF

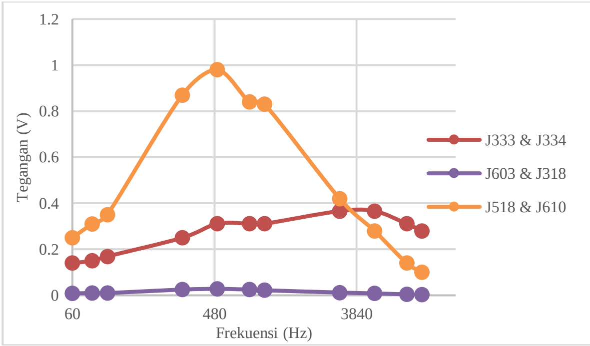

Figure 8. Frequency Response and Volume Voltage ½, 1V, Bass Min, Treble Min, Superbass OFF

Based on the graphic data, at points J333 & J334 an input voltage of 0.14V at a frequency of 60Hz was detected. An increase in frequency causes an increase in the measured voltage. The voltage peaks at 3KHz & 5KHz frequencies, reaching a level of 0.197V. However, the signal reaching points J603 & J318 is below the voltage threshold of 0.02V. The lowest voltage occurs at a frequency of 10KHz, only 0.0015V. The highest voltage occurs at a frequency of 500Hz, reaching 0.0169V. The voltage flowing through this point will go through points J518 & J610 or the amplifier block. The voltage will be increased, as seen at a frequency of 500Hz with a measured voltage of 0.49V and at 10KHz of 0.056V. Thus, it can be concluded that the enlargement or strengthening that occurred at this point was 30.3 times.

2) Bass Mid, Treble Mid, Superbass OFF

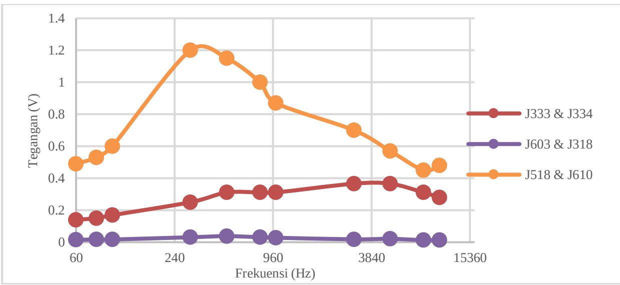

Figure 9. Frequency Response and Volume Voltage ½, 1V, Bass Mid, Treble Mid, Superbass OFF

The initial voltage at a frequency of 60Hz is 0.14V as the initial input point at J333 & J334. The increase in frequency is positively correlated with voltage, peaking at 0.36V around the frequency of 3840Hz. The signal to be processed goes to J603 & J318, but the measured voltage shows a value that is far below the input point. Although the voltage at the signal processing point is below 0.038V, after passing through the

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amplifier, the voltage level starts at around 0.2 and rises to more than 1.2V at a frequency of 500Hz. However, after passing this frequency, the voltage decreases significantly. The gain in this condition is 33.3 times.

3) Bass Max, Treble Max, Superbass OFF

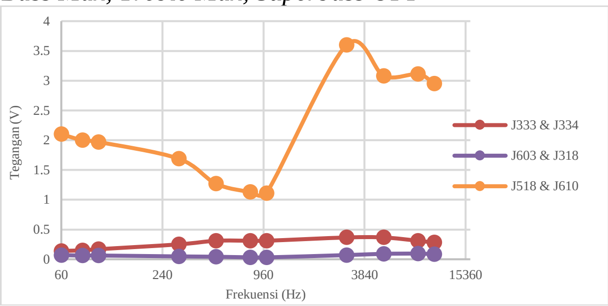

Figure 10. Frequency Response and Volume Voltage ½, 1V, Bass Max, Treble Max, Superbass OFF

The graph above depicts frequency variations in voltage measured at certain points. At points J333 & J334, the measured input voltage ranges from 0.1 V to 0.4V for each frequency. The signal that has gone through the tone control process and is measured shows a much lower voltage than the input signal, which is around 0.07V at a frequency of 60Hz, decreasing to 0.0311V at a frequency of 1KHz, and ending with a voltage of 0.085V at a frequency of 10KHz. After going through the signal travel process and reaching points J518 & J610, the signal is strengthened and shows a voltage of 2.1V at a frequency of 60 Hz. The signal then decreases in the center frequency until it reaches 0.0311 at around 800Hz, but then experiences a significant increase until it reaches more than 3.5V. The average reinforcement with this condition is 34.74 times.

