

Review – The MeterBuilder MB-1 Programmable RF Power/SWR Meter  
Phil Salas – AD5X

Introduction

At Dayton 2011 FullWave LLC introduced a new programmable RF power meter kit, the MB-1. This is a very sophisticated power meter/SWR kit with many features and capabilities in an attractive package that looks great in your station.



Meterbuilder MB-1 displaying average power, peak power, SWR & coupler selected.



Rear view of the MB-1. Many interface options!

MB-1 Overview

The MB-1 is a thinking ham's Power/SWR meter. It provides extremely accurate RF power and SWR measurements as well as many other radio-related parameters – many which can be displayed simultaneously. You can also provide transmitter and amplifier SWR protection, and you can add RF and non-RF sensors and extend up to four analog meters to other operating positions if desired. The MB-1 is larger than other meters (9-1/4"W x 5-7/8"H x 10"D), but that is because of all the display and interface functionalities available in the unit. A summary of the major features is given below:

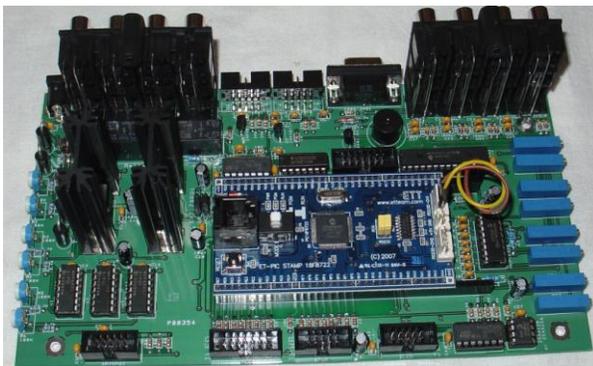
- Interface with up to four remote couplers. Patent Pending Generic Meter capability interfaces to most RF and analog sensors or transducers for a variety of measurements.
- Pre-loaded Calibration Table for the included MB-HF1 coupler
- Full Scale power ranges from 1 watt to 30,000 watts.
- Hi-visibility LED display, LCD display and a Cross-needle Analog Meter provide real-time responses capable of tracking SSB and CW signals.
- 15 Bit effective low range resolution.
- Multiple parameters can be simultaneously displayed: Tune RF Power, Peak RF Power, Average RF Power, Forward-Reflected Power, Delivered Forward Power, Reflected Power, SWR, RF Current, Coupler Selected, Coupler Calibration Band, Analog Meter full scale value, Bar Graph full scale value.
- Optional Expansion Kit permits adding external Cross-needle meters (2), high visibility 7-Segment LED Displays (2), and/or a high visibility LED Bar Graph module.
- Auto-Max Bar Graph – Full scale value is automatically set to the maximum encountered signal in 1 watt steps. Eliminates the need to choose from a compromise set of fixed values.

- Single button backup and restore capability for six custom meter settings plus the factory default setting. Each backup set can give the meter an entirely different personality.
- Interrupt Driven Menus permit making meter configuration changes on the fly using the four menu buttons without disrupting normal meter operation.
- An RS232 interface is available for software updates. However, all features are controllable directly from the front panel so a computer is not required for normal operation.

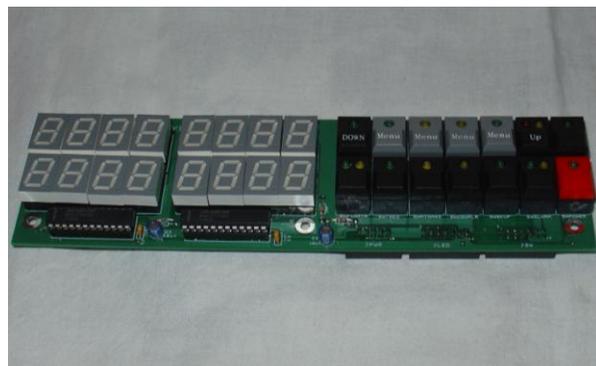
### Building and calibrating the MB-1

The MB-1 is only available in kit form. You must build the Main and Display printed circuit board assemblies, solder a LCD daughter board to the LCD display, and wire up the analog meter wiring harness. The SMD PIC processor controller board, which plugs into the Main printed circuit board, is supplied fully built and tested.

