

# **LDG RT-100 100-Watt Remote Automatic Tuner**



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Trial Version (Visit <http://www.aplussofts.com>)

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## INTRODUCTION

Congratulations on selecting the LDG RT-100 100-watt remote automatic tuner. The RT-100 provides full- and semi-automatic antenna tuning across the entire HF spectrum plus 6 meters, at power levels up to 100 watts. It will tune dipoles, verticals, Yagis, or virtually any coax-fed antenna. It will match an amazing range of antennas and impedances, far greater than many other tuners you may have considered, including the internal tuners in many radios.

The RT-100 uses the same proven technology as other LDG tuners, but is engineered to be installed outdoors near the antenna feedpoint, reducing potential SWR losses in the transmission line. DC power is provided over the coax; no separate power cable is required. The RT-100 contains an internal “Bias Tee” circuit that separates RF and DC at the tuner.

The RT-100 is designed to be used with the optional RC-100 remote controller near the operating position. It provides for on/off control, as well as automatic and semi-automatic tuning, and contains a Bias Tee to inject DC onto the coax. The RC-100 is not required, but without it you will need to provide a Bias Tee circuit near your transmitter or transceiver. Commercial units are readily available, or you can easily homebrew one; circuit details are provided in this manual.

LDG pioneered the automatic, wide-range switched-L tuner in 1995. From its laboratories near the 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.

## JUMPSTART, OR “REAL HAMS DON’T READ MANUALS!”

Ok, but at least read this one section before operating the RT-100 (this Jumpstart assumes you have an optional RC-100 controller):

1. Turn off power to your radio.
2. Connect the antenna jack on the transceiver to the “Radio” jack on the optional RC-100.
3. Connect the “Tuner” jack of the optional RC-100 to the “Radio” jack on the RT-100 via a suitable length of coax feedline.
4. Connect the antenna to the “Ant” jack on the RT-100.
5. Connect a source of 12VDC, 500mA to the Power jack on the optional RC-100.
6. Power up your radio and begin operating normally; the tuner will automatically initiate a tuning cycle if there is an SWR mismatch.

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## SPECIFICATIONS

- 0.1 to 100 watts (peak) on SSB and CW, 30 watts on 100% duty-cycle modes.
- Latching relays for ultra-low power operation.
- 2,000+ memories for near-instantaneous frequency and band changing.
- Requires 12VDC, 500mA, extracted from the coax feedline via built-in Bias Tee. DC injection Bias Tee included in optional RC-100 controller, otherwise provided by user.
- 1.8 to 54.0 MHz coverage.
- Tunes 4 to 800 ohm loads (16 to 150 ohms on 6M), 16 to 3200 ohms with optional 4:1 Balun.
- For Dipoles, Verticals, Vees, Beams or any Coax Fed Antenna.
- Water-resistant case and rubber gaskets. Not immersible.
- Operating temperature range: 0°F-110°F (-18°C - +43°C)
- Optional external Balun allows tuning of random length, long wire or antennas fed with ladder line.
- Optional RC-100 controller provides DC power injection, On/Off switch, and Tune button.
- Dimensions: 7.0”L x 5.5”W x 3.5”H.
- Weight: 1 lb. 0 oz.

## AN IMPORTANT WORD ABOUT POWER LEVELS

The RT-100 is rated at 125 watts peak power input *at most*. Many ham transmitters and transceivers, and virtually all amplifiers, are capable of transmitting well over 125 watts. Power levels that significantly exceed specifications will definitely damage or destroy your RT-100. If your tuner fails during overload, it could also damage your transmitter or transceiver. Be sure to observe the specified power limitations.

## IMPORTANT SAFETY WARNING

**Never install antennas or transmission lines over or near power lines. You can be seriously injured or instantly 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 overhead power lines should be at least twice the length of the longest antenna, transmission line or support dimension.**

## GETTING TO KNOW YOUR RT-100

Your RT-100 is a quality, precision instrument that will give you many years of outstanding service; take a few minutes to get to know it.

