Compu-Bias™

Automatic

Vacuum Tube Bias Meter

Operation Guide

Release 1.0, Version 4.0

SCOPE

This publication describes basic specifications and use of the Compu-Bias™ Bias Probe

INTENDED AUDIENCE

This Operation Guide is intended for the user/operator of this device. The user/operator of this device must have good work practices and be aware of the potential of electric shock while operating this device. If the user/operator does not possess these skills he/she should obtain the appropriate technical assistance in use of this device.

Disclaimer

This device is sold as an industrial/commercial test device. The instructions provided are offered as a guide in the use/operation of this device (Compu-Bias™ Bias tester**) only. Compu-Bias is not responsible for any errors or omissions in this guide. Neither Compu-Bias nor any other entity can or will be liable for any damage be it personal, property or monetary that may occur using this device. This includes the amplifier or tubes being tested. This device is in contact with potentially lethal voltages. The operator/user of this device should have appropriate technical expertise commensurate with the tasks required. If while using or operating this device the user/operator requires technical assistance it is the responsibility of user/operator to acquire that assistance. Operation of this device or any unit without an appropriate ground is not advised.**

 **High voltage may be present inside amplifiers. Take appropriate precautions!** 

READER'S COMMENTS

We would like to know what you think about this publication. For that purpose, we have included an Email address for our Information Development project leader. Our Information Development address is:

info@compu-bias.com

Web Site Address
www.compu-bias.com

ALERT MESSAGES

This publication contains the following types of alert messages:

- **NOTE** 

PROVIDES ADDITIONAL INFORMATION THAT MIGHT BE OF SPECIAL INTEREST. A NOTE CAN POINT OUT EXCEPTIONS TO RULES OR PROCEDURES. A NOTE USUALLY, BUT NOT ALWAYS, FOLLOWS THE INFORMATION TO WHICH IT RELATES.

- **CAUTION** 

Informs you of conditions that might result in damage to hardware, or health hazard to people. A caution always precedes the information to which it relates.

- **Warning** 

Alerts you to conditions that might result in injury or death. A warning always precedes the information to which it relates.

- **WARNING ELECTRIC SHOCK** 

Informs you of conditions that might result in damage to hardware, or health hazard to people. A caution always precedes the information to which it relates.

Table of Contents

Features and Options

Can be used on Fixed Bias, Adjustable Bias or Cathode Biased Amplifiers (Common Cathode)
Instantly indicates Balance of Output Tubes
Instantly indicates Total Power Dissipated in Watts
Requires no additional measurements or calculations

COMPU-BIAS

Connect up to 2 tubes
9pin and Octal
or
Wattage Probe
Concurrently Displays

- Display Plate Voltage
- Display Cathode Current (Total)
  Vp * Ik + Is = D
- Display Total Tube Dissipation (Watts)
- Base Model 1 Probe (Octal or Noval)
  Fully Automatic
  Easy to read LCD display
  Second Probe Optional *
  Multiple Probes Optional*

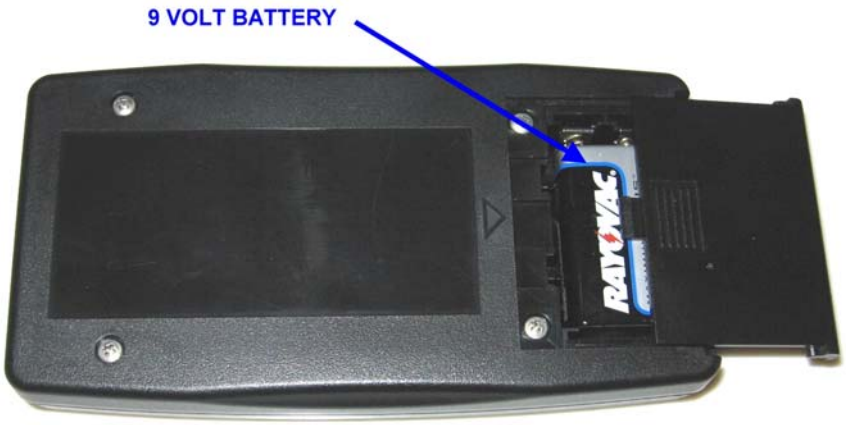
Additional Functions

- Display Output Watts*
  (RMS from Peak to Peak)
  (Mathematically Calculated)
  Low distortion sine wave only
  Clip to speaker or load
- Unit automatically sets mode depending on probe/probes attached
- Factory Calibrated and Programmed
- Factory Re-Programmable
  New Software Versions
  Software Updates
- Powered by Standard 9v Transistor Battery
  Not included
- Power Save Mode (Plate voltage <10vdc)
- Battery life >200hrs with Power Save
- Works with any filament voltage

