Welcome: Thank you for your purchase of the DWM-4 Digital Wattmeter. The DWM-4 represents an advancement in technology that has never before been available in RF power measurement. With the integration of a microprocessor to existing RF sensor technology, the DWM-4 offers the flexibility of digital processing while keeping the interface to the user simple and straightforward.

Introduction: The DWM-4 is a four channel, microprocessor controlled RF wattmeter. It consists of two main parts, the display unit and the remote sensor. The display unit has a 2 by 16 backlit LCD module that provides the user with information about the RF that is being sampled by the remote sensor. The user can simultaneously view forward power, reverse power and swr on the same display for instant analysis of the antenna system.

There are two types of remote sensors. The HF/QRP sensor can sample RF from 1.8 to 54 MHz and up to 150 watts. The VHF/UHF sensor can sample RF from 140 to 160 and 420 to 470 and up to 150 watts. The modular design allows for the maximum flexibility with the minimum cost. The remote sensor is supplied with a six-foot cable to connect to the display unit. A longer cable can be used for truly remote sensing.

The display unit is controlled by a selection of menu screens on the display. The menu screens and the data on them are selected by the two pushbuttons (Menu and Select) on the front panel. Status information is also shown on the display.

Building the Kit: If you purchased the DWM-4 as a kit, the following instructions will give an overview of how to assemble it. If the DWM-4 was purchased assembled, you may still want to review the assembly instructions to become more familiar with the unit. If you want to get right to operating the unit, skip the assembly instructions and go right to the operation section.

Before getting the soldering iron out, go through all of the parts in the kit and familiarize yourself with each component and its placement. Most of the parts are common, but there may be a few of them that may be new to some builders. There are just over 100 parts and 200 solder connections, so take your time.

The instructions are written to assemble the unit using the height order of the parts form lowest to highest. This will assist the builder in the installation of the components. There are various photos

in the assembly instructions to assist the builder. These can be used for parts identification and PC board placement.

Assembly: You will first install (locate, place, and solder in place) the parts on the DWM-4 Main PC board. Use the silk screen layout in the back of this manual to assist in locating where parts are to be installed.

___ Install all of the resistors, R2, 8, 22, 26, 29 and 30. Be sure to check the values with the parts list. Most of the resistors are 1/8 watt and may be hard to read. Use an ohmmeter to verify the values if you have trouble identifying them.

___ Install the 1N4001 diode, D1. Note the band polarity.

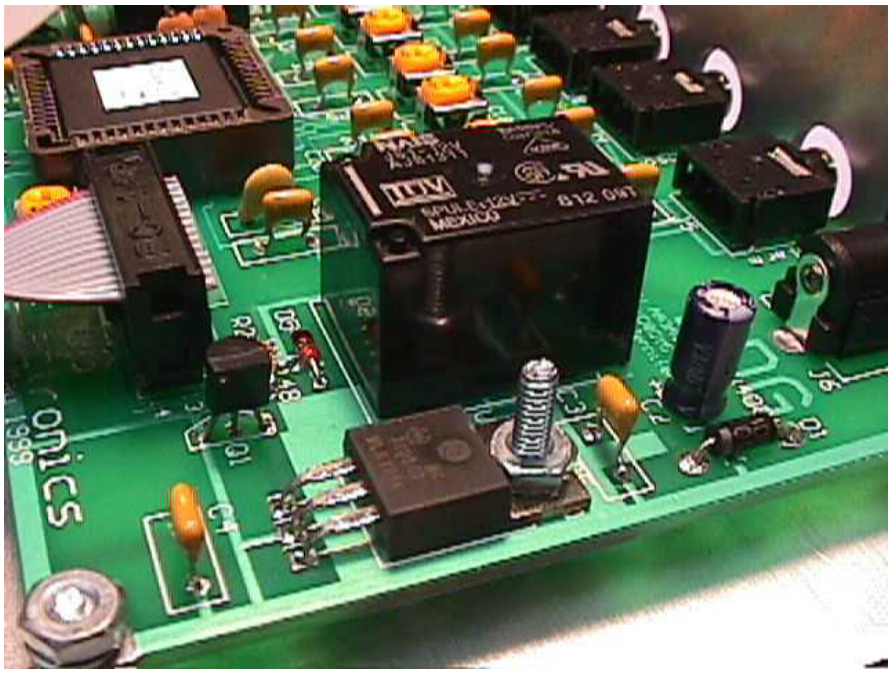
___ Install the 1N4148 diodes, D2-5. Note the band polarity.