The assembly and user manuals are only available on-line. I found it easiest to download the assembly manual to my laptop and keep the laptop adjacent to my work area. There are a lot of parts that must be soldered to the main and display printed circuit boards – and frankly when I first opened up the kit I wondered what I’d got myself into! But it turned out to be surprisingly easy – albeit time consuming. I would put the kit complexity and assembly as something a ham with moderate soldering experience could easily put together. And there is really nothing critical that needs to be done. The assembly instructions are not step-by-step check-off instructions like you’ve seen with Elecraft or Heathkit. Instead, the instructions will say “mount all resistors”, “mount all capacitors”, etc on the two pc board assemblies. However, this is not difficult as all parts are labeled and all component locations and values are legibly printed on the pc boards. I estimate that the complete assembly took me about 8-hours over a two-day period.



Completed Main Board with PIC daughter board plugged in.



Completed Display Board

Once the MB-1 assembly is complete, you must calibrate it. The MB-1 comes with the MB-HF1 160-6 Meter pre-calibrated coupler with its wide-range performance data already pre-loaded into the MB-1 firmware. This pre-loaded data covers 80-meters, 10-meters, and 6-meters and is taken at numerous power levels so as to provide excellent linearity from 10 milliwatts to 2000 watts from 1.6-30 MHz (10 milliwatts to 1000 watts on 6-meters). However, you must set the side coupler trim pots so that everything reads correctly. This is easily done with just your transceiver and a digital voltmeter – i.e. no precision external wattmeter is required! The MB-HF1 coupler comes labeled with actual measured detected voltages versus RF power levels.

Therefore, adjust your transceiver output level so the MB-1 detected output corresponds to that shown on the coupler. Since the actual RF power corresponds to the calibrated detector output, adjust the MB-1 trim pots so the MB-1 correctly reads this RF power.



Completed MB-1 ready for calibration



MB-HF1 Pre-calibrated 160-6M coupler

Since I have a NIST-traceable Minicircuits PWR-6GHS+ power sensor and calibrated attenuators (see the PWR-6GHS+ review on my website at [www.ad5x.com](http://www.ad5x.com)) I adjusted the MB1 potentiometers so the MB1 and MiniCircuits test set-up measured the same. I found that the MB1-HF coupler detected voltage output was very consistent over the full 160-6 meter frequency range. Therefore I just used the 80 meter reference preloaded data and adjusted the pots while driving the coupler with a 20 meter signal. The resulting data is shown below.

<u>Band</u>	<u>MB1</u>	<u>PWR-6GHS+</u>
160M	103	101
20M	98.2	99.0
10M	92.0	92.5
6M	93.8	93.7

As you can see, the power readings are VERY accurate across the full range (worst case is just 2% variation on 160 meters). So while the MB-1 provides you the capability to change reference data based on the band, this is not required with the provided MB-HF1 coupler across the full 160-6 meter frequency range. However, the band reference change capability is useful when using other vendor's couplers, such as VHF and UHF couplers available from Array Solutions.

