About the AT-1000

Why was the AT1000 Microprocessor Controlled Automatic Tube Tester developed?
The AT1000 was developed over approximately one year by a dedicated team. The reason it exists is simple: The only general purpose vacuum tube testing equipment currently available has not been manufactured for decades. It is only available on the used market, and in variable conditions of age, wear, calibration, etc. Specialized spare parts are no longer available including the complicated switch banks, potentiometers, panel meters and power transformers.

Calibration is cumbersome, voltages and currents are unregulated, and they are tedious to use. Roll charts, punched cards, numerous rotary switches and dials are now a thing of the past. Vacuum tube users want to maintain their equipment using state of the art techniques. By applying modern digital and analog technology to the task of vacuum tube testing, the user is freed from the drudgery of manually looking up and inputting test parameters. More precise and repeatable tests can be completed in much less time, with much less trouble. With the old testers, a misplaced rotary switch or loading dial could not only produce invalid results but also damage the tube or the tester. This can't happen with the AT1000. The AT1000 is portable in its own compact carrying case, and is built to tough industrial standards with high quality materials, engineering and manufacturing. And it is extremely simple to use, with only 5 keys plus a power switch. The user is guided through all operations with an easy-to-view 4-line by 40-character, backlit LCD display.

What does the AT1000 Tube Tester do?
The AT1000 will automatically test diode, triode, tetrode, pentode and heptode vacuum tubes for shorts, emission, mutual conductance (GM), and gas and heater-to-cathode leakage (where applicable). It tests both single and multiple-section tubes. It also tests Electron Ray Indicators (“Magic Eye" Tubes).

The tester will find use by those persons involved with the repair and maintenance of vintage and modern vacuum tube equipment, as well as designers and engineers who are developing new vacuum tube-based devices. Collectors of vacuum tubes and related equipment will also find the AT1000 useful and easy to use.

What physical sizes of tubes will the AT1000 test?
The AT1000 accommodates 7 and 9-pin miniature tubes, standard octal tubes, and 4, 5 and 6-pin small base tubes with a filament voltage between 1.0 and 12.6 volts. Tubes with a grid or plate cap can also be tested.

Will it test directly-heated tubes, such as the 2A3?
Yes. It will test both indirectly heated (heater-cathode) tubes as well as filament tubes like the 2A3, 3Q5, 45 and 300B.

Why doesn’t the AT1000 test tubes with heater voltages above 12.6?
The AT1000 was primarily designed to support modern and vintage vacuum tube hi-fi, guitar amplifiers and associated equipment. Many industrial and mil-spec types are also supported. Tubes with heater voltages above 12.6 were originally intended for the series-heater-string radios and television sets of the 1950s and 60s. Instead, we have concentrated on producing a tube tester targeting vacuum tubes employed in a wide variety of consumer and professional audio and industrial equipment, of both modern and ‘vacuum tube heyday’ vintage. In addition, a very few tubes with unusual filament/heater pin assignments are not supported.

In detail, what tests does the AT1000 perform?
Each tube is tested for emission, which is the ability of the cathode or filament to emit electrons. The reading obtained will reveal the relative remaining useful life of a tube. It then tests the amplifying ability of triode, tetrode, pentode and heptode tubes. Tests are performed at the optimum value of bias for a particular tube, set each time automatically by the microprocessor. A true mutual conductance test is then performed, where the tube amplifies a 1kHz signal, and the AC plate current is read by the microprocessor. The true GM value is then averaged over several seconds and displayed to the user in Milliamperes per Volt (ma/V). 1.00 mA/V equals 1,000 micro-Mhos. Heater-to-cathode leakage is tested and displayed for all tubes that are indirectly heated. Finally, a test is made to detect any excessive gas within the tube.

What is the importance of the emission test?
The emission test is performed while the microprocessor is adjusting the control grid bias on the tube under test. The bias is automatically adjusted so that the nominal specified plate current is flowing in the tube. Once this has been established, the actual grid voltage and the grid voltage specification are compared. The results are given both in ‘Good-Fair-Poor’ fashion, as well as the actual voltages. If a tube has very weak (or no) emission, the specification plate current will not be achieved. Such tubes usually also exhibit very low or zero transconductance.

What is the importance of the transconductance test?
Most tubes with three or more electrodes are employed as either AC or DC amplifiers. Transconductance, otherwise called Mutual Conductance or GM, is a test of the gain, or relative amplification factor that a particular tube is capable of. When performed in the laboratory this test is done after carefully adjusting the filament/heater voltage, grid and plate voltages, and plate current. The AT1000 tests vacuum tubes the same way, using original tube manufacturers’ specifications. Most other tube testers (even the highly-sought vintage models) do not test tubes using the full voltages and currents that they were designed and specified for, and under which conditions the tubes see in actual use. For example, the popular Hickok 600 tester has only 160V available to test tubes. The AT1000, however, will provide plate voltage at up to 500V and 160mA. This means a much more accurate picture of tube condition and performance is delivered to the user. Flaws that won’t show up at the abnormally low voltages and currents used in other testers WILL show up with the AT1000. You just can’t properly test a 300B with only 160 volts on the plate!

