

**LDG AT-1000Pro 1KW
Automatic Memory
Antenna Tuner**

Manual Version 1.0



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LDG AT-1000Pro 1KW Automatic Memory Antenna Tuner

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Introduction

Congratulations on selecting the LDG AT-1000Pro tuner. The AT-1000Pro is an important update of LDG's flagship tuner, now providing fully automatic antenna tuning with memories for high power amplifiers. The AT-1000Pro is intended for use with most tube or solid-state amplifiers outputting up to 1,000 watts SSB. It will tune dipoles, verticals, Yagis or virtually any coax-fed antenna.

LDG pioneered the automatic, wide-range switched-L tuner in 1995. From its laboratories near our Nation's Capital, LDG continues to define the state of the art in this field with innovative automatic tuners and related products for every amateur need.

IMPORTANT TUNER SAFETY WARNINGS

Like all high power antenna tuners, your AT-1000Pro handles a great deal of RF energy. Very large RF currents flow through the tuner, and very high RF voltages are sometimes present. Your AT-1000Pro is designed to safely handle this RF energy *within its specifications*, with a reasonable margin of safety. However, some amateur amplifiers are capable of outputting RF levels in excess, sometimes *far* in excess, of the specified maximums. Operating significantly above specifications will definitely damage or destroy your AT-1000Pro. Operating above specifications can cause catastrophic failure of internal components; under extreme overload, components could actually explode. You must observe the stated specifications of your AT-1000Pro, just as you do with your amplifier or any conventional tuner operating at this power level. Never operate your AT-1000Pro with the cover removed; lethal RF voltages may be present during operation.

IMPORTANT ANTENNA SAFETY WARNING

Never install antennas or transmission lines over or near power lines. You can be seriously injured or killed if any part of the antenna, support or transmission line touches a power line. Always follow this antenna safety rule: the distance to the nearest power line should be at least twice the length of the longest antenna, transmission line or support dimension.

Jumpstart, or “Real hams don’t read manuals!”

Ok, but at least read this one section before you transmit:

Safety Warning: Never operate your AT-1000Pro with the cover removed; lethal RF voltages may be present during operation. Never exceed the rated specifications.

1. Connect your AT-1000Pro to a source of 11 – 15-volt DC power capable of supplying at least 1 Amp. Press the Power button to turn on the tuner (Power LED will be on).
2. Connect your amplifier output to the AT-1000Pro input socket labeled “Transmitter” using 50-ohm coaxial cables. Connect the coax lead to your antenna to the AT-1000Pro output socket labeled “Ant 1”.
3. Select Ant 1 (Ant 1 LED will be on). Select Auto mode to be off (Auto LED will be off).
4. Set your amplifier to “Standby” mode so it will NOT operate when you transmit.
5. Transmit a carrier from your exciter of about 30 watts CW, FM or AM.
6. Momentarily press the “Tune” button on your AT-1000Pro. An automatic tuning cycle will begin, then stop. Check the meter to ensure an SWR of 2 or less before using your amplifier.
7. Turn your amplifier on; you’re ready to transmit.