4) Bass Min, Treble Min, Superbass ON

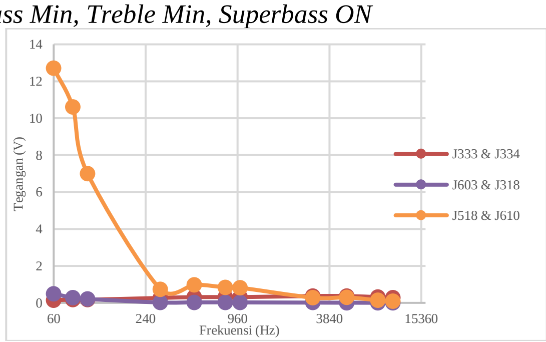

Figure 11. Frequency Response and Volume Voltage ½, 1V, Bass Min, Treble Min, Superbass ON

In the graph 3.4, at points J518 & J610, low frequencies dominate which results in low frequency voltage reaching more than 12V. Voltage tends to decrease as frequency increases. The lowest voltage occurs at a frequency of 10KHz, only 0.0029V. At points J333 & J334, the measured voltage is below 0.5V, where the highest voltage occurs at a frequency of 3KHz and 5KHz, reaching 0.37V, while the lowest voltage is at 0.14V at a frequency of 60Hz. However, at the tone control or points J603 & J318, the highest voltage occurs at a frequency of 60Hz, namely 0.42V, while the lowest voltage occurs at a frequency of 10KHz, only 0.0042V. The average gain in this condition is 31.6 times.

5) Bass Mid, Treble Mid, Superbass ON

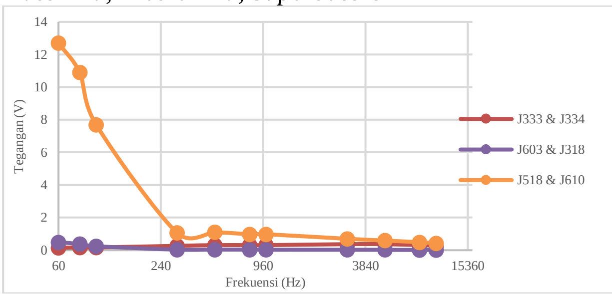

Figure 12. Frequency Response and Volume Voltage ½, 1V, Bass Mid, Treble Mid, Superbass ON

In the given graph analysis, the significant impact of superbass at high frequencies becomes clear. At points J518 & J610, there is a dominance of low frequencies which causes the high voltage level to be at 12.7V. In addition, it can be seen that the higher the frequency, the voltage tends to decrease. The lowest voltage drop was recorded at a frequency of 3KHz with a value of 0.7V. On the other hand, at points J333 & J334, the measured voltage is below 0.4V, with the highest voltage occurring at the 3KHz and 5KHz frequencies of 0.37V. However, there is an interesting contradiction at points J603 & J318, where the highest voltage occurs at a frequency of 60Hz of 0.49V, while the lowest voltage recorded at a frequency of 10KHz is only 0.0014V. So,it can be seen that the average strengthening under this condition is 29.8 times.

6) Bass Max, Treble Max, Superbass ON

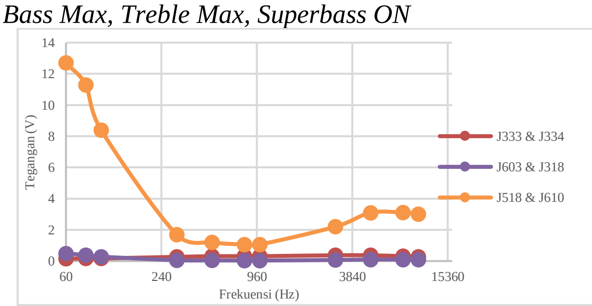

Figure 13. Frequency Response and Volume Voltage ½, 1V, Bass Max, Treble Max, Superbass ON