___ Install the 10K 10-pin SIP resistor, RP1. Be sure to note the orientation of the SIP resistor. A small line (or dot) on the side with writing marks pin 1.

___ Install the .01uf monolithic capacitors, C1, 3-5, 7-10, 12-15, 17-20, 22-25.

___ Install the ceramic capacitors, C6 100pf 1KV; C26 & 27 10pf 500v.

___ Install U2, the 7805. Align the .2" hole in the regulator with the .2" hole in the PC board. Solder and clip the three legs. Then place one screw through the bottom of the PC board, through the hole in the 7805 and tighten a nut on it from the top of the PC board.



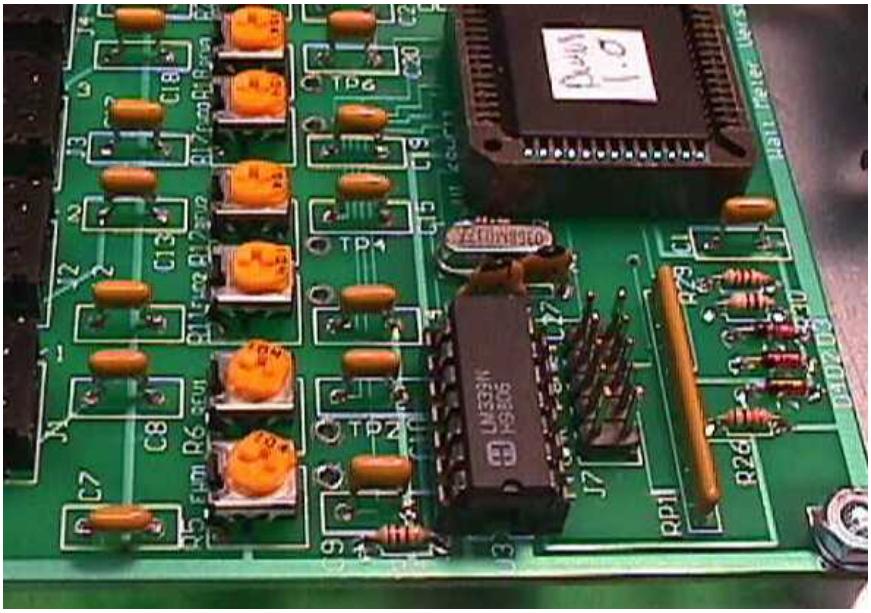
___ Install the 2N3904 transistor, Q1. Note the correct orientation.

___ Install the variable resistors (100K pots), R5-6, 11-12, 17-18, 23-25.

___ Install the socket for U3, 14-pin DIP socket. Match the notch on the silk screen with the notch on the socket. Do not install the U3 (the LM339) until later.

___ Install the socket for U1. Note the orientation of the socket. The flattened corner goes in the upper left, toward the 14-pin DIP socket for U3. Do not install U1 (the 68HC11) until later.