Specifications

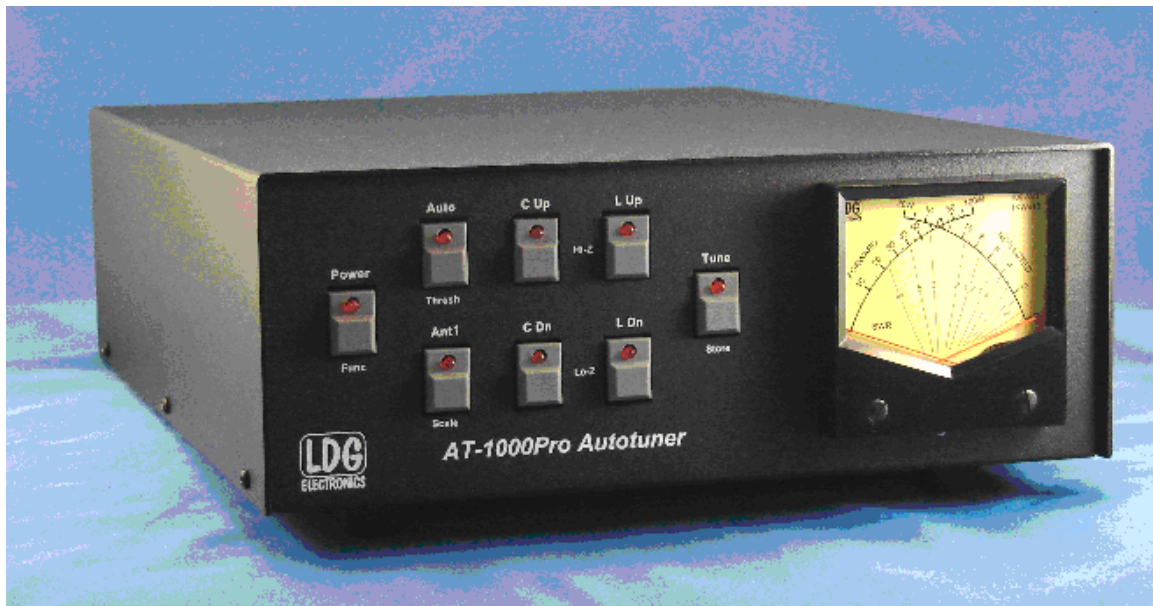
- Microprocessor controlled Switched L tuning network
- Two position antenna switch with 2000 3-D memories for each position
- Adjustable threshold for Auto mode
- Lighted cross needle meters
- Continuous coverage 1.8 to 54 MHz
- Power rating HF (1.8 to 30 MHz):
 - 1000 Watts Single Side Band
 - 750 Watts CW
 - 500 Watts Digital (RTTY, Packet, etc.)
- Power rating 6 meters: 250 Watts (any mode)
- Capacitor / Inductor fine tune controls
- Tuning time: 0.2 recall, 10 seconds average, 30 seconds max.
- Antenna impedance: 6 to 1000 Ohms (about 10:1 SWR, 3:1 on 6M)
- Dual meter scale 100/1000 watts
- Tuning power: 5 to 125 watts maximum
- Relay protection software prevents tuning:
 - Greater than 125 watts in any load
 - Greater than 75 watts into a 3:1 SWR load
- Soft touch buttons
- Includes 6 foot power cable, Icom and Yaesu interface, coax jumper (300 watt limit)
- Power requirements: 11 to 15 volts DC @ 1 Amp (user supplies power source)
- Enclosure sizes: 9.5W x 13D x 3.5H inches
- Weight: 5.2pounds

Operating Instructions

Getting to know your AT-1000Pro

Your AT-1000Pro is a quality, precision instrument that will give you many years of outstanding service; take a few minutes to get to know it. On the front panel, there are eight pushbutton switches:

- **Power:** turns your AT-1000Pro on and off
- **Auto:** toggles tuner between Auto and Semi-Auto tuning modes
- **Tune:** begins a tuning cycle, places the tuner in bypass mode
- **Ant1:** Toggles between the two antenna ports
- Manual capacity and inductance adjustments (rarely needed)
 - **Ind Up:** adds inductance
 - **Ind Dn:** subtracts inductance
 - **Cap Up:** adds capacitance
 - **Cap Dn:** subtracts capacitance

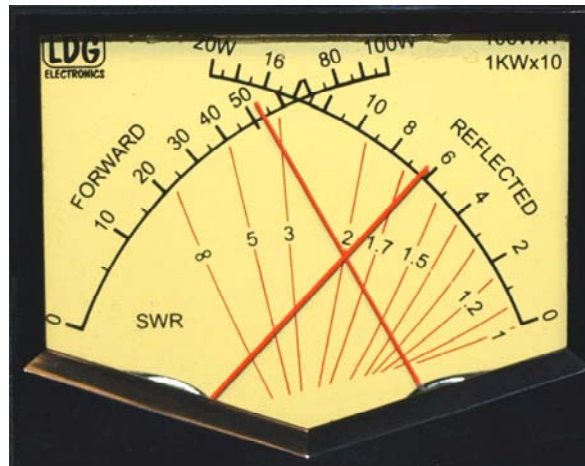


The Power switch does not turn the tuner completely off. It places it in a low-current “sleep” mode. In the Off mode (Power LED is off), the tuner is in bypass, routing RF directly from your amplifier to the antenna with no matching. On power-up, the tuner automatically restores the last tuned setting.

Each pushbutton has a dedicated LED that indicates that function’s status. These LEDs are also used to indicate other tuner conditions; see section on Button Functions and LED Indications.

In addition to the pushbuttons, there is a lighted cross-needle meter. This meter indicates forward power up to 1,000 watts, reflected power up to 200 watts and SWR (see Theory of Operation, below). Power readings are accurate to +/- 10% of full scale across the entire range.

Forward and reflected power are indicated on individual scales. SWR is read at the intersection of the two needles, on the curved red scales across the center of the meter face. In the picture below, the meter is indicating an SWR of 2.0.



