



PowerMaster Series



Digital RF Power & V.S.W.R. Indicator

Array Solutions

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Manufactured in the U.S.A.

INTRODUCTION

Thank you very much for purchasing the Array Solutions PowerMaster Series RF Power/VSWR Indicator. The PowerMaster represents a breakthrough in features for measurement of the performance of your transmitting system. Microprocessor control insures fast capture time and low power consumption. With the ability to monitor your VSWR and power levels at all times, you will know that your transmitter, RF source, and load, or antenna systems are operating effectively and safely. In addition, the power and VSWR relay alarms can quickly shut down your power amplifier system and alert you to the alarm condition. This places an additional layer of protection in your transmitting system to help preserve expensive tubes and finals. The PowerMaster also features the ability to be monitored and controlled from a PC via the bundled software, and the unique ability to be monitored and controlled over a LAN or from the internet. PowerMaster firmware updates will be made

available for download from the Array Solutions website as they become available. This means that the user can take full advantage of features or enhancements just by installing the firmware update. No need to return the meter to the factory for updates.

There are many features introduced in the PowerMaster that have not been seen before! We are very proud of our product and are interested in learning about your experiences with this meter. We also want to know if you have ideas about new features we can bring forth for the meter. We have built in the ability to enhance the meter with software updates that you can download from the internet. We think you will agree that this is a totally new concept in an RF Wattmeter, and one that should extend its lifetime for a long time to come.

IF YOU HAVE PROBLEMS

We want you to be satisfied with your purchase. If you have any type of problem, please check the Trouble Shooting section of this manual. If your problem persists, call our Customer Service Department at

972 203 2008. Please have the PowerMaster and this manual at hand when you call.

Write your new PowerMaster serial number and calibration data for your coupler here (see coupler sticker)

Serial Number _____
Date of purchase _____

Coupler Calibration Table	
Forward Power 30MHz	<input type="text"/>
Reverse Power 30 MHz	<input type="text"/>
Forward Power 50 MHz	<input type="text"/>
Reverse Power 50 MHz	<input type="text"/>



Federal Communications Commission (FCC) Statement

Note: This equipment has been tested and found to comply with the limits for Class B digital devices, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult a qualified radio/TV technician for help.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. Array Solutions is not responsible for any radio or television interference caused by using other than recommended cables or connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interferences, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Responsible Party: Array Solutions, Telephone 972 203 2008

Industry Canada Compliance Statement

This Class B digital apparatus meets the requirements of the Canadian Interference-Causing Equipment Regulations.

Avis de conformité à la réglementation d'Industrie Canada

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.



European Union Declaration of Conformity

PowerMaster RF Wattmeter Series

Council Directive --- 89/336/EEC; EMC Directive

Standards: EN 55022 Class B
EN61000-4-2
EN61000-4-3

TYPE OF EQUIPMENT: ITE
EQUIPMENT CLASS: B

WE, THE UNDERSIGNED, HEREBY DECLARE THAT THE EQUIPMENT SPECIFIED ABOVE CONFORMS TO THE ABOVE STANDARDS PER 89/336/EEC:

Array Solutions Date of testing May 3, 2005

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The application software for the PowerMaster is copyrighted. ©2005 by D. Kinsell, All rights reserved.

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UNPACKING AND SETUP

INITIAL SETUP

Unpack the PowerMaster. The box should contain:

- One Display Head – Black enclosure
- One Directional Coupler – Gold colored box with connectors
- One shielded interconnect cable for the coupler and display enclosure – 6 feet long
- One DC 2.1mm coaxial plug power cable – 6 feet long
- One CD Rom with the LITE version of software, and optionally the PRO version if ordered
- Manual

If anything is missing, give us a call and we'll remedy the problem.

The PowerMaster consists of two major components: The Display Unit and the Directional Coupler. The Directional Coupler is installed in series with the output of your transmitter and antenna. A six-foot (1.8m) cable is provided for connection between the Display Head and the Directional Coupler. You may use a longer cable if you wish (consult the Special Applications section later in this manual).