___ Install the 8 MHz crystal.



___ Install the electrolytic capacitor, C2, 10uf radial. Note the polarity.

___ Install the 1/8" stereo jacks, J1-5.

___ Install the power jack, J6.

___ Install the 10-pin header, J7. Solder the shorter ends of the pins to the PC board.

___ Install the 14-pin header, J8. Solder the shorter ends of the pins to the PC board.

___ Install the relay K1. Be careful not to bend the pins over pushing them in.

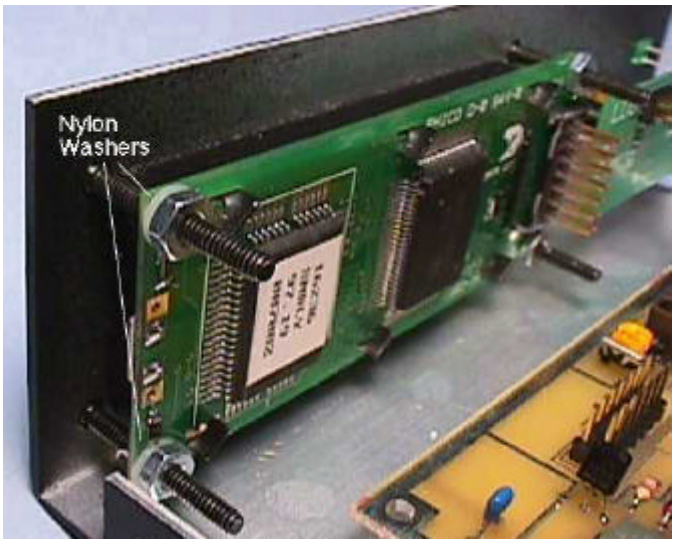
You are finished with the assembly of the DWM-4 Main PC board. Proceed with the assembly of the Front Panel PC board.

Assembly of the DWM FP PC board.

___ Install the 10 pin header (J7) with 0.1 inch spacing to the side of the front panel PC board that has the white silk screen. (In copper you can read "Place connector this side". Solder the shorter ends of the pins to the PC board.

___ Unwrap the chassis (bottom part of the enclosure) and put the 4 rubber feet on the bottom.

___ Install the LCD Module in the chassis. Use the 4 black flat head screws, the two #4 nylon washers and four nuts. Use the washers on the Status/SWR side of the chassis. Do not over tighten the mounting screws.



___ Install the SPST toggle switch (SW1) in the chassis in the Power On position. Remove the nut and one washer from the switch. Place the switch in the hole with the 2 prongs toward the bottom. Then replace the lock washer and nut on the switch. You may need to re-align the switch later, so don't tighten yet.

___ Install the 2 push button switches (PB1 & PB2) in the chassis in Menu and Select positions. Remove the nut and washer from the switch. Place the switch in the hole and replace the washer and nut on the switch. Be sure the solder terminals of the switches are aligned one on top of the other. You may need to realign the switches later, so don't tighten yet.

___ Place the LEDs in the front panel board, D1 Green, D2 Yellow. Be sure to place ground side down. The ground leg of the LED is the one with the notched plastic next to it. Do not solder them at this time.

___ Install the Front Panel PC board on the switches. The side without the white silkscreen will be placed on the solder terminals of the switches. Gently push the pc board onto the switches. The LEDs should slide into the holes in the chassis. Once you have checked the alignment, then solder the switches to the pc board. Tighten the nuts on the switches at this time. Next, slide the LEDs into the chassis and solder the legs to the pc board. Then clip the legs of the LEDs.

You are now ready to mount the DWM PC board in the chassis.

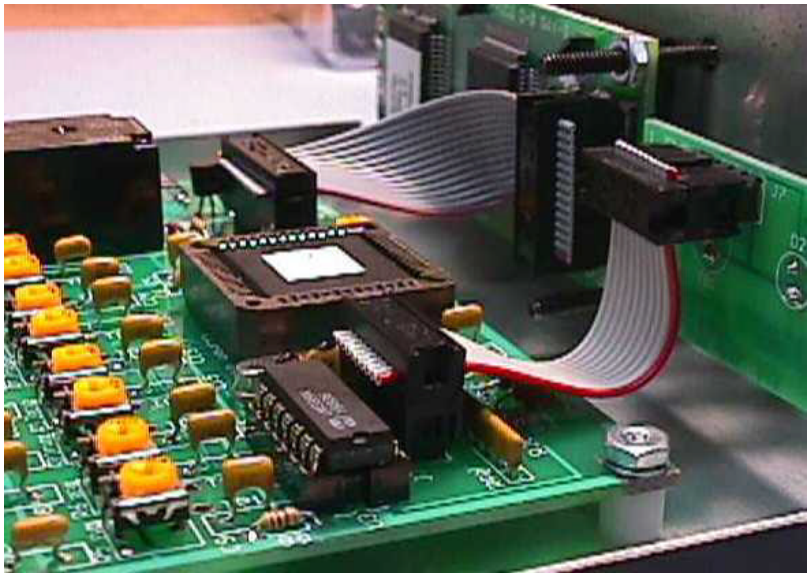
___ Install the DWM-4 PC board in the chassis using four screws, nylon spacers, washers and nuts. Do not drill out the holes in the PC board

___ Install U1 (the 68HC11) by carefully pressing it into place in its socket. Note that U1 has a flattened corner that should match the socket.