Vp=Plate Voltage (Voltage between Cathode and Plate)
Ik=Cathode Current
D=Tube Dissipation in Watts (total as measured at cathode)

* Indicates specific options that may or may not be made available depending on specific model ordered

Compu-Bias Locations



Accessories

OCTAL PROBE

NOVAL PROBE

WATT PROBE

Bias Operation (EASY)

Verify a good battery is installed in the Compu-Bias
Verify Amp is properly grounded and in good working condition

1. **TURN OFF AMP**

2. **LOCATE OUPUT TUBES**

3. **REMOVE OUTPUT TUBES**

4. **PLUG OUTPUT TUBES INTO PROBES**

5. **PLUG PROBES WITH TUBES INTO AMP**

6. **COMPU-BIAS AUTOMATICALLY POWERS UP WHEN PROBE 1 IS CONNECTED**
7. **PLACE AMP IN STANDBY IF AVAILABLE**
8. **TURN ON POWER**
9. **VERIFY ALL FILAMENTS ARE ON (THIS INDICATES PROPERLY INSTALLED PROBES)**
10. **PLACE STANDBY SWITCH IN OPERATE POSITION**
11. **VERIFY VOLUME IS AT MINIMUM (DISCONNECT ANY INPUTS)**
12. **PLATE VOLTAGE, CATHODE CURRENT AND WATTAGE ARE AUTOMATICALLY DISPLAYED**
    NO CALCULATORS, NO GUESSING

13. **MAKE ADJUSTMENT IF NEEDED** (use approved methods for adjusting bias)
14. **DISCONNECT AND UNPLUG PROBES WHEN FINISHED (RECHECK AS NEEDED)**

Bias Operation (DETAILED)

Verify a good battery is installed in the Compu-Bias
Verify the unit under test is properly grounded and in good working order

1. Attach the Probe to the Compu-Bias

- Plug Probe 1 (either the 9 pin or Octal Probe) into socket labeled Probe 1
  A second probe if available may be plugged in at this time
- The Compu-Bias will turn on automatically
- The Display will indicate that the unit is powering up by displaying the prolog and the software version number.
- After about 3 seconds the Compu-Bias is ready to use
- There will be either 1 or 2 lines of information displayed depending on the number and type of probes attached

2. Setup the amp for measurement

- Verify the amp you want to test is off
- Turn down the volume controls and remove any inputs
- Always make sure that there is a proper load on the amp (speaker)
- Remove one of the output tubes and plug it into the Probe adapter socket (being careful to align the pins with the socket) *(use caution as the tubes may be hot)*
- If there are more than 2 output tubes you should test them in pairs
- Plug the tube with the adapter socket attached back into the amp (carefully align the pins with the socket)
- Repeat this procedure with the other tube and the second Probe if available
- Verify none of the wires from the Compu-Bias are touching any of the tubes to avoid damage

- **DO NOT** plug the Probe adapter into the Rectifier socket

3. Turn on the amp

- Turn the Standby switch to the Standby position
- Turn on the amp

  Verify that the filaments in the power tubes are on, this is an indication that the tube and adapter are properly installed
- After a sufficient warm-up move the standby switch to the operate position
- The Plate Voltage, Cathode Current and the calculated Wattage will automatically be displayed
- Wattage is calculated by multiplying plate voltage and cathode current. Screen current is included in the measurement of cathode current.

4. Set the bias for correct power tube dissipation

- Find the recommended dissipation (wattage) for your amp using the manufactures data and set the bias (if required) within those specifications. Set balance if needed

- We recommend using 50 to 70 percent of the rated dissipation value for most tubes (see chart page 11)
- Verify these setting with the manufacturer if possible
  (Use appropriate working practices if high voltage is present)

5. Remove Probes from amp and Compu-Bias

- Turn amp off and remove Probes by reversing procedure in step 2
- Unplugging Probes from the Compu-Bias will automatically turn it off
- Store in safe place

6. Verify settings

- Run the amp a number of hours after making adjustments then recheck your settings