In graph 3.6 with Volume ½, 1V, Bass Max, Treble Max, Superbass ON conditions at points J518 & J610 it is measured that the voltage at the 60Hz frequency is the same as the condition when the bass and treble are in min or mid, this is because the active superbass dominates the frequency low, so no matter what the tone control conditions are, it will not be affected due to the dominance of the superbass. However, the thing that has an effect is when the frequency is high, because in this condition the treble is max, it can be seen that the voltage increases when the frequency starts to be in the high area or 1KHz and above. You can see the voltage increasing from 1.06V to 3V. The measurement at the point J333 & J334 will remain the same as the previous condition provided that the input is still 1V because at this point there is no interference from signal processing. In this condition the average strengthening is 30.03 times.

E. Power Supply Output Voltage Analysis

At certain measurement points, such as C596, J626, and J709, voltage stability is very important. Point C596 produces a stable voltage of 13V in all measurement conditions, point J626 is -11.5V, and point J709 is 5V. This voltage stability is the effect of using a 12V Zener diode, which functions to maintain a constant voltage throughout the circuit. Zener diodes are very useful in applications that require a stable reference voltage, such as voltage regulators, even if the input voltage changes. Errors in voltage readings on analog oscilloscopes can occur and cause measurement differences, but the basic principle remains important: maintaining a stable voltage is the key to optimal performance.

Reasons for stable voltage:

1. As Component Protector: Unstable voltage can cause components in the audio system to experience excessive stress or even damage. Components such as transistors in amplifiers are very susceptible to unstable or too high voltages. Transistors that operate outside safe voltage specifications can experience overheating, operational disruption, or even complete failure. With stable voltage, components can work within safe limits, so their life and reliability increases.
2. Maintain Consistent Audio Performance: Stable voltage ensures audio devices such as amplifiers and speaker drivers operate at the desired power level. Voltage fluctuations can cause changes in audio output, such as unstable volume or sound distortion. For example, if an amplifier receives inconsistent voltage, its output power will also fluctuate, which can result in uneven audio output and reduce the quality of the listening experience.

IV. Conclusion

1. The average gain of the TDA2050V amplifier is 29.54 times. This means that the input signal entering the amplifier will be amplified by almost 30 times, resulting in a much stronger output. This significant gain makes the TDA2050V suitable for audio applications requiring strong and clear sound, such as home audio systems or active speakers.
2. The output voltage from the power supply is 13V, -11.5V, and 5V. These three voltages are crucial for ensuring the stable and efficient operation of various components within the audio system. The 13V and -11.5V are typically used to power the amplifier section, while the 5V may be used for logic circuits or other control functions.
3. When the bass and treble are set to maximum and superbass is turned off, the output voltage at midrange frequencies is reduced. This means that the midrange frequencies will not be as strong as the low and high frequencies, creating a sound profile that emphasizes bass and treble while having a weaker midrange.
4. When the bass and treble are set to minimum and superbass remains off, the output voltage at midrange frequencies experiences a peak in gain. This produces a sound more focused on the midrange, while the low and high frequencies become less dominant.
5. When superbass is activated, the voltage at low frequencies is amplified while high frequencies are suppressed. This significantly impacts the sound profile, making the bass more dominant and reducing the treble.
6. In addition to amplifying low frequencies, active superbass also reduces the effect of tone control on low frequencies. This means that the bass setting on the tone control will be less effective when superbass is activated, due to the additional boost from superbass.
7. The voltage in the amplifier block has a positive correlation and is highly dependent on the voltage in the tone control block. Tone control settings will influence how the voltage in the amplifier changes, ultimately affecting the quality and characteristics of the audio output.
8. The higher the bass setting, the higher the voltage at low frequencies. This means that increasing the bass setting will significantly enhance the low-frequency sound, producing a deeper and more powerful bass effect.
9. The higher the treble setting, the higher the voltage at high frequencies. This will result in a brighter and clearer sound, with sharper detail in the high-frequency range.
10. The voltage measurements at both the right and left points of the PAS8E10 speaker in all conditions are the same. This indicates that the audio system has good channel balance, ensuring that the sound produced by both speakers is consistent and balanced, providing an optimal stereo audio experience.

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