___ Install U3 (the LM339) by carefully pressing it into place in its socket. Note that U3 has a notch that should match the socket.

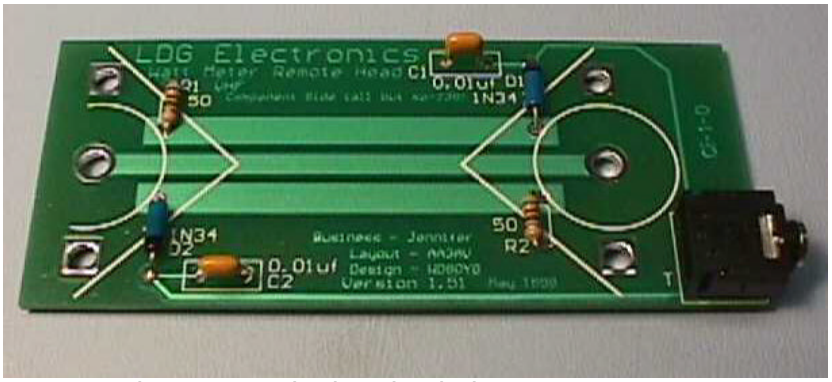
___ Install the ribbon cable with the red stripe connecting pin 1 of J7 to pin 1 of J7 (2 x 7 header) on the front panel.

___ Install the ribbon cable with the red stripe connecting pin 1 of J8 to pin 1 of the LCD Module on the front panel.



VHF/UHF Remote Sensor Assembly Instructions

___ Install the resistors, R1 and 2.



___ Install the diodes, D1 and D2. Note the band polarity.

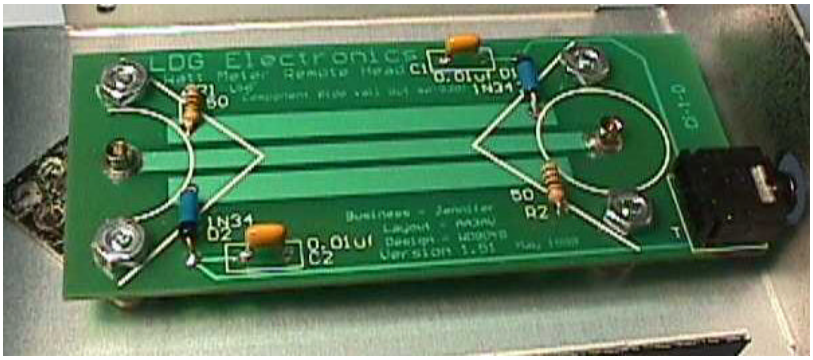
___ Install the .01uf monolithic capacitors, C1 and C2.

___ Install 1/8" stereo jack.

___ Unwrap the enclosure. Install the SO-239 connectors. Put one #4 screw in hole and place two nuts on the screw. Repeat with the other three screws. Do not tighten them at this time.

___ Place the PC board onto the SO-239s. Align the 1/8" jack with the hole in the enclosure. Once this is in place, you may tighten the nuts that are underneath the PC board. You do this by pressing the board down on the nuts while turning the screw. Repeat with the other three screws.