The RT-100 is designed to be installed at or near the antenna feedpoint. This reduces or eliminates SWR losses in the coax transmission line, which can be significant under some circumstances. The RT-100 is weatherproof and is intended to be installed outdoors. Tips on outdoor installation appear later in this manual.

The RT-100 is powered over the coaxial cable that carries both RF energy and DC power; no separate power cable is required. An internal “Bias Tee” circuit in the RT-100 separates RF from DC power; this process is virtually lossless and has no effect on SWR. A second Bias Tee is required at the transmitter end of the coax to inject DC power on to the coax. The RT-100 is designed to be used with the optional RC-100 controller, which contains a Bias Tee to inject DC power. It provides an Off/On power button, LED status indicator, and a Tune button which starts an automatic tune cycle. If you do not use an RC-100, you must provide a Bias Tee to inject DC power. They are available commercially, or you can easily “homebrew” one; details are provided later in this manual.

The RT-100 provides 2,000 frequency memories. When tuning on or near a previously tuned frequency, the RT-100 automatically uses “Memory Tune” to recall the previous tuning parameters in a fraction of a second. If no memorized settings are available, the tuner automatically runs a full tuning cycle, storing the parameters for memory recall on subsequent tuning cycles on that frequency. In this manner, the RT-100 “learns” as you use it, adapting itself to your favorite bands and frequencies. The RT-100’s latching relays hold the tuned configuration indefinitely, even when DC power is removed. Tuning memories are stored in non-volatile FLASH memory; they are retained indefinitely even when power is removed.



### *RT-100 Connections*

The RT-100 has three connectors:

- **ANT SO-239:** Output to the antenna. Connect the antenna feedpoint to this SO-239.
- **Gnd (wingnut):** Connect to an earth ground.
- **Radio SO-239:** RF and DC input. Connect to the feedline which comes from the transmitter or transceiver via the optional RC-100 controller or other Bias Tee.

The tuner case is made of POLYLAC®, a flame-retardant ABS plastic.

**Important Note:** The transmission line between the Bias-Tee at the operating position (or the RC-100 control unit) and the RT-100 tuner must never be grounded. Doing so would cause the Bias-Tee to attempt to source 12 VDC directly to ground, damaging the unit. Never use coax switches that ground unselected ports.



## INSTALLATION

The RT-100 tuner is designed for outdoor operation; it is water-resistant, but it is not waterproof and must not be immersed. LDG strongly recommends using silicone coax sealing tape on all outdoors coax connectors after installation to seal them. See *Tips for Outdoor Installation* later in this manual for more on best amateur practice to ensure that your RT-100 will provide reliable service outdoors.

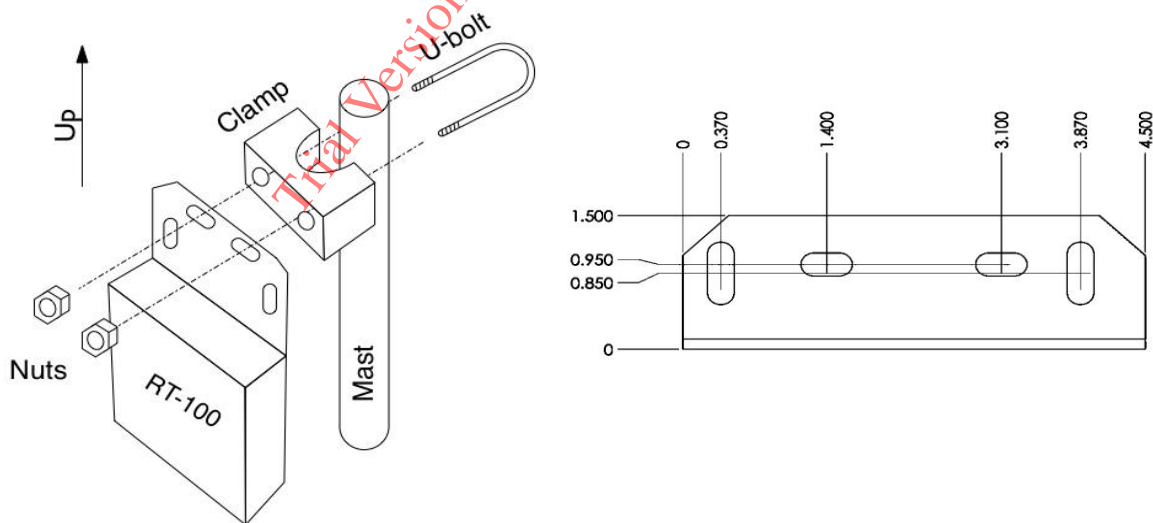
The RT-100 is designed for use with coax-fed antennas. To use it with longwires or antennas fed by ladder line, an external balun is required; the LDG RBA-4:1 is recommended.