On the back panel, there are six connections:

- Ant 1, standard SO-239 socket
- Ant 2, standard SO-239 socket
- Ground (wingnut)
- Transmitter, standard SO-239 socket
- Radio interface jack (stereo 1/8" jack)
- DC power input (2.5 x 5.5 mm coaxial power connector, center pin positive)



Installation

Your AT-1000Pro is intended for indoor use only; it is not water-resistant. If you use it outdoors (Field Day, for example) you must protect it from rain. Place your AT-1000Pro as near as practical to your exciter (your transceiver or transmitter) and your amplifier, keeping free access to the front panel controls. You should avoid placing other equipment on top of your AT-1000Pro if possible.

Grounding will significantly improve the safety and performance of your tuner. Attach the ground connection on the back panel to a suitable ground using heavy-gauge wire or metal braid. A dedicated outside ground rod is best, but a nearby cold water pipe is sometimes satisfactory. The ground connection on an AC outlet will not work satisfactory.

Connect the socket marked “Transmitter” on the back of your AT-1000Pro to your amplifier output using high-quality 50-ohm coaxial cable and PL-259 plugs. Do not use crimp-on plugs for this connection; only properly soldered plugs will be safe and provide satisfactory performance. The coaxial cable should be rated for the maximum output of your amplifier. Keep the cable as short as practical.

Attach your antenna lead-in coax to the desired antenna socket, either Ant 1 or Ant 2 on the rear of the tuner with a soldered PL-259 plug. You can have two antennas connected at the same time and switch between them using the front panel switch. Use cable rated for the maximum power output of your amplifier. Your AT-1000Pro is intended for use with coax-fed (unbalanced) antennas only. If you wish to use it with antennas fed with ladder-line, or with longwire antennas you must provide a suitable balun to adapt your AT-1000Pro to the balanced load. LDG does not presently sell a balun that handles 1,000 watts, but they are readily available from many ham radio vendors.

Your AT-1000Pro requires 11 – 15 volts DC at 1 Amp. If your radio runs on 12 volts DC, you can use the same power supply for your AT-1000Pro if it can provide the necessary 1 Amp current; otherwise, you will need a separate power supply. We recommend a regulated supply be used for satisfactory results. Connect the power supply to the DC power jack on the back of your AT-1000Pro using the provided 2.5 x 5.5 mm coaxial power plug. Be sure to observe proper polarity; the center pin and the red lead are positive.

Setup

There are three power-up options, selected by holding down one or more buttons while applying DC power (typically by plugging in the DC power connector).

Version Display:

Press and hold the Power button while applying DC power to the tuner. The upper three LEDs (on Auto, C Up and L Up switches) will blink the version number. The left-hand LED will blink the whole number, the middle LED the decimal point (one blink) and the right-hand LED the fractional part of the version number. For example, if your tuner has Version 3.2 of the software, the left-hand LED will blink three times, the center once and the right-hand LED twice: 3.2. This is only an example; your tuner may have a different software version number.



Tune Memory Clear

Press and hold the Power and Tune button while applying DC power, then release the buttons. This clears all tune memories, and is indicated by all the LEDs doing their version of the Finale from Riverdance. Memory is clear when the dance ends.

Power-Up On/Off

Press and hold the Auto button while applying DC to turn on the Power-Up On option. In this mode the tuner will automatically power up when DC is applied. Upper 3 LEDs (C Up and L Up) will flash 3 times to confirm.

Hold the Ant 1 button while applying DC to set the Power-Up Off option. In this mode the tuner will be off up when DC is applied. The lower 3 LEDs (C Dn and L Dn) will flash 3 times to confirm.

Function Modes

Press the Power (Func) switch for 0.5 seconds to place the tuner in function mode. In this mode you can set the SWR threshold for Automatic tuning, set the power meter scale range or manually store tuning parameters.

All LEDs light to show Function mode has been entered until the Power (Func) button is released. Once the Func Button is released, the three LEDs for Thresh, Scale and Store will be on.

While in function mode, pressing the Scale Ant 1 (Scale) button will toggle the meter between its 100 and 1000 watt scales. The meter will indicate the scale on the Forward power meter. It will move to “10” for 100 watt scale and to “100” for 1000 watt scale. Press Power (Func) again to save the setting.

Press the Auto (Thresh) button to set the SWR threshold at which a tuning cycle will begin when in Auto mode. Each press of the button selects a higher SWR (1.5, 1.7, 2.0, 2.5, and 3.0), cycling back to the beginning when you reach the end of the range. The selected SWR is shown on the meter at the intersection of the two needles. Press Power (Func) again to save the setting.

Press Tune (Store) to manually store tuning parameters. Use this function to store manually adjusted capacitor and inductor settings.

If no buttons are pressed within five seconds of entering Function mode, the tuner exits the Function mode automatically.

Recap of function operation:

- 1) Press Func button for ½ second to enter Function mode.
- 2) Make selection
- 3) Press Func button again to exit Function mode.