___ Install the remaining four nuts on top of the PC board and tighten.



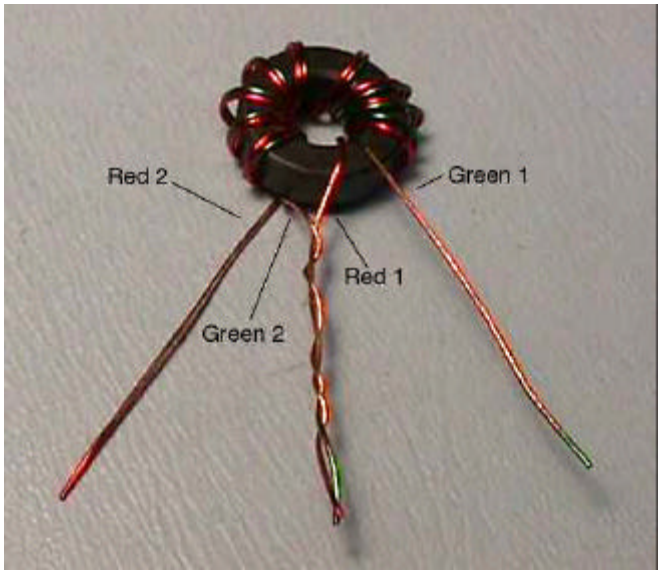
___ Solder the SO-239s to the PC board.

You are now finished with the VHF/UHF Remote Sensor.

HF/QRP Remote Sensor Assembly Instructions

___ Wind T1 with 10 turns using the red and green #28 gauge wire. T1 is the small, black toroid just under one half inch in diameter. See picture below and wind this in bifiliar fashion by using two lengths of wire and winding them at the same time. It doesn't matter if you twist them or wind them side by side. Note: you must wind this in the direction shown in figure 2.

___ After scraping the insulation from the ends of all four wires, connect the green 2 wire to the red 1 wire and twist together. You will now have three leads: the red wire on the left, the twisted pair and the green wire on the right. Do not install T1 yet.

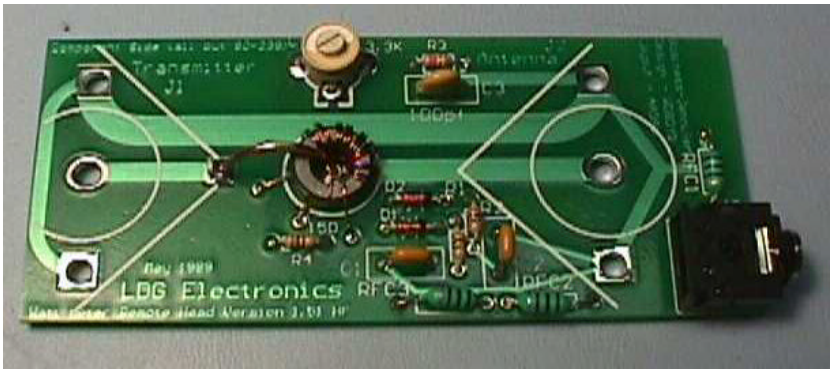


___ Install all of the resistors, R1, 2, 3 and 4.

___ Install the 1N4148 diodes, D1 and D2. Note the band polarity.

___ Install 10 uH Chokes, RFC1, 2 and 3.

___ Install the .01uf monolithic capacitors, C1 and C2.



___ Install the ceramic capacitor, C3 100pf 1KV.

___ Install C4, 3.5-13 pf trimmer capacitor. Note that C4 has two pins that are common (connected). They should line up with the two holes in the PC board that are connected together with a trace on the bottom.

___ Install T1. It lies flat against the PC board and the #18 wire will pass through the center (you will install this later). Hold the PC board so you can read the silk screen. With the PC board in this position, install T1 with the green wire coming over the top on the right, and the red wire coming from underneath to the left.

___ Install the #18 bare wire (included in the kit) to the PC board in the hole to the left of T1. Place the other end through the center of T1 and solder to the bottom of the PC board.

___ Install 1/8" stereo jack.

___ Unwrap the enclosure. Install the SO-239 connectors. Put one #4 screw in hole and place two nuts on the screw. Do not tighten them at this time.

___ Place the PC board onto the SO-239s. Align the 1/8” jack with the hole in the enclosure. Once this is in place, you may tighten the nuts that are underneath the PC board. You do this by pressing the board down on the nuts while turning the screw. Repeat with the other three screws.