Always turn your radio off before plugging or unplugging any external devices. The radio may be damaged if cables are connected or disconnected while the power is on.

### *Secure the RT-100 to a Mast*

Your RT-100 is designed to be mounted on a mast or other similar support; a clamp and matching U-bolts are provided for this purpose. Remove the nuts and clamp from the U-bolt. Place the U-bolt around the mast, then slide the clamp over the threaded ends of the U-bolt, so that the flat edge of the clamp faces away from the mast. Insert the threaded ends of the U-bolt through the back of the mounting bracket at the top of the RT-100. Thread the nuts back onto the U-bolt, and snug them up. Tighten only as much as is required to keep the RT-100 from sliding down the mast; do not over-tighten.

Although the U-bolt is electroplated to resist corrosion, you may wish to apply a thin layer of grease to help prevent rust and aid in later removal. If you wish to use a larger U-bolt (to bolt the tuner to a larger mast, or other support), refer the RT-100 mounting bracket dimensions for sizing.



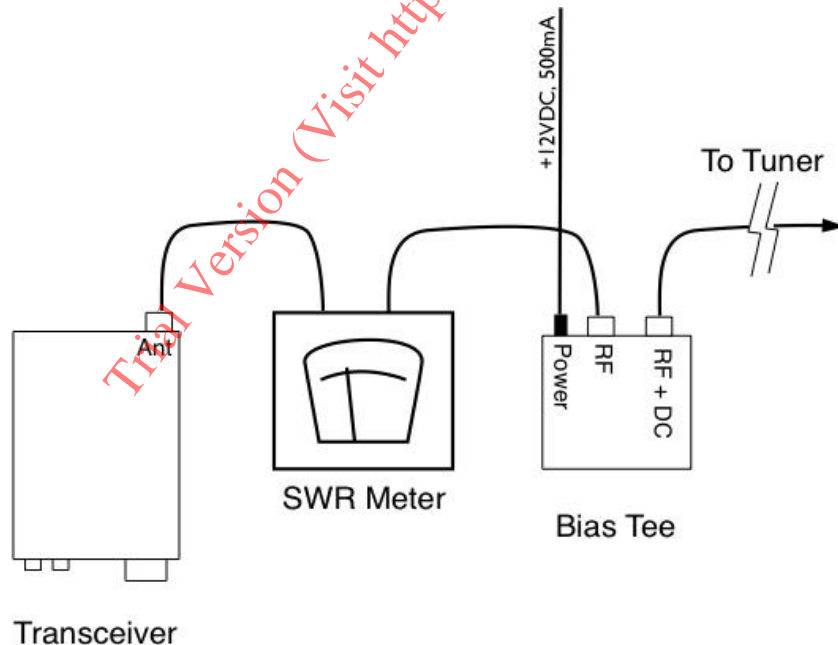
### Connect to Transceiver and Antenna

If upgrading an existing antenna, move the coax feedline from the antenna feedpoint to the **RADIO** jack on the RT-100. Connect a 50-ohm coax jumper (as short as practical) from the RT-100's **ANT** jack to the antenna's feed point.