- **The PowerMaster uses a standard 2.1mm coaxial power plug, center pin is + V.**
- **Make sure your power source can supply at least 600 ma of current.**
- **Please do not use a cheap wall wart. These devices are usually not regulated and may cause RFI.**

Quick Setup

If you are currently using a wattmeter in your setup, you have everything you need for a test. If you are not using a wattmeter, then you will need a suitable jumper to connect the Directional Coupler to your station.

Connect the Directional Coupler as follows:

Using RG-8, RG213, or RG-58 or other 50 ohm coaxial cables

SOURCE goes to your transmitter or linear amplifier (directly)
ANTENNA goes to your antenna (or tuner)

For the 3 or 10 KW HF PowerMaster, plug the ¼” connector into the Directional Coupler and Display Enclosure. Supply 12V DC power by connecting a standard 2.1 mm coaxial plug to the DC jack in the back of the Display Enclosure. The center pin is “+” 12V DC.

The PowerMaster is protected against polarity reversals, but be careful just the same. Apply 12-15 volt DC power. You should observe that the Vacuum Fluorescent Display becomes active and the firmware version number will be displayed for a few seconds, then the unit will display the operational mode screen. You are now ready for a test.

Simply use your normal procedure to transmit. The PowerMaster will give you an instant indication of your power and VSWR. If your transmitter has an internal tuner, you might want to turn it off. The internal tuner will cause a 50 ohm impedance to be presented to the finals of your transmitter, thereby changing the characteristic impedance present at the antenna jack on the transmitter. This will affect the accuracy of the PowerMaster (just as it would any other measuring

device).

If the PowerMaster is functioning with a display of your forward power and VSWR number with a bar graph to indicate relative power, you may now proceed to program it from the front panel buttons or the control software.

If you are having other problems, refer to the Trouble Shooting section of this manual.

INSTALLATION DETAILS - DISPLAY HEAD AND COUPLER LOCATION

The Display Enclosure is designed to be either table-top or 19-inch rack mounted with the optional rack mounting plates. You can mount one or two meters side by side in a standard 19-inch rack with the available mounting plates in a 2U high space. If using the Display Enclosure as a table top or shelf mount, simply place it into a position that is easily seen, but be careful not to place it on top of an amplifier in a way that it blocks the cooling of your amplifier. Choose a suitable location for the Directional Coupler and mount it as well. We suggest mounting it with an adapter right at the output of your amplifier. Be sure that you mount the Directional Coupler close enough to the Display Head so that the supplied cable can reach. If you require a longer cable, any shielded ¼" "Stereo" jumper cable will suffice. If you use a longer cable, test it for accuracy and RF immunity.

Connect a 12-15V DC power supply cable with 2.1mm plug to the Display Head. The center pin is the "+" side of the DC power plug. Wire your cable to a clean DC power source. Remember that some switch mode or cheap wall warts are RF "noisy". The Display Head is protected against polarity reversal.

DIRECTIONAL COUPLER WIRING - Since the purpose of the PowerMaster is to provide an indication of the match of your antenna system to your transmitter, it is critical that the Directional Coupler be installed as the first element after the antenna jack on your transmitter or amplifier and before a tuner. Connect from your transmitter's antenna jack to the SOURCE connector on the Directional Coupler.

The standard Directional Coupler comes with SO-239 connectors. You can order optional "N" connectors or 7/16 Din connectors for very high power operation.

If you are using an amplifier, install the Directional Coupler after your amplifier. Connect the cable that goes to your antenna system to the ANTENNA jack on the Directional Coupler. You may use the VSWR protection circuitry if desired.

Recheck your cables/adapters and fasten them down appropriately. Turn on the power to the Display Head. You should see the firmware version number displayed, and then the PowerMaster will go to its normal operational state.

Note that the display will become dimmer after 2 minutes of not sensing power, and completely dark after 10 minutes of not sensing power. This feature allows you to keep the meter on all the time and not reduce the lifetime of the display.