Operation

Button Functions and LED Indications

Power: The Power button turns the tuner on and off. In the off state, the tuner is in bypass mode, routing RF from your transmitter or amplifier directly to Ant 2 with no matching. No buttons, except the Power button, will be active.

Pressing the Power button toggles the tuner between off and on states. When toggled to the on state, the tuner resets to the last tuned setting (including antenna selection) before the previous power-down. To turn the tuner off (that is, to put it in its low-power standby state), press and hold the Power button for about 3 seconds. The LEDs will all light, then go out as the tuner powers down.

Auto: The Auto button toggles the tuner between Automatic and Semi-automatic tuning. In Auto mode, the tuner will begin a tuning cycle any time the SWR exceeds a threshold you set. In Semi-automatic mode, the tuner will begin a tuning cycle only when you press the Tune button. The Auto LED is on when the tuner is in Automatic mode.

Tune: The Tune button begins a semi-automatic tuning cycle, a memory tuning cycle, or places the tuner in bypass mode. A momentary press (< 0.5 seconds) toggles the tuner between bypass and its last tuned setting. The LED will blink once to confirm the change to bypass. Another short press will restore the last tuned setting; the LED will blink three times.

A medium press (0.5 - 3 seconds) begins a memory tune; memories for the current frequency will be scanned for a match. If stored parameters are not found, the tuner will automatically begin full tuning cycle. The LED will come on after 0.5 seconds to indicate a memory tune. If the Tune button is held longer than 3 seconds, the Tune LED will go off and a full tune will begin when the Tune button is released.

Ant 1: Press the Ant 1 button to toggle between Ant 1 and Ant 2. The Ant 1 LED will be on for Ant 1 and off for Ant 2. When you change antennas, the tuner references the last frequency used on that antenna, and recalls tuning settings for that frequency, if any. When the tuner is off (or if DC power is removed), the antenna selection defaults to the Ant 2 position.

Cap Up: The C Up button adds capacitance; holding the button down auto-repeats the add. The LED blinks when you reach the upper capacitance limit.

Cap Dn: The C Dn button subtracts capacitance; holding the button down auto-repeats the subtract. The LED blinks when you reach the lower capacitance limit.

Ind Up: The L Up button adds inductance; holding the button down auto-repeats the add. The LED blinks when you reach the upper inductance limit.

Ind Dn: The L Dn button subtracts inductance; holding the button down auto-repeats the subtract. The LED blinks when you reach the lower inductance limit.

Hi/Low Z: The Hi/Lo-Z relay can be manually selected to Hi by pressing the C Up and L Up together. The two LEDs will light while the buttons are held. Pressing the C Dn and L Dn buttons will set the relay to Lo. This setting is reset any time the tuner tunes.

Normal Operation

To prepare the tuner for use, press the “Power” button on the front panel. The red LED above the button, and the meter lights come on, indicating that your AT-1000Pro has powered up. The tuner resets to the last tuned setting (and Antenna selection) before the previous power-down.

Select the desired antenna by pressing the Ant 1 button. The LED is on when Ant 1 is selected, and is off when Ant 2 is selected.

Set your amplifier to standby, so it will *not* operate when you transmit; tune with your exciter only. Set your exciter to transmit up to 125 watts (with rollback), 30 watts max (without rollback; see below), or on the frequency you plan to use. CW is usually the most convenient mode, but you can also use RTTY, FM or an AM carrier.

While transmitting 5 – 125 watts, press and release the “Tune” button on the tuner front panel; an automatic tuning cycle will begin. You will hear the relays in your AT-1000Pro operate as they switch inductors and capacitors in and out seeking a match; they make a fairly loud buzzing noise. You can observe the present reflected power and SWR on the meter during the tuning process—but watch closely; it happens fast!

The tuning cycle will automatically end in a few seconds, with the meter indicating the final achieved SWR, usually 1.5 or less. The Tune LED will blink five times, indicating a good tune and a memory save. Check for an SWR of 2 or less. If the SWR is greater than 2, use the manual adjustment buttons to adjust the SWR to level less than 2 (see “Fine-tuning the tuner”, below). Unkey your exciter.

After tuning is completed, set your amplifier to operate, key your exciter and tune your amplifier as usual (if needed). Good practice dictates tuning your amplifier into a 50-ohm dummy load with a suitable power rating. You may tune your amplifier into the antenna through your AT-1000Pro providing it has tuned the antenna to a low SWR, and also providing you do not exceed the specified ratings of either your amplifier or your AT-1000Pro. Never press the Tune button while transmitting more than 125 watts. Unkey when done; you are ready to transmit.