- It is ***not recommended*** and the indications on the Compu-Bias may not be useful if you play the amp with the Compu-Bias attached. – *readings are only taken with no signal applied* – This could actually damage the Compu-Bias and/or the probes due to the extremely high AC voltages

Wattage Probe

1. Connect the Wattage Probe to the Compu-Bias

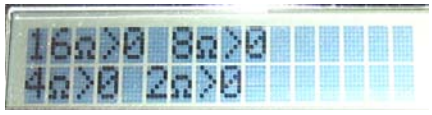
- Plug the Wattage Probe into the Probe 1 connector
- The Compu-Bias will automatically power up in the Wattage measurement mode

2. Connect the Wattage Probe Clips to a known load

- A resistive load will produce more predictable results
  Speakers are inductive, the impedance (ac resistance) will vary as the applied ac signal changes.

3. Apply a signal to the load under measurement

- Apply a stable signal to the amplifier under test
- As the voltage across the load rises the Compu-Bias will indicate the power being dissipated in that load. (V^2 / R = P See 4. Interpreting the displayed wattage measurement)
- The wattage reading is displayed next to the reference resistance.



4. Interpreting the displayed Wattage measurement

- The Compu-Bias displays the output power to the point of clipping
- The Compu-Bias calculates RMS power in the following way
  The Compu-Bias is not a typical True RMS Reading Meter
  (See Page 14. Understanding RMS Voltage, Power and Calculations)
  (See Page 15. Why use RMS measurements to rate power from amplifiers…. *)*
  The voltage applied to the Compu-Bias is first rectified (full wave)
  This rectified voltage is then filtered (this represents the peak voltage)
  The filtered voltage is measured
  RMS power is calculated using mathematical calculations
  (The calculations compensate for the voltage drops in the rectification circuit)
  The power displayed will be pseudo independent of the input wave shape
  Power displayed is the output power into a non-reactive load up to the point of clipping

Power calculations past the point of clipping do not represent true power of an amp regardless of what the amp is used for. Stereo / HI-FI amps should not be operated at or past the point of clipping. Guitar amps are commonly operated at or past the point of clipping. In the case of guitar amps the tonal qualities of an amp operating in this region are subjective. See page 15 for more information.

Specifications

- Absolute Maximum Plate Voltage 600vdc
- Plate Voltage Accuracy +/-5%
- Plate Voltage Measured Between Cathode and Plate
- Absolute Maximum Cathode Current 500ma dc / 30 seconds
- Cathode Current Accuracy +/-5%
  [To be used for Idle Current readings only does not display peak]
  [Excessive PEAK input voltages may damage unit]
- Absolute Maximum RMS Speaker Wattage Measurement (see below)
  150w into 16 ohms
  300w into 8 ohms
  600w into 4 ohms
  1200w into 2 ohms
  (maximum wattage measurement input voltage 50vacrms single tone sustained) [Does not display peak]
- Can be used with 2 Probes on any amp with common Cathodes
  (If the user is unsure about common cathode connection use only one Probe and test each tube separately)
- Battery life >200 hours (3-4ma current draw in normal operation)
- Power down mode will reduce consumption ~500ua
- Display not back-lighted (to conserve power)
- Battery contacts embedded in product enclosure
- No user serviceable parts inside enclosure
- Connections to High Voltage are insulated from user by nonconductive probes
- Voltage from probes are double insulated inside device by not having any external power connections or common points such as exposed grounds
- No voltage from tube probes will exceed 5vdc in normal operation (Internal common is at cathode potential)
- Speaker connection (Wattage Measurement) will not expose user to voltage greater than voltage developed by the speaker
- Improper use of this device may damage the device or the unit under test. Read and understand the operations manual before use
- Unstable indications are an indication of noise (check for power supply noise or oscillations)
- Unit has not been approved by any governing bodies and contains a 4mhz oscillator. Although there are no high voltages developed by this device there may also be compliance directives associated with its use that apply in other countries.
  FCC part 97 15.103 (c.) Exempted devices (Industrial and Commercial TEST equipment)

Note: This generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.
-- Increase the separation between the equipment and receiver.
-- Consult the dealer or an experienced radio/TV technician for help.
-- Discontinue use of the device.

More on Bias

Fixed Bias

Non Adjustable:

The bias voltage is developed by a fixed resistor divider. It is possible that the bias voltage will need to be changed when new or different type tubes are installed or if you want to change the operation of the amplifier. This is done by replacing one or more of the divider resistors to set the bias voltage for the proper power tube dissipation. Typically this should be done by an experienced technician as it requires knowledge of electronic circuits. There may also be a balance control.