USING THE POWERMASTER – Front Panel Controls

GENERAL OPERATION

In addition to the large vacuum fluorescent display, there are two buttons on the front of the PowerMaster: “Menu” and “Mode Select.”

These buttons are used to select the operational mode, and to program the meter’s several functions such as VSWR Alarm, Power Monitor Alarm, Auto Ranging Scales, etc.

The following discussion shows you how to operate the meter. As we add more features, you will be able to download more options for your meter from the Array Solutions Website. You are invited to join the **Array Solutions User’s Group** which can be found on the Array Solutions website.

Note the Pictures used in the following text are of the previous meter box mixed with the new meter box. The functions are all the same.

Operation Menus - A tour of how to program from the front panel buttons



After Power-Up the meter enters the Normal Operation

Mode – see upper left character selection

Push the mode select button to choose from:

- F – Fast hold of peak power, .2 second
- M – Medium hold, 1 second
- S – Slow hold of peak power, 2 seconds
- L - Long 5 seconds
- V – VSWR is displayed on Bar Graph – see next page



VSWR Bargraph Mode

Used to allow easy adjustment of a tuner for minimum VSWR.
Dip it for minimum VSWR.

Pushing the menu button again takes us to the first menu item.



VSWR Alarm Menu

Push the mode select button to select the VSWR alarm trip point:

- Off
- 1.5
- 2.0
- 2.5
- 3.0

Push the mode select button to reset the VSWR alarm and LED

Pushing the menu button again takes us to the next menu.



Alarm Polarity Menu

(This option only displays if VSWR Alarm Limit is not set to off)

Select by pushing the mode select button:

- ALARM OPENS Relay
- ALARM CLOSSES Relay

This applies to the PTT/ALC relay only – not the Power Monitor relay.

Pushing the menu button again takes us to the next menu.



Low Power Alarm Menu

Push the mode select button to choose trip point in watts:

- Off
- 5
- 50
- 100
- 250
- 500
- 1,000
- 2,000

If the peak power remains below this setting for a few seconds the power alarm LED will light and the power monitor relay will actuate.

Push the mode select button to reset the alarm and LED

Pushing the menu button again takes us to the next menu.



High Power Alarm Menu

Push the mode select button to choose trip point in watts:

- 0 (off)
- 175
- 225
- 700
- 1,100
- 1,600
- 2,600
- 3,000

If the peak power exceeds this setting the power alarm LED will flash and the power monitor relay will cycle on and off. If the “Alarm Trips Amp”, next menu, option is selected then the VSWR alarm LED will also flash and the PTT/ALC relay will actuate but will not cycle.

Push the mode select button to reset the alarm and LED

Pushing the menu button again takes us to the next menu.



Alarm Trips Amp Menu

Select with mode select button:

- Yes
- No

This menu option allows the high power alarm to actuate the PTT/ALC relay just like a VSWR alarm does.

Pushing the menu button again takes us to the next menu.



Auto Alarm Reset Menu

This will automatically reset the both the VSWR and Power Alarms or if "Off" will force a manual reset only.

Select by pushing the mode select button:

- Off
- 5 seconds
- 10 seconds
- 20 seconds



Alarm Polarity Menu

(This option only displays if High Power Alarm Limit is not set to off, 0)

Select by pushing the mode select button:

- ALARM OPENS Relay
- ALARM CLOSSES Relay

This applies to the PTT/ALC relay only – not the Power Monitor

Pushing the menu button again takes us to the next menu.



Show Call Text Menu

Select with mode select button:

- Yes
- No

This will display your call letters or any other text you programmed into the meter via the software application program. You must use the software to program the call text.

Pushing the menu button again takes us to the next menu.



Display Intensity Menu

Select with mode select button:

- 1
- 2
- 3
- 4 (brightest)

Pushing the menu button again takes us to the next menu.