___ Install the remaining four nuts on top of the PC board and tighten.

___ Solder the SO-239s to the PC board.

You are now finished with the HF/QRP Remote Sensor.

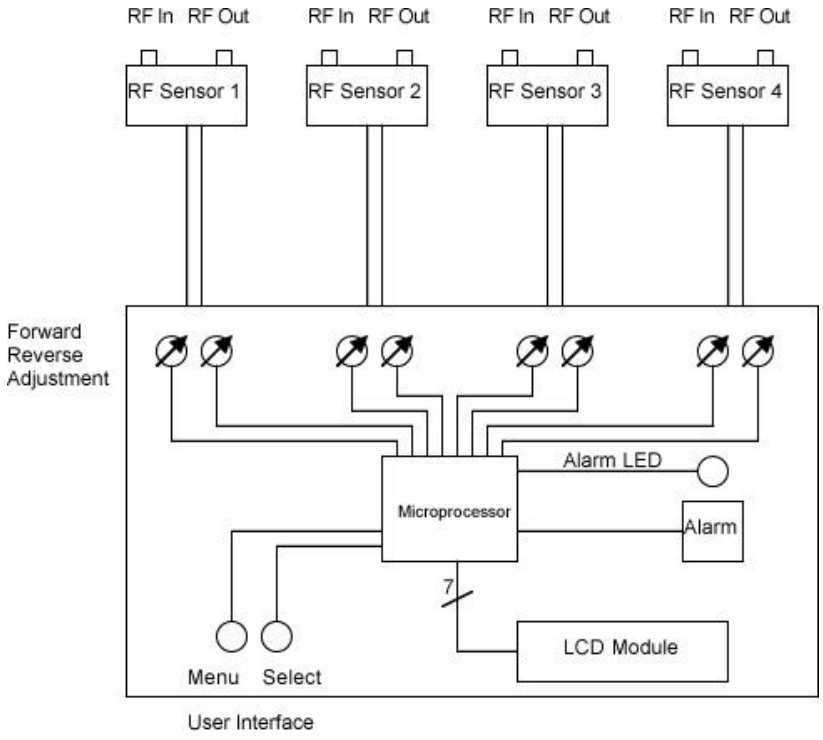
Installation: The DWM-4 operates from an 11 to 15 volt DC power source. The current requirement is about 75 mA. Be sure to use a power supply or power adapter that meets these requirements. The coaxial DC jack on the back of the display unit will accept a plug with an OD of 5.5 mm and ID of 2.5 mm.

You can use any 50 ohm cable to connect the remote sensor in-line with your antenna system. Be sure to use the proper cable for your power level. Do not use RG-58 for power levels over 500 watts.

Connect coaxial cable from the transmitter to the SO-239 labeled Transmitter on the remote sensor. Then connect coaxial cable from the SO-239 labeled Antenna on the remote sensor to your antenna or antenna tuner.

Connect one end of the six-foot, 1/8" stereo cable to the remote sensor. Connect the other end to input #1 on the DWM-4 display unit.

Other remote sensors (for a total of four) can be connected the same way to other inputs on the display unit.



Operation: Turning the display unit on will show the model and software version of the DWM-4. The power LED is software controlled, so it will only come on if the software is running properly. You may have to adjust the contrast pot (R25) fully counter-clockwise to properly view the LCD module information. After the display comes on, adjust R25 for best view.

The software will default to channel one and all channels will be configured as numeric display, HF, 150 watt, peak reading sensors with no swr alarms set. The user can now scroll through the menus with the user interface to select the setup for each channel.

The user interface consists of the LCD, one toggle switch (S1), two pushbutton switches (S2 and S3) and two LEDs (DS1 and DS2). The LCD provides the operator with a series of menus. Each

menu offers information about each of the four sensor inputs. Some items are common across different menus.

There are two basic wattmeter modes: setup and operate. During setup, you can select bargraph or numeric display, peak or average display, set SWR alarms, and select which sensor type is connected to each input along with a power range for each sensor. In operation, the display shows forward or reverse power (as a bargraph or numeric display), SWR (in digits) and error notification.