Many other testers do not provide transconductance information in the industry standard units of mA per volt, or micro-Mhos. They provide this information only as ‘good-fair-poor’, or, ’100 out of a possible 130’ or some other arbitrary numbers. The AT1000 displays transconductance in mA/V (which is easily translated to uMhos by simply multiplying by 1000). For quick refernce, the AT1000 also provides a ‘good-fair-poor’ transconductance indication.

What is the purpose of the heater-cathode leakage test?
Indirectly heated tubes, (those with a separate cathode) sometimes develop a leakage resistance between the heater and cathode. In the case of a cathode-follower circuit, this resistance appears across the circuit’s output, causing excessive loading. Heater-to-cathode leakage can also adversely affect a cascode amplifier circuit. Even worse, tubes with heaters operating on AC will couple line frequency noise and hum into the signal path. This is highly undesirable for virtually all applications, especially in low-level audio preamp stages. Most tube testers do not test for heater-to-cathode leakage when the heater is hot. They only test the tube cold, as part of the shorts test before any voltages are applied to the tube. The AT1000 tests the leakage on each heater/cathode assembly in the tube while it is hot. Leakage as low as 1 microampere is detected, which is much more sensitive that the usual ‘neon lamp’ shorts test of conventional tube testers.

What is the purpose of the gas test?
When a vacuum tube is manufactured, atmospheric gasses such as nitrogen, and oxygen are pumped out of the tube. Many tubes employ an active getter, which continues to absorb any residual gas after the tube is sealed off. Gas can come from electrodes within the tube itself, especially if it has been overheated. It can also leak in around the seals at the tube's pins. If this gas is not absorbed by the getter, it interferes with electric fields and electron movements within the tube, disturbing normal operation. Oxygen in a tube can also 'poison' the oxide coating on the filament or cathode. In severe cases, a power tube can 'run away', where excessive gas pulls the control grid positive. This results in more plate current, more heat, and more gas release. The phenomena thusly becomes self-sustaining. Such a tube may destroy itself and other expensive components in the equipment, such as the output transformer. The gas test of the AT1000 actually measures the effects of the gas, by introducing a higher than normal grid resistance. If gas is present in the tube, it acts against the increased grid resistance, resulting in a plate current increase. The amount of plate current increase is measured and then displayed to the user.

What about shorts?
Tubes sometimes develop short circuits between elements. Such shorts will make the tube inoperative, and possibly damage equipment. The old, vintage testers of the 1940s and 1950s had a problem with the possibility of a tube short, because it could also damage the tester. Therefore, a test for dead shorts and 'high resistance' shorts was made before applying operating voltages to the tube. It had to be done this way to avoid damaging components inside the tester. The AT1000 does it differently. Tubes are tested for shorts and leakages as part of the other tests. Since the AT1000 power supplies are themselves overload and short circuit protected, they are not damaged should a tube be shorted. Instead, an 'intermittently shorted' tube can be exposed, as the tube is continually being checked for shorts while it undergoes automatic test. Any detected short, even a brief one, will cause the power supplies within the AT1000 to shut down. In addition, the user is advised by a special message on the LCD screen and the test is halted immediately.

What information is displayed on the Results Screen(s)?
When the test sequence concludes, plate and screen voltage is removed from the tube, while bias and heater voltage are maintained. Then the LCD screen shows the user both the specification and the actual measured values for each section of the tube. The specification grid voltage is presented, along with the grid voltage which the tester determined was necessary to achieve the required plate current. The specification and actual measured transconductance values are also shown. In addition, the measured heater-to-cathode leakage and gas current are displayed. Each tube section is generally shown on a separate screen, navigated simply by using the up and down keys. When the user is finished reviewing the data, the tube can be re-tested immediately, bypassing the heater warm up. This can be repeated several times if necessary, in order to confirm a drifting tube parameter or intermittent fault.

What about matching tubes, can the AT1000 do this?
Absolutely! Not only will it match tubes by grid voltage (emission), but tubes can further be matched by transconductance. Matching of multi-section tubes is possible too, since the results for each section of such a tube are displayed separately. And most importantly, it will match tubes at normal current and voltage levels, faithfully reproducing the actual operating conditions found in many amplifiers, preamps and other equipment.

What about roll charts, lookup tables, etc?
These don't exist with the AT1000! The tester's internal FLASH memory contains test data on over 400 types of the most popular tubes, including vintage and high end audio power and preamp types, European types, mil-spec/industrial, and some transmitting types. The tube type numbers are easy to browse through to find your tube, using the intuitive 'up/down' and 'left/right' keys. Pressing Enter then loads all the selected tube's data into the microprocessor, where it is readied for testing the selected tube. Another key press, and the user is prompted as to which socket on the unit in which to insert the tube. A final key press and the test begins. There are no charts to roll, no books to use, or dials or switches to set. All of the tests are performed automatically in sequence, for each tube section, under complete microprocessor control.

How long does it take to test a tube?
The time can vary, from as little as 40 seconds to about three minutes. It all depends on the voltage and current values being applied during the test, and how many different sections a given tube contains. The heater warm up for directly-heated tubes is 15 seconds, while tubes with a heater-cathode construction are heated for 60 seconds before the tests commence.