Place a Bias Tee (RC-100 or other) convenient to the operating position. Connect the RT-100's **RADIO** jack to the Bias Tee's **RF+DC** jack via a suitable length of coax feedline; it can be as long as necessary. This can be new coax for a new installation, or existing coax if you are installing the RT-100 on your present antenna; simply move the existing coax from your transmitter or transceiver's Antenna jack to the **RF+DC** jack on the Bias Tee. Connect a 50-ohm coax jumper (as short as practical) from the transmitter or transceiver's Antenna jack to the Bias Tee's **RF** jack. For installation using the optional RC-100 controller, see the RC-100 user manual.

Connect the Bias Tee to a source of 12VDC power capable of providing 500 mA. A regulated power supply is recommended, but is not required.

The RT-100 has no SWR display. If your transmitter or transceiver does not have a built-in SWR display, you may wish to put an external SWR meter between the output of the transmitter or transceiver and the RF input of the Bias Tee:



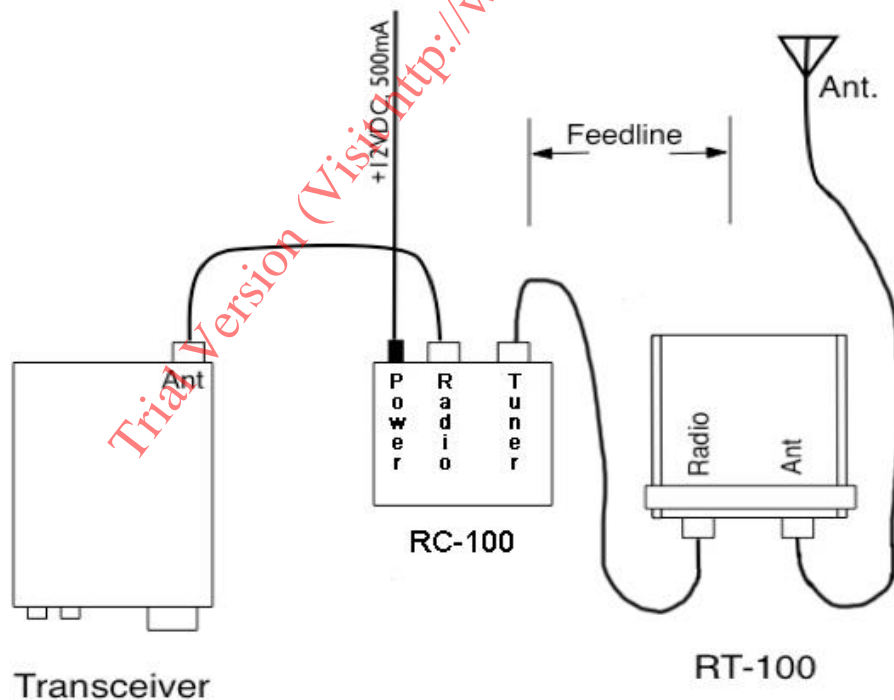


### *Tips for Outdoor Installation*

The RT-100 is water-resistant, but it is not fully waterproof. The RT-100 should be mounted on a mast with the mounting bracket facing upward, and the SO-239 jacks facing downward; do not simply lay it on the ground. If necessary, pound a short mast into the ground near your antenna and mount the RT-100 to it as shown on page 7. LDG strongly recommends grounding the RT-100 tuner via the wingnut marked **GND**.

To prevent rain water from running down the coax and into the connectors, all connections should be wrapped with coax sealing tape, such as Coax Seal™. Additionally, a drip loop should be provided by coiling the coax and zip-tying it into a loop which hangs below the connectors. The drip loop collects any water running along the coax, and makes it drip away from the tuner. Also provide a drip loop where the coax enters the house, to prevent water from running along the coax and into the house. Be sure the drip loop hangs below the coax entry point into the house.