Menus: The heart of the user interface is the menu system. There are seven menus through which you can scroll to set the functions of each channel. Under normal operation, you start at the Main menu. This menu displays the forward and reverse power, SWR, active channel, and alarm status. Pressing the Select button, S3, cycles the displayed channel from 1 to 4 and A. Option A stands for automatic operation. When in automatic mode, the display is automatically switched to the channel that is currently sensing forward power. Channel number prioritizes the channels. If channel a 1 and 3 transmit at the same time, channel 1 will be shown.

Pressing Menu button S2 cycles through the menus for the selected channel. The DISPLAY READOUT menu chooses between BAR and NUMBER for the forward and reverse displays. The SAMPLE REPORT menu chooses between a PEAK and AVERAGE for the forward and reverse power. There are PK and AV icons on the status line to show the selection.

The ALARM THRESHOLD menu selects the point at which the front-panel yellow LED illuminates to warn of high SWR. Pressing and holding the Select button turns on the alarm and counts from 1.1 to 30.0 for the alarm threshold. Pressing the Select button again turns off the alarm.

The RELAY THRESHOLD menu is separate from the ALARM THRESHOLD. The Select button works as it does with the ALARM THRESHOLD, but only controls the operation of the relay, K1. The RELAY RESET menu chooses between MANUAL and AUTO reset. In MANUAL reset, you must press the Select button to de-energize the relay. In AUTO reset, the relay is reset when the SWR drops below the RELAY THRESHOLD value.

The SENSOR TYPE menu allows you to select one of the four sensor types available. The sensors and ranges are HF HI (0 to 150 W), HF LOW (0 to 15 W), VHF (0 to 150 W) and UHF (0 to 150 W).

At any time, pressing the Menu and Select buttons simultaneously return you to the MAIN menu. Press the menu button fist to keep from changing any selection settings.

Errors: There are three error conditions for the DWM-4: (1) The forward maximum power level has been exceeded; (2) the reverse maximum power level has been exceeded, and (3) the reverse power level is greater than the forward power level. The display indicates these errors as they occur. When the error condition is removed, the display returns to normal.

Calibration: Most of the adjustments are on the main PC board. Each forward and reverse line for each channel is equipped with a variable resistor for calibration. The HF sensor also has a balancing capacitor on its PC board. There are no adjustments to be made within the VHF/UHF sensor.

Note: Observe proper safety practices when adjusting the sensors. Keep your fingers away from the wires and traces that carry RF. A RF burn from a 100 W transmitter can be quite painful. Keep each sensor’s enclosure cover in place during operation.

At a minimum, a 100 W HF radio and good 50ohm dummy load can be used to calibrate the HF sensor and display unit. Even if you know how much power your radio emits, consider using an additional wattmeter of known accuracy to assist you during the calibration process.

Start by setting R1 through R8 to their center positions. Connect the HF sensor to INPUT 1 on the main board. Attach a voltmeter between ground and the reverse test point of the HF sensor. Apply 100 W through the HF sensor to a dummy load or resonant antenna; adjust C1 in the HF sensor for minimum voltage. The minimum reading should be just about 0 Volts. A reading of 0.1 Volt or less is fine. Be sure the pot for the reverse channel is centered for this adjustment. It is possible to get a 0 Volt reading if the pot is not set correctly.

Again apply 100 W and adjust R1 on the main board so that the forward display reads 100 W. Set the LCD to display numbers instead of the bargraph. Swap the input and output leads of the HF sensor and again apply 100 W. Adjust R2 to read 100 W on the reverse display. An error message (REV>FWD) will appear, but the display is still visible between error-message flashes.

For VHF and UHF, connect a VHF/UHF sensor to one of the other channels. Apply RF power and adjust the corresponding variable resistor to obtain a correct forward power display. Swap the input and output leads and repeat for the procedure for reverse power. Repeat the foregoing process for the other channels by connecting the appropriate sensor to each input and adjusting the corresponding variable resistors.

Remote Operation: The display head is designed to mount at the station transmitter. The display unit can be used as table top or under shelf by using the mounting bracket. The mounting bracket can also be used in a mobile installation.