Memory Operation

At the end of each successful tuning cycle (SWR <1.5), the tuning parameters are stored in non-volatile memory. For each antenna port, there are four banks of 2,000 memories, allowing you to use an external 4-way antenna switch connected after the antenna jack. Each time a tuning cycle is started, if a previous successful tune was performed on the given frequency, the stored parameters for that frequency are quickly tried. If one of the stored parameters gives an SWR of 1.5 or less, the tuning cycle ends. If not, a full tuning cycle begins automatically, with the new tuning parameters stored automatically upon successful completion of the cycle. The Tune LED will blink five times, indicating a good tune and a memory save.

The memory storage and tuning process is completely automatic, with no impact on your operation of the tuner. The effect is much faster overall tuning once the tuner has "learned" your most common bands and frequencies. You will probably want to use memory tuning most of the time.

Fine-tuning the tuner

In certain circumstances, the automatic tuning cycle will end with a relative high SWR, perhaps 1.8 or 2. This is usually due to operation far from the antenna's natural resonant frequency. You can manually adjust the match using the Ind and Cap Up and Down buttons on the front panel. While still transmitting with your exciter after the automatic tuning cycle ends (amplifier still off), press these buttons and observe the effect on SWR on the meter.

Since you don't know how the automatic tuning cycle set the inductors and capacitors, you will have to make manual adjustments by trial and error. Press the Cap or Ind Up button three times and observe the change in SWR. If it gets worse, tap the Dn button three times to return to your starting place, then try three taps of the Dn button. Once you've gone through this process a few times, you will get a better feel for matching certain antennas or frequencies.

Frankly, you won't use the Cap and Ind buttons or the Hi/Low Z buttons very often; your AT-1000Pro is very good at finding a match. These buttons are included only to provide you with maximum flexibility and utility.

Error Indications

The LEDs may indicate several error and status states:

Power too low: your AT-1000Pro requires at least 5 watts to tune. If the power is too low, all LEDs will flash once.

Loss of power during tune: if RF power is removed before a tuning cycle has ended, all LEDs will flash twice.

Final SWR over 3: in rare cases, your AT-1000Pro will not be able to achieve an SWR lower than 3. This is most often due to attempting to tune very far from the resonant frequency of your antenna, or load up a lawn chair. All LEDs will flash three times. The resultant tune settings are not stored

Power too high: if the power exceeds 125 watts, a tuning cycle will not begin; all LEDs will flash four times In this case, reduce power and begin a new tuning cycle.

SWR too high for the power level: if power exceeds 100 Watts while the SWR is greater than 3, or if power exceeds 75 watts while the SWR is greater than 5, a tuning cycle will not begin, and all LEDs will flash five times In this case, reduce power and begin a new tuning cycle.

A word about "roll-back" circuits

Modern amateur exciters with solid state finals usually employ a "rollback" circuit to protect the final amplifier transistors from high SWR, which can damage or destroy them. A rollback circuit senses the SWR at the antenna terminal during transmit, and reduces the output power as the SWR rises above a preset level, often 2:1. The higher the SWR, the lower the power is set to prevent damage.

If your solid state or tube-type exciter has a rollback circuit, you can simply key down and tune as described above at any power level from 5 to 125 watts. If your exciter lacks a rollback circuit, you must manually set the power level for tuning to 30 watts. At higher power levels, the reflected power encountered during the tuning cycle could damage your exciter or tuner. Check your exciter owner's manual to determine if yours has a rollback circuit. Most solid state radios (except Ten-Tec) have a rollback circuit.

LED Error codes

Condition	LED Code
Good tune	Tune LED blinks 5 times
Insufficient or no RF	All LEDs flash one (1) time
RF lost before tune completed	All LEDs flash two (2) times
No satisfactory match found	All LEDs flash three (3) times
RF > 125 watts when Tune req.	All LEDs flash four (4) times
RF > 75 watts and SWR > 3 when Tune req.	All LEDs flash five (5) times
Meter over scale	Cap and Ind Up/Down LEDs flash

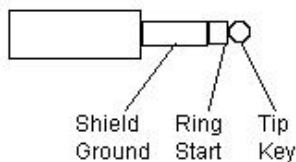
Default Setting

Values	Setting
Auto	On
Ant	Ant 1
Threshold	2.0
Scale	1,000
Power Up On/Off	On

Radio Interface

The AT-1000Pro includes interface cables for most Icom and the FT-857 (D) and FT-897(D) radios. The Icom interface will provide DC power to the tuner as well as control the keying of the radio during the tune cycle. The Yaesu interface will only control the keying of the radio.

The interface follows the same format as most Icom radios. The Start line (an input to the tuner) is grounded to start the tuning process. The Key line (an output from the tuner) is grounded for the duration of the tuning cycle. It is possible for the user to build their own custom interface.