If you are using existing coax between the RT-100 and the indoor Bias Tee, inspect it carefully for water damage. Best Amateur practice calls for cutting away one foot of coax for each year the coax has been outdoors. If the coax was sealed with waterproof tape or other material this may not be necessary.

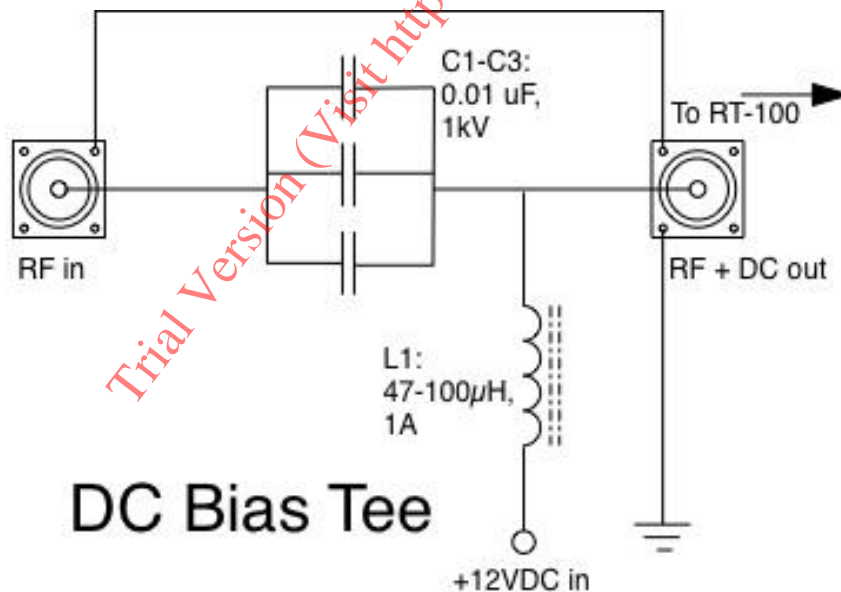


## BIAS TEE INFORMATION

The LDG RT-100 incorporates a Bias Tee in the tuner itself, but a second Bias Tee is needed at the transmitter end and is not included; you must supply one. The optional LDG RC-100 is an ideal companion to the RT-100, and includes a built-in Bias Tee designed specifically for the RT-100. However, you can easily “homebrew” your own Bias Tee from readily available components.

Alternatively, ready-made Bias Tees are available from commercial suppliers, including the SGC 54-70 DC Coaxial Line Isolator, the Array Solutions Bias Tee Master, and many others. The Bias Tee must be rated for at least 1A current draw, and 1.8 to 54 MHz. For more information on Bias Tee construction and theory, see the Wikipedia article “Bias Tee” at [http://en.wikipedia.org/wiki/Bias\\_tee](http://en.wikipedia.org/wiki/Bias_tee), ARRL’s QST article in the January 2013 issue, Vol. 97, Issue 1, p46, or the Array Solutions Bias Tee Master product review in the September 2009 issue of QST.

A Bias Tee is a circuit which injects DC power onto the coax feedline, while isolating the DC power from both the transmitter and the antenna; two are required, one at each end of the coax. A sample schematic is shown below.



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## OPERATION

### *Automatic Operation*

Your RT-100 is capable of fully automatic operation, tuning whenever needed. Simply operate normally and the RT-100 will maintain an SWR of about 1.7 or less on all frequencies within its specifications without your intervention. In most cases it is not necessary to transmit a steady carrier; the RT-100 tunes as you talk or send CW or other non-100% duty cycle modes. You can also manually start an automatic tuning cycle whenever you wish (semi-automatic operation), or you can turn the tuner off completely for straight-through operation.

Two types of automatic tuning cycle are available. When transmitting on a frequency for the first time, a **full tuning cycle** achieves a match by switching in inductors and capacitors according to LDG's state-of-the-art algorithms until a suitable match is found. You can observe the progress of the tuning cycle on your SWR meter. When a full tuning cycle ends the selected configuration is stored, indexed to that frequency for later reuse in a memory tuning cycle. In this manner the RT-100 "learns" as you use it, adapting itself to the bands and frequencies you use the most. 2,000 individual tuning configurations can be stored in non-volatile memory.