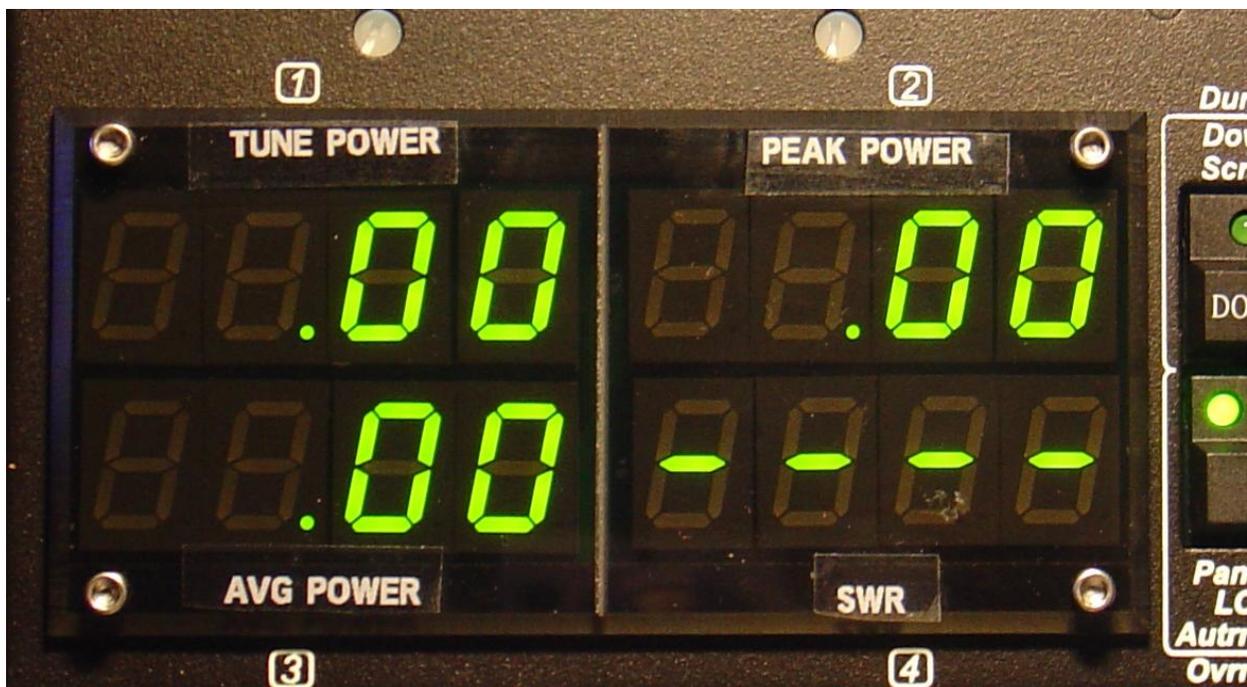
### Using the MB-1

The MB-1 provides numerous radio-related parameters simultaneously using the LED displays, the LCD display and the analog cross-needle meter where the display parameters are easily chosen. And that is just the beginning. The MB-1 includes the capability for additional couplers or sensors, each of which can be calibrated for not only RF power and SWR, but also temperature and voltage or any other sensor parameter you might want to monitor. I.e., you can

display your DC operating voltage and current, or even AC voltages and current with the appropriate sensors attached to the MB-1 (a DC monitor can be set-up with nothing more than an external voltage divider). Information on setting up virtually any external sensor is well detailed in the MB-1 User Manual.

The MB-1 also provides two sets of SPDT contacts, accessible through RCA connectors on the rear panel, that can be used for high-SWR amplifier disabling or other controls you might think of. In my case, I pass my transceiver-amplifier amp-enable control through one set of contacts, and I connect an Array Solutions ALC-1 ALC control unit to the other set of contacts ([www.arrayolutions.com/Products/alc\\_alarm.htm](http://www.arrayolutions.com/Products/alc_alarm.htm)). The ALC-1 is a nifty little device that feeds a negative ALC voltage to your transceiver to back down power when it is enabled by the MB-1. So when a high SWR condition occurs (I set a 2:1 SWR trip-point as I have a solid-state amplifier), the MB-1 opens the amp-enable line and the ALC-1 simultaneously backs down my transceiver power.

Finally, after using the MB-1 for awhile I decided on Tune Power, Peak Power, Average Power and SWR for the large LED display. To make it easier to remember, I labeled the LED display using an inexpensive Casio labeler and 9mm white-on-clear labeling tape as shown below.



Display labeled with Casio Labeler and 9mm white-on-clear labeling tape

#### A few interesting features of the MB-1

**SWR Stabilizer:** The MB-1 software monitors its digital filter results to determine when an accurate and stable SWR calculation has been acquired. This provides accurate and constant SWR measurements even when operating SSB. It also prevents an otherwise inaccurate SWR value from falsely triggering the SWR alarm, or from registering an invalid SWR minimum or maximum value when the Min/Max function is being used to monitor SWR. Additionally, an “SWR Changing” Indicator monitors the quality of the current SWR value being displayed. An

unstable SWR may be the result of a true time varying SWR of the load (as when adjusting an antenna tuner, or hot switching antennas). The green LED on the DISPLAY/SETUP switch illuminates when the software determines that the SWR is changing and a stable SWR value has not yet been acquired. This takes a fraction of a second in CW mode, or a few syllables in SSB. Until the new SWR value is determined, the "best current" value of the SWR will be displayed, providing a reasonable measurement for most real world operating conditions.

Average Power display: Many high-end digital meters do a good job of reading peak power. However, reading average power is usually not provided. An important parameter for average power measurements is the period of time over which the signal is averaged. To be meaningful, the period should be at least as long as a few syllables for SSB, or as long as a few dits and dahs for CW. To measure average power, the MB-1 accumulates and processes all samples in a 0.3-to-8 second sliding window (user selectable), to arrive at an average power measurement. The MB-1 measures average power, instantaneous power and peak power, and can display all three measurements simultaneously.

### Conclusion

The MB-1 is an extremely flexible Power/SWR meter. Maybe a better name for it would be a Station Monitoring System. Yes, you have to build it. But once completed you have a unit that looks great in your station and provides extremely accurate radio-related measurements of all types, most of which can be displayed simultaneously. Additionally, you can add additional RF and non-RF sensors, LED and bargraph displays, and can extend external analog meters to other operating positions. There is so much that the MB-1 can do that it is impossible to cover it all in this short review. I refer you to the 230 page MB-1 user manual at [www.meterbuilder.com](http://www.meterbuilder.com) for much more information.