Theory of Operation

Some basic ideas about impedance

The theory underlying antennas and transmission lines is fairly complex, and in fact employs a mathematical notation called “complex numbers” that have “real” and “imaginary” parts¹. It is beyond the scope of this manual to present a tutorial on this subject, but a little background will help you understand what your AT-1000Pro is doing, and how it does it.

In simple DC circuits, the wire resists the current flow, converting some of it into heat. The relationship between voltage, current and resistance is described by the elegant and well-known “Ohm’s Law”, named for Georg Simon Ohm of Germany, who first described it in 1826. In RF circuits, an analogous but far more complicated relationship exists.

RF circuits also resist the flow of electricity. However, the presence of capacitive and inductive elements causes the voltage in the circuit to lead or lag the current, respectively. In RF circuits this resistance to the flow of electricity is called “impedance”, and can include all three elements: resistive, capacitive, and inductive.



The output circuit of your amplifier consists of inductors and capacitors, usually in a series/parallel configuration called a “pi network”. The transmission line can be thought of as a long string of capacitors and inductors in series/parallel, and the antenna is a kind of resonant circuit. At any given RF frequency, each of these can exhibit resistance, and impedance in the form of capacitive or inductive “reactance”.

Transmitters, transmission lines, antennas and impedance

The output circuit of your amplifier, the transmission line, and the antenna all have a characteristic impedance. For reasons too complicated to go into here, the standard impedance is about 50 ohms resistive, with zero capacitive or inductive components. When all three parts of the system have the same impedance, the system is said to be “matched”, and maximum transfer of power from the amplifier to the antenna occurs. While the output circuit and transmission line are of fixed, carefully designed impedance, the antenna presents a 50 ohm, non-reactive load only at its natural resonant frequencies. At other frequencies, it will exhibit capacitive or inductive reactance, causing it to have an impedance different from 50 ohms.

When the impedance of the antenna is different from that of the amplifier and transmission line, a “mismatch” is said to exist. In this case, some of the RF energy from the amplifier is reflected from the antenna back down the transmission line, and into the amplifier. If this reflected energy is strong enough it can damage the amplifier’s output circuits.

The ratio of transmitted to reflected energy is called the “standing wave ratio”, or SWR. An SWR of 1 (sometimes written 1:1) indicates a perfect match. As more energy is reflected, the SWR rises to 2, 3 or higher. As a general rule, modern solid state amplifiers must operate with an SWR

¹ For a very complete treatment of this subject, see any edition of the ARRL Radio Amateur’s Handbook

of 3 or less. Tube exciters are more tolerant of high SWR. If your 50 ohm antenna is resonant at your operating frequency, it will show an SWR of 1. However, this is usually not the case; operators often need to transmit at frequencies other than resonance, resulting in a reactive antenna and a higher SWR.

$$SWR = \frac{1 + \sqrt{R/F}}{1 - \sqrt{R/F}} \quad \text{where F = Forward power (watts), R = Reflected power (watts)}$$

SWR is measured using a device called an “SWR bridge”, inserted in the transmission line between the amplifier and antenna. This circuit measures forward and reverse power from which SWR may be calculated (some meters calculate SWR for you). More advanced units can measure forward and reverse power simultaneously, and show these values and SWR at the same time.

An antenna tuner is a device used to cancel out the effects of antenna reactance. Tuners add capacitance to cancel out inductive reactance in the antenna, and vice versa. Simple tuners use variable capacitors and inductors. The operator adjusts them by hand while observing reflected power on the SWR meter until a minimum SWR is reached. Your LDG AT-1000Pro automates this process.

No tuner will fix a bad antenna. If your antenna is far from resonance, the inefficiencies inherent in such operation are inescapable; it’s simple physics. Much of your transmitted power may be dissipated as heat in the tuner, never reaching the antenna at all. A tuner simply “fools” your amplifier into behaving as though the antenna were resonant, avoiding any damage that might otherwise be caused by high reflected power and providing maximum power transfer. Your antenna should always be as close to resonance as practical.