BarGraph Ranges Menu

Select with mode select button:

50 250 1250
100 500 2500
200 1000 3000
400 2000 3000

Pushing the menu button again takes us to the next menu.



Forward Power Trim Menu

Select with mode select button to scroll from +15% to -10%.

Set the Forward Power Trim factor to the settings indicated on your coupler for HF (30MHz setting). It is now possible to get better than 5% accuracy at 50 MHz if you use the setting in the calibration table for 50 MHz.

Pushing the menu button again takes us to the next menu.



Reverse Power Trim Menu

Select with mode select button to scroll from +15% to -10%.

Set the Reverse Power Trim factor to the settings indicated on your coupler for HF (30MHz setting). It is now possible to get better than 5% accuracy at 50 MHz if you use the setting in the calibration table for 50 MHz.

Pushing the menu button again takes us to the next menu.



Power Display Menu

Select with mode select button:

Net Power (Forward Power – Reverse Power)

Forward Power only (Reverse power is not subtracted)

Selects your preferred way you chose to display power and is shown on the digital power readout and bar graph.

Pushing the menu button again takes us to the next menu.



RS232 Port Baud Rate Menu

Select with mode select button:

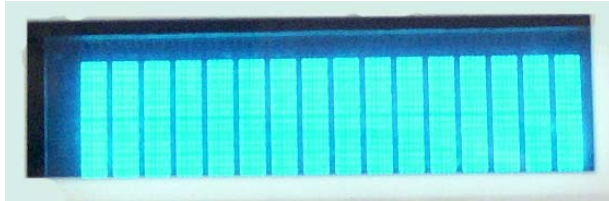
9,600
19,200
38,400

We recommend the highest speed.

Pushing the menu button one last time will evoke the Display Refresh Screen. This is used to completely fill the display with bright refresh pixels to restore display fluorescents of the display.



Screen fills with dots when "YES" is selected



Refresh Display Menu

Select with mode select button:

No – do not refresh the screen
Yes – Refresh the screen

Then push the menu button and screen will fill with bright dots for approximately 19 minutes.

We recommend doing this about every 6 months or when you notice some dots are weaker than others.

Other useful aspects of the meter:

VSWR is not displayed if the forward power is less than 5 watts.

VSWR alarm function is disabled if the forward power is less than 10 watts in normal modes or less than 50 watts in VSWR dipping mode.

The minimum displayed power is 1 watt. The maximum displayed power is 3005 watts (3 KW HF coupler).

Under 100 Watts the meter will display power in tenths of a watt

The call sign/message which you can program into the display can be up to 16 characters long.

The bar graph has 80 segments and auto ranges in 3 ranges.

Display will auto dim after 2 minutes and automatically turn off after 10 minutes if no power is detected. Display lifetime is 35,000 hours at maximum intensity before it will reach 50% brightness. This is a lifetime display in normal use.

The meter can have its internal firmware updated from the serial port connected to your PC. Just download the latest revision of firmware from the Array Solutions web site at www.arrayolutions.com. See the LITE or PRO software manuals on the CD for the procedure.

The meter can be used on the internet via the PRO version of the control software.

The PRO version of the software will allow rig control and auto VSWR testing of your antennas, as well as other automatic functions combined with your radio or amplifier.

See the help files in the LITE and PRO software packages for detailed information on the features of these software options.

REAR PANEL CONNECTIONS



From left to right

- Coupler – plug for coupler cable.
- Power Monitor Alarm – 1/8" stereo jack, relay will close or open depending on how you program it, these are .5 amp 50V contacts.
Tip Normally Open
Ring Normally Closed
Sleeve Common
- DC 12-15V – 2.1 mm coaxial DC power jack used to supply meter with DC power, center pin is "+V."
- PTT IN and PTT OUT – Route PTT through this connector. or an ALC voltage to the amplifier to shut it down fast. .5 amp 50V contacts.
- RS232 – connect a DB9 cable to a PC com. port to program and read the meter with the application software.