A **memory tuning cycle** attempts to tune very quickly based on stored parameters from previous full tunes at or near the frequency in use. If the tuner previously succeeded in tuning on the present frequency, the settings for that match will be loaded, and checked to see that an acceptable SWR match is found. If this fails to find a good SWR match, then a full tuning cycle will automatically begin. Memory tuning cycles can complete in just a fraction of a second.

The RT-100 powers up in fully automatic, memory tuning mode. Whenever RF is present, if the SWR is above about 1.7 a memory tuning cycle will automatically begin. You will probably use memory tuning most of the time; it takes advantage of any saved tuning settings, but automatically defaults to a full tuning cycle if no stored data is available.

### *Force a Full Tuning Cycle*

In some instances you may wish to force the RT-100 to begin a full tuning cycle instead of the usual memory cycle. Turn off power to the RT-100 by switching off power to the Bias Tee, begin transmitting a carrier, and while still keying the radio, turn on power to the Bias Tee; an automatic tuning cycle will begin. Continue transmitting the tuning carrier until the automatic tuning cycle ends with the SWR settled below about 1.7, then unkey and continue to operate normally. If you are using an RC-100 controller, transmit a carrier, press the **Tune** button on the RC-100 for one second then release. Continue transmitting the tuning carrier until the tuning cycle ends.

### *Re-tuning Termination*

Very rarely, when an antenna is used far from its resonant frequency, the RT-100 may erroneously continue a tuning cycle, even though it has already found a good match for the current antenna and frequency. In these cases simply turn the RT-100 off by removing power from the Bias Tee. The latching relays in the tuner will keep the current match settings even with power off, but the tuner will stop attempting to re-tune.

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### *Recovering from a “hang-up”*

On rare occasions your RT-100 may seem to “hang”, and stop operating correctly. In that case, follow these steps to recover normal operation:

- Put your radio in AM mode
- Push the PTT and hold it
- Press the Tune button on the RC-100 and hold for 2 seconds, then release
- Keep the PTT pressed while the tuner tunes
- When tuning cycle ends, check for good SWR, release PTT
- Resume normal operation
- If using your own Bias-Tee, change bands, force a tune, then return to the desired band

### *MARS/CAP Coverage*

The RT-100 provides continuous tuning coverage from 1.8 to 54.0 MHz, not just in the ham bands. This makes it useful for MARS or CAP operation, or any other legal HF operation.

### **ABOUT LDG TUNERS**

In 1995 LDG Electronics pioneered a new type of automatic antenna tuner. Instead of the usual variable inductors and capacitors, LDG tuners are a “Switched L” type using banks of fixed capacitors and inductors, switched in and out of the circuit by relays under microprocessor control. An SWR sensor provides feedback; the microprocessor searches the capacitor and inductor banks for the lowest possible SWR. The L network can tune unbalanced loads such as coax-fed dipoles, verticals, Yagis, or virtually any coax-fed antenna over a very wide impedance range.

In a Switched L tuner the series inductors are switched in and out of the circuit, and the parallel capacitors are switched to ground. A high/low impedance relay switches the capacitor bank to either the transmitter or receiver side of the inductor bank as needed, allowing the tuner to handle loads significantly greater or less than 50 ohms. LDG tuners use a proprietary algorithm that minimizes the number of tuner adjustments. The algorithm steps through the inductors to find an initial coarse match, then steps through the individual capacitors to find the best coarse match. If no coarse match is found, the algorithm repeats the coarse tuning, adjusting for high/low impedance. Finally, the algorithm fine tunes the inductors and capacitors to achieve a match of 1.5:1 or less.

The microprocessor runs at 32 MHz; the tuning algorithm executes in only a few milliseconds. However, the switching relays require several milliseconds of settling time for each combination of inductors and capacitors, so it can take several seconds to cycle through all relay combinations to find a match.