		Forward Power (Watts)								
		20	30	40	50	60	70	80	90	100
Reflected Power (Watts)	2	1.92	1.70	1.58	1.50	1.45	1.41	1.38	1.35	1.33
	4	2.62	2.15	1.92	1.79	1.70	1.63	1.58	1.53	1.50
	6	3.42	2.62	2.26	2.06	1.92	1.83	1.75	1.70	1.65
	8	4.44	3.14	2.62	2.33	2.15	2.02	1.92	1.85	1.79
	10	5.83	3.73	3.00	2.62	2.38	2.22	2.09	2.00	1.92
	12	7.87	4.44	3.42	2.92	2.62	2.41	2.26	2.15	2.06
	14	11.24	5.31	3.90	3.25	2.87	2.62	2.44	2.30	2.20
	16	17.94	6.42	4.44	3.60	3.14	2.83	2.62	2.46	2.33
	18	37.97	7.87	5.08	4.00	3.42	3.06	2.80	2.62	2.47
	20	-	9.90	5.83	4.44	3.73	3.30	3.00	2.78	2.62
	22	-	12.92	6.74	4.94	4.07	3.55	3.21	2.96	2.77
	24	-	17.94	7.87	5.51	4.44	3.83	3.42	3.14	2.92
	26	-	27.96	9.32	6.17	4.85	4.12	3.65	3.32	3.08
	28	-	57.98	11.24	6.95	5.31	4.44	3.90	3.52	3.25
	30	-	-	13.93	7.87	5.83	4.79	4.16	3.73	3.42
	32	-	-	17.94	9.00	6.42	5.18	4.44	3.95	3.60
	34	-	-	24.63	10.40	7.09	5.60	4.75	4.19	3.80
	36	-	-	37.97	12.20	7.87	6.07	5.08	4.44	4.00
	38	-	-	77.99	14.60	8.80	6.60	5.44	4.71	4.21
	40	-	-	-	17.94	9.90	7.19	5.83	5.00	4.44
42	-	-	-	22.96	11.24	7.87	6.26	5.31	4.68	
44	-	-	-	31.30	12.92	8.65	6.74	5.65	4.94	
46	-	-	-	47.98	15.08	9.56	7.27	6.02	5.22	
48	-	-	-	97.99	17.94	10.63	7.87	6.42	5.51	
50	-	-	-	-	21.95	11.92	8.55	6.85	5.83	

SWR Lookup Table

Find SWR at intersection of forward power column and reflected power row.

The LDG AT-1000Pro

In 1995 LDG pioneered a new type of automatic antenna tuner. The LDG design uses banks of fixed capacitors and inductors, switched in and out of the circuit by relays under microprocessor control. A built-in SWR sensor provides feedback; the microprocessor following an algorithm searches the capacitor and inductor banks, seeking the lowest possible SWR.

The tuner is a “Switched L” network consisting of series inductors and parallel capacitors. LDG chose the L network for its minimum number of parts and its ability to tune unbalanced loads, such as coax-fed dipoles, verticals, Yagis; in fact, virtually any coax-fed antenna. Using seven toroidal inductors, the total inductance ranges from 0 to 10 μH . Each inductor’s value is selected to provide 128 different combinations, with a resolution of 0.08 μH . The inductors are switched in and out of the circuit by relays controlled by the microprocessor. The inductors are wound with #16 wire on 2” toroid forms.

Using seven 2,500 volt capacitors, the total capacitance ranges from 0 to 650 pF. Each capacitor’s value is selected to provide 128 combinations, with a resolution of 5 pF. The capacitors are connected to ground with the seven capacitor relays. Another relay switches the entire capacitor bank to the input or output side of the inductor. This switching allows the AT-1000Pro to automatically handle loads that are greater than 50 ohms (high setting) and less than 50 (low setting). All of the relays are SPDT types sized to handle up to 1,000 watts SSB (500 watts key down).

The SWR sensor is a variation of the Bruene circuit. This SWR measuring technique is used in most dual-meter and direct-reading SWR meters. Slight modifications were made to the circuit to provide voltages (instead of currents) for the analog-to-digital converters (ADCs) that provide signals proportional to the forward and reverse power levels. The single-lead primary through the center of the sensor transformer provides RF current sampling. Diodes rectify the sample and provide a DC voltage proportional to RF power. Variable resistors calibrate the forward and reverse power levels. Once adjusted, the forward and reverse power sensors produce a DC voltage proportional to the forward and reverse RF power levels. These two voltages are read by the ADCs in the microprocessor. Once in a digital format, they are used to calculate SWR in real time.