The remote sensor is supplied with a six-foot cable. The sensor is usually mounted near the transmitter, but it is possible to mount the remote sensor at the antenna for remote sensing. Be sure to note that when mounting the sensor at the antenna, the use of an antenna tuner will not produce the proper readings.

For remote sensing at long distances, a three wire shielded cable must be used. The wire must be #20 or larger to prevent voltage loss with distances over 100 feet.

Accuracy—a Virtual Bird: The accuracy of the DWM-4 is directly related to its calibration. If you have an accurate wattmeter or RF power source to which to compare it, the accuracy of the DWM-4 will be correspondingly precise. The displayed values are derived from a huge look-up table stored in the microprocessor. These table values were taken from the readings of a Bird 43A wattmeter. The table was derived by comparing the A/D reading supplied by the HF and VHF/UHF sensors for various RF readings on the Bird meter. The Bird readings were then graphed and extrapolated where needed to fill in the gaps.

The resolution of the DWM-4 is about 1 W on the 150 W scale and 0.1 on the 15 watt scale.

Even though the overall accuracy as compared to a Bird wattmeter is better than 0.1%, the actual accuracy still depends on the calibration.

Trouble Shooting: If there are any problems, first check all components for proper value, placement and polarity. Next look at the solder connections. Check for cold solder joints and solder bridges first, since they are the number one cause of problems with the kits.

Does nothing: Check for 12 volts getting to PC board (be sure the switch is on). Check for 5.0 volts out of 7805 (the left pin). Make sure the 10-pin ribbon cable is installed. Make sure the socket for U1

was installed correctly. Make sure U3 is installed correctly. Check D1 for polarity. Check the SIP resistor (RP1) for proper orientation.

No Display: Make sure the 14-pin ribbon cable is installed and oriented properly. Be sure the nylon washers are in place on the two nuts closest to the outside. Turn R25 (LCD Contrast) fully counter-clockwise for initial settings. Then adjust for best viewing.

Can't get 0.0 volts on REV with HF remote sensor: Make sure T1 was wound correctly in the HF remote sensor. Make sure the #18 gauge wire from the PC board passes through the center of T1. Check polarity of D1 and D2 on the HF board.

Alarm does not work. Check Q1 and D5 for orientation. Check menu for proper swr setting. Be sure to note that the relay alarm is different than the LED alarm.

Tech Support: Telephone technical support at 410-586-2177 is available most weekdays from 8 am to 9pm Eastern Standard Time. Replies by FAX (410-586-8475) are welcome; e-mail (ldg@ldgelectronics.com) is also answered on a daily basis.

Last Resort: As a last resort only, LDG Electronics will attempt to repair any problems. We have a flat fee of $40 plus parts to repair a DWM-4 (most resistors and capacitors are included in that fee). The 68HC11 chip is the most expensive at $25.

We will not attempt to repair any unit that has been soldered with acid core. We reserve the right to refuse repair due to excessive problems or damage due to construction.

Before any unit is sent to us, you must first call (or e-mail) to get return authorization. All units sent back must be prepaid, either by check, money order or Credit Card unless other arrangements are made. Package the unit carefully and keep in mind that we will use your packaging to return the unit back to you. Include a description of what problem you are having along with your name, address and a phone number that you can be reached at in case we have questions. Repairs average about 3 to 6 weeks, depending on the particular problem.

If you have an idea of how the unit can be made better (in software or hardware), please send a description of your upgrade. If we use it for the DWM-4, we'll send you a free upgrade. Future upgrades will be available for about $15 with 68HC11 chip trade in. If you purchased the kit from LDG, we will notify you when future upgrades and modifications are available through the LDG Newsletter. If you purchased the unit through a distributor and would like to be added to our mailing list, just drop us a note by mail, fax or e-mail.

Feedback: We encourage everyone who builds the DWM-4 kit to drop us a note (card, letter or e-mail preferred) to let us know how well it works for you. We're also always on the lookout for photographs of the DWM-4 in use. We frequently place pictures that we receive into the DWM-4 Newsletter or on our Web site (www.ldgelectronics.com).