What if I want to test a tube that isn't listed in the AT1000 Data Table?
This is the best part! The AT1000 has been designed with a user-reprogrammable Tube Data memory. The user can edit the tube Tata Table, customize it to his own specifications or preferred tube types, and even add tubes if desired. Most tubes that will fit into one of the sockets, have a heater voltage between 1.0 and 12.6Vat less than 3.5 amperes, and can be tested with 500V or less on their plate and screen can be tested. Tube data is available for free on the internet from original scans of vintage tube data books. All you need to know is the heater voltage, the Class A Plate and Screen voltage and current, and the Grid voltage and Transconductance specified for that class of operation. Tube data is entered or edited on any personal computer (PC) with a standard serial port and text editing software such as Notepad. Data is stored on the computer as a Comma Delimited File (.CSV file extension). The data files are compatible with Microsoft Excel, which makes it extremely easy to change or add to the tube data table. We also include on CD ROM an executable program which will upload a new or modified Tube Data Table to the AT1000 over its built-in RS232 serial port. Once the Tata Table has been uploaded, the RS232 link is disconnected, and the AT1000 again becomes a fully portable unit, but with YOUR customized tube test data stored in its FLASH memory!

For tubes that the AT1000 does not have sockets for, socket adapters may be made available if the demand is sufficient. Lacking this, you can even make you own adapters with an old tube base and a tube socket that fits your tube. This would even be applicable to the aforementioned odd tubes that have unusual filament/heater pin assignments.

But I'm a tube person, and am not into computers. I don't have (or want to use) a computer.
Not a problem. We will make you a custom FLASH EEPROM (memory chip) with the tube data you provide, for up to 5 additional tube types. We also include the default tube types (normally shipped with current version testers) and send the EEPROM to you for only $11.95 anywhere within the U.S. (overseas, separately quoted). You will have to open the tester and replace the EEPROM (instructions will be provided), which is positioned in socket. If you are uncomfortable doing this, ask a knowledgeable friend or take the unit to a reputable repair shop.

How about diode tubes?
Many tubes have simple diode sections which are sometimes used as AM or FM detectors and peak rectifiers. Examples are the 6AL5, 6T8 and 12SQ7. All of these kinds of tubes can be tested. In addition to the standard transconductance test, a forward and reverse conductance test is done on the diode sections of these tubes. The voltage used is 100V at one milliampere, well within the capabilities of these types of tubes. The test results screen displays not only forward and reverse conduction (in microamperes), but also measured heater-to-cathode leakage for the diode sections.

What tests does it perform on Electron Ray Indicator types?
The AT1000 is capable of testing tubes such as the 6E5, 6BR5/EM80, 6HU6 and more. The display section of such tubes is tested using the nominal operating voltages, and allows the user to check for brightness and shadow movement. If the tube has a separate triode amplifier section, it is tested for leakage, emission, shorts, transconductance and gas just like other triodes.

Tubes operate at high voltages, is the AT1000 safe to use?
When the directions, cautions and warnings in the manual are followed, the AT1000 is perfectly safe to use. If you are working with vacuum tubes, you already understand the dangers of their high voltage power supplies. Because the AT1000 operates tubes at the voltage levels they were designed for, it produces up to 500V DC. Tubes must never be inserted or removed while a test is in progress. Plate and grid cap accessories must likewise never be connected or disconnected while a test is in progress, and they should only be handled by their insulating parts with clean and dry hands. Tubes can get very hot during operation. A metal-envelope 6L6 will become uncomfortable to the touch with only its heater lit. Even though the complete test for a 6CA7/EL34 tube lasts under 90 seconds, its envelope can become very hot. Plate and screen voltage is cut off after a test, limiting the temperature rise of a tube’s envelope. However, repeated use of the HOT RETEST function will further heat the tube. Following test completion, the tube should be allowed to cool to a safe temperature before removing it from its socket. Appropriate gloves may help in this area.

Common sense applies to the use of this equipment, as it does to servicing all vacuum tube electronics. The user must keep his fingers away from any metal contacts while inserting or removing a tube – unless the tester is unplugged. This is the same thing he would do when working on his own vacuum tube equipment.

What special design features does the tube tester employ?
The AT1000 contains independently-adjustable Plate, Screen-grid, Control-grid and Heater Power Supplies. Each power supply is fully regulated to within better than 1% of its full-scale voltage, and is protected against overloads and short circuits. Each of these four power supplies is controlled by a 16-bit D-to-A Converter, interfaced to the microprocessor. The Plate/Screen and Heater supplies are ramped-up over a brief interval, avoiding thermal shock to your valuable tubes. The slow ramp of the heater supply is particularly effective in preventing the ‘bright flash’ sometimes encountered with cold heaters in miniature tubes. The power supplies are also protected against overheating by thermal protective devices. Should the unit overheat, the user is notified to wait until it cools down, and further tests are inhibited until this occurs.
Three separate fuses protect the Microcontroller, Heater and Plate/Screen Power Supplies.