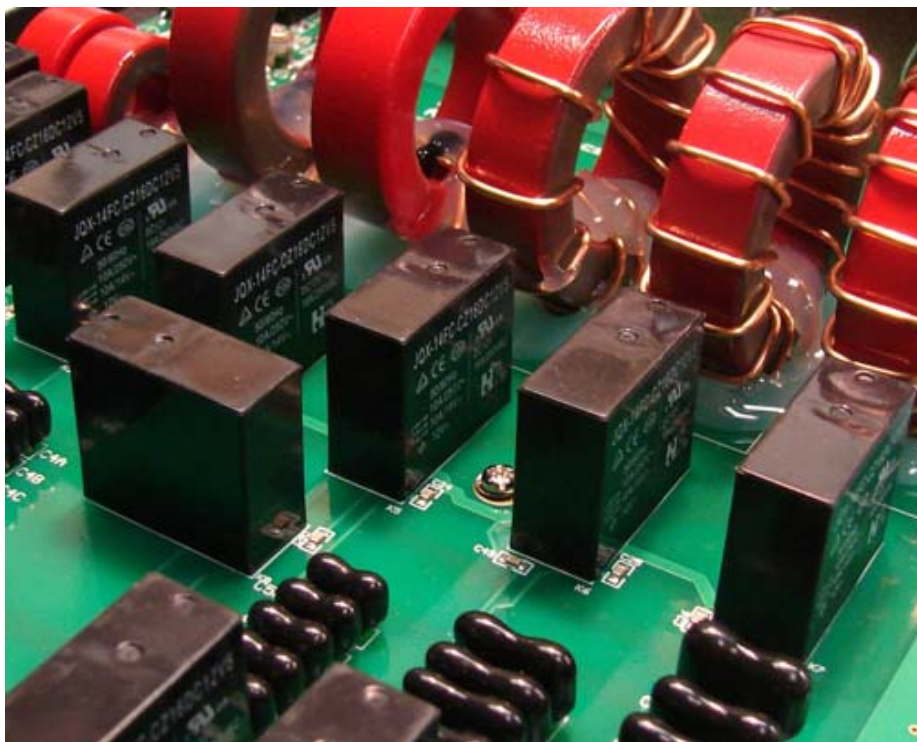
The relays operate from an external 12 volt DC power supply. The total current drawn by the AT-1000Pro depends primarily on the number of energized relays, with the maximum current drain being approximately 1 Amp.

Although the microprocessor’s oscillator runs at 20 MHz, its internal bus speed is one-half that, or 10 MHz. The main tuning routine takes about 75 cycles to make a tuner adjustment and take a new SWR measurement, or 67.5 ms per tuner adjustment. If running at maximum speed, the microprocessor can try all inductor-capacitor combinations in just five seconds. Unfortunately, the mechanical relays can’t react as quickly as the microprocessor, and the tuning speed must be slowed down to compensate for relay settling time.

The tuning routine uses an algorithm to minimize the number of tuner adjustments. The routine first de-energizes the high/low impedance relay if necessary, and then individually steps through the inductors to find a coarse match. With the best inductor selected, the tuner then steps through the individual capacitors to find the best coarse match. If no match is found, the routine repeats the coarse tuning with the high/low impedance relay energized. The routine then fine tunes the

capacitors and inductors. The program checks LC combination to see if a 1.5 or lower SWR can be obtained, and stops when it finds a good match.

The number of tuner adjustments is between 4 and 288. There are 1 to 16 checks for the coarse inductor tuning, 1 to 16 for the coarse capacitor and between 2 and 256 for the inductor and capacitor fine tuning. With the speed reduced to 20 ms per selection to compensate for relay settling, the maximum tuning time is 12 seconds for a full tune and the minimum tuning time is 0.2 second for a memory tune. Generally, the farther away from resonance an antenna is from the exciter's operating frequency, the longer it takes the tuner to find a match.



Care and Maintenance

Your AT-1000Pro tuner is essentially maintenance-free; just be sure to observe the power limits discussed in this manual. The outer case may be cleaned as needed with a soft cloth slightly dampened in household cleaning solution. As with any modern electronic device, your AT-1000Pro can be damaged by temperature extremes, water, impact or static discharge. LDG strongly recommends that you ground your AT-1000Pro, and use a good quality, properly installed lightning arrestor in the antenna lead.

Technical Support

We are happy to help you with your product. Telephone technical support is available at 410-586-2177 weekdays from 9 am to 5 pm Eastern Time. Inquiries by Fax at 410-586-8475 are welcome, and prompt e-mail support is available at ldg@ldgelectronics.com.

Warranty and Service

Your product is warranted against defects in parts or workmanship for two years from purchase. The warranty does not cover damage due to abuse or exceeding specifications. This warranty applies to the original purchaser only; it is not transferable. A copy of the receipt showing the purchaser's name and the date of purchase must accompany units returned for warranty service. All returns must be shipped to us pre-paid; we will not accept units with postage due. A return form is provided on our web site for your convenience.

If you need to return your product to us for service, package it carefully, keeping in mind that we will re-use your packaging to return the unit to you. Download the return form from our web site (www.ldgelectronics.com), fill it out completely and return it with your tuner. Include a full description of the problem, along with your name, address and a phone number or e-mail address where we can reach you with any questions. Repairs average about 3 to 6 weeks.

We will be glad to service your LDG product after the warranty period has ended. We will notify you of repair charges by phone or e-mail, and bill you after repairs are completed.

Visit LDG's web site for support, sales and for information on exciting new products from LDG. You can find us on the web at www.ldgelectronics.com.