REMOTE COUPLER MOUNTING, RFI, and REMOTE SITE INSTALLATIONS

A remote mountable directional coupler vs. a Power/VSWR meter that is all in one box is ideal since the remote coupler can be placed very close to the amplifier or source output. The effects of coaxial transmission line losses are then minimized, and you get a more accurate reading of the status of your antenna and power being delivered. It also keeps possible RFI troublesome cables away from your transmitter, audio, data and CW circuits, therefore reducing the chance of RFI and distortion to your signal.

A Power/VSWR meter that requires you to run coax to it since it has no remote coupler means you have to mount the meter very close to your operating position. Since you're routing your coaxial cables through it, you are also bringing in possible RFI that can affect your audio,

CW tone, modulation, and also your PC. The PowerMaster eliminates this possible source of RFI since the signals passed to its display head are merely DC voltages from the remote coupler.

The remote mounting capability is perfect for multiple transmitter sites, remote power sensing for tuners, PA stages, broadcast towers, etc. The ability to have the meter report alarms via the relay closures or the software makes it a very flexible instrument for remote sites as well.

Remotely controlled radio applications over the internet should find this meter readily adaptable with the PRO application software.

DIRECTIONAL COUPLER CONNECTORS

- You may order the unit with SO239 (standard) connectors, Type-N, or 7/16 Din.
- The connectors are field replaceable if you should need to do so.

ACCURACY AND CALIBRATION

The PowerMaster resolves 12 equivalent bits of analog to digital data. There are 8 sampling channels: 4 forward and 4 reverse. A calibration table is generated for each meter that resides in the processor's non-volatile memory for each of these channels. This allows the best accuracy possible over the auto ranging scales. This results in a display that has 1024 steps for each auto ranging scale.

Chose your bar graph scale so that it is the best choice of resolution for the power your equipment is running. For instance, if you have a 2,000 watt amplifier, chose the 2,500 watt bar graph scale. This will result in the bar graph displaying most of the graph at this power level. At the highest scale the meter will display a resolution of 2.4 watts, but when you're at exciter levels of 100 watts or less the auto range scale can display resolutions of 1 watt even though it is resolving .09 watts in the sampling circuit. We intentionally limit the display to 1 watt increments.

The Power Master is calibrated in two segments: HF (2-30MHz) and at 50.1 MHz. It has better than +/- 3% accuracy on our certified calibrated lab test equipment. We provide a calibration table on each directional coupler just like the calibrated sensors we use from our measurement system. The ability to program the

PowerMaster with this calibration "trim" data assures you that you have the best calibration possible with your meter. The data supplied has two ranges:

- 1.5 to 30 MHz – HF Range noted as 30MHz on the coupler sticker
- 50 MHz – 6 Meter Amateur Radio Band noted as 50 MHz on the coupler sticker

Program the Forward and Reverse Power trim settings in your meter to match your coupler for the frequencies you will use. We typically see +/- 3% accuracy at HF and even better at the 6 meter band.

If your application calls for better accuracy on a certain band, you can easily recalibrate the unit to suit your needs by adjusting the forward power and reverse power trim settings. In this case, you can enjoy enhanced accuracy since you have calibrated exactly to your test equipment. There are no potentiometers or variable capacitors in the coupler or the display enclosure to adjust. The calibration values are held in non-volatile memory.



Test equipment used to calibrate and generate calibration tables

- HP436A micro wattmeter calibrated and traceable to NIST
- HP wattmeter sensor with calibration traceable to NIST
- Bird 30 dB 2 KW calibrated attenuator traceable to NIST

OPTIONS

- Software – PowerMaster Lite is supplied with the unit. The PRO version is available at additional cost. Both versions of software have an extensive help menu and directions for use on the CD and in the application itself.
- Additional couplers – VHF and UHF couplers
- Firmware updates are announced on the web site, and our user’s group. They allow you to update the FLASH memory and add functions to your meter via the internet - Use the **Firmware Updater** program supplied on the CD ROM or on our web site to update the flash memory in the meter.
- Coupler Scanner is a hardware option that will scan up to 8 couplers.