Adjustable:

The ability to change "adjust" the DC bias voltage placed on the grid of a tube in relation to its cathode thereby obtain proper power tube dissipation. Amps of this type will have a pot to set or "adjust" the idle (no signal) bias voltage. This is similar to Fixed bias but is adjustable. There may also be a balance control.

Cathode or Self Bias:

The bias voltage is obtained by a resistor placed on the cathode of the power tube/tubes. As the tube conducts, voltage is dropped across this resistor causing the cathode to become positive in reference to ground. The grids are DC grounded. The negative relationship between the cathode and the grid is how bias voltage is obtained in this type of amp. It is possible that the bias voltage will need to be changed when new or different tubes are installed or if you want to change the operation of the amplifier. This is done by replacing the cathode resistor with a different value to set the bias voltage for proper power tube dissipation. Typically this should be done by an experienced technician as it requires knowledge of electronic circuits.

RAISING THE BIAS?

A bias voltage that is more negative in reference to the cathode will cause the tube to draw less plate current. If the bias voltage changes in a positive direction the tube will draw more plate current. Don't be confused with terms like "raising the bias". This is a bit confusing because raising the bias voltage I.E. making the bias voltage bigger by going from –40vdc to –50vdc will cause the tube dissipation to be reduced. Or it could mean to make the bias voltage more positive by going from –50vdc to –40vdc causing the tube to dissipate more power.

COMPU-BIAS CALCULATIONS

Because the wattage displayed on the Compu-Bias indicates TOTAL dissipation through the cathode (Cathode current = Plate current + Screen current) using the recommended Plate dissipation will afford a safety factor as some of the power is actually being dissipated in the Screen. There is no need to take your amp apart to measure anything, keep logs or place stickers all over your amp when you use the Compu-Bias. Simply remember the tube dissipation or use the chart. Knowing the idle current is only half the answer. Without knowing that and the plate voltage before doing the math you are wasting you time.

WHAT IS THE CORRECT BIAS FOR MY AMP?

The correct bias for an amp is subjective, but should be near the reference chart supplied in the manual in any case. There is an acceptable high and low range. The tube will either be too near cutoff (indicated by crossover distortion) or will be dissipating excessive power with no signal applied if the bias is too high or too low. Setting your bias to a point where you are satisfied with the tone while maintaining power dissipation within the limits of the tube is correct. Class A and AB1 amps can have significantly different dissipation values. For example it is not uncommon to see EL84 amps idling at 12 watts. To extend the life of your power tubes use the lowest setting that provides the tone you are looking for. Remember candles that burn very bright typically don't burn very long. Under biased amps typically do not sound pleasing, this condition is easily verified with a scope if you don't understand what you are hearing.

CAUTION:

Do not plug the Compu-Bias into a broken amplifier. It won't fix anything and may damage the Compu-Bias.

Do not use the Compu-Bias if the probes or leads are damaged.

Potentially Lethal voltages exist inside any vacuum tube amplifier this includes the tube sockets.

If you need to change the bias and do not posses the technical knowledge required to perform this task. Take the amp to experienced technician as it requires knowledge of electronic circuits and high voltage safety.

Typical AB1 Power tube Ratings and suggested settings for each tube**

Class A amps typically will be at the high end of these recommendations (probably even higher)
The chart below should be used as a guide and reflects idle (no signal) values

TUBE TYPE	POWER RATING	SETTING 50% LOW	SETTING 70% HIGH
6K6	8W	4W	6W
6V6	14W	7W	10W
6L6,G,GA,GB,GT	19W	8W	13W
6L6,GC	30W	15W	21W
SV6L6GC	30W	15W	21W
5881	23W	11W	16W
6550	35W	17W	25W
SV6550,C	35W	17W	25W
EL84	12W	6W	8W
EL34	25W	12W	18W
KT66	25W	12W	18W
KT88	42W	21W	29W
KT90	42W	21W	29W
7581	30W	15W	21W
7581,A	35W	17W	25W

The above ratings have been compiled from multiple publications.

Any power tube replacement or changes to the output section of an amp requires verification of proper power tube bias.

The power ratings for tubes are normally Plate Dissipation ratings. Screen current is included in the total cathode current and used for the actual Power in Watts indicated on the Compu-Bias display. The results will be well within 10% of the actual plate current value in normal operation and should add a small safety margin when setting your amp.