The internal SWR sensor is a variation of the classic Bruene circuit used in many SWR meters, modified to provide voltage inputs to an analog-to-digital converter (ADC). A single-lead primary through the center of the sensor transformer provides RF current sampling. Diodes

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rectify the sample and provide the ADC with DC voltages proportional to forward and reverse RF power, allowing computation of SWR in real time.

## **A WORD ABOUT TUNING ETIQUETTE**

Be sure to use a vacant frequency when tuning. With today's crowded ham bands, this is often difficult. However, causing interference to other hams should be avoided as much as possible. The RT-100's very short tuning cycle minimizes the impact of tuning transmissions.

## **CARE AND MAINTENANCE**

The RT-100 tuner is essentially maintenance-free. Always strictly observe the power limits listed in this manual. The outer case may be cleaned as needed with a soft cloth slightly dampened with household cleaning solution; do not use a garden hose to clean the tuner. As with any modern electronic device, the RT-100 can be damaged by temperature extremes, impact, or static discharge. LDG strongly recommends the use of a good quality, properly installed lightning arrestor in the antenna lead, and an earth ground connected to the **Gnd** connector.

## **TECHNICAL SUPPORT**

The LDG customer support staff is available on the telephone and by e-mail to answer your questions as the need may arise.

LDG regularly updates its on-line support documentation which is available all day and every day at: [www.ldgelectronics.com](http://www.ldgelectronics.com)

The LDG website provides links to our product user manuals (both current and past), specifications, and photographs. There is also a link to LDG's Dealers which are ready to help with a purchase decision.

## **TWO-YEAR TRANSFERRABLE WARRANTY**

All LDG products are warranted against defects in parts and workmanship for two full years from the date of purchase. This warranty is fully transferable; when you sell or otherwise transfer your LDG product, give the new owner a copy of the original sales receipt, and the warranty goes with the product to the new owner.

There is no need to complete a warranty card or to register an LDG product; the product receipt establishes eligibility for warranty service. Include a copy of the receipt whenever you send your product to LDG for repair. Products sent to LDG without a receipt are considered requests for out-of-warranty repair.

The LDG warranty does not cover product damage or abuse. Failures that LDG determines to be caused by the customer, by exceeding published specifications and limitations, or by exposure to hostile environments (water, electrical discharge, etc.) will not be covered under warranty.

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## OUT OF WARRANTY SERVICE

LDG will repair products after their warranty period has expired. Send your product to LDG; we will diagnose the problem, fix it, and bill you. You may request an estimate before repairs are performed if you wish.

## RETURNING YOUR PRODUCT FOR SERVICE

If your LDG product needs service, simply ship it to us; no return authorization is required. Download the LDG Product Repair Form from our web site, fill it out detailing the problem, and include it along with a copy of your receipt. LDG recommends using a shipping service that provides tracking; be sure to give the shipper your e-mail address so they can confirm delivery. Include your e-mail address on the Repair Form and we will have the tracking number of the returned repair e-mailed to you for tracking purposes. Repairs can take six to eight weeks, but are often faster; our staff makes every effort to complete repairs as quickly as possible. LDG appreciates your patience.

Repairs can take six to eight weeks, but are usually faster. The most recent information on returning products for service is found on the LDG website under Support, then Tech Support. Send your carefully packaged unit with the Repair Form to:

Carefully pack your product with the Repair Form and receipt and ship to:

LDG Electronics, Inc.  
Attn: Repair Department  
1445 Parran Rd  
St. Leonard, MD 20685-2177

## PRODUCT FEEDBACK

We encourage product feedback; tell us what you think of our products! In a card, letter, or e-mail (preferred) tell us how you used the product, how well it worked in your application, and any suggestions you have for improvements or for new products. Send along a photo or even a schematic or drawing to illustrate your narrative. We like to share your comments with our staff, our dealers, and other customers at the LDG website:

<http://www.ldgelectronics.com>