IN CASE OF TROUBLE

The PowerMaster is well designed and should give you many years of trouble-free service. Most of the problems you will encounter usually occur during installation and startup. If the items below aren't sufficient to help you solve your problem, please give us a call.

Unit will not come on

Check power connections. Is the unit on? DC Polarity OK?

High VSWR displayed; no forward power displayed

Be sure that the SOURCE input to the Directional Coupler goes to your transmitter (or amplifier).

Be sure your interconnection cable is fully seated in both the display and coupler.

VSWR doesn't change when adjusting a tuner

Be sure that you have installed the Directional Coupler **AHEAD OF** the tuner. If your rig has an internal tuner, you should turn it off to make the most accurate measurements.

SPECIFICATIONS - *Specifications subject to change without notice. (Applies to 3 kW model, similar specs for 10KW)*

Frequency Range	1.5 – 30MHz, 50-54 Mhz
Line Impedance	50 ohms nominal, <1.05 V.S.W.R. insertion
Insertion Loss	.05 dB or less
Line Connections	SO-239 female (Type-N, and 7/16 DIN optional)
Power Ranges	1 to 3,005 watts (3KW HF) 1 to 9,999 watts (10 KW HF) - Limited by VSWR to the limits of the connector
VSWR Range	1.00 to 99.00
Accuracy	< ±3% as measured against NIST traceable calibrated instruments (see accuracy section on how to achieve better accuracy)
Resolution	10 Bit A/D – 4 overlapping channels of auto ranging = 12 Bit effective resolution
Peak Power Capture Time	< 10 milliseconds
VSWR Alarm Relay Actuation time	< 45 milliseconds
Bar Graph Response	> 30Hz
VSWR Alarm	Off, 1.5, 2.0, 2.5, 3.0 – relay programmable to open or close on trip
Low Power Monitor Alarm	Off, 5, 50, 100, 250, 500, 1,000, 2,000 watts - NC and NO relay contacts are available
High Power Monitor Alarm	Off, 175, 225, 700, 1,100, 1,600, 2,600, 3,000
Alarm Relay Contacts	.5 Ampere 50 volts AC/DC
Control	Manual front panel (stand alone) or via RS232 – application software
Power Required	12 - 15V DC at 600 ma
Temperature of Operation	-35C to +25C
Regulatory Testing and Certification	Exceeds FCC Class B (tested) and CE - both emissive and conductive (tested) as well as EMP 4 KV and 8 KV on cables
Dimensions	Display 8 ¼" X 3 ½" Face, 4 ¼" Deep Coupler 2 ¾" X 2 ¾" X 6 ½"
Shipping Weight	5 lbs (2.3 kg)

LIMITED WARRANTY

The PowerMaster is warranted by Array Solutions to be free of defects for two years from the date of purchase. **THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS.** In no event will Array Solutions be liable for consequential damages.

If you must return the unit to the factory, you must obtain authorization from the factory. Be sure to provide a copy of your original purchase receipt to validate your warranty. We will repair the PowerMaster during the warranty period at no charge. We will not honor the warranty if in our opinion the product has been damaged due to misuse or subjected to adverse environmental conditions. We might elect not to honor the warranty on units modified by you.

After the warranty has expired, you may return the unit to the factory for repair (after receiving authorization to do so). We will examine the unit for a fee of \$25 and give you a quote on the repair costs before any work will be done.

Any information you can provide regarding the problem you are having would be very helpful. Please be sure to give us a daytime telephone number in case our service technicians have any questions for you.

Please call for shipping instructions if you are returning the PowerMaster to us. Ship the unit (make sure it is insured) to:

Array Solutions
350 Gloria Rd.
Sunnyvale, TX 75182

ATTN: Service
Phone 972 203 2008

Some states might allow you additional rights under this warranty.

Thank you very much for purchasing this product. Please give us your feedback.

The Array Solutions RF PowerMaster Team