➡ Some amplifiers use esoteric methods of power tube drive and bias. One of these amp types would be a push pull cathode driven type with fixed grid/screen and or grounded grid bias. The Compu-Bias will display the actual idle current for this configuration but it may not be of any value without fully understanding the circuit. Class A amplifiers typically use much higher idle dissipation settings than AB1 types, be aware of this when setting your bias. Simply increasing the Idle current doesn't guarantee Class A operation. Contact the manufacturer for application questions. A good rule is to avoid exceeding the manufactures maximum values in any case. Additional information on Bias and Tone can be found on the internet or by asking a knowledgeable source.

If you can find" to read "If you can find them, use the manufacturer's recommended tubes, settings and bias procedures. If not, use the above chart.

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Understanding RMS Voltage, Power and Calculations

WAVEFORM	Half-Wave Average	RMS (Effective)	Peak	Peak-Peak
Sine Wave	1.000	1.110	1.567	3.140
	0.900	1.000	1.414	2.828
	0.637	0.707	1.000	2.000
	0.318	0.354	0.500	1.000
Square Wave	1.000	1.000	1.000	2.000
Triangle or Sawtooth	1.000	1.150	2.000	4.000
	0.870	1.000	1.730	3.460
	0.500	0.578	1.000	2.000
	0.250	0.289	0.500	1.000

Table 1.1

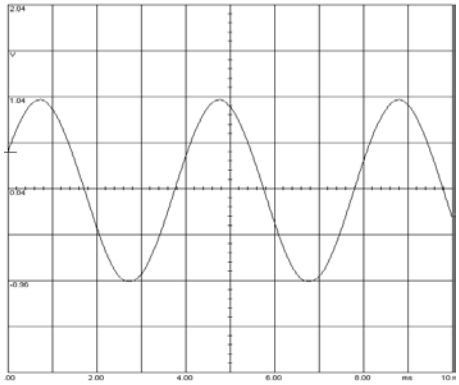

Table 1.2
Sine Wave 2.0vp-p 0.707vrms

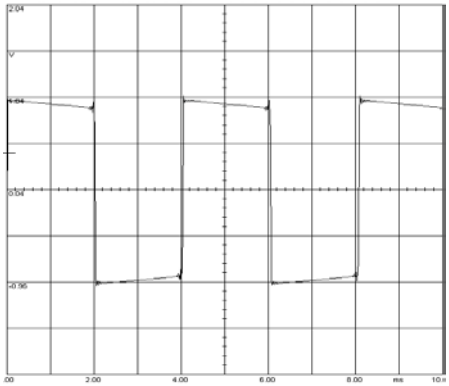

Table 1.3
Square Wave 2.0vp-p 1.0vrms

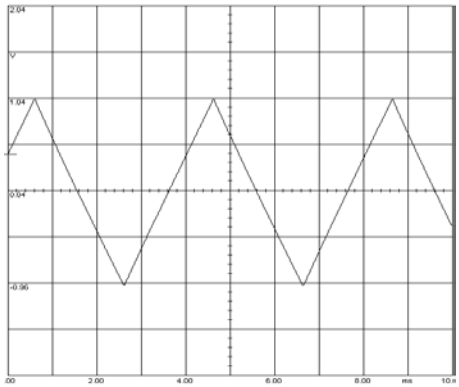

Table 1.4
Saw-Tooth 2.0vp-p 0.578vrms

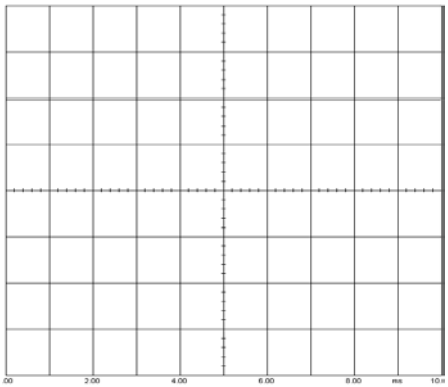

Table 1.5
DC 1.00vdc

(Note: the above displayed wave shapes are not exact, simply descriptive representations)

Table 1.1 is a standard conversion for the various waveforms and voltages. This table can be used to convert the Peak or Peak to Peak for a given wave form to a RMS voltage. The tables that follow (Table 1.2 – 1.5) describe the various wave forms and their associated voltages. These wave shapes represent various *true undistorted wave shapes* used to arrive at the voltage calculations in Table 1.1.

Why use RMS measurements to rate power from amplifiers….

Using effective or RMS values of AC voltages and currents, and a circuit that is purely resistive (i.e., with no phase shifts due to capacitance or inductance), we can simply multiply the voltage and current together to give the power dissipated (just as is done for DC - **P=V * I** -). For example, an AC waveform of (100V RMS) applied across a resistive load (10 ohms) would draw the equivalent current (10A RMS) this is the same as 100V DC, and the load would dissipate the same amount of heat energy (1000 watts). Another name for this "*RMS power*" is continuous effective power.

Although it is not too difficult to calculate the RMS value of regular repetitive waveforms like sine, saw-tooth, triangular or square waves as seen in Tables 1.2 to 1.5, it is much more difficult with non-repetitive waveforms such as a music signal with non-repetitive peaks. This is why amplifier power ratings are typically calculated and measured with true undistorted sine wave signals into a purely resistive load. Although audio and guitar amplifiers normally don't simply reproduce sine waves, these waveforms do provide a standardized way to measure and rate amplifier performance.

Some DMM's do in fact measure the RMS value of voltages and currents, and these *True RMS* reading meters are generally the best type to use if you really need to know the RMS value of sine-wave voltages and currents. These meters sample the voltage many times throughout the duration of the wave shape. Then they average these samples to arrive at the *True RMS* voltage. This voltage will include any DC component.

Knowing this, it would seem simple to arrive at the output power for a given amplifier into a resistive load. Not quite so, below is an example that easily displays the difficulty in measuring and understanding the *True RMS power* output.

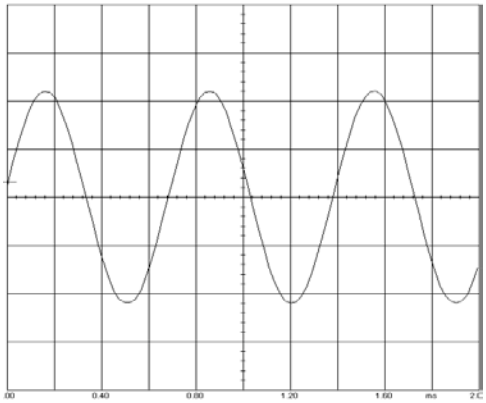

Table 2.1

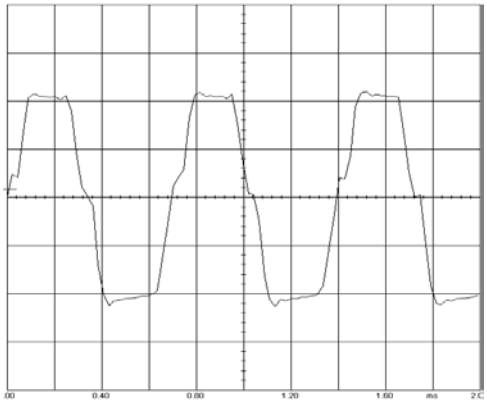

Table 2.2

Table 2.1 is a clean sine wave of 15.68vacrms using a Fluke 77 *True RMS* voltmeter (22.08v peak, 44.16v peak to peak). This would represent a 30.73 watt output into an 8 ohm load (calculated using the Fluke).

Table 2.2 is a distorted sine wave of 17.41vacrms using a Fluke 77 *True RMS* voltmeter (22.0 v peak, 44.0v peak to peak). This would represent a 37.88 watt output into an 8 ohm load (calculated using the Fluke).

Analyzing the above calculations we can arrive at some conclusions.

- The actual (correct) output power as depicted in Table 2.1 (before clipping or a significant increase in distortion) is 30.73 watts. (Typically this Power Rating will be given for a measured Distortion Value)

- At the onset of clipping (or a significant increase in distortion) the amp will deliver more power to the speaker and to be sure it will become louder. This does not mean it will have the characteristics desired or will be pleasing to every player in the case of a guitar amp. The tone of an amp past its ability to accurately reproduce its input becomes subjective. This condition is not acceptable for a HI-FI amp.

- Properly rating the output power with a *True RMS* voltmeter is possible only when using a known low distortion signal such as a sine wave. This is not dependent on the Class of the amp (A, AB, AB1, etc)

- Table 2.2 also indicates cross over distortion and imbalance. This is dependent on the Type, Class and design characteristics.